Land Use Policy 89 (2019) 104247

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Land fragmentation and household income: First evidence from rural Vietnam

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ARTICLE INFO

JEL classification:
D31
D63
Q12
Q15
Q18

Keywords:
Cropland
Land law 1993
Land reform
Fragmentation
Household income
Rural Vietnam

ABSTRACT

We analyze the impact of land fragmentation on household income in rural Vietnam. Vietnam offers an especially interesting case study as fragmentation has been a direct outcome of land reforms since the early 1990s. Our study provides the first evidence that land fragmentation has negative consequences for household income, possibly because of its negative effects on crop income. Notably, using the Instrumental Variables (IV) method, we find that the negative effect is much greater after addressing the endogeneity of land fragmentation. IV analysis, therefore, suggests that a conventional approach which often uses the Ordinary Least Squares (OLS) method, ignoring the endogeneity of land fragmentation, is likely to underestimate the impact of land fragmentation on rural households. In addition, we find that the occupation of household heads was a major factor contributing to household income. Household income was also largely determined by some commune-level factors, such as road access, susceptibility to natural disasters and economic conditions. Our findings offer two key policy implications: (i) reducing land fragmentation would minimize its negative consequences for household income by reducing its negative effect on crop income; (ii) there is a need to increase job opportunities for rural households by improving access to better education, and increasing the demand for skilled labour. Both measures should be of practical use in rural areas.

1. Introduction

Land plays a strategic role in rural areas because of its multi-dimensional function. It constitutes a major factor in production (Finan et al., 2005), offers collateral in credit markets (Lipton, 1985), provides security against natural disasters or shocks, and gives social, economic and political status (Tran, 2013). A large number of studies have confirmed the importance of land and land reform in poverty reduction in developing countries (Nguyen and Tran, 2013; Tran, 2013). In Vietnam, the availability of cropland has contributed to the reduction of both the incidence and intensity of poverty in the Northwest region (Tran et al., 2015), while forestland was found to be a major factor contributing to household income and poverty alleviation in the North Central region (Nguyen and Tran, 2018).

Although arable land is the key asset of rural households in Vietnam, it is highly fragmented and the plots are small (Nguyen, 2014; Pham et al., 2007). In the northern plains, for instance, the median farm size is less than a quarter of a hectare and on average, farmland is fragmented into 5.5 distinct plots (Markussen et al., 2016). While the consequences of land fragmentation for agricultural production have been well established in the literature, no evidence exists, to the best of our knowledge, for its effect on household income in rural Vietnam. This scenario motivated the authors to conduct the current study to answer the research question concerning the extent to which land fragmentation affects household income in rural Vietnam.

The study provided the first evidence that cropland fragmentation had a negative effect on both incomes from crops and household income. Using different model specifications, the current study found notably that the negative impact is much greater when the instrumental variables (IV) method was employed. The IV analysis suggests that the conventional approach that often uses the OLS method, ignoring the endogeneity of land fragmentation, is likely to underestimate the impact of this fragmentation on rural households. Our research finding accords with previous work, which found that fragmentation has a negative effect on crop income, which in turn may reduce household income. Our findings suggest that by mitigating its negative effect on crop income, reducing land fragmentation would also reduce its negative effect on household income.

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https://doi.org/10.1016/j.landusepol.2019.104247
Received 19 March 2019; Received in revised form 6 September 2019; Accepted 18 September 2019

The paper is structured as follows. A literature review is provided in Section 2, followed by an overview of land fragmentation in Vietnam in Section 3, while data and methods are described in Section 4. The empirical results and discussion are reported in Section 5, and finally the conclusion and policy implications are given in Section 6.

2. Literature review

Empirical evidence often shows that land fragmentation has negative effects on agricultural production because fragmentation is a barrier to using modern, mechanized equipment, such as tractors and harvesters. Also, it can hinder the adoption of crops which can only be cultivated profitably on a larger scale (Markussen et al., 2016). Fragmentation often requires more labour input, both because of the obstacles to using mechanized equipment and because significant amounts of time are spent travelling between plots (Ciaian et al., 2018). More is involved in maintaining boundary demarcations (Markussen et al., 2016) and there are higher costs for the irrigation of many small units of land (Pham et al., 2007). Consequently, land fragmentation has significant negative effects on agricultural efficiency and growth in South Asia (Niroula and Thapa, 2005), Japan (Kawasaki, 2010), India (Manjunatha et al., 2013) and Vietnam (Nguyen, 2014; Pham et al., 2007).

Although the effects of land fragmentation have been found to be negative in numerous studies, not all forms of land fragmentation have resulted in disadvantages for farm households in certain cases (Ntihinyurwa et al., 2019). Fragmented farms may be more fertile and less likely to be exposed to the risk of crop diseases or natural disasters (Markussen et al., 2016). Land fragmentation may reflect a situation where farmers hold many plots of differing quality, enabling them to diversify their crops, spread labour requirements, and reduce production and price risks (Ciaian et al., 2018; Ntihinyurwa et al., 2019; Pham et al., 2007). By cultivating plots in different locations (such as lowland and upland areas), variation in farming outputs may be minimized as the risk from droughts, floods and diseases can be spread (Pham et al., 2007). A study by Ciaian et al. (2018) revealed that land fragmentation in rural Albania significantly fostered agricultural diversification, thereby improving food security, and the effects were greater among subsistence farm households than market-oriented households. The same result was also found for farm households in Rwanda where land fragmentation had a positive effect on food quality, food sustainability and food security (Ntihinyurwa et al., 2019).

The literature review suggests that land fragmentation can yield negative or positive net benefits for farming (Ciaian et al., 2018; Kawasaki, 2010; Ntihinyurwa et al., 2019), whereas there is little empirical evidence about its effect on household income. On the one hand, land fragmentation may have a positive or negative influence on household income, depending on whether it generates positive or negative effects on farming efficiency. On the other hand, in certain cases, the disadvantages or costs of land fragmentation may persuade farmers to diversify their livelihoods towards non-farm activities, which may offer higher returns than farming (Tran, 2014). The discussion suggests that land fragmentation may have either positive or negative effects on household income, depending on each specific case considered. Thus, empirical studies are needed to examine these effects.

3. An overview of land reform in Vietnam

3.1. Land collectivization

The collectivization process started in the North of Vietnam after the radical land reform of 1953-1955. Land was seized from landlords (địa chủ) by the Vietnamese Communist Party (VCP) and allocated to about 2 million households (Jamal and Jansen, 1998). However, this land policy was replaced by the institution of collective cooperatives, i.e., the collectivization process in the North between 1959 and 1960, and in the South of Vietnam after 1975 (Nguyen and Westen, 2012). Under the collective model, most farmers' land and production assets, livestock, and equipment were expropriated and made shared assets under the management of cooperatives (Bui and Preechametta, 2016). Each household was also allowed to hold a small plot of land, called "five percent" land, for its own private use.

However, the disadvantage of collectives had long been recognized by farmers and local cadres of the VCP (Akram-Lodhi, 2005). Many farmers felt that no matter how hard they worked, they still would not have enough food to eat (Nguyen and Westen, 2012). Thus, during the collective period, households spent most of their time and labor on their five percent land (Fforde, 2004) and productivity on private land was much higher than on collective land (Jamal and Jansen, 1998). In the North, while 75% of farmers joined cooperatives, they derived more than 60% of their income from outside the cooperatives, from the five percent land and non-farm work (Le, 1955).

After the reunification of North and South in 1975, the collective farming system was applied in the South of Vietnam. However, peasant resistance against this policy included both a refusal to join cooperatives and direct confrontation. By the end of 1979, only 33.5% of farm households had joined cooperatives, accounting for 27% of the cultivated area. Notably, in the whole Mekong Delta region, cooperatives covered only 0.6% of the area by 1991(Bui and Preechametta, 2016). The failure of the collective farming system was viewed as one of the main causes of socio-economic crisis in the 1980s. This encouraged the Vietnamese Communist Party to seek urgent solutions (Nguyen and Westen, 2012).

3.2. Land decollectivization and fragmentation

The "first wave" of agrarian reform lasted from 1981 to 1987. The reform commenced with the establishment of a household responsibility system, whereby land was reallocated from collectives to households as production units. State purchase prices of agricultural products were increased, resulting in huge improvements in agricultural production (Nguyen, 2014). In particular, Resolution 10 in 1988 provided for the decollectivization of agriculture and allocated land to farming households, leading to a boost in agricultural output and improvements in the living standard of the rural population (Nguyen, 2014; WB, 2016). It has been recognized that the agricultural reforms in the late 1980s contributed substantially to raising both food production and household welfare in rural Vietnam (Nguyen and Tran, 2013; WB, 2016). From being a net food consumer in the early 1980s, Vietnam has since emerged as a leading food exporter. In addition, the country's agricultural sector has made the shift from central planning to a dynamic market agricultural system (WB, 2016).

In the "second wave" of agrarian reform, the Land Law of 1993 and Decree 64 (1993) allocated agricultural land to long-term farmers with a history of stable land use and provided them with five land rights, including the right of transfer, exchange, lease, inheritance and mortgage. According to Resolution 10 in the late 1980s, the crucial principle in decollectivizing the agricultural system was to ensure equality in land allocation. Land was distributed according to two main criteria: (i) the number of household members and (ii) land quality as determined by the irrigation system, distance among plots and other farming conditions (Nguyen, 2014). Consequently, every household tended to receive more than one plot of land with different qualities and locations. This policy of equal distribution has become the major cause of land fragmentation in Vietnam (Van Hung et al., 2007). Other causes are the absence of a complete regulatory framework and the high transaction costs that prevent participation in the land market (WB, 2003).

In Vietnam, land reform and the process of agriculture decollectivization have been implemented as a crucial part of the country's economic renovation policies (Đổi Mới) (Kirk and Nguyen, 2009). The expansion of land use rights under various waves of land reform actively stimulated buying, selling and renting activities in the land

market and as a result, agricultural land could be transferred and accumulated by more efficient farmers (Dang and Malcolm, 2010; Ravallion and Van de Walle, 2008). While land reform significantly facilitated the consolidation of land (reducing land fragmentation) in Vietnam (Dang and Malcolm, 2010), this change in the agricultural sector was reviewed and found to be one of the main causes of the rise of landless poor peasants and the formation of a rich peasant class in rural Vietnam (Akram-Lodhi, 2005; Dao, 1995). However, agricultural transformation in both Vietnam (Tran, 2014) and other developing countries (Bryceson, 1996; Ellis, 2000; Rigg, 2006) indicated that nonfarm diversification emerged as a common trend among farming households. In general, these studies concluded that land had lost its important role in determining rural livelihood and its function was gradually displaced by other elements, such as education, skills, and networks.

4. Data and methods

4.1. Data

To investigate the impact of land fragmentation on household income, the research utilized data from the 2014 VHLSS (Vietnam Household Living Standards Survey), which was carried out by the General Statistical Office of Vietnam (GSO) with technical assistance from the World Bank (WB). Each VHLSS covers 9189 households sampled from 3063 communes (2280 rural and 783 urban communes). Households were randomly selected and representative on the national, rural and urban levels.

Data on both households and communes were collected by the VHLSS. Household data include detailed information about demography, employment and education, expenditure and income, assets and housing, and especially arable land and other types of land. Commune data were collected for rural areas only and cover demography, infrastructure and socio-economic characteristics. The information was merged with household data, providing a sub-sample of about 3300 rural households owning annual croplands. The combined data allowed us to examine both household and commune-related factors affecting household income.

4.2. Methods

4.2.1. Measuring land fragmentation

While land fragmentation is commonly described as a large number of non-contiguous small plots or a large number of plot co-owners, it is actually a more complex issue, including other factors, such as plot size, the shape of individual plots, the distance of plots from home and distances among plots (Latruffe and Piet, 2014). Since it is difficult to measure all dimensions of land fragmentation at the same time (Ciaian et al., 2018), most studies quantify farmland fragmentation using Simpson's diversification index, which takes into account the number of plots, plot size and farm size (Van Hung et al., 2007).

The Simpson's index of land fragmentation is described as $(1 - (\sum a_j^2/A^2))$ where a_j is the size of the plot j, A is the farm size and $A = \sum a_j$. The value of the index varies between zero and one, with a greater value meaning more diversity or more land fragmentation (Ciaian et al., 2018). A zero value means that the farming household has only one parcel or plot of land, indicating complete land consolidation, while a value close to one shows that the household has numerous plots and the farm is "very fragmented" (Van Hung et al., 2007). In our study, because fragmentation is most common with annual cropland, only this type of land was measured, not other types of land. Also, households without annual cropland were excluded from our research sample.

4.2.2. Modelling the impact of land fragmentation on household income

Following Nguyen and Tran (2013), we used a Cobb–Douglas production function in the form of a double-log function commonly used to model the effect of land on household welfare (Ravallion and Van de Walle, 2008). Our study assumed that per capita household income is a function of land holdings and other explanatory variables, as given in Eq. (1).

$$LnY_{ij} = b_0 + b_1X_{ij} + b_2LnZ_{ij} + b_3C_j + e_{ij} \quad (1)$$

where LnY_{ij} is the natural logarithm of per capita household income of household i in commune j. X_{ij} is a vector of household characteristics, such as ethnicity, education, gender and age of household heads, household size, dependency ratio and the main job of household heads (e.g., skilled vs unskilled)[1] . Z_{ij} is a vector of variables of various types of land and annual cropland fragmentation. C_j is a vector of commune variables controlling for natural and socio-economic characteristics. The variable of interest is the annual cropland fragmentation; e_{ij} is the error term.

$$Lncrop_{ij} = b_0 + b_1X_{ij} + b_2LnZ_{ij} + b_3C_j + e_{ij} \quad (2)$$

Eq. (2) was also used to examine the effect of land fragmentation on crop income, using the same controlling variables as those in Eq. (1), because land fragmentation is likely to be determined by other exogenous factors, such as geographic characteristics. A number of studies confirm that land fragmentation more commonly occurs in the north than the south of Vietnam (Nguyen, 2014; Van Hung et al., 2007). This suggests that potential endogeneity may arise because land fragmentation is an explanatory variable but is jointly determined with household income by regional variables. Consequently, the OLS method would yield biased and inconsistent estimates and the method of instrumental variables (IV) should be used instead to generate consistent estimators (Wooldridge, 2013).

We use two dummy variables for geographical regions, namely the Southeast and Mekong Delta, as the two instruments for annual cropland fragmentation.[2] The reason for this choice is that the level of fragmentation is much lower in these two regions than in other regions (see Table 2). This suggests that the geographical dummy variables are closely linked with land fragmentation, which meets the requirements of instrument relevance. However, using regional variables as the instruments may fail to meet the assumption of instrument exogeneity because some regions have better socio-economic conditions which may directly affect household income. This discussion indicates that several necessary IV tests must be used to verify whether both the assumption of instrument relevance and of exogeneity are satisfied, or at least that the use of a set of invalid and weak instruments providing imprecise estimates and misleading conclusions can be avoided (Baum et al., 2003).

First, the IV method estimates the effect of instrumental variables on land fragmentation. It then estimates the impact of land fragmentation on household income. By following this procedure, instruments affect income only through their impact on fragmentation. The current study utilized a formal weak instrument test proposed by Stock and Yogo (2005), using a test statistic value that is the F-statistic form of the Cragg-Donald Wald F statistic. Table 3 shows that the values of the Cragg-Donald Wald F-statistic were 176.83, a figure much larger than the reported critical value of 19.93, suggesting that the instruments are not weak and satisfying the relevance requirement. The results of the first stage of regression (Appendix A) show that the first-stage F-statistic is 173.08, which indicates that our study did not suffer from weak instrument problems (Stock et al., 2002).

[1] Following the specific instructions of the International Standard Classification of Occupations (ISCO) (International Labour Organisation, 2012), we classified the main job of household heads into four groups, using ISO-88 and one-digit levels. Thus, four occupational groups are identified as: (i) unskilled workers; (ii) skilled manual workers; (iii) low-skilled non-manual workers; (iv) high-skilled non-manual workers.

[2] The omitted category is other geographical regions, as given in Table 2.

We also checked the validity of the instruments using an over-identifying restrictions test, with both 2SLS (two stage least squares) and LIML (limited information maximum likelihood) estimates.[3] Both results showed that the Hansen J-statistics were not statistically significant (p-value = 0.90) and thus confirmed the validity of the instrumental variables (Baum et al., 2003). The specification tests showed that the selected instrumental variables are in fact reliable instruments. Because land fragmentation is potentially an endogenous explanatory variable, an endogeneity test of this variable was performed. The results confirmed that the null hypothesis of exogenous regressors was rejected at the 1% level, indicating that land fragmentation is endogenous (Table 3). This result implies that it is more appropriate to use the IV than the OLS model.

5. Results and discussion

5.1. Descriptive statistics analysis

According to the descriptive statistics reported in Table 1, each household has an average of 4.0 members but household size may include as many as 11 members, given that households often have relatives in the extended family. The average age of the head of household is 50 years and ranges between 16 and 105 years, while their average years of education are approximately 7.20, varying between 0 and 16. The data show that household heads in unskilled jobs comprise about 62% of the sample, followed by those with skilled manual jobs (29%), while those with low-skilled and high-skilled non-manual jobs account for about 7% and 3%, respectively. The commune data indicate that most households live in communes that are accessible by road. The percentage of households living in communes prone to natural disasters is 60%. About one fifth of households reside in poor communes. The distribution of households by geographic region indicates that about half live in inland delta areas, while about 42% live in mountainous areas. Only 4% and 5% live in coastal and hills/midland areas, respectively.

Fig. 1 presents the distribution of income sources over income quintiles. It shows that income from agriculture accounted for about 30% of total household income, while about 70% were contributed by sources outside agriculture. This implies that incomes from sources outside agriculture play an important role in rural household livelihoods. Diversification towards nonfarm activities was also found for the poorest quintile, with about 50% of their household income earning from sources outside agriculture. As compared to the households in the higher income quintiles (the fourth and fifth), the households in lower income quintiles (the first and second) earned a higher share of agricultural income, while those in the richer groups had a higher share of non-farm self-employment income. This suggests that some income sources are closely linked with the income distribution; specifically, there is a positive association between the non-farm self-employment income share and per capita income, but a negative correlation between the farm income shares and per capita income.

Table 2 shows some of the main characteristics of land fragmentation. The average number of annual cropland plots per household is 2.88 for the whole sample. However, the figure varies significantly across regions, from only 1.41 in the Southeast region to 4.04 in the Northeast Mountains. On average, each plot has an area of 2573 m^2 for the whole sample. The smallest plot size is found in the Red River Delta (RRD) region (947 m^2), while the largest is in the MK region (7150 m^2). The average value of Simpson's diversification index is about 4.0 for all households, ranging from 0 to 0.93 (Fig. 2 and Table 1). This index of land fragmentation records its lowest values of 0.12 and 0.14 in the SE and MK regions, and the greatest values of 0.54 and 0.47 in the WNM and NCC regions, respectively. Overall, the data suggest that land fragmentation is much higher in the central (NCC and SCC) and northern regions (RRD, ENM, WNM) than in the southern regions (SE and MK).

Table 1
Descriptive statistics of the household sample.
Source: Author's estimation using data from the 2014 VHLSS.

Variable	Mean	Std. Dev.	Min	Max
Education of household heads (years of schooling)	7.22	3.80	0	16
Gender of household head (1 = male; 0 = female)	0.82	0.38	0	1
Age of household head (years)	50.22	13.98	16	105
Marital status of household head (1 = married; 0 = single)	0.02	0.13	0	1
Ethnicity of household head (1 = major; 0 = minor)	0.75	0.43	0	1
Dependency ratio (ratio)	0.36	0.29	0	1
Household size (total number of family members)	4.00	1.62	1	11
Unskilled job (1 = yes; 0 = other)	0.62	0.49	0.62	1
Skilled manual job (1 = yes; 0 = other)	0.29	0.45	0.29	1
Low-skilled non-manual job (1 = yes; 0 = other)	0.07	0.25	0.07	1
High-skilled non-manual job (1 = yes; 0 = other)	0.03	0.16	0.03	1
Annual cropland: m^2	4937	8020	0	140000
Perennial cropland: m^2	860	4230	0	100000
Forestland: m^2	2260	12324	0	400000
Water area for aquaculture: m^2	279	4200	0	200000
Residential land and gardens: m^2	530	938	0	21000
Number of annual cropland plots	2.88	2.27	1	18
Annual cropland fragmentation (ratio)	0.39	0.31	0	0.93
Access to roads (1 = yes; 0 = not)	0.94	0.24	0	1
Natural disaster prone (1 = yes; 0 = no)	0.59	0.49	0	1
Coastal areas (1 = yes; 0 = other)	0.04	0.19	0	1
Inland delta (1 = yes; 0 = other)	0.48	0.50	0	1
Hills/midlands (1 = yes; 0 = other)	0.05	0.22	0	1
Low mountains (1 = yes; 0 = other)	0.21	0.41	0	1
High mountains (1 = yes; 0 = other)	0.21	0.41	0	1
Poor commune (1 = yes; 0 = no)	0.22	0.42	0	1

5.2. Econometric analysis

Table 3 reports the results of the effect of land fragmentation on household income, using both OLS and IV estimators. The Simpson index is used to measure land fragmentation, which is the variable of interest. Our regression model controlled for household characteristics such as age, gender, ethnicity, the education and main job of household heads, and the size of various types of land. In addition, commune factors related to infrastructure, and regional characteristics are also controlled for.

As mentioned earlier, one of the main purposes of our study is to examine the relationship between land fragmentation and household income. Using an OLS estimator, Model 2 analyzes the impact of land fragmentation, ignoring the endogenous issue[4] . To address the endogeneity problem, the study used the IV method and the results are given in Table 3. The coefficient of the land fragmentation variable in both estimators is negative and statistically highly significant. This confirms that land fragmentation has a depressing effect on household income, even after controlling for the endogeneity issue and other factors in the models. In particular, the estimates of the IV estimator show that increasing land fragmentation by one percentage point is associated with a decrease in household income by -0.34%, as compared to only -0.08% when using the OLS estimator. Therefore, the IV analysis suggests that the OLS estimation may underestimate the effect of land fragmentation. Our study provides the first evidence that land

[3] Angrist and Pischke (2008, p. 213) advise: "Check over-identified 2SLS estimates with LIML. LIML is less precise than 2SLS but also less biased. If the results come out similar, be happy. If not, worry, and try to find stronger instruments or reduce the degree of over-identification".

[4] Endogeneity test in Table 3 confirms that land fragmentation is endogenous and thus the IV estimator should be preferred.

Table 2
Descriptive statistics of annual cropland fragmentation.
Source: Author's estimation using data from the 2014 VHLSS.

Region	No of plots		Size of plot		Land fragmentation		Total area	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Red River Delta (RRD)	2.98	2.26	947	3379	0.41	0.32	2104	3671
East Northern Mountains (ENM)	4.04	2.84	1280	2052	0.54	0.28	3908	6425
West Northern Mountains (WNM)	3.06	1.95	3783	4359	0.43	0.27	9553	10139
North Central Coast (NCC)	3.10	2.06	1461	2185	0.47	0.28	3510	3446
South Central Coast (SCC)	2.88	2.17	1419	2709	0.41	0.31	3613	6403
Central Highlands (CH)	1.82	1.03	6103	9692	0.23	0.23	9640	11698
Southeast (SE)	1.41	0.96	6703	8777	0.12	0.22	8594	10699
Mekong Delta (MK)	1.44	0.82	7150	9815	0.14	0.24	9682	12286
Total	2.88	2.27	2573	5584	0.39	0.31	4937	8020

Table 3
The impact of land fragmentation on household income.

	IV estimator		OLS estimator	
Explanatory variables	Coefficients	SE	Coefficients	SE
Land fragmentation	−0.34***	(0.098)	−0.08**	(0.038)
Education	0.04***	(0.004)	0.04***	(0.003)
Gender	0.00	(0.036)	0.00	(0.035)
Age	0.01***	(0.001)	0.01***	(0.001)
Marital status	−0.19**	(0.090)	−0.18**	(0.089)
Ethnicity	0.25***	(0.054)	0.26***	(0.052)
Dependency ratio	−0.40***	(0.043)	−0.37***	(0.041)
Household size	−0.06***	(0.008)	−0.06***	(0.008)
Skilled manual job	0.17***	(0.027)	0.17***	(0.027)
Low-skilled non-manual job	0.37***	(0.043)	0.37***	(0.042)
High-skilled non-manual job	0.32***	(0.066)	0.34***	(0.063)
Annual cropland	0.09***	(0.013)	0.08***	(0.012)
Perennial cropland	0.04***	(0.010)	0.05***	(0.009)
Forestland	0.00	(0.010)	0.00	(0.010)
Aquaculture land	0.07***	(0.015)	0.06***	(0.015)
Coastal	0.24***	(0.070)	0.25***	(0.070)
Inland delta	0.40***	(0.050)	0.41***	(0.049)
Hills/midlands	0.34***	(0.063)	0.31***	(0.065)
Low mountains	0.28***	(0.052)	0.25***	(0.052)
Poor commune	−0.33***	(0.047)	−0.32***	(0.047)
Natural disaster prone	−0.08***	(0.025)	−0.08***	(0.024)
Road access	0.14***	(0.051)	0.11**	(0.051)
Constant	6.42***	(0.095)	6.45***	(0.095)
Observations	3,265		3,265	
Centered R2/R-squared	0.26		0.37	
Excluded instrumental variables: The Southeast; Mekong Delta				
Weak identification test (Cragg-Donald Wald F-statistics) 172.82				
[Stock-Yogo weak ID test critical value at 10%] 19.93				
Hansen J statistic (*p-value*) 0.97				
Endogeneity test of land fragmentation (*p-value*) 0.00				

Robust standard errors (SE) are in parentheses and are clustered at the commune level. *** p < 0.01, ** p < 0.05, * p < 0.1. Estimates accounted for sampling weights. The omitted categories in the dummy variable analyses are female sex, unmarried, ethnic minorities, unskilled job; high mountains; non-poor communes; no disasters; no road access.

fragmentation does, in fact, result in a negative effect on household income in rural Vietnam. This can be explained by the consideration that land fragmentation may reduce crop income, which in turn may lower household income. Using the IV estimator, we also examine whether land fragmentation has a negative effect on crop income. The results (see Appendix B) confirm that land fragmentation has the effect of reducing crop income.

The study finds that except for forestland, most types of land have a positive effect on household income. For instance, both models indicate that a 1% increase in annual cropland would increase per capita income by about 0.09% on average, holding all other factors in the model constant. A positive effect is also observed for perennial cropland (0.04%-0.05%). Our research finding that forestland has no effect on income accords with results for the Northwest region (Tran, 2015) but contrasts with that from a study by Nguyen and Tran (2018), who found that forestland had a positive effect on household income in the North Central region. The reason for the discrepancy may be that our study used the VHLSS data covering the whole rural region, whereas other studies (Tran, 2015; Nguyen and Tran, 2018) focused on only one geographical region.

The study confirms that the occupation of household heads plays a major role in household welfare. The results in both models in Table 3 show that on average, per capita income is about 17% higher for a household whose head has a skilled manual occupation than it is where the head works as an unskilled laborer. The effect is also much higher for a household whose head works in a low-skilled non-manual job (37%) or has a high-skilled non-manual occupation (32%–35%), relative to one whose head works as an unskilled laborer.

The education of household heads has a positive impact on household income, and an additional year of formal schooling increases per capita income by 4%, keeping all other factors in the models constant. We find that ethnicity plays a major role in explaining income differentials in rural Vietnam. Per capita income is about 25% higher for a household whose head belongs to the Kinh/Hoa (ethnic majority) group than for one whose head comes from an ethnic minority group. Household size and dependency ratio are also found to be negatively linked with household income, suggesting that the presence of more family members and dependents reduces household welfare in rural Vietnam. Similar results are also reported in previous studies in Vietnam (Nguyen and Tran, 2013).

Finally, the current study reveals that some commune-related factors play a significant role in household welfare. The results from the OLS estimator suggest that households living in a commune with road access have higher income (11%) than those living in a commune without. Susceptibility to natural disasters also reduces household income (about 8%), while those residing in poor communes have much lower income than those residing in non-poor communes, with an income gap of about -33%. Households living in high mountain areas earn much lower incomes than those living in other regions. This suggests that geographic region is a major factor explaining income differentials among rural households.

6. Conclusion and policy implication

Vietnam presents a particularly interesting case for investigating land fragmentation, as this is a consequence of land policy reform carried out in the early 1990s. Land reform is considered the most important cause of land fragmentation, and this issue persists to the present day. Although there have been several studies investigating whether fragmentation hinders or is beneficial to crop production, no evidence exists for the impact of fragmentation on household income in rural Vietnam. Thus, our study fills a gap in the literature on Vietnam by investigating the consequences of land fragmentation for household income.

Our study provides evidence that fragmentation has a negative effect on household income, even after controlling for other factors in the models. Notably, using the instrumental variables (IV) method, we find

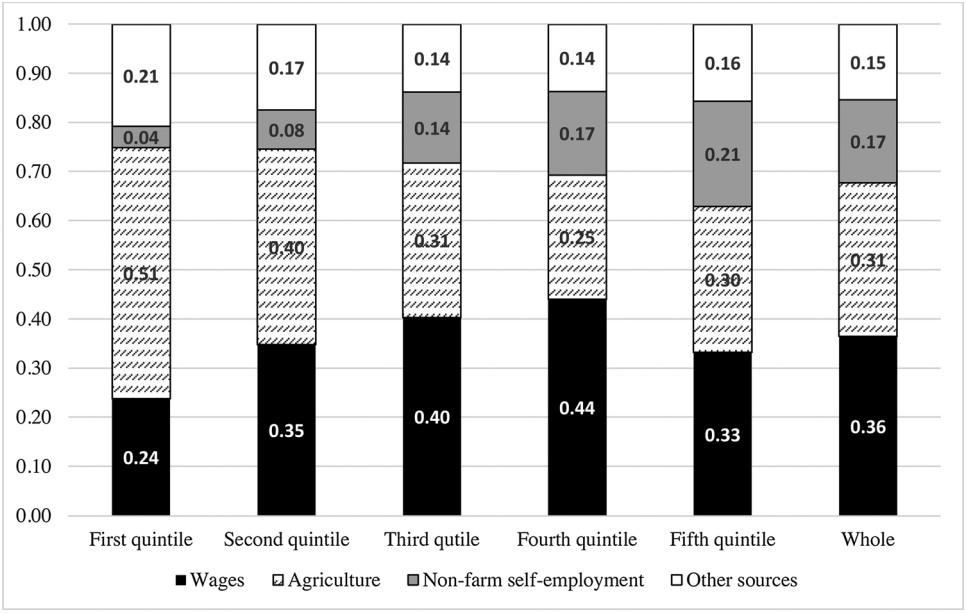

Fig. 1. Income structure by income quintiles.
Note: Quintiles are estimated based on per capita household income.
Source: Author's estimation using data from the 2014 VHLSS.

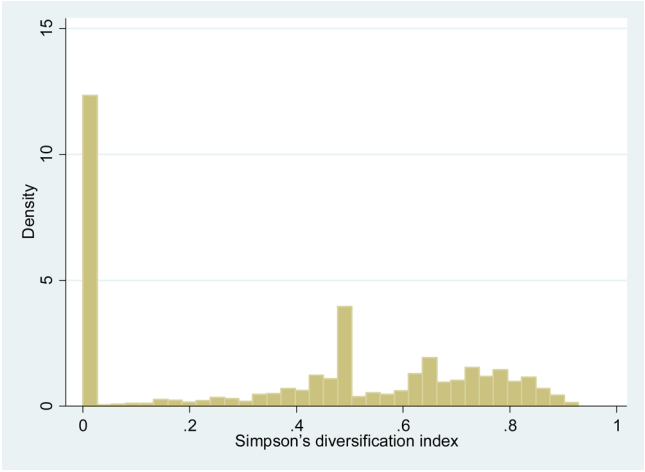

Fig. 2. Distribution of land fragmentation.
Source: Author's estimation using data from the 2014 VHLSS.

that the negative effect is much greater after addressing the endogeneity of land fragmentation. IV analysis, therefore, suggests that a conventional approach which often uses the OLS method, ignoring the endogeneity of land fragmentation, is likely to underestimate the impact of fragmentation on rural households.

In order to answer the question as to what may be the potential causes of the negative effect of land fragmentation on household income, we further examine the effect of fragmentation on crop income, using an IV estimator. The result confirms that higher levels of fragmentation are closely linked with lower levels of crop income, which suggests that land fragmentation reduces overall household income, possibly through its negative effect specifically on crop income. The finding thus suggests that reducing land fragmentation or increasing land consolidation can be expected to increase crop income, thereby improving household income in rural Vietnam.

Our study also identifies a number of other factors making a substantial contribution to household income. Specifically, the occupation of household heads was found to play a major role in explaining income differentials. Household heads who have jobs that are non-manual or require higher skills help their households earn much higher income. Such jobs usually require better education, suggesting that educational policies should be prioritized and adopted as a major approach for improving living standards in rural areas. This suggests that policies improving the access of rural households to better education, together with efforts to increase the demand for skilled labour, should be of practical use in rural areas.

Our findings support previous conclusions (e.g., Bryceson, 1996; Ellis, 2000; Rigg, 2006) that land has lost its crucial influence in determining rural livelihoods. This role has been gradually taken over by non-farm activities that often require education, skills, and networks, rather than land ownership. This implies that a land distribution policy should not be viewed as the main approach to rural poverty reduction in rural Vietnam. We also found that some commune factors, such as the availability of roads and the prevalence of natural calamities, have an influence on household income. A policy implication here is that local government can minimize the negative effects of natural disasters by improving preparedness and mitigation measures for various natural disasters. Finally, increasing rural-urban linkages by increasing rural household access to roads in their villages is also expected to generate more non-farm job opportunities for the rural population.

Our study has certain limitations. Due to the fact that detailed information about land fragmentation was only available in the 2014 VHLSS and longitudinal or panel data were therefore lacking, we were unable to examine the effect of land fragmentation over time. The use of panel data for formulating a household income equation would reduce bias, as this method accounts for time-invariant unobservable household characteristics. This suggests that further research is needed to address this issue, given the availability of panel data.

Funding

This research is funded by National Foundation for Science and Technology Development (NAFOSTED), Hanoi, Vietnam.

Declaration of Competing Interest

The authors declare that they have no conflict of interest in this research.

Appendix A. Factors associated with land fragmentation (the first stage regression)

Explanatory variables	Coefficients	Robust Standard errors
Education	0.003	0.002
Gender	0.002	0.015
Age	0.000	0.000
Marital status	−0.030	0.037
Ethnicity	−0.093***	0.020
Dependency ratio	0.013***	0.004
Household size	0.019	0.014
Skilled manual job	0.007	0.022
Low-skilled non-manual job	−0.062*	0.035
High-skilled non-manual job	0.096***	0.007
Annual cropland	−0.020***	0.005
Perennial cropland	0.009**	0.004
Forestland	0.031***	0.007
Aquaculture land	0.071*	0.042
Coastal	0.095***	0.027
Inland delta	0.193***	0.038
Hills/midlands	0.165***	0.026
Low mountains	−0.029	0.021
Poor commune	−0.010	0.014
Natural disaster prone	0.045*	0.025
Road access	0.003	0.002
Mekong Delta	−0.373***	0.029
South East	−0.340***	0.021
Constant	−0.113**	0.049
Observations	3,265	
Centered R2/R-squared	0.264	
The first-stage F-statistic	173.08	

Robust standard errors (SE) are in parentheses and clustered at the commune level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimates accounted for sampling weights.

Appendix B. The impact of land fragmentation on crop income (IV estimator)

VARIABLES	Coefficient	SE
Land fragmentation	−0.63***	(0.238)
Education	0.01**	(0.006)
Gender	0.18***	(0.056)
Age	0.00	(0.002)
Marital status	0.12	(0.140)
Ethnicity	0.11	(0.071)
Dependency ratio	−0.42***	(0.075)
Household size	0.08***	(0.012)
Skilled manual job	−0.09**	(0.043)
Low-skilled non-manual job	−0.25***	(0.076)
High-skilled non-manual job	−0.37***	(0.132)
Annual cropland	0.60***	(0.024)
Perennial cropland	0.23***	(0.017)
Forestland	0.01	(0.012)
Aquaculture land	0.13***	(0.026)
Coastal	−0.11	(0.116)
Inland delta	0.12	(0.083)
Hills/midlands	−0.05	(0.108)
Low mountains	0.16**	(0.076)
Poor commune	−0.22***	(0.060)
Natural disaster prone	−0.12***	(0.040)
Road access	0.03	(0.074)
Constant	6.70***	(0.161)
Observations	3,113	
R-squared	0.415	
Weak identification test (Cragg-Donald Wald F statistics) 157.19		
[Stock-Yogo weak ID test critical value at 10%] 19.93		
Hansen J statistic (*p-value*) 0.71		
Endogeneity test of land fragmentation (*p-value*) 0.00		
Excluded instrumental variables: The Southeast; Mekong Delta		

Robust standard errors (SE) are in parentheses and clustered at the commune level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimates accounted for sampling weights.

References

Angrist, J., Pischke, J.S., 2008. Mostly Harmless Econometrics: an Empiricist's Companion. Princeton University Press, Princeton, NJ.

Akram-Lodhi, A.H., 2005. Vietnam's agriculture: processes of rich peasant accumulation and mechanisms of social differentiation. J. Agrar. Change 5 (1), 73–116.

Baum, C.F., Schaffer, M.E., Stillman, S., 2003. Instrumental variables and GMM: estimation and testing. Stata J. 3 (1), 1–31.

Bryceson, D.F., 1996. Deagrarianization and rural employment in sub-Saharan Africa: a sectoral perspective. World Dev. 24 (1), 97–111.

Bui, M.T.T., Preechametta, A., 2016. Land Inequality or Productivity: What Mattered in Southern Vietnam after 1975? Asia Pac. Policy Stud. 3 (2), 300–319.

Ciaian, P., Guri, F., Rajcaniova, M., Drabik, D., y Paloma, S.G., 2018. Land fragmentation and production diversification: a case study from rural Albania. Land Use Policy 76, 589–599.

Dang, H.H., Malcolm, M., 2010. Land Policy for Socioeconomic Development in Vietnam. Harvard Kennedy School, the Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD), Washington D.C.

Dao, T.T., 1995. The peasant household economy and social change. In: Tria, K.B., Porter, D.J. (Eds.), Vietnam's Rural Transformation. Singapore: nstitution of Southeast Asian Studies, pp. 139–163.

Ellis, F., 2000. Rural Livelihoods and Diversity in Developing Countries. Oxford university press.

Fforde, A., 2004. Vietnamese agriculture: changing property rights in a mature collectivized agriculture. Communist Agriculture. Routledge, pp. 117–141.

Finan, F., Sadoulet, E., De Janvry, A., 2005. Measuring the poverty reduction potential of land in rural Mexico. J. Dev. Econ. 77 (1), 27–51.

Jamal, V., Jansen, K., 1998. Agrarian Transition in Viet Nam. ILO Working Papers. International Labour Organization, Geneva, Switherland.

International Labour Organisation, 2012. International Standard Classification of Occupations (ISCO-08). Volume 1: Structure, Group Definitions and Correspondence Tables. International Labour Office, Geneva.

Kawasaki, K., 2010. The costs and benefits of land fragmentation of rice farms in Japan. Aust. J. Agric. Resour. Econ. 54 (4), 509–526.

Kirk, M., Nguyen, T.A.D., 2009. Land-Tenure Policy Reforms: Decollectivization and the Doi Moi System in Vietnam Vol. 927 International Food Research Institute, Washington D.C.

Latruffe, L., Piet, L., 2014. Does land fragmentation affect farm performance? A case study from Brittany, France. Agric. Syst. 129, 68–80.

Le, N., 1955. Cuộc sống mới của nông dân sau cải cách ruộng đất" [A Farmer's New Life after Land Reform]. NXB Sự Thật, Hanoi, Vietnam.

Lipton, M., 1985. Land Assets and Rural Poverty. World Bank Staff Working Papers Number 744. The World Bank, Washington DC.

Manjunatha, A., Anik, A.R., Speelman, S., Nuppenau, E., 2013. Impact of land fragmentation, farm size, land ownership and crop diversity on profit and efficiency of irrigated farms in India. Land Use Policy 31, 397–405.

Markussen, T., Tarp, F., Thiep, D.H., Tuan, N.D.A., 2016. Inter-and Intra-farm Land Fragmentation in Viet Nam. No. 2016/11. The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki.

Nguyen, C.V., Tran, A.N., 2013. The role of crop land during economic development: evidence from rural Vietnam. Eur. Rev. Agric. Econ. 41 (4), 561–582.

Nguyen, H., 2014. The Effect of Land Fragmentation on Labor Allocation and the Economic Diversity of Farm Households: the Case of Vietnam. MPRA Paper No. 57521. Munich, Germany. Retrieved from. http://mpra.ub.uni-muenchen.de/57521/.

Nguyen, P.Q., Westen, Gv., 2012. Emerging Land conversion from agriculture to urban development: situation and raised concerns in Vietnam. In: Paper Presented at the The 18 Annual International Sustainable Development Research Conference (ISDRC 18). Hull University, UK.

Nguyen, T.V., Tran, T.Q., 2018. Forestland and rural household livelihoods in the North Central Provinces, Vietnam. Land Use Policy 79 (2), 1–13.

Ntihinyurwa, P.D., de Vries, W.T., Chigbu, U.E., Dukwiyimpuhwe, P.A., 2019. The positive impacts of farm land fragmentation in Rwanda. Land Use Policy 81, 565–581.

Niroula, G.S., Thapa, G.B., 2005. Impacts and causes of land fragmentation, and lessons learned from land consolidation in South Asia. Land Use Policy 22 (4), 358–372.

Pham, H.V., Gordon MacAulay, T., Marsh, Sally P., 2007. The economics of land fragmentation in the north of Vietnam. Aust. J. Agric. Resour. Econ. 51 (2), 195–211.

Ravallion, M., Van de Walle, D., 2008. Land in Transition: Reform and Poverty in Rural Vietnam. The World Bank, Hanoi, Vietnam.

Rigg, J., 2006. Land, farming, livelihoods, and poverty: rethinking the links in the rural South. World Dev. 34 (1), 180–202.

Stock, J.H., Yogo, M., 2005. Chapter 5: testing for weak instruments in linear IV regression. In: Andrews, D.W.K., Stock, J.H. (Eds.), Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg. Cambridge University Press, Cambridge, UK, pp. 80–108.

Stock, J.H., Wright, J.H., Yogo, M., 2002. A survey of weak instruments and weak identification in generalized method of moments. J. Bus. Econ. Stat. 20 (4), 518–529.

Tran, T.Q., 2013. Farmland Acquisition and Household Livelihoods in Hanoi's Peri-urban Areas. University of Waikato, Waikato, New Zealand.

Tran, T.Q., 2014. A review on the link between nonfarm employment, land and rural livelihoods in developing countries and Vietnam. Ekonomski horizonti 16 (2), 113–123.

Tran, T.Q., 2015. Socio-economic determinants of household income among ethnic minorities in the North-West Mountains, Vietnam. Croat. Econ. Surv. 17 (1), 139–159.

Tran, T.Q., Nguyen, S.H., Vu, H.V., Nguyen, V.Q., 2015. A note on poverty among ethnic minorities in the Northwest region of Vietnam. Post-Communist Econ. 27 (2), 268–281.

Wooldridge, J.M., 2013. Introductory Econometrics: a Modern Approach, 5 ed. South-Western Cengage Learning, Mason, OH.

WB, 2003. Vietnam: delivering on its promise. Vietnam development report 2003. In: the World Bank in Collaboration With the ADB Vietnam Consultative Group Meeting. Hanoi, Vietnam: World Bank.

WB, 2016. Transforming Vietnamese Agriculture: Gaining More From Less. The World Bank, Washington, DC.