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Heterogeneous impacts of land quality on household income in Vietnam's north central region

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ABSTRACT

This paper examines the heterogeneous effects of land quality on household income in Vietnam's North Central region. It aims to explore how land quality influences income distribution and whether its benefits are shared equally among households. We employ an instrumental variable quantile regression to analyze the impact of land quality across different income levels while addressing potential endogeneity issues. This approach allows for a more nuanced understanding of how land quality affects households at various points in the income distribution. Our results indicate that only households above the median income level benefit from better land quality, while poorer households experience no significant gains. Land quality positively influences crop income for all groups, but its effects are stronger for those with higher crop incomes. This suggests that wealthier households benefit disproportionately from improved land quality. The findings challenge conventional methods that focus on mean effects, highlighting the importance of accounting for heterogeneity when analyzing land quality's impact. Ignoring these differences may lead to misleading policy recommendations. The study underscores the need for targeted government policies to support poorer households in utilizing their land more effectively. Policymakers should design interventions that enhance agricultural productivity for lower-income farmers to ensure more equitable benefits from land quality improvements.

Contribution/Originality: This study provides the first empirical evidence on the heterogeneous effects of land quality on household income using an instrumental variable quantile regression approach. Unlike previous studies that focus on average effects, our findings highlight how land quality benefits wealthier households more than poorer ones. This research contributes to the literature by emphasizing the importance of considering income distribution when evaluating agricultural policies and land quality improvements.

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1. INTRODUCTION

Land quality is an important factor in determining the effectiveness and sustainability of agricultural production, particularly in developing nations where agriculture typically serves as a cornerstone of the economy (Lal, 2020;

Nguyen, Tran, Hoang, Tran, & Nguyen, 2023). Land quality refers to a range of characteristics, such as soil fertility, water availability, terrain, and climate conditions, that have a direct influence on agricultural yields, livestock well-being, and the general prosperity of farming households (Berazneva, McBride, Sheahan, & Güereña, 2018; D'Hose et al., 2014; Leonard, Parker, & Anderson, 2020; Nguyen et al., 2023; Wiebe, 2003). In developing countries, where there may be limited nonfarm job opportunities, reliance on the natural condition of the land becomes even more important (Tuyen, 2014). This implies that better land quality has the power to alleviate the adverse effects of farming constraints, resulting in more stable and higher agricultural yields. On the other hand, infertile land may aggravate poverty and food insecurity, leading to an ongoing process of inefficiency and poor economic growth.

In the literature, it is well established that land quantity plays a vital role in rural livelihoods in both Vietnam (Nguyen & Tran, 2013, 2018) and several other developing countries (Barbier & Hochard, 2018; Tuyen, 2014). However, most researchers often ignore land quality, possibly due to data unavailability (Nguyen et al., 2023) considering it an unobservable factor in the error term of econometric models (Berazneva et al., 2018; Bhalla, 1988). Land is one of the most important livelihood capitals determining the livelihoods of farming households (Barbier & Hochard, 2018). Better insight into the influence of land quality on household income is useful for both researchers and governments (Nguyen et al., 2023). Recently, a number of studies in Vietnam and other developing countries have examined the effect of land quality on household income using a mean regression approach (e.g., ordinary least squares or instrumental variable estimators) (Nguyen et al., 2023). To the best of our knowledge, however, no study has analyzed the hypothesis that the impact of land quality on household income varies significantly between poor, middle, and wealthier households in rural Vietnam. This gap in the literature, as well as the topic's importance, motivated us to conduct this research. In particular, unlike previous studies that frequently employed a mean regression approach to estimate a mean or homogeneous relationship between land quality and household income, the current study is the first to apply a quantile regression framework to uncover the heterogeneous link between land quality and income among households in Vietnam's North Central region.

The article is structured as follows: The next part discusses relevant references, followed by Part 3 concerning data and econometric methods. Part 4 presents the results and discussion, while Part 5 provides a summary and some policy recommendations.

2. THEORETICAL AND EMPIRICAL EVIDENCE

Recently, the international development community has increasingly recognized the crucial role of land in agriculture and human development (Nguyen et al., 2023). In line with this, the United Nations Food and Agriculture Organization designated 2015 as the International Year of the Soil. This growing awareness has led development and agricultural economics researchers to integrate land data into their studies to better understand soil properties and fertility (Berazneva et al., 2018). Various methods exist to assess soil or land quality. Many household surveys rely on farmers' self-reported assessments, which include information on input and output levels as well as farming conditions (Ali, Deininger, & Ronchi, 2019; Arslan & Taylor, 2009; Nguyen et al., 2023).

The economic return on land is a function of land and its quality (Bhalla, 1988). Empirical evidence generally confirms that land quality is positively related to income, especially in developing countries (Heger et al., 2020; Nguyen et al., 2023). The mechanism explaining this link is quite intuitive. Land is one of the most essential resources determining income for poor households (Barbier & Hochard, 2018). The water-holding capacity of soil is a vital factor that determines the growth of plants (Wong & Asseng, 2006). Louwagie, Gay, Sammeth, and Ratinger (2011) discovered that shallow soils, stoniness, and chemical problems, such as salinity or acidity, adversely affect crop production. Furthermore, the geographical characteristics of the terrain, such as height and incline, influence soil erosion and ease of access for humans and machinery (Zuazo & Pleguezuelo, 2009).

According to Barrett and Bevis (2015a), there are some channels through which low-quality land can hinder efforts to alleviate poverty. Poor and degraded soils initially have adverse effects on farming and environmental income. The correlation between poor soil quality and restricted capital accumulation is mutually reinforcing. Inadequate soil quality hinders the process of capital accumulation, while limited capital accumulation impedes investment in soil improvement (Barrett & Bevis, 2015b; Eswaran, Almaraz, van den Berg, & Reich, 1997). Furthermore, degraded poor-quality soils lack soil micronutrients, leading to dietary mineral deficiencies that can have a negative effect on human health (Barrett & Bevis, 2015b). As noted by Heger et al. (2020), the adverse impact of deteriorating personal health on an individual's ability to generate income is a commonly acknowledged factor in the field of economics, evidenced in Luft's study (Luft, 1975).

Many studies using microdata confirm the positive impact of land quality on enhancing agricultural productivity and income in various countries (Nguyen et al., 2023). Berazneva et al. (2018) have demonstrated that evaluating land quality, whether subjectively or objectively, enhances maize yield in Kenya. Additional research conducted in Mexico (Arslan & Taylor, 2009) and Rwanda (Ali et al., 2019) shows that the quality of land, as measured subjectively, has a beneficial effect on agricultural production. A comprehensive analysis of 83 developing nations reveals a direct correlation between land degradation and the rise in poverty rates from 2000 to 2012 (Barbier & Hochard, 2016). Heger et al. (2020) used data from sub-Saharan Africa and employed rainfall as an instrumental variable for land quality. Their study found evidence that land fertility has a causal impact on reducing poverty in the region. Barbier and Hochard (2018) performed a study that further supports the thesis that poor land quality contributes to increasing poverty in many low-income nations, especially in South Asia. According to Bashir and Schilizzi (2013), the most important variable influencing food security in many Asian and African nations was the high quality of the land.

Whereas a large number of studies examine the impact of land quantity on income and poverty in Vietnam, similar evidence for land quality is quite limited, mainly due to the unavailability of land fertility data (Nguyen et al., 2023). A recent study by Nguyen et al. (2023) investigated the role of land quality in income and poverty among households in Vietnam's North Central Region. The study employed an instrumental variable estimator to address the possible endogeneity of land quality. For households in this region, land quality increases income and reduces poverty. Nevertheless, their mean regression approach fails to determine whether the effect of land quality differs among poor, middle, and wealthier households. To the best of our knowledge, no study using a quantile regression approach has examined the heterogeneous effect of land quality on income. Our study fills this gap by using an instrumental-variable quantile regression estimator to explore this heterogeneous relationship in the same region, while also accounting for the endogeneity of land quality and other observable covariates.

3. DATA AND METHODS

3.1. Data and Measurements

This study uses a secondary dataset from the 2016 QSESERPA (Quantitative Socioeconomic Survey for Emission Reduction Program Areas), conducted by the Mekong Development Research Institute. The survey aimed to gather data on the socioeconomic characteristics of communities targeted by the Emission Reduction Program (ERP), with a particular focus on poor and forest-dependent households. Data collection covered six provinces in Vietnam's North Central region: Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, and Thua Thien Hue.

A multistage sampling method was employed. Initially, 102 communes were randomly selected from these provinces using probability proportional to population size. Next, two villages were randomly chosen within each commune, and 15 households were interviewed per village, yielding a total sample of approximately 3,000 households. The surveyed households included various ethnic minorities such as Thai, Muong, Bru-Van Kieu, H'Mong, Co Tu, Ta Oi-Pa Co, and other ethnic groups (Nguyen et al., 2023). After data cleaning and variable selection, the current study analyzes a final sample of 2,456 households. Table 1 presents the names, definitions, and measurements of the variables used.

In line with previous studies conducted in other countries (Arslan & Taylor, 2009; Berazneva et al., 2018; Sherlund, Barrett, & Adesina, 2002) and in Vietnam (Tran & Van Vu, 2021) this research evaluates annual cropland quality referred to as "land quality"—using self-reported household data. Respondents rated their land quality on a scale from 1 (extremely poor) to 5 (excellent), with intermediate values of 2 (poor), 3 (average), and 4 (good). To construct a land quality index, the study calculates a weighted average that accounts for differences in plot sizes." The Simpson index of fragmented land is estimated as $(1-(\sum a_j^2 / A^2))$ where a_j is the area of plot j, and A is the farm size ($A=\sum a_j$). This index has values varying from zero to one, with a greater value showing that the land is more fragmented (Ciaian, Guri, Rajcaniova, Drabik, & y Paloma, 2018). A number of zeros reveals that the household possesses only one plot of land, resulting in complete land consolidation. Conversely, a value close to one implies that the household owns several plots, indicating a high degree of fragmentation on their farm. In Vietnam, the prevalence of fragmentation is highest in annual cropland, as shown by Tran and Van Vu (2019). As a result, our study assesses only the level of fragmentation for this specific type of land and not for other types. Our research sample excluded households that did not have annual cropland.

3.2. Econometric Model

Following the rural livelihood conceptual framework (Scoones, 1998) and previous studies (Bhalla, 1988; Glewwe, 1991; Nguyen et al., 2023; Tran & Van Vu, 2019; Van Hoang, Tran, Nguyen, & Nguyen, 2019; Zhao & Barry, 2014) our study assumes that household income is a reduced function of land size and quality and other household and regional factors:

$$Y_{ij} = \beta_0 + \beta_1 L_{ij} + \gamma X_{ij} + \delta T D_j + \varepsilon_{ij} \qquad (1)$$

Equation 1 is specified in the semi-log form, in which the dependent variable is household income per capita in log form, while some of the independent variables also are in log form (e.g., size of various types of land) while others, such as ethnicity, gender, employment, migration and regional variables, cannot be transformed into log form because they are dummy variables. Y_{ij} indicate the log of household income for the household i in province j. X_i represents several control variables (household characteristics; L_{ij} is the quality of land and D_j presents province dummy variables that capture unobservable province factors. β_0 is the intercept; β_1, γ and δ are the parameters to be estimated, and ε_{ij} indicate the error term.

Following previous studies in Vietnam (Nguyen et al., 2023; Tran Quang Tuyen, Lim, Cameron, & Vu Van Huong, 2014) and developing countries (Jansen, Pender, Damon, Wielemaker, & Schipper, 2006) our study focuses exclusively on certain household assets, including human and natural capital, that are stable or change slowly. Due to their inherent stability, these features are highly likely to be predetermined factors. Because these types of assets typically determine or even depend on household well-being, we do not consider physical, financial, and social capital as factors affecting income. The names and measurements of the included variables are provided in Table 1.

First, we estimate Equation 1 using two-stage least squares (2SLS). However, the 2SLS method only analyzes the homogenous or mean relationship between land quality and household income, missing valuable information. We are more interested in uncovering the heterogeneous effects of land quality on household income in this study, which is why we should employ a quantile regression framework instead of a mean regression approach. The former provides a more comprehensive view of the association among variables and allows researchers to evaluate the effect of land quality on income at various points of the income distribution (Koenker, 2005). The model specifies the θ^{th} – quantile ($0< \theta <1$) of the conditional distribution of the income variable, given a set of covariates, as in Equation 2.

$$Q_\theta(Y_{ij}|x_{ij}) = \beta_0 + \beta_1 L_{ij} + \gamma X_{ij} + \delta TD_j + u_{ij} \qquad (2)$$

However, land quality may be endogenous due to several factors, including omitted variable bias (e.g., unobserved soil management practices), measurement error in land quality assessment, and simultaneity (e.g., wealthier households may invest more in soil improvement, creating a bidirectional relationship).Therefore, our study should estimate Equation 2 employing the instrumental variable quantile regression (IVQR) estimator, as the quantile regression estimator would produce biased and inconsistent results (Chernozhukov & Hansen, 2004, 2008). The IVQR estimator is a statistical method that estimates parameters at various points in the outcome distribution. It also takes into account endogeneity issues that can arise due to factors such as self-selection, exclusion of relevant variables, or measurement errors (Chernozhukov & Hansen, 2004, 2008). Following Nguyen et al. (2023), we select the level of land fragmentation at the commune level as the instrument for land quality because there is a strong correlation between the two variables. The mechanism behind this relationship is that farming costs (e.g., maintaining field embankments, irrigation, or moving between plots) tend to be higher with fragmented land. Consequently, such land often receives less investment, resulting in less fertile land (Ali et al., 2019; Tran & Van Vu, 2019).

4. RESULTS AND DISCUSSION

4.1. Statistical Analysis of Household Characteristics

Initially, we divided the sample into three groups of similar size (N = 819, 819, 819) based on their household income per capita (poor, middle-, and high-income groups). Then, we compared the differences in the mean values of household characteristics among the three groups. On average, the per capita income for the whole sample is about 835 thousand VND. However, the figure is much higher for the high-income group (1860 thousand VND), followed by the middle-income group (about 489 thousand VND), and the poor (about 158 thousand VND). Land quality is also slightly higher for wealthier households than for middle- and low-income households. The average age of household heads is higher for those in the high-income group (about 35) than for those in the middle (about 35.5) and poor groups (about 32.8). The proportion of households whose heads belong to the Kinh group (the major ethnicity) increases significantly from the poor (11%) to the middle (23%) and high-income groups (42%). This suggests a close relationship between poverty and ethnicity.

There are substantial differences in education levels among the three groups. The proportion of household heads without education is highest in the poor group (46%), and it is much higher than that of the middle-income group (34%) and the high-income group (18%). Also, the percentage of household heads who completed upper secondary school is only about 5% in the poor group, whereas the corresponding figures for the middle-income group are about 7%, and about 10% for the high-income group. Both the household size and dependency ratio are larger for the poor than for the middle-income and wealthier groups. This suggests that some demographics are also associated with economic status.

Regarding economic activities, about 47% of poor households reported at least one member working as a wage earner. The corresponding figure is much higher for those in the middle-income (72%) and high-income groups (77%). Only about 6% of poor households engaged in nonfarm activities, but this figure is about 16% for those in the high-income group. The percentage of households with migrant members is highest among high-income households (22%), followed by middle-income (15%) and poor households (13%). The average size of annual cropland is very similar for the rich and poor groups but lower for the middle class. However, the wealthier group has the largest amount of forestland, perennial cropland, and residential land.

Table 1. Descriptive statistics of the research sample.

Income group	**Low income**		**Middle income**		**High income**		**Whole sample**	
Household characteristics	**Mean**	**Sd**	**Mean**	**Sd**	**Mean**	**Sd**	**Mean**	**Sd**
Income per person (Thousand Vietnam Dong/month)	157.72	77.22	488.99	138.32	1860.81	1691.94	835.42	1226.62
Land quality (Likert scale from 1 to 5)	1.83	1.01	1.95	1.04	2.02	1.11	1.93	1.06
Age of household head	32.84	7.09	33.53	7.31	35.02	7.66	33.80	7.41
Ethinicity (1=Kinh;0=Other ethnicity)	0.11	0.32	0.23	0.42	0.42	0.49	0.25	0.43
Gender of household head (1=Male;0=Female)	0.89	0.31	0.89	0.31	0.89	0.31	0.89	0.31
No education (1=Yes; 0=No)	0.46	0.50	0.34	0.47	0.18	0.39	0.33	0.47
Primary education (1=Yes; 0=No)	0.25	0.43	0.30	0.46	0.25	0.44	0.27	0.44
Lower secondary (1=Yes; 0=No)	0.23	0.42	0.27	0.45	0.36	0.48	0.29	0.45
Upper secondary (1=Yes; 0=No)	0.05	0.22	0.07	0.25	0.10	0.30	0.07	0.26
Above upper secondary (1=Yes; 0=No)	0.01	0.10	0.02	0.15	0.11	0.31	0.05	0.21
Household size (Members)	4.99	1.75	4.62	1.53	4.20	1.56	4.60	1.64
Dependency ratio[a]	1.00	0.78	0.83	0.67	0.66	0.63	0.83	0.71
Wage employment (1=Yes; 0=No)	0.47	0.50	0.72	0.45	0.77	0.42	0.65	0.48
Nonfarm employment (1=Yes; 0=No)	0.06	0.23	0.08	0.28	0.16	0.36	0.10	0.30
Migration (1=Yes; 0=No)	0.13	0.34	0.15	0.36	0.22	0.41	0.17	0.37
Annual cropland (m^2)	6543.42	9369.92	5491.30	8362.89	6541.31	10834.14	6191.87	9584.59
Perenial cropland (m^2)	286.89	1208.79	470.05	1994.93	614.27	2470.49	457.01	1965.19
Forestland (m^2)	7120.40	14617.98	9833.05	16672.79	15948.88	28849.41	10965.41	21317.47
Residential land (m^2)	296.00	675.26	412.54	960.66	584.06	994.18	430.80	895.75
Observations	819		819		819		2456	

Note: This ratio is calculated by the number of members aged 16 and 60, divided by the total number of members.
a refers to the overall dependency ratio, which combines both the youth dependency ratio (0–14 years) and the old-age dependency ratio (65+ years) for each income group.

Table 2 compares land quality among income groups. The poor group reports that about 3.34% of the total number of plots are of very bad quality, a higher percentage than that for the middle- and high-income groups. Similarly, the poor group has the highest percentage of plots assessed as of bad quality, while the high-income group has the lowest percentage. The percentage of the total number of plots considered to be of average quality is quite similar among the three groups, but the proportion of the total number of plots assessed as good or very good increases with the level of income, higher for the middle class and highest for wealthier households. The data suggests a correlation between land quality and economic well-being.

Table 2. Land quality by income group.

Land quality	Number of plots	Poor	Middle	Rich	Total
Very bad	Number	55	50	44	149
	%	3.34	3.09	2.64	3.02
Bad	Number	528	446	411	1,385
	%	32.02	27.55	24.64	28.06
Average	Number	736	730	750	2,216
	%	44.63	45.09	44.96	44.89
Good	Number	323	383	436	1142
	%	19.59	24	26.14	23.14
Very good	Number	7	10	27	44
	%	0.42	1	1.62	0.89
Total	Number	1649	1619	1668	4936
	%	100	100	100	100

4.2. Econometric Analysis

Table 3 presents the regression results from the 2SLS and IVQR models. The 2SLS estimates indicate that the coefficient for the land quality variable is 0.04 and is not statistically significant (p-value = 0.45). This suggests that, on average, land quality has no effect on household income. However, the IVQR estimates confirm that land quality only benefits those with higher income levels. For example, for households in the 75th quantile, their income level would increase by about 9% if land quality improved by one point. We also find a similar but larger effect, about 14%, for those in the 90th quantile. Our study provides fresh evidence that land quality does not improve income for those with incomes below the median level, but does so for those with incomes above the median level (see more in Figure 1).

As discussed by Nguyen et al. (2023), the role of crop income explains the mechanism behind the positive association between land quality and household income. Therefore, we further analyze the effect of land quality on crop income, employing both 2SLS and IVQR methods. The results in Table 4 reveal that, on average, per capita income would improve by about 35% if land quality improved by one point, controlling for other factors in the models. All income groups experience this effect, but its magnitude increases with income levels, suggesting that those with higher crop incomes benefit more from land quality (Figure 2). Specifically, the crop income of the poorest group would increase by approximately 23% if land quality improved by one point. However, the corresponding effect for the richest group would be around 42%. The smaller effect on poorer groups may contribute to the lack of a significant positive impact on their overall household income.

Table 3 also reveals that many other factors influence household income. Table 3's 2SLS results demonstrate the positive impact of ethnicity on households. On average, Kinh households earn about 64% more per person than ethnic minority households. The IVQR estimates also reveal the same results for all income groups. For all income groups, better education would result in positive effects on household income. Surprisingly, the magnitude of education's income effects is quite similar across income quantiles. These findings are similar to those in Vietnam's North West region (Tuyen, 2015) and the Mekong Delta region (Van Hoang et al., 2019).

Table 3. The effect of land quality on household income.

Explanatory variables	Two stage least squares (2SLS)		Instrumental variable quantile regression (IVQR)									
			10th quantile		25th quantile		50th quantile		75th quantile		90th quantile	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Land quality	0.04	0.05	-0.10	0.08	-0.03	0.06	0.03	0.05	0.09**	0.04	0.14***	0.05
Age	-0.00	0.00	-0.01	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethnicity	0.64**	0.06	0.54***	0.10	0.58***	0.08	0.61***	0.06	0.64***	0.06	0.67***	0.07
Gender	0.05	0.07	0.08	0.12	0.06	0.09	0.04	0.07	0.02	0.07	0.00	0.08
Primary edu	0.18**	0.06	0.21**	0.09	0.19***	0.07	0.18***	0.05	0.17***	0.05	0.15***	0.06
Lower secondary	0.24**	0.06	0.24***	0.10	0.24***	0.07	0.24***	0.06	0.24***	0.05	0.24***	0.06
Upper secondary	0.42**	0.09	0.42***	0.15	0.41***	0.11	0.41***	0.09	0.41***	0.09	0.40***	0.11
Above upper secondary	1.15**	0.10	1.43***	0.17	1.28***	0.12	1.14***	0.09	1.01***	0.08	0.91***	0.10
Household size	-0.07**	0.01	-0.03	0.03	-0.05***	0.02	-0.07***	0.01	-0.09***	0.01	-0.10***	0.01
Dependency ratio	-0.19**	0.03	-0.22***	0.06	-0.21***	0.04	-0.19***	0.03	-0.18***	0.03	-0.17***	0.03
Annual cropland	-0.01	0.02	-0.04	0.03	-0.02	0.02	-0.01	0.02	0.00	0.01	0.01	0.02
Perenial cropland	0.07**	0.02	0.06**	0.03	0.07***	0.02	0.07***	0.02	0.08***	0.01	0.08***	0.02
Forestland	0.05**	0.01	0.05***	0.02	0.05***	0.01	0.05***	0.01	0.05***	0.01	0.05***	0.01
Residential land	0.08**	0.02	0.07*	0.04	0.08***	0.03	0.08***	0.02	0.09***	0.02	0.10***	0.03
Nghe An	-0.28**	0.06	-0.40***	0.10	-0.33***	0.07	-0.28***	0.06	-0.22***	0.06	-0.18**	0.07
Ha Tinh	-0.27*	0.11	-0.27	0.17	-0.27**	0.13	-0.27***	0.11	-0.27**	0.11	-0.27**	0.13
Quang Binh	-0.34**	0.08	-0.28**	0.12	-0.31***	0.09	-0.34***	0.07	-0.37***	0.07	-0.39***	0.09
Quang Tri	-0.50**	0.07	-0.76***	0.12	-0.63***	0.09	-0.51***	0.07	-0.40***	0.07	-0.31***	0.09
Thua Thien Hue	-0.24**	0.07	-0.35***	0.12	-0.29***	0.09	-0.24***	0.07	-0.20***	0.07	-0.16*	0.09
Constant	8.85**	0.19	7.90***	0.32	8.43***	0.24	8.93***	0.18	9.39***	0.18	9.77***	0.21
Centered R2	0.2292											
Observation	2456											

Note: *,**,*** indicate statistically significant at 10%, 5% and 1%, respectively.

Table 4. The effect of land quality on crop income..

Explanatory variables	Two stage least squares (2SLS)		Instrumental variable quantile regression (IVQR)									
			10th quantile		25th quantile		50th quantile		75th quantile		90th quantile	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Land quality	0.35**	0.06	0.23**	0.12	0.29***	0.08	0.34***	0.06	0.38***	0.06	0.42***	0.07
Age	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ethnicity	0.40**	0.08	0.43***	0.13	0.41***	0.09	0.39***	0.08	0.38***	0.08	0.37***	0.10
Gender	0.15+	0.09	0.17	0.16	0.15	0.12	0.14	0.09	0.12	0.09	0.11	0.11
Primary edu	-0.09	0.07	-0.04	0.13	-0.05	0.09	-0.07	0.07	-0.08	0.07	-0.08	0.08
Lower secondary	-0.10	0.07	-0.06	0.12	-0.07	0.09	-0.09	0.07	-0.10	0.07	-0.11	0.09
Upper secondary	-0.03	0.11	-0.02	0.20	-0.01	0.14	0.00	0.11	0.01	0.11	0.02	0.13
Above upper secondary	-0.07	0.14	0.05	0.25	0.00	0.17	-0.04	0.13	-0.08	0.13	-0.11	0.16
Household size	0.07**	0.02	0.07**	0.03	0.07***	0.02	0.07***	0.02	0.07***	0.02	0.07***	0.02
Dependency ratio	-0.14**	0.04	-0.15**	0.07	-0.15***	0.05	-0.14***	0.04	-0.13***	0.04	-0.13***	0.05
Annual cropland	-0.01	0.02	0.00	0.03	0.00	0.02	-0.01	0.02	-0.01	0.02	-0.02	0.03
Perenial cropland	-0.03+	0.02	0.02	0.03	-0.01	0.02	-0.03*	0.02	-0.05***	0.02	-0.07***	0.02
Forestland	0.03**	0.01	0.01	0.02	0.02	0.02	0.03**	0.01	0.03***	0.01	0.04***	0.01
Residential land	-0.00	0.03	-0.01	0.05	0.00	0.04	0.00	0.03	0.01	0.03	0.01	0.03
Nghe An	-0.39**	0.08	-0.59***	0.13	-0.48***	0.09	-0.38***	0.07	-0.30***	0.07	-0.23***	0.09
Ha Tinh	-0.01	0.14	-0.31	0.26	-0.13	0.18	0.02	0.14	0.15	0.13	0.26	0.16
Quang Binh	-0.71**	0.10	-0.93***	0.17	-0.79***	0.12	-0.67***	0.10	-0.57***	0.10	-0.48***	0.12
Quang Tri	-0.57**	0.10	-1.04***	0.17	-0.78***	0.12	-0.55***	0.09	-0.36***	0.09	-0.19***	0.11
Thua Thien Hue	-0.12	0.09	-0.63***	0.18	-0.36***	0.13	-0.12	0.10	0.07	0.10	0.25	0.12
Constant	-0.66**	0.24	-2.11***	0.42	-1.27***	0.30	-0.52**	0.23	0.07	0.23	0.62**	0.27
Centered R2	0.1337											
Observation	2456											

Note: *,**,*** indicate statistically significant at 10%, 5% and 1%, respectively.

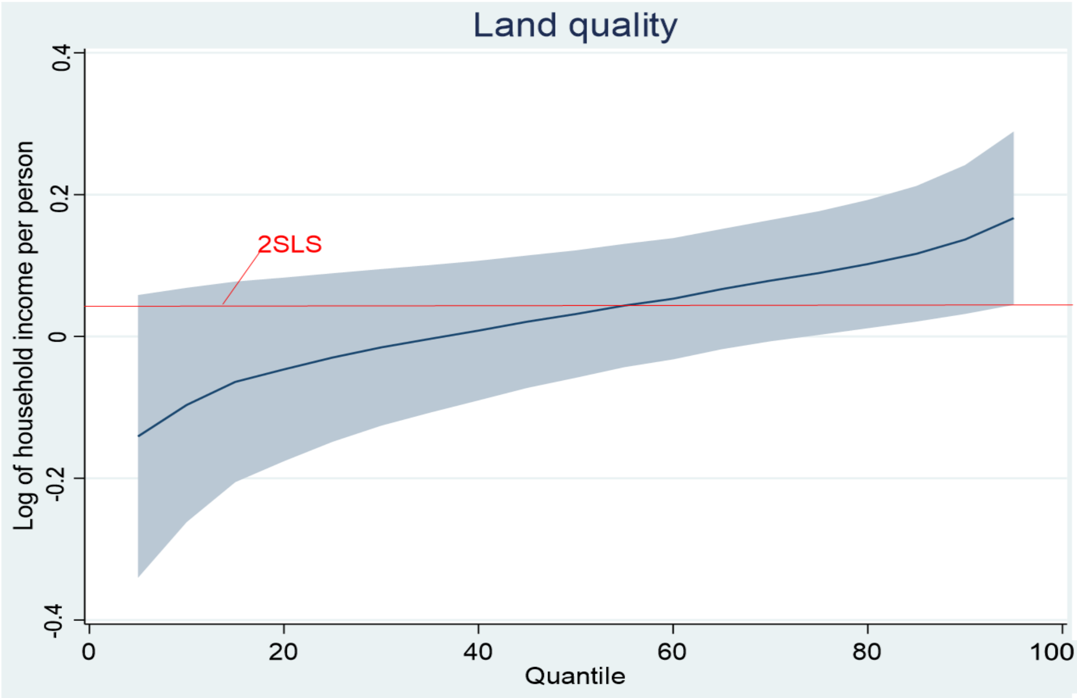

Figure 1. Heterogeneous effects of land quality on household income per person.

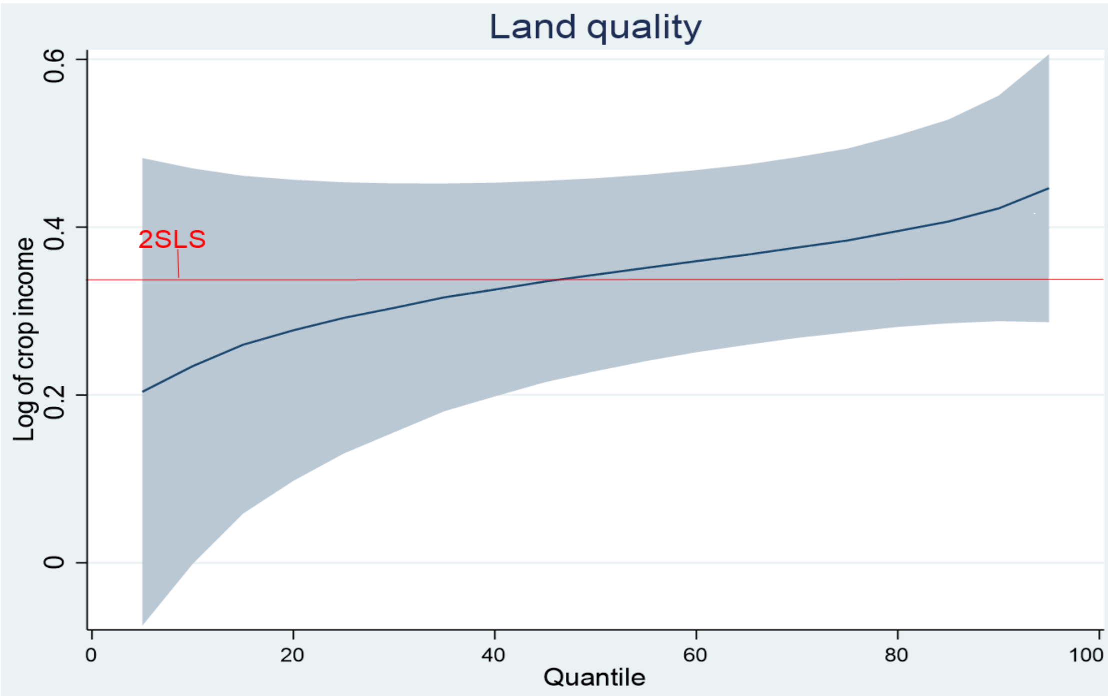

Figure 2. Heterogeneous effects of land quality on crop income.

According to the 2SLS estimates, having more household and dependent members would reduce per capita income. Researchers found the same result in rural Vietnam (Phan, Tran, Phan, & Hoang, 2019). However, the negative effect of household size increases with higher income quantiles. With respect to the role of land in enhancing income, Table 3 indicates that holding more annual cropland does not improve household income for any income groups. Nevertheless, having more land of other kinds enhances income for all income groups. Furthermore, the effect of perennial cropland, forestland, and residential land on income is quite similar across income groups, suggesting that all receive the same returns on those kinds of land. The findings are partially congruent with those in the Mekong Delta region (Van Hoang et al., 2019).

Table 4 shows some other factors affecting the total amount of crop income. Surprisingly, education levels play no role in improving crop income for any income group. Crop income is not affected by the size of annual cropland but is significantly boosted by its quality, as previously discussed. The finding suggests that the quality of annual cropland plays a critical role in raising crop income for local households. Ethnicity emerges as a significant factor affecting crop income. Specifically, Kinh households earn about 40% more than ethnic minority households. Male-led households, on average, earn about 15% more crop income than female-led households. The finding suggests that having more household members is necessary for farming activities, as larger household sizes have a positive effect on crop income. Having more dependents, however, reduces crop income. Finally, controlling for other household characteristics, our study finds that households in Nghe An, Quang Binh, and Quang Tri have lower crop income on average than those in Thanh Hoa (the base group).

5. CONCLUSION AND POLICY IMPLICATIONS

The current research is the first to examine the heterogeneous effect of land quality on household income in rural Vietnam. The study applies an instrumental variable quantile regression approach to test the hypothesis that the impact differs among income groups. We provide new evidence that land quality has a positive impact only for those above the median income level, but not for those below it. Our findings suggest that land quality only benefits the better-off. Possibly, this result may reflect the fact that only better-off households know how to take advantage of land quality to promote their economic well-being. Also, this suggests that wealthier households have better knowledge, skills, and financial resources to make good use of land quality. The findings confirm that land quality significantly influences crop income, particularly for those with higher crop income levels. Therefore, our findings suggest the need for government policies to assist the poor in effectively cultivating their annual cropland.

In addition, we find several other factors contributing to household income in the study region. All income groups agree that better education improves household income. Kinh households earn significantly higher incomes than ethnic minority households. While the quality of annual cropland significantly influences both household and crop income, its size does not have the same effect. Other types of land also positively influence both household income and crop income. This suggests the important role of natural assets in rural household livelihoods. We also observe differences in income levels across provinces, indicating that some unobservable provincial factors may significantly influence household income and crop income.

We recognize that the current study has certain limitations that offer opportunities for future investigation. The subjective measurement of land quality, which relies on self-reported assessments, is less reliable compared to the objective approach (Nguyen et al., 2023). Ferrer-i-Carbonell and Frijters (2004) have discussed the ongoing question of whether to classify the resulting data as ordinal or interval. Therefore, we recommend that future studies incorporate both assessment methodologies to validate the findings. In addition, our study's reliance on cross-sectional data constrains its ability to analyze the dynamic nature of the association between land quality and household income. Given the availability of longitudinal data, future studies should explore the dynamic relationship between land quality and household income while accounting for unobservable time-invariant factors. Finally, while the IVQR method effectively addresses endogeneity concerns, our model relies on a single instrumental variable, so it is identified exactly. This limitation prevents the standard overidentification test from being conducted to assess instrument validity. Future research could explore additional instrumental variables to enable overidentification tests, which would provide a more robust assessment of instrument validity and help mitigate concerns associated with relying on a single instrument.

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