Determinants of Smallholders' Decisions to Leave Land Fallow: The Case of Kosovo

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Abstract
The objective of this article is to investigate why farmers in Kosovo leave land fallow when the total land of their farms is small and households, almost fully dependent on farming for their livelihoods, are large. In order to elicit some of the barriers to land utilization, the article uses a comprehensive survey carried out during the agricultural year 2005/2006 to explore agricultural households' perceptions of production, market conditions, and general security six years after the end of the military conflict in the former Yugoslavia. Several agro-environmental, household and farm characteristics are employed to empirically approximate the significance of different factors for leaving land fallow. Three different econometric models are used to address the characteristics of the dependent variable distribution by accounting for endogeneity. The main determinants of the share of land left fallow are found to be related to the economic and institutional structure: low profitability of farming; difficulty in accessing production factors and variable inputs; as well as uncertainty regarding property rights in land.
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Introduction

Understanding the factors behind the decision to leave land fallow has always been of great interest to policy makers, in particular in countries with a high dependency on agriculture as a source of income for the rural population. While most of the previous studies have concentrated on developing countries, only a few papers have dealt with this issue in the countries in transition from a centrally planned to a market system. In the context of transition and the restoration of private property rights in land, some land plots have been left unutilized. This is also the case for the Western Balkans, a region that has not only been affected by the privatization of the land of socially-owned enterprises, but also by ethnic conflicts. The focus on the decision to leave land fallow is therefore particularly interesting in the case of the Western Balkans owing to the exacerbation of typical problems of development by three simultaneous processes: first, the economic and social effects of the military conflict at the end of 1990s; second, the rapid transfer to private ownership of the land of the formerly socially-owned agricultural enterprises by the Kosovo Privatization Agency; and third, the political objective set by the Kosovo government to join the European Union (EU), requiring EU alignment and the creation of institutions able to deliver EU policies.

This article investigates the determinants behind farmers' decisions to leave land fallow in the Western Balkans, taking Kosovo as the case study area. The underlying question is why Kosovo farmers leave land fallow when the total agricultural land of their farms is small and farm households, who almost fully depend on farming, are large. Is land left fallow due to the post-conflict insecurity; for the sake of soil fertility improvement; or are Kosovo farmers' production decisions constrained by underdeveloped markets and market institutions?

Kosovo is a small, landlocked country with a total area of 1.1 million hectares (ha), of which 53% is agricultural land. In 1998/99 there was a military conflict with Serbia, as a result of which Kosovo was placed under United Nations (UN) administration. Kosovo has a high population density, and consequently a small amount of agricultural land area per inhabitant (0.24 ha), and little arable area per household (Riinvest 2005). Following the privatization of the socially-owned enterprises in the 2000s, 86% of the agricultural land is privately owned and operated by family farms; the remainder is under the ownership of producer cooperatives (1%) or is in the socially-owned enterprises (13%) leftover from the Yugoslav system (UNMIK 2003).

Agriculture accounts for 25% of the gross domestic product (GDP) and between 25% and 35% of the total employment (World Bank and SOK 2007). This shows the crucial role played by agriculture in the region compared to both the EU-27 average (1.2% of GDP and 5.9% of employment in 2006) and to the most agricultural EU new member state, Romania, where in 2006 agriculture accounted for 7.2 % of GDP and 30.6% of employment (European Commission 2007). Nearly 60% of the population of Kosovo lives in rural areas. Despite its largely rural typology, the country is strongly dependent on imports of agricultural commodities and processed food. Lingard (2003) argues that one of the main reasons for this situation is that agriculture is stagnating as most of the farms produce for self-consumption. Latruffe, Davidova and Desjeux (2008) indicate that the average share of agricultural output sold is only 13.5%, whilst the share of output used for household consumption is 38.1% (the remainder is used on-farm and a small portion is wasted). They argue that the main barriers to market integration are the imperfections in the land and labor markets. These are underdeveloped, with much uncertainty in property rights; high transaction costs incurred during exchanges; and a lack of a skilled labor force during crucial seasons. From the point of view of the physical infrastructure, commercializing farm output is difficult and costly due to underdeveloped roads. There are, however, several highways that connect Kosovo to the bordering countries: highway north, which connects northern Kosovo with Serbia; highway east, which connects eastern Kosovo with Serbia; highway south-southeast, which connects Kosovo with the Former Yugoslav Republic of Macedonia (FYROM), and highway south which connects the country with Albania. Whilst Kosovo has very good economic relations with Albania and relatively good ones with the FYROM, the relations with Serbia are tense as a consequence of the recent conflict. Therefore, the location of a farm household close to a particular border implies a certain set of opportunities for cross-border co-operation and perceptions of security. These will depend on which border the household is near to.

In order to deduce some of the barriers to land utilization in Kosovo, the article is based on a comprehensive agricultural households survey carried out by the Statistical Office of Kosovo (SOK) at the end of 2005. This recorded land utilization and output data, and agricultural households' perceptions of barriers to land use. The article employs several agro-environmental, household and farm characteristics in order to empirically approximate the significance of different factors for leaving land fallow. The determinants of leaving land fallow are investigated using three different econometric modeling procedures that each addresses a specificity of the data distribution. The classic Tobit model is first applied using the share of land left fallow as the dependent variable. Then a fractional response regression is applied, followed by a zero-inflated binomial regression. All models are estimated accounting for possible endogeneity.

The article contributes to the existing studies of farmers' decisions to leave land fallow in several aspects. First, our models accurately reflect the distribution of the dependent variable. Instead of using binary models to explain why some farmers leave land fallow and others do not, here quantitative models are used to explain the determinants of the proportion of land left fallow. This enables deeper insights into the constraints faced by rural households in Kosovo to be obtained. Second, from an empirical point of view, this issue has never been investigated for the Balkans using such a rich and comprehensive data set. This allows light to be shed on the consequences of both ethnic conflicts and the transition to a market economy on land use. Finally, in addition to exogenous determinants, farmers' own perceptions of constraints to land utilization are used in the econometric models.

Our analysis shows that the impediments to land utilization are not particularly site- or output- specific. The analytical results reveal that the way in which the State-owned land was rented out to private individuals acted as a major determinant in the decision to leave land fallow. Lack of liquidity and costly access to farm inputs have also prevented farmers from fully utilizing agricultural land.

The article is structured as follows. The next section provides a brief review of previous studies in order to identify variables which might be important in the decisions to leave land fallow. The third section describes the household survey data used. The fourth section is devoted to modeling and analysis, whilst section five presents and discusses the results. The last section concludes.

Potential determinants of the decisions to leave land fallow

With different aims and different methodologies, several studies in various fields – agronomy, geography, environment, economics – have investigated the land use decisions of farmers, including the decision to leave land fallow. With some simplification, factors influencing such decisions can be classified in five groups: agronomic (agro-environmental); economic; non-pecuniary; institutional; and policy. It should be noted that there are overlaps between these groups.

Agronomic factors

To leave some land uncultivated for a certain period of time may be part of a strategy to improve soil fertility. Leaving land uncultivated for one or more seasons helps soil recovery and can result in higher crop yields (e.g. Grisley and Mwesigwa 1994; Mertz et al. 2008). Besides such a fertility strategy, leaving some land unused, or even abandoned, may be a consequence of poor agro-environmental conditions in specific areas, which may discourage farmers from using certain plots. For example, Chomitz and Thomas (2003) report that land abandonment is common in high rainfall areas in Amazonia, while Mmopelwa (1998) explains that insufficient rainfall is one reason for fallowing land in Botswana. Several studies (e.g. Bamwerinde et al. 2006; Coxhead and Demeke 2004; Wicky 1994) have shown a positive relationship between low soil fertility and the decision to leave land fallow.

Economic factors

Farmers' objective of profit maximization explains why plots for which marginal production costs outweigh marginal revenue are left fallow. This may be the case for plots situated in remote locations, and to which access is too difficult or costly (Bamwerinde et al. 2006; Gellrich and Zimmermann 2007; Bakker and van Doorn 2009). Leaving plots uncultivated may be a result of the high costs that would be incurred to improve soil fertility. Farmers may also choose to leave some land idle when it is highly fragmented, as farming a small parcel of land may not be profitable. Fragmentation is, for example, put forward by Kopeva, Noev and Evtimov (2002) as one reason explaining the large area of unutilized land in Bulgaria during the period of market reforms, while Baudry and Thenail (2004) observe that in France smaller fields are more often left fallow than larger ones. Some studies also report that costly access to inputs or liquidity constraints may prevent farmers from using their land (e.g. Scatena et al. 1996; Ravnborg and Rubiano 2001; Coxhead and Demeke 2004; Sauer and Balint 2008).

Farmers also trade-off between farm and non-farm jobs, potentially resulting in areas left uncultivated. Gellrich and Zimmermann (2007) observe that land abandonment is higher in Swiss mountainous regions characterized by a lower share of full-time farmers. Wicky (1994) reports that, at the beginning of the transition to a market economy, one of the main reasons for leaving land fallow in Poland was the availability of non-farm jobs. The relationship between the availability of non-farm jobs and land abandonment is particularly strong when labor markets are characterized by high transaction costs in the hiring of farm labor. Migration of rural inhabitants to urban areas or abroad may be another factor leading to land being left idle, as observed in Albania during the transition (Müller and Sikor 2006). The case of the migration of adult children outside the household is similar if it forces their aged parents to retire land from production (Scatena et al. 1996).

Non-pecuniary factors

Human factors, such as farmer's age and education may explain why some plots are left uncultivated (see, for example, Scatena et al. 1996).

The fact that part-time farmers, or farmers who migrate out of rural areas or abroad, keep their land unused instead of transferring it to another user may be explained by non-economic factors. For example, land may be viewed as an asset with a personal or family value. This reason may drive aged landowners with children in the cities to keep their land unused in order to bequeath it to their heir(s) or to transfer it once their successor is ready.

Attachment to land may explain the widespread case of land left unused by absentee landowners in the former centrally planned economies in Central and Eastern Europe. During the transition to a market economy, land that was previously collectivized was restituted to the former owners or their heirs, who often lived in cities and were engaged in non-farm jobs. Some of these absentee landowners wanted to keep the land out of attachment to a family asset and, owing to an under-developed land market, they left it out of production (Nikodemus et al. 2005; Hedin 2005).

Institutional factors

Institutional factors, such as unclear property rights and missing or under-developed land market institutions, are common in the former centrally planned economies owing to the incomplete land reforms (Swinnen and Vranken 2005; Latruffe and Le Mouël 2006). Uncertainty regarding land ownership and the high transaction costs incurred during land exchanges may prevent agricultural land from being used (e.g. Kopeva, Mishev and Jackson 1994; Vranken, Noev and Swinnen 2004).

Policy factors

Agricultural policy may result in land being left fallow (e.g. Schoney 1995). It may be compulsory for farmers to leave some arable land uncultivated, such as in the case of the set-aside requirements in the context of the EU Common Agricultural Policy (CAP) in force until the 2003 CAP Reform. In the United States, government programs targeted at land retirement (e.g. land conservation programs) provide financial incentives to farmers to divert land from production (e.g. Khanna et al. 2003: Kirwan, Lubowski and Roberts 2005). By contrast, Goodwin and Mishra (2006) argue that AMTA (Agricultural Markets Transition Act) payments imply less land being left fallow.

Therefore, there is an array of factors that may induce the decision to leave agricultural land uncultivated. Some of these factors are specific to countries in transition to a market economy.

Data set

The present study is based on data from the Agricultural Household Survey carried out by SOK in November and December 2005[1]. The definition of household applied is a union of persons who live together and pool their incomes. The survey covers land farmed by agricultural households living and farming in rural areas[2]. The survey does not include land areas belonging to rural households who are not farming or land belonging to agricultural households living in urban areas or abroad unless the land is rented out to farming households. Additionally, the land area belonging to the producer co-operatives leftover from the Yugoslav system and the non-privatized areas of the socially-owned enterprises are not included in the survey.

The survey is based on a two-level stratified sample (SOK 2006). The initial sample size comprised 4,446 agricultural households. The first level of stratification is by region in order to obtain region estimates and ensure full geographic coverage. The second level of stratification is by farm size in order to ensure representation of different agricultural households according to their cultivated area. Once a village was chosen to be included in the survey, the agricultural households in the village were stratified into three size categories (using land under cultivation as the value for stratification): 0-1.5 ha, 1.51-3.0 ha, and greater than 3 ha. After stratification, households were randomly selected for interview. To reduce the heterogeneity of the sample frame, and thus improve the estimates, all farms that were beyond the normal distribution in terms of farm size or numbers of livestock were identified and enumerated fully. These are referred to as ‘large and specialized farms’, and treated separately (SOK 2006). They are not included in the present analysis[3].

Land use was recorded plot by plot, including kitchen gardens. The survey also recorded plots left fallow for the production season 2005/2006. The respondents (usually the heads of household) were asked to identify reasons for leaving plots fallow from a pre-determined list which also included post-conflict variables, with an open option at the end allowing respondents to specify a reason not included in the list.

The largest share of respondents (30.6%) emphasized the low economic profitability of farming as one of the reasons behind their decision. The lack of equipment and lack of manpower were the second and third main reasons. This indicates that farmers identified economic factors as their main constraints to the utilization of agricultural land. Farmers gave a lower priority to reasons related to the recent military conflict, e.g. land mines, or to soil fertility, e.g. crop rotation. The responses concerning farmers' perceptions of barriers to the cultivation of all their land area are summarized in figure 1.

(figure 1 about here)

After cleaning the survey data, 2,010 usable records are analyzed in the present article. Out of these 2,010 households, 322 have some land left fallow. On average, the sample households have 6% of their land area left uncultivated. The descriptive statistics of the variables used in the analysis are presented in table 1.

(table 1 about here)

Measured in land area, farms are small with a mean size of 1.41 ha. The minimum size of zero concerning the arable land is due to the fact that some households have other types of utilized land, for example orchards, vineyards, or pastures, classified in the survey in different categories. In addition, farm land area is fragmented into more than six plots on average. Households mainly employ their own resources (land and labor), and their integration into the factor and product markets is low (e.g. just below 9% of output is sold in the market). The value of farm equipment, estimated according to the farmers' judgments of the selling value, has a large standard deviation, with a rather low mean value (1,568 Euro).

Kosovo has traditional large households where several generations live under the same roof, and share income and meals. Table 1 indicates that the mean size of the households included in the analysis is 9.4 members. Usually, the decision-maker is the head of the household.

On average, the head of households are above 50 years of age, and their level of education is between completed secondary school and some years in high school. The dependency ratio (c/w), representing the ratio between consumers (c: household members outside working age) and workers (w: number of household members in working age) is rather low reflecting the age structure in Kosovo[4]. According to SOK the population of Kosovo is one of the youngest in Europe – 61% of the population is within the age bracket 15-64 years and only 6% are 65 and over.

Modeling the fallow decision

As previously mentioned, determinants of the decision to leave land fallow are investigated using three different econometric modeling procedures that might possibly fit the shape of the data distribution. The classic Tobit model is used first, and then results are compared with those of two other models addressing potential problems not accounted for in the Tobit model: a fractional response regression, and a zero-inflated binomial regression. All models are estimated accounting for endogeneity.

Dependent and explanatory variables

Instead of using binary models to explain why some farmers leave land fallow and others do not, or more generally to explain land use decisions, as in most of the existing literature using statistical models (e.g. Ravnborg and Rubiano 2001; Bamwerinde et al. 2006), here quantitative models are used to explain the determinants of the proportion of land left fallow. In all three models used, the dependent variable of interest is the 'fallow share', reflecting the share of the total amount of land per farm left fallow in the reference production year 2005/2006. Some farmers in the data set utilized all their land and consequently reported a zero fallow share. To avoid a likely selectivity bias with respect to estimation, the full sample is used and not just the sub-sample of farms that had some of their land fallow. Hence, by definition, the dependent variable is censored at 0 (i.e. total amount of land is utilized) and 1 (i.e. total amount of land is left fallow).

Based on the above literature review about the determinants of decisions to leave land idle, several explanatory variables are included in the three models: agronomic, human, economic and institutional.

The reasons stated by the respondents for leaving land fallow are included as well. Policy factors are not considered here as Kosovo does not have policy interventions that can alter farmers' incentives. Agronomic conditions are proxied by the plot altitude and the crop rotation reason as stated by respondents. Human factors refer to the age of the head of the household and the maximum level of education attained within the household. Proxies for economic and institutional factors include household size; c/w ratio; total arable land; total land owned; share of output sold; three dummies indicating farm specialization (dummies equal to 1 if more than half of the farm revenue is from grains, fruit and vegetables, or forage); share of irrigated land; value of equipment per ha; share of hired labor; number of plots; size of the smallest plot; mean size of fallow plots (the last three variables are fragmentation proxies); household income per ha; share of land rented from private owners; share of land rented from the State. The economic factors also include the stated reasons of low economic profitability, lack of equipment, lack of manpower, and lack of inputs. In order to control for peer-group effects, the average shares of fallow land in the village and in the municipality where the household is located are also included. Lack of security, mines, and other reasons stated by the respondents are included as additional, Kosovo-specific, determinant categories.

Some of the reasons stated by the respondents for leaving land fallow might be endogenously determined by: the prevailing soil and environmental conditions; the location of the farm and the plots; the farms' surrounding infrastructure; the socioeconomic characteristics of the farmer and the household; and the social interaction with peer-group members and opinion leaders. To deal with the problem of endogeneity, exogenous determinants must be used as instruments. Methods using instrumental variables are widely used in economics (for an overview see Stock and Yogo 2002). However, these methods bring additional challenges of bias and precision (see e.g. Murray 2006; Baum, Schaffer and Stillman 2007). In general, it may be difficult to find variables that can serve as valid instruments since most variables that have an effect on included endogenous variables also have a direct effect on the dependent variable (Baum, Schaffer and Stillman 2007). In the presence of weak instruments (i.e. satisfactorily exogenous instruments which are only weakly correlated with included endogenous regressors) the loss of statistical precision will be significant (Bound, Jaeger and Baker, 1995). Hence, to ensure efficient and unbiased estimates, it is necessary to test for the assumed endogeneity of the stated reasons as well as for the correct identification of the estimators and unbiasedness of the instruments used. Table 2 summarizes such potential exogenous determinants for the different stated factors.

(table 2 about here)

A Durbin-Wu-Hausmann (DWH) testing formula is used to test for the assumed endogeneity of all stated reasons (Wu 1973; Hausman 1978; Baum, Schaffer and Stillman 2007). The null hypothesis states that an ordinary least squares (OLS) estimator of the same equation would yield consistent estimates, and a rejection of the null indicates that endogenous regressors' effects on the estimates are meaningful, and instrumental variables techniques are required to estimate the models efficiently. As outlined above, weak instruments can produce biased instrumental variables regression estimators and hypothesis tests. Hence, a familiar Wald test formula is used to test for the quality of the instruments and a Hansen-Sargan test is applied to test for possible overidentification, where the joint null hypothesis states that the instruments are valid instruments, that is to say uncorrelated with the error term, and that the excluded (i.e. exogenous) instruments are correctly excluded from the estimated equation. In addition, we apply the Anderson canonical correlations likelihood-ratio test of whether the equation is identified, that is to say that the excluded instruments are relevant. The null hypothesis of the test states that the estimation equation is underidentified. This statistic provides a measure of instrument relevance and a rejection of the null indicates that the model is correctly identified. However, as Hall, Rudebusch and Wilcox (1996) and Staiger and Stock (1997) conclude, a result of rejection of the null hypothesis should be treated with caution as weak instrument problems may still be present. Shea (1997) suggests a 'partial R-squared' measure of instrument relevance that takes intercorrelations among instruments into account. More recently Stock and Yogo (2001 and 2002) show that many researchers are misled when reaching a conclusion about the validity of their instruments by only referring to the critical value of the F-statistic of one or more testing formulas. They suggest using the F-statistic form of the Cragg-Donald test for the presence of weak instruments (i.e. that the equation is only weakly identified) and provide critical values based on the first-stage F-statistic given by this test.

The various test results are summarized in tables 3 and 4. Given these detailed results, it can be concluded that, for the dataset used, endogeneity of the stated reasons is present and, if not accounted for, it would lead to model misspecification and biased results (see table 3). Further, it can be concluded that the instruments proposed to address this endogeneity seem not to be significantly correlated and lead to a correct identification of the estimators (see table 4). Finally, the Stock-Yogo critical values suggest that nearly all endogenous variables are identified with a minor bias significantly less than 10% of the corresponding OLS inconsistency (only for the variable 'other reasons' is this about 10% of the OLS inconsistency).

(tables 3 and 4 about here)

As mentioned, three econometric models are used to estimate the determinants of 'fallow share' which is distributed between 0 and 1, with a large share of observations carrying a value of zero. All models account for the specificity of the data distribution. By using these different econometric models, we are able to produce estimates with a higher statistical significance leading to conclusions with greater robustness.

Model 1 - Instrumental variable Tobit regression

As explained above, the dependent variable's distribution is censored on the left at 0 and on the right at 1, and thus a Tobit model seems appropriate. To take into account endogeneity problems, an instrumental variable version of the Tobit regression is used (Maddala 1991; Greene 2003). Formally,

$$y_{1i}^* = y_{2i}\beta + x_{1i}\gamma + u_i \qquad (1)$$

$$y_{2i} = x_{1i}\prod_1 + x_{2i}\prod_2 + v_i \qquad (2)$$

where $i = 1,\ldots,N$ with N the number of farms, y_{2i} is a $(1\times p)$ vector of endogenous variables, x_{1i} is a $(1\times k_1)$ vector of exogenous variables, x_{2i} is a $(1\times k_2)$ vector of additional instruments, and the equation for y_{2i} is written in reduced form. By assumption, the error terms u_i and v_i are randomly normally distributed with zero means. β and γ are vectors of structural parameters, and Π_1 and Π_2 are matrices of reduced-form parameters. The latent variable y_{1i}^* is not observed, instead, we observe

$$\begin{cases} y_{1i}^* = 0 \text{ if } y_{1i} \le 0 \\ y_{1i}^* = y_{1i} \text{ if } 0 < y_{1i} < 1 \\ y_{1i}^* = 1 \text{ if } y_{1i} \ge 1 \end{cases} \qquad (3)$$

More specifically, y_{1i} is the share of land left fallow, the vector y_{2i} refers to the stated reasons for leaving land fallow that are endogenous (see table 2), the vector x_{1i} refers to other explanatory variables, and the vector x_{2i} refers to instruments (see table 2). The model is estimated by using an efficient full maximum likelihood technique based on the likelihood function outlined in Greene (2003).

Model 2 - Fractional response regression

The dependent variable being the share of land left fallow, this regression is based on proportional data censored by 0 and 1. As Maddala (1991) observes, such data are not observationally censored but rather are defined only over the interval [0,1]. Hence, the censored normal regression model (Model 1 above) may be conceptually flawed for proportional data and might result in misleading and biased estimates. Rather, the conditional mean must be a nonlinear function of the regressors, and heteroscedasticity could be a problem (Lin and Schmidt 1984; Cook, Kieschnik and McCullogh 2008). Here the procedure follows Papke and Wooldridge (1996, 2008) who propose the assumption of a functional form for the dependent variable that imposes the desired constraints on the conditional mean of the dependent variable, namely $E(y|x) = G(x\theta)$ where $G(.)$ is a known nonlinear function satisfying $0 < G(.) < 1$. The most obvious choice for $G(.)$ is the logistic function which must be estimated using nonlinear techniques. The fractional response model to be estimated would follow the one outlined by equation (1) and be

$$E\left[y_{1i}^{*} \middle| (y_{2i}\beta + x_{1i}\gamma) \right] = G\left[(y_{2i}\beta + x_{1i}\gamma)\theta \right] \quad (4)$$

A quasi-maximum likelihood (QML) estimation procedure is used, based on the Bernouilli log-likelihood function given by $LL_i(\theta) = y_{1i}^{*} \log\left[G\left(\left(y_{2i}\beta + x_{1i}\gamma \right)\theta \right) \right] + \left(1 - y_{1i}^{*} \right) \log\left[1 - G\left(\left(y_{2i}\beta + x_{1i}\gamma \right)\theta \right) \right]$.

The corresponding QML estimator of θ is defined by (Wagner 2001) $\hat{\theta} \equiv \arg\max_{\theta} \sum_{i=1}^{N} LL_i(\theta)$.

To account for the possible endogeneity of some of the stated reasons for the fallow decision, in the first stage a multivariate probit is estimated (Maddala 1991; Greene 2003). Hence, an *M*-equation multivariate probit model is considered; the model for the m-*th* stated reason being

$$\begin{cases} y_{im}^{*} = \beta_m^{'} x_{i1m} + \gamma_m^{'} x_{i2m} + \varepsilon_{im} \\ y_{im} = 1 \text{ if } 0 < y_{im}^{*} < 1 \\ y_{im} = 0 \text{ otherwise} \end{cases} \quad (5)$$

where $m = 1,\ldots,M$ with *M* the number of stated reasons, ε_{im} are error terms distributed as multivariate normal, each with a mean of zero and a variance-covariance matrix *V*, where *V* has values of 1 on the leading diagonal and correlations $\rho_{jk} = \rho_{kj}$ as off-diagonal elements. The $(1 \times M)$ vector of dependent variables y_{im} refers to the stated reasons for leaving land fallow. x_{1i} refers to the exogenous variables and x_{2i} are the same instruments as in Model 1. The model is estimated by using a simulated maximum likelihood technique based on the likelihood function outlined in Cappellari and Jenkins (2003). The estimates obtained by the multivariate probit model are then used as the vector y_{2i} in equation (4)[5].

Model 3 - Zero-inflated binomial regression

The distribution of the dependent variable 'fallow share' is skewed to the left and contains a large proportion of zeros (i.e. excess zeros), namely 84%. To account for this, a zero-inflated negative binomial regression model (ZINB) is applied, which is a modified Poisson regression model and accounts for unobserved individual heterogeneity as a reason for such overdispersion in the data set. Lambert (1992) introduced the following zero-inflated Poisson (ZIP) model

$$\begin{cases} y_i \sim 0 & \text{with probability } q_i \\ y_i \sim Poisson(\lambda_i) & \text{with probability } 1 - q_i \quad (y_i = 0,1,2,3,\ldots) \end{cases} \quad (6)$$

where $q_i = \dfrac{e^{z_i\gamma}}{1 + e^{z_i y}}$.

The individual farms are divided into farms which use all land for production (i.e. fallow share = 0) with probability q_i, and farms that potentially set a proportion of their land aside with probability $1 - q_i$. The unobservable probability q_i is generated as a logistic function of the observable covariates to ensure non-negativity. Following Greene (2003), the observed variable y_i – here 'fallow share' – is generated as the product of the two latent variables z_i and y_i^*, such that $y_i = z_i y_i^*$ where z_i is a binary variable with values 0 or 1 and y_i has a negative binomial (NB) distribution. Then,

$$\begin{cases} \Pr\left(y_i = 0\right) = \Pr\left(z_i = 0\right) + \Pr\left(z_i = 1, y_i^* = 0\right) = q_i + (1-q_i)\, f(0) \\ \Pr(y_i = k) = (1-q_i)\, f(k) \qquad k = 1, 2, \ldots \end{cases} \tag{7}$$

where $f(.)$ is the NB probability distribution for y_i^*. The binary process z_i is modeled as a logit specification using a constant-only specification for the inflation part, and the likelihood function is given in Greene (2003). The Vuong non-nested test can be used to choose the best model specification, based on the test statistic $V = \frac{\sqrt{N\tilde{m}}}{s_m}$ where $m_i = \ln\left[\hat{P}_1(y_i|x_i) / \hat{P}_2(y_i|x_i)\right]$, $\hat{P}_1(y_i|x_i)$ and $\hat{P}_2(y_i|x_i)$ are the predicted probabilities of the two competing models with $\tilde{m}$ as the mean of the squares of the point-wise log-likelihood ratios, s_m as the standard deviation of *m*, and *V* follows an asymptotically normal distribution. To account for endogeneity of the stated factors for the fallow decision, in a first stage a multivariate probit is again estimated following the specification outlined above by equations (5).

Results and discussion

The results of the three estimated models are presented in tables 5, 6, and 7 respectively. According to the different diagnosis tests performed, all estimated model specifications show a statistical significance at a satisfactory level and no severe signs of misspecification. Several explanatory variables show a consistent sign and significance across all three models. They provide several insights into the determinants of the decision to leave some land fallow.

(tables 5, 6 and 7 about here)

First, the results suggest that agronomic and agro-environmental factors may explain the decision to leave land fallow in Kosovo, particularly in the hilly and mountainous areas. Plot altitude and the stated reason of crop rotation both have a positive relationship with the share of fallow land in all three models. This is consistent with results from other countries in different agro-environmental areas (Chomitz and Thomas 2003; Bamwerinde et al. 2006) and suggests a rational strategy to increase soil fertility and a response to the high costs of farming in poor agro-environmental conditions. However, it may also reveal liquidity constraints affecting Kosovo's farmers' ability to invest in the improvement of soil nutrients.

Second, economic factors seem to play a crucial role in the decision-making on land use. The first factor is land fragmentation proxied by the number of plots. It affects positively the share of land left fallow. On the other hand, the effect of the size of arable land and of the size of the plots left fallow is negative. These results are in agreement with previous studies from the region (e.g. Kopeva, Noev and Evtimov 2002) indicating that land fragmentation is one of the determinants behind the decision to leave land uncultivated.

Concerning the reasons stated by farmers, seven of them have a highly significant impact (at the 1% level) on the decision to leave land fallow in all three models. The reasons of the lack of inputs and of equipment have generally the largest (positive) coefficients. Thus, it seems that costly access to inputs or liquidity constraints, as found in Romania (Sauer and Balint 2008) or in developing countries (Scatena et al. 1996; Ravnborg and Rubiano 2001; Coxhead and Demeke 2004), are major determinants of land left fallow by Kosovo smallholders.

Third, as highlighted for Bulgaria (Kopeva, Mishev and Jackson 1994; Vranken, Noev and Swinnen 2004), institutional factors regarding the land market prevent Kosovo farmers from using all their land. Indeed, while the share of land rented from private owners has a negative sign and is statistically significant in two of the models (no significant impact in the zero inflated model), the share of land rented from the State significantly increases the proportion of land left fallow in all three models. When bureaucrats are involved in the exchange process renting out socially-owned land to households, it appears that there is not a strong incentive built into the contract to use the land for farm production. This is in contrast to the case of the share of land rented from private owners. This finding may also reflect the high uncertainty attached to the State-owned land, which may be privatized and thus withdrawn from tenants at any time.

Finally, human factors (age and education) are not always significant determinants behind the decision to leave land idle in Kosovo, but village peer-group effects increase the proportion of land left fallow.

As for Kosovo-specific (or, more generally, Western Balkans-specific) determinants of general lack of security and danger of landmines, although they always appear to significantly increase the share of fallow land, their significance level and coefficient value are not as high as the other reasons stated by respondents.

Conclusions

This article is one of the first to investigate smallholders' fallowing decisions in a transition and post-conflict region; most of the previous studies concentrated on developing countries. The comprehensive data set has allowed the classic determinants in the literature (agronomic and economic) to be accounted for, as well as factors specific to the region, such as institutional and security aspects. Regarding the methodology, the use of three econometric models was motivated by the belief that no single model was able to consider all specificities of the data distribution. In this article, the factors behind the decisions to leave land fallow in Kosovo were investigated by three econometric models run on household-level data. In contrast to previous studies investigating only the binary decision either to leave or not to leave land fallow, in this study the share of land left fallow was used as the dependent variable. Three models were used in turn with each addressing a specificity of the data distribution. All three models, a Tobit model, a fractional response regression, and a zero-inflated binomial regression (all accounting for endogeneity), produced statistical significance at a satisfactory level and did not show severe signs of misspecification. The results were robust and several significant determinants of the share of land left fallow were identified with a consistent sign by all three models.

Although Kosovo farmers may leave some land fallow due to poor agronomic conditions (high altitude, crop rotation), or the feeling of a general lack of security, the main factors for leaving land idle, indicated by the respondents and confirmed by the estimates, are economic problems such as costly access to inputs or the lack of funds to purchase equipment. Increasing incentives to farmers by improving market institutions up- and downstream is one measure that could help improve profitability and decrease the impediments to land use. The problem of lack of liquidity to cover production costs is recurrent in transition countries, in particular due to the limited access to credit. Credit constraints faced by farmers during transition have been highlighted by several authors (e.g. Davis and Gaburici 1999; Swinnen and Gow 1999) and their negative influence on farmers' production or investment decisions demonstrated (e.g. Petrick 2004; Latruffe 2005; Falkowski, Ciaian and Kancs 2009). The situation is known to the policy-makers in Kosovo. In their mid-term policy agenda (2004-2008) they define subsistence and semi-subsistence farms as a target group for support and suggest the introduction of tax concessions on inputs and equipment (UNMIK 2003). Such measures may be more appropriate than the commodity specific subsidies that have long been used in industrialized countries, or imposing penalties for land abandonment. For example, during the period of the typical productivist approach to farming in Western Europe, there were various (sometimes quite drastic) legal penalties for under-use of agricultural land – ranging from monetary penalties and the compulsory leasing of under-utilized land to a third party, to the very controversial compulsory purchase of the land based on the principle of social obligation of ownership (Carty 1977). However, this might be counter-productive in

Kosovo where financing needed for full land utilization is still lacking and where the government-introduced process of the privatization of the land of socially-owned enterprises is still underway.

Another important conclusion from this article is that it is necessary to improve the process of renting out the socially-owned land to private individuals. The discretionary power of bureaucrats in this process may have led to farm land being rented out to households who do not intend to use it for farming. Also, the uncertainty of property rights lowers the incentives to fully utilize farm land. Market forces could provide incentives to redistribute land to more efficient users. However, improving the land institutions necessary for a more active land market will be a long and painful process, bearing in mind the ethnic divisions and the memories of the recent conflict.

Future research in this area should focus on the collection and analysis of panel data sets with respect to socioeconomic household data as well as the conducting of large-scale surveys with respect to farmers' production behavior and expectations. Based on the availability of such longitudinal data, one could investigate changes in farmers' expectations over time and the reasons for such changes in order to decide on effective policy measures for an increase in the efficiency of input and output markets as well as improvements in the food chain. Among the pre-eminent research questions to be investigated should be the question of how far and what kind of governmental transfer payments would be necessary to stimulate the use of fallow land for agricultural production or environmental services.

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[1] The survey benefited from the technical assistance of the project 'Agricultural Statistics and Policy Analysis Unit for Kosovo' (ASPAUK) funded by the EU European Agency for Reconstruction (EAR).

[2] At least one member of the agricultural household should be working in farming.

[3] The threshold for large and specialized farms was 50 ha cereals, 10 ha potatoes, 4 ha vineyards, 3 ha field vegetables etc.

[4] This low average ratio also reflects frequent zeros as several households have zero consumers. However, even when ignoring the zero cases the average c/w ratio is still low (0.81).

[5] Because of limited space the estimates for the multivariate probit are not reported here.

References

Bakker, M., and A. van Doorn. 2009. "Farmer-Specific Relationships between Land Use Change and Landscape Factors: Introducing Agents in Empirical Land Use Modeling." *Land Use Policy* 26(3): 809-17.

Bamwerinde, W., B. Bashaasha, W. Ssembajjwe, and F. Place. 2006. "Determinants of Land Use in the Densely Populated Kigezi Highlands of Southwestern Uganda." Paper Presented at the International Association of Agricultural Economists (IAAE) Conference, Gold Coast, Australia. 12-18 August.

Baudry, J., and C. Thenail. 2004. "Interaction between Farming Systems, Riparian Zones, and Landscape Patterns: A Case Study in Western France." *Landscape and Urban Planning* 67(1-4): 121-29.

Baum, C., M. Schaffer, and S. Stillman. 2007. "IVENDOG: Stata Module to Calculate Durbin-Wu-Hausman Endogeneity Test after ivreg". Statistical Software Components S494401, Boston College Department of Economics, revised 29 May 2007.

Bound, J., D.A. Jaeger, and R. Baker. 1995. "Problems with Instrumental Variables Estimation When the Correlation between the Instruments and the Endogenous Explanatory Variables is Weak." *Journal of the American Statistical Association* 90: 443-50.

Cappellari, L., and S.P. Jenkins. 2003. "Multivariate Probit Regression Using Simulated Maximum Likelihood." *The Stata Journal* 3: 278-291.

Carty, J.A. 1977. *Methods of Compulsory Purchase of Land in Europe*. Department of Public International Law, University of Glasgow, Scotland, UK. http://www.caledonia.org.uk/land/carty.htm

Chomitz, K., and T. Thomas. 2003. "Determinants of Land Use in Amazonia: A Fine-Scale Spatial Analysis." *American Journal of Agricultural Economics* 85(4): 1016-28.

Cook, D.O., R. Kieschnik, and B.D. McCullogh. 2008. "Regression Analysis of Proportions in Finance with Self-Selection." *Journal of Empirical Finance* 15(5): 860-7.

Coxhead, I., and B. Demeke. 2004. "Panel Data Evidence on Upland Agricultural Land Use in the Philippines: Can Economic Policy Reform Reduce Environmental Damages?" *American Journal of Agricultural Economic* 86(5): 1354-60.

Davis, J.R., and A. Gaburici. 1999. "Rural Finance and Private Farming in Romania." *Europe-Asia Studies* 51(5): 843-69.

European Commission. 2007. *Agriculture in the European Union – Statistical and Economic Information*. Luxemburg.

Falkowski, J., P. Ciaian, and d'A. Kancs. 2009. "Access to Credit, Factor Allocation and Farm Productivity: Evidence from the CEE Transition Economies." Faculty of Economic Sciences, University of Warsaw, Poland. Working Paper No. 12/2009(22).

Gellrich, M., and N. Zimmermann. 2007. "Investigating the Regional-Scale Pattern of Agricultural Land Abandonment in the Swiss Mountains: A Spatial Statistical Modelling Approach." *Landscape and Urban Planning* 79(1): 65-76.

Goodwin, B., and A. Mishra. 2006. "Are 'Decoupled' Farm Program Payments Really Decoupled? An Empirical Evaluation." *American Journal of Agricultural Economics* 88(1): 73-89.

Greene, W. 2003. *Econometric Analysis*. Prentice-Hall, Inc. 5th Edition. New Jersey.

Grisley, W., and D. Mwesigwa. 1994. "Socio-Economic Determinants of Seasonal Cropland Fallowing Decisions: Smallholders in South-Western Uganda." *Journal of Environmental Management* 42(1): 81-9.

Hall, A.R., G.D. Rudebusch, and D.W. Wilcox. 1996. "Judging Instrument Relevance in Instrumental Variables Estimation." *International Economic Review* 37: 283-9.

Hausman, J.A. 1978. "Specification Tests in Econometrics." *Econometrica* 46: 1251-71.

Hedin, S. 2005. "Land Restitution in the Former Swedish Settlements Areas in Estonia – Consequences for Land Ownership, Land Use and Landscape." *Landscape and Urban Planning* 70(1-2): 35-44.

Khanna, M., W. Yang, R. Farnsworth, and H. Öna. 2003. "Cost-Effective Targeting of Land Retirement to Improve Water Quality with Endogenous Sediment Deposition Coefficients." *American Journal of Agricultural Economics* 85(3): 538-53.

Kirwan, B., R. Lubowski, and M. Roberts. 2005. "How Cost-Effective are Land Retirement Auctions? Estimating the Difference between Payments and Willingness to Accept in the Conservation Reserve Program." *American Journal of Agricultural Economics* 87(5): 1239-47.

Kopeva, D., P. Mishev, and M. Jackson. 1994. "Formation of Land Institutions and their Impact on Agricultural Activity." *Journal of Rural Studies* 10(4): 377-85.

Kopeva, D., N. Noev, and V. Evtimov. 2002. "Land Fragmentation and Land Consolidation in the Agricultural Sector – A Case Study from Bulgaria." Paper Presented at the international symposium on 'Land Fragmentation and Land Conservation in CEEC: A Gate towards Sustainable Rural Development in the New Millenium', Munich, Germany. 25-28 February.

Lambert, D. 1992. "Zero-Inflated Poisson Regression with an Application to Defects in Manufacturing." *Technometrics* 34: 1-14.

Latruffe, L. 2005. "Credit Market Imperfections and Farm Investment in Poland." *Post-Communist Economies* 17(3): 349-62.

Latruffe, L., and C. Le Mouël. 2006. "Description of Agricultural Land Market Functioning in Partner Countries." FP6 project IDEMA (Impact of Decoupling and Modulation in the Enlarged Union), Deliverable 9. http://www.sli.lu.se/IDEMA/idemahome.asp

Latruffe, L., S. Davidova, and Y. Desjeux. 2008. "Perpetuation of Subsistence Farming in Western Balkans: The Role of Factor Market Imperfections." Paper Presented at the 82nd Annual Conference of the UK Agricultural Economics Society (AES), Royal Agricultural College, Cirencester, UK. 31 March-2 April.

Lin, T.-F., and P. Schmidt. 1984. "A Test of the Tobit Specification against an Alternative Suggested by Cragg." *Review of Economics and Statistics* 66: 174-7.

Lingard, J. 2003. "A Comparative Advantage Analysis of Kosovan Agriculture." *Post-Communist Economies* 15(3): 417-33.

Maddala, G.S. 1991. *Limited Dependent and Qualitative Variables in Econometrics*. Cambridge, UK.

Mertz, O., R. Wadley, U. Nielsen, T. Bruun, C. Colfer, A. de Neergaard, M. Jepsen, T. Martinussen, Q. Zhao, G. Noweg, and J. Magid. 2008. "A Fresh Look at Shifting Cultivation: Fallow Length an Uncertain Indicator of Productivity." *Agricultural Systems* 96(1-3): 75-84.

Mmopelwa, G. 1998. "Factors Contributing to Land Fallowing in a Permanent Cultivation System: The Case of Semi-Arid Botswana." *Journal of Arid Environments* 40(2): 211-6.

Müller, D., and T. Sikor. 2006. "Effects of Post-Socialist Reforms on Land Cover and Land Use in South-Eastern Albania." *Applied Geography* 26(3-4): 175-91.

Murray, M.P. 2006. "The Bad, the Weak, and the Ugly: Avoiding the Pitfalls of Instrumental Variables Estimation." Bates College, Discussion Paper.

Nikodemus, O., S. Bell, I. Grine, and I. Liepins. 2005. "The Impact of Economic, Social and Political Factors on the Landscape Structure of the Vidzeme Uplands in Latvia." *Landscape and Urban Planning* 70(1-2): 57-67.

Papke, L.E., and J.M. Wooldridge. 1996. "Econometric Methods for Fractional Response Variables with an Application to 401(k) Plan Participation Rates." *Journal of Applied Econometrics* 11: 619-32.

Papke, L.E., and J.M. Wooldridge. 2008. "Panel Data Methods for Fractional Response Variables with an Application to Test Pass Rates." *Journal of Econometrics* 145(1-2): 121-33.

Petrick, M. 2004. "A Microeconometric Analysis of Credit Rationing in the Polish Farm Sector." *European Review of Agricultural Economics* 31(1): 77-101.

Ravnborg, H., and J. Rubiano. 2001. "Farmers' Decision Making on Land Use – The Importance of Soil Conditions in the Case of Rio Cabuyal Watershed, Colombia." *Danish Journal of Geography* 101: 115-30.

Riinvest. 2005. "Kosovo Socio-Economic Profile and Development Challenges." Mimeo.

Sauer, J., and B. Balint. 2008. "Distorted Prices and Producer Efficiency – The Case of Romania." *Journal of Productivity Analysis* 29(2): 131-42.

Scatena, F., R. Walker, A. Kingo Oyama Homma, A. Jose de Conto, C. Armando Palheta Ferreira, R. de Amorim Carvalho, A. Carlos Paula Neves da Rocha, A. Itayguara Moreira dos Santos, and P. Mourao de Oliveira. 1996. "Cropping and Fallowing Sequences of Small Farms in the "terra firme" Landscape of the Brazilian Amazon: A Case Study from Santarem, Para." *Ecological Economics* 18(1): 29-40.

Schoney, R. 1995. "The Impact of Price Stabilizing Policies on the Risk Efficient Crop/Fallow Decisions of Wheat Farmers in the Brown Soil Zone of Saskatchewan." *Canadian Journal of Agricultural Economics* 43(2): 259-70.

Shea, J. 1997. "Instrument Relevance in Multivariate Linear Models: A Simple Measure." *The Review of Economics and Statistics* 79: 348-52.

Staiger, D., and J.H. Stock. 1997. "Instrumental Variables Regression with Weak Instruments." *Econometrica* 65: 557-86.

Stock, J.H., and M. Yogo. 2001. "Testing for Weak Instruments in Linear IV Regression." Harvard University.

Stock, J.H., and M. Yogo. 2002. "Testing for Weak Instruments in Linear IV Regression." National Bureau of Economic Research. NBER Technical Working Papers 0284.

SOK. 2006. *Agricultural Household Survey*. Statistical Office of Kosovo, Pristina, Kosovo.

Swinnen, J., and H. Gow. 1999. "Agricultural Credit Problems and Policies during the Transition to a Market Economy in Central and Eastern Europe." *Food Policy* 24(1): 21-47.

Swinnen, J., and L. Vranken. 2005. "The Development of Rural Land Markets in Transition Countries." Report for the Subregional Office for Central and Eastern Europe of the FAO in Budapest, Hungary, and the Faculty of Management in the Slovak University of Agriculture in Nitra, Slovakia.

UNMIK. 2003. The Kosovo Green Book: A Strategy for Sustainable Agricultural and Rural Development in Kosovo. United Nations Interim Administration Mission in Kosovo, Pristina, Kosovo. May.

Vranken, L., N. Noev, and J. Swinnen. 2004. "Fragmentation, Abandonment and Co-Ownership: Transition Problems of the Bulgarian Land Market." *Quarterly Journal of International Agriculture* 43(4): 391-408.

Wagner, J. 2001. "A Note on the Firm Size-Export Relationship." *Small Business Economics* 17: 229-337.

Wicky, L. 1994. "State and Reasons for Fallow Land in Individual Farmsteads (an Example of Three Parishes)." *Roczniki Nauk Rolniczych* Serie G 86(3): 101-9.

World Bank and SOK. 2007. *Kosovo Poverty Assessment*. Report No. 39737-XK, Poverty Reduction and Economic Management Unit, Europe and Central Asia Region, World Bank, October.
Wu, D.-M. 1973. “Alternative Tests of Independence between Stochastic Regressors and Disturbances.” *Econometrica* 41: 750-73.

Table 1. Descriptive Statistics of the Household Sample Used (2,010 Observations)

Variable	Mean	Std. Dev	Min	Max
Share of land left fallow (%)	6	16	0	100
Total arable area (ha)	1.41	2.41	0	62.0
Share of area owned (%)	93.8	18.7	0	100
Land owned (ha)	2.94	2.77	0	28.17
Share of irrigated land (%)	24	36	0	100
Area under grains (ha)	0.94	2.10	0	61.1
Area under fruit and vegetables (ha)	0.18	0.55	0	11.2
Area under forage (ha)	1.01	1.29	0	13.8
Number of plots	6.5	3.2	1	28
Mean size of plots left fallow (ha)	0.43	0.47	0.0007	7.75
Size of the smallest plot (ha)	0.05	0.06	0.0004	1
Share of land rented from private owners (%)	3.0	1.4	0	10.6
Share of land rented from the State (%)	3.2	5.9	0	100
Share of land left fallow in the farm’s village (%)	7	7.8	0	51.5
Share of land left fallow in the farm’s municipality (%)	7	0.5	0.1	29.5
Share of hired labour (%)	1	7	0	100
Value of farm equipment per ha (Euro)	1,568	6,267	0	265,000
Share of output sold (%)	8.9	20.7	0	100
Farm income per ha (Euro)	355	994	0	27,486
Altitude of the farm (m)	596	205	360	1,500
Household head age (years)	53.9	14.5	21	99
Number of household members	9.4	5.5	1	71
Maximum education within the household *	5.7	1.7	1	9
Dependency c/w ratio	0.69	0.61	0	6

* Nine educational categories were defined in the questionnaire: 1 No education; 2 Some primary school; 3 Primary school completed; 4 Some secondary school; 5 Secondary school completed; 6 Some high school; 7 High school completed; 8 Some study towards university degree; 9 University degree completed.

Table 2. Exogenous Determinants for the Stated Reasons to Leave Land Fallow

Stated reason for the fallow share (endogenous variables)	*Exogenous determinants (i.e. instruments)*
Crop rotation	soil type and quality, environmental factors such as e.g. average precipitation at t-1
Mines	location of the farm/plot: e.g. region bordering Macedonia, region bordering Serbia, region bordering Albania, main municipality, location near major road axis
Lack of security	location of the farm/plot: e.g. region bordering Macedonia, region bordering Serbia, region bordering Albania, main municipality, location near major road axis
Low profitability	soil type and quality, environmental factors such as e.g. average precipitation at t-1, transaction costs for participation in input or output markets (proxy: distance to main road axis), expenditure on fertilizers and chemicals at t-1, expenditure on seeds at t-1, expenditure on machinery at t-1, expenditure on wages at t-1, other input expenditures at t-1
Lack of equipment	transaction costs for participation in input or output markets, expenditure on machinery at t-1, other input expenditures at t-1
Lack of manpower	transaction costs for participation in input or output markets, expenditure on wages at t-1
Lack of inputs	expenditure on fertilizers and chemicals at t-1, expenditure on seeds at t-1, expenditure on machinery at t-1, other input expenditures at t-1
Other reasons	peer-group effects (proxy: average fallow share in farm's village, average fallow share in farm's municipality), transaction costs for participation in input or output markets

Table 3. Results of Endogeneity Tests

Test	*Test Formula (degrees of freedom)*	*Test Statistic*	*P-Value*	*Conclusion*
Anderson Canonical Correlations	Chi-Square (8)	30.591	0.0001	H_0 rejected (i.e. model is identified, instruments are relevant)
Durbin-Wu-Hausman	Chi-Square (8)	17.878	0.022	H_0 rejected (i.e. endogenous regressors' effects are significant)
Hansen-Sargan	Chi-Square (8)	3.312	0.855	H_0 not rejected (i.e. instruments are valid, i.e. uncorrelated with the error term, exclusion of exogenous instruments is correct)
Wald	Chi-Square (8)	594.710	0.0001	H_0 rejected (i.e. instruments are exogenous)
Wu-Hausman	F (8,1971)	2.211	0.024	H_0 rejected (i.e. endogenous regressors' effects are significant)

Table 4. Results of Instruments Tests for Intercorrelations and Weak Identification

Variable (stated reason for fallow share)	*Shea Partial R-square*	*Cragg-Donald Statistic (Stock-Yogo critical values based)*		*Conclusion **
		F(15,1972)	P-Value	
Crop rotation	0.0072	29.33	0.0001	Shea R2: no significant intercorrelations among instruments; C-D test: H_0 rejected (i.e. estimator is identified, bias significantly less than 10% of the OLS inconsistency)
Lack of inputs	0.0102	28.30	0.0001	Shea R2: no significant intercorrelations among instruments; C-D test: H_0 rejected (i.e. estimator is identified, bias significantly less than 10% of the OLS inconsistency)
Lack of manpower	0.0019	27.93	0.0001	Shea R2: no significant intercorrelations among instruments; C-D test: H_0 rejected (i.e. estimator is identified, bias significantly less than 10% of the OLS inconsistency)
Lack of equipment	0.0051	25.85	0.0001	Shea R2: no significant intercorrelations among instruments; C-D test: H_0 rejected (i.e. estimator is identified, bias significantly less than 10% of the OLS inconsistency)
Lack of profitability	0.0153	52.91	0.0001	Shea R2: no significant intercorrelations among instruments; C-D test: H_0 rejected (i.e. estimator is identified, bias significantly less than 10% of the OLS inconsistency)
Mines	0.0093	26.07	0.0001	Shea R2: no significant intercorrelations among instruments; C-D test: H_0 rejected (i.e. estimator is identified, bias significantly less than 10% of the OLS inconsistency)
Lack of security	0.0094	42.73	0.0001	Shea R2: no significant intercorrelations among instruments; C-D test: H_0 rejected (i.e. estimator is identified, bias significantly less than 10% of the OLS inconsistency)
Other reasons	0.0086	20.71	0.0001	Shea R2: no significant intercorrelations among instruments; C-D test: H_0 rejected (i.e. estimator is identified, bias about 10% of the OLS inconsistency)

* Shea R2: Shea R-square. C-D test: Cragg-Donald test.

Table 5. Estimates for the Instrumental Variable Tobit Model (Model 1)

(*N* = 2,010)	coefficient [1]	t-value
Dependent variable: share of fallow land (between 0 and 1)		
Stated reasons for fallow decision - endogenously determined [2]		
crop rotation	0.545***	8.75
lack of security	0.586***	12.09
mines	0.311***	3.59
other reasons	0.609***	13.01
low profitability	0.669***	21.71
lack of equipment	0.759***	17.58
lack of manpower	0.614***	15.17
lack of inputs	0.729***	20.83
Exogenous explanatory variables		
plot altitude	8.38e-05*	1.76
maximum level of education within household	-0.001	-0.20
household head age	-5.53e-04	-0.84
c/w ratio	-0.009	-0.54
household size	-0.001	-0.14
total arable land	-0.036**	-2.01
dummy for main farm output – grain	-6.93e-06***	-2.49
dummy for main farm output – fruit and vegs	-1.45e-06***	-2.85
dummy for main farm output – forage	-1.13e-05***	-4.60
share of irrigated land	-0.137***	-4.89
value of farm equipment per ha	-3.87e-06	-0.81
share of hired labor	0.095	0.91
mean size of fallow plots	-0.149***	-10.15
number of plots	0.005*	-1.95
size of the smallest plot	-0.086	-0.55
farm income per ha	-0.041*	-1.87
share of output sold	-0.001	-0.78
total land owned	-0.008	-1.49
share of land rented from private owners	-0.029**	2.17
share of land rented from the State	0.069***	3.84
peer-group effects in the farm’s village	0.570***	5.22
peer-group effects in the farm’s municipality	0.102**	2.19
constant	-0.411**	-6.15
Model statistics		
Log likelihood	2161.91	
LR chi2(30)	1776.37	
Wald chi2(30) [prob>chi2]	1932.44*** [0.000]	
Alpha	-3.68*	
Lns	-1.26***	
Lnv	-2.61***	
S	0.28***	
V	0.07***	

[1] * - 10%-, ** - 5%-, *** - 1%-level of significance. [2] Exogenous instruments as summarized in table 2.

Table 6. Estimates for the Fractional Response Model (Model 2)

(*N* = 2,010)	OIM coefficient [1]	z-value
Dependent variable: share of fallow land (between 0 and 1)		
Stated reasons for fallow decision – endogenously determined [2]		
crop rotation *(estimate)*	3.324***	10.91
lack of security *(estimate)*	3.184***	13.14
mines *(estimate)*	0.892*	1.81
other reasons *(estimate)*	3.546***	13.35
low profitability *(estimate)*	3.857***	24.27
lack of equipment *(estimate)*	4.334***	22.05
lack of manpower *(estimate)*	3.565***	18.34
lack of inputs *(estimate)*	4.127***	24.01
Other exogenous explanatory variables		
plot altitude	0.001***	4.43
maximum level of education within household	-0.008	-0.30
household head age	-9.24e-04	-0.31
c/w ratio	-0.053	-0.72
household size	0.007	0.68
total arable land	-0.389***	-3.19
dummy for main farm output – grain	-5.39e-05*	-1.65
dummy for main farm output – fruit and vegs	-2.30e-05**	-2.37
dummy for main farm output – forage	-1.24e-04***	-5.81
share of irrigated land	-0.759***	-5.59
value of farm equipment per ha	-7.64e-06	-0.43
share of hired labor	0.205	0.42
mean size of fallow plots	-1.331***	-10.91
number of plots	0.028*	1.86
size of the smallest plot	-0.245	-0.30
farm income per ha	-5.12e-05**	-2.08
share of output sold	-7.38e-04	-0.29
total land owned	-0.398*	-2.01
share of land rented from private owners	-0.196*	-1.97
share of land rented from the State	0.605***	3.13
peer-group effects in farm's village	2.986***	5.53
peer-group effects in farm's municipality	0.957**	2.11
constant	-5.136***	-15.55
Model statistics		
Log likelihood	-145.609	
(1/df)deviance	0.038	
(1/df)pearson	0.116	
AIC	0.176	
BIC	-14976.02	
Variance function	V(u) = u*(1-u/1)	
Link function	g(u) = ln(u/(1-u))	

[1] * - 10%-, ** - 5%-, *** - 1%-level of significance. [2] Estimates obtained by the multivariate probit model. Exogenous instruments as summarized in table 2.

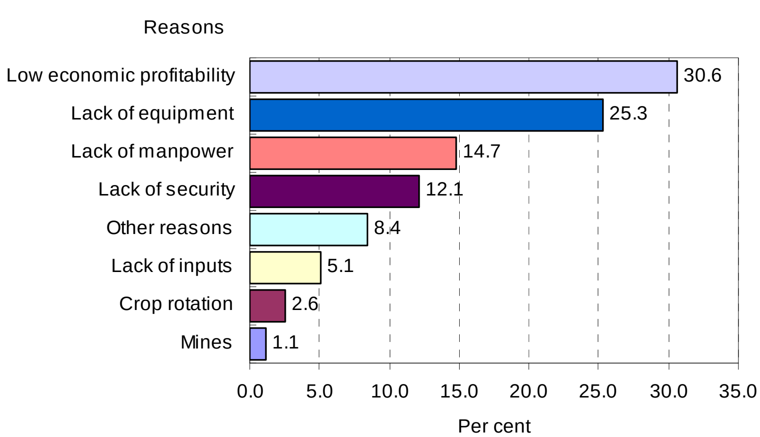
Table 7. Estimates for the Zero-Inflated Binomial Model (Model 3)

(N = 2,010)	robust coefficient[1]	z-value
Dependent variable: share of fallow land (between 0 and 1)		
I) Zero-inflated negative binomial model		
Stated reasons for fallow decision – endogenously determined [2]		
crop rotation *(estimate)*	2.034***	3.47
lack of security *(estimate)*	2.845***	11.97
mines *(estimate)*	1.404***	5.03
other reasons *(estimate)*	1.902***	5.00
low profitability *(estimate)*	2.476***	11.10
lack of equipment *(estimate)*	2.544***	10.33
lack of manpower *(estimate)*	2.244***	9.43
lack of inputs *(estimate)*	2.607***	9.87
Other exogenous explanatory variables		
plot altitude	8.41e-04***	3.39
maximum level of education within household	-0.173***	-4.91
household head age	-0.019***	-5.66
c/w ratio	-0.287**	-2.39
household size	-0.002	-0.12
total arable land	-0.334*	-1.73
dummy for main farm output – grain	-5.20e-05	-0.78
dummy for main farm output – fruit and vegs	-1.34e-06**	-0.14
dummy for main farm output – forage	-3.71e-05**	-2.02
share of irrigated land	-0.128	-0.85
value of farm equipment per ha	-1.58e-05	-0.68
share of hired labor	0.201	0.53
mean size of fallow plots	-0.507***	-5.21
number of plots	1.07***	4.51
size of the smallest plot	-1.775*	-1.77
farm income per ha	-1.45e-04*	-1.84
share of output sold	-1.75e-04	-0.07
total land owned	-0.135***	-2.91
share of land rented from private owners	-0.011	-0.08
share of land rented from the State	0.426***	3.04
peer-group effects in farm’s village	1.875***	2.43
peer-group effects in farm’s municipality	2.332	0.77
II) Inflation (logit) model		
Other exogenous explanatory variables		
plot altitude	2.962e-04	1.12
maximum level of education within household	-0.062*	-1.73
household head age	-0.002	-0.50
c/w ratio	-0.139*	-1.69
household size	-6.16e-04	-005

total arable land	-4.12e-05	-0.02
dummy for main farm output - grain	-1.23e-05*	-1.83
dummy for main farm output - fruits and vegs	-1.99e-06*	-1.82
dummy for main farm output - forage	-1.51e-05	-0.55
share of irrigated land	0.064	0.32
value of farm equipment per ha	-4.35e-06	-0.13
share of hired labor	0.208	0.34
mean size of fallow plots	-0.107**	-2.01
number of plots	0.025*	1.75
size of the smallest plot	-0.335	-0.29
farm income per ha	-4.87e-05*	-1.69
share of output sold	-8.42e-04	0.21
total land owned	-0.023*	-1.86
share of land rented from private owners	-0.047*	-1.84
share of land rented from the State	0.035*	1.93
peer-group effects in farm's village	0.764*	1.73
peer-group effects in farm's municipality	0.387	1.12
constant	-19.178***	-20.18
Model statistics		
Lnalpha	-18.426***	10.32
Alpha	0.995***	5.49
Log pseudolikelihood	-249.381	
Nonzero observations	322	
Zero observations	1,688	
Wald chi2(28) [prob>chi2]	2934.40 [0.000]	
LR-test (alpha=0) chibar2(1) [prob>chi2]	5.753*** [0.000]	
Vuong test of ZINB vs. NB	47.234*** [0.000] i.e. NB rejected in favor of ZINB	

[1] * - 10%-, ** - 5%-, *** - 1%-level of significance. [2] Estimates obtained by the multivariate probit model. Exogenous instruments as summarized in table 2.

Figure 1. Reasons for leaving land fallow: share of respondents



Source: based on data from the Agricultural Household Survey (SOK, 2006)