Heterogeneous effects of livelihood strategies on household well-being: An analysis using unconditional quantile regression with fixed effects

Tran, Tuyen and Vu, Huong

International School, Vietnam National University, Hanoi, Duy Tan University, VNU University of Economics and Business

15 December 2019

Heterogeneous effects of livelihood strategies on household well-being: An analysis using unconditional quantile regression with fixed effects[1]

Tuyen Quang Tran[1*], Huong Van Vu[2]

[1]*International School, Vietnam National University, Hanoi, Vietnam*
Address: Building G7 &G8, No. 144, Xuan Thuy Street, Cau Giay District, Hanoi, Vietnam
*email:tuyentranquang@isvnu.vn

[2]*Institute of Theoretical and Applied Research, Duy Tan University, Da Nang, Vietnam and VNU University of Econmics and Business, Hanoi, Vietnam*

Abstract

Using a household panel dataset for the 2008-2016 period, we analyze the heterogeneous effects of livelihood change on household well-being in rural Vietnam. We use an unconditional quantile regression (UQR) model with fixed effects to control for unobservable time-invariant household characteristics. We find that when a fixed-effects estimator is employed, households switching from a crop livelihood to any non-crop livelihood (e.g., livestock, wage-earning, nonfarm or private transfer livelihoods) increase their per capita income and food consumption. However, the results from the UQR with fixed effects reveal a significant variation in the effect of such a switch in livelihood across various quantiles of well-being distribution, with a larger effect for poorer households. The income effect, however, tends to decline with higher quantiles and even turns negative with a switch to a wage-earning or public transfer livelihood for the better off. Notably, our study confirms the advantage for the poor of changing livelihood from crop to non-crop activities in rural Vietnam. Our research results also suggest that a mean regression approach, that often assumes a homogeneous/mean effect of livelihoods on well-being, may miss some heterogeneity that is useful to researchers and policy makers.

Keywords: Cluster analysis; fixed effects; food consumption; livelihood; unconditional quantile regression.
JEL codes: C21; C23; C31; Q12; P 25; O12

Compliance with Ethical Standards

Conflict of Interest:

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

Acknowledgements: This research is funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 502.01-2020.07.

[1] The revised and final version of this paper has been published in ***Economic Analysis and Policy***, October 2020, https://www.sciencedirect.com/science/article/pii/S0313592620304331

1. Introduction

Livelihood diversification is one of the most typical characteristics of rural households. The empirical literature consistently confirms that diversifying towards nonfarm livelihood strategies instead of depending solely on subsistence farming enables rural households to earn higher income, improve food security and promote agricultural production (Babatunde & Qaim, 2010; Bezu, Barrett, & Holden, 2012; Liu, Golding, & Gong, 2008; Reardon, Delgado, & Matlon, 1992; Zhao & Barry, 2014). Similar findings have been reported in numerous studies in rural Vietnam (Nguyen & Vu, 2018; Hoang, Tran, Nguyen, & Nguyen, 2019; Hoang, Pham, & Ulubaşoğlu, 2014; Nguyen, Van den Berg, & Lensink, 2011; Pham, Bui, & Le, 2010; Tran, 2014, 2015a; Van de Walle & Cratty, 2004). For instance, Hoang et al. (2014) found that nonfarm employment increased household expenditure and reduced poverty in rural Vietnam. It is also evident that in the Northwest (Tran, 2015a) and North Central regions (Nguyen & Tran, 2018), households with nonfarm employment (wage-earning or self-employment) earned higher income than those without.

In the aforementioned literature, however, most studies often assume a homogeneous relationship between nonfarm diversification and household well-being, using standard linear regression techniques, such as ordinary least squares (OLS) and random or fixed effects estimators (e.g., Bezu et al., 2012; Nguyen & Vu, 2018; Hoang et al., 2014; Nguyen et al., 2011; Pham et al., 2010; Tran, 2015b). Such a mean regression approach summarizes the average relationship between nonfarm diversification and household well-being, based on the conditional mean of well-being distribution (Koenker & Hallock, 2001). This approach yields only a partial view of the relationship between variables because it focuses only on changes at the conditional mean (Davino, Furno, & Vistocco, 2013). Researchers are more interested in examining the relationship at different points in the conditional distribution of well-being, and quantile regression provides that capability (Koenker & Hallock, 2001).

Recently, a few studies have investigated the heterogeneous effects of livelihood diversification on household well-being, using a quantile regression approach (Asfaw, Scognamillo, Di Caprera, Sitko, & Ignaciuk, 2019; Edirisinghe, 2015; Zhao & Barry, 2014). For example, Asfaw et al. (2019) found that the income effect of nonfarm diversification in Sub-Saharan Africa is much greater for those in the lowest quantile (the poorest), but declines and turns negative in some cases for those at the upper end of income distribution. The finding, therefore,

emphasizes the benefit for the poor of nonfarm diversification in the rural African context. The same result in rural China was also reported earlier by Zhao and Barry (2014), who showed that participating in nonfarm employment and migration brings higher incomes for poorer households than they do for the better off. To the best of our knowledge, however, no study similar to ours has been conducted in Vietnam thus far.

Empirical evidence on the heterogeneous effects of livelihoods on rural household well-being is essential to provide policy makers with useful information for policy design and intervention that better match the needs and characteristics of rural households (Zhao & Barry, 2014). This is especially relevant to rural Vietnam, where landless farmers account for a sizeable proportion of the rural population who often have limited opportunities, so must migrate to big cities in search of work (United Nations, 2014). In particular, because rural Vietnamese households diversify their livelihoods in multiple ways (Nguyen, Doan, & Tran, 2020; Tarp, Vinh, & Tuan, 2017), a comparison of the effects of various livelihood strategies on household well-being is expected to provide guidance for these households to improve their well-being in more effective ways. The main reasons for conducting this study are the importance of the research topic and the gap in the literature concerning Vietnam.

The main objectives of this paper are (i) to classify the various livelihoods adopted by rural households and (ii) to quantify the heterogeneous effects of livelihoods on household income and food consumption. Notably, our main concern was to test the hypothesis that the effect differs significantly between poor, middle-income and high-income households. To achieve this aim, a household panel dataset from the 2008-2016 Viet Nam Access to Resources Household Survey (VARHS) was analyzed to classify different livelihoods. Unconditional quantile regression (UQR) with fixed effects was then employed to investigate the heterogeneous effects across income quantiles. Such an econometric specification provides a more comprehensive relationship among variables than a linear regression estimator can, while controlling for the effects of distinguishing demographics, education, assets and unobservable time invariant factors.

The rest of the paper is organized as follows. Section 2 presents the data and econometric model used in the present study. The empirical results are presented in Section 3, while the final section provides conclusions and policy implications.

2. Data and method

2.1. Data sources

The current study utilizes five cycles of the Viet Nam Access to Resources Household Surveys (VARHS) from 2008 to 2016. The surveys were conducted every two years in 12 provinces in Vietnam. While the surveys are not nationally representative, they are representative at the provincial level and provide a great deal of detailed information on individual and household characteristics, such as demographics, education, employment, economic activities and income sources. The surveys were implemented in collaboration with the Central Institute for Economic Management (CIEM) of the Ministry of Planning and Investment of Vietnam (MPI), and the Institute of Labor, Science and Social Affairs (ILSSA) of the Ministry of Labor, Invalids, and Social Affairs of Vietnam (MOLISA). VARHSs 2008, 2010, 2012, 2014, and 2016 include 2278, 2245, 2760, 2725 and 2669 households, respectively. These surveys provide an unbalanced panel dataset of repeated observations of the same 2131 households over the 2008-2016 period.

2.2. Conceptual framework

The sustainable rural livelihood (SRL) approach (Ellis, 2000b; Scoones, 1998) was used as the conceptual framework for our study. Following Ellis (2000), we used the relative contribution of various income sources to classify households according to income livelihood typologies. Our study considers smallholder household income sources and activities as livelihood strategies designed to manage adverse effects on income and food consumption caused by negative climate events, uncertain farming production, unexpected market shocks (Asfaw et al., 2019; Barrett, Bezuneh, & Aboud, 2001; Gautam & Andersen, 2016) and land shortage (Tran, Lim, Cameron, & Vu, 2014; Tran & Van Vu, 2019). In this way, our study considers rural households as decision-unit agents, then examines the effect of livelihoods on their well-being as measured by household income and food consumption per capita.

2.3. Clustering household livelihoods

The data from the 2008-2016 VARHS show that each household member engaged in one or more income-earning activities and that each household often participated in more than one activity[2]. This suggests that household livelihoods cannot be identified by a single activity only. Thus, we

[2] Using data from the 2016 VARHS, our study reveals that only about 22% of Vietnamese rural households engaged in a single activity, while approximately 50% participated in two activities and around 28% were involved in three activities.

used cluster analysis techniques to classify households according to different livelihoods. This approach allows researchers to allocate a number of households to a set of mutually exclusive, exhaustive, groups, such that households in one group or cluster are similar to one another while those in different groups are dissimilar (Everitt, Landau, Leese, & Stahl, 2011).

Table 1: Income from various sources

Categories	Definitions
1. Crop income	Income from annual, perennial and forest crops.
2. Livestock income	Income from poultry, cattle and fish production.
2. Nonfarm income	Income from self-employment in non-farm activities (non-farm household businesses).
3. Wage income	Income from all wage-earning activities, including both formal and informal wage-paying work (wage-paying work with and without a labor contract).
4. Private transfer	Income derived from gifts and remittances, both domestic and international.
5. Public transfer	Income received from pensions, social welfare, retirement allowances and various government programs.
6. Rental income	Income received from renting out land and non-land assets (e.g., interest).

Note: All income sources are measured in both cash and kind.

Table 1 shows the relative proportion of income components used as input variables for cluster analysis, following Ellis (2000) and empirical studies (Edirisinghe, 2015; Hoang et al., 2019; Tran et al., 2014) A two-step cluster analysis approach was performed as follows. First, we applied a hierarchical method to find the optimal number of clusters, using the Calinski stopping rule (Halpin, 2016). The result from this stage indicates that the largest value of Calinski/Harabasz pseudo-F is 4866.51, corresponding to the optimal number of seven clusters (see Appendix 1). Second, cluster analysis was implemented with seven groups, using k-mean clustering. Finally, seven livelihood groups were identified, with their corresponding household income structures and characteristics being given in Figure 1 and Tables 2 and 3.

2.4. Econometric model specification

Following the sustainable rural livelihood conceptual framework and empirical studies (Bezu et al., 2012; Nguyen & Vu, 2018; Glewwe, 1991; Hoang et al., 2014; Zhao & Barry, 2014), we assume household well-being is a reduced function of livelihood strategies and various household characteristics:

$$Ln(Y_{it}) = \beta_0 + \beta_{it}L_{it} + \gamma_{it}\bar{X}_{it} + \delta_t Year_t + \varepsilon_{it} \quad (1)$$

Where $Ln(Y_{it})$ refers to the log-transformed outcome variable (i.e., monthly per capita income or food consumption) by household i in year t; L_{it} represents the livelihood strategy of household i in year t; $\bar{X}_{it}$ is a vector of control variables (household distinguishing characteristics, such as demographic variables, education and arable land); $Year_t$ is the year dummy variable that

captures structural change over time. β_0 is the constant term; β_{it}; γ_{it} and δ_t are the parameters to be estimated; and ε_{it} represents the idiosyncratic error term.

Equation (1) was estimated using a fixed-effect estimator with a panel dataset of households for the 2008-2016 period. This method removes the effects of time-invariant unobserved regional, household and individual characteristics that can influence household well-being (Wooldridge, 2016). Given the assumption that the idiosyncratic error ε_{it} should be uncorrelated with each explanatory variable across all time periods, using a fixed effect estimator in Equation (1) provides unbiased estimates (Wooldridge, 2016). Also, in Equation (1) the effect of livelihoods on household well-being is captured by β_{it}. With the nature of panel data, a fixed effect or random effects estimator can be used to estimate the homogeneous or mean effect of livelihoods on well-being.

However, valuable information could be missed if we only examine the mean effect using a fixed effects estimator as given in Equation (1). In this paper, since we are more interested in estimating the heterogeneous effects of livelihoods on well-being, a quantile regression (QR) should therefore be employed. Notably, the QR offers a more comprehensive view of the relationship among variables, and provides a method for modelling the level of changes in the response variable at various points of distribution when such levels of change differ. In the heterogeneous framework, QR coefficients vary in size (or magnitude) and sign (direction) and thus provide location and shape shift information on the response variable (Davino et al., 2013).

Specifically, our study used the unconditional quantile regression (UQR) estimator developed by Firpo, Fortin, and Lemieux (2009), because it is widely believed that the UQR estimator yields more policy-relevant information than does the conditional quantile regression (CQR) estimator (Khanal, Mishra, & Honey, 2018; Maclean, Webber, & Marti, 2014). This is partially due to the advantage with UQR that quantiles are defined pre-regression. Consequently, the model is not affected by including or excluding any covariates (Killewald & Bearak, 2014). In UQR, for example, we can include fixed effects to account for selection bias without redefining the quantiles (Borgen, 2016).

The UQR estimator involves regressing the Recentered Influence Function (RIF) of the unconditional quantile of the independent variable on the explanatory variables. According to Firpo et al. (2009), the RIF of the τ-th quantile of the Y_{it} distribution can be expressed by the following equation:

$$RIF(Y_{it};\ q_\tau, F_{Y\,it}) = q_\tau + \frac{\tau - 1\{Y_{it} \le q_\tau\}}{f_Y(q_\tau)} \quad (2)$$

where Y_{it} refers to the outcome variable (i.e., income or consumption per capita), q_τ represents the value of the outcome variable at quantile τ; $F_{Y\,it}$ denotes the cumulative distribution function (CDF) of Y_{it}; the indicator function, $1\{Y_{it} \le q_\tau\}$, shows whether the value of the outcome, Y_{it}, for household i is below q_τ , and $f_Y(q_\tau)$ is the density of Y_{it} at q_τ.

After this transformation, an OLS regression with the RIF as the dependent variable can be performed. For instance, consider the 90^{th} quantile (τ=90). To identify the RIF for this quantile, we need to (1) estimate the value of the outcome variable at that quantile, $q_{0.90}$; (2) estimate the density of $f_y(q_{0.90})$ at $q_{0.90}$ using, for example, kernel methods; and (3) create a dummy variable, $\{Y_{it} \le q_{0.90}\}$, which shows whether the value of the outcome variable is at or below the 90^{th} quantile, $q_{0.90}$. The resulting dummy variable RIF holds the values $q_{0.90}$ +$\{0.90/f_y(q_{0.90})\}$ for those above the 90^{th} quantile and the values $q_{0.90}$ -$\{0.10/f_y(q_{0.90})\}$ for those at or below the 90^{th} quantile (Borgen, 2016).

Given our panel data, we need to include fixed effects in the UQR estimator to control for unobservable individual, household and regional factors that are time invariant. The two-step approach proposed by Firpo et al. (2009) and extended by Borgen (2016) enables us to feasibly include high-dimensional fixed effects in the UQR estimator. The name, definition and measurement of included variables are given in Table 2.

3. Empirical results

3.1. Descriptive statistics analysis

Cluster analysis identified seven livelihood groups, as given in Figure 1. Figure 2 indicates that the total sample consisted of 12,180 households, of whom about 23% adopted a wage-earning livelihood, followed by those with a wage/crop livelihood (21%), crop livelihood (17%), nonfarm livelihood (14%), livestock/crop/rent livelihood (10%), private transfer livelihood (8%) and public transfer livelihood (7%). This shows that wage, wage/crop and crop livelihoods are the most common three choices among households. For the whole sample, wage and crop income made up the largest portion of total household income. Combined, they contributed 57% of total income. Also, an examination of each type of livelihood pursued by households reveals that while one or two income sources, on average, often account for the largest portion of total household income,

households still earned from other sources.

Figure 1: Income sources by livelihood
Sources: Authors' calculation from the 2008-2016 VARHS.

Figures 2 and 3 compare the distribution of per capita real income and food consumption across livelihoods over the 2008-2016 period. It is evident that median income and food consumption are always the highest for households adopting a nonfarm livelihood, whereas those choosing a crop livelihood often attain a much lower income and food consumption median than other livelihoods. In particular, the data show that livelihood groups that are linked to crops, namely crop, wage/crop and livestock/crop and rent livelihoods, seemed less profitable than did other livelihoods. Comparing the mean real income and food consumption per capita across livelihoods also yields the same results, as given in Table 3.

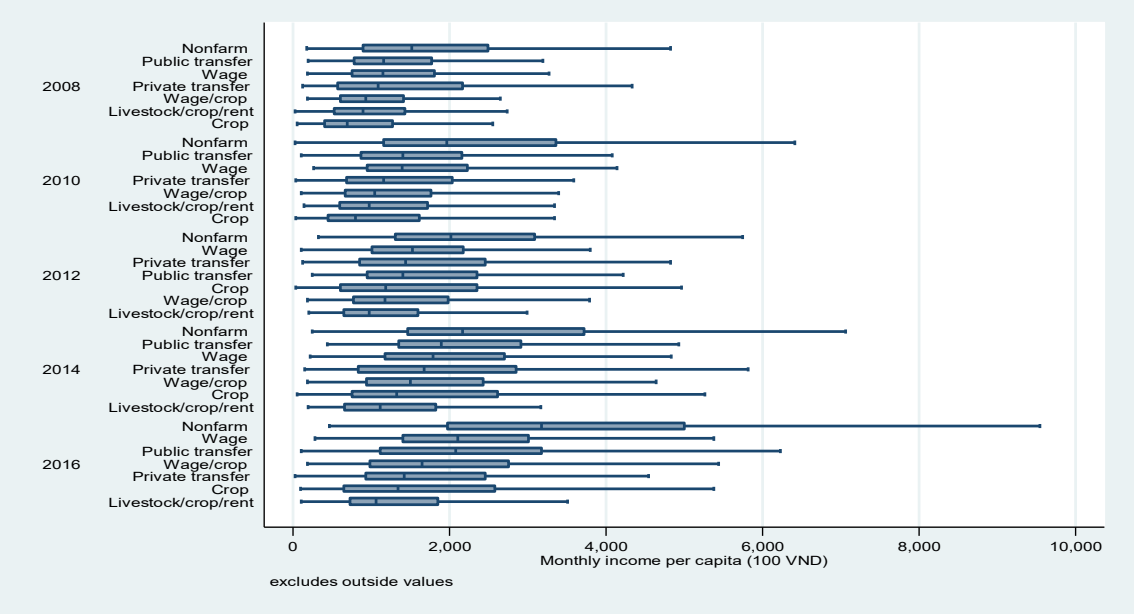

Figure 2: Income per capita by livelihood, 2008-2016
Sources: Authors' calculation based on the 2008-2016 VARHS.

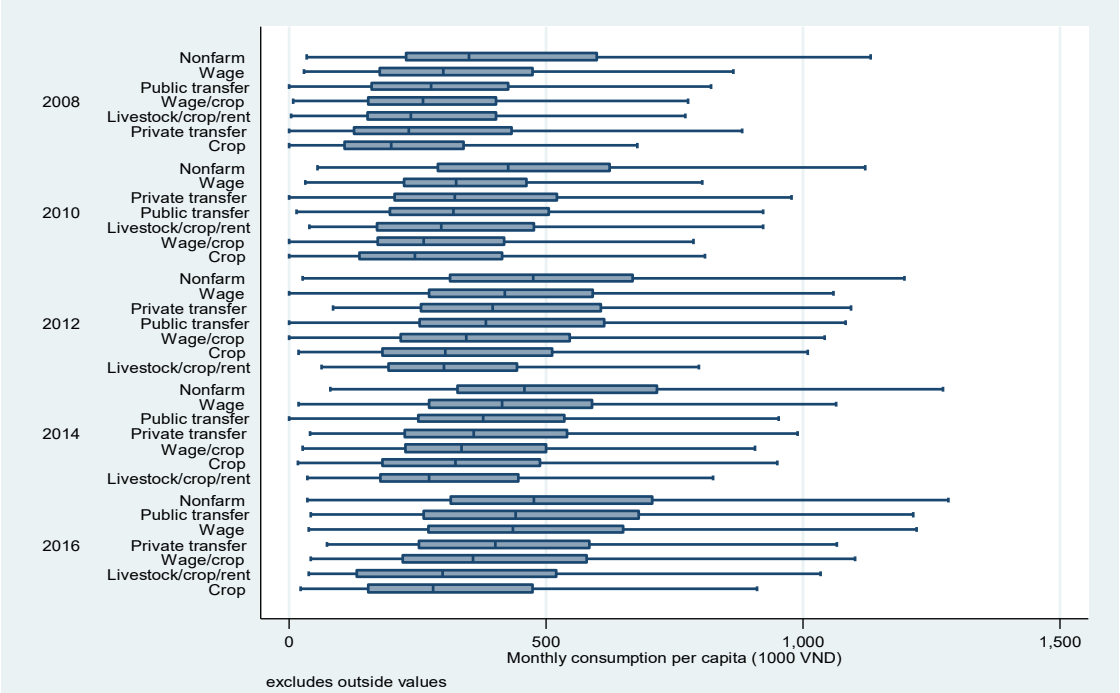

Figure 3: Consumption per capita by livelihood, 2008-2016
Sources: Authors' calculation from the 2008-2016 VARHS.

Table 2 reveals that between 2008 and 2016, real income and food consumption per capita increased by 78% and 44%, respectively. As can be seen in Figure 4, the Growth Incidence Curve (GIC) of food consumption shows the growth rate of food consumption for every percentile of food consumption distribution over the 8-year period. This span of time shows a solid decline in inequality, with the growth in food consumption by households at the bottom being substantially

higher than those at the top. In food consumption, this result generally represents growth favoring the poor in rural Vietnam. By contrast, Figure 5 reveals that the GIC of real income took an inverted U shape, indicating a pattern of growth favoring the middle income group over the 2008-2016 period. Notably, the lowest growth rates were observed for those at the bottom and at the top of income distribution, whereas those in the middle quantiles attained the highest growth rates.

Figure 4: Growth Incidence Curve (GIC) of food consumption per capita, 2008-2016.
Sources: Authors' calculation from the 2008-2016 VARHS.

Figure 5: Growth Incidence Curve (GIC) of real income per capita, 2008-2016.
Sources: Authors' calculation from the 2008-2016 VARHS.

Table 2 displays various characteristics of households over the 2008-2016 period. It shows that the ethnicity, gender and marital status of the household head seem not to change over time. The mean household size decreased from 4.53 to 4.09, while the dependency ratio increased from 0.36 to 0.43. Regarding the education level of household heads, Table 2 reveals that the proportion of household heads without education dropped by 5 percentage points between 2008-2016, while

the proportion of those with upper secondary education and college/university degrees increased from 16% to 28% and 2% to 4%, respectively. The average arable farmland per household declined from 7452 m^2 to 6445 m^2. The proportion of households that reported suffering from various shocks, such as natural disasters (i.e., floods or drought), agricultural diseases and sickness, declined significantly between 2008 and 2016.

Table 2 also shows the changes in livelihoods over the 2008-2016 period. Clearly, in 2008 at the beginning, a crop livelihood was the predominant choice for rural households (27%), while the second choice was a wage-earning livelihood (22%). By 2016, the choice of livelihood had dramatically changed, with the most common choice being a wage-paying livelihood (31%). In contrast, a crop livelihood was the choice of only 13% of total households. The proportion of households adopting a nonfarm livelihood increased slightly, from 13% to 15%, while the corresponding figure of households with a livestock/crop/rent livelihood showed a reduction by two percentage points. The number of households with a private transfer livelihood increased from 5% to 8% but the proportion of those with a public transfer livelihood remained unchanged over the 2008-2016 period.

While household characteristics were less variable over time, they varied considerably across livelihoods, as shown in Table 3. For instance, the proportion of household heads belonging to the Kinh population (the ethnic majority) was much lower for households with a crop livelihood and livestock/crop/rent livelihood than that for those adopting the remaining livelihoods. The proportion of male-headed households was much lower among those engaged in public and private transfer livelihoods than those in other livelihoods. Moreover, these livelihood groups had a smaller household size and greater dependency ratio than did other livelihood groups.

Households adopting nonfarm, wage and public transfer livelihoods had higher levels of education than did those following crop, livestock/crop/rent and private transfer livelihoods. Unsurprisingly, households with livelihoods related to crop production, on average, owned larger farms than did those in other livelihood groups. Also, a higher percentage of households suffering from natural disasters was found among those with crop livelihoods. A larger proportion of households affected by agricultural diseases was recorded for those with a livestock/crop/rent livelihood, while households with private and public transfer livelihoods reported a greater percentage of sick members.

Table 2: Household characteristics by year

Year	2008		2010		2012		2014		2016		Total	
Household characteristics	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Household head's ethnicity (1=Kinh; 0=minority)	0.79	0.41	0.80	0	0.76	0.43	0.80	0.40	0.79	0.41	0.79	0.41
Household head's gender (1=male; 0=female)	0.78	0.41	0.78	0.41	0.81	0.39	0.77	0.42	0.76	0.42	0.78	0.41
Household head's marital status (1=married; 0=not married)	0.81	0.39	0.81	0.39	0.82	0.38	0.80	0.40	0.79	0.41	0.80	0.40
Household head's age (years)	51.83	13.85	53.17	13.45	50.70	13.92	52.73	14.48	54.16	14.20	52.58	14.06
Household size (members)	4.53	1.79	4.32	1.75	4.35	1.71	4.14	1.73	4.09	1.75	4.27	1.75
Dependency ratio	0.36	0.29	0.36	0.30	0.35	0.28	0.38	0.30	0.40	0.31	0.37	0.29
Highest level of education of household head												
No education (1=yes; 0=no)	0.14	0.34	0.11	0.31	0.11	0.31	0.12	0.32	0.09	0.29	0.11	0.32
Primary education (1=yes; 0=no)	0.28	0.45	0.27	0.45	0.24	0.43	0.18	0.39	0.16	0.37	0.22	0.42
Lower secondary education (1=yes; 0=no)	0.43	0.50	0.43	0.50	0.48	0.50	0.46	0.50	0.47	0.50	0.45	0.50
Upper secondary education (1=yes; 0=no)	0.16	0.36	0.18	0.39	0.18	0.38	0.24	0.43	0.28	0.45	0.21	0.41
No vocational education (1=yes; 0=no)	0.89	0.31	0.87	0.34	0.79	0.41	0.72	0.45	0.77	0.42	0.80	0.40
Short-term vocational education (1=yes; 0=no)	0.04	0.20	0.06	0.23	0.13	0.34	0.16	0.37	0.14	0.34	0.11	0.31
Long-term vocational education (1=yes; 0=no)	0.01	0.11	0.01	0.11	0.02	0.13	0.02	0.15	0.02	0.14	0.02	0.13
Professional secondary education (1=yes; 0=no)	0.03	0.18	0.04	0.20	0.04	0.20	0.05	0.22	0.04	0.19	0.04	0.20
College/university (1=yes; 0=no)	0.02	0.13	0.02	0.15	0.03	0.16	0.04	0.20	0.04	0.19	0.03	0.17
Arable land (m2)	7452	13676	7161	13013	7647	13094	6741	12397	6645	12651	7099	12946
Natural disasters (1=yes; 0=no)	0.43	0.50	0.42	0.49	0.35	0.48	0.23	0.42	0.20	0.40	0.32	0.47
Agricultural diseases (1=yes; 0=no)	0.27	0.44	0.25	0.43	0.27	0.44	0.16	0.37	0.12	0.32	0.21	0.41
Sick members (1=yes; 0=no)	0.39	0.49	0.38	0.49	0.33	0.47	0.27	0.44	0.28	0.45	0.32	0.47
Nonfarm livelihood (1=yes; 0=no)	0.13	0.34	0.14	0.35	0.12	0.32	0.14	0.34	0.15	0.35	0.14	0.34
Private transfer livelihood (1=yes; 0=no)	0.05	0.23	0.09	0.28	0.08	0.27	0.09	0.28	0.08	0.28	0.08	0.27
Crop livelihood (1=yes; 0=no)	0.27	0.44	0.16	0.37	0.18	0.39	0.13	0.34	0.13	0.34	0.17	0.38
Livestock/crop/rent livelihood (1=yes; 0=no)	0.10	0.30	0.12	0.33	0.11	0.31	0.11	0.31	0.08	0.27	0.10	0.31
Wage-earning livelihood (1=yes; 0=no)	0.15	0.35	0.18	0.38	0.22	0.41	0.27	0.44	0.31	0.46	0.23	0.42
Wage/crop livelihood (1=yes; 0=no)	0.22	0.41	0.22	0.41	0.23	0.42	0.20	0.40	0.18	0.39	0.21	0.41
Public transfer livelihood (1=yes; 0=no)	0.07	0.26	0.08	0.28	0.06	0.24	0.07	0.25	0.07	0.25	0.07	0.26
Income per capita	1412	1739	1742	2514	1826	1949	2217	2251	2511	2631	1971	2288
Consumption per capita	333	315	366	250	447	307	443	316	478	387	417	325
Observations	2278		2242		2269		2724		2667		12180	

Sources: Authors' calculation from the 2008-2016 VARHS.

Table 3: Household characteristics by livelihood

Livelihoods	Nonfarm		Private transfer		Crop		Livestock/crop/ rent		Wage-earning		Wage/crop		Public transfer	
Household characteristics	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Ethnicity	0.96	0.21	0.90	0.30	0.59	0.49	0.59	0.49	0.89	0.31	0.77	0.42	0.85	0.35
Gender	0.81	0.39	0.59	0.49	0.87	0.34	0.87	0.33	0.75	0.43	0.79	0.41	0.65	0.48
Marital status	0.85	0.36	0.59	0.49	0.87	0.34	0.87	0.34	0.79	0.41	0.83	0.38	0.71	0.45
Age	50.51	12.62	62.51	15.33	49.43	13.03	51.00	12.96	50.47	12.95	51.26	12.95	66.47	13.14
Household size	4.36	1.58	2.76	1.58	4.68	1.90	4.44	1.80	4.39	1.48	4.59	1.57	3.22	1.89
Dependency ratio	0.34	0.26	0.58	0.39	0.36	0.27	0.35	0.29	0.31	0.23	0.31	0.24	0.69	0.33
No education	0.04	0.21	0.14	0.34	0.19	0.39	0.16	0.37	0.07	0.26	0.10	0.30	0.11	0.31
Primary education	0.16	0.37	0.27	0.44	0.26	0.44	0.26	0.44	0.19	0.39	0.22	0.42	0.25	0.43
Lower secondary	0.51	0.50	0.44	0.50	0.42	0.49	0.45	0.50	0.47	0.50	0.47	0.50	0.34	0.47
Upper secondary	0.29	0.45	0.16	0.36	0.13	0.33	0.13	0.33	0.26	0.44	0.21	0.41	0.31	0.46
No vocational training	0.75	0.43	0.87	0.33	0.93	0.26	0.91	0.29	0.69	0.46	0.80	0.40	0.73	0.44
Short-term vocational training	0.15	0.35	0.08	0.27	0.04	0.20	0.05	0.23	0.17	0.38	0.12	0.33	0.07	0.25
Long-term vocational training	0.03	0.18	0.02	0.13	0.01	0.07	0.01	0.08	0.02	0.15	0.01	0.11	0.03	0.16
Professional secondary	0.05	0.22	0.02	0.15	0.02	0.14	0.02	0.15	0.05	0.22	0.04	0.20	0.09	0.29
College/university	0.02	0.13	0.01	0.10	0.01	0.08	0.01	0.07	0.06	0.24	0.02	0.15	0.08	0.28
Arable land	4518	11440	3481	5524	17099	19070	8732	14517	3205	5825	6177	10158	4295	11367
Natural disasters	0.20	0.40	0.25	0.43	0.43	0.50	0.48	0.50	0.21	0.41	0.38	0.48	0.27	0.45
Agricultural diseases	0.12	0.33	0.15	0.36	0.29	0.45	0.36	0.48	0.13	0.34	0.23	0.42	0.17	0.37
Sick members	0.27	0.45	0.44	0.50	0.33	0.47	0.29	0.45	0.27	0.44	0.31	0.46	0.53	0.50
Year														
2008	0.12	0.33	0.15	0.36	0.29	0.45	0.36	0.48	0.13	0.34	0.23	0.42	0.17	0.37
2010	0.19	0.39	0.13	0.34	0.29	0.45	0.18	0.39	0.12	0.33	0.20	0.40	0.20	0.40
2112	0.19	0.39	0.20	0.40	0.17	0.38	0.22	0.41	0.14	0.35	0.19	0.39	0.22	0.42
2014	0.16	0.37	0.19	0.39	0.19	0.40	0.20	0.40	0.18	0.38	0.21	0.40	0.16	0.36
2016	0.22	0.42	0.24	0.43	0.17	0.38	0.23	0.42	0.26	0.44	0.21	0.41	0.22	0.42
Income per capita	3234	4249	1921	1854	1690	2224	1556	1977	1991	1368	1584	1206	1973	1806
Food consumption per capita	529	379	427	341	329	272	355	270	464	341	386	303	432	307
Observations	1658		951		2122		1265		2778		2551		855	

Sources: Authors' calculation from the 2008-2016 VARHS.

3.2. Econometric results

Estimates for the impact of livelihood types on household well-being using the UQR regression with fixed effects are reported in Tables 4 and 5. For simplicity, we only report the results estimated at the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} quantiles. For comparison, we also report the results estimated from the fixed-effects estimator in the last column of Tables 4 and 5.

The results from the fixed effects model show that on average, a switch from a crop livelihood (the reference group) to any other type of livelihood would have a positive effect on household income and food consumption, even after controlling for important individual and household characteristics and unobservable time-invariant factors. For instance, the last column of Tables 4 and 5 reveals that, on average, per capita income and food consumption would increase by 45% and 25%, respectively, for a household switching from a crop to a nonfarm livelihood. The positive effect of various livelihoods on income ranges from 45% to 18%, while that on food consumption varies between 25% and 12 %. The finding, therefore, confirms that moving out of a crop-based livelihood would bring higher well-being for rural households. This supports previous findings that participating in nonfarm activities results in higher income (Barrett et al., 2001; Tran, 2015a) and expenditure (Hoang et al., 2014; Pham et al., 2010) for Vietnamese rural households.

However, a more complete, more interesting picture of the relationship between variables emerged when looking at the results estimated from the UQR with fixed effects in Tables 4 and 5. These results show that the effect of livelihood types on income and food consumption was significantly heterogeneous at different quantiles. Also, the effect was the largest for households at the bottom of the list (the 10^{th} and 25^{th} income and food consumption quantile). Similar trends were also found for the effect on food consumption, indicated in Table 5. Specifically, changing from a crop to nonfarm livelihood increases per capita income by 81% and 53% for households in the lowest quantiles, the 10^{th} and 25^{th} respectively, while the corresponding figures are 22% and 28% for those in the 75^{th} and 90^{th} quantiles. Similar effects were also found for those pursuing a private transfer livelihood. After that, however, the positive effect tends to decline in the higher quantiles, and in some cases turns negative, at the 75^{th} income quantile for a wage-earning livelihood and at the 90^{th} income quantile for a public transfer livelihood. Moving to a wage and wage/crop livelihood would result in higher income only for those in the median and lower quantiles, while switching to a livestock/crop/rent or public transfer livelihood would increase income only for those in the lower median quantile.

Table 4: Impact of livelihood on household income per capita: UQR and fixed-effect OLS estimations

Explanatory variables	Unconditional quantile regression (UQR) with fixed effects					OLS with fixed effects
	10th quantile	25th quantile	50th quantile	75th quantile	90th quantile	Mean
Ethnicity	0.18	-0.07	0.07	0.19*	0.09	0.06
	(0.152)	(0.114)	(0.113)	(0.116)	(0.151)	(0.065)
Gender	-0.09	-0.10	-0.03	0.14*	0.16	0.02
	(0.083)	(0.071)	(0.072)	(0.074)	(0.111)	(0.042)
Marital status	-0.11	-0.11**	-0.11*	-0.08	-0.00	-0.10***
	(0.075)	(0.053)	(0.063)	(0.066)	(0.083)	(0.037)
Age	-0.02	-0.00	0.01*	0.03***	0.03***	0.01
	(0.018)	(0.011)	(0.009)	(0.009)	(0.013)	(0.006)
Age squared	0.00	0.00	-0.00*	-0.00***	-0.00**	-0.00*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Household size	-0.08***	-0.07***	-0.06***	-0.06***	-0.06***	-0.07***
	(0.014)	(0.011)	(0.011)	(0.011)	(0.014)	(0.007)
Dependency ratio	-0.58***	-0.44***	-0.27***	-0.12*	-0.20**	-0.31***
	(0.073)	(0.064)	(0.053)	(0.063)	(0.082)	(0.036)
Primary	0.11	0.01	0.03	0.03	-0.03	0.04
	(0.078)	(0.059)	(0.041)	(0.035)	(0.040)	(0.026)
Lower secondary	0.18**	0.06	0.04	-0.03	-0.08	0.03
	(0.082)	(0.070)	(0.045)	(0.044)	(0.053)	(0.031)
Upper secondary	0.14	0.04	0.08	0.02	-0.05	0.06
	(0.104)	(0.080)	(0.060)	(0.057)	(0.076)	(0.039)
Short-term vocational training	-0.07	0.08**	0.05	0.06	0.01	0.06**
	(0.043)	(0.039)	(0.041)	(0.041)	(0.062)	(0.025)
Long-term vocational training	-0.03	-0.00	0.08	0.21**	0.17	0.09*
	(0.061)	(0.070)	(0.081)	(0.088)	(0.158)	(0.051)
Professional secondary	-0.02	0.07	0.14**	0.07	-0.11	0.08*
	(0.069)	(0.061)	(0.062)	(0.081)	(0.131)	(0.043)
College/ university	-0.10	0.09	0.30***	0.23*	0.19	0.23***
	(0.066)	(0.079)	(0.104)	(0.130)	(0.223)	(0.064)
Arable land per capita	0.04*	0.05***	0.03*	0.07***	0.10***	0.06***
	(0.023)	(0.019)	(0.018)	(0.021)	(0.028)	(0.014)
Natural disasters	-0.06	-0.12***	-0.20***	-0.11***	-0.06	-0.11***
	(0.049)	(0.035)	(0.031)	(0.031)	(0.038)	(0.018)
Pest diseases	-0.00	0.01	0.13***	0.12***	0.06	0.06***
	(0.054)	(0.042)	(0.034)	(0.028)	(0.034)	(0.020)
Sick household members	-0.02	-0.04	-0.04	-0.04**	-0.01	-0.03**
	(0.027)	(0.026)	(0.023)	(0.020)	(0.030)	(0.013)
Nonfarm livelihood	0.81***	0.53***	0.35***	0.22***	0.28***	0.45***
	(0.075)	(0.054)	(0.043)	(0.045)	(0.071)	(0.034)
Private transfer livelihood	0.64***	0.46***	0.28***	0.15***	0.12**	0.30***
	(0.077)	(0.060)	(0.051)	(0.044)	(0.059)	(0.038)
Livestock/crop/rent livelihood	0.61***	0.32***	0.06	-0.03	0.04	0.19***
	(0.082)	(0.052)	(0.039)	(0.035)	(0.042)	(0.028)
Wage-earning livelihood	0.83***	0.58***	0.24***	-0.01	-0.19***	0.29***
	(0.071)	(0.051)	(0.041)	(0.036)	(0.051)	(0.029)
Wage/crop livelihood	0.70***	0.35***	0.10***	-0.01	-0.06	0.20***
	(0.069)	(0.042)	(0.037)	(0.028)	(0.043)	(0.025)
Public transfer livelihood	0.73***	0.45***	0.07	-0.14**	-0.08	0.18***
	(0.103)	(0.066)	(0.059)	(0.055)	(0.071)	(0.040)
2010	0.21***	0.17***	0.17***	0.13***	0.09***	0.14***
	(0.043)	(0.030)	(0.026)	(0.027)	(0.032)	(0.016)
2012	0.41***	0.36***	0.36***	0.26***	0.20***	0.31***
	(0.040)	(0.032)	(0.028)	(0.030)	(0.036)	(0.017)
2014	0.51***	0.46***	0.48***	0.36***	0.28***	0.42***
	(0.042)	(0.033)	(0.032)	(0.029)	(0.038)	(0.019)
2016	0.50***	0.52***	0.60***	0.55***	0.48***	0.52***
	(0.051)	(0.040)	(0.034)	(0.036)	(0.047)	(0.021)
Constant	6.15***	6.52***	6.58***	6.44***	6.61***	6.54***
	(0.563)	(0.364)	(0.312)	(0.330)	(0.428)	(0.221)
R-squared (within)	0.099	0.120	0.138	0.100	0.054	0.226
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000
Observations	12,068	12,068	12,068	12,068	12,068	12,068
Groups	2819	2819	2819	2819	2819	2819

Note: Bootstrapped standard errors are in parentheses for UQR. *** p<0.01, ** p<0.05, * p<0.1. Sources: Authors' calculation based on the 2008-2016 VARHS.

Table 5: Impact of livelihood on food consumption per capita: UQR and fixed-effect OLS estimations

Explanatory variables	Unconditional quantile regression (UQR) with fixed effects					OLS with fixed effects
	10th quantile	25th quantile	50th quantile	75th quantile	90th quantile	Mean
Ethnicity	0.05	0.01	0.15	0.11	0.18	0.09
	(0.183)	(0.139)	(0.117)	(0.113)	(0.131)	(0.083)
Gender	-0.25**	0.08	0.03	0.08	0.17	0.02
	(0.113)	(0.072)	(0.067)	(0.075)	(0.108)	(0.049)
Marital status	0.07	-0.03	-0.03	-0.07	-0.15*	-0.03
	(0.103)	(0.074)	(0.053)	(0.061)	(0.080)	(0.038)
Age	-0.00	-0.01	-0.00	0.01	0.00	0.00
	(0.022)	(0.012)	(0.007)	(0.009)	(0.011)	(0.006)
Age squared	-0.00	0.00	0.00	-0.00	-0.00	-0.00
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Household size	-0.11***	-0.08***	-0.07***	-0.07***	-0.07***	-0.08***
	(0.020)	(0.013)	(0.010)	(0.010)	(0.012)	(0.008)
Dependency ratio	-0.22**	-0.16**	-0.04	-0.10*	-0.15**	-0.15***
	(0.104)	(0.067)	(0.050)	(0.053)	(0.071)	(0.038)
Primary	0.10	0.05	0.11***	0.07**	0.08**	0.09***
	(0.111)	(0.052)	(0.036)	(0.032)	(0.037)	(0.030)
Lower secondary	0.09	0.18***	0.10**	0.08*	0.04	0.11***
	(0.119)	(0.059)	(0.042)	(0.042)	(0.048)	(0.034)
Upper secondary	0.11	0.17**	0.14***	0.03	-0.05	0.10**
	(0.126)	(0.071)	(0.054)	(0.059)	(0.075)	(0.041)
Short-term vocational	0.05	0.06	0.12***	0.10**	0.06	0.07***
	(0.052)	(0.042)	(0.039)	(0.043)	(0.053)	(0.024)
Long-term vocational	0.01	0.09	0.09	0.11	0.28**	0.10
	(0.119)	(0.086)	(0.077)	(0.089)	(0.126)	(0.061)
Professional secondary	0.20*	0.07	0.17**	0.17**	0.25***	0.17***
	(0.107)	(0.071)	(0.069)	(0.072)	(0.094)	(0.043)
College/university	-0.00	0.01	0.04	0.06	0.17	0.12*
	(0.116)	(0.102)	(0.095)	(0.128)	(0.196)	(0.064)
Arable land per capita	0.07***	0.05**	0.05***	0.06***	0.06**	0.06***
	(0.027)	(0.022)	(0.018)	(0.020)	(0.026)	(0.014)
Natural disasters	-0.02	-0.05	-0.08***	-0.07***	-0.06*	-0.06***
	(0.057)	(0.035)	(0.028)	(0.026)	(0.032)	(0.020)
Agricultural diseases	-0.01	0.05	0.08**	0.06*	0.03	0.05**
	(0.061)	(0.041)	(0.036)	(0.029)	(0.035)	(0.022)
Sick household members	-0.07*	0.02	0.03*	0.02	-0.00	0.01
	(0.037)	(0.025)	(0.019)	(0.021)	(0.024)	(0.014)
Nonfarm livelihood	0.40***	0.26***	0.22***	0.20***	0.21***	0.25***
	(0.071)	(0.050)	(0.046)	(0.044)	(0.058)	(0.029)
Private transfer livelihood	0.27***	0.16**	0.11**	0.07	0.06	0.14***
	(0.088)	(0.064)	(0.048)	(0.046)	(0.059)	(0.032)
Livestock/crop/rent livelihood	0.36***	0.19***	0.08**	0.05	0.04	0.15***
	(0.094)	(0.052)	(0.033)	(0.033)	(0.039)	(0.027)
Wage-earning livelihood	0.44***	0.24***	0.17***	0.10***	0.10*	0.21***
	(0.072)	(0.054)	(0.038)	(0.036)	(0.052)	(0.027)
Wage/crop livelihood	0.33***	0.16***	0.08**	0.06**	0.10***	0.15***
	(0.070)	(0.049)	(0.032)	(0.030)	(0.035)	(0.024)
Public transfer livelihood	0.23*	0.13*	0.09	0.06	0.10	0.12***
	(0.125)	(0.074)	(0.055)	(0.054)	(0.059)	(0.038)
2010	0.35***	0.22***	0.12***	0.04*	-0.02	0.15***
	(0.050)	(0.031)	(0.027)	(0.024)	(0.030)	(0.017)
2012	0.73***	0.48***	0.35***	0.26***	0.21***	0.40***
	(0.053)	(0.036)	(0.028)	(0.028)	(0.035)	(0.019)
2014	0.51***	0.40***	0.28***	0.16***	0.11***	0.30***
	(0.061)	(0.037)	(0.030)	(0.032)	(0.038)	(0.020)
2016	0.45***	0.38***	0.32***	0.26***	0.18***	0.34***
	(0.058)	(0.044)	(0.030)	(0.032)	(0.037)	(0.022)
Constant	4.41***	4.93***	5.37***	5.53***	6.06***	5.16***
	(0.596)	(0.410)	(0.248)	(0.313)	(0.415)	(0.229)
R-squared (within)	0.054	0.067	0.068	0.048	0.027	0.132
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000
Observations	12,068	12,068	12,068	12,068	12,068	12,068
Groups	2819	2819	2819	2819	2819	2819

Note: Bootstrapped standard errors are in parentheses for UQR. *** p<0.01, ** p<0.05, * p<0.1.
Sources: Authors' calculation from the 2008-2016 VARHS.

Our study provides the first evidence that shifting from a crop-based livelihood to non-crop livelihoods, namely nonfarm, livestock/crop/rent, wage-earning, wage/crop, public or private transfer livelihoods, has a greater positive effect on income and food consumption for poorer than for more affluent households. In part, the finding accords with that for Malawi, Niger, and Zambia (Asfaw et al., 2019) and China (Zhao & Barry, 2014), which found that the effects of diversification towards nonfarm activities tended to be greater for poorer than for more affluent rural households. In particular, our research finding highlights the importance of the benefit for the poor of nonfarm diversification in rural Vietnam. Also, the finding supports the argument made by Ellis (2000a) that rural households diversify towards non-crop livelihoods not only for their survival but also to build wealth, which is a proactive step leading to well-being and upward mobility.

Our study also finds a number of other factors affecting household well-being in rural Vietnam. Having more family members reduces both income and food consumption per capita. For example, on average, one additional household member reduces per capita income by about 7% and a similar effect was also found for all quantiles considered. The dependency ratio has a negative effect on income and food consumption per capita in all quantiles but the negative effect is larger for poorer households. The fixed-effect estimator shows that on average, gaining vocational training, professional higher level education or a college/university degree increases both income and food consumption per capita. However, this positive effect was only found in some income quantiles. Specifically, the positive effect of short-term and long-term vocational education was found only in the 25^{th} and 75^{th} quantiles, respectively, while that of college/university degrees was observed in the 50^{th} and 75^{th} quantiles. Also, attaining a higher level of general education, or vocational or professional advanced education, increases food consumption in some quantiles, whereas attaining a college or university degree has no positive effect at any quantiles considered. In addition, owning more arable land raises both per capita income and food consumption for households in every quantile. Surprisingly, not all shocks has a negative effect on well-being. For example, the effect is negative for natural disasters but positive for agricultural diseases.

4. Conclusion and policy implications

Previous studies often assume a homogeneous effect from nonfarm diversification on household well-being, using a mean regression approach. Going beyond this approach, our article contributes to the literature by exploring the heterogeneous effects of livelihood changes on household income and food consumption per capita, using a panel data set from the 2008-2016 Viet Nam Access to

Resources Household Survey (VARHS).

First, we used cluster analysis to classify the household sample into mutually exclusive livelihood groups, based on the combination of income-earning activities by source. Seven livelihoods adopted by households were identified, namely crop, nonfarm, wage-earning, wage/crop, livestock/crop/rent, private transfer, and public transfer livelihoods. We then employed an unconditional quantile regression (UQR) with fixed effects to control for unobservable, time-invariant individual and households traits. For comparison, we also estimated the mean or homogeneous effect using a fixed effects estimator.

Estimates from the fixed effect model show a positive effect on both income and food consumption for households that switch from a crop livelihood to any type of non-crop livelihood (i.e., livestock/crop/rent, nonfarm, wage-earning, wage/crop, public or private transfer livelihoods). The finding is robust even after controlling for important individual and household-related variables and the unobserved time-invariant characteristics of individuals and households. This suggests that, on average, moving out of crop livelihoods would result in higher returns for rural households.

However, estimates from the UQR with fixed effects provided a more comprehensive and more interesting view of the effect of livelihood changes on household well-being. Notably, our research finding shows a significant variation in effect at various quantiles of income distribution. Specifically, shifting from a crop to a non-crop livelihood has the largest positive effect for the poorest households (those in the 10^{th} quantile). The positive effect tends to decline in the higher quantiles, however, and even turns negative for richer households (those in the 75^{th} and 90^{th} quantiles) that switch to a wage-earning or public transfer livelihood. A similar trend was also found for the effect on food consumption, with a much larger effect for the poor and a discount effect for richer households.

Notably, our study provides the first evidence of the benefit to the poor of a switch in livelihood from crop to non-crop activities in rural Vietnam. This result also suggests that rural households change their livelihood not only for survival but also to build wealth. This is a proactive choice that leads to greater well-being and upward mobility. A policy implication here is that removing the barriers preventing rural households from accessing non-crop livelihood opportunities is expected not only to improve income for the poor but also to reduce inequality in rural Vietnam. Finally, regarding the methodology applied to estimate the well-being effects of livelihood diversification, our research finding suggests that a mean regression approach that often considers only the role of livelihood choice on mean household well-being and disregards differences in well-being distribution, may conceal some heterogeneity that is useful to policy

makers.

References

Asfaw, S., Scognamillo, A., Di Caprera, G., Sitko, N., & Ignaciuk, A. (2019). Heterogeneous impact of livelihood diversification on household welfare: Cross-country evidence from Sub-Saharan Africa. *World Development, 117*, 278-295.

Babatunde, R. O., & Qaim, M. (2010). Impact of off-farm income on food security and nutrition in Nigeria. *Food Policy, 35*(4), 303-311.

Barrett, C. B., Bezuneh, M., & Aboud, A. (2001). Income diversification, poverty traps and policy shocks in Côte d'Ivoire and Kenya. *Food Policy, 26*(4), 367-384.

Bezu, S., Barrett, C. B., & Holden, S. T. (2012). Does the nonfarm economy offer pathways for upward mobility? Evidence from a panel data study in Ethiopia. *World Development, 40*(8), 1634-1646.

Borgen, N. T. (2016). Fixed effects in unconditional quantile regression. *The Stata Journal, 16*(2), 403-415.

Davino, C., Furno, M., & Vistocco, D. (2013). *Quantile regression: theory and applications* (Vol. 988): John Wiley & Sons.

Edirisinghe, J. C. (2015). Smallholder farmers' household wealth and livelihood choices in developing countries: A Sri Lankan case study. *Economic Analysis and Policy, 45*, 33-38.

Ellis, F. (2000a). The determinants of rural livelihood diversification in developing countries. *Journal of Agricultural Economics, 51*(2), 289-302.

Ellis, F. (2000b). *Rural livelihoods and diversity in developing countries*: Oxford university press.

Everitt, B. S., Landau, S., Leese, M., & Stahl, D. (2011). *Cluster analysis*: John Wiley & Sons.

Firpo, S., Fortin, N. M., & Lemieux, T. (2009). Unconditional quantile regressions. *Econometrica, 77*(3), 953-973.

Gautam, Y., & Andersen, P. (2016). Rural livelihood diversification and household well-being: Insights from Humla, Nepal. *Journal of Rural Studies, 44*, 239-249.

Glewwe, P. (1991). Investigating the determinants of household welfare in Côte d'Ivoire. *Journal of Development Economics, 35*(2), 307-337.

Halpin, B. (2016). DUDAHART: Stata module to calculate and graph Duda-Hart cluster stopping indices from distance matrix. Boston, USA: Boston College Department of Economics.

Hoang, C. V., Tran, T. Q., Nguyen, Y. H. T., & Nguyen, K. D. (2019). Is Land Ownership a Key Factor in the Choice of Livelihood in the Mekong Delta, Vietnam? *Human Ecology, 47*(5), 681-691.

Hoang, T. X., Pham, S. C., & Ulubaşoğlu, M. A. (2014). Non-farm activity, household expenditure, and poverty reduction in rural Vietnam: 2002–2008. *World Development, 64*, 554-568.

Khanal, A. R., Mishra, S. K., & Honey, U. (2018). Certified organic food production, financial performance, and farm size: An unconditional quantile regression approach. *Land Use Policy, 78*, 367-376.

Killewald, A., & Bearak, J. (2014). Is the motherhood penalty larger for low-wage women? A comment on quantile regression. *American Sociological Review, 79*(2), 350-357.

Koenker, R., & Hallock, K. F. (2001). Quantile regression. *Journal of economic perspectives, 15*(4), 143-156.

Liu, C., Golding, D., & Gong, G. (2008). Farmers' coping response to the low flows in the lower Yellow River: a case study of temporal dimensions of vulnerability. *Global Environmental Change, 18*(4), 543-553.

Maclean, J. C., Webber, D. A., & Marti, J. (2014). An application of unconditional quantile regression to cigarette taxes. *Journal of Policy Analysis and management, 33*(1), 188-210.

Nguyen, C. V., Van den Berg, M., & Lensink, R. (2011). The impact of work and non-work migration on household welfare, poverty and inequality: New evidence from Vietnam. *Economics of Transition, 19*(4), 771-799.

Nguyen, C. V., & Vu, L. H. (2018). The Impact of Migration and Remittances on Household Welfare: Evidence from Vietnam. *Journal of International Migration and Integration, 19*(4), 945-963. Doi: 10.1007/s12134-018-0571-3

Nguyen, H., Doan, T., & Tran, T. Q. (2020). The effect of various income sources on income inequality: a comparison across ethnic groups in Vietnam. *Environment, Development and Sustainability, 22*(2), 813-834.

Nguyen, T. V., & Tran, T. Q. (2018). Forestland and rural household livelihoods in the North Central Provinces, Vietnam. *Land Use Policy, 79*, 10-19.

Pham, T. H., Bui, T. A., & Le, D. (2010). *Is nonfarm diversification a way out of poverty for rural households? Evidence from Vietnam in 1993-2006*. PEP Working Paper series 2010-17. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1715603

Reardon, T., Delgado, C., & Matlon, P. (1992). Determinants and effects of income diversification amongst farm households in Burkina Faso. *The Journal of Development Studies, 28*(2), 264-296.

Scoones, I. (1998). *Sustainable rural livelihoods: a framework for analysis*. Brighton, UK: Institute of Development Studies.

Tarp, F., Vinh, D. Q., & Tuan, N. D. A. (2017). Characteristics of the Vietnamese rural economy: Evidence from a 2016 rural household survey in 12 provinces of Viet Nam. *Tokyo, Japan: United Nations University*.

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

Tran, T. Q. (2015a). Nonfarm employment and household income among ethnic minorities in Vietnam. *Economic research-Ekonomska istraživanja, 28*(1), 703-716.

Tran, T. Q. (2015b). Socio-economic determinants of household income among ethnic minorities in the North-West Mountains, Vietnam. *Croatian Economic Survey, 17*(1), 139-159.

Tran, T. Q., Lim, S., Cameron, M. P., & Vu, V. V. (2014). Farmland loss and livelihood outcomes: a micro-econometric analysis of household surveys in Vietnam. *Journal of the Asia Pacific Economy, 19*(3), 423-444.

Tran, T. Q., & Van Vu, H. (2019). Land fragmentation and household income: First evidence from rural Vietnam. *Land Use Policy, 89*, 104247.

United Nations. (2014). *Migration, Resettlement and Climate Change in Viet Nam: Reducing exposure and vulnerabilities to climatic extremes and stresses through spontaneous and guided migration*. Hanoi, Vietnam: United Nations.

Van de Walle, D., & Cratty, D. (2004). Is the emerging non-farm market economy the route out of poverty in Vietnam? *Economics of Transition, 12*(2), 237-274.

Wooldridge, J. M. (2016). *Introductory econometrics: A modern approach*: Nelson Education.

Zhao, J., & Barry, P. J. (2014). Income diversification of rural households in China. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 62*(3), 307-324.

Appendix 1: Results of the first state of cluster analysis

Number of clusters	Calinski/ Harabasz pseudo-F
2	3064.39
3	1752.64
4	2173.55
5	4251.64
6	4381.58
7	4866.51
8	4209.07
9	3723.72
10	4579.07
11	4239.15
12	3884.26
13	3680.14
14	3570.97
15	3417.97