Farming efficiency, cropland rental market and welfare effect: Evidence from panel data for rural Central Vietnam

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Paper prepared for presentation at the 165. EAAE Seminar 'Agricultural Land Markets – Recent Developments, Efficiency and Regulation'

Humboldt-Universität zu Berlin, Germany, April 4-5, 2019

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Abstract: (max. 100 words)

Using panel data of more than 1,000 rural households from three rural provinces in Vietnam, we find that farming efficiency is a driver of cropland rental market development that enhances land use efficiency and results in an overall income gain for market participants. Our findings highlight the importance of cropland rental markets in facilitating economic transformation in rural areas of rapidly growing economies, but also indicate the need to take care of the poor to ensure that they are not left behind.

Keywords: farming efficiency; cropland rental market; stochastic frontier analysis; heteroscedasticity-based identification strategy; quantile regression; Vietnam

JEL Code: D01, Q12, O12

Acknowledgements:

We thank the farmers in Ha Tinh, Thua Thien Hue and Dak Lak provinces for their support and cooperation. Constructive comments from Martin Odening and the participants in the EAAE Seminar "Agricultural Land Markets - Recent Developments, Efficiency and Regulation" organized by the Humboldt University in April 4-5, 2019 are acknowledged. We also thank the German Research Foundation (DFG) for the financial support through the long-term Thailand-Vietnam Socioeconomic Panel Project (www.tvsep.de).

1 Introduction

Structural change in agriculture during economic growth is characterised by reallocation of labour from farm to non-farm sectors and transfer of cropland from those who move to non-farm sectors to those who continue farming (Lewis, 1954; Ngai and Pissarides, 2007). This process can be considered as adjustments of economic entities in the agricultural sector in response to various driving forces (Odening and Grethe, 2012) such as farming ability (Gollin *et al.*, 2002; Üngör, 2013) and development of non-farm sectors (Hansen and Prescott, 2002; Wang *et al.*, 2016). It is a notion that the consolidation of cropland is integral to the process of agricultural transformation, which is facilitated by market mechanisms for voluntary cropland transfers such as land rental markets (Hüttel *et al.*, 2013; Adamopoulos and Restuccia, 2014). Theoretically, if rural markets for non-land factors of farm production are competitive, then achieving land use efficiency may not require cropland rental markets to function (Bardhan and Udry, 1999; Kimura *et al.*, 2011). These factors can be rented in or rented out by farmers until the marginal products for all factors of production are equal (Pender and Fafchamps, 2006). In reality, smallholders in developing economies tend to confront missing or highly imperfect markets for both land and non-land factors (Holden and Ghebru, 2016). In this regard, understanding the drivers and welfare impacts of cropland rental markets is important to provide policy makers with useful information for fostering rural transformation and economic growth.

There are three important questions that attract the attention of policy makers and researchers with regard to cropland rental market operation in developing countries. The first is whether rental markets transfer cropland from less to more efficient farmers, thereby increasing land use efficiency. The second is whether the markets create opportunities for the rural poor to access cropland, and thus enhancing equity in access to land. The third is how the welfare gains from participation in the markets for the poor are as compared to the non-poor. Making agricultural and rural transformation more efficient and inclusive has always been a norm in agricultural and development economics literature. These issues are especially important in rapidly growing and densely populated economies where cropland is limited and competed by various non-agricultural land use demands.

As a rapidly growing but densely populated economy, Vietnam is a typical example for an examination of these three concerns, namely the efficiency, equity, and welfare effects of cropland rental market participation. It is one of the fastest growing economies in the world, with the annual gross domestic product (GDP) growth of about 7% during 2004-2014 (Do *et* *al.*, 2019), and non-agricultural sectors currently contribute more than 80% to the national GDP. This leads to considerable increases in non-farm employment opportunities for farmers (Tarp, 2017). These achievements are the results of a series of structural reforms known as "*Doi Moi*", which included the distribution of cropland to farmers and allowed for transfer of cropland in spite of various institutional constraints (Huy and Nguyen, 2019). Even though its share in GDP has declined, agriculture has made important contributions to poverty reduction and to overall development in Vietnam. The annual growth rate of agriculture was about 4.2% during 1990-2003 (Food and Agriculture Organization (FAO), 2006). However, there are still several challenges that need to be addressed in the agricultural sector and rural economy in this country. These include a high share of labour employed in agriculture and a small farm size, which have significantly hindered economic transformation. While these challenges are known and a number of measures have been implemented to address them such as facilitating cropland accumulation, the average farm size in terms of cropland area has only increased marginally during the last ten years (Parvathi *et al.*, 2019), and the agricultural transformation in Vietnam seems to be much slower compared to its neighbouring countries, such as Thailand and China, during the similar economic growth period (World Bank (WB), 2016).

In this study, we investigate the linkage between farming efficiency and cropland rental market participation and its welfare impacts in Vietnam. We use a panel dataset of more than 1,000 rural households collected in three rural provinces during 2007-2017. Our empirical analysis includes the following steps. First, we apply the one-step stochastic frontier approach to estimate farming efficiency. Second, we use the predicted farming efficiency as one of the covariates to examine its effect on the likelihood of rural households to participate in cropland rental markets. Third, cropland rental market participation is used as a covariate to estimate the welfare impacts of land rental market participation in terms of household income for the whole sample as well as for subsamples of asset-poor and asset non-poor households. This enables us to see how the benefits from participation in the rental markets are different between the poor and the non-poor.

The rest of the paper is organized as follows. Section two provides context by reviewing the role of agriculture in Vietnam's development, key institutional changes regarding cropland market operation, and the major remaining challenges. Section three reviews the literature and highlights the contributions of our work. Section four introduces the data and reports their descriptive statistics. Section five presents the conceptual model and econometric specifications for empirical analysis. Section six discusses the results and section seven concludes.

2 Agriculture and land institutional reforms in Vietnam's economic transformation

After the unification in 1975, Vietnam followed the centrally-planned economic policies throughout the country as in other former socialist economies. Cropland and other important production factors were nationalized and managed by a system of state-owned enterprises and agricultural cooperatives (Nguyen *et al.*, 2016). These centrally-planned economic policies turned Vietnam into one of five poorest countries in the world in 1985 (Glewwe *et al.*, 2004), forcing the country to commence the renovation policy package and to begin the transition towards a market-oriented economy (Nguyen, 2012).

As the majority of the Vietnamese population lived in rural areas and depended on agriculture for their living at that time, a series of renovations were started in the agricultural sector. This was first by assigning land use contracts to individual farmers (so-called "Directive 100"), second by distributing cropland to farmers (so-called "Resolution 10"), and third by formalizing land allocations to individuals and households on a permanent basis with various land laws (Land Laws 1988, 1993, 2003) (Deininger and Jin, 2008). Directive 100 of the Communist Party in 1981 allowed farmers to cultivate cropland contracted by their agricultural cooperatives and to keep the surplus they produced over the contracted output that had to be paid to the government. Indeed, Directive 100 shifted agricultural production in Vietnam from a fixed wage of the collective system to a fixed rent system (Do and Iyer, 2008). However, it did not allow farmers to transfer cropland use rights and to use cropland as collateral for loans. Resolution 10 of the Communist Party in 1988 recognized farm households as an independent economic unit and allowed for the distribution of cropland to farm households based on household size on a more permanent basis. The de-collectivization process was started. A new land law (Land Law 1993) formalized this resolution and granted five more rights to households in addition to the use right, namely rights to transfer, exchange, inherit, rent and mortgage. The duration for land use was defined as 20 years for annual crops and 50 years for perennial crops (Nguyen *et al.*, 2010), but can be renewed on expiry if land users wish to do so and if they have used the land properly in accordance with the regulations. Land use certificates (internationally known as land titles) were provided (Do and Iyer, 2008). However, cropland size of each farm household was regulated with land ceilings of two ha in the North and three ha in the South for annual crops, and ten ha for perennial cropland and forested land. Further revisions in Land Law 2003 removed land ceilings and encouraged the establishment of large farms (Huy and Nguyen, 2019). These land institutional improvements have fundamentally changed the agricultural sector from a collective to an individual basis and formalized cropland market operation. The egalitarian distribution of cropland resulted in pro-poor growth (Ravallion and van de Walle, 2008). Improved land tenure security encouraged small landholders to increase their farm output by applying more labour, their most abundant input at that time (Huy and Nguyen, 2019), leading to gains in agricultural production with only modest growth in the use of market inputs and with little or no technological change (Che *et al.*, 2006).

In addition, various other renovations have been implemented such as deregulating agricultural input-output markets and liberalizing trade. As a result, Vietnam's economy has maintained its high annual growth rate of GDP for more than three decades. Per capita GDP measured in constant 2010 US$ increased from about 900 US$ in 1990 to about 6,700 US$ in 2017. Growth of the rural economy, driven by agriculture and rural industrialization, has contributed significantly to rapid poverty reduction in Vietnam. The poverty headcount share decreased from 58% in 1993 to 9.8% in 2016, and about 28 million people were estimated to have been lifted out of poverty during 1993-2013 (WB, 2016). Non-farm employment has played a critical role in the nation's structural transformation and has been a key factor for economic growth (Nguyen and Mont, 2012; Nguyen *et al.*, 2017). Labour intensification in the farming sector and non-farm growths were combined to promote Vietnam's rural economy (van de Walle and Cratty, 2004; Hazell *et al.*, 2007).

Even though economic growth and transformation have been positive, there are challenges in the agricultural sector that need to be addressed. First, its share of labour force is still relatively high, making labour productivity in the sector low. This share was 47% in 2012, although there was a sharp decline in its share of GDP, from 30% in the early 1990s to less than 20% in the early 2010s, putting Vietnam into a group of 20 countries with the lowest agricultural labour productivity (WB, 2009). Second, the average farm size in terms of cropland area remains small. In 2011, 8.9 million farm households cultivated 8.9 million ha of cropland (WB, 2016), making the average farm size in Vietnam to be among the smallest in the world. Third, the farming sector, dominated by labour-intensive small farms, mainly relies on family labour. However, as the economy grows fast, a rising real wage rate has made labour-intensive production expensive and this has significant effects on its farming efficiency. Fourth, despite cropland transfers are legal, many researchers find various administrative constraints for cropland transfer at the local level. For example, Smith *et al.* (2007) report that a formal land transaction in An Giang province passed through 23 administrative steps. These challenges need to be addressed for further agricultural transformation. In these regards, examining the drivers and welfare impacts of cropland rental markets in Vietnam is of particular interest.

3 Literature review

Cropland is a key productive asset of rural households in developing countries, and cropland rental markets play an important role in agricultural transformation. Therefore, the efficiency, equity and welfare effects of cropland rental markets particularly concern policy makers and researchers (Skoufias, 1995; Deininger, 2003; Chamberlin and Ricker-Gilbert, 2009). Some of the most important factors affecting cropland rental markets in developing countries include the farming ability of farmers and the development of non-farm sectors. Theoretically, from the demand side, land rental markets provide a mechanism through which farm households with higher farming abilities and less non-farm employment opportunities can rent in additional cropland to expand their farm operation, whereas less efficient farmers that are more able in non-farm employment can rent out their cropland, gradually exiting agriculture (Zhang *et al.*, 2018). As a consequence, cropland rental markets allow farmers with smaller land endowment and higher farming abilities to gain access to more land. In addition, poor households may also have opportunities to access land through rental markets as they do not have sufficient capital for land purchases. From the supply side, efficient cropland rental markets impose an opportunity cost on the landholder of underutilised or idle cropland (Huy and Nguyen, 2019). Therefore, the markets not only allow more efficient farmers to increase their farming operations over time, but also provide less efficient farmers an easier way to work in non-farm sectors without losing their cropland. At the same time, the markets offer these efficiency and equity gains without the threat of distress sales of cropland and a 'landless class' problem as they entail only a temporary transfer of certain use rights. Land rental transactions would not be possible unless the rental agreement benefited both lessors and lessees (Vranken and Swinnen, 2006).

Even though many studies have examined cropland market operation in developing countries (Deininger *et al.*, 2003; Deininger and Jin, 2005; Deininger *et al.*, 2008; Jin and Deininger, 2009; Chamberlin and Ricker-Gilbert, 2009; Kimura *et al.*, 2011; Zhang *et al.*, 2018; Li *et al.*, 2019; Huy and Nguyen, 2019), there are a number of empirical, technical, and data issues that need further attention. First, previous studies tended to focus exclusively on the efficiency and equity outcomes of land markets, without sufficient consideration of the welfare impacts and their distributions over different household clusters, especially for the poor. Therefore, an investigation of the welfare impacts and how they differ between the poor and the non-poor is needed as welfare gains or losses might be different between them (Chamberlin and Ricker-Gilbert, 2009; Zhang *et al.*, 2018).

Second, these previous studies on the efficiency and equity outcomes of land market operation provide mixed results. For example, while the positive effects on efficiency and equity outcomes of the markets are confirmed by, for example, Deininger *et al.* (2008) and Jin and Deininger (2009), other authors such as Ghebru and Holden (2009) and Chamberlin and Ricker-Gilbert (2009) find insignificant or even opposite evidence. This indicates that the effects might be country- or region-specific and thus need further empirical evidence.

Third, farming ability, one of the important drivers of cropland market operation, is unobservable. In previous studies, it was assumed to be time-invariant and was estimated based on the Cobb-Douglas type of production function (Deininger *et al.*, 2003; Deininger and Jin, 2005; Jin and Deininger, 2009; Chamberlin and Ricker-Gilbert, 2009). While this is a step forward, the approach is still restrictive because of several reasons: (i) the Cobb-Douglas functional form restricts the elasticity of substitution between factors of production to be constant (Yang *et al.*, 2016), and (ii) the assumption of time-invariant farming ability is essentially too strong (Ahn *et al.*, 2000). We suggest the translog form of the agricultural production function, instead.

Fourth, previous studies relied on cross-sectional data or only short-term panel data (Zhang *et al.*, 2018) as long-term panel data are not available in many instances in developing countries; and where long-term panel data might be available, there is often a non-trivial issue of respondent attrition. The attrition issue can be problematic when those who leave the sample are systematically different from those who remain in the sample with regard to their farming ability and non-farm employment opportunity. If attrition rates are high, estimates will be biased. Long-term panel data also allow for controlling for unobserved sources of heterogeneity (Ward, 2016).

Fifth, another important issue in welfare impact measurement studies in general, and in welfare impact measurement of cropland rental market participation in particular, is the potential endogeneity. Households with higher farming abilities may be more likely to participate in cropland rental markets, and for the same reason they may also be more likely to have higher levels of welfare. In this case, failure to control for endogeneity would lead to overestimating the relationship between land rental participation and the welfare indicators of interest (Chamberlin and Ricker-Gilbert, 2009).

Last, with regard to Vietnam, the impacts of improved land tenure security on cropland market development in Vietnam were examined by, for example, Deininger and Jin (2008), Do and Iyer (2008) and Ravallion and van de Walle (2008). However, these studies were conducted in the context of Land Law 1993 and used the data from the Vietnam Living Standard Survey waves 1993 and 1998. These data had been collected before the regulation on land ceilings was removed and the promotion of large farms was started in 2003. Huy *et al*. (2016) and Huy and Nguyen (2019) used the Vietnam Household Living Standard Survey data collected in 2004 and 2008 to identify the factors affecting land rental market development. Nevertheless, there have been no attempts to examine the welfare impact and its distribution of cropland rental market participation using a long-term panel dataset.

Our study thus contributes to filling these gaps. We examine these three concerns, namely efficiency, equity, and welfare impacts in a systematic way. We relate the farming efficiency, which is consistently estimated and time-variant, with the decision to participate in cropland rental markets. We use panel data of rural households collected in a 10 year period (2007-2017). We control for potential endogeneity of cropland rental market participation in the welfare models of interest by employing the heteroscedasticity-based identification strategy to generate internal instrumental variables combined with an external instrument to augment the heteroscedasticity-based instruments. We test the robustness of empirical results with various econometric specifications. Our findings are expected not only being relevant for Vietnam but also for other rapidly growing economies.

4 Data and descriptive statistics

Data for our study are taken from a large-scale survey under the research project "*Thailand Vietnam Socioeconomic Panel* (www.tvsep.de)". The sample is representative of the population in Central Vietnam. The sampling procedure for data collection is based on the guidelines of the UN Department of Economic and Social Affairs (UN, 2005) and includes the following steps. First, three rural provinces in Central Vietnam, Ha Tinh, Thua Thien Hue and Dak Lak were selected as our study sites (Figure 1). This region and its three provinces were chosen based on their high reliance on agriculture, a low average per capita income, and poor infrastructure. Second, two villages per sub-district were sampled proportionally to the size of the population in the sub-districts. Third, a fixed sample of ten households from each sampled village was randomly selected with equal probability selection. Six waves of the survey were conducted in 2007, 2008, 2010, 2013, 2016 and 2017.[1] The average attrition rate across the panel is below 5% (Parvathi *et al.*, 2019). This study uses only the data from farming households. The number of farming households in each survey wave in our sample is 1,251 in 2017, 1,284 in 2008, 1,331 in 2010, 1,311 in 2013, 1,208 in 2016, and 1,183 in 2017, making the total number of sampled 7,568 observations.

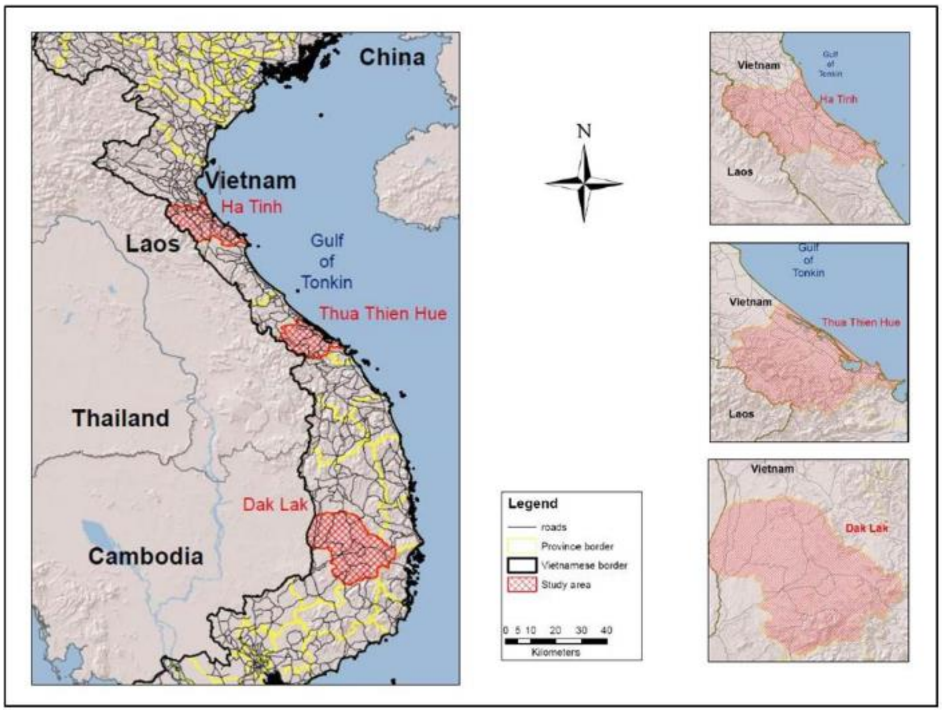

Figure 1: Map of selected provinces as our study sites in Vietnam (Source: Do et al., 2019)

[1] For more information about the project and data collection, see Klasen and Waibel (2015) and Phung *et al*. (2015).

Two structural questionnaires are used for data collection.[2] The village questionnaire is used to collect information on the village location, economy, access to public infrastructure, and social structure by interviewing the village head. Two important variables in the village questionnaire are the number of enterprises that provide non-farm employment opportunities in the village and the distance from the village to the district's town. The household questionnaire includes information on household characteristics, education level of household members, income and consumption details and assets. It also contains extensive sections on cropland, agricultural and non-farm employment activities as well as participation in cropland markets and transacted land areas. The collected data pertain to the last 12 months prior to the survey time. Our sample includes 5,837 households that do not participate and 1,731 households that participate in cropland rental markets. The number of households renting in and renting out cropland is 1,359 and 372, respectively. Table 1 presents the descriptive statistics of some key household and village characteristics of the whole sample and of the groups of market non-participants, lessees and lessors.

Table 1 shows that the mean age of lessors is higher than that of lessees and non-participants. Lessors have the smallest household size but highest ratio of dependent persons. However, they also have the highest share of members having finished high schools or higher education. Lessors have the lowest number of labourers but the highest share of labourers working in non-farm sectors. Non-participants in land rental markets have the largest owned land area, lowest household asset value, lowest number of phones used by household members, and lowest share of households having remittances sent back home by migrant members. Both lessees and lessors have higher asset values, higher per capita income and per capita consumption than land market non-participants. At the village level, land market participants seem to live in the villages that are closer to the district's town and have a higher number of enterprises with at least nine9 employees within the village.[3] Figure 2 presents per capita household income and consumption as well as the shares of farm and non-farm income during 2007-2017. Overall, per capita household income and consumption increased during this time period. Per capita farm income share was higher than per capita non-farm income share until 2017. The difference between these two shares became smaller and smaller over time, indicating the development of non-farm sectors and their contributions to farm household income in our study sites.

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[2] Both village and household questionnaires are available at www.tvsep.de.

[3] This enterprise size of at least nine employees is assumed to be larger than a family-run business.

Table 1: Basic household and village characteristics for the pooled sample and by cropland market status

	Pooled sample	Non-participant	Lessee	Lessor
Household and farm characteristics				
Age of household head (years)	51.69	51.97	48.07	60.47
	(12.95)	(12.98)	(11.47)	(12.74)
Household size (no. of persons)	4.21	4.22	4.42	3.27
	(1.71)	(1.74)	(1.47)	(1.66)
Ratio of dependent persons[a]	0.37	0.37	0.36	0.50
	(0.29)	(0.29)	(0.25)	(0.38)
Ratio of persons with high school degrees[b]	0.11	0.11	0.09	0.16
	(0.19)	(0.19)	(0.16)	(0.26)
Household labour (no. of labourers)	2.39	2.43	2.31	2.03
	(1.07)	(1.10)	(0.87)	(1.06)
Ratio of non-farm labour[c]	0.15	0.14	0.17	0.21
	(0.19)	(0.19)	(0.18)	(0.25)
Owned land size[d] (ha)	0.90	1.00	0.52	0.70
	(2.08)	(2.31)	(0.69)	(1.05)
Household asset value (1,000$)	6.75	6.52	7.39	8.04
	(15.55)	(16.56)	(10.59)	(14.43)
No. of phones used by household members	0.93	0.90	1.00	1.05
	(0.69)	(0.69)	(0.67)	(0.66)
Household has remittances (yes=1)	0.52	0.50	0.54	0.75
	(0.50)	(0.50)	(0.50)	(0.44)
Per capita household income (1,000$)	1.63	1.57	1.60	2.60
	(2.48)	(2.46)	(1.95)	(3.89)
Per capita farm income (1,000$)	0.60	0.60	0.59	0.63
	(1.28)	(1.17)	(1.22)	(2.53)
Per capita non-farm income (1,000$)	0.59	0.55	0.65	0.90
	(1.59)	(1.67)	(1.07)	(1.86)
Per capita household consumption (1,000$)	1.44	1.39	1.51	1.96
	(1.26)	(1.22)	(1.24)	(1.66)
Village characteristics				
Distance to district town (km)	12.07	12.28	11.67	10.33
	(9.70)	(9.81)	(9.61)	(7.93)
No. of enterprises in the village[e]	0.40	0.36	0.48	0.62
	(1.41)	(1.42)	(1.27)	(1.75)
No. of observations	**7,568**	**5,837**	**1,359**	**372**

[a]) no. of dependent members (age<16 or age>60 years old) divided by household size; [b]) no. of members with at least high school degrees or higher divided by household size; [c]) no. of members working in non-farm sectors divided by household size; [d]) including farm land, home garden and residential land areas owned by the household; [e]) only the no. of enterprises with at least nine employees which is bigger than a family-run business; monetary values measured in constant 2005 PPP$; standard deviations in parentheses

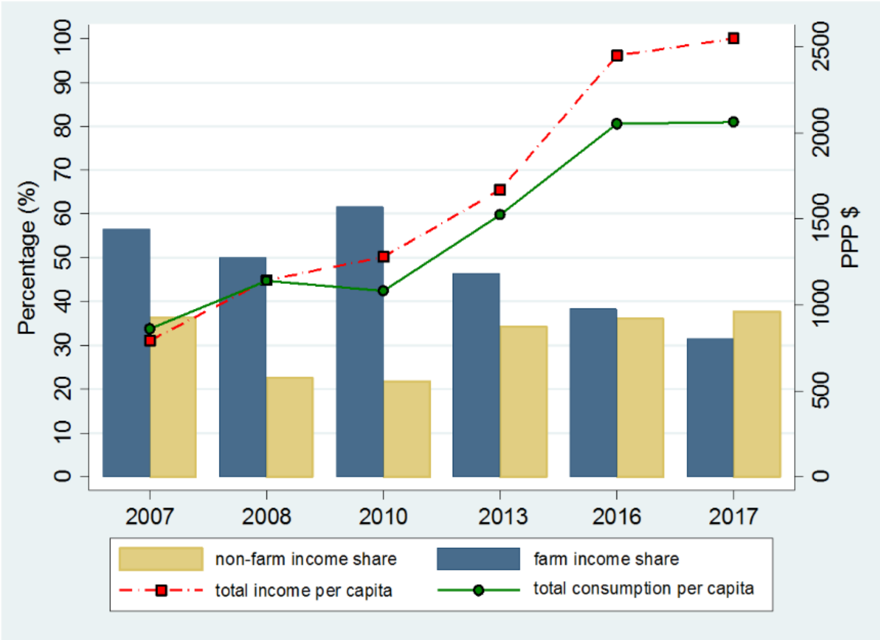

Figure 2: Per capita household income and consumption (2005 PPP US$) and shares of farm and non-farm incomes from 2007-2017

Table 2: Output and inputs of farm production for the pooled sample and by cropland market status

	Pooled sample	**Non-participant**	**Lessee**	**Lessor**
Value of crop output (1,000$)	1.80	1.71	2.42	0.95
	(3.05)	(3.09)	(3.16)	(1.13)
Operated cropland area (ha)	0.61	0.59	0.78	0.39
	(0.69)	(0.66)	(0.70)	(0.99)
Cost of seeds and seedlings (1,000$)	0.08	0.08	0.10	0.04
	(0.26)	(0.25)	(0.21)	(0.06)
Cost of fertilizers (1,000$)	0.25	0.24	0.34	0.11
	(0.35)	(0.33)	(0.46)	(0.12)
Cost of pesticides and insecticides (1,000$)	0.05	0.05	0.09	0.03
	(0.12)	(0.11)	(0.16)	(0.04)
Cost of harvesting and pre-processing (1,000$)	0.08	0.08	0.12	0.06
	(0.18)	(0.16)	(0.20)	(0.33)
Other costs (1,000$)	0.11	0.10	0.15	0.06
	(0.18)	(0.18)	(0.19)	(0.08)
No. of farming labourers	1.99	2.05	1.89	1.47
	(1.04)	(1.09)	(0.80)	(0.93)
No. of observations	**7,568**	**5,837**	**1,359**	**372**

monetary values in constant 2005 PPP$; standard deviations in parentheses

Table 2 presents a summary of inputs and output value of crop production. Lessors have a low value of crop output, a smaller operated cropland area, a lower number of labourers for crop production, and lower costs of input use than lessees. Crop output value of market non-participants is higher than that of lessors but lower than that of lessees. The operated cropland area of market non-participants is smaller than that of lessees but larger than that of lessors. This pattern seems to be similar with regard to costs of input use in crop production except for labour. Market non-participants use a higher number of labourers for crop production than lessors and lessees.

Table 3 presents the descriptive statistics of the sample in terms of farmers' landholding and its distribution as well as land rental market participation. The statistics are consistent with the characteristics of farms in Vietnam presented in the previous sections. First, the average landholding is small, being less than 1 ha, although it increased marginally from 2007 to 2017. Second, a small landholding of less than or equal to 0.5 ha is dominant, accounting for more than 50% of all farms. Nevertheless, it reduced by about 5% over the period 2007-2007; at the same time, the share of large landholding of more than 4 ha increased. With regard to the cropland rental markets, our data indicate that the markets have been developing, with increasing numbers of both renting-in and renting-out farmers. However, the transacted land area is still modest, probably due to the small nature of farm size in Vietnam.

Table 3: Average farm size, land distribution and rental market

	Pooled sample	**2007**	**2017**
Owned land size (ha)	0.90	0.81** [b]	0.92** [b]
	(2.08)	(1.48)	(1.24)
Share of farms with land area ≤ 0.5ha (%)	53.44	55.96** [a]	50.97** [a]
	(49.89)	(49.66)	(50.01)
Share of farms with land area from 0.5ha to 2ha (%)	35.69	35.25	37.79
	(47.91)	(47.79)	(48.51)
Share of farms with land area from 2ha to 4ha (%)	8.22	6.79	8.03
	(27.47)	(25.18)	(27.19)
Share of farms with land area more than 4ha (%)	2.66	2.00* [a]	3.21* [a]
	(16.08)	(14.00)	(17.64)
Share of farms renting in land (%)	17.96	13.99*** [a]	21.47*** [a]
	(38.39)	(34.70)	(41.08)
Rented-in land area (ha)	0.06	0.04*** [b]	0.07*** [b]
	(0.25)	(0.18)	(0.24)
Share of farms renting out land (%)	4.92	3.28*** [a]	11.67*** [a]
	(21.62)	(17.81)	(32.11)
Rented-out land area (ha)	0.01	0.005*** [b]	0.03*** [b]
	(0.09)	(0.04)	(0.16)

**** p<0.01, ** p<0.05, * p<0.1; standard deviations in parentheses; [a]) two-sample Wilcoxon rank-sum (Mann-Whitney) test; [b]) t test (mean-comparison test)*

5 Conceptual model and econometric specifications

5.1 Conceptual model

We extend the models of Deininger *et al.* (2003, 2008) to incorporate farming efficiency. As mentioned in Section 2, in previous studies, the farming ability of a farm household was assumed to be time-invariant. Instead, we estimate the farming efficiency and link it to cropland rental market participation. Assuming that a farm household is endowed with a fixed amount of labour and farm land denoted as L and A, respectively. Relative land scarcity, together with the cost of supervising labour makes hired labour for farming undesirable in equilibrium (Deininger *et al.*, 2003). Thus, L can be allocated to farming activities (l_a) and to non-farm employment (l_n) at an exogenous wage (w). In addition to farm and non-farm income, the household might also have non-labour income such as money transfer (T). Farming is represented by a concave production function $q(\Gamma, l_a, A_o)$ where Γ is the farming efficiency, with which the household uses the technology. Thus, $1 - \Gamma$ is the inefficiency effect, which indicates the extent in which the farm output is less than the maximum possible output as denoted by the production frontier (Nguyen *et al.*, 2018). A_o is the operated cropland.

As cropland rental markets are allowed, there are three rental regimes available to a farm household: renting in, renting out, and autarky (non-participation). When there are imperfections in markets for agricultural production factors, there exists, for each farmer, a desired (optimal) operational farm size that may not correspond to the farmer's current land endowments ($A_o \neq A$). Accordingly, participating in cropland rental markets will allow farmers to correct imbalances in factors of farm production, given their existing land endowments and farming technology (Teklu and Lemi, 2004). Let the return of farming be m, the land rent paid for renting in be r^{in} and the land rent received for renting out be r^{out}. The maximization of household income can be represented as follows:

$$\Pi = Max_{l_a l_n A_o} m\Gamma q(l_a, A_o) + wl_n - R^{in}(A_o - A)r^{in} + R^{out}(A - A_o)r^{out} + T \qquad (1)$$

subject to

$$l_a + l_n \leq L \qquad (1a)$$

$$l_a, l_n, A_o \geq 0 \qquad (1b)$$

$A_o = A$ for autarky, $A_o > A$ for renting in, and $A_o < A$ for renting out (1c) where R^{in} is a dummy variable for renting in (=1 for rent-in and 0 otherwise); R^{out} is a dummy variable for renting out (=1 for rent-out and 0 otherwise). Following Deininger *et al.* (2008), the first order conditions (FOC) for the maximisation of equation (1) with respect to the optimal level of l_a, l_n A_0 are as follows:

$$mq_{l_a}(\Gamma, l_a, A_o) = w \quad (2)$$

and for renting-in households:

$$mq_{A_0}(\Gamma, l_a, A_o) = r^{in} \quad (3)$$

and for renting-out households:

$$mq_{A_0}(\Gamma, l_a, A_o) = r^{out} \quad (4)$$

Total differentiation of both sides of equation (2) with respect to Γ yields

$$mq_{l_a\Gamma}\left(\Gamma, l_{a,}A_o\right) + m\left(q_{l_a l_a}\frac{\partial l_a}{\partial \Gamma} + q_{l_a A_o}\frac{\partial A_o}{\partial \Gamma}\right) = 0 \quad (5)$$

Total differentiation of both sides of equations (3) and (4) with respect to Γ yields

$$mq_{A\Gamma}(\Gamma, l_a, A_o) + m\left(q_{A_o A_o}\frac{\partial A_o}{\partial \Gamma} + q_{A_o l_a}\frac{\partial l_a}{\partial \Gamma}\right) = 0 \quad (6)$$

Obtaining $\frac{\partial l_a}{\partial \Gamma}$ from equation (5) and substituting it into equation (6) yields

$$\frac{\partial A_o^*}{\partial \Gamma} = \frac{q_{A_o l_a} q_{l_a \Gamma} - q_{A_o} q_{l_a l_a}}{(q_{A_o A_o} q_{l_a l_a} - q_{A_o l_a} q_{l_a A_o})} = \frac{q_{A_o l_a} q_{l_a \Gamma} - q_{A_o \Gamma} q_{l_a l_a}}{[(q_{A_o A_o} q_{l_a l_a} - q_{A_o l_a})^2]} > 0 \quad (7)$$

Equation (7) indicates that operated cropland area increases with farming efficiency, implying that renting in (out) cropland is increasing (decreasing) in farming efficiency. Cropland will thus be transferred from less to more efficient farmers.

5.2 Estimating farming efficiency

The first step of our empirical analysis is to estimate farming efficiency, Γ. The standard panel data model for the stochastic frontier production (SFP) function can be written as follows:

$$q_{it} = f(x_{it})\exp(v_{it} - u_{it}) \quad (8)$$

where q_{it} is the farm output produced by household *i* in year *t;* x_{it} is a vector of inputs used by household *i* in year *t* to produce q_{it}; v_{it} is assumed to be distributed as i. i. d N(0,σ2v); u_{it} is a nonnegative random variable measuring technical inefficiency of household *i* in year *t*. With these assumptions on v_{it} and u_{it}, the method of Maximum Likelihood Estimation can be used to estimate the model (Belotti *et al.*, 2013; Sipiläinen *et al.*, 2013; Kumbhakar *et al.*, 2014).

We use the translog form of the agricultural production function instead of the Cobb-Douglas functional form which was popularly used in previous studies to estimate farming ability (Deininger *et al.,* 2003, 2008; Chamberlin and Ricker-Gilbert, 2009). The translog functional form is more flexible while the Cobb-Douglas functional form restricts the elasticity of substitution between factors of production to be constant.[4] As we have panel data, we apply the true random effects stochastic frontier model (TRE) (Greene, 2005). Compared to the standard random-effects stochastic frontier model as in Pitt and Lee (1981), this model has the advantage that it could separate unobserved farm-specific heterogeneity from the technical inefficiency component (see Abdulai and Tietje, 2007; Kumbhakar *et al.*, 2009; Sauer and Latacz-Lohmann, 2010). Our estimation is specified as follows:

$$\ln Q_{it} = \alpha_0 + k_i + \sum_m \alpha_m lnx_{itm} + \frac{1}{2}\sum_m \sum_n \alpha_{mn} lnx_{itm} lnx_{itn} + V_{it} - U_{it} \qquad (9)$$

where k_i denotes farm-specific and time-invariant heterogeneity. All inputs variables in equation (6) are normalized by their respective means before estimation, then the coefficients on the first order term can be interpreted directly as elasticities at means[5] (see Yang *et al.*, 2016; Holtkamp and Brümmer, 2017). The farming efficiency for farm i at time t will be predicted as:

$$\Gamma_{it} = E[\exp(-U_{it})\,|(V_{it} - U_{it})] \qquad (10)$$

We include the operated cropland area, number of household labourers working on farm, cost of seeds and seedlings, cost of fertilizers, cost of pesticides and insecticides, cost of harvesting and pre-processing, and other costs (e.g. for irrigation) in x_{it}. Q_{it} is the constant value of crop output of household *i* in year *t*. All variables in monetary terms are measured in constant 2005 PPP US$. The Huber-White robust standard errors are used to control for possible heteroscedasticity.

5.3 Determining factors affecting cropland rental market participation

The second step of our empirical analysis is to identify the determinants of land rental markets, either renting in or renting out. As conceptualized above, the general form of land rental functions can be

$$R_{it}^{in/out} = \beta + \mu\Gamma_{it} + z_{it}'\lambda + \varepsilon_{it} \qquad (11)$$

---

[4] Our likelihood-ratio test also shows that the translog functional form is more appropriate than Cobb-Douglas functional form (see Appendix 1).

[5] Normalization of inputs: $\ln(x_{mit}^*) = \ln(\frac{x_{mit}}{\bar{x}_m})$

where R^{in} is a dummy variable for renting in (=1 for rent-in and 0 otherwise); R^{out} is a dummy variable for renting out (=1 for rent-out and 0 otherwise) of household *i* in year *t* as defined in equation (1); Γ_{it} is the predicted farming efficiency estimated from the previous step; z_{it} includes the household and farm characteristics, including non-farm employment and the characteristics of community where the household resides (e.g. village characteristics); and ε_{it} is the error term of the model. We employ the random-effects probit models for our panel data. In addition, as the households' decisions to participate either in renting in or in renting out might be correlated, we also use the seemingly (un)related probit model for our pooled data to estimate this equation.[6]

5.4 Identifying welfare effects of cropland rental market participation

In the third step, we identify the effects of renting in or renting out on household welfare by estimating the following model:

$$ln\, Y_{it} = \delta + \gamma R_{it} + z_{it}^{'}£ + \eta_{it} \tag{12}$$

where Y represents a measure of household welfare (per capita household income, per capita farm income, and per capita non-farm income in ln form); R_{it} is the renting-in or renting-out cropland of household *i* in year *t*; other variables were defined above and η is the error term.

In equation (12), R_{it} is an exogenous variable measuring the impacts of participation in land rental markets on household welfare. However, it is the dependent variable in equation (11) and thus lead to the endogeneity problem in equation (12). To deal with this, the fixed effects models for panel data can be used to control for time-invariant factors. However, controlling only for time-invariant factors is not able to completely solve this problem (i.e., omitted variables) in equation (12), we thus follow the method proposed by Rigobon (2003) and Lewbel (2012) to generate instruments. This method suggests an internal instrumental variable estimation called identification through heteroscedasticity (hetero IV) and allows us to achieve identification without imposing any exclusion restrictions (Tran *et al.*, 2018). This procedure is described as follows. Assume that as a complement to (12) the reverse effect of household welfare on land rent status could be modelled as

$$R_{it}^{in/out} = \pi + \Omega Y_{it} + z_{it}^{\prime} \curlywedge + \xi_{it} \tag{13}$$

[6] Instead of these dummy variables, the rented-in area ($A_o - A$), or rented-out area ($A - A_o$) can also be used as the dependent variables in equation (11) and the tobit models can be employed.

where $R_{it}^{in/out}$ is defined as in equation (11), z_{it} is defined as above, and ξ_{it} is the error term. Besides the usual regression assumptions that the structural error terms in equations (12) and (13) are independent from each other and from z_{it}, the heteroscedasticity-based identification strategy additionally assumes the existence of heteroscedasticity in ξ_{it} and hence in $R_{it}^{in/out}$. Specifically, while the usual assumptions are

$$Cov\left(z_{it}', \eta_{it}\right) = Cov(z_{it}', \xi_{it}) = Cov\left(z_{it}', \eta_{it}\xi_{iht}\right) = 0 \qquad (14)$$

it is now additionally assumed the heteroscedasticity in equation (13) that

$$Cov(z_{it}', \xi_{it}^2) \neq 0 \qquad (15)$$

Lewbel (2012) suggests using $[z_{it}' - E(z_{it}')]\hat{\xi}_{it}$ as an internal instrumental variable (IV) for $R_{it}^{in/out}$ in estimating equation (12), where $\hat{\xi}_{it}$ is the predicted residuals obtained by estimating equation (13) excluding Y_{it} on the right-hand side. This is a promising instrument because $[z_{it}' - E(z_{it}')]\hat{\xi}_{it}$ is uncorrelated with η_{it} as it is already assumed that $Cov\left(z_{it}', \eta_{it}\xi_{it}\right) = 0$ and it is correlated with $R_{it}^{in/out}$ through ξ_{it} as in equation (13).

Moreover, Lewbel (2012) and Baum *et al.* (2012) also suggest using an additional external instrument improves efficiency of this hetero IV approach as the external instrument augments generated instruments in equation (12). We thus employ the share of households participating in land rental markets in the sub-district as a standard external instrument.

In summary, we deal with endogeneity in assessing the welfare impact of cropland rental markets through the following three steps. First, we follow Baum *et al.* (2012) to eliminate household-specific fixed effects by means of the within transformation (controlling for household fixed effects). Second, we use an internal IV estimation called identification through heteroscedasticity method (hetero IV) as in Lewbel (2012). Third, we additionally employ an external IV (share of households participating in land rental markets in the sub-district) to improve efficiency of heteroscedasticity-based IV estimation. We call this three-step method as “all IV method”. We apply this all IV method first for the whole sample, and then for two subsamples. The first subsample includes the households at the lowest 20% of household asset value distribution. The second subsample includes the rest of our sampled households - those belong to the highest 80% of household asset value distribution. This allows us to examine how different the welfare benefits of the poor and the non-poor are from participating in cropland rental markets.

6 Results and discussion

6.1 Farming efficiency

Table 4 presents the translog stochastic production frontier function estimates and shows that most of the inputs used in crop production are significant, except labour.[7] The production elasticity of cropland is the highest (0.6), followed by that of fertilizer (0.18). These results are consistent with those reported by the World Bank (2016) indicating that the success of Vietnam's agricultural production in recent years has mainly stemmed from more intensive use of cropland and fertilizers. It also indicates that crop production in Vietnam has moved from labour intensification at the beginning of *Doi Moi* to land and capital intensification during the last decade. In a recent study, Huy and Nguyen (2019) also argue that small cropland size is a limiting factor for farm production in Vietnam, and among all inputs used in farm production, enlarging farm size would bring the highest benefits to farmers. Our predicted production elasticity for cropland is also lower than that of wheat farmers in eastern England (0.76) (Wilson *et al.*, 2001) and of UK potato growers (0.87) (Wilson *et al.*, 1998), which is reasonable as Vietnam is a developing country.

[7] See Appendix 1 for our test if inefficiencies are not stochastic and not present in the model.

Table 4: Translog stochastic frontier production estimation

	Coef.	Robust SE
ln operated cropland area (*a*)	0.596***	(0.033)
ln cost of seeds and seedlings (*b*)	0.048***	(0.011)
ln cost of fertilizers (*c*)	0.177***	(0.018)
ln cost of pesticides and insecticides (*d*)	0.062***	(0.012)
ln cost of harvesting and pre-processing (*e*)	0.091***	(0.010)
ln other costs (*f*)	0.021**	(0.010)
ln farming labourers (*g*)	-0.028	(0.020)
a^2	0.031	(0.021)
b^2	0.006***	(0.001)
c^2	0.018***	(0.002)
d^2	0.006***	(0.001)
e^2	0.010***	(0.001)
f^2	0.003***	(0.001)
g^2	-0.005*	(0.003)
a * *b*	-0.004**	(0.002)
a * *c*	-0.007**	(0.003)
a * *d*	0.007**	(0.003)
a * *e*	0.005**	(0.002)
a * *f*	-0.003*	(0.002)
a * *g*	0.003	(0.005)
b * *c*	0.000	(0.000)
b * *d*	0.000	(0.000)
b * *e*	-0.000	(0.000)
b * *f*	-0.000	(0.000)
b * *g*	0.001	(0.001)
c * *d*	-0.000	(0.000)
c * *e*	-0.000	(0.000)
c * *f*	-0.001**	(0.000)
c * *g*	-0.002*	(0.001)
d * *e*	-0.000	(0.000)
d * *f*	0.000	(0.000)
d * *g*	-0.001	(0.001)
e * *f*	0.000	(0.001)
e * *g*	-0.000***	(0.000)
f * *g*	-0.000	(0.001)
constant	7.636***	(0.021)
No. of observations	**7,568**	
Log simulated-likelihood	-6847.492	
Sigma_u; Sigma_v; Lambda	0.297***; 0.477***; 0.623***	
Wald Chi^2(35)	7564.27	
Prob.	0.000	
Test constant return to scale (p value)	0.167	

**** p<0.01, ** p<0.05, * p<0.1; robust standard errors clustered at sub-district level in parentheses; as all input variables are normalized by their respective means prior to estimation, the coefficient on the first order term could be interpreted as the elasticity; ln: natural logarithm.*

The predicted farming efficiency scores and their distribution are presented in Figure 3. The mean score of farming efficiency is 0.754, and most of farm households (80%) have efficiency scores from 0.7 to 0.9. Less than five percent of farm households have efficiency scores smaller than 0.5, while less than one percent of farm households have efficiency scores higher than 0.9. This indicates that, with existing technology and input resources, farmers are still able to improve their production by 25% through a more efficient use of production factors. Our predicted farming efficiency score of 0.754 is less than the one reported by Huy and Nguyen (2019). However, these authors use the data for the entire Vietnam while our sample is limited to poorer provinces of Ha Tinh, Thua Thien Hue, and Dak Lak.

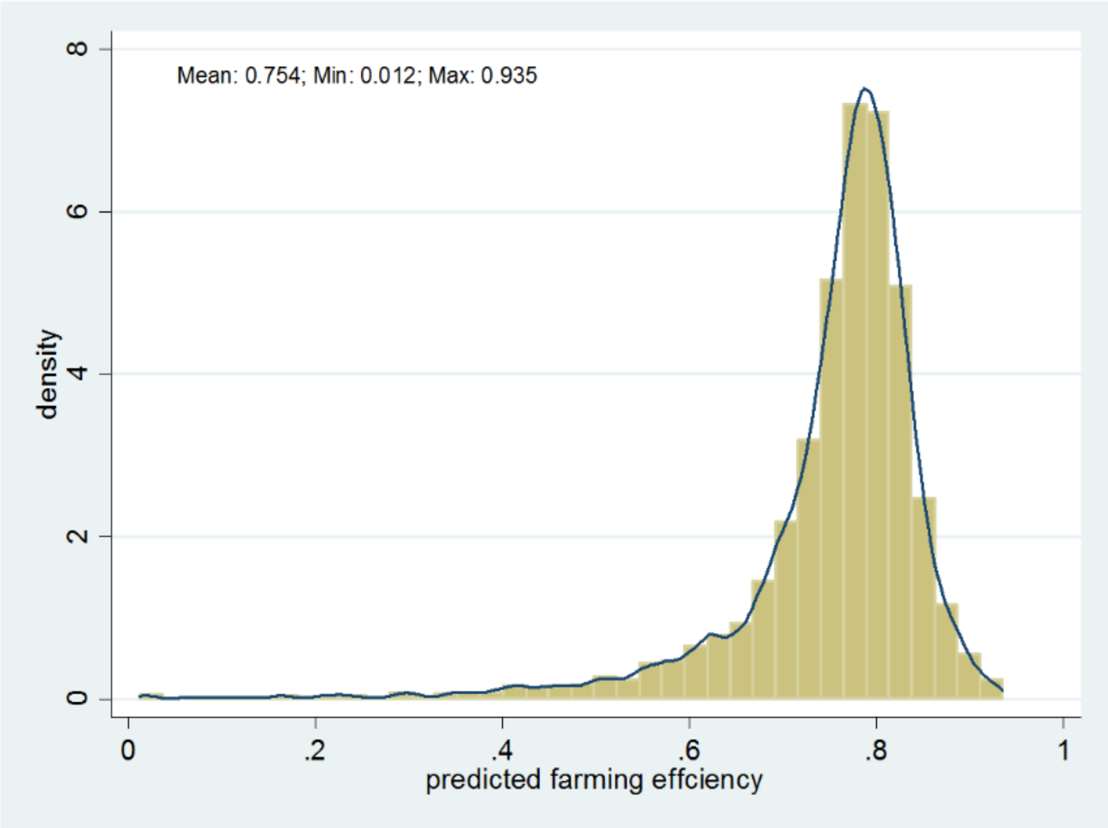

Figure 3: Distribution of predicted farming efficiency

Table 5 presents the differences in farming efficiency between lessees, lessors and cropland market non-participants. On the supply side, lessors have the average efficiency score of 0.747. On the demand side, the average efficiency score of lessees is 0.767. Regarding market non-participants, their average farming score is 0.75. Our test shows that the efficiency score of lessees is significantly higher than that of lessors and market non-participants. Meanwhile, the efficiency score is not significantly different between lessors and non-participants. Our results are consistent with Huy and Nguyen (2019) who report that lessees are more efficient in farming than lessors. In addition, to provide more insights on the difference in farming efficiency between non-participants, lessees, and lessors, we follow Ahn *et al.* (2010) to estimate long-run and short-run efficiency scores. The results are also consistent with our estimates that lessees are more efficient than lessors are.[8]

Table 5: Farming efficiency score by rental land status

	Lessee	Lessor	Non-participant
Mean	0.767***1,2	0.747***1	0.750***2
Standard error	0.002	0.006	0.001
95% confidence interval	0.762-0.771	0.732-0.757	0.747-0.753
No. of observations	**1,359**	**372**	**5,837**

**** $p<0.01$, ** $p<0.05$, * $p<0.1$; [1]) lessee vs lessor; [2]) lessee vs non-participant; we find no significant difference between lessor and non-participant groups.*

6.2 Determinants of renting-in and renting-out cropland

The effects of farming efficiency and other explanatory variables on renting-in and renting-out cropland by rural households are presented in Table 6. Specifications 1 and 2 stack the results of the random-effects probit models for panel data in which equation (11) is run separately for renting-in and renting-out decisions. Specifications 3 and 4 include the results of the seemingly (un)related probit model for pooled data in which equation (11) is run simultaneously for renting-in and renting-out decisions. In all these specification, in addition to farming efficiency we also control for (i) the age of household head, (ii) the main characteristics of the farm and household (household size, ratio of dependent persons, ratio of persons with at least high school degrees, ratio of non-farm labour, owned farm land area, household asset value (in ln form), number of phones used by household members and whether the household has remittances), and (iii) the main characteristics of the village (distance to the district's town and the number of enterprises with at least 9 employees in the villages).

With respect to farming efficiency, our results reveal that households with higher farming efficiencies are more likely to rent in cropland whereas households with lower farming efficiencies are more likely to rent out their land. The effects of farming efficiency on the rental decisions are consistent throughout all our econometric specifications. This finding confirms our hypothesis on the efficiency outcome of land rental markets that the markets allow cropland to be transferred from less efficient to more efficient farmers, which is in line with most of the current literature, for example, Deininger *et al.* (2008), Kimura *et al.* (2011), and Zhang *et al.*

[8] See the results of these estimates in Appendix 2.

(2018). In addition, as there might be concerns about the endogeneity between the predicted farming efficiency and other explanatory variables in these models, we perform additional specifications which include the lagged value of the predicted farming efficiency (the predicted farming efficiency in the previous time period).[9] Results of these additional specifications are also consistent that farming efficiency has a positive effect on the decision to rent in, and a negative effect on the decision to rent out.

With regard to landholding, on the demand side of rental markets, the results show a significant and negative effect on renting in. It means that the smaller the landholding is, the higher the probability that the household rents in land. On the supply side, the effect of landholding is insignificant. This is probably due to the fact that all farm sizes in our sample are small and the egalitarian distribution of cropland resulted in equal distribution of cropland as reported by Ravallion and van de Walle (2008). The effect of household asset value is significantly positive on renting in, implying that cropland is transferred from asset-poor to asset-rich households. This raises the concern on land accumulation by asset-rich households. However, we find the effect of non-farm labour ratio being statistically significant for renting out. It means that the higher the number of household members involved in non-farm employment is, the more likely the household will rent out land. Households having remittances are also more likely to rent in and rent out cropland. These results are consistent with the literature that development of non-farm sectors will boost agricultural transformation as reported, for example, by Deininger *et al.* (2014) and Wang *et al.* (2016). Regarding the effects of other explanatory variables, households with older heads are less likely to rent in and more likely to rent out. A larger household size would lead to rent in more and rent out less; but a higher ratio of dependent persons would lead to rent out more. The higher the ratio of household members with at least high school degrees is, the less likely the household will rent in and more likely it will rent out. This is reasonable as a higher education level would facilitate the household members to look for employment opportunities in non-farm sectors and might eventually exit agriculture in the long-run.

[9] See Appendix 3 for the results of these additional specifications.

Table 6: Determinants of renting-in and renting-out cropland (probit models)

	Random-Effects		Seemingly Unrelated	
	rent-in	rent-out	rent-in	rent-out
	(1)	(2)	(3)	(4)
	marginal effect	marginal effect	marginal effect	marginal effect
Farming efficiency	0.132***	-0.041*	0.145***	-0.028**
	(0.047)	(0.023)	(0.044)	(0.013)
Age of household head	-0.004***	0.001***	-0.004***	0.001***
	(0.001)	(0.000)	(0.001)	(0.000)
Household size	0.009***	-0.010***	0.009***	-0.005***
	(0.003)	(0.002)	(0.003)	(0.001)
Ratio of dependent persons	-0.014	0.043***	0.006	0.023***
	(0.017)	(0.009)	(0.014)	(0.005)
Ratio of persons with high school degrees	-0.077***	0.027*	-0.094***	0.017*
	(0.028)	(0.015)	(0.026)	(0.009)
Ratio of non-farm labour	0.008	0.048***	0.012	0.026***
	(0.034)	(0.013)	(0.030)	(0.008)
Owned farm land area	-0.080***	0.001	-0.073***	0.000
	(0.014)	(0.001)	(0.014)	(0.000)
Ln household asset value	0.030***	0.001	0.027***	0.000
	(0.006)	(0.003)	(0.005)	(0.002)
No. of phones used by household members	0.019**	0.004	0.011*	0.002
	(0.008)	(0.004)	(0.007)	(0.002)
Household has remittances	0.031***	0.022***	0.018**	0.012***
	(0.009)	(0.006)	(0.007)	(0.003)
Distance to district town	0.000	-0.000	0.000	-0.000
	(0.001)	(0.000)	(0.001)	(0.000)
No. of enterprises in the village	0.002	0.002	0.003	0.001
	(0.004)	(0.001)	(0.003)	(0.001)
No. of observations	**7,568**	**7,568**	**7,568**	
Wald $Chi^2(12)$	177.12	160.85		
Wald $Chi^2(24)$			497.36	
Prob.	0.000	0.000	0.000	

**** p<0.01, ** p<0.05, * p<0.1; standard errors clustered at sub-district level in parentheses*

6.3 Welfare effects of cropland rental market participation and their distribution

Estimation results on the effect of cropland rental market participation and other factors on per capita farm income, per capita non-farm income, and total per capita income are reported in Table 7. The results are from the all IV method based on the centered data as suggested in the *ivreg2h* package of Baum *et al.* (2012), which is based on demeaning the interested variables. In addition to the renting-in or renting-out decisions, we also control for the main household and farm characteristics as well as village characteristics. Model diagnostic tests of underidentification, overidentification and weak identification are provided in the bottom rows of the table. The underidentification test is an LM test based on Kleibergen and Paap (2006) with the null hypothesis that the model is unidentified. The overidentificaiton test is based on the Hansen J test with the null hypothesis that all instruments are valid. The reported statistics of these tests are p-values. The weak identification test is based on the F statistics as described in Staiger and Stock (1997). Overall, the diagnostic tests support our all IV method using internal and external instrumental variables.

With regard to cropland rental market participation, our results show positive and significant effects of renting in and renting out on per capita household income. Renting-in decision leads to higher per capita farm income while renting-out decision leads to higher per capita non-farm income. These effects result in an overall positive effect on household income. This supports the hypothesis that land rental market operation benefits both lessors and lessees. Our finding is in line with Chamberlin and Ricker-Gilbert (2016) for Malawi and Zambia and Zhang *et al.* (2018) for China. Obviously, for efficient farmers, renting in would lead to a higher level of farm income, and for inefficient farmers, renting out would relax labour to work in non-farm sectors and increase non-farm income. As a consequence, both are better-off.

With respect to cropland, the results show that households with larger owned cropland areas are more likely to have higher per capita income. This is reasonable because in rural areas land is regarded as the most important source for income (Hüttel *et al.*, 2013), even though the effect of owned cropland area on per capita farm income is insignificant but still positive. We also document a positive effect of household asset value on per capita farm income. This is probably related to the levels of farm investment and farm input use. Better-off households might be able to spend more on farm expenditure on time and to invest more in farm equipment, which can lead to a higher per capita farm income.

Table 7: Impact of renting land on household income (all IV model)

	Ln per capita farm income	Ln per capita non-farm income	Ln per capita income
	(1)	(2)	(3)
Household renting in	0.312*	0.265	0.444***
	(0.162)	(0.218)	(0.151)
Household renting out	-0.244	0.831***	0.526***
	(0.174)	(0.255)	(0.141)
Age of household head	0.003	0.003	-0.010***
	(0.003)	(0.003)	(0.002)
Household size	-0.239***	-0.085***	-0.222***
	(0.013)	(0.019)	(0.015)
Ratio of dependent persons	0.019	-0.499***	-0.079
	(0.078)	(0.105)	(0.059)
Ratio of persons with high school degrees	-0.212	0.032	-0.053
	(0.148)	(0.143)	(0.096)
Ratio of non-farm labour	-0.070	1.936***	1.236***
	(0.099)	(0.136)	(0.096)
Owned farm land size	0.015	-0.002	0.010**
	(0.014)	(0.006)	(0.005)
Ln household asset value	0.176***	-0.038	0.018
	(0.023)	(0.024)	(0.017)
No. of phones used by household members	0.146***	0.392***	0.310***
	(0.028)	(0.036)	(0.022)
Household having remittances	0.047	0.152***	0.433***
	(0.033)	(0.041)	(0.028)
Distance to district town	-0.001	-0.013**	-0.010*
	(0.004)	(0.005)	(0.006)
No. of enterprises in the village	0.009	0.036***	0.017*
	(0.008)	(0.014)	(0.010)
No. of observations	**6,652**	**5,119**	**7,214**
R^2	0.115	0.186	0.259
Prob.	0.000	0.000	0.000
Underidentification	0.000	0.000	0.000
Overidentification	0.291	0.524	0.235
Weak identification	30.954	26.683	37.559

**** p<0.01, ** p<0.05, * p<0.1; robust standard errors clustered at the sub-district level in parentheses; the underidentification test is an LM test based on Kleibergen and Paap (2006) rk LM statistics with the null hypothesis that the model is underidentified. The overidentification test is based on the Hansen J test with the null hypothesis being all instruments are valid. For weak identification, Kleibergen-Paap rk Wald F statistics is reported; some observations were dropped as their asset value and/or per capita income in ln form are missing; Ln: natural logarithm.*

Regarding the effects of other factors, households with older heads are more likely to have lower per capita household income. The effect of household size on per capita household income is obvious. A larger household size significantly reduces both per capita farm income and non-farm income, and as a consequence has lower per capita household income. The ratio of dependent persons also significantly lowers per capita non-farm income while the ratio of non-farm labour increases per capita non-farm income and household income. We also find that the number of phones used by household members increases per capita farm and non-farm income. This variable reflects the network of partners that the household has for both farm and non-farm activities. Having remittances would also support the household in non-farm activities and results in higher per capita non-farm income. With respect to the village characteristics, we find consistent evidence that the number of enterprises in the village has positive effects and the distance from the district's centre has negative effects on per capita non-farm and household income as expected. The positive effects of these village variables on household income are in line with the findings of Nguyen *et al.* (2017) for Vietnam and also in line with the notion that the development of non-farm sectors and rural infrastructure contributes positively to rural transformation and economic growth in many developing countries.

The last part of our analysis is devoted to the welfare impact of land rental markets on different household clusters. We divide our sample into two subsamples based on their asset value, the lowest 20% and the rest 80% of household asset value distribution. In relative terms, it is possible to state that the first subsample includes the so-called asset poor households while the second subsample include the so-called asset non-poor households. We run separate regressions for these two subsamples (full results in appendices 4 and 5). We summarize the full results in Table 8, which indicates several important findings with regard to the distribution of income gains from participation in cropland rental markets. First, we find that while the overall impact is positive for the whole sample, it is mainly for asset non-poor households. These households have higher per capita farm income from renting in, and higher per capita non-farm income from renting out. Thus, the overall income gains are positive and significant. Second, for asset poor households, the overall income effect is insignificant. The effect on per capita non-farm income is also insignificant. More importantly, the effect of renting out is significant but negative for per capita farm income. These findings imply that these asset poor indeed do not benefit from participation in cropland rental markets as the rest of the rural population do. Our findings are consistent with Chamberlin and Ricker-Gilbert (2016) and Zhang *et al.* (2018) who report that active cropland rental markets lead to overall welfare gains but the welfare gains of the poor are minor or insignificant. This is probably due to the fact that these poorest households have very small farm land areas and low farming efficiency. At the same time, non-farm employment opportunities are also limited to them. Thus, renting in would not result in higher farm income and renting out land not lead to higher non-farm income. In addition, as the findings in the previous section raise the concern that cropland is likely to be transferred to asset rich household, the poor seem to be vulnerable.

Table 8: Impact of renting land on household income of asset poor and asset non-poor subsamples

	Per capita farm income (ln)		**Per capita nonfarm income (ln)**		**Per capita income (ln)**	
	20% poorest (1)	other 80% (2)	20% poorest (3)	other 80% (4)	20% poorest (5)	other 80% (6)
Household renting in	0.482	0.367^{*}	0.142	0.215	0.511	0.358^{**}
	(0.357)	(0.188)	(0.561)	(0.219)	(0.343)	(0.151)
Household renting out	-1.065^{**}	-0.208	0.716	0.972^{***}	0.359	0.636^{***}
	(0.461)	(0.181)	(0.665)	(0.260)	(0.330)	(0.148)
No. of observations	**1,240**	**5,412**	**9,20**	**4,199**	**1,394**	**5,820**
R^2	0.061	0.090	0.153	0.180	0.134	0.225
Prob.	0.000	0.000	0.000	0.000	0.000	0.000
Underidentification	0.022	0.000	0.021	0.000	0.039	0.000
Overidentification	0.119	0.860	0.359	0.082	0.101	0.238
Weak identification	5.594	23.714	6.050	20.873	5.886	25.546

*** p<0.01, ** p<0.05, * p<0.1; full results in appendices 4 and 5; robust standard errors clustered at the sub-district level in parentheses; the Underidentification test is an LM test based on Kleibergen and Paap (2006) rk LM statistics with the null hypothesis that the model is underidentified; the overidentification test is based on the Hansen J test with the null hypothesis being all instruments are valid. For weak identification, Kleibergen-Paap rk Wald F statistics is reported; some observations were dropped as their asset value and/or per capita income in ln form are missing.

7 Conclusions

Understanding the drivers and welfare impacts of land rental markets in rapidly growing economies is important. In this study, we investigate the relationship between farming efficiency and cropland rental market development and examine the welfare impacts of the participation in cropland rental markets. We use a panel dataset of more than 1,000 rural households collected in 2007, 2008, 2010, 2013, 2016 and 2017 in three rural provinces of Vietnam. We apply the one-step stochastic frontier approach to evaluate farm production efficiency, the random-effects probit models for panel data and the seemingly (un)related probit model for pooled data to identify the determinants of land renting in and renting out, and the all instrumental variable method to examine the welfare impacts of cropland rental market participation. We employ the heteroscedasticity-based identification strategy to address the endogeneity issues in welfare impact assessment and check the robustness of our results with different econometric specifications.

The main results of our study are as follows. First, cropland rental markets have been developing but still at a modest level of land transaction. Second, the markets contribute to enhancing land use efficiency as they allow cropland to be transferred from less to more efficient land users. Third, participation in cropland rental markets results in higher household income for both renting-in and renting-out households. However, at the same time, we find that the poor benefit insignificantly from participating in the markets and it is likely that cropland is transferred to asset rich households. These findings lead to some important policy implications: (i) as cropland market development leads to an overall increase in household income, administrative barriers on its operation should be removed; (ii) supporting farmers to increase their farming efficiency would facilitate cropland market operation; (iii) further development of non-farm sectors in rural areas should be encouraged; and (iv) there is the need to support the poorest cluster of rural population as their gains from land market participation is minor and the markets might make them more vulnerable.

Even though our study provides useful insights on cropland rental market development in Vietnam, it still has a number of limitations. First, in the analysis of land markets, the spatial dimension is important and we have not been able to incorporate this issue. Future studies using spatial models are thus suggested. Second, we are not able to determine at what efficiency levels farmers will switch from renting in to renting out, or from non-participation to participation. Third, our study covers only the rural areas in Central Vietnam and has the data of only ten years. As rural transformation is a lengthy process, future studies should extend the coverage in terms of both spatial and temporal dimensions. Fourth, as our study raises concerns on the equity of access to land and the vulnerability of the poor, these need to be further examined. Lastly, as rural industrialization is an important driver of rural transformation, an examination of the factors affecting this process is needed.

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Appendix Section

Appendix 1: Hypothesis test for stochastic frontier production function

	Likelihood ratio test $\lambda = -2\left[\log L(\widehat{\Omega}_{H0}) - L(\widehat{\Omega}_{H1})\right]$	Degrees of freedom	P-value
Choice of functional form (Cobb-Douglas vs Translog) H0: Cobb-Douglas is more appropriate	984.912	25	0.000
Inefficiencies are not stochastic, not present in the model ($\gamma = 0$) H0: $\gamma = 0$	540.735	1	0.000

$L(\widehat{\Omega}_{H0})$ is the log likelihood of constrained models under the null hypothesis, and $L(\widehat{\Omega}_{H1})$ is the log likelihood of the alternative hypothesis in Table 4

Appendix 2: Long-run and short-run production efficiency score by rental land status

	Lessee	**Lessor**	**Non-participant**
Long-run efficiency			
Mean	$0.886^{***1,2}$	0.877^{***1}	0.876^{***2}
Standard error	0.001	0.002	0.0006
95% confidence interval	0.884-0.888	0.873-0.882	0.874-0.877
Short-run efficiency			
Mean	$0.764^{***1,2}$	0.756^{***1}	0.755^{***2}
Standard error	0.002	0.004	0.0008
95% confidence interval	0.761-0.767	0.748-0.764	0.753-0.757
No. of observations	**1,359**	**372**	**5,837**

*** $p<0.01$, ** $p<0.05$, * $p<0.1$; ^{1}: lessee vs lessor; ^{2}: lessee vs non-participant

Appendix 3: Determinants of renting-in and renting-out including the lagged value of farming efficiency

	Random-effects Probit Models		Seemingly (un)related Probit Model	
	rent-in	rent-out	rent-in	rent-out
	(1)	(2)	(3)	(4)
	marginal effect	marginal effect	marginal effect	marginal effect
Lagged farming efficiency	0.102*	-0.065***	0.109**	-0.036***
	(0.054)	(0.024)	(0.047)	(0.013)
Age of household head	-0.004***	0.002***	-0.004***	0.001***
	(0.001)	(0.000)	(0.001)	(0.000)
Household size	0.010**	-0.012***	0.009***	-0.006***
	(0.004)	(0.003)	(0.003)	(0.002)
Ratio of dependent persons	-0.022	0.040***	-0.006	0.021***
	(0.021)	(0.010)	(0.019)	(0.005)
Ratio of persons with high school degrees	-0.093***	0.029	-0.101***	0.018*
	(0.031)	(0.018)	(0.029)	(0.010)
Ratio of non-farm labour	-0.002	0.054***	0.000	0.028***
	(0.037)	(0.015)	(0.031)	(0.009)
Owned farm land size	-0.081***	0.000	-0.074***	0.000
	(0.014)	(0.001)	(0.014)	(0.001)
Ln household asset value	0.039***	0.003	0.034***	0.001
	(0.006)	(0.003)	(0.006)	(0.002)
No. of phones used by household members	0.009	0.006	0.005	0.003
	(0.010)	(0.005)	(0.008)	(0.003)
Household has remittances	0.030***	0.013*	0.021**	0.008**
	(0.011)	(0.007)	(0.009)	(0.004)
Distance to district town	-0.000	-0.001	0.000	-0.000
	(0.001)	(0.000)	(0.001)	(0.000)
No. of enterprises in the village	0.002	0.002	0.002	0.001
	(0.004)	(0.001)	(0.003)	(0.001)
No. of observations	**5,727**	**5,727**	**5,727**	
Wald $Chi^2(12)$	1,455	145.76		
Wald $Chi^2(24)$			573.62	
Prob.	0.000	0.000	0.000	

**** p<0.01, ** p<0.05, * p<0.1; standard errors clustered at sub-district level in parentheses; some observations were dropped due to the inclusion of lagged efficiency scores; Ln: natural logarithm*

Appendix 4: Impact of renting cropland on per capita income of asset poor households (all IV method)

	Ln per capita farm income	Ln per capita non-farm income	Ln per capita income
	(1)	(2)	(3)
Household renting-in	0.482	0.142	0.511
	(0.357)	(0.561)	(0.343)
Household renting-out	-1.065**	0.716	0.359
	(0.461)	(0.665)	(0.330)
Age of household head	0.012	0.017*	-0.011
	(0.008)	(0.009)	(0.007)
Household size	-0.226***	-0.120	-0.179***
	(0.047)	(0.082)	(0.056)
Ratio of dependent persons	-0.168	-0.130	-0.068
	(0.318)	(0.383)	(0.254)
Ratio of persons with high school degrees	-0.465	-0.660	-0.540
	(0.961)	(0.889)	(0.618)
Ratio of non-farm labour	-0.143	2.163***	1.030***
	(0.488)	(0.595)	(0.396)
Owned farm land size	0.004	-0.012***	0.004
	(0.005)	(0.002)	(0.004)
Ln household asset value	0.181**	0.032	0.003
	(0.073)	(0.067)	(0.050)
No. of phones used by household members	0.028	0.652***	0.391***
	(0.088)	(0.112)	(0.085)
Household having remittances	0.106	0.008	0.329***
	(0.103)	(0.147)	(0.085)
Distance to district town	-0.015*	-0.005	-0.010*
	(0.009)	(0.005)	(0.006)
No. of enterprises in the village	0.033	0.078	0.054
	(0.041)	(0.060)	(0.053)
No. of observations	1,240	920	1,394
R^2	0.061	0.153	0.134
Prob.	0.000	0.000	0.000
Under-/overidentification	0.022/0.119	0.021/0.359	0.039/0.101
Weak identification	5.594	6.050	5.886

**** p<0.01, ** p<0.05, * p<0.1; robust standard errors clustered at the sub-district level in parentheses; the underidentification test is an LM test based on Kleibergen and Paap (2006) rk LM statistics with the null hypothesis that the model is under identified; the overidentification test is based on the Hansen J test with the null hypothesis being all instruments are valid; for weak identification, Kleibergen-Paap rk Wald F statistics is reported; some observations were dropped as their asset value and/or per capita income in natural logarithm are missing; Ln: natural logarithm.*

Appendix 5: Impact of renting cropland on per capita income of asset non-poor households (all IV method)

	Ln per capita farm income	**Ln per capita non-farm income (ln)**	**Ln per capita income**
	(1)	(2)	(3)
Household renting-in	0.367*	0.215	0.358**
	(0.188)	(0.219)	(0.151)
Household renting-out	-0.208	0.972***	0.636***
	(0.181)	(0.260)	(0.148)
Age of household head	-0.001	0.002	-0.008***
	(0.003)	(0.005)	(0.003)
Household size	-0.245***	-0.080***	-0.221***
	(0.016)	(0.021)	(0.017)
Ratio of dependent persons	0.052	-0.502***	-0.058
	(0.098)	(0.121)	(0.073)
Ratio of persons with high	-0.221	0.187	0.019
school degrees	(0.167)	(0.151)	(0.100)
Ratio of non-farm labour	0.027	2.146***	1.222***
	(0.122)	(0.153)	(0.118)
Owned farm land size	0.033	0.015	0.010
	(0.047)	(0.014)	(0.014)
Ln household asset value	0.166***	-0.049	-0.019
	(0.028)	(0.030)	(0.022)
No. of phones used by	0.159***	0.304***	0.259***
household members	(0.032)	(0.041)	(0.024)
Household having remittances	0.034	0.139***	0.425***
	(0.040)	(0.043)	(0.033)
Distance to district town	0.000	-0.021***	-0.009
	(0.005)	(0.006)	(0.007)
No. of enterprises in the	0.011	0.032**	0.018**
village	(0.008)	(0.013)	(0.009)
No. of observations	**5,412**	**4,199**	**5,820**
R^2	0.090	0.180	0.225
Prob.	0.000	0.000	0.000
Under-/overidentification	0.000/0.860	0.000/0.082	0.000/0.238
Weak identification	23.714	20.873	25.546

**** p<0.01, ** p<0.05, * p<0.1; robust standard errors clustered at the sub-district level in parentheses; the underidentification test is an LM test based on Kleibergen and Paap (2006) rk LM statistics with the null hypothesis that the model is under identified; the overidentification test is based on the Hansen J test with the null hypothesis being all instruments are valid; for weak identification, Kleibergen-Paap rk Wald F statistics is reported; some observations were dropped as their asset value and/or per capita income in natural logarithm are missing; Ln: natural logarithm.*