Economic Analysis and Policy 68 (2020) 348–362

Contents lists available at ScienceDirect

Economic Analysis and Policy

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

Policy debates and controversies

The pro-poor impact of non-crop livelihood activities in rural Vietnam: A panel data quantile regression analysis

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ARTICLE INFO

Article history:
Received 19 April 2020
Received in revised form 5 October 2020
Accepted 9 October 2020
Available online 20 October 2020

JEL classification:
C21
C23
C31
Q12
P 25
O12

Keywords:
Crop livelihood
Fixed effects
Pro-poor
Income
Unconditional quantile regression

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, private or 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 pro-poor impact 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.

1. Introduction

The diversification of livelihood activities away from agricultural production has become a trend in the economic growth of developing societies. The effect of nonfarm diversification on rural households is well established (Tarp, 2017). Overall, the literature in this field confirms that diversification is positively associated with household income and expenditure, poverty reduction and food consumption in several developing countries (Asfaw et al., 2019; Barrett et al., 2001b; Bezu et al., 2012; Gautam and Andersen, 2016; Hoang et al., 2014; Imai et al., 2015; Nguyen and Vu, 2018; Pham et al., 2010; Tran, 2015; Zhao and Barry, 2014). However, as rural households diversify toward non-agricultural activities, it is likely that some will benefit disproportionately, while others will be left behind. Households with favorable initial resources are more likely to adopt high-return activities while those with less favorable initial conditions tend to engage in low-return activities. This suggests that different outcomes from livelihood diversification may potentially increase inequality (Tarp, 2017).

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https://doi.org/10.1016/j.eap.2020.10.005
0313-5926/

In the aforementioned literature, however, most studies often assume a homogeneous relationship between nonfarm diversification and rural household well-being, using standard linear regression techniques, such as ordinary least squares (OLS) and random or fixed effects estimators. 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 and 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 et al., 2013). Researchers are more interested in examining the relationship at different points in the conditional distribution of well-being. Also, empirical evidence for 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 and Barry, 2014).

Our paper contributes to the literature by quantifying the heterogeneous effects of livelihood choice on household income and food consumption in rural Vietnam. The study has two strong main points. *First*, we use cluster analysis techniques to classify the household sample into mutually exclusive livelihood groups, based on the combination of income-earning activities by source. *Second*, we use unconditional quantile regression (UQR) with fixed effects to investigate heterogeneous effects across well-being quantiles. This econometric specification provides a more comprehensive relationship among variables than a linear regression estimator, while controlling for the effects of distinguishing demographics, education, assets and unobservable time-invariant factors. Notably, this econometric approach allows us to test the hypothesis that these effects differ significantly between poor, middle-income and high-income households.

We find that when a fixed-effects estimator is employed, a switch from a crop livelihood (the reference group) to any other type of livelihood would have a positive effect, on average, on household 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 in the 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 pro-poor impact of changing livelihood from crop to non-crop activities in rural Vietnam. Thus, our research results suggest that a mean regression approach that often assumes a homogeneous/mean effect of livelihood choice on well-being may miss some heterogeneity that is useful to researchers and policy makers.

The rest of the paper is organized as follows. The literature review is given in Section 2, while Section 3 presents the data and econometric model. The empirical results and discussion are presented in Section 4, followed by Section 5 providing conclusions and policy implications.

2. Literature review

Livelihood diversification is described as "the process by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living" (Ellis, 1998), p. (4). According to Ellis (2000a), the drivers of diversification can be grouped into two broad categories: diversification by choice and diversification of necessity. The former is the voluntary decision of a household to diversify. In this case, the household decides to diversify, not so much for survival as to increase wealth. This is a proactive step that results in upward mobility and increased well-being. The latter, however, is the result of hopelessness, the last solution of vulnerable households struggling to survive. In this situation, necessity-led diversification may force households into a worse or more vulnerable livelihood than the one chosen earlier (Davies, 1996).

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 increase agricultural production (Babatunde and Qaim, 2010; Bezu et al., 2012; Liu et al., 2008; Reardon et al., 1992; Zhao and Barry, 2014). Similar findings have been reported in numerous studies in rural Vietnam (Hoang et al., 2014; Nguyen and Vu, 2018; Pham et al., 2010; Tran, 2015; Van de Walle and 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, 2015) and North Central regions (Nguyen and Tran, 2018), households with nonfarm employment (wage-earning or self-employment) earned higher income than those without.

A number of studies have often found greater positive effects from nonfarm diversification for richer households than for poorer ones. Richer households tend to adopt high-return activities, while poorer ones are more likely to diversify into lower-return activities. Nonfarm diversification helped the poor improve their incomes, but had an unequalizing effect on income distribution in rural India (Birthal et al., 2014). While diversification from farming activities resulted in higher income and lower poverty, it also increased inequality among households at the village level in rural India. Such rising inequalities could undermine the impact of rural structural transformation favoring the poor currently ongoing in this country (Lanjouw et al., 2014). A study in Bhutan by Rahut et al. (2015) using Gini income decomposition revealed that nonfarm income, both self-employment and wage-earning income, had the effect of increasing inequality, whereas farm income reduced inequality. Also, lower levels of education and a lack of nonfarm opportunities emerged as the main barriers hindering the access of the poor to profitable nonfarm activities in Bhutan.

Recently, a number of studies have investigated the heterogeneous effects of livelihood diversification on household well-being, using a quantile regression approach (e.g., Asfaw et al. (2019), Edirisinghe (2015), Mishra et al. (2015) and

Zhao and Barry (2014)). For example, Asfaw et al. (2019) found that the income effect of nonfarm diversification in Sub-Saharan Africa was much greater for those in the lowest quantile (the poorest), but declined and in some cases turned negative 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 brought higher incomes for poorer households than they did for the better off. However, a study in rural Bangladesh shows that while nonfarm engagement had positive effects for households at the medium and higher quantiles, it had no effect for poorer households (those in the 25th quantile) (Mishra et al., 2015).

To the best of our knowledge, no study heretofore has tested the hypothesis that the effect of nonfarm livelihoods on household well-being differs significantly between poor, middle-income and high-income households in Vietnam. This topic is especially relevant for 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 many ways (Tarp et al., 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 more effectively. The main reasons for conducting this study are the importance of the research topic and the gap in the literature concerning Vietnam.

3. Data and method

3.1. Conceptual framework

The sustainable rural livelihood (SRL) approach (Ellis, 2000b; Scoones, 1998) was used as the conceptual framework for our study. Following Ellis (2000a) and Ellis (2000b), 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 et al., 2001a; Gautam and Andersen, 2016) and land shortage (Tran et al., 2014; Tran and 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.

3.2. Econometric model specification

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

$$Ln(Y_{it}) = \beta_0 + \beta_1 L_{it} + \gamma X_{it} + \delta T_t + \varepsilon_{it} \quad (1)$$

In Eq. (1), $Ln(Y_{it})$ 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; X_{it} is a vector of control variables (household distinguishing characteristics, such as demographic variables, education and arable land); T_t is the year dummy variable that captures structural change over time; β_0 is the constant term; β_1, γ and δ are the parameters to be estimated, and ε_{it} represents the idiosyncratic error term. The name, definition and measurement of included variables are given in Table 3.

Eq. (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). 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. Whether the variables are stationary or not has a major influence on the empirical results (Lin and Xu, 2020; Xu and Lin, 2017). Thus, we performed some tests for unit roots or stationarity in panel datasets and the results confirm the stationarity of the variables (see Appendix C).

However, valuable information could be missed if we examine only the mean effect using a fixed effects estimator as given in Eq. (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. The QR offers a more comprehensive view of the relationship among variables, and provides a method for modeling the level of changes in the response variable at various points of distribution, when such levels of change differ. Notably, the QR estimator enables us to evaluate whether a given livelihood increases or reduces income inequality. If the returns on a livelihood increase by quantile, this suggests that the livelihood in question has a greater effect for the better-off. By contrast, decreasing returns by quantile indicate that the effects are greater for the poor. When returns are the same across the quantiles considered, the livelihood has no effect on income inequality.

Specifically, our study used the unconditional quantile regression (UQR) estimator developed by Firpo et al. (2009), because it is widely believed that the UQR estimator yields more policy-relevant information than does the conditional

Table 1
Income from various sources.

Categories	Definitions
1. Crop/forest income[a]	Income from annual or perennial crops, and forests.
2. Livestock income	Income from poultry, cattle and fish production.
3. Nonfarm income	Income from self-employment in non-farm activities (non-farm household businesses).
4. 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).
5. Private transfer	Income derived from gifts and remittances, both domestic and international.
6. Public transfer	Income received from pensions, social welfare, retirement allowances and various government programs.
7. Rental income	Income received from renting out land and non-land assets (e.g., interest).

[a]Forest income was not used as a variable for cluster analysis because only 3.43% the total households had forest income, accounting for 0.14% of total household income.
Note: All income sources are measured in both cash and kind.

quantile regression (CQR) estimator (Khanal et al., 2018; Maclean et al., 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 and 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 outcome variable on the explanatory variables (Firpo et al., 2009). The RIF unconditional quantile is based on the idea of the influence function developed from robust statistics and described in Hampel et al. (2011). The RIF regression outlines the effect of an individual observation on a given distributional statistic, such as inter-quantile range, median, or any quantile (see more in Appendix A). The RIF regression is constructed to quantify how a change in the underlying distribution affects a distributional statistic (the quantile) and is actually a linear approximation to the nonlinear function of a distributional statistic (Mishra et al., 2015).

Firpo et al. (2009) indicate that the marginal effects of a quantile can be estimated by averaging the RIF with respect to the change in the distribution of the explanatory variables. Thus, the linear RIF regression of the household is given in Eq. (2). The unconditional property of the RIF regression was also demonstrated by Firpo et al. (2009), suggesting that the result from the RIF estimator can be interpreted in a similar way to the coefficients from an OLS estimator. Eq. (2) uses the same explanatory variables as those in Eq. (1).

$$E[RIF(Ln_{Yit}; q_\tau)|X, L, T] = \beta_0 + \beta_1 L_{it} + \gamma X_{it} + \delta T_t + \varepsilon_{it} \quad (2)$$

3.3. 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.[1] 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.

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

Table 1 shows the relative proportion of income components used as input variables for cluster analysis. The income share approach has long been advocated because incomes, which are directly comparable, are a key factor, making the method more straightforward and easier to interpret in quantitative analysis (Soltani et al., 2012). There are numerous

[1] Lao Cai, Phu Tho, Lai Chau, Dien Bien, Hanoi (Ha Tay), Nghe An, Quang Nam, Khanh Hoa, Dak Lac, Dak Nong, Lam Dong and Long An.

[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.

Table 2
Income sources by livelihood.
Source: Authors' calculation from the 2008–2016 VARHS.

Income shares by source	Rental income	Wage income	Crop income	Livestock income	Nonfarm income	Private transfer	Public transfer
Crop livelihood (2122)	5%	7%	73%	6%	2%	4%	4%
Livestock/crop/rent livelihood (1265)	12%	7%	25%	44%	4%	5%	4%
Nonfarm livelihood (1658)	2%	8%	7%	3%	73%	3%	2%
Public transfer livelihood (855)	4%	7%	9%	4%	3%	8%	64%
Private transfer livelihood (981)	5%	7%	11%	5%	2%	63%	7%
Wage livelihood (2778)	2%	84%	7%	2%	1%	2%	2%
Wage/crop livelihood (2551)	4%	51%	20%	8%	6%	5%	5%
Whole sample (12180)	4%	34%	23%	9%	13%	9%	8%

Notes: The number of households in each livelihood group is given in parentheses.

methods for applying cluster analysis techniques. Following Nguyen et al. (2015), a two-step cluster analysis approach was performed, as follows. First, we applied an average-linkage cluster analysis to find the optimal number of clusters, using the Calinski stopping rule (Halpin, 2016). The results from this stage indicate that the largest value of Calinski/Harabasz pseudo-F is 4866.51, corresponding to the optimal number of seven clusters (see Appendix B). Second, cluster analysis was implemented with seven groups, using k-mean clustering. Finally, we defined and labeled the obtained clusters and interpreted them by comparing the mean values of the clustering variables across various clusters. Specifically, seven livelihood groups were identified, and their corresponding household income structures and characteristics are given in Tables 2–4.

4. Empirical results

4.1. Background of household characteristics and livelihoods

Using cluster analysis, we identified seven livelihood groups with their corresponding income sources, as given in Table 2. The last column in Table 3 indicates that the total sample consisted of 12,180 households for the 2008–2016 period, 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. Table 2 reveals that 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.

Table 3 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 for 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.

Table 3 displays various characteristics of households over the 2008–2016 period. It shows that the ethnicity, gender and marital status of the household head do not seem 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 3 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.

While household characteristics were less variable over time, they varied considerably across livelihoods, as shown in Table 4. 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 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.

Table 4 also indicates that 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

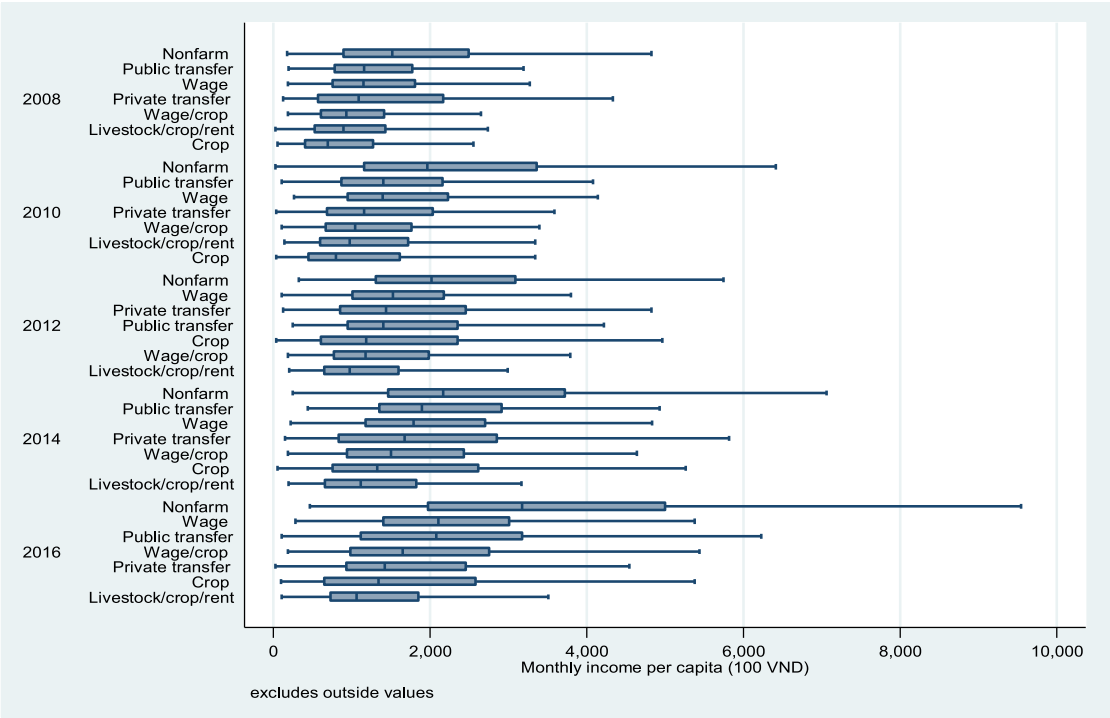

Fig. 1. Income per capita by livelihood, 2008–2016.
Source: Authors' calculation based on the 2008–2016 VARHS.

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.

Figs. 1 and 2 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, earned less than other livelihoods. A comparison of the mean real income and food consumption per capita across livelihoods also yields the same results, as given in Table 4.

Table 3 reveals that between 2008 and 2016, real income and food consumption per capita increased by 78% and 44%, respectively. We also calculated the growth incidence curve (GIC), developed by Ravallion and Chen (2003), to measure the level of growth favoring the poor in rural Vietnam. The GIC compares changes in income distribution between two points in time and measures how growth is distributed over the quantiles. As can be seen in Fig. 3, 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, Fig. 4 reveals that the GIC of real income follows 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.

4.2. Econometric results and discussion

Estimates for the impact of livelihood types on household well-being using the UQR regression with fixed effects are reported in Tables 5 and 6. For simplicity, we report only the results estimated at the 10th, 25th, 50th, 75th and 90th quantiles. For comparison, we also report the results estimated from the fixed-effects estimator in the last column of Tables 5 and 6.

Table 3
Household characteristics by year.
Source: Authors' calculation from the 2008–2016 VARHS.

Year	2008		2010		2012		2014		2016		2008–2016	
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)[a]	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)[a]	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)[a]	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	

[a]Self-reported by the household. For example, "has your household experienced any natural disaster in the last 12 months?"

Table 4
Household characteristics by livelihood.
Source: Authors' calculation from the 2008–2016 VARHS.

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	

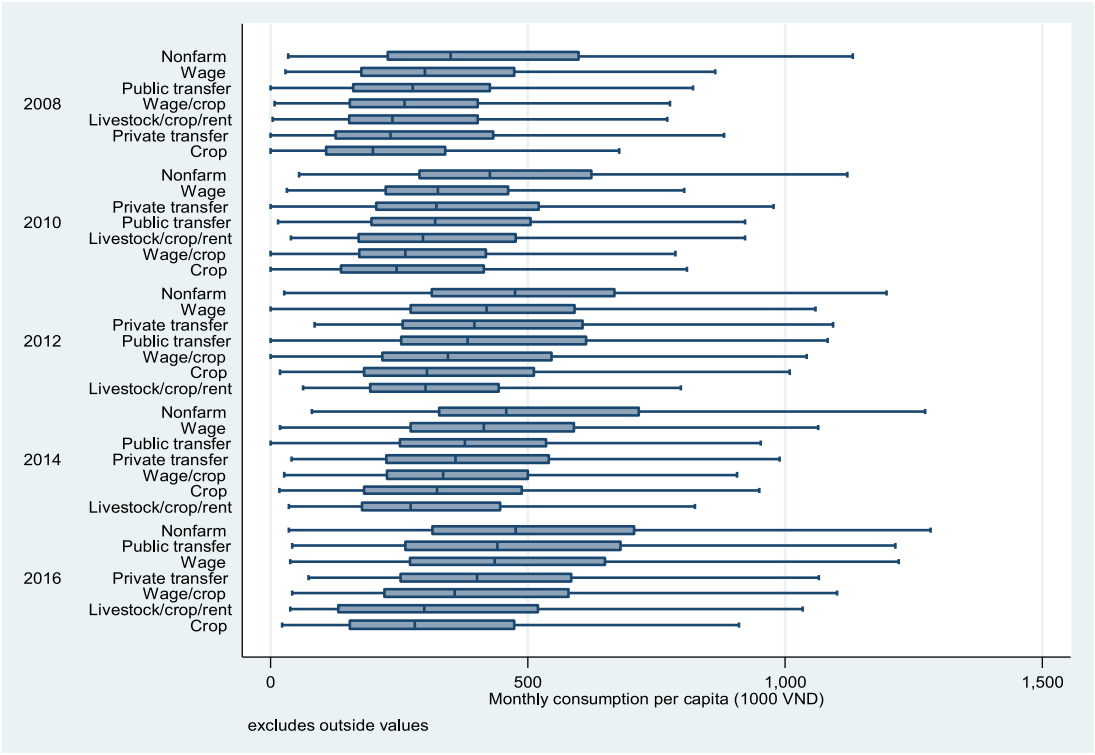

Fig. 2. Consumption per capita by livelihood, 2008–2016.
Source: Authors' calculation from the 2008–2016 VARHS.

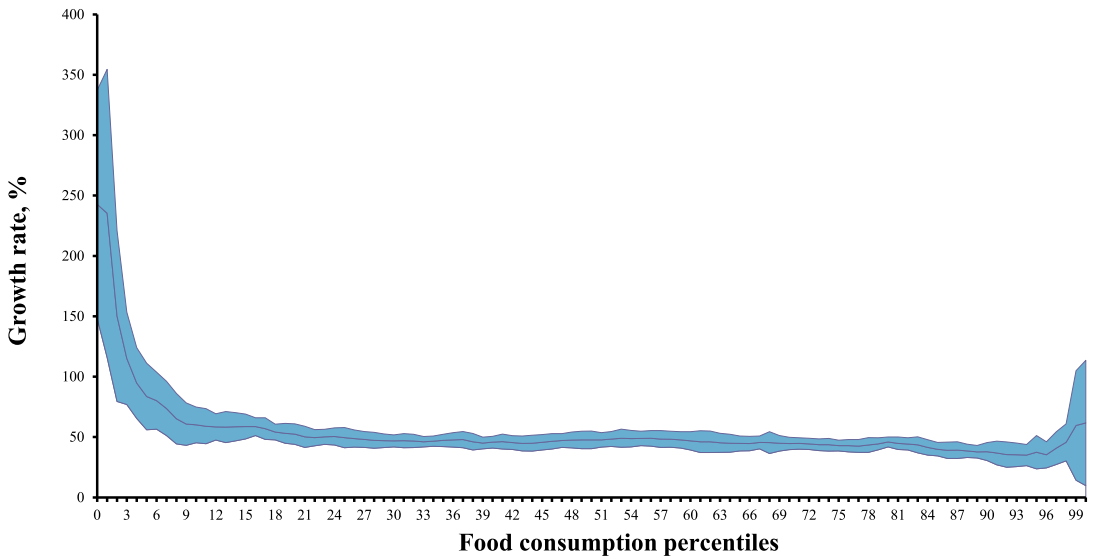

Fig. 3. Growth Incidence Curve (GIC) of food consumption per capita, 2008–2016.
Source: Authors' calculation from the 2008–2016 VARHS.

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 5 and 6 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

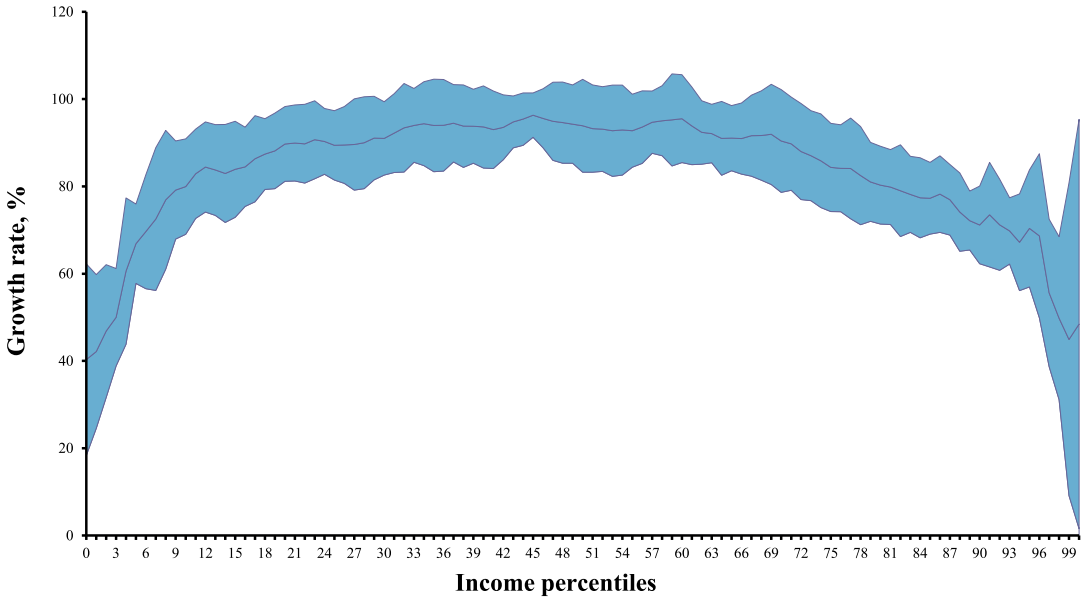

Fig. 4. Growth Incidence Curve (GIC) of real income per capita, 2008–2016.
Source: Authors' calculation from the 2008–2016 VARHS.

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.

However, a more complete and more interesting picture of the relationship between variables emerged when looking at the results estimated from the UQR with fixed effects in Tables 5 and 6. 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 10th and 25th income and food consumption quantile). Specifically, changing from a crop to nonfarm livelihood increases per capita income by 81% and 53% for households in the lowest quantiles, the 10th and 25th, respectively, while the corresponding figures are 22% and 28% for those in the 75th and 90th 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 75th income quantile for a wage-earning livelihood and at the 90th 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.

Our finding supports previous findings that participating in nonfarm activities results in higher income (Barrett et al., 2001a,b; Tran, 2015) and expenditure (Hoang et al., 2014; Pham et al., 2010) for Vietnamese rural households. Notably, 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 findings accord with those for Malawi, Niger, and Zambia (Asfaw et al., 2019) and China (Zhao and 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. However, our finding is inconsistent with that in Bangladesh, where nonfarm participation increased food consumption only for households in the medium and higher quantiles (Mishra et al., 2015).

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. On average, for example, one additional household member reduces per capita income by about 7% and a similar effect is also found for all quantiles considered. The dependency ratio[3] has a negative effect on income and food consumption per capita in all quantiles but the negative effect is larger for poorer households. The findings support previous results that having more family members and dependents tends to reduce household well-being (Jansen et al., 2006; Nguyen and Tran, 2018; Tran, 2015).

[3] This ratio is calculated by the number of members aged under 15 and over 59, divided by the total number of family members.

Table 5
Impact of livelihood on household per capita income: UQR and fixed-effect OLS estimations.
Source: Authors' calculation based on the 2008–2016 VARHS.

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
Gender	−0.09	−0.10	−0.03	0.14*	0.16	0.02
Marital status	−0.11	−0.11**	−0.11*	−0.08	−0.00	−0.10***
Age	−0.02	−0.00	0.01*	0.03***	0.03***	0.01
Age squared	0.00	0.00	−0.00*	−0.00***	−0.00**	−0.00*
Household size	−0.08***	−0.07***	−0.06***	−0.06***	−0.06***	−0.07***
Dependency ratio	−0.58***	−0.44***	−0.27***	−0.12*	−0.20**	−0.31***
Primary	0.11	0.01	0.03	0.03	−0.03	0.04
Lower secondary	0.18**	0.06	0.04	−0.03	−0.08	0.03
Upper secondary	0.14	0.04	0.08	0.02	−0.05	0.06
Short-term vocational training	−0.07	0.08**	0.05	0.06	0.01	0.06**
Long-term vocational training	−0.03	−0.00	0.08	0.21**	0.17	0.09*
Professional secondary	−0.02	0.07	0.14**	0.07	−0.11	0.08*
College/ university	−0.10	0.09	0.30***	0.23*	0.19	0.23***
Arable land per capita	0.04*	0.05***	0.03*	0.07***	0.10***	0.06***
Natural disasters	−0.06	−0.12***	−0.20***	−0.11***	−0.06	−0.11***
Pest diseases	−0.00	0.01	0.13***	0.12***	0.06	0.06***
Sick household members	−0.02	−0.04	−0.04	−0.04**	−0.01	−0.03**
Nonfarm livelihood	0.81***	0.53***	0.35***	0.22***	0.28***	0.45***
Private transfer livelihood	0.64***	0.46***	0.28***	0.15***	0.12**	0.30***
Livestock/crop/rent livelihood	0.61***	0.32***	0.06	−0.03	0.04	0.19***
Wage-earning livelihood	0.83***	0.58***	0.24***	−0.01	−0.19***	0.29***
Wage/crop livelihood	0.70***	0.35***	0.10***	−0.01	−0.06	0.20***
Public transfer livelihood	0.73***	0.45***	0.07	−0.14**	−0.08	0.18***
2010	0.21***	0.17***	0.17***	0.13***	0.09***	0.14***
2012	0.41***	0.36***	0.36***	0.26***	0.20***	0.31***
2014	0.51***	0.46***	0.48***	0.36***	0.28***	0.42***
2016	0.50***	0.52***	0.60***	0.55***	0.48***	0.52***
Constant	6.15***	6.52***	6.58***	6.44***	6.61***	6.54***
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: Standard errors for UQR are estimated using bootstrap techniques with 1000 replications.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

In addition, 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. This finding emphasizes the key role of education in improving household well-being in rural Vietnam. Our research finding is consistent with the human capital theory in the empirical literature (Mishra et al., 2015).

The results from UQR, however, show that the positive effect of education was only found in some income quantiles. Specifically, the positive effect of short-term and long-term vocational education was found only in the 25th and 75th quantiles, respectively, while that of college/university degrees was observed in the 50th and 75th 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 have a negative effect on well-being. For example, the effect is negative for natural disasters but positive for agricultural diseases.

5. Conclusion, policy implications and limitations

5.1. Summary of findings

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). The main findings can be summarized as follows.

Table 6
Impact of livelihood on food consumption per capita: UQR and fixed-effect OLS estimations.
Source: Authors' calculation from the 2008–2016 VARHS.

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
Gender	−0.25**	0.08	0.03	0.08	0.17	0.02
Marital status	0.07	−0.03	−0.03	−0.07	−0.15*	−0.03
Age	−0.00	−0.01	−0.00	0.01	0.00	0.00
Age squared	−0.00	0.00	0.00	−0.00	−0.00	−0.00
Household size	−0.11***	−0.08***	−0.07***	−0.07***	−0.07***	−0.08***
Dependency ratio	−0.22**	−0.16**	−0.04	−0.10*	−0.15**	−0.15***
Primary	0.10	0.05	0.11***	0.07**	0.08**	0.09***
Lower secondary	0.09	0.18***	0.10**	0.08*	0.04	0.11***
Upper secondary	0.11	0.17**	0.14***	0.03	−0.05	0.10**
Short-term vocational	0.05	0.06	0.12***	0.10**	0.06	0.07***
Long-term vocational	0.01	0.09	0.09	0.11	0.28**	0.10
Professional secondary	0.20*	0.07	0.17**	0.17**	0.25***	0.17***
College/university	−0.00	0.01	0.04	0.06	0.17	0.12*
Arable land per capita	0.07***	0.05**	0.05***	0.06***	0.06**	0.06***
Natural disasters	−0.02	−0.05	−0.08***	−0.07***	−0.06*	−0.06***
Agricultural diseases	−0.01	0.05	0.08**	0.06*	0.03	0.05**
Sick household members	−0.07*	0.02	0.03*	0.02	−0.00	0.01
Nonfarm livelihood	0.40***	0.26***	0.22***	0.20***	0.21***	0.25***
Private transfer livelihood	0.27***	0.16**	0.11**	0.07	0.06	0.14***
Livestock/crop/rent livelihood	0.36***	0.19***	0.08**	0.05	0.04	0.15***
Wage-earning livelihood	0.44***	0.24***	0.17***	0.10***	0.10*	0.21***
Wage/crop livelihood	0.33***	0.16***	0.08**	0.06**	0.10***	0.15***
Public transfer livelihood	0.23*	0.13*	0.09	0.06	0.10	0.12***
2010	0.35***	0.22***	0.12***	0.04*	−0.02	0.15***
2012	0.73***	0.48***	0.35***	0.26***	0.21***	0.40***
2014	0.51***	0.40***	0.28***	0.16***	0.11***	0.30***
2016	0.45***	0.38***	0.32***	0.26***	0.18***	0.34***
Constant	4.41***	4.93***	5.37***	5.53***	6.06***	5.16***
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: Standard errors for UQR are estimated using bootstrap techniques with 1000 replications.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

Using cluster analysis, we identified seven livelihoods adopted by households, 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 household traits. For comparison, we also estimated the mean or homogeneous effect using a fixed effects estimator.

Estimates from the fixed effects 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.

However, estimates from the UQR with fixed effects provides 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 10th quantile). The positive effect tends to decline in the higher quantiles, however, and even turns negative for richer households (those in the 75th and 90th 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. 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.

5.2. Policy implications

The study has several policy implications. Our econometric analysis confirms that, on average, moving out of crop livelihoods would result in higher returns for rural households. Notably, the result from the UQR highlights the benefit

to the poor of a switch in livelihood from crop to non-crop activities in rural Vietnam. This result 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 can be expected not only to improve income for the poor but also to reduce inequality in rural Vietnam. Overall, our finding implies that diversifying away from dependence on crops into non-crop activities has the effect of benefiting the poor in rural Vietnam.

Rural households in Vietnam, in particular the poor, can increase their food consumption and income by switching their livelihoods to non-crop activities, especially nonfarm self-employment and wage-paying work. Apart from offering job opportunities, the rural nonfarm sector may discourage rural-to-urban migration, revive traditional crafts, and develop small industries utilizing local resources. Given these advantages, the rural nonfarm sector should be viewed as an effective engine for improving income, reducing poverty and inequality, creating jobs and developing local industry. Appropriate policies focused on improving human capital and training programs that increase the probability of successful livelihood transformation should be implemented or at least seriously discussed by policy makers.

5.3. Limitations and future research

We acknowledge that our study has several limitations that should be taken into consideration for future research. First, some self-reported data, such as the impact of natural disasters and agricultural diseases, may suffer from inconsistency from the VARHS, and this may cause potential bias. This suggests that future research should account for the shortcomings of such self-reported data using exogenous measures (Nguyen and Nguyen, 2020).

Second, while our econometric specification can eliminate unobservable time-invariant factors that may affect both livelihoods and household well-being, this may not account for time-dependent factors. In addition, livelihood choices may potentially be endogenous, suggesting that this limitation should be addressed in further research using an instrumental variables estimator.

Finally, influenced by many different factors, farming households in developing countries in general, and in rural Vietnam in particular, pursue multiple livelihood activities. As noted by Nguyen et al. (2017), weather shocks and physical and economic conditions in the localities where people live, among other factors, have emerged as major determinants of farmers' land use decisions and livelihood choices. This suggests that future research should investigate the factors affecting changes from crop to non-crop livelihoods in rural Vietnam.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

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

Appendix A. Recentered influence functions (RIFs)

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:

$$RIF\left(Y_{it}; q_\tau, F_{Y_{it}}\right) = q_\tau + \frac{\tau - 1\left\{Y_{it} \le q_\tau\right\}}{f_Y(q_\tau)} \tag{3}$$

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) ofY_{it}; the indicator function, $1\left\{Y_{it} \le q_\tau\right\}$, 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 90th quantile ($\tau = 90$). 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 90th quantile, $q_{0.90}$. The resulting dummy variable RIF holds the values $q_{0.90} + \left\{0.90/f_y(q_{0.90})\right\}$ for those above the 90th quantile and the values $q_{0.90} - \left\{0.10/f_y(q_{0.90})\right\}$ for those at or below the 90th 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.

Appendix B. 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

Appendix C. The result of panel unit-root test

Our study uses a very short panel dataset, meaning a large cross section of households observed for a limited number of time periods (T = 5, covering five years: 2008; 2010; 2012; 2014 and 2016). However, the panel-data cointegration tests are used for long panel datasets (Neal, 2014) which suggest that the tests are not practical in our study. Also, it is appropriate to use the Harris–Tzavalis test to check the null hypothesis of a unit root (STATA, 2015). The test confirms the stationarity of variables used in the models. For instance, the results for the log of household income test indicates that the statistics of Rho are −0.1441, z = -55.5062 and *p*-value = 0.0000, providing evidence against the null hypothesis and therefore leading to the conclusion that the log of household income is stationary. Similar results are also obtained in the case of the log of food consumption expenditure (Rho = -0.1626; z = -57.1025; p-value = 0.000).

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