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## Abstract

This paper investigates the effects of forestland on household income, poverty and inequality among households in Vietnam's poorest rural districts, the North Central Provinces, using data from the Quantitative Socio-Economic Survey for Emission Reduction-Program (ER-P) Provinces Areas [QSESERPA]. Local people are extremely poor, with 54% living below the poverty line. Forest income constitutes about 17% of their total income; only wage income (37%) ranks higher. Surprisingly, those better off depend on forest income more than the poor do. Such income is comprised mainly of non-timber forest plants (77%), followed by timber products (18%). Our micro-econometric analysis indicates that gaining access to more forestland would increase household per capita income and reduce the incidence and intensity of poverty, even after controlling for all other variables in the model. In addition, we find that forest income was the second largest contributor to overall income inequality and had the largest marginal effect on it. A policy implication here is that increasing the access of the poor to forest resources and improving their efficiency in forest management could have a substantial effect on income, poverty and inequality in the study area.

**Keywords:** forestland; forest income; fractional probit; Gini decomposition; shortfall.

**JEL classification codes:** I 32, O12, J15

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## 1. Introduction

The role of forest resources in rural household livelihoods in developing countries has received increasing attention from scientific communities and policy makers (Angelsen et al., 2014; Das, 2010; Hogarth, Belcher, Campbell, & Stacey, 2013; Kar & Jacobson, 2012; Rahut, Behera, & Ali, 2016). While the Agricultural Revolution occurred more than 10,000 years ago, millions of rural households in developing societies have earned as much income from forest resources as from cultivating crops (Wunder, Angelsen, & Belcher, 2014). Forests offer a variety of products and services to local households dwelling in and around them and are a main source of livelihood for millions of people around the world (Behera, 2009). A number of recent studies on the importance of forest resources to household livelihoods reveal that forests have a substantial potential for improving income and reducing both poverty and inequality among forest-dependent people (Das, 2010; Rahut et al., 2016).

Vietnam has a total mainland area of about 331,600 km$^2$, including mountains and tropical forests, as well as more densely populated plains in both the north and south of the country (PricewaterhouseCoopers [PWC], 2016). Mountains and hills cover about three-quarters of Vietnam's total area, whereas only 15% is made up of farmland (De Jong & Van Hung, 2006). The midland and upland areas of Vietnam contain the bulk of the country's forest resources (Vietnamembassy-usa, 2017). Over the past two decades, the Vietnamese government has implemented several reforestation and development programs that have targeted upland regions of the country. Several programs, such as Programs 134, 135, 327 and 336, have aimed at allocating forest land use and replanting, developing local markets and infrastructure, and delivering housing, health and education services, with the dual objectives of protecting forest resources and raising the living standards of ethnic minority households and those living in remote or mountainous areas (Thulstrup, 2015).

It was estimated that about 25 million forest-dependent poor and ethnic minority groups use forests for subsistence livelihoods in Vietnam (WB, 2016). A number of studies have investigated the importance of forests to rural households in Vietnam (McElwee, 2008; Muller, Epprecht, & Sunderlin, 2006; Sunderlin & Huynh, 2005; Thulstrup, 2015; To, Dressler, Mahanty, Pham, & Zingerli, 2012). However, to the best of our knowledge, limited econometric evidence exists on the effect of forest resources on household income, poverty reduction and inequality among ethnic minorities and the poor in remote and mountainous areas in Vietnam. A better understanding of the contribution of forest resources to local household livelihoods is of great importance when adjusting and designing policy interventions to meet people's needs and improve their economic welfare. The current study was conducted to fill this gap.

Our study is the first to investigate the role of productive forestland (hereafter called "forestland") on income, poverty and inequality among rural households in the Northern Central Coastal Region – one of the poorest regions of Vietnam. The study has three main objectives: (i) to quantify the effect of forestland on household income; (ii) to measure the role of forestland on the incidence and intensity of poverty at the household level; and (iii) to estimate the influence of forest income on overall income inequality among households.

Two main findings are: *first*, access to more forestland would increase household per capita income, reduce the likelihood of a household falling into poverty and mitigate its poverty gap, even after controlling for all other factors in the models; *second*, forest income was the second largest contributor to overall inequality and had the largest incremental effect on it. The findings differ from those in previous studies of Vietnam's Northwest Mountains. These studies alleged that forestland has no connection with household income or poverty eradication (Tran, Nguyen, Vu, & Nguyen, 2015), that forest income is the smallest factor in total income inequality, and does have an equalizing effect on it (Tran, 2016).

## 2. Background of the Study

Following the economic and political reforms known as "Đổi Mới" launched in 1986, Vietnam's forestry sector has transitioned from forestry controlled by central planning to people-oriented forestry. Policies for land and forest have been continually revised and adjusted, as can be seen in several laws (e.g. Land Law 1993, revised in 1998 and 2003; Law on Forest Protection and Development 1991, revised in 2004) and other regulations such as Decree 02/CP, Decree 01/CP, Decree 163/1999/ND-CP, etc.) (Nguyen, 2009). This process removed subsidies previously given to state forest enterprises (SFEs) and closed down numerous unproductive and inefficient SFEs (To et al., 2012). The Vietnamese government allocated land and forest to individuals, households, communities and other entities. At the same time, the government implemented reforestation programs, such as 327/CT and the 5 Million Hectare Reforestation Program (Program 661), with the dual objectives of increasing forest coverage and contributing to hunger elimination and poverty alleviation (Nguyen, 2009; Thulstrup, 2015). This has resulted in changes in the livelihoods of local people by giving them access to living resources.

According to the National Assembly's 2004 Law on Protection and Development of the Forest (Forest Law 2004) (WB, 2011), forestland can be categorised according to three main functions, namely special-use, protection and production. Special-use forests (SUF) are used mainly for the conservation of nature, protection of historical and cultural relics, in service of recreation and tourism in combination with protection, and contributing to environmental protection. Protection forests are reserved for the protection of water streams and soils, to prevent soil erosion and desertification, and to mitigate natural calamities and regulate climate. Production forests have the main purpose of the production and export of timber and non-timber forest products, in combination with protection. Production forests are planted on production forest land (The National Assembly, 2004). Of the three types of forest, the production forest area remains the largest, covering about 6 million hectares (ha) of the country, followed by protection forests, consisting of 5 million ha, then special-use forests with almost 2 million ha (WB, 2011).

The current study focuses on the Northern Central Coastal Region, which has a tropical monsoonal climate, with a land area of about 5.15 million ha (16% of Vietnam's total land area), of which 80% comprises hills and mountains while the remainder is made up of coastal plains with agricultural land (Ministry of Agriculture and Rural Development [MARD], 2016). The region is administered in six provinces, namely Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri and Thua Thien Hue, with a population of about 10.3 million people (12% of the total population of Vietnam) living in 1,820 communes (MARD, 2016). The forest coverage is 44% in the region and 1.7 million ha of the region's forestland are administered by the state, while about 0.9 million ha have been allocated to households or village communities. Natural forests cover 2.1 million ha, making up 41% of the total area, and most of this is evergreen broadleaf forest (EBF). The major portion of natural forest is poor EBF (1.3 million ha), followed by EBF of medium quality (452,900 ha), then rich EBF, accounting for only 226,626 ha (4%). Other forestland consists of 138,755 ha, while timber plantations cover 637,651 ha, making up 12% of the area (MARD, 2016).

## 3. Data and method

### *3.1. Data*

The dataset from the Quantitative Socio-Economic Survey for Emission Reduction-Program (ER-P) Provinces Areas [QSESERPA] was used for the current study. The QSESERPA was conducted by the Mekong Development Research Institute [MDRI] in 2016 (MDRI, 2016). The main objective of the project was to collect information on the socio-economic profile of the communities in the proposed ER-P program, including details concerning vulnerable groups and forest-dependent households and communities (especially ethnic minorities). This information is a vital prerequisite and key input for designing the project (MDRI, 2016). The survey was conducted in six provinces in the Northern Central Coastal Region, namely Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri and Thua Thien Hue, where the richest natural forests are located (MDRI, 2016).

The sampling frame for the survey contains 327 communes in six provinces. The 327 selected communes met the following criteria: (i) the number of ethnic minority households is greater than 100 and the number of households in poverty or close to it is larger than 100; (ii) the deforestation and degradation area is larger than 200 ha; the afforestation or reforestation and regeneration area is larger than 200 ha; and bare land available for afforestation is more than 180 ha (MDRI, 2016).

A multi-stage sampling procedure was used for the survey. First, 102 communes from the six provinces mentioned above were randomly selected, based on probability proportional to the population size of the provinces. Secondly, from each of the selected communes, two villages were randomly selected and 15 households in each village were randomly chosen for the interview, yielding a total sample size of 3,060 households (MDRI, 2016). The survey covered a large number of households from various ethnicities, such as Thai, Muong, Bru-Van Kieu, H'Mong, Co Tu, Ta Oi-Pa Co, and other ethnic minorities (EM). The survey contains rich data on households and individuals, including characteristics of household members, education and employment, income sources, housing, durables and detailed information about land and income sources (MDRI, 2016).

*3.2. Method*

*Measures of poverty*

This study used the class of poverty measures developed by Foster, Greer, and Thorbecke (1984) [FGT] that is most commonly employed for measuring poverty (Coudouel, Hentschel, & Wodon, 2002). The FGT class of poverty measures is described as:

$$P_{\propto}= \frac{1}{N}\sum_{i=1}^{q}(\frac{Z-Yi}{Z})^{\propto}$$

Where $N$ is the size of the total population (or sample); $Yi$ is the income per capita of the $\text{household}_i$; $Z$ is the poverty line; $q$ is the number of poor households ( those with income per capita below $Z$); $\propto$ is the Poverty Aversion Parameter Index which takes on the values of 0, 1 and 2, representing the incidence of poverty, poverty gap and severity of poverty (Foster et al., 1984).

When ∝=0, then the FGT is reduced to $P_0 = \frac{q}{N}$, which is the *headcount index* (incidence of poverty), measuring the percentage of the population categorised as poor. This measure is by far that most commonly used because of its very straightforward, simple method of calculation (WB, 2005). When ∝=1, then the FGT class of poverty measure ($P_1$) is defined as $P_1 = \frac{1}{N}\sum_{i=1}^{q}(\frac{Z-Yi}{Z})^1$, which is the *poverty gap index* or the depth of poverty. This measures the degree to which individuals remain below the poverty line as a percentage of that line. Note that this measure yields the mean proportionate poverty gap being calculated for the population or whole sample, where the non-poor have a zero poverty gap. This provides information about how far removed the poor are from the poverty line. Thus, the poverty gap index has merit because it shows the intensity or depth of poverty (WB, 2005).

When ∝=2, the FGT class of poverty measure ($P_2$) becomes: $P_2 = \frac{1}{N}\sum_{i=1}^{q}(\frac{Z-Yi}{Z})^2$, which is the squared *poverty gap* ("poverty severity") *index*. This averages the squares of the poverty depth relative to the poverty line. This measure considers not only the distance between the poor and the poverty line (the poverty gap), but also inequality among them. That is, greater weight is put on poor households who are further away from the poverty line (Coudouel et al., 2002).

*Model specification*

We assume that household per capita income is a reduced function of household characteristics and assets, as given in equation (1), where $\mathrm{Ln}(\mathrm{y}_{\mathrm{ij}})$ is the natural logarithm of annual per capita income of household *i* in province *j;* $X_{ij}$ is a vector of household distinguishing characteristics, such as demographic variables and education; $\lambda_{ij}$ represents all types of lands; $D_j$ is the dummy variable of provinces and $\varepsilon_{ij}$ is an error term.

$$\mathrm{Ln}(\mathrm{y}_{\mathrm{ij}}) = \beta_0 + X_{ij}\beta_1 + \lambda_{ij}\beta_2 + D_j\beta_3 + \varepsilon_{ij} \quad (1)$$

Factors associated with the incidence of poverty were modeled using a probit model in equation (2), where the dependent variable $P_{\mathrm{ij}}$ is a binary variable that has a value of one if a household was classified as poor and a value of zero otherwise.

$$P_{\mathrm{ij}} = \beta_0 + X_{ij}\beta_1 + \lambda_{ij}\beta_2 + D_j\beta_3 + \varepsilon_{ij} \quad (2)$$

Because the dependent variable ($G_{\mathrm{ij}}$) represents the poverty gap, defined as shortfall (i.e., the poverty line, minus income, is a fractional response variable having the values from zero to 100%), we modelled factors associated with the poverty gap in equation (3) using a fractional probit model developed by Papke and Wooldridge (1996) to deal with models containing fractional dependent variables bounded between zero and 100%. The empirical model can be estimated by the quasi-maximum likelihood estimator, with heteroscedasticity-robust asymptotic variance (Papke & Wooldridge). Both equations (2) and (3) used the same explanatory variables as those in equation (1).

$$G_{\mathrm{ij}} = \beta_0 + X_{ij}\beta_1 + \lambda_{ij}\beta_2 + D_j\beta_3 + \varepsilon_{ij} \quad (3)$$

The definition, measurement and descriptive statistics of explanatory variables are given in Table 1. Our specifications included household size, dependency ratio, the age, education and gender of household heads and certain other socio-economic characteristics, such as household participation in wage and nonfarm self-employment activities. We also take into account some productive household assets, such as the size of various types of land. In addition, we controlled for province fixed effects by including five province dummy variables.

*Gini decomposition by income source*

Following Tran (2016) and Tran, Lim, Cameron, and Vu (2014), we also used the decomposition method of the Gini coefficient to measure the extent to which forest income affects and contributes to overall income inequality among households in the study area. This method was developed by Lerman and Yitzhaki (1985) and has been commonly used to decompose inequality by income sources (Tran, 2016). According to this method, the Gini coefficient $G_y$ can be decomposed as:

$$G_y = \sum_{i=1}^{n} G_i R_i S_i \quad (4)$$

where $y$ is total household income and $i$ is the income source $i$. $G_i$ is the Gini of income source $i$, which indicates how equally or unequally each income source $i$ is distributed. $R_i$ is the correlation coefficient between income from source $i$ and the distribution of total household income ($y$) whereas $S_i$ represents the share of income source $i$ in $y$.

$W_i$ is the contribution of income source $i$ to overall inequality *($G_y$)*, which is represented as follows:

$$W_i = (S_i\, G_i R_i)/G_y \tag{5}$$

According to Adams (1991), $C_i = G_i R_i$ is defined as the concentration ratio of income source $i$, while the relative concentration coefficient of income source $i$ in $G_y$ is computed as:

$$g_i = \frac{G_i R_i}{G_y} = \frac{C_i}{G_y} \tag{6}$$

An income source $i$ can be classified as decreasing or increasing inequality, depending on whether the relative concentration coefficient ($g_k$) is bigger or smaller than unity. Income source $i$ increases inequality if $g_i > 1$, and decreases inequality if $g_i < 1$ and does not affect inequality if $g_i = 1$ (Tran, 2016).

Lerman and Yitzhaki (1985) indicated that the Gini decomposition method allows researchers to estimate the effect on overall inequality of small changes in a given income source, holding all other income sources constant. Let a small change in income from source $i$ be equal to $ey_i$, where $e$ is close to 1 and $y_i$ represents the income from source $i$. Stark, Taylor, and Yitzhaki (1986) indicate that the partial derivative of the Gini coefficient with respect to a percent change $e$ in source $i$ is given as:

$$\frac{\partial_G}{\partial_e} = S_i\,(G_i R_i - G_y) \tag{7}$$

where $G_y$ is the Gini coefficient before the income change. The percentage change in inequality caused by a small percentage change in income from source $i$ equals the contribution of income source $i$ to the overall Gini coefficient and subtracts its contribution to total household income:

$$\frac{\partial_G/\partial_e}{G_y} = \frac{S_i\, G_i R_i}{G_y} - S_i \tag{8}$$

Note that the overall Gini coefficient ($G_y$) would be unchanged, if all the income sources changed by the same percentages (Tran, 2016).

## 4. Results and discussion

*4.1. Descriptive analysis of household characteristics and income sources*

Table 1

*Statistical Summary of Variables in the Estimation*

| **Variables** | All households | | Poor | | Non-poor | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| *Household head characteristics* | | | | | | |
| Gender (1=male; 0=female) | 0.87 | 0.34 | 0.87 | 0.34 | 0.87 | 0.34 |
| Ethnicity (1=majority; 0=minority) | 0.31 | 0.46 | 0.20 | 0.40 | 0.44 | 0.50 |
| Age (years) | 33.88 | 7.40 | 33.27 | 7.20 | 34.61 | 7.57 |
| No degree | 0.32 | 0.47 | 0.40 | 0.49 | 0.22 | 0.42 |
| Primary | 0.27 | 0.44 | 0.27 | 0.44 | 0.26 | 0.44 |
| Lower secondary | 0.29 | 0.45 | 0.26 | 0.44 | 0.32 | 0.47 |
| Upper secondary | 0.07 | 0.26 | 0.06 | 0.23 | 0.09 | 0.28 |
| Above upper secondary | 0.06 | 0.24 | 0.02 | 0.13 | 0.11 | 0.31 |
| *Household characteristics* | | | | | | |
| Household size (numbers) | 4.39 | 1.69 | 4.68 | 1.75 | 4.05 | 1.55 |
| Dependency ratio (ratio) | 0.78 | 0.71 | 0.89 | 0.75 | 0.65 | 0.64 |
| Wage employment (1=yes; 0=otherwise) | 0.62 | 0.48 | 0.54 | 0.50 | 0.72 | 0.45 |
| Nonfarm self-employment (1=yes; 0=otherwise) | 0.12 | 0.33 | 0.08 | 0.27 | 0.18 | 0.38 |
| Includes migrant worker? (1=yes; 0=otherwise) | 0.17 | 0.37 | 0.15 | 0.36 | 0.19 | 0.39 |
| Annual cropland ($m^2$) | 1358 | 3528 | 1213 | 3356 | 1529 | 3714 |
| Perennial cropland ($m^2$) | 1399 | 5570 | 1013 | 4195 | 1855 | 6823 |
| Forestland ($m^2$)[a] | 6942 | 18323 | 5275 | 13895 | 8915 | 22304 |
| Residential land ($m^2$) | 441 | 1153 | 349 | 821 | 551 | 1443 |
| Observations | 3060 | | 1658 | | 1402 | |

Table 1 reveals that there are substantial differences between the two groups in the mean values of most household characteristics. While there is no gender difference among household heads between poor and non-poor, the proportion of ethnic minority households among the poor is almost double that for non-poor. This suggests that ethnicity may be strongly linked to poverty in the study area. The poor had larger families and a much higher dependency ratio than did the non-poor. A difference between the two groups in the age and education of household heads was also observed. On average, the household heads of non-poor households were approximately one year older than those of poor households. In addition, the household heads of the poor group had a lower rate of school completion at higher levels of education than those of the non-poor group.

Participation rates in both wage and nonfarm self-employment were found to be higher for the non-poor than for the poor. There were disparities between the two groups in holdings of all types of land. The amount of annual cropland owned by poor households was significantly less than that owned by non-poor households. In addition, non-poor households had much larger areas of perennial cropland and forestland than did poor households. The poor also owned less residential land than did the non-poor. The finding implies that land is an important factor associated with poverty.

Table 2

*Household Economic Welfare by Ethnicity and Province*

| | Total | Ethnic minorities | Kinh (the ethnic majority) | Thanh Hoa | Nghe An | Ha Tinh | Quang Binh | Quang Tri | Hue |
|---|---|---|---|---|---|---|---|---|---|
| Household income per capita[a] | 12084 | 8870 | 19245 | 12773 | 11172 | 16860 | 10490 | 10179 | 13659 |
| (SD) | 22435 | 11478 | 35466 | 23323 | 29364 | 18683 | 11478 | 20281 | 15502 |
| Poverty head count | 0.54 | 0.63 | 0.34 | 0.51 | 0.58 | 0.37 | 0.55 | 0.66 | 0.47 |
| Poverty gap | 0.29 | 0.35 | 0.17 | 0.24 | 0.33 | 0.19 | 0.28 | 0.41 | 0.24 |
| Poverty severity | 0.19 | 0.23 | 0.11 | 0.13 | 0.22 | 0.18 | 0.30 | 0.15 | 0.15 |

Note: Authors' calculation from the survey data. [a] annual income in thousand Vietnamese dong (VND). FGT is estimated using the poverty line of 609 thousand VND per person per month. This poverty line is calculated using the poverty line for rural areas in 2014 (GSO, 2015) and adjusted for the CPI (consumer price index) in 2015.

As shown in Table 2, the average annual per capita income for the whole sample was estimated at about 12 million Vietnamese dong (VND). However, the per capita income for the ethnic majority (the Kinh) is nearly double that for ethnic minorities. In addition, the incidence, intensity and severity of poverty remain much higher for ethnic minorities than for the Kinh. The data also indicate that there are differences in living standards across provinces. Households in Ha Tinh and Hue attained a higher level of per capita income and had a lower poverty rate than those in other provinces.

Table 3 compares the sources of income, including forest income, for the poor and non-poor. It shows that the per capita income earned by the noon-poor was approximately seven times higher than that of the poor. Interestingly, forest income contributed a large share of total income (17%); only wage income ranks higher (37%). However, an examination of each group reveals that for the poor, crop income is much higher (26%) than forest income (15%), whereas the corresponding proportions for the non-poor are 9% and 17%, respectively. The finding implies that the poor depend more heavily on crop income, whereas the non-poor depend more on forest income. Nevertheless, wage income accounted for the largest amount of income for both poor and non-poor households.

Table 3

*Household Income Sources*

| Group | All | Poor | Non-poor |
|---|---|---|---|
| Annual total household income (1000 VND) | 47243 | 15674 | 84557 |
| | (71738) | (10655) | (92349) |
| Annual per capita income (1000 VND) | 12084 | 3383 | 22374 |
| | (22435) | (1939) | (29984) |
| *Household income by source (%)* | | | |
| Wages | 0.37 | 0.30 | 0.39 |
| Crops | 0.12 | 0.26 | 0.09 |
| Livestock | 0.09 | 0.06 | 0.10 |
| Forest | 0.17 | 0.15 | 0.17 |
| Nonfarm self-employment | 0.10 | 0.08 | 0.11 |
| Remittances | 0.01 | 0.02 | 0.01 |
| Rentals | 0.04 | 0.04 | 0.04 |
| Pension | 0.04 | 0.02 | 0.05 |
| Subsidies | 0.04 | 0.08 | 0.03 |
| Annual forest income (1000 VND) | 8053 | 2414 | 14722 |
| | (37511) | (4708) | (54442) |
| *Forestry income by source (%)* | | | |
| Timber forest products | 0.18 | 0.06 | 0.20 |
| Non-timber forest plants | 0.77 | 0.84 | 0.76 |
| Forest animals | 0.03 | 0.07 | 0.02 |
| Allowances for forest management | 0.02 | 0.04 | 0.01 |
| Observations | 3060 | 1658 | 1402 |

Note: standard deviation in parentheses.

As given in Table 3, each household earned on average about 8.053 million VND from forest resources. However, there is a large gap in forest income between the poor and non-poor. The amount of forest income derived by non-poor households was nearly six times as much as that earned by poor households (14.7 million VND vs 2.4 million VND). The data in Table 3 indicate that non-timber forest plants accounted for the largest portion of total forest income (77%), followed by timber forest products (18%) and other forest income sources (5%). Interestingly, the structure of forest income is quite different between the two groups. Specifically, timber forest products made up 20% of the total forest income for the non-poor, while that proportion for the poor was only 6%. In addition, income from non-timber forest plants and animals contributed about 84% and 7% respectively to total forest income for the poor, whereas the corresponding figures for the non-poor were 76% and 2%.

The concentration curve of income sources developed by Jann (2016) was used to illustrate how various income sources were distributed across the population, ranked by household per capita income. Figure 1 confirms that forest and other income sources were skewed much more towards high income households than was crop income. For instance, in income distribution, the top 20% of households received about 70% of total forest income but only 40% of total crop income.

It is also profitable to examine whether the contribution of forest and croplands favoured the rich (see the concentration curve of lands in Figure 2). The figure shows that forestland benefited better-off households slightly more than croplands did. Interestingly, a comparison between the concentration curve of forestland and forest income in Figure 2 reveals that the distribution of forest income was skewed much more towards the better-off than was forestland ownership. Specifically, the top 20% of richest households earned about 70% of total forest income but owned only around 40% of total forestland. This discrepancy may stem from differences in the quality of forestland or differences between rich and poor in the efficiency of forest management.

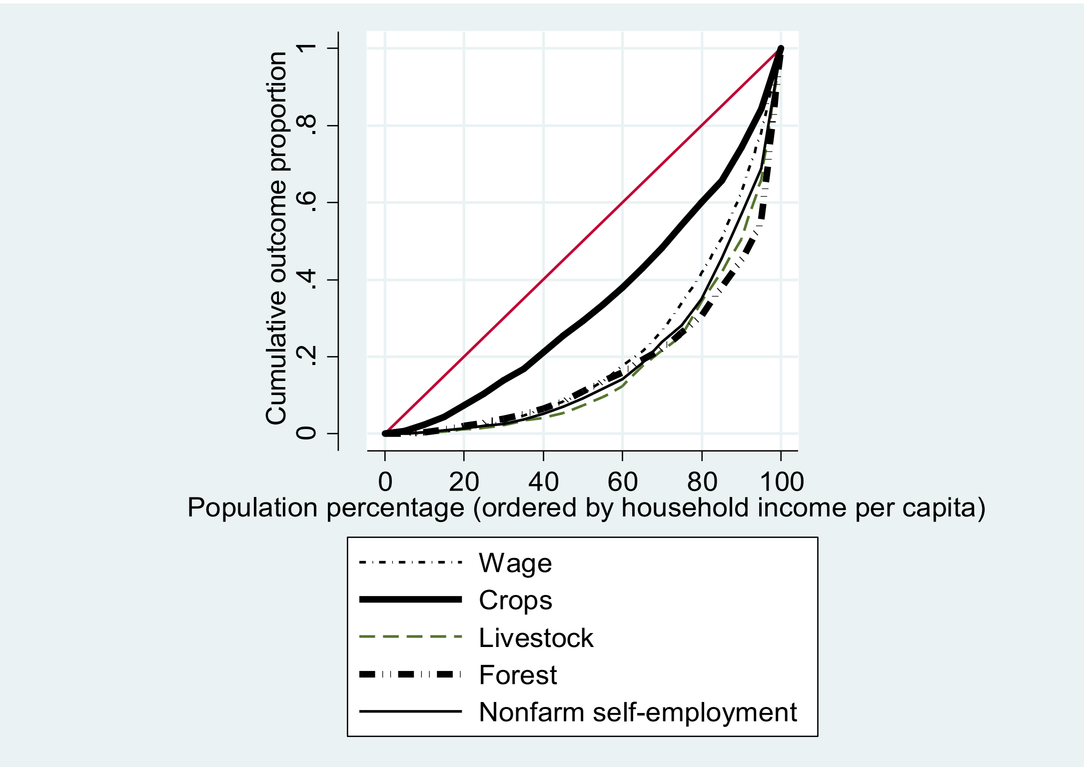


*Figure 1*. Concentration curves of major income sources.

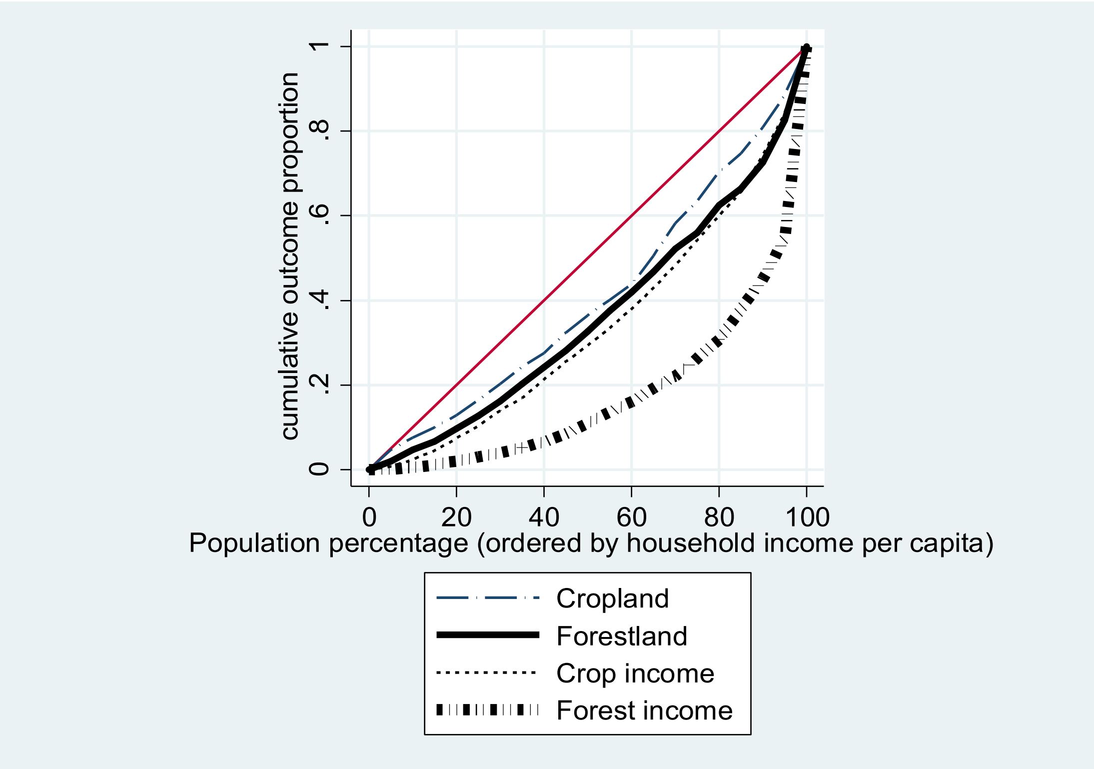


*Figure 2*. Concentration curves of income sources and lands.

## *4.2. Econometric results*

### 4.2.1. Impact of forestland on income and poverty

Table 4 reports the results from the income model. It shows that the model explains roughly 34.5% of the variation in household income. Also, many coefficients are statistically highly significant ($p<0.05$), with their signs as expected. The results confirm that not all types of land are positively associated with household income. While perennial cropland, forestland and residential land have a positive effect on household income, a similar effect was not found in the case of annual cropland. A 1% increase in the size of forestland would result in an increase in per capita income of 0.067%, holding all other things constant in the model. The corresponding results for perennial cropland and residential land are 0.079% and 0.108%, respectively. Interestingly, the value of beta coefficients (standardized coefficient) in Table 4 indicates that forestland played a larger role in household income than other land types.

Table 4

*Ordinary Least Squares Estimates for Factors Associated with Household Income*

| Explanatory variables | Coefficient | SE | p-value | Beta |
|---|---|---|---|---|
| Gender | 0.072 | 0.090 | | 0.019 |
| Ethnicity | 0.645 | 0.075 | *** | 0.254 |
| Age | -0.074 | 0.029 | ** | -0.382 |
| Age squared | 0.001 | 0.000 | *** | 0.395 |
| Primary secondary | 0.031 | 0.076 | | 0.011 |
| Lower secondary | 0.006 | 0.085 | | 0.002 |
| Upper secondary | 0.387 | 0.129 | *** | 0.082 |
| Above upper secondary | 0.794 | 0.113 | *** | 0.151 |
| Household size | -0.109 | 0.022 | *** | -0.141 |
| Dependency ratio | -0.060 | 0.044 | | -0.035 |
| Wage employment | 0.836 | 0.090 | *** | 0.308 |
| Nonfarm self-employment | 0.645 | 0.090 | *** | 0.200 |
| Migration | -0.002 | 0.096 | | -0.001 |
| Annual cropland (log) | 0.007 | 0.020 | | 0.009 |
| Perennial cropland (log) | 0.079 | 0.017 | *** | 0.086 |
| Forest land (log) | 0.067 | 0.013 | *** | 0.127 |
| Residential land (log) | 0.108 | 0.030 | *** | 0.095 |
| Nghe An | -0.199 | 0.069 | *** | -0.047 |
| Ha Tinh | -0.437 | 0.110 | *** | -0.163 |
| Quang Binh | -0.431 | 0.083 | *** | -0.126 |
| Quang Tri | -0.405 | 0.082 | *** | -0.117 |
| Hue | -0.171 | 0.074 | ** | -0.052 |
| Constant | 7.048 | 0.523 | *** | |
| R-squared | 0.345 | | | |
| Observation | 2905 | | | |

Note: SE – robust standard errors. *** p<0.01, ** p<0.05, * p<0.1. Beta – standardized coefficient. Estimates are adjusted for sampling weights and clustered at the commune level. Thanh Hoa province is the reference group. The dependent variable is the log of annual household income per capita. The area of all land types was divided by 100 and transformed into the natural logarithm.

The results in Tables 5 and 6 also reveal that the incidence and intensity of poverty would decrease for a household owning more perennial cropland, forestland and residential land. However, this is not the case for annual cropland. Specifically, a 1% increase in the size of forestland would reduce the incidence and intensity of poverty by 0.024% and 0.010%, respectively. Our findings contrast with those of Tran et al. (2015) and Tran (2015b) on Vietnam's Northwest Mountains. Their study concluded that control of more annual cropland would increase household per capita income and reduce the incidence and depth of poverty, whereas the size of forestland showed no association with income and poverty. This discrepancy in the findings may possibly result from differences in the quality of forestland or in the efficiency of forest management between households in the Northwest Mountains and those in the study area. Overall, our findings confirm the importance of forestland for the livelihoods of local households.

Table 5

*Probit Estimates for Factors Associated with the Incidence of Poverty*

| Explanatory variables | Coefficient | SE | p-value | Marginal effect | SE |
|---|---|---|---|---|---|
| Gender | -0.156 | 0.169 | | -0.047 | 0.051 |
| Ethnicity | -0.839 | 0.101 | *** | -0.254 | 0.029 |
| Age | 0.074 | 0.038 | ** | 0.023 | 0.011 |
| Age squared | -0.001 | 0.001 | ** | 0.000 | 0.000 |
| Primary secondary | 0.045 | 0.111 | | 0.014 | 0.033 |
| Lower secondary | -0.051 | 0.134 | | -0.016 | 0.041 |
| Upper secondary | -0.457 | 0.179 | ** | -0.139 | 0.054 |
| Above upper secondary | -0.965 | 0.239 | *** | -0.292 | 0.070 |
| Household size | 0.105 | 0.031 | *** | 0.032 | 0.009 |
| Dependency ratio | 0.099 | 0.077 | | 0.030 | 0.024 |
| Wage employment | -0.570 | 0.123 | *** | -0.173 | 0.035 |
| Nonfarm self-employment | -0.836 | 0.144 | *** | -0.254 | 0.040 |
| Migration | 0.095 | 0.103 | | 0.029 | 0.031 |
| Annual cropland (log) | 0.014 | 0.038 | | 0.004 | 0.011 |
| Perennial cropland (log) | -0.093 | 0.025 | *** | -0.028 | 0.007 |
| Forest land (log) | -0.079 | 0.026 | *** | -0.024 | 0.008 |
| Residential land (log) | -0.162 | 0.048 | *** | -0.049 | 0.014 |
| Nghe An | 0.154 | 0.151 | | 0.047 | 0.046 |
| Ha Tinh | 0.429 | 0.162 | *** | 0.130 | 0.049 |
| Quang Binh | 0.620 | 0.160 | *** | 0.188 | 0.048 |
| Quang Tri | 0.431 | 0.159 | *** | 0.131 | 0.049 |
| Hue | 0.136 | 0.150 | | 0.041 | 0.045 |
| Constant | -0.454 | 0.699 | | -0.047 | 0.051 |
| Pseudo R2 | 0.22 | | | | |
| Prob > chi2 | 0.0000 | | | | |
| Observation | 2905 | | | | |

Note: SE – robust standard errors. *** p<0.01, ** p<0.05, * p<0.1. Estimates are adjusted for sampling weights and clustered at the commune level. Thanh Hoa province is the reference group. The dependent variable is 1 if the household is poor, 0 otherwise. The area of all land types was divided by 100 and transformed into the natural logarithm.

With respect to the contribution of nonfarm employment to household income, the results outlined in Table 4 confirm that participation in nonfarm activities, either wage-paying or self-employment, increases a household's per capita income. For example, holding all other variables constant, a household engaging in wage employment would, on average, have a per capita income level approximately 84% higher than would those without wage employment. The corresponding figure for those with nonfarm self-employment was about 65%. This implies that local households can make a substantial improvement in their income by participating in nonfarm activities. The same finding was also reported in previous studies (Tran, 2015a; Van de Walle & Cratty, 2004).

Table 6

*Fractional Probit Estimates for Factors Associated with Poverty Gap*

| Explanatory variables | Coefficient | SE | p-value | Marginal effect | SE |
|---|---|---|---|---|---|
| Gender | -0.113 | 0.102 | | -0.027 | 0.024 |
| Ethnicity | -0.684 | 0.091 | *** | -0.164 | 0.021 |
| Age | 0.069 | 0.029 | ** | 0.017 | 0.007 |
| Age squared | -0.001 | 0.000 | ** | 0.000 | 0.000 |
| Primary secondary | 0.041 | 0.070 | | 0.010 | 0.017 |
| Lower secondary | -0.027 | 0.064 | | -0.007 | 0.015 |
| Upper secondary | -0.226 | 0.149 | | -0.054 | 0.036 |
| Above upper secondary | -0.914 | 0.172 | *** | -0.219 | 0.040 |
| Household size | 0.087 | 0.022 | *** | 0.021 | 0.005 |
| Dependency ratio | 0.101 | 0.041 | ** | 0.024 | 0.010 |
| Wage employment | -0.676 | 0.071 | *** | -0.162 | 0.019 |
| Nonfarm self-employment | -0.645 | 0.124 | *** | -0.155 | 0.031 |
| Migration | 0.105 | 0.098 | | 0.025 | 0.024 |
| Annual cropland (log) | -0.005 | 0.025 | | -0.001 | 0.006 |
| Perennial cropland (log) | -0.050 | 0.019 | *** | -0.012 | 0.005 |
| Forest land (log) | -0.042 | 0.015 | *** | -0.010 | 0.004 |
| Residential land (log) | -0.086 | 0.034 | ** | -0.021 | 0.008 |
| Nghe An | 0.186 | 0.103 | * | 0.045 | 0.025 |
| Ha Tinh | 0.483 | 0.176 | *** | 0.116 | 0.044 |
| Quang Binh | 0.474 | 0.113 | *** | 0.114 | 0.026 |
| Quang Tri | 0.376 | 0.110 | *** | 0.090 | 0.026 |
| Hue | 0.151 | 0.106 | | 0.036 | 0.025 |
| Constant | -1.706 | 0.587 | *** | | |
| Log pseudolikelihood | -1301234.332 | | | | |
| Observation | 2905 | | | | |

Note: Se – robust standard errors. *** p<0.01, ** p<0.05, * p<0.1. Estimates are adjusted for sampling weights and clustered at the commune level. Thanh Hoa province is the reference group. Dependent variable: the shortfall in per capita income as a percentage of the poverty line. The area of all land types was divided by 100 and transformed into the natural logarithm.

The results in Tables 5 and 6 also suggest that a household earning nonfarm income was more likely to escape poverty and reduce its poverty gap. Holding all other things constant, the probability of falling into poverty would be 17% lower for a household participating in wage activities and about 25 % lower 25% lower for a household participating in nonfarm self-employment. Similarly, participating in wage employment would reduce the depth of poverty by 16.2% while the corresponding figure for nonfarm self-employment is 15.5%. The findings are congruent with those of Tran et al. (2015), who showed that earning nonfarm income reduced the risk of poverty and mitigated the shortfall in income among households in Vietnam's Northwest Mountains.

The result in Table 4 indicates that larger household sizes would reduce per capita income and increase the risk of being poor and of income shortfall. Holding all other variables constant, an additional family member corresponds to a decrease in per capita income of about 11%. The negative sign of the age of the household head and the positive sign of its squared term suggest that the age of the household head has an increasing impact on household income. Contrary to expectation, the gender of the head of household did not affect household income or poverty status.

The current study has found that not all levels of education have a positive effect on income and poverty status. While attaining a lower secondary or primary education was not associated with higher income or lower poverty status, a household whose members have an upper secondary or higher level of education earns more income and is at less risk of poverty. For instance, for a household whose head had attained an upper secondary education or higher, per capita income would be about 39% and 80% higher, respectively, compared to that of a household whose head lacked education. For a household whose head had completed upper secondary education or higher, the corresponding likelihood of poverty would be reduced by about 14% and 29%, respectively.

While migration showed no association with income or poverty status, the ethnicity of household heads was found to be a major factor affecting income and poverty. We found that ethnic minorities earned much less income, were more likely to be poor, and had higher income shortfalls than the Kinh. On average, holding all variables constant in the models, per capita income is 64.5% higher for the Kinh than for the ethnic minorities. Similarly, among Kinh households, the likelihood of being poor and the depth of poverty were 25.4% and 16.4% lower, respectively, than among ethnic minority households. Finally, Table 4 shows that all the coefficients of province dummy variables are negative and statistically significant, suggesting that on average, households with equal lands, education and other characteristics would have per capita income levels higher in Thanh Hoa than in all other provinces. The disparities in income across provinces suggest that livelihood outcomes were substantially affected by provincial factors.

4.2.1. Impact of forest income on income inequality

Table 7 reports the results from the Gini decomposition of income inequality by income source. The overall Gini coefficient for households was 0.554, which is much higher than the Gini coefficient of 0.430 for the whole country in 2014 (GSO, 2015). The estimates in Column 4, Table 7, show that among other income sources, crop income emerged as the most equally distributed source, with the Gini coefficient value remaining at 0.676, followed by wage income (*Gi*=0.746). Other income sources showed an extremely unequal distribution, with a Gini index of about 0.9 and higher. Crop and wage incomes were more equally distributed than other income sources, possibly because a larger proportion of households earned income from them. As revealed by the survey data, about 82% reported income from crop cultivation and 62% received income from wage-paying work. However, the proportion of households with forest income, livestock income and nonfarm-self-employment income, was only 53%, 40% and 36%, respectively.

Table 7

*Gini Decomposition by Income Source*

| Income source | Income share | Relative concentration coefficient | Gini | Correlation with the distribution of total income | Share to total income inequality | Relative marginal effect |
|---|---|---|---|---|---|---|
| | $S_i$ | $(G_iR_i)/G$ | $G_i$ | $R_i$ | $\frac{(S_i G_iR_i)}{G}$ | $\frac{(S_i G_iR_i)}{G} - S_k$ |
| Wages | 0.374 | 1.057 | 0.746 | 0.785 | 0.396 | 0.021 |
| Crops | 0.124 | 0.544 | 0.676 | 0.446 | 0.068 | -0.057 |
| Livestock | 0.092 | 1.113 | 0.890 | 0.693 | 0.103 | 0.010 |
| Forest | 0.167 | 1.150 | 0.886 | 0.719 | 0.193 | 0.025 |
| Nonfarm self-employment | 0.104 | 1.074 | 0.896 | 0.664 | 0.111 | 0.008 |
| Remittances | 0.013 | 0.756 | 0.965 | 0.434 | 0.010 | -0.003 |
| Rentals | 0.043 | 1.204 | 0.965 | 0.691 | 0.052 | 0.009 |
| Pension | 0.041 | 1.224 | 0.970 | 0.699 | 0.050 | 0.009 |
| Subsidies | 0.041 | 0.442 | 0.881 | 0.278 | 0.018 | -0.023 |
| | | | **0.554** | | | |

The estimates in Column 6, Table 7, show that forest income was the major contributor to overall income inequality (19.3%), just after wage income (39.6%). Combined, they accounted for about 60% of total income inequality, while the remaining income sources contributed about 40% to total inequality. The large contribution of forest income to overall inequality can be explained by the fact that: (i) forest income remained the second largest contributor to total income; (ii) this income source was unequally distributed; and (iii) it was the second source most closely correlated with the distribution of total income ($R_i$=0.719). Unsurprisingly, wage income contributed the largest share to total inequality because it accounted for the largest portion of total income and was most closely correlated with total income distribution, although wage income was more equally distributed than other sources ($R_i$=0.785).

The magnitude of relative concentration coefficients in Column 3 of Table 7 indicates which income sources increase inequality and which reduce it. The size of relative concentration coefficients is smaller than 1 for crop income, remittances and subsidies, suggesting that these sources have the effect of reducing income inequality. By contrast, the corresponding figures for wage, livestock, forest, nonfarm self-employment, remittances and rental incomes are greater than 1, indicating that they have the effect of increasing inequality. As can be seen in Column 7, Table 7, the relative marginal effect of forest income is 0.025, while that of crop income is -0.057, meaning that 10% increases in these sources are associated with a 0.33% increase and a 0.57% decline, respectively, in overall income inequality. Notably, the results confirm that forest income, among other sources, has the largest marginal effect on inequality.

Our research finding differs from that of Tran (2016), who found that forest income reduced income inequality among households in Vietnam's Northwest Mountains. The discrepancy might be explained by the fact that forest income is more equally distributed in the Northwest Mountains (Tran, 2016) and therefore favours the poor, whereas this income source was more unevenly distributed and tended to benefit the better-off in our study (Figure 1).

## 5. Conclusion and policy implications

There is limited quantitative evidence for the role of forest resources in income, poverty and inequality in Vietnam. Using a micro-econometric approach with household survey data, the current study has attempted to examine the effect of forestland on household income and poverty status in Vietnam's North Central Provinces. Notably, this study measures the contribution of forest income to local households and its effect on total income inequality.

The main findings of the study are these. *First*, the availability of more forestland would increase household income, reduce the likelihood of a household falling into poverty and mitigate its poverty gap, even after controlling for all other factors in the models. *Second*, forest income was found to contribute the second largest share to overall inequality and had the largest increasing effect on it. Our findings do not accord with those in previous studies of Vietnam's Northwest Mountains, which suggest that forestland is not associated with household income or poverty status (Tran et al., 2015) and that forest income accounts for the smallest share of total income inequality and has a reducing effect on it (Tran, 2016).

The current study has found evidence that some household characteristics are strongly associated with income and poverty status. Ethnic minority households have much lower per capita income and a greater likelihood of falling into poverty than Kinh households. Having more members reduces per capita income and increases the likelihood of remaining in poverty and experiencing shortfalls in income. Nonfarm work, either wage-paying or self-employment, improves income and the chance of escaping poverty. Better education was also found to reduce the poverty gap and enable a household to move out of poverty. The use of more perennial cropland and residential land was positively associated with household income and poverty reduction.

We also found that wage and nonfarm self-employment incomes increase inequality, while crop income decreases it. As already discussed, in comparison with other income sources, crop income was more equally distributed and flowed disproportionately towards the poor. However, forest and nonfarm income sources are more unequally distributed and are skewed substantially towards the rich. Since crop income is inequality-decreasing and a major income source for the poor, measures for promoting crop productivity are likely to increase income for the poor, and this in turn can reduce inequality. Because nonfarm and forest income tend to favour the better-off, it can be suggested that the removal of barriers facing the poor in accessing nonfarm activities and forestland can be expected not only to have a positive effect on income and poverty eradication, but also to have an equalizing effect on income distribution in the study area.

This study does have one limitation, however. Using cross-sectional data, it was unable to address the endogeneity problem resulting from unobservable household characteristics that may affect their income and poverty status. This issue suggests a potential venue for future research, using panel data to account for unobservable time-invariant factors that might affect household income and poverty. With panel data and using similar methodology, future studies can further examine how do the changes in forestland affect the changes in income and poverty status. With panel data, one can also compare changes in the contribution of forest income to overall income inequality and the marginal effect of forest income on it over time.

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