Does land fragmentation affect land productivity? Empirical evidence from Bulgaria

*Natalia BOLIARI**

* **Corresponding author**: Manhattan College, Department of Economics and Finance, Riverdale, 10471, New York, US
e-mail: natalia.boliari@manhattan.edu

***Abstract** – Land fragmentation is considered a major obstacle to the efficient use of land and other agricultural resources in Bulgaria. This study is concerned with formally testing the relationship between fragmentation of land plots and land productivity in the country. Multiple regression analysis and agricultural data obtained from the 2003 Bulgaria Multi-topic Household Survey is employed for the purpose. Results of the study suggest that the level of current fragmentation is relatively low and not likely to adversely affect land productivity. Other conditions being equal, therefore, land consolidation may not lead to any significant improvement in productivity in Bulgaria.*

***Keywords:** Bulgaria, Agriculture, Land fragmentation, Land productivity, Multi-topic Household Survey*

Est-ce que la fractionnement de la terre affecte la productivité de la terre ? Évidence empirique de la Bulgarie.

Résumé – Le fractionnement de la terre est considéré comme un obstacle majeur à l'utilisation efficiente de la terre et des autres ressources agricoles en Bulgarie. Cette étude s'intéresse à tester formellement la relation entre le fractionnement des parcelles de terre et la productivité de la terre dans le pays. À cette fin, une analyse à régression multiple est menée avec des données obtenues à partir de la *2003 Bulgaria Multi-topic Household Survey*. Les résultats de cette étude suggèrent que le niveau actuel du fractionnement est relativement bas, et il est peu probable qu'il affecte la productivité de la terre de manière négative. Par conséquent, lorsque les autres conditions sont égales par ailleurs, la consolidation de la terre peut ne pas engendrer d'amélioration significative de la productivité en Bulgarie.

Mots-clés : Bulgarie, agriculture, fractionnement de la terre, productivité de la terre, Questionnaire multi-sujet des ménages

JEL Classification: C36, Q15, Q18

1. Introduction

Issues related to land tenure institutions have figured prominently on the development agenda as a result of post-socialist countries' introduction of radical land reforms in the early nineties as well as the introduction of land reforms in various developing countries in Africa, Asia and Latin America. The 1990s land reform of post-socialist Bulgaria took the form of land restitution which required the massive transfer of land rights from state or collective units to private parties, often the former owners of the land or their heirs. In the wake of the reform, concerns over fragmentation of land plots, defined in this study as the situation where a single farm household operates more than one separate parcel of land, emerged as a major policy issue.[1] Viewed as a historical feature, the fragmentation of agricultural land holdings in Bulgaria is widely believed to be one of the major causes of poor farming practices, low levels of agricultural productivity, inefficient uses of land and other agricultural resources, and an obstacle to the development of efficient land markets.[2] In response to the perceived disadvantages of land fragmentation, the Bulgarian Ministry of Agriculture and Food Supply (MAFS) initiated a number of projects to assess farmers' willingness to consolidate their agricultural land and to develop policies for farm land consolidation (MAFS Annual Agricultural Report 2004: 22-27).

Appropriate and effective policy solutions to combat land fragmentation, however, require: 1. understanding the underlying causes for land fragmentation; 2. the accurate measuring of land fragmentation; and 3. assessing its impacts on productivity or other economic outcomes. Insofar as Bulgaria is concerned, these three distinct areas of research have received little to no attention despite an increasing recognition of their significance in the literature. In particular, none of the available studies on Bulgarian land fragmentation provides solid evidence documenting the negative effects of land fragmentation on agricultural productivity in the country. It seems that the initiatives for the development of consolidation policies in Bulgaria are based on the widely-accepted assumption that fragmentation inevitably causes agricultural inefficiencies.

The absence of such evidence is the motivation for this study; it is concerned precisely with the latter requirement which is the empirical

[1] From now on, the terms "fragmentation" or "land fragmentation" will refer, for short, to "fragmentation of land plots" as defined above.

[2] Almost all studies and documents referring to or discussing the problems in Bulgarian agriculture mention fragmentation as one of the major obstacles to the efficient use of land and other agricultural resources. Examples include the Annual Reports of the Ministry of Agriculture (MAFS 2004, 2005, 2007), the Bulgaria Rural Development Programme (2007-2013) of the European Union's European Agricultural Fund for Rural Development, Kabil (2004), Kasabov and Koritarova (2004), Kopeva (2001, 2002), Kopeva and Noev (2001), Noev *et al.* (2004), Rembold (2003), Risina and Mladenova (2002), Thomas (2006), Van Dijk (2003), Van Dijk and Kopeva (2006).

assessment of the impacts of land fragmentation on land productivity in Bulgaria. The goal here is to use multiple regression analysis to examine and analyze the relationship between fragmentation of land plots and land productivity.

The paper is organized as follows. Section 2 reviews some of the evidence in the general literature on the impacts of fragmentation on productivity and other economic indicators. Section 3 describes the methodology of the study which is based on an econometric model suggested by Blarel *et al.* (1992). Section 4 describes the data and variables of the model. Section 5 presents and discusses the results and Section 6 concludes.

2. Review of the evidence on the impact of fragmentation on economic outcomes

Empirical studies conducted in countries or regions within countries to formally test the impacts of fragmentation on various economic outcomes are relatively limited and provide rather mixed evidence. A summary of the scope of analysis, methodologies used, and findings of some of the studies are provided in Table 1.

With respect to measuring fragmentation, the Simmons Index of Simmons (1964), the Januszewski Index of Januszewski (1968) and the Simpson Index of Blarel *et al.* (1992) are among the most commonly used fragmentation indices in the literature.

None of these indices is superior to one another; they are essentially similar to each other and incorporate the same three parameters desirable in assessing the degree of fragmentation: 1. the farm size; 2. the number of plots; and 3. the size of plots.[3] As discussed in Section 4, the choice of index for this study is the Simmons Index.

With respect to methodologies used to estimate the impact of fragmentation on land productivity, multiple regression analysis, stochastic frontier and production function models are the most commonly used econometric models. Each of these methodologies has its own limitations and is preferred depending on data availability and focus of the study. The household survey data set used in this study allows for the use of multiple regression analysis, the particulars of which are discussed in Section 3.

[3] See Bentley (1987) for a detailed review of these indices. The Simmons index is defined as $SI = \frac{\Sigma A_i^2}{A^2}$ where A_i is the area of the i^{th} parcel and A is the total farm area. The index expresses the relationship between the number of parcels comprising a farm and the relative sizes of these parcels; also, the index is independent of total farm size. The Simpson Index of Blarel *et al.* (1992) is expressed as the inverse of the Simmons Index. Similarly, the Januszewski Index is expressed as $SI = \frac{\Sigma A_i^2}{A^2}$ where A_i is the area of the i^{th} parcel and A is the total farm area.

Table 1. **Review of studies on the impacts of fragmentation on various economic indicators**

Author(s)/Year	Country(s)	Scope of Analysis	Measurement of Fragmentation	Findings
Blarel *et al.* (1992)	Ghana, Rwanda	To test the relation between fragmentation and land productivity and risk reduction by using multiple regression analysis.	1. The Simpson Index 2. The number of parcels per farm	1. Agricultural land in both Ghana and Rwanda is highly fragmented. 2. The degree of fragmentation has no adverse effect on land productivity. 3. The distance between the household residence and its parcels is positively related to the costs generally attributed to fragmentation, such as travel time. However, this relationship is statistically insignificant. 4. Fragmentation increases the diversity of agro-climatic conditions available to the farmer, and this leads to more diversified crop patterns. This can be beneficial for risk reduction, reducing peaks and troughs in labour demand and enhancing household food security. 5. Fragmentation is not as inefficient as widely assumed, and it offers farmers a tool for managing risk, seasonal labour shortages, and food insecurity. 6. Other things being equal, consolidating land in these regions should not be considered as a plausible policy tool to increase land productivity.
Sundqvist and Andersson (2006)	Northern Vietnam	To test the relation between fragmentation and land productivity by using multiple regression analysis.	1. The Simpson Index 2. The number of parcels per farm	1. Land fragmentation has positive effects on land productivity. 2. The positive effects, however, were found to be related to the increase in the use of fertilizers and hours worked on the farm in relation to increase in the number of plots. 3. There is no significant correlation between labour productivity and land fragmentation.

Table 1. **Review of studies on the impacts of fragmentation on various economic indicators (*Continued*)**

				4. Machine use is insignificantly but yet positively related to fragmentation which suggests that fragmentation in Northern Vietnam may not be a barrier for the use of machinery. 5. It is suggested that consolidation programs had little or perhaps no impact on productivity in Northern Vietnam.
Hung *et al.* (2007)	Two Northern Vietnam provinces	To investigate the economics of land fragmentation by using theoretical comparative static analysis.	1. The Simpson Index 2. The number of parcels per farm	1. Small-sized farms are relatively more fragmented compared to larger-sized farms. 2. Fragmentation had negative impacts on crop productivity. 3. Fragmentation led to the increased use of family labour and to increased monetary expenses. 4. Consolidation, however, is not considered as an effective solution at present.
Jha *et al.* (2005)	Two contiguous villages in Southern India	1. To assess the impacts of land fragmentation on productivity. 2. To measure the degree of technical efficiency and its relation to the level of land fragmentation by employing stochastic production function methods.	The Januszewski Index	1. There is a positive relationship between farm size, average plot size and yield. 2. There is a negative relationship between number of plots cultivated and the yields for two dominant crop sequences, leading to the implication that fragmentation has adverse effects on crop productivity. 3. There might be some economies of scale related to the number of plots and there are significant economies of scale in relation to both farm size and plot size. 4. Hired labour seems to be more efficient than family labour leading to the suggestion that farmers can achieve the desired level of efficiency by hiring labour for different activities.

Table 1. **Review of studies on the impacts of fragmentation on various economic indicators (*Continued*)**

Author(s)/Year	Country(s)	Scope of Analysis	Measurement of Fragmentation	Findings
				5. Farm size has a positive impact on technical efficiency. 6. The effects of fragmentation on technical efficiency are mixed, both positive and negative with some of the positive effects being significantly large. This, according to the authors, "is an added evidence to suggest that farmers on an average want to possess their holdings in optimal number of plots." It is interesting that while the study strongly recommends the undertaking of consolidation policies, it warns that farmers may, nonetheless, prefer some level of fragmentation.
Wan and Cheng (2001)	Four provinces in China	To examine the effects of land fragmentation on five major crop outputs by using a production function model.	The number of plots per farm	1. The highest degree of fragmentation is observed on farms producing rice, the lowest on farms producing maize. 2. Land fragmentation has adverse effects on outputs in every crop production. 3. China's grain output could rise by 71.4 million metric tons simply by eliminating land fragmentation. The gains in output are most apparent in tuber and wheat production

Table 1. **Review of studies on the impacts of fragmentation on various economic indicators (*Continued*)**

				4. Eliminating fragmentation does not mean each family being allocated one piece of land. Rather, it only requires that individual crops be planted on the same block at the family farm level. 5. The implementation of consolidation is strongly recommended.
Lerman (2005)	Four districts in Georgia	To explore the impact of farm fragmentation on productivity.	1. The Simpson Index 2. The number of parcels per farm 3. The average distance to the parcels in each farm	1. Farm productivity decreases with the increase in the number of parcels but the relationship is not statistically significant. 2. Fragmentation has a significant negative effect on productivity. 3. Productivity depends not only on fragmentation but on additional variables, such as farm size The study does not indicate if fragmentation remains when farm size is being controlled for. 4. Total factor productivity decreases as fragmentation and crop specialization increases. 5. Technical efficiency decreases as fragmentation increases.

Furthermore, the study seeks to explain average behaviour with respect to fragmentation as opposed to boundary, frontier or optimal behaviour which would be the focus of stochastic production function models.

As can be seen from the table, findings indicate that fragmentation can have both negative and positive impacts on land productivity, crop output, use of labour, technical efficiency, economies of scale, and other economic variables. Therefore, while it would be inaccurate to make generalizations, it is necessary that positive aspects of fragmentation are weighed against negative ones on a country basis. The findings on the impacts of fragmentation differ not only across countries but also when an identical region is of concern (e.g. Northern Vietnam). It is, therefore, necessary to consider each country, region, or province as a unique case before making the decision or following the theoretical assumption that fragmentation is necessarily a problem requiring a public policy solution such as consolidation. The reported mixed evidence also calls for the conduct of further empirical studies; further research seems to be necessary in terms of developing better methodologies and in terms of assessing if, how, where, to what extent, and under which circumstances fragmentation affects productivity.

Furthermore, two of the studies—Blarel *et al.* (1992) and Jha *et al.* (2005) provide an interesting observation which will be addressed in this study as well. While the two studies provide contrasting evidence with regards to the overall effects of fragmentation, both observe farmers' preference for holding fragmented land. Jha *et al.* (2005) does not dwell in this observation but Blarel *et al.* (1995) suggest that this is so because fragmentation provides a convenient tool to farmers for managing risk, seasonal labour shortages, and food insecurity. Taken together, or individually, achieving such goals may, indeed, outweigh the goal of achieving greater productivity, at least from the farmer's perspective.

3. Methodology

The model developed by this study to formally test the impact of fragmentation on land productivity in Bulgaria is based on the econometric model formulated by Blarel *et al.* (1992). Since the survey data used in this study uses decares as the measurement unit for the size of plots, this unit will be used as a measure of the area or size of plots and farms. For reference, 1 decare is approximately equal to 1,000 sq. m. or 0.25 acres.

The key equation of the four-equation model specifies that the dependent variable yield—the total value of harvested crops *per* decare—is related to a set of household-level variables including 1. the level of farm fragmentation (F); 2. the parcel-level use of direct inputs (L_i); and 3. the current stock of land improvements on each parcel (I_i). Other independent variables of the model are specified as 1. the set of parcel-specific characteristics X_{1i}; 2. the set of household specific characteristics X_2; and 3. district specific characteristics X_3. The subscript *i* indicates the parcel number and the absence of a subscript indicates a variable measured at the household level which will be common to each parcel owned by the household.

Following Blarel *et al.* (1992), the four simultaneous equations of the structural model are as follows:

$$Y_i = f\,(F, L_i, I_i, X_{1i}, X_2, X_3) \qquad i = 1, 2, \ldots, n \qquad (1)$$

$$L_i = f\,(I_i, F, X_{1i}, X_2, X_3) \qquad i = 1, 2, \ldots n \qquad (2)$$

$$I_i = f\,(F, X_{1i}X_2, X_3 I_{i,\ t-1}) \qquad i = 1, 2, \ldots, n \qquad (3)$$

$$F = f\,(X_2, X_3) \qquad i = 1, 2, \ldots, n \qquad (4)$$

Equation (1) determines the monetary value of the yield of the i^{th} parcel; equation (2) determines the level of direct inputs used on the i^{th} parcel; equation (3) determines the current stock of land improvements made to the i^{th} parcel; and equation (4) determines farm fragmentation at the household level.

More specifically, in equation (1), the parcel yield is determined by the use of direct inputs (L_i), the current stock of land improvements on the parcel (I_i), the level of farm fragmentation for the household (F), parcel-specific variables (X_{1i}), household-specific variables (X_2), and district-specific variables (X_3). In equation (2), the level of direct inputs used on the i^{th} parcel is determined by the current stock of land improvements, the level of farm fragmentation, as well as the previously-noted parcel, household, and district variables. In equation (3), the current stock of land improvements on each parcel is determined by the level of farm fragmentation, land improvements made in the previous period on the parcel (I_{t-1}), as well as the parcel, household, and district variables. Finally, in equation (4), the level of farm fragmentation is determined by the household-specific and district-specific variables (X_2, X_3).

It should be noted that in equations (1) – (3) fragmentation is determined at the parcel level. In equation (4), however, fragmentation is determined at the household level. Such a specification is necessary because it is unknown whether fragmentation is an exogenous phenomenon, driven by supply-side factors such as partible inheritance, land laws and reforms or an endogenous phenomenon, driven by demand-side factors such as risk aversion of farmers, optimizing self-employment, low cost to fragmentation. Furthermore, fragmentation appears in equation (1) as an explanatory variable, and therefore directly affects the yield of the i^{th} parcel. Fragmentation also appears in equations (2) and (3) as an explanatory variable and therefore directly affects the level of direct inputs (L_i) and the stock of land improvements (I_i). Since L_i and I_i are included as the explanatory variables of equation (1), fragmentation has both direct and indirect effects on the yield of the i^{th} parcel.

Equation (4) does not include the current values of the other endogenous variables, Y_i, L_i, or I_i. Therefore, the model can be specified in the following semi-reduced form:

$$Y_i = f\,(F, X_{1i}, X_2, X_3) \qquad i = 1, 2, \ldots, n \tag{5}$$

In equation (5), the fragmentation variable captures both the direct and indirect effects of fragmentation on yields. However, equation (5) may not produce the consistent and unbiased estimates of direct and indirect effects of fragmentation on yield if there are unobserved variables that influence both the level of fragmentation and current yield, such as farmer's skill. In other words, F is an endogenous variable and any correlation between the error term in equation (4) and the error term in equation (5) will lead to biased coefficient estimates. To solve this problem, using two-stage least squares, equation (4) is estimated first to obtain the fitted values for F which will be used to replace the actual values of fragmentation in equation (5).

More specifically, it is necessary to estimate the following household-level model to obtain the fitted value for fragmentation:

$$F_j = b_1 X_{2\mathrm{j}} + b_2 X_{3\mathrm{j}} + e_j \qquad j = 1, 2, \ldots, n \tag{6}$$

In this equation F_j is the number of parcels in the j^{th} household; X_{2j} is a vector of household-level explanatory variables; X_{3j} is the vector of district-level variables; b_1 and b_2 are the vectors of the coefficients to be estimated; and e_j is an error term. The fitted $\hat{F}_j$ values will be assigned to the parcels associated with the j^{th} household.

The explanatory variables included in X_{2j} are as follows: household size, gender, farm size, education, and distance to parcels. Non-farm income is excluded since it is considered an endogenous variable. Due to the 1991 restitution of land to pre-communist owners or their heirs, it is assumed that the majority of parcels are inherited. With respect to the use of credits for agricultural purposes, the survey data indicates that households do not have access to such. Among the most important barriers to agricultural credit is the fact that agricultural land is not accepted as collateral by banks and the inability of farmers to meet various regulatory criteria for obtaining loans.

The model is identified by the inclusion of farm size in equation (4), a variable which is strongly related to fragmentation but, as will be explained in the next paragraphs, not directly related to productivity. Farm size is a powerful instrumental variable since it directly affects fragmentation—as discussed in Boliari (2013), Simmons (1964) and Januszewski (1968) suggest evidence that fragmentation increases with farm size. Furthermore, the historical data for Bulgaria supports this argument—for the period between the last quarter of the 19^{th} century and the mid-1930s the level of fragmentation was positively related to farm size—the higher the farm size, the higher was the level of fragmentation (Boliari, 2013). In addition, as indicated by the data used in this study, farm size is strongly related to the number of parcels.

The econometric procedures explained above will produce fitted values of fragmentation that are not correlated with the error term of equation (5). However, it needs to be underlined that the explanatory power of the variables included in the other equation of the model will be determined by the degree of correlation between the fitted values and observed values of fragmentation.

Equation (1) will be estimated in double log form for parcel *i* of household *j* located in district *k* as follows:

$$\log Y_{ij} = \alpha V_k + \beta_1 \log X_{1ij} + \beta_2 \log X_{2ij} + \beta_3 \hat{F}_{ij} + \mu_j + e_{ij} \qquad (7)$$

In this equation μ_j is a household random effect satisfying $E(\mu_{\text{j}}) = 0, E(\mu^2{}_{\text{j}}) = \sigma^2_\mu$, and is independent across households. As explained by Blarel *et al.* (1992, p. 245), μ_j represents unobserved household-level effects. The household random effect μ_j may be correlated with explanatory variables other than the fitted values of fragmentation. On the other hand, since this study focuses mainly on the coefficient of fragmentation, and since fitted values that are used for F_j are not correlated with μ_j, the coefficient of fragmentation will not be biased. Interpreting coefficients other than the coefficient of F, however, will require caution.

Equation (7) includes the fitted values for fragmentation and all other variables with the exception of farm size. Since farm size is the instrument of the first stage equation it cannot be a determinant of the second stage equation's dependent variable, parcel yield.

An objection to excluding farm size from the productivity equation would be the argument that due to economies of scale, farm size will necessarily affect productivity. However, as will be seen, in the data the majority of farms are smaller than 50 decares and, in fact, more than 50 percent are smaller than 20 decares. For such small farms, there are no opportunities to explore economies of scale. Furthermore, the figures for Bulgaria in general indicate that 77 percent of farms use no more than 10 decares of agricultural area. Sources indicate that large business farms and agricultural cooperatives (those who cultivate more than 100 decares or 10 hectares) may enjoy economies of scale (FAO, 2003; MAFS, 2004). But the number of farms larger than 100 decares in the sample used in this study is just 11 (0.85 percent of the total). And for Bulgaria in general, the proportion of farms larger than 100 decares is less than 2 percent. Finally, consolidation initiatives concern primarily the small fragmented farms precisely because they are unable to explore economies of scale. Farm size can therefore be omitted from Equation (1).

4. Data

4.1. General description

The source of data for this study is the Bulgaria 2003 Multi-topic Household Survey (MHS), funded by the World Bank and conducted by the National Statistical Institute (NSI) of Bulgaria in November 2003. The MHS is a nationally representative, multi-purpose household survey which includes information on a series of subjects such as household composition, income, education, consumption, employment, loans and credits, use of agricultural land, and farm production. It is, therefore, well-suited to a statistical study of land fragmentation. The survey sample is comprised of 3,023 households (8,250 individuals) from the 28 official districts in the country. For the purposes of this study, data were extracted from the survey modules on agriculture, household characteristics, income, credits, and education, respectively. Nonetheless, the nature of the data and the size of the sample require several compromises described below.

Because the interest of the study is in farm fragmentation, only those households who hold farmland were initially included in the working data set. 1,759 households (58.2% of the total sample of 3,023) reported to hold (own or rent) farmland. However, only 23 of the 1,759 households reported that they rent the land they hold. Since 23 is a relatively small subset, it was excluded from the working data set thereby reducing it to 1736. Furthermore, from the 1,736 selected households, 440 (more than 25 percent of this sample) did not cultivate their lands.[4] Since the goal is to test the impact of fragmentation on land productivity, the 440 households whose land was reported to be uncultivated must be excluded. With this exclusion, the sample size declined to 1,296 farms. Finally, this sample contained three farms, the sizes of which (600, 800, and 1,200 decares) were considerably larger than the average farm size of 14.92 decares.[5] These large farms were excluded as outliers so that the final sample used in the econometric model includes 1,293 farms.

The agriculture module includes characteristics such as ownership of farm land, size and location of plots, types of crops grown, amounts

[4] This appears to be a common feature for Bulgaria. A consultation with representatives from the Institute of Agricultural Economics (IAE) and the NSI revealed that vast amounts of agricultural land in Bulgaria are left idle for a range of reasons (lack of access to credits and capital, low profitability of farm enterprises, undersized parcels of land, and others) completely unrelated to fragmentation. Nationwide, the average amount of unused agricultural land is estimated at 45 percent of the total and in some districts it reaches 90 percent. Moreover, from 1989 to 2001 the amount of unused agricultural land has increased by more than 26 percent. And since there is no tax on land, there is no direct cost to holding the land idle. Source: Interviews by the author in Sofia in July, 2007 and further email conversations with representatives from the above institutions.

[5] It is interesting to note that these three large farms were not fragmented; they consisted of one single plot.

harvested, prices of sold produce, purposes for which the produce were used, ownership of machinery for agricultural purposes, expenditures for hiring labour, seeding, fertilizers, transportation, and other agricultural activities. Household characteristics include age, sex, ethnicity, residence, and employment of household members. Data is available on pre-tax regular and non-regular income where "regular income" refers to the sum of earnings from main and second job, unemployment benefits, retirement pensions, heir's pensions, disability and other pensions, family allowances and scholarships. "Non-regular income" includes earnings from the rental or sales of assets, inheritances, lottery winnings, and social transfers. The module on loans and credits includes data for the households' repayment of debts, loans, or credits, and the education module provides detailed information on the level and type of education of all household members.

4.2. Determining the level of fragmentation

The level of farm fragmentation is measured by using the Simmons Index[6], on one hand, and the number of plots/parcels per farm, on the other. Boliari (2013) explains in details the procedures used in measuring land fragmentation for the sample of 1,736 households, that is, all households who own land. The study measures, compares, and discusses the level of land fragmentation in Bulgaria before and after the communist regime. It reports relatively low levels of fragmentation at present and draws attention to the considerable post-communist decline in land fragmentation. For the purposes of comparison, this study includes the fragmentation statistics for the sample of 1,736 (already reported in Boliari (2013)) and the sample of 1293, which is the sample used in the model described in Section 3.

Table 2 summarizes the characteristics of the two samples: 1,736 households who own land and 1,293 households who own and cultivate their land. It is interesting to note that the percentage of household heads with post-secondary and secondary education is smaller when those not cultivating their land are excluded by 3.34 and 2.24, respectively. The figures imply that people with higher education are more likely to leave their land uncultivated which is in line with the explanations of representatives from the IAE and the NSI (see footnote 4).

[6] The Simmons index is defined as $SI = \sum_i A_i{}^2/A^2$ where A_i is the area of the i^{th} plot; $A = \sum_i A_i$ is the total farm size; and $i = 1, 2, \ldots, m$ where m is the number of plots a farm is composed of. The values of the SI can range from zero to one. A value of one indicates that the household owns a single plot of land (complete land consolidation). A value close to zero indicates extreme levels of fragmentation since SI approaches zero as the number of plots cultivated by each farm grows. Because the Simmons Index is sensitive to the number of plots and to dispersion in the size of the plots, the average number of plots is used as an alternative measure of fragmentation (Boliari, 2013).

Table 2. **Selected household characteristics for the samples of 1,736 and 1,293 households**

Description	**Households owning land**	**Percentage of the sample**	**Households owning and cultivating their land**	**Percentage of the sample**
Number of households	1736	57.43	1293	42.77
Mean household size	2.78		2.84	
Median household size	2		2	
Gender of household's head				
Male	1307	75.29	982	75.90
Female	429	24.71	311	24.10
Education of household's head				
Undergraduate or Graduate	246	14.17	140	10.83
High school	674	38.82	473	36.58
Middle school	556	32.03	462	35.73
Elementary school	260	14.98	218	16.86
Households with non-farm income	1099	63.31	839	64.88
Mean non-farm income	804.344[7]		807.4	
Median non-farm income	780		780	

Table 3 summarizes the farm characteristics of the two samples. A comparison of the two groups shows that more than 73 percent of the households who do not cultivate their land own farms composed of just one plot of land. Therefore, it is not surprising that both the mean and median values of the Simmons Index are lower compared to the sample of 1,736. In other words, the farms of the sample of households which own and cultivate their land is more fragmented compared to the farms of the sample which included those who own but do not cultivate their land. On the other hand, the percentage of farms located in the vicinity of the village or town of residence increased to about 81 percent which implies that for a considerable majority of households distance and therefore travel time to parcels should not be of much concern.

Table 4 presents the distribution of farms in both samples. The table shows that majority of farms in the sample of 1,293 are no larger than 5 decares and only two of the farms are larger than 150 decares. Referring to the figures for the sample of 1,736, the largest decrease is in the number of farms smaller than 5 decares indicating that most of the 440 households who choose to leave their land idle are very small farms.

The level of fragmentation for both samples is shown in Table 5. The overall fragmentation level is higher for the sample of 1,293 with the

[7] All currency figures are in Bulgarian Leva (BGN). For 2003, 1 USD ≈ 1.715 BGN at a yearly average exchange rate (Bulgarian National Bank, 2007).

Table 3. **Selected farm characteristics for the samples of 1,736 and 1,293 households**

Description	**Households owning land**	**Percentage of the sample**	**Households owning and cultivating their land**	**Percentage of the sample**
Number of households	1736		1293	
Median farm size (decares)	5.2		4.5	
Mean farm size (decares)	14.92		12.41	
Number of farms composed of one parcel	731	42.11	405	31.32
Number of farms composed of two parcels	532	30.65	449	34.73
Number of farms composed of three parcels	266	15.32	242	18.72
Number of farms composed of four parcels	116	6.68	108	8.35
Number of farms composed of five parcels	45	2.59	44	‘3.4
Number of farms composed of six parcels	20	1.15	19	1.47
Number of farms composed of seven parcels	26	1.50	26	2.01
Median number of parcels per farm	2		2	
Mean number of parcels per farm	2.065		2.31	
Mean parcel size (decares)	7.49		4.63	
Number of farms which use fertilizers	397	22.87	389	30.09
Number of farms which use machinery	137	7.89	132	10.21
Number of farms which use transportation	138	7.95	128	9.9
Number of parcels in the place of residence	1221	70.33	1047	80.97
Number of parcels outside of the place of residence	515	29.67	246	19.03

percentage of completely consolidated farms now being 31.32. Nonetheless, for about 55 percent of farms, the Simmons Index is higher than 0.8 indicating a relatively low level of fragmentation overall.

4.3. Variables included in the model

A number of additional variables were derived from the MHS data in order to estimate the econometric model presented in Section 3 of this paper.

Table 6 lists them and describes their characteristics. The dependent variable of the model, land productivity Y_i, is measured as the total value of

Table 4. **Distribution of farm size for the samples of 1,736 and 1,293 households**

Range of Farm Size (FS, decares) for the sample of 1736	Number of Households	Percentage of Households	Range of Farm Size (FS, decares) for the sample of 1293	Number of Households	Percentage of Households
FS < = 5	865	49.83	FS < = 5	682	52.75
5 < FS < = 10	210	12.1	5 < FS < = 10	140	10.83
10 < FS < = 20	282	16.24	10 < FS < = 20	195	15.08
20 < FS < = 30	145	8.35	20 < FS < = 30	107	8.27
30 < FS < = 40	100	5.76	30 < FS < = 40	73	5.65
40 < FS < = 50	36	2.07	40 < FS < = 50	25	1.93
50 < FS < = 100	79	4.55	50 < FS < = 100	60	4.64
100 < FS < = 150	10	0.58	100 < FS < = 150	9	0.7
150 < FS < = 200	2	0.12	FS > 150	2	0.15
FS > 200	7	0.4			

Table 5. **Fragmentation of farmland in Bulgaria**

Range of the Simmons Index for the sample of 1736	**Number of Households**	**Percentage of Households**	**Range of the Simmons Index for the sample of 1293**	**Number of Households**	**Percentage of Households**
0 < = SI < = 0.2	0	0	0 < = SI < = 0.2	0	0
0.2 < SI < = 0.3	23	1.32	0.2 < SI < = 0.3	23	1.78
0.3 < SI < = 0.4	72	4.15	0.3 < SI < = 0.4	70	5.41
0.4 < SI < = 0.5	138	7.95	0.4 < SI < = 0.5	126	9.74
0.5 < SI < = 0.6	159	9.16	0.5 < SI < = 0.6	137	10.6
0.6 < SI < = 0.7	120	6.91	0.6 < SI < = 0.7	106	8.2
0.7 < SI < = 0.8	134	7.72	0.7 < SI < = 0.8	121	9.36
0.8 < SI < = 0.9	151	8.7	0.8 < SI < = 0.9	134	10.36
0.9 < SI < 1	211	12.15	0.9 < SI < 1	171	13.23
SI = 1	728	41.94	SI = 1	405	31.32
Median SI = 0.94			Median SI = 0.85		
Mean SI = 0.82			Mean SI = 0.78		
Number of Parcels			**Number of Parcels**		
1	731	42.11	1	405	31.32
2	532	30.65	2	449	34.73
3	266	15.32	3	242	18.72
4	116	6.68	4	108	8.35
5	45	2.59	5	44	3.4
6	20	1.15	6	19	1.47
7	26	1.50	7	26	2.01
Median = 2			Median = 2		
Mean = 2.065			Mean = 2.31		
Households with parcels in residence	1221	70.33	Households with parcels in residence	1047	80.97
Households with parcels outside residence	515	29.67	Households with parcels outside residence	246	19.03

Table 6. **Characteristics of variables used in the model**

Variable Name	Variable Description	Mean	Standard Deviation
Dependent Variable			
Productivity, Y_i	Land productivity measured in total value of harvested crops per decare	252.53	241.28
Explanatory (Independent) Variables			
Parcel Specific Variables (X1)			
Farm Fragmentation	Level of farm fragmentation defined at the household level and measured by (1) the Simmons Index and (2) by the number of parcels per farm	(1) 0.78 (2) 2.30	(1) 0.23 (2) 1.34
Farm Size	The sum of the total area of all parcels measured in decares	12.41	20.06
Distance to Homestead	Dummy variable; 1–0 indicator of the location of the parcel in- or out- of the household's residence	0.81	0.39
Area Devoted to Crops	Area of the parcel cultivated with crops measured in decares	3.44	9.94
Use of Fertilizers	Dummy variable; 1–0 indicator of the use of fertilizer on the parcel	0.3	0.46
Use of Machinery	Dummy variable; 1–0 indicator of the use of machinery on the parcel	0.102	0.303
Use of Transportation	Dummy variable; 1–0 indicator of the use of transportation to and from parcels	0.1	0.3
Household Specific Variables (X_2)			
Household Size	Measured as the number of household members	2.83	1.48
Gender of the Head of Household	Dummy variable; 1–0 indicator for gender male or female	0.76	0.43

Table 6. **Characteristics of variables used in the model (*Continued*)**

Variable Name	Variable Description	Mean	Standard Deviation
Education of the Head of Household	Dummy variable; indicator 1 for graduate/undergraduate, 2 for high school, 3 for middle school; and 0 for elementary school or incomplete education	(1) 0.108 (2) 0.366 (3) 0.357	(1) 0.311 (2) 0.482 (3) 0.479
Non-farm Income (BGN)	If applicable, measured as the sum of the eight categories of regular income: second job earnings, unemployment benefits, retirement pension, heir's pension, disability pension, other pensions, family allowances, and scholarships	807.419	804.42
District Specific Variable (X_3)	Bulgaria has 28 districts which differ with respect to soil quality and suitability for growing different crops, use of labour, and agro-climate. This district dummy variable is included to reflect these and other differences which may arise due to land located in different districts; indicator 0 to 27 for the 28 districts listed in Cyrillic alphabetical order	0.036[10]	0.184[11]

[10] The average of all 28 districts.

[11] The average of all 28 districts.

all harvested crops divided by the total planted area of these crops. In order to obtain this variable, a calculation involving reported prices and outputs for 19 crops was performed. The MHS includes codes for 24 crop types, produced in Bulgaria, of which 5 were excluded as insignificant for the estimation of the model.[8] The 19 crop types are wheat, maize, other cereals, potato, beans, tomato, cucumber, cabbage, pepper, onions, other vegetables, apples and pears, grapes, watermelon, sunflower, tobacco, forage, nursery plants, and other crops. The survey has data on 1. the harvested amounts in kilograms for households if they harvested any of the above listed crops; 2. the amount of land measured in decares and used for the crop in question; 3. the amount sold in kilograms; 4. the payment received for the whole amount of harvest sold, not per kilogram; and 5. the purposes for which harvested produce were used.

One issue of concern may be the variable "area devoted to crop" which is included in equation (7) of the econometric model. Area devoted to crop refers to the area of the farm which is under cultivation. Theoretically, it seems highly related to farm size. In fact, one would expect that it is equal or close to farm size raising the impression that farm size is being inappropriately included in the productivity equation under the name "area devoted to crop." However, close examination of the sample reveals that only 289 of the households (22.35 percent) actually cultivate the whole area of their farms and that the majority of these farms are smaller than 0.5 decares. The larger the farm, the smaller is the area cultivated and while the average farms size is 12.41 decares, average cultivated area is just 2.57 decares[9].

It may also be necessary to address the potential problems of inclusion of multiple crops. One possibility is to run separate regression for each crop pattern and the other is to aggregate several crop patterns into one. The second approach will be used in this study with land productivity measured as the total value of all crops divided by the total planted area of these crops. This approach can be supported by the fact that it is generally not possible to determine the corresponding multiple crop areas in a single

[8] The excluded crops are rye, soybeans, plums, and other fruits. Very few farmers grew these types of crops.

[9] Furthermore, area devoted to crop is of interest to this study due to its specific dynamics given the prevalence of subsistence farming in Bulgaria. The MHS data shows and the literature indicates that majority of landholders do not sell their produce in the market. Rather, they use it for consumption, for payments in kind, to feed animals, exchange with neighbours and relatives, and as canned food for winter consumption. Therefore, area devoted to crop is a variable determined by the family by taking into account its annual needs for consumption. If the family has a small farm size, then area devoted to crop will obviously be large in relation to farm size, perhaps very close to farm size. The impact of the area devoted to crop on productivity, however, would not be due to economies of scale but due to the family's survival or consumption motives. And as will be seen in the results section, the relationship between area devoted to crop and productivity is negative and significant.

parcel—separate regressions for each cropping pattern will produce small sample sizes. Aggregated regressions, as opposed to separate regressions will also capture the effects created by farmers switching to more profitable crops.

5. Estimation and discussion of results

The model was estimated using the "ivreg" command of Stata with robust standard errors. As explained in Section 3, the first step is to estimate equation (6) of the model.

$$F_j = b_1 X_{2j} + b_2 X_{3j} + e_j \qquad j = 1, 2, \ldots, n \tag{6}$$

Recall that in this equation F_j is the number of parcels in the j^{th} household; X_{2j} is a vector of household-level explanatory variables; and X_{3j} is the vector of district-level variables. The explanatory variables represented by X_{2j} include household size, gender and formal education of the household head, inherited farm size, and distance from homestead to parcels. The explanatory variable X_{3j} represents the district-specific characteristics of the parcels associated with the j^{th} household.

The values of R-squared (0.6745) and adjusted R-squared (0.6644) obtained from the first-stage regression indicate that, overall, the estimated model fits the data well. Moreover, the F-statistic of 66.57 shows that the overall fit of the estimated equation is statistically significant.

With respect to variables, the first-stage results indicate that, as expected, the instrumental variable farm size is positively related to—and has a statistically significant effect on—the level of fragmentation. If the majority of farms are inherited, as was assumed in Section 3 due to the restitution process, current farm size can be assumed to be inherited farm size. In such a case, the results will support the supply-side explanations for fragmentation. On the other hand, area devoted to crops, distance to parcels, and use of fertilizers are also positive and statistically significant. These outcomes give credence to the demand-side explanations for fragmentation. Finally, 11 of the 28 district variables are statistically significant with 7 having positive signs. This indicates that, depending on the nature of district characteristics, either supply-side or demand-side factors may influence the level of fragmentation.

Proceeding to the second-stage regression, the goal is to estimate the effect of fragmentation on land productivity using Equation (7) of Section 3:

$$\log Y_{ij} = \alpha V_k + \beta_1 \log X_{1ij} + \beta_2 \log X_{2ij} + \beta_3 \hat{F}_{ij} + \mu_j + e_{ij} \tag{7}$$

Table 7. **Results**

Log Productivity	Coefficient	Robust Standard Error	t
Log Fragmentation	.3563	.0862	4.13
Log Household Size	.3110	.0474	6.55
Log Area Devoted to Crops	–.440	.0268	–16.42
Distance	.1616	.0688	2.35
Education 3	.0840	.0694	1.21
Education 2	.0492	.0705	0.70
Education 1	–.1605	.1196	–1.34
Transportation	.2678	.0796	3.36
Machinery	–.0155	.0757	–0.21
Fertilizers	.2972	.0667	4.45
Non-farm Income	.0000	.0000	1.31
Gender	.0715	.0612	1.17
Constant	4.452	.1792	24.84
Log Farm Size (From the first-stage regression)	.2090	.00647	32.27
Wu-Hausman F test	8.95934	F (1, 1252)	P-value: 0.00281
Durbin-Wu-Hausman chi-sq test	9.18699	Chi-sq (1)	P-value: 0.00244

Instrumented: Log Fragmentation.

Instrument: Log Farm Size.

Number of observations: 1293.

F (39, 1253) : 66.57.

Adjusted R-squared : 0.6644.

Since the "accepted wisdom" is that fragmentation has a negative impact on productivity, the null hypothesis is set to state that fragmentation has a coefficient less than or equal to zero:

$$H_0 : \beta_3 \leq 0$$

$$H_A : \beta_3 > 0$$

This means that the null hypothesis can only be rejected if the coefficient on fragmentation is a positive and significant one.

Table 7 shows the second-stage regression results when fragmentation is measured by the number of parcels per farm. The coefficient on fragmentation is positive and significant. Therefore, the null hypothesis that fragmentation negatively affects yields is rejected.

Two different interpretations can be provided to explain this result. First, as seen in Section 4.2 the data demonstrates that the average level of fragmentation in Bulgaria is relatively low and as such it may present no threat to farm productivity. Second, and on a more detailed level, the lack of negative relationship between fragmentation and productivity as demonstrated by the regression results provides support for the demand-side explanations of fragmentation discussed in the literature (Bentley, 1987; Blarel *et al.,* 1992; Fenoaltea, 1976; Heston and Kumar, 1983; King and Burton, 1982; McCloskey, 1975a and 1975b). Demand-side explanations are based on the simple idea that the positive effects of land fragmentation might well outweigh its negative effects and therefore yield net benefits for farmers—as McCloskey (1975a, 1975b) and Fenoaltea (1976) famously argued, by having scattered plots, individuals systematically diversify their land portfolio in order to stabilize (decrease the variance in) their farm output.

The most plausible demand-side explanations for fragmentation include: 1. the risk aversion of farmers; 2. the goal of farmers to optimize self-employment; and 3. low or no cost to fragmentation.

For example, McCloskey (1975a, p. 114) suggested that fragmentation may be desired as a mechanism to deal with variations in underdrainage, slope, soil structure and chemistry, crops, exposure to frost, sun, rain and wind. The argument is that risk-averse farmers may be willing to split their farms into several pieces in order to have land in different zones with different soil, elevations, altitude or other characteristics of the local environment. Such a diversification of land would aim at spreading the risk from natural hazards (such as frost, hail, flood, or fire) in order to reduce the variability in total output (Blarel *et al.*, 1992; Heston and Kumar, 1983) as well as the variability in total income (McCloskey 1975a, p. 115) due to possible yearly fluctuations in the prices of different crops. In other words, farmers, by keeping their plots scattered, may be trying to trade off possible higher returns from consolidated lands for lower variance in output and income over the years. And so they may prefer an agricultural system geared primarily towards stability rather than productivity (King and Burton, 1982).

The presence of great variety of soils and topographic characteristics on Bulgaria's territory raises the high likelihood of such a demand-side explanation for fragmentation. For example, Georgiev and Penov (2006) point to the specifics of Bulgaria's topography, soil characteristics, and the configuration and structure of crops in different regions as the primary factor for the persistence of fragmentation. Similarly, indicating the great variety of fertile soil types in Bulgaria present even within small localities, such a single village, Di Falco *et al.* (2008) observe that "farmers take advantage of differences in land quality by selecting crop species and varieties best suited to the plots they have available". Indeed, the study reports empirical evidence suggesting that the profitability of farms growing a variety of products is significantly higher in comparison to the profitability of those that do not.

Optimizing self-employment as a demand-side factor of fragmentation is first emphasized by Fenoaltea (1976) who argues that farmers may choose to own scattered plots as a mechanism to maximize productivity by optimizing self-employment. Holding large plots would require hiring of outside labour and farming the field at a given time period. To avoid the high transaction costs involved in the employment of outside labour, such as identifying and supervising workers, farmers may prefer fragmentation since scattered plots could be worked at different time periods thereby allowing the completion of work with minimum or no outside labour. Based on empirical evidence, Tan *et al.* (2005), for example, argue that Chinese farmers prefer to hold scattered plots in order to spread household labour (in addition to spreading risks).

While there is no precise documentation of such reasoning by farmers in Bulgaria, it remains a possibility to consider. Dolinsky (1932), for example, briefly notes that the Bulgarian landowner works the farms himself, uses the labour of his family for all purposes and "in the majority of cases avoids hiring outside labour". Stoianovich (1976) supports this argument by suggesting that the domestic family was organized to perform a great variety of ritualized interrelated functions such as stock-raising and farming through its precise definition of rights, duties and taboos. In the data used for this study and in the sample of Di Falco *et al.* (2008) it appears that it is household members who are engaged in all farm activities.

Finally, following Heston and Kumar (1983) we can consider the possibility of existing low costs to fragmentation given the requirements for transplantation and cultivation. The most important cost associated with fragmentation is the cost of travel time between plots and between the homestead and each plot. If all plots of a farm are located at different places in the immediate vicinity of the village (as this is the case in Bulgaria), however, the distance and therefore the travel costs would not be large. Moreover, if plots are farmed and cultivated at different time periods following rotational husbandry (as is, again, in the case of Bulgaria) then the waste of travel time between plots would not be a matter of consideration. In such cases, a farmer would not be concerned with costs created by fragmentation since they would be minimal or no higher than if he had to work on a consolidated or single plot of land. And furthermore, from an economic point of view, it is not time *per se* that matters, but the value of that time measured as the opportunity cost of production foregone (King and Burton, 1982). Therefore, when costs to fragmentation are low or effectively non-existent but there are some benefits, fragmentation will likely occur and be preferred by farmers.

With respect to the other variables of the model, household size is significantly and positively related to yield. This result was expected since the more people the household has, the higher is the likelihood that more labour time would be invested in farming without the need to hire outside labour. The survey data shows that, in general, households do not hire labour and seem to prefer to work the land on their own.

Similarly, the use of fertilizers and transportation are positively and significantly related to yield. This is again not surprising given that fertilizers enhance the natural fertility of the soil and therefore are expected to increase crop production levels. Higher levels of transportation help in travelling to plots, carrying equipment for tillage, planting, harvesting, storage, and sale of produce, transporting fertilizers, pesticides, insecticides and well as providing convenience, mobility and flexibility. In other words, it affects productivity by allowing for more efficient use of valuable resources. "Distance to homestead" is also positively and significantly related to yield. Since distance was specified as a dummy variable (indicator 1 for parcels in residence and indicator 0 for parcels out of residence) the results imply that productivity is higher for those parcels located in the immediate vicinity of the place of residence. Naturally, a household can more efficiently manage and operate land which is close to their home.

Finally, the area devoted to crop is significantly but negatively related to yield which means that the larger the area cultivated, the lower is productivity. This can be explained as follows. First, it is known that the soil on a given plot of land is not equally fertile or favourable for growing crops. Therefore, cultivating a greater area of that plot will reduce the output *per* unit decare. Second, the larger is the area cultivated, the larger is the likelihood of loss of output due to infestation or other natural hazards. Such cases, which are common in agriculture, will reduce the output *per* unit decare.

The rest of the variables—gender of the household head, education, use of machinery, and non-farm income—have no significant effect on yield. Eleven district variables (not shown in the table) are significantly and negatively related to productivity.

For reference purposes, similar first-stage regression results for the effects of farm size, area devoted to crops, distance to parcels, use of fertilizers, and 11 district variables are obtained when using the Simmons Index as the measure of fragmentation. The problem with this model is its explanatory power. Although the F-statistic of 14.06 shows that the overall fit of the estimated equation is statistically significant, the estimated model does not fit the data as well as the first model does. The R-squared of 0.27 indicates a relatively low correlation between the fitted and actual values of fragmentation. Moreover, farm size does not appear to be a very strong instrument when the Simmons Index is used as a measure of fragmentation. The second-stage regression results for this model would, therefore, be unreliable.

6. Conclusion

The following conclusions can be derived from this study. First, the nationally representative MHS data demonstrates that fragmentation in Bulgaria is present, but its average level is relatively low—two separate parcels *per* farm of which one is usually a backyard. As such, it may not really be considered an issue of priority or of much concern for policy makers, especially given the fact that the majority of both farm and parcel sizes are so small that their size is just enough to provide for much needed household consumption. Moreover, as indicated in Section 4.2, the largest farms of the sample are already consolidated and are operated as single plot of land.

Second, as the data showed, significant numbers of households in the country do not cultivate their lands and those who do, do not actually use all land available for cultivation. This brings the necessity to investigate thoroughly the reasons for which land is left totally or partially idle. As indicated in footnote 4, lack of access to credit and capital, the inability of farmers to use land as collateral, and the relatively low profitability of farm enterprises appear to be major reasons for why owners leave their land idle. Amount of land farmed can be increased through much necessary policies targeting improvement in the markets for credit and capital which in turn can increase agricultural and land productivity. Introducing collateralization arrangements in these markets is of particular importance—without such arrangements farmers are not able to obtain credit in order to improve their farming techniques. Moreover, introducing a tax on abandoned farm land (currently there is no such tax) is necessary in order to provide incentives for absentee owners to sell, lease, or rent their land.

Third, the multiple regression analysis showed that the level of fragmentation in 2003, measured as the number of parcels *per* farm, was not likely to adversely affect productivity. This is the main econometric finding of the study which brings into question the plausibility of the extremely expensive and, as the literature indicates, in practice largely ineffective consolidation policies (Bentley, 1987; King & Burton, 1982; Sengupta, 2006). The results of the study indicate that other things being equal, consolidation policies are unlikely to improve land productivity in Bulgaria. It is possible that some districts in the country may be more fragmented than others and so in such districts negative effects of fragmentation on productivity may be a matter of concern. This can be further investigated by measuring the impacts of fragmentation on a district by district basis. Consolidation policies, if desired by farmers, may be considered as a solution if empirical evidence is presented that fragmentation adversely affects productivity in those districts. On the other hand, policymakers should also consider alternatives to consolidation. For example, in order to enlarge the area of cultivation, incentives could be provided to both absentee and existing owners to formally or informally lease their land which could be accomplished in several different forms (Bullard, 2007).

Fourth, the cost of travel time, most often attributed to fragmentation, seems to be a matter of concern given that distance to parcels seems to significantly affect productivity. However, in the case of Bulgaria a considerable majority of parcels are closely located to the household's homestead and most are listed in the survey as backyards (plots adjacent to the homestead). In addition, distance from home to parcels seems to negatively affect the level of fragmentation implying that the shorter the distance, the more likely is that fragmentation will occur. In other words, attempts to consolidate parcels which are fragmented but still close to the farm household will be not only unnecessary but also unsuccessful.

Finally, the study is most likely the first to attempt to estimate the impact of fragmentation on land productivity in the country by using multiple regression analysis. The study can be improved in several ways. First, a closer and more detailed picture of the level of fragmentation may be obtained by its measurement on a district by district basis. Such measurement would help in identifying the districts with higher or lower fragmentation. This in turn would allow for further studying the district specific supply-side or demand-side causes of fragmentation and for the subsequent design of policies targeting those causes. It will also allow for using the model to estimate the impact of fragmentation on land productivity in a specific district and therefore the consideration of consolidation or alternative policies in districts where this impact appears to be negative.

References

Boliari N. (2013) Land fragmentation in Bulgaria: reconsidering its measurement and extent, *Review of European Studies 5*(1), 99-109.

Bentley J. W. (1987) Economic and ecological approaches to land fragmentation: In defense of a much maligned phenomenon, *Annual Review of Anthropology 16*, 31-67.

Blarel B., Hazell P., Place F., Quiggin J. (1992) The economics of farm fragmentation: Evidence from Ghana and Rwanda, *World Bank Economic Review 6*(2), 233-254.

Bulgarian National Bank (2007) 2003 Exchange Rates of Foreign Currencies against the Bulgarian Lev.

Bullard R. (2007) Land consolidation and rural development, Papers in Land Management No. 10, Cambridge and Chelmsford, UK, Anglia Ruskun University,148 p.

Di Falco S., Penov I., Aleksiev A., Van Rensburg T. M. (2008) Agricultural biodiversity and land fragmentation: The case of Bulgaria, Department of Economics Working Paper No. 0132, Galway, Ireland, National University of Ireland, 21 p.

Dolinsky N. V. (1932) Difficulties in Bulgarian Farming, *Journal of Farm Economics 14*(2), 355-358.

FAO (2003) What is land consolidation? In “The design of land consolidation pilot projects in Central and Eastern Europe”, Land tenure studies 6, Rome, Food and Agriculture Organization of the United Nations (FAO), chapter 3.

Fenoaltea S. (1976) Risk, transaction costs, and the organization of medieval agriculture, *Explorations in Economic History 13*(2), 129-151.

Georgiev M., Penov I. (2006) (In Bulgarian) Vliyanie na razhodite po prehv”rlyane na zemedelska zemya v”rhu konsolidatsiyata na pozemlenata sobstvenost, *Ikonomika i upravlenie na selskoto stopanstvo 51*(3), 19-26.

Heston A., Kumar D. (1983) The persistence of land fragmentation in peasant agriculture: An analysis of South Asian cases, *Explorations in Economic History 20*(2), 199-220.

Hung P. V., MacAulay T. G., Marsh S. P. (2007) The economics of land fragmentation in the north of Vietnam, *Australian Journal of Agricultural and Resource Economics 51*(2), 195-211.

Januszewski J. (1968) Index of land consolidation as a criterion of the degree of concentration, *Geographia Polonica 14*, 291-296.

Jha R., Nagarajan H. K., Prasanna S. (2005) Land fragmentation and its implications for productivity: Evidence from Southern India, ASARC Working Paper 2005/01, Australia South Asia Research Centre, Australian National University, 38 p.

Kabil N. (2004) Guidelines for Bulgarian land policies, Study of the Ministry of Agriculture and Forestry of Bulgaria presented at the Plovdiv Agricultural University workshop “Land Consolidation and Land Policy in Bulgaria”, held on 1-4 July 2004 in Plovdiv, Bulgaria.

Kasabov M., Koritarova V. (2004) Bulgarian-Dutch Project for Land Consolidation, Study of the Ministry of Agriculture and Forestry of Bulgaria presented at the Plodiv Agricultural University workshop “Land Consolidation and Land Policy in Bulgaria”, held on 1-4 July 2004 in Plovdiv, Bulgaria.

King R. L., Burton S. P. (1982) Land fragmentation: Notes on a fundamental rural spatial problem, *Progress in Human Geography* 6(4), 475-494.

Kopeva D. (2001) Land Markets in Bulgaria, In “Land Settlement and Cooperatives”, *FAO and World Bank, Land Reform 2003/3*, Special Edition, 41-58.

Kopeva D. (2002) Country case study: Land markets in Bulgaria, presented at the World Bank regional workshop on land policy issues in Central Europe and CIS, April 3-6, 2002, Budapest, Hungary.

Kopeva D., Noev N. (2001) Aspects of land consolidation after the Land Reform, In *The New Structure of the Rural Economy of Post-communist Countries*, Ieda O. (ed.), Sapporo, Japan, Hokkaido University, 123-159.

Lerman Z. (2005) Farm fragmentation and productivity: Evidence from Georgia, Discussion Paper No. 8.05, Department of Agricultural Economics and Management, The Hebrew University of Jerusalem, 10p.

MAFS (2004) Bulgaria Ministry of Agriculture and Food Supply, Annual Agricultural Report 2004, Section A, p. 277.

MAFS (2005) Bulgaria Ministry of Agriculture and Food Supply, Annual Agricultural Report 2005, Section A, p. 277.

MAFS (2007) Bulgaria Ministry of Agriculture and Food Supply, *National Strategy Plan for Rural Development (2007-2013)*, Under the European Union Special Accession Program for Agriculture and Rural Development (SAPARD), p. 46.

McCloskey D. N. (1975a) The persistence of English common fields, In: *European peasants and their markets: Essays in agrarian economic history*, Parker, Jones (eds), Princeton, New Jersey, US, Princeton University Press, 73-119.

McCloskey D. N. (1975b) The economics of enclosure: A market analysis, In: *European Peasants and Their Markets: Essays in Agrarian Economic History*, Parker Jones (eds), Princeton, New Jersey, US, Princeton University Press, 123-160.

Noev N., Swinnen J. F. M., Vranken L. (2004) The development of land rental markets in Bulgaria and the former Yugoslav Republic of Macedonia, Research group on food policy, transition, and development, Working paper n°2004/1, Leuven, Belgium, Katholieke Universiteit Leuven, 92 p.

Rembold F. (2003) Land fragmentation and its impact in Central and Eastern European countries and the Commonwealth of Independent States. In *Land Reform, Land Settlement and Cooperatives*, FAO and World Bank, Land Reform 2003/3, Special Edition, 82-89.

Risina M., Mladenova M. (2002) (in Bulgarian) Po v"prosa za komasatsiyata na zemedelska zemya u nas, *Ikonimka i upravlenie na selskoto stopanstvo* 6, 13-19.

Sengupta N. (2006). Fragmented landholding, productivity, and resilience management, *Environment and Development Economics 11*(4), 507-532.

Simmons A. J. (1964) An index of farm structure, with a Nottinghamshire example, *East Midlands Geographer 3*, 255-261.

Stoianovich T. (1976) Balkan peasants and landlords and the Ottoman State: Familial economy, market economy and modernization. Proceedings of the association of South-Eastern European studies and international conference on social and economics held on March 23–26, 1976 in Hamburg, Germany, Institut d'Études Balkaniques, Musée National Polytechnique, [1977]), 164-204.

Tan S., Qu F., Heerink N. (2005) What drives land fragmentation? Theoretical approaches and empirical analysis, In: *Developmental dilemmas: Land reform and institutional change in China*, Ho P. (ed), New York, US, Routledge, 178-201.

Sundqvist P., Andersson L. (2006) A study of the impacts of land fragmentation on agricultural productivity in Northern Vietnam, Sweden, Uppsala University, 41 p.

Thomas J. (2006) Property rights, land fragmentation and the emerging structure of agriculture in Central and Eastern European countries, *The Electronic Journal of Agriculture and Development Economics 3*(2), 225-275.

Van Dijk T. (2003) Scenarios of Central European land fragmentation, *Land Use Policy 20*(2), 149-158.

Van Dijk T., Kopeva D. (2006) Land banking and Central Europe: Future relevance, current initiatives and Western European past experience, *Land Use Policy 23*(3), 286-301.

Wan G. H., Cheng E. (2001) Effects of land fragmentation and returns to scale in the Chinese farming sector, *Applied Economics 33*(2), 183-194.