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Poverty and Inequality Maps in Rural Vietnam: An Application of Small Area Estimation*

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The objective of the present paper is to estimate poverty and inequality for rural Vietnam at different levels of aggregation by combining the Vietnam Household Living Standard Survey from 2006 and the Rural Agriculture and Fishery Census from the same year. Using the small area estimation method, estimates at the regional, provincial and district level are produced, and both expenditure and income based measures are considered. It is found that all provinces across the country have experienced a noticeable reduction in rural poverty during the period 1999–2006. Some of the largest reductions in poverty are observed for provinces with poverty rates close to the national average. The poorest provinces are experiencing reductions in poverty, albeit at a more modest pace. Provinces and districts with a larger poverty reduction in the period 1999–2006 tended to have a lower level of inequality in 2006. Results based on expenditure poverty estimates are found to be very similar to those based on income poverty estimates.

Keywords: agricultural census, household survey, poverty mapping, poverty measurement, Vietnam.

JEL classification codes: I31, I32, O15.

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Introduction

Vietnam has set up poverty reduction as a major development policy. To achieve this goal, Vietnam has maintained an extensive public safety net and launched a large number of poverty reduction programs. Poverty reduction programs in general benefit from having precise information on where the poor are located, and on how poor they are (see e.g. Bigman and Fofack, 2000; Elbers et al., 2007).

The objective of the present study is to estimate poverty and inequality for rural Vietnam at different levels of aggregation by combining the Vietnam Household

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Living Standard Survey (VHLSS) from 2006 and the Rural Agriculture and Fishery Census from the same year. Estimates will be produced at the regional, provincial and district level, and both expenditure and income based measures will be considered. The estimates are obtained by adopting the small area estimation method put forward by Elbers et al. (2003), which has since been used for over 40 countries.

The information on all households provided for by the census combined with the detailed information on selected households from the survey makes it possible to estimate poverty at levels of aggregation the survey alone does not allow for. The standard errors of our province-level estimates are comparable to the standard errors of the region-level estimates based on survey data only. The standard errors of our district level estimates are obviously larger, but still acceptable.

The use of the agricultural census denotes a modest variation of the approach of Elbers et al. (2003), which conventionally uses a population census instead. The motivation for using the agricultural census is that the population census is only available once every 10 years. In Vietnam, the agricultural census is conducted every 5 years. This means that by alternating the population census with the agricultural census we are able to triple the frequency of poverty and inequality estimates at the small area level. The latter is important as it makes the small area estimation exercise a more suitable tool to monitor poverty and inequality over time, to channel resources when and where they are most needed and to evaluate poverty reduction initiatives across the different areas in Vietnam.

Although replacing the population census with the agricultural census does not require any methodological changes, there are some differences worth noting. Most importantly, the agricultural census only allows us to provide estimates for rural Vietnam, where the population census covers both rural and urban areas. The two different census datasets each have their own specific variables, in addition to a standard set of variables that they have in common. Plausibly, the agricultural census is in comparison more informative of rural livelihoods.

Other poverty maps of Vietnam that have been constructed in the recent past include the following. Minot (2000) combines the Vietnam Living Standard Survey (VLSS) from 1993 and the Agricultural Census from 1994 to estimate rural poverty at the province and district level. Minot et al. (2003) and Gian and van der Weide (2007) combine the 1998 VLSS and a 33-percent sample of the population census from 1999. Fujii and Roland-Holst (2008) study the effects of Vietnam's access to the WTO on poverty. They too combine the 1998 VLSS and a 33-percent sample of the 1999 population census to estimate provincial poverty rates. Nguyen et al. (2007b) attempt to bridge the 3-year gap between the VHLSS from 2002 and the 1999 population census to estimate poverty levels for 2002. Nguyen et al. (2005) and Nguyen et al. (2007a) produce a district map of poverty and inequality of Ho Chi Minh City for the year 2004. However, most of these poverty maps are now out-of-date.

The paper proceeds as follows. Section II describes the data sources. Section III presents the method of small area estimation of Elbers et al. (2003). The poverty and inequality estimates and the models used for the expenditure and the income based measures are reported in Sections IV and V, respectively. Section VI compares the estimates of expenditure-based poverty to those based on income, and the poverty rate reported by the Ministry of Labour, War Invalids and Social Affairs (MOLISA). Finally, concluding remarks are presented in Section VII.

II. Data

II.1 Household survey and agricultural census

The two data sources used are: the VHLSS for 2006 and the 50-percent sample of the Rural Agriculture and Fishery Census (RAFC) for 2006. Both datasets were collected by the General Statistic Office of Vietnam (GSO).

The 2006 VHLSS includes 9189 households (with 39 071 individuals), of which 2250 are urban and 6939 rural households. The collected information on household characteristics includes: income, expenditure, employment status, education level, housing condition and fixed assets owned by household. The survey is designed to be representative at the regional level. This means that the survey does not guarantee consistent poverty estimates at lower levels of aggregation (such as at the province level).

The RAFC includes all households in rural areas, and is conducted every 5 years. Although the agricultural census and the population census have a range of variables in common (demographics, education, dwelling unit characteristics and asset ownership), there are also some important differences.

First, the agricultural census only covers rural households such that the small area poverty and inequality estimates represent the rural population of Vietnam. Estimates based on the population census represent the entire population.

Second, the agricultural census includes a selection of specific variables that are particularly informative about rural livelihoods and that are not available in the population census. These include variables on rice cultivation, aquatic cultivation and household ownership of farming tools and machinery. These variables are important correlates of the household's agricultural activities that will directly affect the household's income.

Data on individual household members, however, is only collected for members aged 15 years or older (the population census covers all household members). To ensure consistency between the variables from the census and the survey, household members aged 14 years or younger were dropped from the latter. In addition, the head of household is not identified in the agricultural census.

Finally, the codes that identify communes, districts and provinces did not provide a perfect match between the census and the survey. We managed to resolve this problem by using the names of both the provinces and the districts to merge data from different sources.

II.2 Poverty line

In the report we use two poverty lines: one for expenditure and one for income. Household members are classified as poor if their per capita expenditure (income) is below the expenditure (income) poverty line.

The GSO calculated the expenditure poverty line with technical support from the World Bank in Vietnam. The expenditure poverty line is designed to measure the price of a consumption basket that meets pre-specified nutritional needs and essential non-food expenditures that include clothing and housing. For 2006, the expenditure poverty line was equal to VND2 560 000/person/year (in national real terms).

The income poverty line is set by MOLISA. It equals VND2 400 000/person/year (VND200 000 per month) for the year 2006 (in national real terms). When this poverty line is applied to household income data from the 2006 VHLSS, however, we obtain a poverty estimate for rural Vietnam of approximately 7.5 percent. This is considerably lower than the MOLISA rural poverty rate of 19 percent for that same year.

Although MOLISA sets up an income poverty line to identify poor households, this poverty line is not applied because collection of income for the whole population is very costly, and almost impossible. In reality, the poverty classification procedure is rather complicated. Basically, a village committee prepares a list of the poor based on their own criteria, which might, for example, include asset levels, food security, type of housing and school-going of children. The number and nature of the criteria differ widely between villages. The preliminary list is submitted to a commune-level committee of Hunger Eradication and Poverty Reduction, which might conduct a very simple income survey for some households on the list. These surveyed households are expected to have income around the poverty line; therefore, their income data should be collected for cross-check. The resulting incomes are compared to the income poverty line of MOLISA. Those households with higher per capita income than this poverty line are excluded from the list. Finally, the refined list is updated by the village committee and the People's Committee and People's Council in an iterative procedure (MOLISA, 2003). Thus, there is a large difference between the poverty estimates based on the VHLSS and the poverty incidence reported by MOLISA.

To facilitate comparisons between our income poverty estimates and the income-based poverty rates from MOLISA, we adjust the income poverty line such that income poverty estimated using the 2006 VHLLS coincides with the MOLISA poverty rate (at approximately 18.5 percent for rural areas in 2006). The income poverty is set at VND3 288 000 /person/year (in national real terms).

III. Methodology

The small area estimation method developed by Elbers et al. (2002, 2003) is arguably most popular in the context of poverty analysis. In Elbers et al., two

datasets, a socioeconomic survey and a census are combined through an income or expenditure model. This combination allows us to obtain small area estimates (SAE) of income or expenditure based poverty and inequality. By using the survey alone, we would only be able to disaggregate at the region level.

Typical indicators considered are average expenditure/income, percentage of poor (with expenditure/income below the poverty line), poverty density (number of poor per area) and the Gini coefficient. We will determine both the point estimates and the standard errors associated with them. The standard errors are important because they make explicit the trade-off between the statistical precision of the poverty and inequality estimates and the level of disaggregation.

The census is assumed to enjoy complete coverage (of all rural households), such that sampling error might safely be ignored. The basic idea behind the small area estimation method is to replace a small number of exact observations of expenditure/income (using households from the survey) with a large number of estimates of expenditure/income (using households from the census) to obtain accurate estimates of aggregate poverty and inequality. This means that we will be replacing sampling error with approximation error. As approximation errors cancel out, on average, the errors induced by approximation tend to be small when the number of households is large.

III. 2 The Elbers et al. framework

Let us provide a brief review of the Elbers et al. methodology. In the standard setup, we consider the following model:

$$\ln(y_{ch}) = x_{ch}^T \beta + \eta_c + \varepsilon_{ch}, \tag{1}$$

where $\ln(y_{ch})$ denotes the dependent variable (think of logarithmic per capita expenditure), x_{ch} the vector of explanatory variables, β the vector of regression coefficients, η_c the cluster-specific random effect and ε_{ch} the household-specific random effect. The subscript ch refers to household h living in cluster c. The explanatory variables x_{ch} must be available in both the census and the survey. The household-specific errors are assumed to be independent from each other, and independent from the cluster error.

Once all the parameters of interest have been identified, the dependent variable is imputed into the census:

$$\hat{\ln}(y_{ch}) = x_{ch}^T \hat{\beta} + \hat{\eta}_c + \hat{\varepsilon}_{ch}, \tag{2}$$

where $\hat{\beta}$, $\hat{\eta}_c$ and $\hat{\varepsilon}_{ch}$ denote the estimates for β, η_c and ε_{ch}. Now suppose that we want to estimate poverty for a given district. As an illustrative example, let us consider the headcount index, which measures the percentage of poor households in the district:

$$\mathrm{W} = \frac{1}{n}\sum_{ch} 1_{(y_{ch}<z)}, \tag{3}$$

where $1_{(y_{ch}<z)}$ denotes the indicator function that equals 1 if $y < z$ and 0 otherwise, and where n denotes the number of households living in the district. An estimate of W can be obtained by replacing y_{ch} with $\hat{y}_{ch}$ for all households, ch.

For accurate estimation of the standard error of W, Elbers et al. advocate repeated Monte Carlo simulations. In each round, a simulated regression coefficient $\tilde{\beta}^{(r)}$ is drawn (from its estimated distribution), where r denotes the rth round of simulation. Furthermore, $\tilde{\eta}_c^{(r)}$ and $\tilde{\varepsilon}_{ch}^{(r)}$ are drawn from their estimated distributions, which means we will have a simulated cluster error for each cluster and a simulated household error for each household in the census. The imputed dependent variable for household h in cluster c, in the rth round, therefore, is given by:

$$\tilde{\ln}(y_{ch})^{(r)} = x_{ch}^{T}\tilde{\beta}^{(r)} + \tilde{\eta}_c^{(r)} + \tilde{\varepsilon}_{ch}^{(r)}. \tag{4}$$

Each round of simulation yields a new estimate, $\tilde{W}^{(r)}$. By taking the average and standard deviation over the r different simulated values of $\tilde{W}^{(r)}$, we obtain both the point estimate and the corresponding standard error.

In the present paper, we measure poverty using three Foster–Greer–Thorbecke poverty indexes, including the poverty headcount index, the poverty gap index and the poverty severity index (see Foster et al., 1984). Inequality is measured by the Gini coefficient. The Foster–Greer–Thorbecke poverty indexes and the Gini index are the most popular measures of poverty and inequality, especially for developing countries. They are often reported in poverty assessment studies in Vietnam, such as the Vietnam Development Reports (see World Bank, 2003, 2007).

III.2 Two key assumptions

The Elbers et al. method is based on two key assumptions:

The model is accurate at each level it is applied: Tarozzi and Deaton (2009) refer to this as the 'area homogeneity' assumption. Although the model is typically estimated at the regional level, predicted expenditures are aggregated over much smaller areas (think of provinces and districts). Therefore, consistency requires that any omitted variables, which end up in the error term, have zero expectation at any level of aggregation.

Spatial correlation is accurately accounted for: the errors for different households are likely to exhibit a level of correlation, in particular when the households live close to each other such that they are subject to similar (unobserved) geographical effects. An accurate account of this spatial correlation is important for the precision of the standard errors of the SAE.

Elbers et al. accommodate spatial correlation by assuming that the error can be decomposed into a cluster error (an error that is shared by all households living in the same cluster) and a household-specific error. The common error is referred to as a location error. The household-specific error will also be referred to as an

idiosyncratic error. Empirical results from a wide range of countries indicate that spatial correlation is indeed significant, and that the approach put forward by Elbers et al. works quite well.

A violation of either of the two key assumptions will affect the precision of the SAE. Therefore, each time the method is used, it is important that the user tests the validity of these assumptions, as this might vary from country to country. Specifically, if one decides to ignore spatial correlation, while it is, in fact, present, one runs the risk of significantly underestimating the standard errors and, hence, overestimating precision.

IV. Estimates of Expenditure Poverty and Inequality

IV.1 Selection of explanatory variables

The first step in the poverty mapping exercise is to select the explanatory variables in the regression model with either expenditure or income as the dependent variable. These variables should meet the following criteria:

- Available in both the household survey and the census
- Household survey and census are comparable (both questionnaires accommodate the same variable definition, and both datasets show similar summary statistics).
- Sufficiently correlated with household expenditure or income.

After carefully screening the questionnaires and examining the data (comparing summary statistics) of candidate common variables from the 2006 VHLSS and the 2006 RAFC, we selected 27 household variables that will be used as the explanatory variables in the models for expenditure and income.

We also constructed commune level data that was merged with the household level data. For selected household level variables from the 2006 RAFC we derived commune mean values, which were merged with the VHLSS at the commune level. For example, we construct the percentage of ethnic minorities of communes and the average household size of communes. Note that these variables are comparable by construction. They are referred to as the 'mean variables of communes'.

The commune (and district level) variables were complemented with Geographic Information System (GIS) variables from third data sources. The list of all the explanatory variables is presented in Table A1 in the Appendix.

IV.2 Expenditure models

The regression models used for (log) expenditure will be presented in this section. There are eight geographical regions in Vietnam. To allow for geographical heterogeneity, we estimate a separate expenditure model for each region.

Our strategy of model selection is forward stepwise regressions. We start with a model including only one explanatory variable but providing the best fit. Then other

variables are added one by one to the model to increase the goodness of fit. Therefore, different regions have different expenditure models. Overall, to avoid overfitting, we tend to use models that are both relatively small and robust. To examine the sensitivity of the poverty estimates to model specifications, for each region, we compare two different models, which vary mostly in the number of explanatory variables they include. The poverty and inequality estimates from large and small models are found to be very similar. Interestingly, when we compare standard errors, the differences are rather small. The poverty estimates obtained with the large model tend to come with relatively smaller standard errors. We are inclined to label the estimates from the larger model as more precise. In this paper, we will present the estimation results from the large models.

It should be noted that several explanatory variables, such as assets, education and employment, can be endogenous in expenditure and income equations. Ideally, all explanatory variables should be exogenous. However, if we use only exogenous variables such as demography and GIS variables, the prediction power will be small. Therefore, we have to use all available household variables. It is expected that the endogeneity of several variables is not a serious problem in the poverty map exercises, because our objective is to predict expenditure (or income) rather than to estimate the causal effect of explanatory variables on expenditure (or income).[1]

Tables A2–A9 in the Appendix present the GLS regressions of the logarithm of per capita expenditure (the large models). The results were obtained using the latest version of the PovMap program (updated in March 2009).[2] The location effect was modeled at the district level. (The latter affects the estimates of the variance–covariance matrix and, hence, the GLS estimates of the model parameters.)

It is found that all estimates of the model parameters make economic sense (have expected signs). Given the controlled variables, ethnic minorities still have lower per capita expenditure than Kinh and Hoa people. Large-sized households are more likely to have lower per capita expenditure than small-sized households. As expected, assets are positively correlated with per capita expenditure. Households that have more working members or members with vocational training tend to have higher expenditure. Finally, the R^2 values are quite encouraging, with the range from 0.43 to 0.7.

IV.3 Poverty estimates

Regional estimates

Table 1 presents the estimates of the poverty incidence of the eight rural regions. It shows that the estimates from the small area estimation exercise are very close

1. Another issue is multicollinearity between explanatory variables. We calculated the variance inflation factor (VIF) for multicollinearity after regressions, and almost all the estimates of VIF are below 5. This implies that the multicollinearity is not serious. In addition, we also report the correlation matrix of household explanatory variables in Table A11 in the Appendix.

2. The program has been developed by researchers of the World Bank: http://iresearch.worldbank.org/PovMap/PovMap2/PovMap2Main.asp.

Table 1 Poverty incidence estimates of regions

Region	*VHLSS 2006*	*Small area estimation*
Red River Delta	11.0	11.3
	[1.1]	[0.9]
North East	29.9	31.6
	[1.8]	[1.6]
North West	56.4	57.3
	[3.7]	[2.6]
North Central Coast	33.1	32.9
	[2.4]	[1.7]
South Central Coast	17.1	17.8
	[2.1]	[1.2]
Central Highlands	34.4	39.9
	[3.7]	[2.0]
South East	9.9	10.1
	[1.5]	[0.9]
Mekong River Delta	11.8	12.6
	[1.0]	[1.3]

Note: Standard errors are in brackets. VHLSS, Vietnam Household Living Standard Survey.
Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

to the estimates based on the 2006 VHLSS (both for the large and small models). Although we observe a noticeable difference for the Central Highlands, the difference is not statistically significant. The standard errors for the Central Highlands estimates based on the 2006 VHLSS are rather large due to the small number of observations.

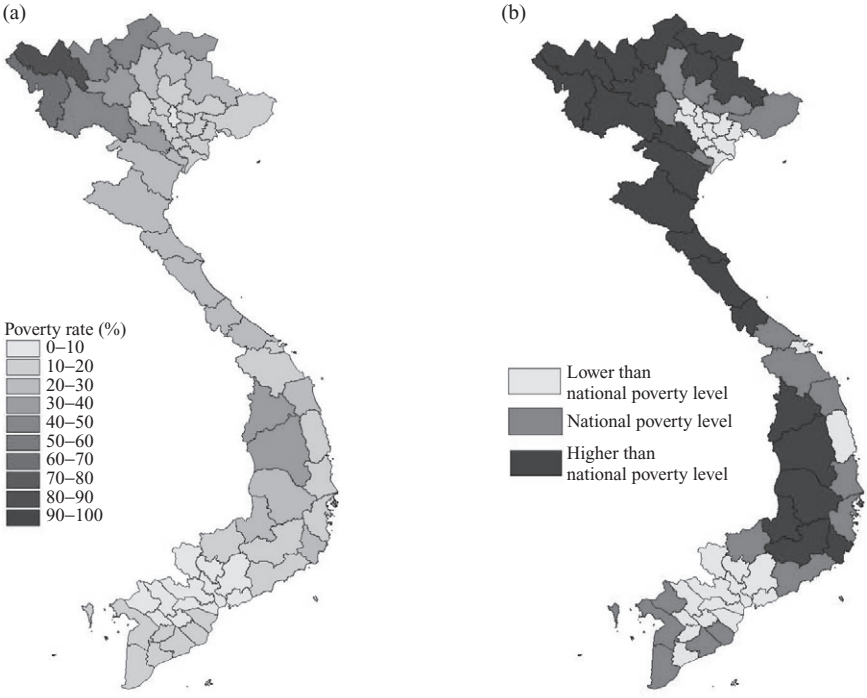
The poorest region is the North West, with a poverty rate of above 50 percent. In regions with low levels of poverty, approximately 10 percent of the rural population lives below the poverty line.

Provincial estimates

The estimates of provincial poverty are presented in Table A10 in the Appendix.[3] The table shows that the poorest provinces are Lai Chau, Dien Bien and Ha Giang, which have a poverty rate of over 60 percent. These provinces belong to the North West and the North East. Cities such as Ho Chi Minh, Ha Noi and Binh Duong have very low rural poverty rates (below 5 percent). There is a considerable level of variation in provincial poverty rates within the regions. Estimates of the poverty gap, the poverty severity and the Gini coefficient are also included.

3. In Table A10, we present the poverty headcount, the poverty gap index and the Gini coefficients. Detailed estimates of the poverty headcount, the poverty gap index, the poverty severity index and the Gini coefficients of all the provinces and districts can be provided on request.

Figure 1 Map of the provincial poverty rates: (a) the poverty rate and (b) relative to national poverty



Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

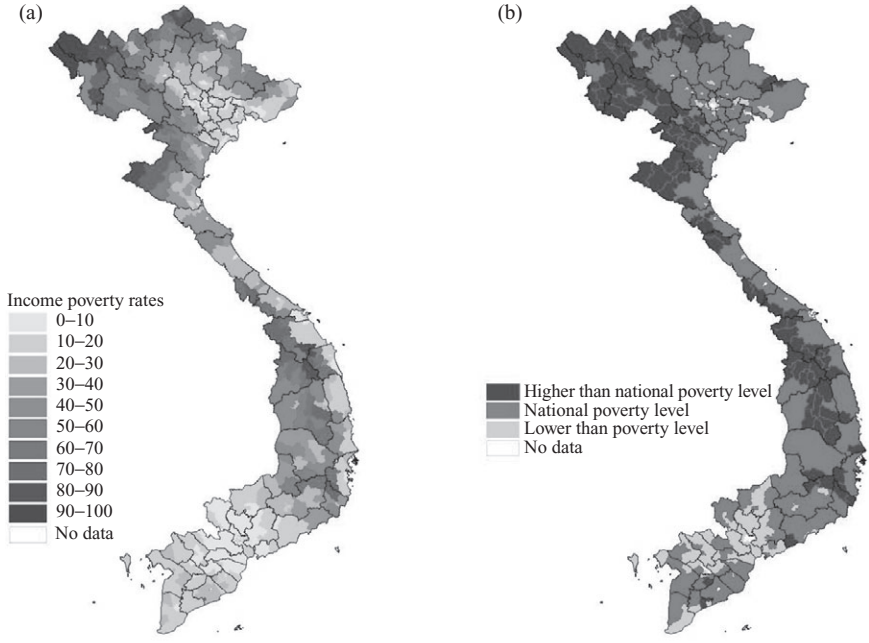
Figure 1a presents a map with the provincial poverty estimates. It can be seen that the North East and the High Land regions tend to experience higher levels of poverty, while the delta regions (such as the Red River Delta and the South East) are areas with lower levels of poverty.

In Figure 1b, the standard errors of the poverty estimates are taken into account. Provinces are divided into three groups: (i) provinces with poverty estimates that are significantly lower than the national poverty level (which is 20 percent); (ii) provinces with poverty estimates that are insignificant from the national poverty level; and (iii) provinces with poverty estimates that are significantly higher than the national poverty level.

District estimates

To improve poverty targeting, it is key to have precise poverty estimates at low levels of aggregation (such as districts and communes). Although estimates at the commune level will be unreliable, due to the small number of households in

Figure 2 The expenditure poverty incidence of districts: (a) the poverty rate and (b) relative to national poverty



Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

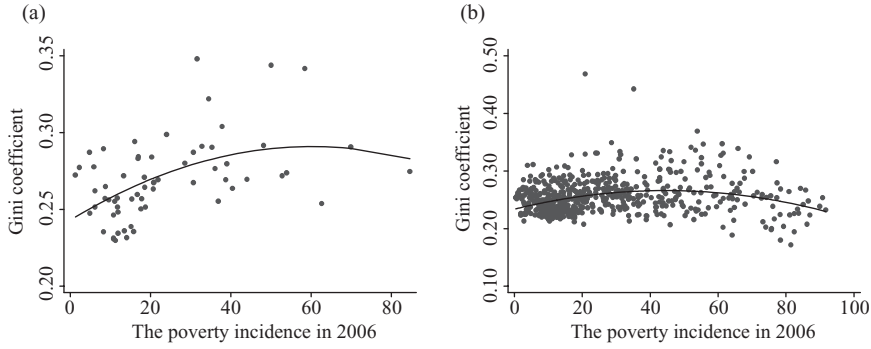
communes and given that we only have a 50-percent rural sample of the 2006 ARFC, estimates of district poverty can be obtained with an acceptable level of precision. Figure 2 presents the maps with estimates of poverty at the district level.

IV.4 Inequality and poverty

We also examine the spatial pattern of expenditure inequality (the Gini coefficient) in Vietnam. The provincial estimates of the Gini coefficients can be found in Table A10 in the Appendix. Inequality varies across provinces and districts, albeit with small differences. Average inequality (based on expenditure) is rather low at 0.27 for provinces and 0.25 for districts. The province with the lowest Gini coefficient (0.23) is Thai Binh, whereas the province with the highest Gini coefficient (0.35) is Lam Dong. At the district level, the Gini coefficient varies from 0.17 to 0.47. The Meo Vac district of Ha Giang Province has the lowest Gini coefficient (0.17), whereas Da Lat city of Lam Dong province has the highest Gini coefficient (0.47).

Interestingly, low levels of inequality are found in both the poorest provinces and the richest provinces. Figure 3 plots the relationship between poverty and

Figure 3 Inequality (Gini index) and poverty (P0): (a) Provinces and (b) Districts



Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

inequality. The quadratic relationship is highly significant both at the province and district level. Inequality tends to be lower in areas with relative low poverty and areas with relatively high poverty rates, although the differences are not enormous. This finding is consistent with the Kuznets hypothesis that inequality first increases as the economy develops, and then decreases once a high level of economic development is reached.

IV.5 Poverty change during the period 1999–2006

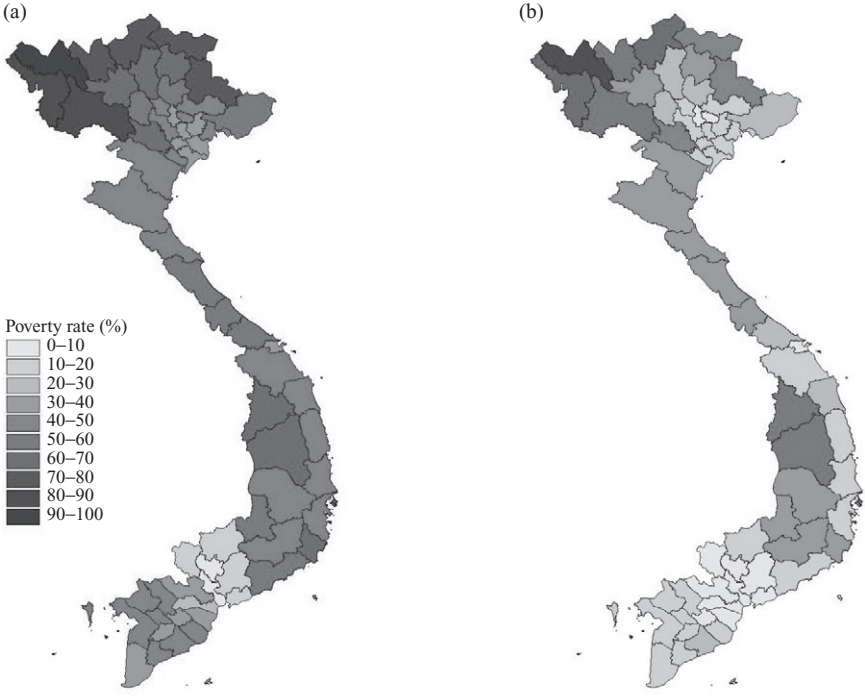
Figure 4 compares the poverty maps for the years 1999 and 2006. This shows how poverty has been reduced across the country during 1999–2006. Virtually all provinces experienced a reduction in the poverty rate. The areas where progress has been slow are the poorest areas of the country (the North West of Northern Vietnam and the North West of Southern Vietnam).

Figure 5 confirms that the poverty reduction is most noticeable in areas with an average level of poverty. It is, of course, not surprising that areas that had already achieved low levels of poverty in 1999 show smaller changes in poverty in percentage points. What was not expected, however, is that the poorest areas have been relatively unsuccessful in reducing poverty.

Figure 6 reveals the estimates of district poverty for the years 1999 and 2006. In addition, here we see that districts with very low and very high poverty in 1999 experienced smaller reductions in poverty (see also Figure 7).

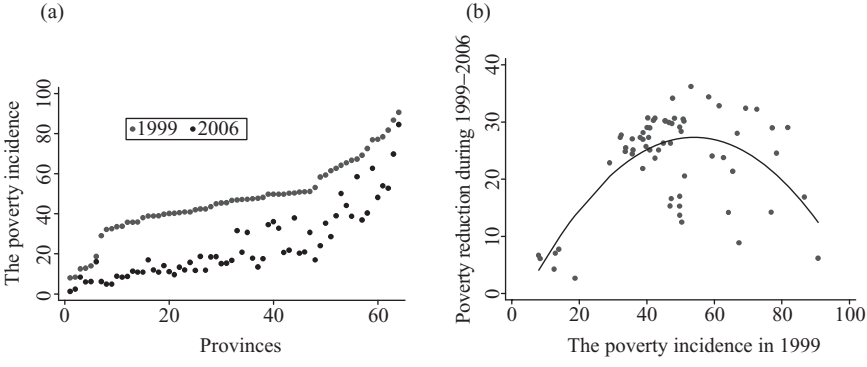
Figure 8 presents the relation between poverty reduction in the period 1999–2006 and the inequality level in 2006. It shows that provinces and districts with a larger poverty reduction in the period 1999–2006 tended to have a lower level of inequality in 2006. This means that poverty reduction can be associated with inequality reduction.

Figure 4 The provincial poverty incidence over: (a) 1999 and (b) 2006



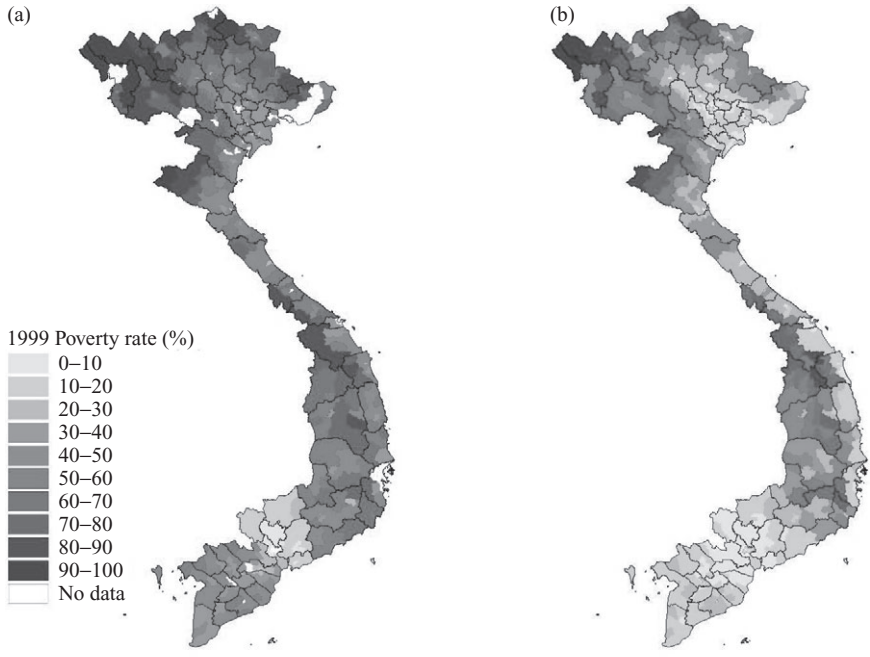
Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

Figure 5 The provincial poverty incidence in 1999 and 2006: (a) Poverty rate and (b) Change in poverty rate



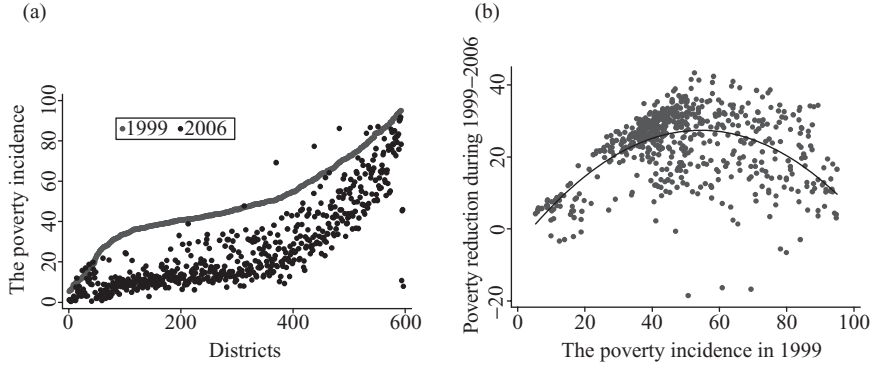
Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

Figure 6 The district poverty incidence over: (a) 1999 and (b) 2006



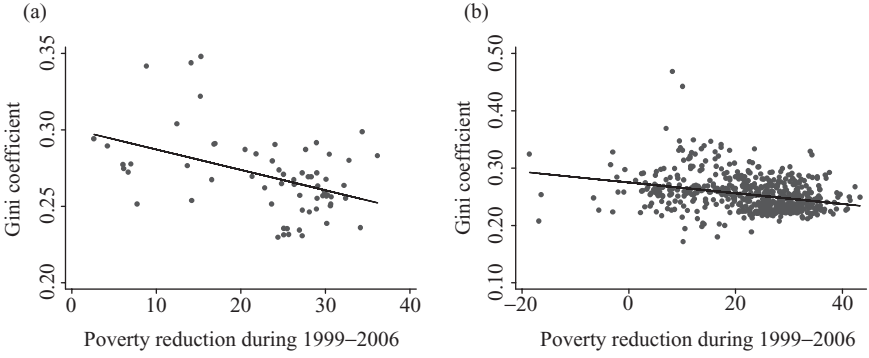
Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

Figure 7 The district poverty incidence in 1999 and 2006: (a) Poverty rate and (b) Change in poverty rate



Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

Figure 8 Poverty reduction and inequality during 1999–2006: (a) Provinces and (b) Districts



Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

V. Estimates of Income Poverty and Inequality

Because the government of Vietnam is using the income poverty line, we also estimate income poverty and inequality measures for provinces and districts.

V.1 Income models

We begin by constructing regression models for (log) income. In addition, we estimate two models for each of the eight regions, a large and a small model specification. The results from the large and the small models are very similar. However, the large models produce lower standard errors of estimates. Therefore, in this paper we present the estimation results from the large models.

Tables A2–A9 in the Appendix present the generalized least squares (GLS) estimates for the large models. It is evident that all model coefficients make economic sense (have expected signs).

V.2 Poverty and inequality estimates

Poverty estimates

Table 2 reports the estimates of the rural poverty incidence for all eight regions. The estimates are all very close to the estimates based on the 2006 VHLSS. The poorest region is the North West, with a poverty rate of just below 50 percent. With a poverty rate of approximately 8 percent, South East is among the least poor regions.

Estimates of provincial poverty are reported in Tables A10. Similar to what we found for expenditure poverty, the poorest provinces are Lai Chau, Dien Bien and Ha Giang, with poverty rates of 50 percent and above. These

Table 2 The income poverty incidences of regions

Region	*VHLSS 2006*	*Small area estimation*
Red River Delta	15.5	15.3
	[1.1]	[0.7]
North East	22.0	24.4
	[1.6]	[1.4]
North West	48.8	49.2
	[3.6]	[2.5]
North Central Coast	28.2	26.7
	[1.9]	[1.1]
South Central Coast	20.3	18.7
	[1.9]	[1.4]
Central Highlands	24.4	25.4
	[3.0]	[1.2]
South East	7.7	8.6
	[1.2]	[1.2]
Mekong River Delta	11.5	11.0
	[0.9]	[1.0]

Note: Standard errors are in brackets. VHLSS, Vietnam Household Living Standard Survey.
Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

provinces belong to the North West and the North East. The rural population in cities such as Ho Chi Minh, Ha Noi and Binh Duong experience low poverty rates. The poverty gap, poverty severity and the Gini coefficient are also included.

Figure 9 shows a map of the income poverty incidence, and a map that compares the provincial poverty estimates with the national poverty rate (20 percent), taking into account the standard errors.

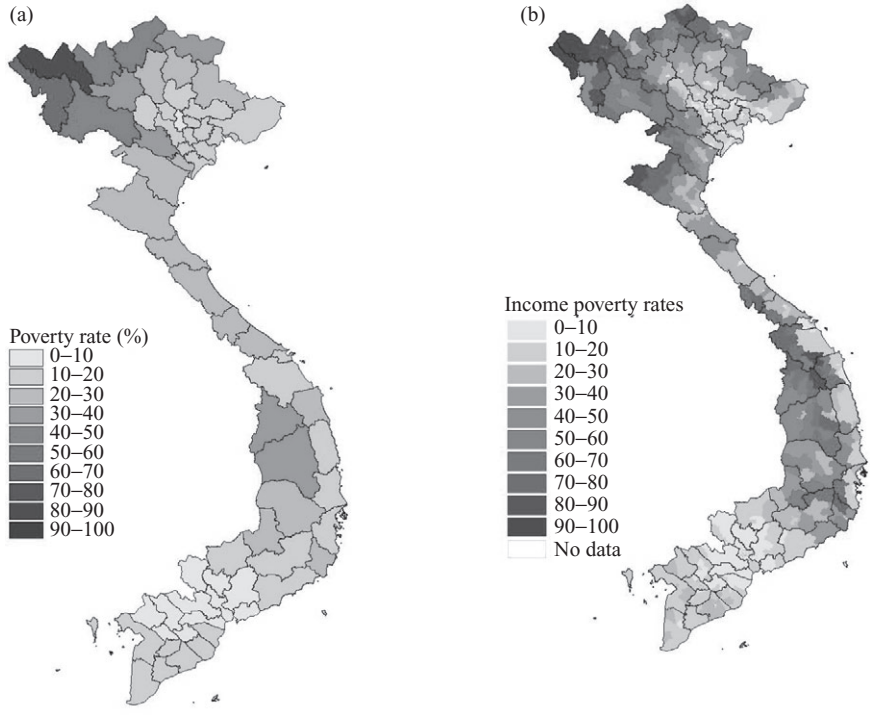
Inequality

Income inequality measured by Gini coefficients is reported in Table A10 in the Appendix. Income inequality is seen to be higher than expenditure inequality. The average Gini for provinces and districts is 0.32 and 0.30, respectively. Income inequality estimates are the lowest in the Binh Dinh province (0.28), and the highest in Son La (0.57). The income inequality estimates for districts range from 0.19 (Nam Giang District and Quang Nam Province) to 0.79 (Son La of Son La Province). Note that these results should be interpreted with care, as standard errors need to be taken into account.

VI. Comparison of Alternative Poverty Indicators

This section compares different indicators of poverty, which include expenditure poverty, income poverty and MOLISA poverty rates.

Figure 9 Map of the (a) provincial and (b) district income poverty incidence (%)



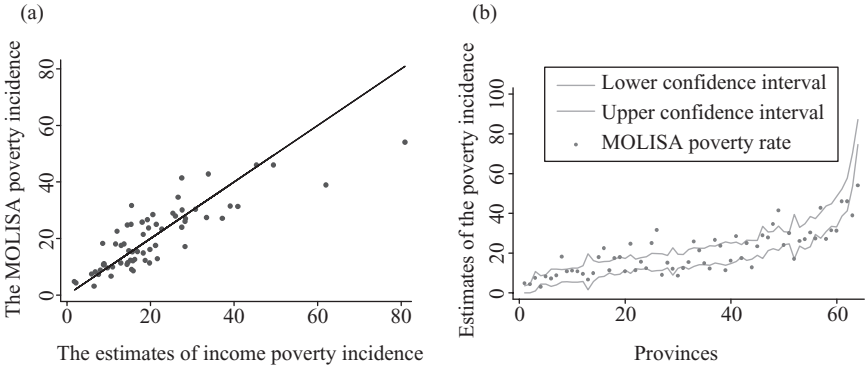
Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

VI.1 Income poverty and the poverty rate reported by the Ministry of Labour, War Invalids and Social Affairs

Figure 10 compares the MOLISA poverty rates with the income poverty estimates at the province level. All estimates refer to the year 2006. Figure 1a provides a simple scatter plot. If the two poverty indicators are comparable, the points will be close to the diagonal line. The two different indicators are clearly related. Judging whether the observed differences are significant is not straightforward. First, we do not have the MOLISA poverty rates for rural areas: the MOLISA poverty rate represents the entire population in a given province (both urban and rural). In contrast, we are estimating rural poverty (as the census only covers rural Vietnam). Second, each estimate comes with standard errors. (We do not have the standard errors for the MOLISA poverty rates.)

Figure 10b plots the 95-percent confidence interval of our income poverty estimates together with the MOLISA point estimates. We find that for 32 out of 64 provinces the MOLISA poverty rate is contained in the 95-percent confidence interval of our income poverty estimates.

Figure 10 MOLISA income poverty rates and income poverty estimates of provinces: (a) point estimates and (b) confidence intervals



Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

The spatial pattern of poverty at the province level shows little differences when we compare the MOLISA poverty rates with our income poverty estimates (see Figure 11).

Figure 12 makes a district level comparison of the MOLISA income poverty rates and our income poverty estimates. Because we do not have the MOLISA poverty rates for the rural districts, we only keep districts with a high percentage of rural population. In our dataset, there are 148 districts in which the rural population accounts for more than 95 percent of the total population. For these districts it is assumed that the MOLISA poverty rates are close to what would be the rural MOLISA poverty rates. It can be seen that the difference between the two different poverty indicators increases with the level of poverty. For 25 out of 148 districts, the MOLISA poverty rate falls outside the 95-percent confidence interval of our income poverty estimates.

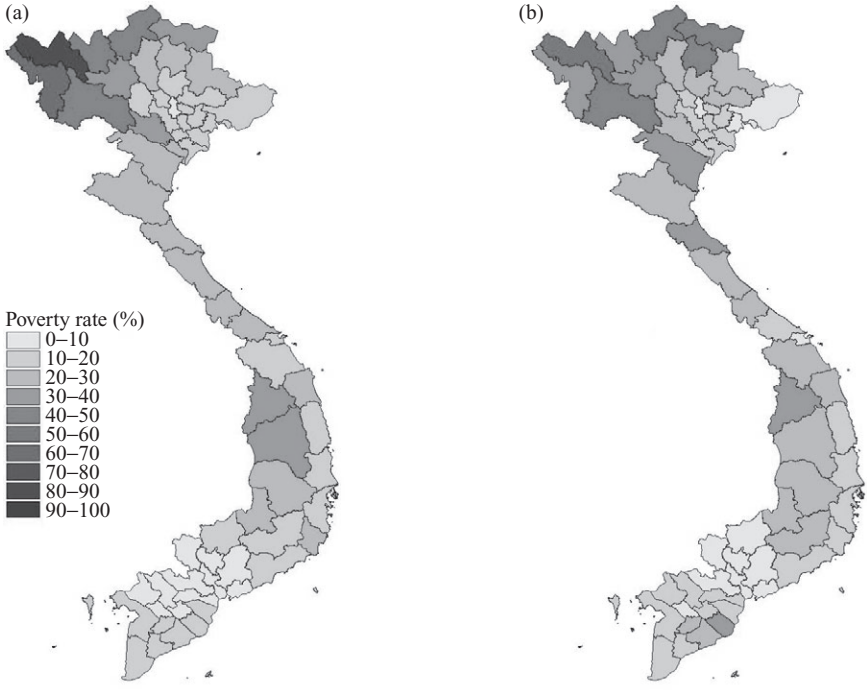
Figure 13 shows that the geographic pattern of the MOLISA poverty rate and our income poverty estimates are rather similar, which indicates that the differences in rankings is not very large.

VI.2 Expenditure and income based poverty

Figure 14 shows that the two different poverty indicators yield similar poverty estimates and a similar ranking at the province level. Differences can be observed for areas with higher levels of poverty, in which case expenditure poverty is found to be higher.

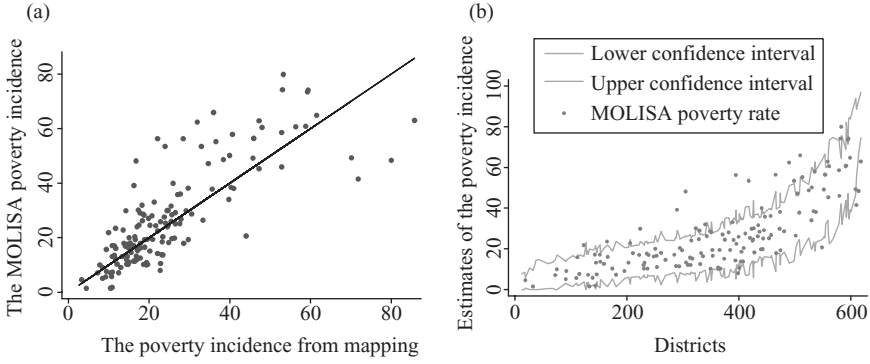
Table 3 reports the correlation coefficients between the two different poverty indicators. It shows that they are strongly correlated. In addition, correlations with the MOLISA poverty rates are rather high. Interestingly, expenditure poverty estimates appear to exhibit a stronger relation with the MOLISA poverty rates than our income poverty estimates.

Figure 11 (a) Income poverty estimates and (b) MOLISA poverty rates of provinces



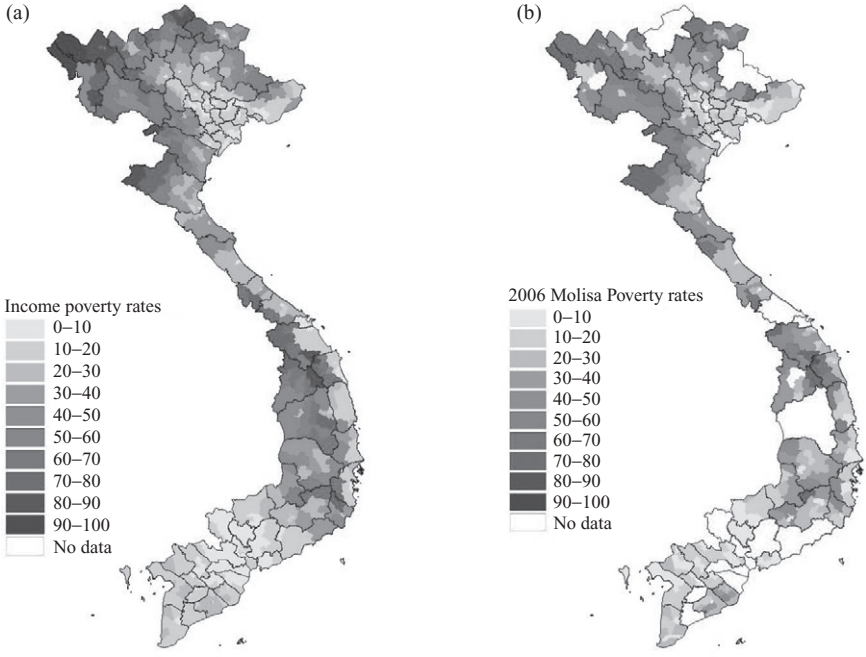
Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

Figure 12 MOLISA income poverty rates and the income poverty estimates of districts: (a) point estimates and (b) confidence intervals



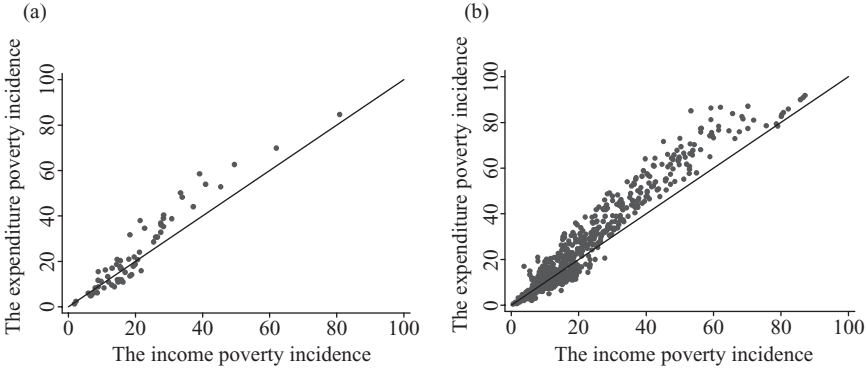
Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

Figure 13 (a) Income poverty estimates and (b) MOLISA poverty rates of districts



Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

Figure 14 The expenditure poverty incidence and the income poverty incidence of provinces



Source: Authors' estimation from VHLSS 2006 and ARFC 2006.

Table 3 Correlation between poverty estimates

	Correlation between the provincial poverty			*Correlation between the district poverty (districts with the percentage of rural population higher than 95%)*		
	Expenditure poverty rate	*Income poverty rate*	*MOLISA poverty rate*	*Expenditure poverty rate*	*Income poverty rate*	*MOLISA poverty rate*
Expenditure poverty rate	1			1		
Income poverty rate	0.9575	1		0.9615	1	
MOLISA poverty rate	0.8693	0.8046	1	0.8503	0.831	1

Note: MOLISA, Ministry of Labour, War Invalids and Social Affairs.
Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

VII. Conclusions

We have updated the small area estimates of poverty and inequality for rural Vietnam, where existing poverty maps were outdated. These new estimates of province and district level poverty for the year 2006 allow us to examine how poverty has changed in Vietnam over the past 7 years.

Vietnam saw a remarkable reduction in (rural) poverty during the period 1999–2006. Poverty declined in virtually all provinces across the country. The largest improvements are observed for provinces with poverty rates close to the national average. It is found, however, that the poorest provinces have shown the lowest rates of improvements; that is, they were least successful in reducing poverty. One possible explanation is that areas of highest poverty tend to have a large proportion of ethnic minorities, and the poverty of ethnic minorities decreased at a slow pace. There is a large gap in household endowments, as well as returns to these endowments between ethnic minorities and Kinh/Chinese people in Vietnam (see Baulch et al., 2008).

Although national inequality seems to be increasing, our estimates of rural inequality within provinces and districts are relatively low. This indicates that the inequality of regions and the nation is largely due to inequality between local areas rather than within local areas. As expected, income inequality is higher than expenditure inequality. Interestingly, inequality tends to be higher in areas with relatively low poverty areas as well as in areas with relatively high poverty rates. In addition, we find that provinces and districts that experienced a larger poverty reduction during the period 1999–2006 were more likely to have a lower level of inequality in 2006.

Policies that might benefit from having small area estimates of poverty and inequality include: (i) cash transfers and income support programs; (ii) local government support and community development programs investing in, for example, health care, infrastructure, education, labor markets, agricultural productivity and micro finance; (iii) food-and-cash for work programs; (iv) fundraising and donor coordination; and (v) evaluation of country strategies and monitoring progress towards millennium development goals.

To take full advantage of the poverty maps, in particular of their policy relevance, it is key that they are accessible to a wide range of policymakers, including local entities as well as high level officials. It is not uncommon that public institutions, many of which might be potential users, are largely unaware of the results from the poverty mapping exercise and their potential applications. Also important is that outdated estimates are replaced with up-to-date estimates of poverty and inequality.

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Appendix

Table A1 Common household variables between the 2006 Vietnam Household Living Standard Survey and the 2006 Rural Agriculture and Fishery Census

Variable	*Type*
Household variables	
Ethnic minorities (yes =1)	Binary
Household size	Discrete
Permanent house	Binary
Semi-permanent house	Binary
Temporary house	Binary
Tap water	Binary
Clean water	Binary
Other water	Binary
Flush toilet	Binary
Other toilets	Binary
No toilet	Binary
Have radio	Binary
Have computer	Binary
Have motorbike	Binary
Have color television	Binary
Have mobile	Binary
Have telephone	Binary
Have refrigerator	Binary
Have fan	Binary
Proportion of female members to working members	Continuous
Proportion of working member to household size	Continuous
Proportion of service members to working members	Continuous
Proportion of working members without vocational training	Continuous
Proportion of working members with vocational training	Continuous
Proportion of working members with college/university	Continuous
Log of per capita living area (log of m^2)	Binary
Have or own annual land (yes =1)	Binary
Commune variables	
Commune have national electricity system cover all villages	Binary
The road to this commune center is concrete and always available in year	Binary
Proportion of concrete road in commune	Continuous
Numbers of primary schools per 1000 households	Discrete
Numbers of secondary schools per 1000 households	Discrete
Number of irrigation systems per 1000 households	Discrete
Number of extension staff per 1000 households	Discrete
Number of markets per 1000 households	Discrete
Number of concrete markets per 1000 households	Discrete
Have bank branch	Binary
Geographic information system variables at the district level	
Percentage of area elevation lower than 250 m in total area	Continuous
Percentage of area slope lower 4 degree in total area	Continuous
Mean elevation (m)	Continuous
Mean sunshine (annual h)	Continuous
Mean temperature (degree Celsius)	Continuous
Mean rainfall (mm)	Continuous

Table A2 Expenditure and income regressions: Red River Delta

	Per capita expenditure			*Per capita income*		
	Coefficient	Standard error	p-*value*	*Coefficient*	*Standard error*	p-*value*
Intercept	7.935	0.082	0.000	8.067	0.106	0.000
Household variables						
Have computer	0.197	0.060	0.001			
Have color TV				0.289	0.037	0.000
Have mobile	0.203	0.022	0.000	0.305	0.047	0.000
Have motorbike	0.154	0.033	0.000	0.179	0.029	0.000
Have refrigerator	0.135	0.028	0.000			
Have telephone	0.176	0.026	0.000	0.181	0.035	0.000
Household size	–0.056	0.008	0.000	–0.073	0.011	0.000
Log of living area per capita	0.114	0.021	0.000	0.094	0.030	0.002
Flush toilet	0.135	0.024	0.000			
Permanent house type				0.084	0.028	0.003
Proportion of working members without vocational training	–0.152	0.030	0.000	–0.171	0.042	0.000
Proportion of working member to household size	0.340	0.039	0.000	0.433	0.055	0.000
Flush toilet				0.163	0.034	0.000
Commune variables						
Proportion of households having mobile in commune	0.583	0.168	0.001	0.814	0.212	0.000
Proportion of concrete road in commune	0.098	0.037	0.008			
Proportion of household having no toilet in commune				−1.040	0.453	0.022
Number of observations	1521					
Number of clusters	92			1521		
Adjusted R^2	0.439			94		
ρ	0.096			0.387		

Note: Rho is the ratio of $\hat{\sigma}_{\eta}^2 / \hat{\sigma}_{u}^2$, which measures the relative component of location errors in the total errors in the model.
Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

Table A3 Expenditure and income regressions: North East

	Per capita expenditure			*Per capita income*		
	Coefficient	*Standard error*	p-*value*	*Coefficient*	*Standard error*	p-*value*
Intercept	8.098	0.141	0.000	8.487	0.174	0.000
Household variables						
Have fan	0.118	0.030	0.000			
Have mobile	0.201	0.054	0.000	0.312	0.070	0.000
Have color TV				0.221	0.032	0.000
Have motorbike	0.271	0.025	0.000	0.207	0.031	0.000
Have refrigerator	0.160	0.045	0.001			
Have telephone	0.119	0.043	0.006	0.138	0.053	0.009
Ethnic minority	−0.064	0.033	0.049	−0.084	0.039	0.032
Household size	−0.122	0.028	0.000	−0.053	0.010	0.000
Household size squared	0.006	0.002	0.014			
Temporary house type	−0.139	0.030	0.000	−0.105	0.035	0.003
Log of living area per capita	0.146	0.030	0.000	0.198	0.034	0.000
No toilet	−0.124	0.041	0.002			
Others' water	−0.106	0.029	0.000			
Proportion of working members without vocational training	−0.243	0.044	0.000	−0.347	0.054	0.000
Proportion of service members to working members	0.116	0.045	0.010	0.248	0.057	0.000
Proportion of working member to household size	0.160	0.051	0.002	0.288	0.064	0.000
Commune variables						
Commune proportion of service members to working members	0.487	0.172	0.005			
Average of household size in commune				−0.086	0.031	0.005
Proportion of concrete road in commune				0.147	0.064	0.022
Number of observations	1017			1017		
Number of clusters	105			105		
Adjusted R^2	0.571			0.528		
ρ	0.136			0.100		

Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

Table A4 Expenditure and income regressions: North West

	Per capita expenditure			*Per capita income*		
	Coefficient	*Standard error*	p-*value*	*Coefficient*	*Standard error*	p-*value*
Intercept	7.749	0.196	0.000	8.143	0.242	0.000
Household variables						
Have color TV				0.206	0.049	0.000
Have computer				0.512	0.214	0.017
Have mobile				0.501	0.153	0.001
Have fan	0.154	0.044	0.001			
Have motorbike	0.327	0.042	0.000	0.196	0.048	0.000
Have refrigerator	0.235	0.089	0.009			
Ethnic minority	−0.254	0.068	0.000	−0.193	0.085	0.024
Household size	−0.044	0.012	0.000			
Log of living area per capita	0.215	0.051	0.000	0.271	0.053	0.000
Flush toilet	0.249	0.085	0.004			
No toilet	−0.250	0.058	0.000	−0.300	0.066	0.000
Proportion of working members without vocational training	−0.192	0.082	0.020	−0.823	0.175	0.000
Proportion of working members with vocational training				−0.766	0.221	0.001
Proportion of working member to household size				0.432	0.131	0.001
No clean water				−0.122	0.061	0.046
Commune variables						
Proportion of households having color TV in commune						
Proportion of household having tap water in commune				3.308	1.399	0.019
Number of observations	346			346		
Number of clusters	33			33		
Adjusted R^2	0.595			0.551		
ρ	0.112			0.082		

Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

Table A5 Expenditure and income regressions: North Central Coast

	Per capita expenditure			*Per capita income*		
	Coefficient	*Standard error*	p-*value*	*Coefficient*	*Standard error*	p-*value*
Intercept	7.487	0.169	0.000	8.009	0.196	0.000
Household variables						
Have fan	0.140	0.035	0.000			
Have motorbike	0.281	0.027	0.000	0.258	0.039	0.000
Have refrigerator	0.251	0.057	0.000	0.253	0.077	0.001
Have telephone	0.198	0.042	0.000	0.309	0.057	0.000
Household size	–0.050	0.010	0.000	–0.054	0.014	0.000
Temporary house type	–0.142	0.044	0.001	–0.224	0.061	0.000
Log of living area per capita	0.186	0.033	0.000	0.208	0.045	0.000
No toilet	–0.197	0.043	0.000			
Have color TV				0.212	0.042	0.000
Have mobile				0.236	0.086	0.006
Proportion of working members without vocational training	–0.174	0.056	0.002	–0.300	0.070	0.000
Proportion of service members to working members	0.173	0.048	0.000			
Proportion of working member to household size	0.378	0.057	0.000	0.415	0.081	0.000
Commune variables						
Proportion of households having color TV in commune	0.399	0.102	0.000			
Proportion of households having others toilet in commune	–0.280	0.070	0.000	–0.230	0.090	0.010
Proportion of household having permanent house in commune				0.627	0.173	0.000
Number of observations	849			849		
Number of clusters	76			76		
Adjusted R^2	0.542			0.466		
ρ	0.102			0.038		

Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

Table A6 Expenditure and income regressions: South Central Coast

	Per capita expenditure			*Per capita income*		
	Coefficient	*Standard error*	p-*value*	*Coefficient*	*Standard error*	p-*value*
Intercept	7.535	0.103	0.000	7.982	0.175	0.000
Household variables						
Have mobile				0.341	0.079	0.000
Have motorbike	0.281	0.033	0.000	0.265	0.046	0.000
Have telephone	0.248	0.045	0.000	0.292	0.066	0.000
Ethnic minority	−0.367	0.067	0.000	−0.206	0.072	0.004
Log of living area per capita	0.260	0.029	0.000	0.178	0.047	0.000
No toilet	−0.082	0.033	0.014			
Household size				−0.058	0.016	0.000
Temporary house				−0.203	0.062	0.001
Flush toilet				0.118	0.054	0.029
Proportion of working members without vocational training	−0.330	0.053	0.000	0.409	0.113	0.000
Proportion of service members to working members	0.112	0.046	0.015			
Proportion of working member to household size	0.365	0.071	0.000	0.169	0.079	0.032
Number of observations	585			585		
Number of clusters	53			53		
Adjusted R^2	0.529			0.445		
ρ	0.066			0.078		

Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

Table A7 Expenditure and income regressions: Central Highland

	Per capita expenditure			*Per capita income*		
	Coefficient	*Standard error*	p-*value*	*Coefficient*	*Standard error*	p-*value*
Intercept	7.735	0.165	0.000	7.744	0.184	0.000
Household variables						
Have mobile	0.254	0.076	0.001	0.322	0.087	0.000
Have motorbike	0.362	0.040	0.000	0.331	0.051	0.000
Have telephone	0.326	0.075	0.000	0.254	0.083	0.002
Ethnic minority	−0.332	0.047	0.000	−0.334	0.057	0.000
Household size	−0.227	0.056	0.000	−0.028	0.012	0.015
Log of living area per capita	0.276	0.042	0.000	0.277	0.052	0.000
No toilet	−0.127	0.049	0.009	−0.183	0.059	0.002
Temporary house type				−0.191	0.059	0.001
Proportion of working member to household size				0.452	0.116	0.000
Permanent house type				0.234	0.103	0.023
Have radio				−0.180	0.078	0.022
Others water	−0.141	0.048	0.003			
Number of observations	404			404		
Number of clusters	54			54		
Adjusted R^2	0.695			0.616		
ρ	0.177			0.091		

Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

Table A8 Expenditure and income regressions: South East

	Per capita expenditure			*Per capita income*		
	Coefficient	*Standard error*	p-*value*	*Coefficient*	*Standard error*	p-*value*
Intercept	7.604	0.120	0.000	7.806	0.137	0.000
Household variables						
Have computer	0.167	0.062	0.008			
Have refrigerator	0.225	0.042	0.000			
Have telephone	0.129	0.038	0.001	0.211	0.048	0.000
Ethnic minority	–0.289	0.062	0.000	–0.355	0.073	0.000
Household size	–0.037	0.009	0.000			
Log of living area per capita	0.250	0.032	0.000	0.265	0.037	0.000
Flush toilet	0.194	0.039	0.000	0.188	0.049	0.000
Proportion of working members with vocational training	0.219	0.086	0.011			
Have color TV				0.129	0.053	0.015
Have mobile				0.208	0.057	0.000
Have motorbike	0.311	0.040	0.000	0.165	0.053	0.002
Proportion of working members without vocational training				–0.206	0.071	0.004
Proportion of working member to household size				0.476	0.091	0.000
Clean water	0.098	0.040	0.015			
Commune variables						
Proportion of households having temporary house in commune	–0.585	0.187	0.002			
Proportion of households having radio in commune	0.465	0.194	0.017			
Number of observations	639			639		
Number of clusters	60			60		
Adjusted R^2	0.619			0.530		
ρ	0.136			0.146		

Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

Table A9 Expenditure and income regressions: Mekong River Delta

	Per capita expenditure			*Per capita income*		
	Coefficient	*Standard error*	p-*value*	*Coefficient*	*Standard error*	p-*value*
Intercept	7.642	0.095	0.000	9.039	0.311	0.000
Household variables						
Have annual land	0.048	0.020	0.019			
Have fan	0.133	0.022	0.000			
Have mobile	0.174	0.033	0.000	0.249	0.060	0.000
Have motorbike	0.189	0.023	0.000	0.222	0.041	0.000
Have refrigerator	0.192	0.032	0.000	0.298	0.062	0.000
Have telephone	0.179	0.027	0.000			
Ethnic minority	−0.125	0.043	0.004	−0.153	0.071	0.031
Household size	−0.044	0.007	0.000	−0.032	0.014	0.022
Temporary house	−0.103	0.022	0.000	−0.259	0.077	0.001
Log of living area per capita	0.227	0.023	0.000	0.183	0.043	0.000
Have radio				0.093	0.045	0.038
Have color TV				0.190	0.043	0.000
Proportion of working members without vocational training				−0.182	0.075	0.015
Proportion of working members with vocational training	0.190	0.065	0.004			
Proportion of working members with college/university	0.340	0.089	0.000			
Proportion of working members to household size	0.143	0.036	0.000	0.445	0.081	0.000
Commune variables						
Proportion of households having mobile in commune	0.776	0.248	0.002	1.077	0.410	0.009
Average log of living area per capita in commune				−0.362	0.103	0.000
Number of observations	1466			1466		
Number of clusters	111			111		
Adjusted R^2	0.512			0.351		
ρ	0.166			0.044		

Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

Table A10 Poverty and inequality estimates at the provincial level

	Expenditure poverty and inequality						*Income poverty and inequality*					
	Poverty rate (%)		*Poverty Gap*		*Gini*		*Poverty rate (%)*		*Poverty Gap*		*Gini*	
	Estimate	*Standard error*	*Estimate*	*Standard error*	*Estimate*	*Standard error*	*Estimate*	*Standard error*	*Estimate*	*Standard error*	*Estimate*	*Standard error*
Ha Noi	4.8	1.3	0.0081	0.0026	0.2871	0.0128	4.8	1.3	0.0081	0.0026	0.2871	0.0128
Hai Phong	11.8	2.2	0.0209	0.0049	0.2514	0.0068	11.8	2.2	0.0209	0.0049	0.2514	0.0068
Vinh Phuc	13.5	2.5	0.0242	0.0056	0.2360	0.0075	13.5	2.5	0.0242	0.0056	0.2360	0.0075
Ha Tay	11.9	1.6	0.0213	0.0035	0.2481	0.0063	11.9	1.6	0.0213	0.0035	0.2481	0.0063
Bac Ninh	9.6	1.9	0.0166	0.0040	0.2560	0.0092	9.6	1.9	0.0166	0.0040	0.2560	0.0092
Hai Duong	10.8	1.8	0.0184	0.0039	0.2312	0.0055	10.8	1.8	0.0184	0.0039	0.2312	0.0055
Hung Yen	11.9	1.9	0.0210	0.0041	0.2344	0.0055	11.9	1.9	0.0210	0.0041	0.2344	0.0055
Ha Nam	14.1	3	0.0254	0.0069	0.2315	0.0068	14.1	3	0.0254	0.0069	0.2315	0.0068
Nam Dinh	10.8	1.8	0.0186	0.0037	0.2306	0.0052	10.8	1.8	0.0186	0.0037	0.2306	0.0052
Thai Binh	11.3	1.9	0.0194	0.0042	0.2297	0.0053	11.3	1.9	0.0194	0.0042	0.2297	0.0053
Ninh Binh	15.8	3.1	0.0292	0.0073	0.2355	0.0064	15.8	3.1	0.0292	0.0073	0.2355	0.0064
Ha Giang	62.7	3.9	0.1765	0.0197	0.2537	0.0100	62.7	3.9	0.1765	0.0197	0.2537	0.0100
Cao Bang	48.2	3.2	0.1279	0.0152	0.2916	0.0109	48.2	3.2	0.1279	0.0152	0.2916	0.0109
Lao Cai	53.9	3.9	0.1480	0.0180	0.2738	0.0108	53.9	3.9	0.1480	0.0180	0.2738	0.0108
Bac Kan	36.9	4.2	0.0886	0.0142	0.2553	0.0076	36.9	4.2	0.0886	0.0142	0.2553	0.0076
Lang Son	40.4	3.8	0.0956	0.0132	0.2635	0.0076	40.4	3.8	0.0956	0.0132	0.2635	0.0076
Tuyen Quang	28.6	4.8	0.0628	0.0138	0.2799	0.0097	28.6	4.8	0.0628	0.0138	0.2799	0.0097
Yen Bai	38.8	4.4	0.0969	0.0156	0.2693	0.0094	38.8	4.4	0.0969	0.0156	0.2693	0.0094
Thai Nguyen	21.9	3.3	0.0438	0.0085	0.2693	0.0071	21.9	3.3	0.0438	0.0085	0.2693	0.0071
Phu Tho	20.9	3.2	0.0405	0.0087	0.2676	0.0088	20.9	3.2	0.0405	0.0087	0.2676	0.0088
Bac Giang	17.6	2.7	0.0341	0.0067	0.2501	0.0078	17.6	2.7	0.0341	0.0067	0.2501	0.0078
Quang Ninh	20.3	2.9	0.0425	0.0072	0.2839	0.0078	20.3	2.9	0.0425	0.0072	0.2839	0.0078

Table A10 ***(continued)***

	Expenditure poverty and inequality						*Income poverty and inequality*					
	Poverty rate (%)		*Poverty Gap*		*Gini*		*Poverty rate (%)*		*Poverty Gap*		*Gini*	
	Estimate	*Standard error*	*Estimate*	*Standard error*	*Estimate*	*Standard error*	*Estimate*	*Standard error*	*Estimate*	*Standard error*	*Estimate*	*Standard error*
Lai Chau	84.6	2.9	0.3551	0.0292	0.2745	0.0118	84.6	2.9	0.3551	0.0292	0.2745	0.0118
Dien Bien	69.9	3.8	0.2559	0.0245	0.2907	0.0163	69.9	3.8	0.2559	0.0245	0.2907	0.0163
Son La	52.8	3.8	0.1562	0.0181	0.2718	0.0103	52.8	3.8	0.1562	0.0181	0.2718	0.0103
Hoa Binh	44.1	4.3	0.1132	0.0174	0.2694	0.0103	44.1	4.3	0.1132	0.0174	0.2694	0.0103
Thanh Hoa	36.1	2.4	0.0861	0.0080	0.2764	0.0057	36.1	2.4	0.0861	0.0080	0.2764	0.0057
Nghe An	32.8	2.8	0.0814	0.0087	0.2910	0.0065	32.8	2.8	0.0814	0.0087	0.2910	0.0065
Ha Tinh	30.7	3.1	0.0679	0.0098	0.2673	0.0066	30.7	3.1	0.0679	0.0098	0.2673	0.0066
Quang Binh	30.7	4.2	0.0721	0.0135	0.2872	0.0082	30.7	4.2	0.0721	0.0135	0.2872	0.0082
Quang Tri	35.3	3.6	0.0962	0.0122	0.2903	0.0071	35.3	3.6	0.0962	0.0122	0.2903	0.0071
Thua Thien Hue	24.0	2.6	0.0564	0.0081	0.2987	0.0073	24.0	2.6	0.0564	0.0081	0.2987	0.0073
Da Nang	8.3	3.4	0.0137	0.0066	0.2353	0.0054	8.3	3.4	0.0137	0.0066	0.2353	0.0054
Quang Nam	17.8	1.6	0.0406	0.0041	0.2569	0.0072	17.8	1.6	0.0406	0.0041	0.2569	0.0072
Quang Ngai	20.7	1.9	0.0493	0.0055	0.2633	0.0070	20.7	1.9	0.0493	0.0055	0.2633	0.0070
Binh Dinh	15.2	1.9	0.0281	0.0043	0.2387	0.0063	15.2	1.9	0.0281	0.0043	0.2387	0.0063
Phu Yen	18.8	2.1	0.0400	0.0053	0.2514	0.0063	18.8	2.1	0.0400	0.0053	0.2514	0.0063
Khanh Hoa	18.5	2.2	0.0429	0.0059	0.2709	0.0063	18.5	2.2	0.0429	0.0059	0.2709	0.0063
Kon Tum	58.5	3.4	0.1951	0.0208	0.3416	0.0105	58.5	3.4	0.1951	0.0208	0.3416	0.0105
Gia Lai	50.1	2.7	0.1677	0.0158	0.3438	0.0089	50.1	2.7	0.1677	0.0158	0.3438	0.0089
Dak Lak	34.5	2.8	0.0978	0.0116	0.3219	0.0088	34.5	2.8	0.0978	0.0116	0.3219	0.0088
Da Nang	37.9	4.8	0.1051	0.0188	0.3039	0.0119	37.9	4.8	0.1051	0.0188	0.3039	0.0119
Lam Dong	31.6	3.5	0.0889	0.0138	0.3480	0.0123	31.6	3.5	0.0889	0.0138	0.3480	0.0123

Ho Chi Minh	2.3	0.9	0.0035	0.0017	0.2772	0.0106	2.3	0.9	0.0035	0.0017	0.2772	0.0106
Ninh Thuan	39.0	5.4	0.1061	0.0202	0.2797	0.0117	39.0	5.4	0.1061	0.0202	0.2797	0.0117
Binh Phuoc	16.1	2.8	0.0341	0.0077	0.2942	0.0107	16.1	2.8	0.0341	0.0077	0.2942	0.0107
Tay Ninh	6.2	1.6	0.0094	0.0032	0.2515	0.0100	6.2	1.6	0.0094	0.0032	0.2515	0.0100
Binh Duong	1.3	0.5	0.0017	0.0009	0.2724	0.0104	1.3	0.5	0.0017	0.0009	0.2724	0.0104
Dong Nai	8.3	1.6	0.0156	0.0037	0.2894	0.0092	8.3	1.6	0.0156	0.0037	0.2894	0.0092
Binh Thuan	16.9	2.9	0.0353	0.0081	0.2830	0.0095	16.9	2.9	0.0353	0.0081	0.2830	0.0095
Vung Tau	5.9	1.9	0.0095	0.0037	0.2776	0.0091	5.9	1.9	0.0095	0.0037	0.2776	0.0091
Long An	4.9	1.3	0.0077	0.0025	0.2475	0.0073	4.9	1.3	0.0077	0.0025	0.2475	0.0073
Dong Thap	11.7	2.3	0.0205	0.0050	0.2573	0.0072	11.7	2.3	0.0205	0.0050	0.2573	0.0072
An Giang	15.4	3.4	0.0291	0.0083	0.2567	0.0070	15.4	3.4	0.0291	0.0083	0.2567	0.0070
Tien Giang	6.2	1.8	0.0104	0.0037	0.2620	0.0086	6.2	1.8	0.0104	0.0037	0.2620	0.0086
Vinh Long	8.7	2.7	0.0144	0.0056	0.2570	0.0089	8.7	2.7	0.0144	0.0056	0.2570	0.0089
Ben Tre	8.8	2.3	0.0155	0.0050	0.2649	0.0077	8.8	2.3	0.0155	0.0050	0.2649	0.0077
Kien Giang	18.6	3.5	0.0365	0.0089	0.2643	0.0071	18.6	3.5	0.0365	0.0089	0.2643	0.0071
Can Tho	11.1	3.4	0.0190	0.0074	0.2551	0.0123	11.1	3.4	0.0190	0.0074	0.2551	0.0123
Hau Giang	10.8	3.3	0.0179	0.0068	0.2462	0.0083	10.8	3.3	0.0179	0.0068	0.2462	0.0083
Tra Vinh	16.7	3.9	0.0321	0.0096	0.2596	0.0067	16.7	3.9	0.0321	0.0096	0.2596	0.0067
Soc Trang	20.8	3.4	0.0431	0.0094	0.2673	0.0069	20.8	3.4	0.0431	0.0094	0.2673	0.0069
Bac Lieu	13.3	2.8	0.0251	0.0067	0.2718	0.0089	13.3	2.8	0.0251	0.0067	0.2718	0.0089
Ca Mau	17.0	3.1	0.0351	0.0081	0.2843	0.0094	17.0	3.1	0.0351	0.0081	0.2843	0.0094

Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the 2006 Rural Agriculture and Fishery Census.

Table A11 Matrix of correlation coefficients between household variables

	hhsize	*ethnic*	*pedu0*	*Pedu1*	*Pedu2*	*pwork*	*House*	*Toilet*	*Water*	*Radio*	*TV*	*Computer*	*Telephone*	*mobile*	*Motor*	*Fan*	*Refrigerator*
Household size	1																
Ethnic minorities	0.23	1															
pedu0	0.34	0.13	1														
pedu1	−0.02	−0.06	−0.53	1													
pedu2	−0.01	−0.06	−0.32	0.02	1												
pwork	−0.01	0.00	0.42	0.08	0.02	1											
Housing type	−0.02	0.16	0.07	−0.12	−0.09	−0.01	1										
Toilet	0.04	0.25	0.13	−0.16	−0.16	−0.02	0.33	1									
Water	0.14	0.41	0.11	−0.07	−0.07	0.01	0.18	0.26	1								
Radio	0.01	−0.03	−0.03	0.03	0.02	0.02	0.02	−0.03	−0.01	1							
Television	0.09	−0.24	0.00	0.15	0.09	0.10	−0.28	−0.27	−0.22	−0.02	1						
Computer	0.01	−0.07	−0.16	0.14	0.31	0.00	−0.08	−0.17	−0.07	0.03	0.09	1					
Telephone	0.01	−0.17	−0.15	0.20	0.19	0.02	−0.23	−0.34	−0.18	0.05	0.26	0.24	1				
Mobile	0.06	−0.11	−0.13	0.20	0.21	0.04	−0.13	−0.23	−0.13	0.05	0.17	0.27	0.36	1			
Motorbike	0.22	−0.10	0.04	0.18	0.14	0.13	−0.21	−0.24	−0.11	0.01	0.37	0.13	0.31	0.25	1		
Fan	−0.07	−0.33	−0.07	0.11	0.07	0.02	−0.27	−0.25	−0.25	0.01	0.39	0.06	0.19	0.13	0.21	1	
Refrigerator	0.02	−0.11	−0.13	0.17	0.18	0.00	−0.21	−0.30	−0.14	0.05	0.20	0.24	0.43	0.35	0.27	0.14	1

Notes: *pedu0*, proportion of members without vocational training; *pedu1*, proportion of members with vocational training; *pedu2*, proportion of members with college/university

pwork, proportion of working members.

Source: Authors' estimation from the 2006 Vietnam Household Living Standard Survey and from the2006 Rural Agriculture and Fishery Census.