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How Does Vietnam's Accession to the World Trade Organization Change the Spatial Incidence of Poverty?

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Abstract

Trade policies can promote aggregate efficiency, but the ensuing structural adjustments generally create both winners and losers. From an incomes perspective, trade liberalization can raise GDP per capita, but rates of emergence from poverty depend upon individual household characteristics of economic participation and asset holding. To fully realize the growth potential of trade, while limiting the risk of rising inequality, policies need to better account for microeconomic heterogeneity. One approach to this is the geographic targeting, which shifts resources to poor areas. This study combines an integrated microsimulation-CGE model with the small area estimation to evaluate the spatial incidence of Vietnam's accession to the WTO. Provincial-level poverty reduction after full liberalization was heterogeneous, ranging from 2.2 per cent to 14.3 per cent. Full liberalization will benefit the poor on a national basis, but the northwestern area of Vietnam is likely to lag behind. Furthermore, poverty can be shown to increase under comparable scenarios.

Keywords: Trade liberalization, microsimulation, computable general equilibrium, small-area estimation, Vietnam
JEL classification: F13, I32, O24

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Tables and figures appear at the end of this paper.

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1 Introduction

Trade liberalization is good for growth, and growth is good for the poor. This argument is simple but powerful. It has served as the departure point for discussion of the link between trade and poverty among economists and policy-makers, regardless of whether and to what extent they buy this argument. Krueger (1998) considers the inefficiencies that import substitution strategy creates and argues that trade liberalization undertaken at a period of low or negative growth rates can normally lead to a period of higher growth rates. Bhagwati and Srinivasan (2002) emphasize the empirical evidence of China and India. That is, these two giant economies achieved faster growth and poverty reduction through greater integration into the world economy. Dollar and Kraay (2002, 2004) use cross country regression to support this argument.

However, there are also many researchers who have strong reservations about this argument for at least two reasons. The first is methodological, Rodriguez and Rodrik (2001) for example severely criticized earlier studies supporting this argument because the measurement or the method is flawed. Ravallion (2001) points out that working with aggregate numbers can be misleading.

The second reason is the possibility of an adverse impact of trade liberalization on the poor. As pointed out by Winters (2002), there are a number of reasons why the poor may be adversely affected by trade liberalization. Important links include the change in prices of goods and services that poor households transact in relatively large amounts. Trade liberalization and poverty are also connected though government revenue and vulnerability of the economy to negative external shocks. Winters et al. (2004) provide an extensive survey on the relationship between trade liberalization and poverty. While they find no simple relationship, the empirical evidence broadly supports the notion that trade liberalization alleviates poverty in the long run and on an average basis. Yet, trade liberalization almost always creates winners and losers, and the losers may well include poor people.

Trade liberalization would be difficult to justify from the standpoint of poverty reduction if it adversely affects this group. This point is especially important in a country where a substantial portion of the population lives below or close to the poverty line. Aggregate growth alone is not enough to justify trade liberalization policies, particularly if poverty could worsen. Governments may not want to forgo liberalization, but must carefully choose the right mixture of policies, and be ready to implement mitigating policies when necessary.

Some argue that it is indeed possible to do so. Using a computable general equilibrium (CGE) model with a detailed panel of households, Harrison et al. (2003) argue that trade liberalization in Turkey can be designed to ensure that the poor will not lose by using direct compensation to the losers or by using limited policy reform. Their research is an improvement from previous work with very limited treatment of heterogeneity among households. However, making side payments for particular segments of households is not straightforward. As they noted, limited policy reform may induce rent-seeking.

In this study, we consider geographic targeting as a way to direct progressively more resources to areas that are least favourably affected by trade liberalization. Geographic targeting has several advantages. It is easy to understand and straightforward to implement. The distortion caused by geographic targeting is usually considered small because the cost of changing locations, especially for the poor, is often prohibitively high. Further, many countries already have some sort of programmes targeted to poor areas. We only need to modify the set of areas to make the programme more efficient for poverty reduction, instead of implementing a new programme. Hence, given the pre-existence of such a programme, the political cost would also be relatively small.

Of course, the formulation of an effective policy of geographic targeting requires the knowledge of the changes in spatial distribution of the poor after market liberalization. Economic research has provided only limited guidance in this area, because socioeconomic survey data with high temporal and spatial resolution needed for poverty monitoring are usually unavailable. Although policy makers need information on detailed incidence of trade liberalization, prior studies on these impacts were able to provide estimates only for a few representative household categories, very limited spatial decomposition or none at all.

To overcome the limitations of previous studies and elucidate more detailed incidence, we synthesize microsimulation, economy-wide CGE modeling, and small area estimation in an application to Vietnam's WTO accession. This new generation of analytical tools reveals the incidence of trade liberalization at an unprecedented level of microeconomic and spatial detail. We present our results in the form of maps, which help policy makers visualize the spatial impact of trade liberalization on the poor, facilitating the design and implementation of geographically-targeted assistance. The approach set forth in this paper is readily applicable to other countries and can help enlarge the scope of the benefits of trade liberalization across a wider variety of countries and populations. Our study sheds new light on the geographic properties of poverty. It also helps to resolve the conflicts between 'Finance Ministry' and 'Civil Society' orientations, as described by Kanbur (2001), by offering a solution in which all the relevant parties including the poor can enjoy the benefits of trade liberalization.

The paper is organized as follows: in Section 2, we review relevant studies on trade liberalization and poverty in Vietnam. Section 3 describes the data sets we use and discusses the measurement of poverty. We then develop the methodology in Section 4. We first explain the schematic structure of the methodology and then present it formally. Section 5 presents the results, followed by conclusions in Section 6.

2 Trade liberalization and poverty in Vietnam

Since the introduction of *Doi Moi* (Renovation) in 1986 and further market-oriented reforms in 1989, most of the elements of Vietnam's centrally-planned trade regime had been removed by the early 1990s. These reform policies were extremely successful and resulted in very high growth rates of output and exports. The reform generally continued through the late 1990s and tariff measures associated with membership in the ASEAN Free Trade Area (AFTA) were implemented. Since then, the bilateral trade agreement between Vietnam and the United States in 2000 has given additional momentum to the reform process.

As standard economic theory would predict, trade liberalization has generally been beneficial to the overall Vietnamese economy and to its trading partners. Fukase and

Martin (2000) estimate that aggregate Vietnamese welfare gains from the US granting most-favoured-nation status would be about USD 118 million annually, or about 1 per cent higher average real income per capita. Using a multi-sector CGE model, Heng and Gayathri (2004) predict that participation in the ASEAN-China Free Trade and the ASEAN-Japan Free Trade agreements will bring about positive and significant welfare gains to Vietnam. The CGE simulation of various trade liberalization policies by Fukase and Martin (2001) also suggests that the higher level of welfare can be achieved from more comprehensive liberalization. It is beyond dispute that market-oriented reforms have contributed to poverty reduction in Vietnam. Jenkins (2004) argues that improved employment brought about by the growth of exports is one potential way in which globalization has had a positive impact on poverty.

As part of its accession agreement, Vietnam has made substantial commitments to trade policy reforms. These include lowered import tariffs, reduced coverage of tariff rate quotas, removal of export subsidies and non-tariff barriers, the opening of some service sectors, compliance with the agreements of trade-related investment measures (TRIMs) and trade-related intellectual property rights (TRIPs). Further, the state owned enterprises need also to be reformed.[1] Anderson (1999) argues that after the successful accession to the WTO, and given that some appropriate measures are taken, a number of broad-brush effects can be anticipated, including economic growth, expansion of agriculture and export-oriented light manufacturing, enhanced food security, more equitable income distribution, and increased government revenue.

However, the higher economic growth induced by further liberalization does not automatically imply reductions in poverty or inequality. Jensen and Tarp (2005), for example, predict that poverty will rise following a revenue-neutral lowering of trade taxes. Niimi et al. (2004) show that the employment in garment and textiles industries has been adversely affected in the 1990s by trade policies. Liu (2001) analyzes poverty and inequality of Vietnam using the Vietnam Living Standards Surveys (VLSS) 1992–93 and 1997–98. While Vietnam achieved a very rapid poverty reduction before the US bilateral trade agreement or WTO accessions, rural areas have lagged behind urban areas and overall inequality has increased slightly. Decomposition of inequality measures shows that urban-rural and regional differences have been the major source of rising national inequality over time.

Indeed, not everyone in Vietnam has benefited from the broad improvement in living standards, as indicated by results such as Litchfield and Justino (2004). Using the VLSS datasets, their regression model of the change in consumption suggests that there are large differences in household performance in different regions. Glewwe et al. (2002) also reported similar findings using the VLSS datasets.

One of the factors that significantly affected the probability of escaping poverty during the 1990s was location. Urban households, as well as households in the Red River Delta and the South East, had a higher probability of escaping poverty.

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1 See Thanh (2005) for further discussion on the process and progress of Vietnam's efforts to become a WTO member.

Tarp et al. (2002) appraise the consequences of Vietnam's shifting import and export patterns and argue that trade and other reforms will not realize their full potential for all Vietnamese households in the absence of deliberately corrective fiscal measures. Further, Le and Winters (2001) argue that there is an imbalance between aid which promotes economic growth and aid which directly targets the poor. They also argue that aid is not regionally directed in a manner conducive to poverty alleviation and is urban-biased.

All of the above observations motivate us to examine the spatial dimension of trade policy incidence and its implications for poverty. Changes in the spatial distribution of poverty have some practical importance as well, because such changes alter the efficient geographical targeting scheme. However, previous studies gave little guidance about how to shift resources in response to a changing macroeconomic environment. In this study, we show which part of the country is least likely to benefit from trade liberalization. In addition to contributing to Vietnam evidence to the more general debate on globalization and poverty, these results provide guidance for those policy-makers who want to formulate geographic targeting policies for poverty reduction.

3 Data and measurement

We combine four different data sets in this study. First, the information required is a socioeconomic data set. We use the VLSS 1997–98 data set, which contains a wide array of microeconomic data, such as information on housing, employment, household enterprises, income and asset holdings. The survey was conducted by Vietnam's General Statistical Office (GSO). The United Nations Development Programme (UNDP) and the Swedish International Development Agency (Sida) provided financial assistance whereas the World Bank provided technical assistance. The sample of VLSS 1997–98 is nationally representative and stratified into two groups representing urban and rural areas. The number of households in the sample is, 4270 in rural areas and, 1730 in urban areas (World Bank, 2001).

Second, we used the 1999 Population and Housing Census. The census was carried out by the GSO with financial and technical support from the United Nations Population Fund and UNDP. The census data set contains individual-level information such as age, sex, education and occupation as well as household-level information such as housing characteristics and asset holdings. It also contains the employment status of each individual. We used a 33 per cent sample of the census, which contains records for every third household organized by an administrative unit. The sample selection was made by GSO. The sample includes 5,553,811 households and 25,447,457 individuals.

Third, we use a compilation of geographic variables. These include elevation, precipitation, soil quality, sunshine duration and access to cities. Some of the variables are based on remotely sensed data, while others are mean values from community-level data. The geographic variables can be merged into the census and the survey by the administrative codes.

Finally, we use the 2000 Social Accounting Matrix (SAM) for Vietnam as a core building block of the CGE model, representing 97 production activities and commodities, 13 factors of production (labour and capital), 5 household types, and 94 international trading partners. The aggregated version of SAM includes aggregate wage incomes for eight labour segments defined by male/female, skilled/unskilled and urban/rural. It also includes the non-wage household incomes for urban and rural areas.

Let us now briefly discuss the measurement of poverty. In the standard analysis of socioeconomic survey data such as the VLSS, poor people are defined as those living in households whose per capita consumption is below the poverty line. Consumption has several advantages over other income measures and proxies. First, it is a money metric measure and easy to interpret. Second, it does not vary in the short run, unlike income. Despite these advantages of consumption, however, we use the per capita income measure for the household. This is because we need to aggregate the information in the VLSS data set in a way that is consistent with the SAM and to allow the individuals in the microsimulation to switch their employment status. We shall come back to the details of this point in the next section.

To calculate the income measures, we first identified the employment status of all the individuals in the potential labour force. We regarded individuals aged between 15 and 64 who are not students or invalid as being part of the potential labour force. We then classified those in the potential labour force into the following three categories: (1) wage earners, (2) self-employed and (3) not-working. Wage earners are those who earn any wage income and do not engage in the household enterprise. Self-employed people are those who engage in at least one of their household enterprises. All the other people are defined as not-working. Employment status is available in both the census and survey data sets.

We calculated wage incomes for wage-earners and non-wage household incomes for all the households on the annual basis using the VLSS data set. To find the non-wage household income, we calculated the sum of incomes from each household enterprise, asset incomes and transfers. We summed all the wage incomes in the household and the non-wage household income, and divided by the household size to arrive at the per capita income measure. To remove the seasonal and regional price variations, we apply the same price deflator as the one used to calculate consumption poverty.

It is useful to look at how income and consumption measures differ. Table 1 provides some summary statistics for the per capita consumption and income measures. The national-level mean of the per capita consumption is about 13 per cent lower than the corresponding figure for the per capita income, while the standard deviation for the consumption is about half as that for the income.

The comparison of column 1 and column 5 gives the differences in mean per capita income and consumption at the regional level, at which the VLSS is representative. The number of households and population share of each region are reported in Column 9 and Column 10. At the regional level, income and consumption exhibit a very similar pattern and their correlation is higher than 0.98. Even at the individual level, the correlation is as high as 0.64.

We can also compare the consumption-based poverty $\left(P_0^C\right)$ and income-based poverty $\left(P_0^I\right)$ measures. To make the consumption-based and income-based poverty measures comparable, we set the poverty line so that they have the same poverty rates of 37.4 per cent (World Bank, 2001). We set the poverty line at VND 3,452.06 per day per capita.[2]

The poverty rates are identical by construction, but there may be regional differences. This can be checked by looking at Columns 3 and 7. It turns out that the spatial distributions of income and consumption poverty are reasonably close, though there are two notable differences. First, in the Red River Delta, the income poverty is much higher than the consumption poverty. On the other hand, in Mekong River, the consumption poverty is much higher than the income poverty rate. Overall, income and consumption measures show a similar pattern of spatial distribution, though income measure is on average a much noisier measure than consumption.

4 Methodology

Estimation of poverty and other economic indicators at the level of small geographic areas is generally constrained by the availability of representative data. In Vietnam, the VLSS data do not support reliable poverty measures even at the provincial level because the sampling strata are more aggregated than provinces. However, the small area estimation (SAE) developed by Elbers et al. (2002, 2003) has enabled us to reliably estimate measures of poverty and inequality at a spatially disaggregated level.

The SAE approach typically combines survey and census data source. Consumption or income regression models are estimated with the survey data set. The regressors contain only the variables in the geographic data set or the variables that also appear in the census data set. The left-handside variable is then imputed to each census record and aggregated to obtain poverty and inequality measures of interest. Using a Monte-Carlo simulation technique provided by Elbers et al. (2002, 2003), imputation and aggregation are done repeatedly to develop point estimates of poverty and inequality measures as well as their associated standard errors.

The SAE estimates of poverty rates are often plotted on a map, and conventionally named a poverty map. The poverty map is visually immediate and popular among policy-makers and other stakeholders. The SAE estimates can support geographic targeting policies to focus assistance on the neediest people. Such estimates can also be used to analyze the spatial relationship between poverty and geographic variables. In Vietnam, Minot (2000) created a poverty map using the VLSS 1992–93 and the Agricultural Census for 1994 with the probit model. Minot et al. (2003) have produced consumption-based small-area estimates of poverty and inequality using the VLSS 1997–98 and the Population Census for 1999.

Although the SAE estimates are useful, limitations remain. Since existing SAE techniques can only generate static maps, they do not reveal how the poverty map will change as a result of changing macroeconomic environment. Hence, the geographic targeting policy based on the static SAE estimates may be inappropriate after Vietnam's

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2 According to the World Development Indicators, the purchasing power parity conversion factor (for 1998) was USD 1=VND 2,673.

accession to the WTO. To overcome the static nature of poverty mapping, this study combines the SAE method with an integrated microsimulation-CGE model.

Integrated microsimulation-CGE methods were first proposed by Bourguignon et al. (2005). They apply their method to analyze the impact of a change in the foreign trade balance before the Asian financial crisis in Indonesia. Unlike standard CGE models, an integrated microsimulation-CGE model explicitly takes account of detailed heterogeneity among households and linkages between different sectors of the economy. It can be used to analyze a range of national level policies such as trade and taxation as well as macroeconomic shocks.

While the integrated microsimulation-CGE model allows us to identify heterogeneous impacts of trade liberalization, it provides policy makers with little useful information to support geographical targeting after or in coordination with trade policy. This is because the spatial disaggregation of the SAM is usually very limited, and thus the CGE model allows very limited spatial disaggregation. It is only by embedding the SAE method in an integrated microsimulation-CGE model that we can adequately represent the spatial distribution of poverty after trade liberalization and in response to complementary policies.

As noted before, for present discussion we use per capita household income as a measure of welfare. We find a scaling factor for each segment of the economy so that non-wage household income, individual wages and labour supply in the survey sum up to the corresponding macroeconomic figures in the CGE. Formally, this is equivalent to solving for scaling factors *SC* in the following equations:

$$WGI_l = SC_l^{WGI} \sum_{\{(h,i):f(h,i)=l\}} \mathbf{w}_{hi} \tag{1}$$

$$NWI_m = SC_m^{NWI} \sum_{\{h:g(h)=m\}} \mathbf{y}_h \tag{2}$$

$$TNW_l = SC_l^{TNW} \sum_{\{(h,i):f(h,i)=l\}} \mathbf{IW}_{hi} \tag{3}$$

$$TNS_l = SC_l^{TNS} \sum_{\{(h,i):f(h,i)=l\}} \mathbf{IS}_{hi} \tag{4}$$

In Eq(1)–Eq(4), the subscript l is the labour segment, which is a combination of skilled/unskilled, male/female and urban/rural. The subscript m represents the household segment, which is urban/rural. The left-hand-side variables *WGI*, *NWI*, *TNW* and *TNS* are aggregate wage income, non-wage income, the total number of wage earners and total number of self-employed individuals in the SAM. **w**, **y**, **IW** and **IS** are respectively the individual wage income, non-wage household income, indicator variable for being a wage-earner, and indicator variable for being a self-employed individual. The function $f(h,i)$ maps the individual i in household h to the labour segment the individual belongs to. The function $g(\cdot)$ maps household h to urban or rural area.[3]

To elucidate the spatial incidence of trade liberalization, we first estimate poverty measures for small areas before the trade liberalization. This step is conceptually similar to the standard SAE approach. The difference is that we use multiple equations for this estimation. We assume that **w**, **y**, **IW** and **IS** are related to individual or household characteristics through following equations:

$$\log \mathbf{w}_{hi} = \alpha_{g(h,i)} + \mathbf{x}_{hi}\beta_{g(h,i)} + \mu_{hi} \tag{5}$$

$$\log \mathbf{y}_{h} = \gamma_{f(h)} + \mathbf{z}_{h}\delta_{f(h)} + \mathbf{S}_{h}\lambda_{f(h)} + \eta_{h} \tag{6}$$

$$\mathbf{IW}_{hi} = \mathrm{Ind}\left(a^{w}_{g(h,i)} + \mathbf{v}_{hi}b^{w}_{g(h,i)} + u^{w}_{hi} > \sup\left(u^{n}_{hi}, a^{s}_{g(h,i)} + \mathbf{v}_{hi}b^{s}_{g(h,i)} + u^{s}_{hi}\right)\right) \tag{7}$$

$$\mathbf{IS}_{hi} = \mathrm{Ind}\left(a^{s}_{g(h,i)} + \mathbf{v}_{hi}b^{s}_{g(h,i)} + u^{s}_{hi} > \sup\left(u^{n}_{hi}, a^{w}_{g(h,i)} + \mathbf{v}_{hi}b^{w}_{g(h,i)} + u^{w}_{hi}\right)\right) \tag{8}$$

$$\mathbf{S}_{h} \equiv \sum_{i \in \mathscr{I}_h} \mathbf{IS}_{hi} \tag{9}$$

$$\mathbf{H}_{h} \equiv \frac{1}{\mathbf{N}_{h}}\left(\mathbf{y}_{h} + \sum_{\{i: i \in \mathscr{I}_h, \mathbf{IW}_{hi}=1\}} \mathbf{w}_{hi}\right) \tag{10}$$

In Eq(5), individual logarithmic wage is related to individual characteristics $\mathbf{x}_{hi}$ *i*.[4] In Eq(6), logarithmic household non-wage income is related to household characteristics $\mathbf{z}_h$ and the number of self-employed individuals in the household $\mathbf{S}_h$. Labour supply is modeled by Eq(7) and Eq(8), where individual characteristics $\mathbf{v}_{hi}$ are related to the 'utility' from being a wage-earner and self-employed. u^{n}_{hi} can be considered the random reservation utility for working. We assume that the error terms μ_{hi}, η_h, u^{w}_{hi}, u^{s}_{hi} and u^{n}_{hi} are independent. Furthermore, we assume that μ_{hi} follows a normal distribution with mean zero and variance σ^2_{μ}, and η_h a normal distribution with mean zero and variance σ^2_{η}. We also assume that u^{w}_{hi}, u^{s}_{hi} and u^{n}_{hi} follow an identical Gumbel distribution.

Eq(9) simply states that the number of self-employed is the sum of $\mathbf{IS}_{hi}$ over the set of individuals $\mathscr{I}_h$ within household *h*. The per capita household income $\mathbf{H}_h$ is, of course,

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3 An alternative approach is to calibrate the sum so that these equations hold without the scaling factor. Either way, we have to make somewhat arbitrary adjustments. This is unavoidable because the sum of the survey observations is not necessarily consistent with the SAM. Note that we are only concerned about the ratios of these macroeconomic indicators before and after Vietnam's accession to the WTO.

4 **x**, **z** and **v** are expressed in a row vector format.

the sum of wage and non-wage income earned by the household members divided by the household size $\mathbf{N}_h$, as it is defined in Eq(10).

As with the standard SAE, we consider above equations as a predictive model, using a rich set of regressors to explain the variation of left-hand-side variables in Eq(5), Eq(6), Eq(7) and Eq(8). However, regressors can only include the variables shared by the census and the survey.

We first estimate the parameters of the equations above. Only the survey data set is used at this stage. We run OLS to estimate Eq(5) and Eq(6), whereas we use a multinomial logit model to jointly estimate Eq(7) and Eq(8). Therefore, we estimate the regression coefficients α, β, γ, δ, λ, a^w, a^s, b^w and b^s and their associated variance-covariance matrix adjusted for the clustering of the survey sample. We also estimate the distribution parameters σ_μ^2 and σ_η^2. We shall denote the estimates with a hat (e.g. $\hat{\alpha}$).

As with Elbers et al. (2003), we estimate left-hand-side variables in Eq(5)–Eq(10) for each census record repeated by a Monte-Carlo simulation. To allow for the error in the estimated regression coefficients, we draw regression coefficients from a multinomial normal distribution in each round of the simulation. We shall denote the drawn coefficients by superscript (r) to specify the r-th round of the simulation. In addition, we draw error terms for each census record. For example, the estimate of wage income $\hat{\mathbf{w}}_{hi}^{(r)}$ for (census) household h and individual i in the r-th round is calculated as follows:

$$\hat{\mathbf{w}}_{hi}^{(r)} = \exp\left(\hat{\alpha}_{g(h,i)}^{(r)} + \mathbf{x}_{hi}\hat{\beta}_{g(h,i)}^{(r)} + \hat{\mu}_{hi}^{(r)}\right) \tag{11}$$

where $\mathbf{x}_{hi}$ comes from the census data set and $\hat{\mu}_{hi}^{(r)}$ is drawn from the normal distribution with mean zero and variance $\hat{\sigma}_\mu^2$. Note that we know the employment status of each individual in the census and thus we observe $\mathbf{IW}_{hi}$ and $\mathbf{IS}_{hi}$. However, we still need to draw $\hat{u}_{hi}^{w,(r)}$, $\hat{u}_{hi}^{s,(r)}$ and $\hat{u}_{hi}^{n,(r)}$ for the later simulation. We can draw $\hat{u}_{hi}^{n,(r)}$ from the Gumbel distribution. $\hat{u}_{hi}^{w,(r)}$ and $\hat{u}_{hi}^{s,(r)}$ must be drawn conditionally on the observed dummy variables for the employment status $\mathbf{IW}_{hi}$, $\mathbf{IS}_{hi}$ as well as the drawn error term $\hat{u}_{hi}^{n,(r)}$ in order to be consistent with the observed employment status.

It is straightforward to impute household non-wage income using Eq(6). By Eq(10), we get an estimate of the per capita household income $\hat{\mathbf{H}}_h^{(r)}$. We can then obtain aggregate welfare measures such as the FGT measure of poverty, see Foster et al. (1984). Letting $\mathscr{H}_p$ be the set of households in province p and z be the poverty line, the head count poverty rate $P_p^{(r)}$ in province p for the r-th simulation can be written as follows:

$$P_p^{(r)} = \frac{\sum_{h\in\mathscr{H}_p} \mathrm{Ind}\left(\hat{\mathbf{H}}_h^{(r)} < z\right)\cdot \mathbf{N}_h}{\sum_{h\in\mathscr{H}_p} \mathbf{N}_h} \tag{12}$$

Taking the average and standard deviation across simulations, we arrive at the point estimate of poverty rate for province *p* and its associated standard error. The aggregate welfare estimates derived in this manner serve as the baseline information for each province or any geographic units. We shall refer to the poverty estimates before the trade liberalization created in this way as the ex ante poverty estimates.

The next step is to simulate how much change would occur across different sectors of the economy. As with Bourguignon et al. (2005), we need to find error terms for each *survey* record. It is straightforward to find μ_{hi} and η_h, because they are just the observed value minus the predicted value. When the wage data is missing, μ is drawn from the normal distribution. We also draw $\hat{u}_{hi}^{w}$, $\hat{u}_{hi}^{s}$ and $\hat{u}_{hi}^{n}$ from a Gumbel distribution in a way consistent with the observed employment status. Therefore, combining Eq(1)–Eq(4) and Eq(5)–Eq(8) , we have the following relationship:

$$WGI_l = SC_l^{WGI} \sum_{\{(h,i):g(h,i)=l\}} \exp\left(\hat{\alpha}_l + \mathbf{x}_{hi}\hat{\beta}_l + \hat{\mu}_{hi}\right)$$

$$NWI_m = SC_m^{NWI} \sum_{\{h:f(h)=m\}} \exp\left(\hat{\gamma}_m + \mathbf{z}_h\hat{\delta}_m + \mathbf{S}_h\hat{\lambda}_m + \hat{\eta}_h\right)$$

$$TNW_l = SC_l^{TNW} \sum_{\{(h,i):g(h,i)=l\}} \mathrm{Ind}\left(\hat{a}_l^{w} + \mathbf{v}_{hi}\hat{b}_l^{w} + \hat{u}_{hi}^{w} > \sup\left(\hat{u}_{hi}^{n}, \hat{a}_l^{s} + \mathbf{v}_{hi}\hat{b}_l^{s} + \hat{u}_{hi}^{s}\right)\right)$$

$$TNS_l = SC_l^{TNS} \sum_{\{(h,i):g(h,i)=l\}} \mathrm{Ind}\left(\hat{a}_l^{s} + \mathbf{v}_{hi}\hat{b}_l^{s} + \hat{u}_{hi}^{s} > \sup\left(\hat{u}_{hi}^{n}, \hat{a}_l^{w} + \mathbf{v}_{hi}\hat{b}_l^{w} + \hat{u}_{hi}^{w}\right)\right)$$

The macroeconomic CGE provides us with aggregate wage and non-wage household incomes in each segment of the economy, as well as the aggregate labour supply from wage-earners and self-employed individuals. In other words, we obtain aggregate macroeconomic account after the trade liberalization, which we shall denote with tilde (e.g. $\widetilde{WGI_l}$). To maintain the consistency between the left-hand-side and the right-hand-side of the system of equations above, we need to change at least one of the parameters in each equation. Following the method outlined by Bourguignon et al. (2005), we assume that the macroeconomic changes are channelled through the intercepts in the above equations. Bourguignon et al. (2005) show that this assumption implies a neutrality of the change with regard to individual or household characteristics. For example, the ratio of wages in the same labour segment will not be altered before and after the trade liberalization. Similarly, the relative change in the probability that an individual has a certain occupation depends only on the initial ex ante probability of the various occupational choices, and not on individual characteristics. The problem we face is therefore equivalent to solving for the adjustment coefficients $\widetilde{\Delta\alpha}$, $\widetilde{\Delta\gamma}$, $\widetilde{\Delta a^{w}}$ and $\widetilde{\Delta a^{s}}$, which are the difference in ex ante and ex post intercepts, in the following equations:

$$\widetilde{WGI_l} = SC_l^{WGI} \sum_{\{(h,i):g(h,i)=l\}} \exp\left(\widetilde{\Delta\alpha_l} + \hat{\alpha}_l + \mathbf{x}_{hi}\hat{\beta}_l + \hat{\mu}_{hi}\right) \qquad (13)$$

$$\widetilde{NWI}_m = SC_m^{NWI} \sum_{\{h:f(h)=m\}} \exp\left(\widetilde{\Delta\gamma_m} + \hat{\gamma}_m + \mathbf{z}_h\hat{\delta}_m + \mathbf{S}_h\hat{\lambda}_m + \hat{\eta}_h\right) \tag{14}$$

$$\widetilde{TNW}_l = SC_l^{TNW} \sum_{\{(h,i):g(h,i)=l\}} \text{Ind}\left(\widetilde{\Delta a_l^w} + \hat{a}_l^w + \mathbf{v}_{hi}\hat{b}_l^w + \hat{u}_{hi}^w > \sup\left(\hat{u}_{hi}^n, \widetilde{\Delta a_l^s} + \hat{a}_l^s + \mathbf{v}_{hi}\hat{b}_l^s + \hat{u}_{hi}^s\right)\right) \tag{15}$$

$$\widetilde{TNS}_l = SC_l^{TNS} \sum_{\{(h,i):g(h,i)=l\}} \text{Ind}\left(\widetilde{\Delta a_l^s} + \hat{a}_l^s + \mathbf{v}_{hi}\hat{b}_l^s + \hat{u}_{hi}^s > \sup\left(\hat{u}_{hi}^n, \widetilde{\Delta a_l^w} + \hat{a}_l^w + \mathbf{v}_{hi}\hat{b}_l^w + \hat{u}_{hi}^w\right)\right) \tag{16}$$

After finding the adjustment coefficients, we can again impute individual wage income, the ‘utility’ of each individual, and the non-wage household income. This time, however, we include the adjustment coefficients. For example, we replace $\hat{\alpha}_l^{(r)}$ by $\widetilde{\Delta\alpha_l} + \hat{\alpha}_l^{(r)}$ in Eq(11). It should be noted by that the ex post employment status may be different from the observed ex ante employment status, which in turn affects the non-wage household income. Once we have individual wage income and non-wage household income, we can calculate the per capita income for each census household as well as the poverty status in each round of the simulation. By aggregating geographically, we can obtain the poverty estimates after trade liberalization, or the ex post poverty estimates.

5 Results

5.1 Macroeconomic CGE

For economy-wide analysis, a macroeconomic CGE for Vietnam was calibrated to the new 2000 Vietnam SAM for a ‘business as usual’ baseline. This reference scenario was then used to evaluate comparative static experiments provided by GTAP global liberalization results. To implement the latter, we obtained data from GTAP on induced price and external demand changes for the purpose of re-calibrating Vietnamese exports against downward sloping external demand functions. Finally, we assume the so-called Hertel-Keeney medium-run closure. That is, all factors are fully employed before and after experiments, labour and capital are mobile across sectors, but we maintain a specific factor (land) in agriculture. There is no imperfect competition nor economies of scale or dynamic gains from trade (Hertel, 1997).

In this paper, we compare three counterfactual scenarios to the baseline, which we call Unilateral Liberalization (UL), Full Liberalization (FL) and Doha Special and Differential Treatment (DSDT). The baseline scenario corresponds to the ex ante case. In the UL scenario, we assume that Vietnam’s last offer to the WTO is accepted, the country joins the organization. We assume that Vietnam removes all import tariffs and export subsidies. However, Vietnam’s trading partners maintain baseline protection levels with respect to this country and all others. In this case, the benefits of fuller participation in the international economy are severely limited by Vietnam’s inability to penetrate new markets, and the gains of domestic price reform have more limited impact on the growth of income.

The FL scenario includes the same external policy, but embeds this into a larger agenda. This scenario is calibrated to protection rates from the Vietnamese WTO offer, but further assumes that Vietnamese export prices and demand patterns shift according to consensus estimates for a FL scenario obtained using the GTAP global trade database and model. This scenario would greatly expand export opportunities for Vietnam, allowing it to take fuller advantage of efficiency gains arising from border price reforms. In the DSDT scenario, we also assume that Vietnam removes all exports subsidies, but it preserves the Special and Differential Treatment of developing countries. As such, domestic support and tariffs are reduced but not eliminated.

Aggregate comparative static results for these counterfactuals are presented in Table 2. In terms of aggregate growth, these scenarios are generally consistent with intuition. In particular, FL is the biggest stimulus to Vietnam, followed by UL and DSDT. Real GDP rises moderately under UL and FL scenarios, but slightly declines under DSDT scenario. FL also brings about a higher level of real consumption than UL and DSDT do. This is not only a result of greater trade stimulus but also a result of improved terms of trade.

Our CGE results show that textiles, technology, and machinery sectors expand significantly, accompanied by construction, and trade and transport services, while the agricultural sector remains prominent as shown in Table 3. More fundamentally, these results begin to reveal the mechanisms by which external liberalization can affect poverty and inequality in Vietnam. Like many developing countries, Vietnam's poor majority are farmers living at or near the subsistence level. Their assets are generally limited to labour, small land holdings of uncertain quality and livestock. In the Asian context, external liberalization has generally provided the most direct growth impetus to urban populations through expansion of light, intermediate, and heavy industrial activities. The majority of the rural poor have two channels by which they can participate in urban based growth, migration and marketing of food products. The comparative static model used here does not model the former, so we confine our attention to changing income opportunities.

The sectoral results of Table 3 presage our subsequent poverty analysis. The most important difference between the scenarios in this context has to do with food prices and domestic output responses. Under the UL scenario, food prices are suppressed by import liberalization and farmers suffer directly and indirectly. In the case of FL, all primary food prices rise and farm output and income respond accordingly. Clearly, a low income agrarian country like Vietnam needs to see significant agricultural returns from any multi-lateral trade agreement, if its poor rural majority are to benefit in the short or medium term.

5.2 Changes in poverty rates after trade liberalization

As noted in the previous section, our analysis starts by looking at the spatial distribution of poverty under the Baseline (ex ante) scenario. We estimated relevant parameters in Eq(5)–Eq(8) using the VLSS data set.

For Eq(5), we simply ran OLS for each wage-earner of the eight labour segments to find coefficients. The R^2 statistic varied from 0.24 to 0.42, depending on the labour segment. For Eq(6), we ran OLS of logarithmic non-wage income for urban and rural areas, capturing about 35 per cent and 38 per cent of variations. There are about 1.2 per cent of households without any non-wage income, and they were excluded from the estimation. Multinomial logit regressions were run to estimate Eq(7) and Eq(8) for each labour segment. We were able to predict 73 per cent of the individuals correctly after applying the relevant weights. Detailed estimation results are reported in the Appendix.

The macroeconomic CGE results also gives us the aggregate wage income for each combination of skilled/unskilled, male/female and urban/rural as well as the non-wage income for rural and urban households. This allows us to calculate the adjustment coefficients by solving Eq(13)–Eq(16). The adjustment coefficients for each scenario are also reported in the Appendix.

We first imputed the household income for each census record for each round of the Monte-Carlo simulation without applying the adjustment coefficients. We then calculated poverty rates for each province using Eq(12) and plotted them on a map as shown in Figure 1, which we shall call the baseline map. The maximum, minimum and average standard error for the provincial-level estimate of poverty rate were 11.6 per cent, 0.4 per cent and 2.1 per cent respectively. Thus, while there are a few provinces with quite high-levels of standard errors, provincial-level estimates are on average accurate enough to justify this presentation.

To see how our estimates correspond to others in the literature, we first calculated the poverty rate for Vietnam. The point estimate and its associated standard error were 34.6 per cent and 0.7 per cent respectively. The difference between this estimate and the survey-only estimate is not significant. However, the gap is not as small as one would usually find in the standard small-area estimation. This is possibly because we need to estimate many more equations than the standard method. We also plotted the provincial-level estimates of our income poverty rates against the provincial-level consumption poverty rates calculated by Minot et al. (2003). There is a moderately strong correlation between the two measures with the correlation coefficient of 0.4. Overall, our baseline estimates of poverty seem reasonable.

In order to see how income poverty changes after Vietnam's accession to the WTO under various scenarios, we applied the adjustment coefficients and re-calculated the household income for each census household and for each scenario. Then, we re-calculated the poverty rates for each province. This yields ex post estimates of poverty. The ex post estimates of poverty in Vietnam has decreased by 0.8 per cent and 6.8 per cent under the UL and FL scenarios respectively. However, under the DSDT scenarios, the national poverty rate increased by 0.6 per cent. Again, we see that the FL helps reduce poverty most.

We also looked at changes in poverty rates at the provincial-level. Figure 3 shows the spatial incidence of trade policy under the UL scenario. Figure 4 and Figure 5 are for the FL and DSDT scenarios respectively. In each map, lighter colours represent higher levels of improvement or lower levels of aggravation in terms of the provincial-level poverty rate. In other words, the lighter colours get relatively more beneficial impacts from trade liberalization.

Three salient points deserve emphasis here. First, the magnitude of the impact of trade policy on poverty can vary quite substantially across the country. Under the FL scenario, one province achieves 14.3 per cent lower headcount poverty, while another province only achieves 2.4 per cent reduction. This difference is adducible to differences in the initial distribution of income, as well as heterogeneity in the composition of households and individuals. Under the UL and DSDT scenarios, spatial differences in absolute terms are much smaller because the changes in aggregates are also smaller.

Second, the trade liberalization appears to be consistent with poverty reduction overall. The correlations between the ex ante poverty rates and the changes in poverty after trade liberalization at the provincial level are -0.26, -0.71 and -0.60 for the UL, FL and DSDT scenarios. This suggests that the FL scenario not only achieves the largest poverty reduction among all the scenarios, but helps the most impoverished areas. This point may be more clearly seen from Figure 6. It plots the ex ante poverty rate against the change in poverty rate under the FL scenario. It shows that the reductions in poverty rate are generally higher for the areas that are poor ex ante. On the other hand, the change in poverty rates varies substantially among the provinces with similar ex ante poverty rates.

The third point to note is that the spatial pattern is similar across all the scenarios considered. We generally see greater improvement (or less adversity in case of the DSDT scenario) in poverty along the coastal areas, whereas the northwest of Vietnam and the Lao-Vietnam border areas will not see much improvement. On the other hand, the lagging northwestern provinces are of particular concern because the poverty rates are already high there. It might therefore be desirable to target further assistance to this region.
So far, we have ignored changes in the consumer prices. To account for this, we divided the poverty line by the ex post consumer price index. This treatment is rudimentary because we cannot capture potential differences in the changes in consumer prices across the country. However, we can estimate the magnitude of price effects in aggregate terms. If we account the changes in the consumer prices, there will be additional real benefits of 1.4 per cent and 0.3 per cent for the UL and FL scenarios in poverty reduction. Under the DSDT scenario, the increase in poverty rate will be reduced to just 0.4 per cent.

6 Conclusion

This study explored the spatial dimension of poverty associated with Vietnam's accession to the WTO. While Vietnam as a whole is likely to benefit from the accession, the degree and spatial composition of poverty reduction across the country is more ambiguous. The main constraint in this context is estimating the spatial incidence of structural adjustments arising from trade liberalization. By combining the integrated microsimulation-CGE model with the small area estimation technique, we were able to overcome this constraint.

Our simulation results show that aggregate poverty will decrease when Vietnam removes all import tariffs and export subsidies. The amount of improvement will be even larger when other countries also remove tariffs against Vietnamese products. On the other hand, the DSDT scenario leads to a slight increase in poverty.

As Figures 3–5 show, the impacts of Vietnam's accession to the WTO are spatially heterogeneous. The heterogeneity is particularly large under the FL scenario. Our study suggests that poor provinces in the northwestern regions may benefit little from trade liberalization. This is of concern from the view point of spatial equity within the country. Further, spatial heterogeneity in poverty reduction affects the efficiency of the targeting policies. Thus, our estimates provide guidance for policy-makers to develop targeting policies that complement trade liberalization policies. More effective targeting will conserve public resources and prevents poor areas from lagging further behind national growth.

The method we developed in this study has relevance to many other economic policy issues. For example, we can simulate the spatial incidence of exogenous price shocks or hypothetical taxes and other fiscal instruments. While the amount of computation and data requirements (survey, census, and social accounting matrix) may be significant, there are many countries that already possess such resources. Geographic targeting is already widely used in developing countries, but it is often formulated independently of their macroeconomic policies. Our method of combining the integrated microsimulation-CGE model with small-area estimation provides an opportunity for linking the two to achieve a more complete set of microeconomic and macroeconomic objectives.

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Table 1 Summary statistics of income and consumption measures

Column Region	1 Con.	2 (SE)	3 P_0^C	4 (SE)	5 Inc.	6 (SE)	7 P_0^I	8 (SE)	9 Obs	10 Share
Red River Delta	2938	(99)	28.7	(2.2)	3094	(188)	36.9	(2.3)	1175	19.6
Northeast	1987	(94)	55.8	(4.9)	1860	(208)	57.4	(4.2)	731	15.0
Northwest	1567	(85)	73.4	(4.9)	1599	(287)	54.2	(8.1)	128	2.8
North	2197	(89)	48.1	(4.2)	2122	(175)	47.5	(4.1)	708	13.8
South Central Coast	2648	(114)	34.5	(4.3)	3075	(322)	36.8	(4.7)	628	8.5
Central Highlands	1850	(241)	57.9	(9.4)	2191	(622)	52.4	(8.2)	276	2.8
Southeast	4523	(189)	13.5	(3.2)	5860	(395)	15.2	(3.0)	1241	15.9
Mekong River Delta	2536	(87)	36.9	(2.4)	3218	(147)	29.7	(2.3)	1112	21.5
Vietnam	2764	(43)	37.4	(1.3)	3171	(85)	37.4	(1.4)	5999	100.0

Note: All the standard errors are calculated by bootstrapping accounting for the strata, clustering and weights. Poverty rates, their associated standard errors and population share are expressed in percentage.

Table 2 Changes in aggregate indices from the macroeconomic CGE under various scenarios

(Scenario)	UL	FL	DSDT
Real GDP	3.97	5.31	-0.27
GDP at factor cost	3.69	12.90	-1.23
GDP at market prices	-2.81	5.81	-1.25
Real consumption	7.02	10.71	-0.47
Imports	16.46	27.54	-1.28
Exports	14.02	20.53	-0.82
Consumer price index	-5.62	-1.33	-0.61
Terms of trade	-2.89	2.18	-0.74

Note: The numbers are expressed in percentage.

Table 3 Baseline sectoral output in terms of million US dollars for the year 2000, and changes in sectoral output and prices in percentage

Sector	Baseline output	Change in output			Change in price		
(Scenario)		*UL*	*FL*	*DSDT*	*UL*	*FL*	*DSDT*
Rice	105145	1.11	4.50	0.05	-0.80	8.54	-0.76
Raw rubber	2442	-1.44	9.42	0.37	0.19	15.23	-0.54
Coffee bean	7262	1.96	-5.02	-0.64	-0.55	1.32	-1.18
Sugar cane	2911	0.45	6.86	-0.69	-1.74	12.96	-1.61
Other crops	35761	0.43	-0.58	-0.18	-0.09	5.54	-1.09
Pig	13687	3.55	5.75	-0.33	-1.08	5.19	-0.94
Cattle	1107	4.18	6.80	-0.25	-1.11	5.19	-0.88
Poultry	6116	1.01	1.57	-0.10	0.70	8.10	-1.07
Other livestocks	5242	4.84	10.43	-0.09	-2.11	3.72	-0.81
Irrigation services	1277	1.35	3.24	-0.13	-1.61	3.72	-0.78
Other agr. srvices	4839	1.24	4.00	-0.04	-2.23	2.73	-0.71
Forestry	7717	1.68	0.11	0.20	-0.07	5.34	-0.83
Fish	26000	6.57	2.94	-1.77	-2.81	1.59	-0.82
Energy	57461	-3.29	-7.80	0.91	-3.27	0.21	-0.57
Mining	3529	0.25	-4.72	0.54	-1.20	3.22	-0.66
Meat	2883	1.45	-1.09	0.26	-1.45	5.31	-1.11
Dairy products	4815	-1.59	24.47	3.78	-5.76	-4.10	-1.01
Fruits and vegetables	1739	-2.46	-0.77	-0.28	-1.65	3.34	-0.83
Rafined sugar	6794	0.26	7.93	-0.80	-0.90	8.30	-1.09
Coffee and tea bevereages	1538	1.80	1.79	-0.95	-1.15	3.39	-0.90
Other bev. and tobacco	21428	-12.24	-12.32	-0.38	-4.11	0.83	-0.79
Sea food	20412	6.79	-6.94	-3.11	-4.96	-0.61	-0.68
Animal feed	4219	-9.29	-11.39	0.10	-2.89	2.31	-0.76
Other processed foods	19521	-4.80	-6.18	-0.56	-3.10	1.88	-0.72
Building materials	36658	2.27	1.72	-0.04	-1.77	3.08	-0.74
Industrial chemicals	24785	0.23	10.42	0.48	-2.84	-1.06	-0.46
Agro chemicals	5909	-5.35	-10.80	1.08	-2.55	0.36	-0.47
Tech manufacturing	6184	29.04	14.74	4.52	-8.19	-5.59	-0.65
Vehicles	29836	-32.79	-32.02	0.37	-15.52	-13.69	-0.43
Machinery	14014	8.71	9.91	1.60	-6.74	-5.32	-0.39
Metals	18976	3.41	1.20	0.66	-5.10	-3.09	-0.31
Textile and apparel	58078	38.19	67.32	-4.25	-17.09	-16.17	0.01
Other industry	20574	-2.29	-5.76	0.82	-8.61	-6.13	-0.42
Utilities	19061	2.46	3.21	-0.14	-0.26	5.63	-0.84
Construction	84600	4.62	10.31	-0.83	-3.08	0.64	-0.56
Trade and transport	94185	6.75	10.02	-0.53	-3.38	1.80	-0.77
Private service	101236	3.16	2.52	-0.21	-0.97	4.03	-0.70
Public service	56309	1.63	0.27	0.18	-2.54	2.13	-0.68

Appendix

There are three subsections in this Appendix. Section A1 provides the regression results for the wage equation Eq(5) and the adjustment coefficients for Eq(13). Section A2 provides the non-wage household income equation Eq(6) and the adjustment coefficient for Eq(14). Section A3 provides the regression results for the employment status equations Eq(7)–Eq(8) and the adjustment coefficients for Eq(15)–Eq(16). SDBR stands for shortest distance by road. In each table, we present the estimated coefficients and its associated standard errors on the top part of the table. In the middle part of the table, we present some diagnostic statistics for the regression. In the bottom part, we present the adjustment coefficients.

A1 Wage equation

Table 4 Wage equation for rural/male/unskilled

Description	Est.	SE
Arable land in district (km^2)	0.002	(0.000)
Head is married	0.902	(0.472)
Max. education, at least secondary completed	-2.801	(0.981)
Average annual humidity duration	-0.024	(0.005)
Head’s child	-0.962	(0.272)
Not immediately related to head	-1.227	(0.321)
Age squared/1000	-0.554	(0.141)
Female head	-0.366	(0.147)
Head has at least secondary education	3.820	(1.093)
Total length of road in district	-1.870	(0.364)
Number of elderly people in HH	-1.381	(0.329)
Maximum monthly precipitation in a year	2.294	(0.594)
Age of head	0.036	(0.008)
Ratio of elderly in HH	3.825	(1.347)
Spouse has at least 8 years of schooling	0.729	(0.230)
An Giang province	-0.363	(0.213)
Bac Lieu province	0.998	(0.390)
Can Tho province	-0.847	(0.280)
Constant	29.972	(4.794)
Obs	255	
F(18, 236)	6.14	
P-Value	0.000	
R^2	0.319	
$\widetilde{\sigma_\mu}$	0.839	
$\widetilde{\Delta\alpha_{UL}}$	-0.002	
$\widetilde{\Delta\alpha_{FL}}$	0.082	
$\widetilde{\Delta\alpha_{DSDT}}$	-0.010	

Table 5 Wage equation for rural/male/skilled

Description	Est.	SE
Head's ethnicity is Kinh	0.397	(0.109)
Max. education, at least college	0.339	(0.140)
Spouse	0.354	(0.136)
Distance from district town to a city*	0.001	(0.000)
Age	-0.001	(0.003)
Number of Dependents	0.065	(0.027)
Ratio of children in HH	-0.551	(0.183)
Dong Nai province	0.373	(0.156)
Tien Giang province	-0.444	(0.138)
Quang Tri province	-1.405	(0.282)
Nghe An province	-0.714	(0.139)
Thua Thien-Hue province	-1.004	(0.219)
Ho Chi Minh City	0.845	(0.165)
Binh Duong province	0.885	(0.429)
Ha Noi province	0.503	(0.220)
Bac Giang province	-0.720	(0.283)
Nam Dinh province	-0.474	(0.182)
Hai Duong province	-0.796	(0.146)
Can Tho province	-0.899	(0.291)
Constant	7.580	(0.150)
Obs	750	
F(19, 730)	12.06	
P-Value	0.000	
R^2	0.239	
$\widetilde{\sigma_\mu}$	0.790	
$\widetilde{\Delta\alpha}_{UL}$	-0.027	
$\widetilde{\Delta\alpha}_{FL}$	0.030	
$\widetilde{\Delta\alpha}_{DSDT}$	-0.008	

Note: *city with population greater than 1,000,000.

Table 6 Wage equation for rural/female/unskilled

Description	Est.	SE
Distance from district town to a city*	0.029	(0.017)
Length of navigable river in district (km)	-0.020	(0.005)
Max. education, at least 8 years	-0.879	(0.220)
Arable land in district (km^2)	0.000	(0.001)
Parent of the head	-1.515	(0.868)
HH owns house	1.162	(0.668)
Distance from district town to a city**	-0.007	(0.005)
Percentage of area covered by plant/forest in district	-0.112	(0.030)
Distance from district town to a city***	0.005	(0.001)
Ratio of dependents in HH	3.387	(0.926)
House is at least 10 years old	1.278	(0.380)
Head’s religion is Catholic	-0.584	(0.332)
Length of main road (km)	5.740	(2.870)
Head has at least 5 years of education	0.328	(0.188)
Average elevation of district	-0.001	(0.001)
Water is not from running water/rain/well	0.441	(0.173)
HH size	0.235	(0.069)
Number of dependents	-0.655	(0.179)
Semi-permanent house	1.062	(0.375)
Thua Thien-Hue province	2.085	(0.741)
Ho Chi Minh City	1.259	(0.539)
Constant	3.748	(0.879)
Obs	169	
F(21, 147)	3.82	
P-Value	0.000	
R^2	0.353	
$\widetilde{\sigma_{\mu}}$	0.884	
$\widetilde{\Delta\alpha}_{UL}$	-0.013	
$\widetilde{\Delta\alpha}_{FL}$	0.061	
$\widetilde{\Delta\alpha}_{DSDT}$	-0.008	

Note: *city with population greater than 10,000
**city with a population greater than 100,000
**city with a population greater than 250,000.

Table 7 Wage equation for rural/female/skilled

Description	Est.	SE
Head at least some education	0.376	(0.173)
At least secondary completed	0.411	(0.090)
Head's child	0.235	(0.108)
Water from well	0.324	(0.092)
Age	0.012	(0.005)
Minimum monthly precipitation in a year	-0.014	(0.004)
HH has radio	0.292	(0.078)
Tien Giang province	-0.802	(0.232)
Quang Tri province	-2.115	(0.420)
Kien Giang province	-0.911	(0.329)
Hai Duong province	-1.587	(0.238)
Quang Binh province	-1.146	(0.503)
Ho Chi Minh City	0.497	(0.188)
Ha Tay province	-0.593	(0.218)
Constant	6.880	(0.262)
Obs	405	
F(14, 390)	17.26	
P-Value	0.000	
R^2	0.383	
$\widetilde{\sigma_{\mu}}$	0.770	
$\widetilde{\Delta\alpha}_{UL}$	-0.013	
$\widetilde{\Delta\alpha}_{FL}$	0.032	
$\widetilde{\Delta\alpha}_{DSDT}$	-0.006	

Table 8 Wage equation for urban/male/unskilled

Description	Est.	SE
Head is married	-1.421	(0.531)
North central coast region	-1.171	(0.525)
Water from well	-0.459	(0.170)
Age of head	-0.018	(0.006)
House is shared with other HH(s)	0.580	(0.245)
Water from rain	-1.735	(0.417)
Constant	9.602	(0.337)
Obs	84	
F(6, 77)	9.23	
P-Value	0.000	
R^2	0.418	
$\widetilde{\sigma_{\mu}}$	0.679	
$\widetilde{\Delta\alpha}_{UL}$	0.023	
$\widetilde{\Delta\alpha}_{FL}$	0.100	
$\widetilde{\Delta\alpha}_{DSDT}$	-0.002	

Table 9 Wage equation for urban/male/skilled

Description	Est.	SE
Logarithmic population of district	0.162	(0.033)
Never married	-0.356	(0.062)
Logarithmic living area	0.411	(0.062)
Temporary house	1.522	(0.262)
Length of navigable river in district (km)	-0.024	(0.004)
Percentage of bare rock surface in district	-0.027	(0.007)
HH size	-0.049	(0.014)
Head’s religion is Catholic	-0.279	(0.127)
Binh Thuan province	-0.488	(0.246)
Thua Thien-Hue province	-0.699	(0.222)
Ha Noi province	-0.195	(0.090)
Hai Phong province	-0.353	(0.135)
Nam Dinh province	-0.740	(0.209)
Dong Thap province	-0.484	(0.152)
Yen Bai province	-0.505	(0.188)
Son La province	-1.171	(0.955)
Constant	6.073	(0.452)
Obs	819	
F(16, 802)	17.90	
P-Value	0.000	
R^2	0.263	
$\widetilde{\sigma_{\mu}}$	0.814	
$\widetilde{\Delta\alpha}_{UL}$	0.021	
$\widetilde{\Delta\alpha}_{FL}$	0.097	
$\widetilde{\Delta\alpha}_{DSDT}$	-0.010	

Table 10 Wage equation for urban/female/unskilled

Description	Est.	SE
Number of dependents	-0.744	(0.229)
Head has at least 8 years of education	-0.828	(0.267)
Head's religion is Catholic	-0.919	(0.343)
HH size	0.312	(0.092)
Head is married	2.093	(0.668)
Age	0.008	(0.008)
Head's ethnicity is Kinh	-0.541	(0.253)
Ratio of dependents in HH	4.621	(1.258)
House is 3-9 years old	0.865	(0.251)
Constant	6.503	(0.653)
Obs	67	
F(9, 57)	4.47	
P-Value	0.000	
R^2	0.414	
σ_μ	0.791	
$\widetilde{\Delta\alpha}_{UL}$	-0.016	
$\widetilde{\Delta\alpha}_{FL}$	0.095	
$\widetilde{\Delta\alpha}_{DSDT}$	-0.010	

Table 11 Wage Equation for urban/female/skilled

Description	Est.	SE
Maximum education, at least 10 years	0.300	(0.081)
Distance from district town to a city*	-0.002	(0.000)
House is at least 10 years old	-0.210	(0.066)
Head has no religion	0.229	(0.078)
Average annual humidity duration	-0.010	(0.002)
At least 8 years of education	0.327	(0.091)
Distance to provincial town	-0.012	(0.004)
Age	0.010	(0.003)
Hai Phong province	-0.531	(0.157)
Nam Dinh province	-0.931	(0.256)
Tien Giang province	-0.487	(0.180)
Constant	18.180	(1.988)
Obs	618	
F(11, 606)	21.22	
P-Value	0.000	
R^2	0.278	
σ_μ	0.766	
$\widetilde{\Delta\alpha}_{UL}$	0.012	
$\widetilde{\Delta\alpha}_{FL}$	0.120	
$\widetilde{\Delta\alpha}_{DSDT}$	-0.010	

Note: *city with population greater than 250,000.

A2 Non-wage income equation

Table 12 Non-wage equation for rural areas

Description	Est.	SE
Number of self-employed	0.507	(0.037)
Number of self-employed squared	-0.053	(0.006)
HH has TV	0.409	(0.037)
Head's ethnicity is Kinh	0.360	(0.060)
Ratio of students in HH	0.659	(0.085)
Max. educ., at least 10 yrs	0.231	(0.039)
Max. educ., at least some education	0.296	(0.098)
HH has a radio	0.119	(0.034)
House is 3-9 years old	-0.670	(0.098)
Non-flushing toilet	-0.463	(0.092)
Electricity available	0.317	(0.049)
Ratio of elderly in HH	0.500	(0.101)
Max. educ., at least 5 yrs	0.218	(0.053)
Semi-permanent house	-0.361	(0.056)
Log of the living area	0.143	(0.017)
Head's marital status is divorced/separated/widowed	-0.200	(0.049)
Head's age	0.003	(0.002)
Arable land in district (km^2)	0.001	(0.000)
Thua Thien-Hue province	1.552	(0.166)
Monthly minimum precipitation in a year	-0.030	(0.003)
Bac Ninh province	0.426	(0.100)
Bac Giang province	-0.404	(0.109)
Ha Tinh province	1.169	(0.222)
Hai Duong province	-0.477	(0.089)
Quang Tri province	0.835	(0.188)
Vinh Phuc province	-0.683	(0.173)
Phu Tho province	-0.436	(0.101)
Lam Dong province	0.750	(0.181)
Elevation of district town	-0.425	(0.124)
Qhuang Ninh province	0.552	(0.165)
Long An province	-0.527	(0.133)
Thai Binh province	-0.372	(0.105)
Percentage of area covered by plant or forest in district	-0.023	(0.008)
Tra Vinh province	-0.430	(0.131)
Total length of road in district (1000 km)	-0.346	(0.103)
Tien Giang province	-0.282	(0.109)
Dong Thap province	-0.403	(0.126)
Thai Nguyen province	-0.457	(0.173)
Ha Nam province	-0.283	(0.105)
Tuyen Quang province	0.536	(0.187)
Binh Duong Province	-0.400	(0.168)
Proportion of steep slope (8-15%)	0.012	(0.003)
Ninh Thuan province	-0.721	(0.204)
Yen Bai province	-0.368	(0.171)

Quang Nam province	-0.236	(0.130)
Hoa Binh province	-0.283	(0.134)
Constant	6.813	(0.175)
Obs	4248	
F(46, 4201)	56.58	
P-Value	0.000	
R^2	0.383	
σ_γ	1.032	
$\Delta\gamma_{UL}$	0.013	
$\Delta\gamma_{FL}$	0.100	
$\Delta\gamma_{DSDT}$	-0.012	

Table 13 Non-wage equation for urban areas

Description	Est.	SE
Number of self-employed	0.903	(0.063)
Number of self-employed squared	-0.106	(0.016)
HH has TV	0.394	(0.082)
Non-flushing toilet	-0.194	(0.076)
Max. educ., at least 10 years	0.332	(0.066)
Ratio of dependants in HH	0.768	(0.129)
Logarithmic living area	0.346	(0.066)
Semi-permanent house	-0.347	(0.072)
House is 3-9 years old	0.754	(0.278)
House is shared with other HH(s)	-0.427	(0.109)
Logarithmic population in district	0.214	(0.029)
Minimum monthly precipitation in a year	-0.034	(0.005)
Proportion of very deep slope (30%+)	0.033	(0.008)
Hai Phong province	0.743	(0.144)
Maximum monthly precipitation in a year	1.425	(0.491)
Bac Ninh province	0.716	(0.234)
Dong Nai province	-0.333	(0.168)
Max. educ., at least college	0.195	(0.090)
Constant	3.915	(0.458)
Obs	1676	
F(18, 1657)	49.82	
P-Value	0.000	
R^2	0.351	
σ_γ	1.193	
$\Delta\gamma_{UL}$	0.013	
$\Delta\gamma_{FL}$	0.100	
$\Delta\gamma_{DSDT}$	-0.013	

A3 Employment status equations

Table 14 Employment status equations for rural/male/unskilled

Description	Wage-earner		Self-employed	
	Est.	SE	Est.	SE
Spouse	-1.772	(0.517)	-0.513	(0.580)
Head's child	-0.491	(0.369)	-0.548	(0.391)
Literate	1.070	(0.234)	0.710	(0.262)
Head's religion is Catholic	-0.653	(0.458)	-0.830	(0.534)
Head has no religion	-0.390	(0.253)	-0.560	(0.283)
Semi-permanent house	0.840	(0.283)	0.511	(0.324)
House is 6+ years old	-0.210	(0.322)	-1.226	(0.401)
House is 3-9 years old	2.358	(0.735)	1.564	(0.833)
Water from well	1.553	(0.575)	1.626	(0.617)
Water not from running water/rain water/well	1.613	(0.568)	1.509	(0.607)
Quang Ngai province	1.759	(0.937)	0.824	(1.146)
Dac Lac province	-2.325	(1.538)	-2.110	(1.797)
Lam Dong province	-4.036	(1.268)	-2.248	(1.438)
Tay Ninh province	1.064	(0.659)	1.292	(0.758)
Long An province	0.696	(0.848)	1.660	(0.915)
An Giang province	1.032	(0.591)	1.930	(0.624)
Tien Giang province	-0.362	(0.426)	1.137	(0.480)
Ben Tre province	1.416	(0.672)	0.446	(0.830)
Kien Giang province	0.643	(0.549)	0.954	(0.599)
Tra Vinh province	1.888	(1.017)	1.342	(1.084)
Soc Trang province	0.659	(0.502)	1.861	(0.537)
Bac Lieu province	1.314	(0.809)	2.270	(0.879)
Age	0.147	(0.051)	0.179	(0.059)
Age of spouse	0.011	(0.005)	0.007	(0.006)
Ratio of dependents in HH	-1.330	(0.649)	-1.841	(0.745)
Ratio of students in HH	3.539	(0.807)	2.972	(0.905)
Age squared/1000	-2.356	(0.608)	-3.412	(0.753)
Distance from district town to a city*	-0.023	(0.007)	-0.026	(0.008)
Average elevation of district	0.006	(0.001)	0.004	(0.001)
Length of navigable river in district (km)	-0.012	(0.006)	-0.024	(0.008)
Total area over 1500 m in elevation in district	-0.289	(0.082)	-0.267	(0.114)
Constant	-2.230	(1.220)	-1.831	(1.331)
Obs	1382			
χ^2_{66}	400.55			
$\widetilde{\Delta a}_{UL}$	0.011		0.040	
$\widetilde{\Delta a}_{FL}$	0.432		0.430	
$\widetilde{\Delta a}_{DSDT}$	-0.058		-0.058	

Note: *city with population greater than 50,000.

Table 15 Employment status equations for rural/male/skilled

Description	Wage-earner		Self-employed	
	Est.	SE	Est.	SE
Age of spouse squared/1000	0.567	(0.241)	0.712	(0.264)
Spouse	-1.026	(0.264)	-0.546	(0.312)
Never married	-0.826	(0.286)	-0.375	(0.310)
Moved within 5 years from rural area	-0.387	(0.343)	-0.520	(0.387)
House is 6+ years old	0.383	(0.152)	0.328	(0.170)
Electricity available	-0.490	(0.202)	-0.472	(0.227)
Water from rain	0.499	(0.273)	1.078	(0.307)
House is 3-9 years old	0.774	(0.225)	1.014	(0.257)
HH has radio	0.384	(0.138)	0.333	(0.157)
Head has at least some education	0.656	(0.333)	0.671	(0.372)
Head has at least college education	0.915	(0.798)	3.090	(0.927)
Spouse has at least 10 years of education	0.774	(0.544)	1.028	(0.575)
Spouse has at least secondary completed	-0.868	(0.616)	-0.657	(0.651)
Spouse has at least college education	0.701	(0.827)	2.115	(0.961)
Max. educ., at least college education	-0.857	(0.558)	-1.828	(0.732)
Hai Phong province	-0.646	(0.478)	-0.893	(0.563)
Thai Binh province	-0.415	(0.376)	-0.982	(0.466)
Ninh Binh province	-0.780	(0.731)	-1.275	(0.872)
Thai Nguyen province	-0.703	(0.533)	-2.488	(1.041)
Thua Thien-Hue province	-3.096	(1.543)	-3.368	(1.608)
Da Nang province	-4.240	(2.189)	-3.749	(2.256)
Quang Nam province	-3.056	(1.607)	-4.252	(1.699)
Quang Ngai province	-2.761	(1.356)	-2.034	(1.400)
Binh Dinh province	-1.406	(0.869)	-1.125	(0.917)
Ho Chi Minh City	-1.363	(0.518)	-1.019	(0.548)
Tay Ninh province	-1.083	(0.530)	-1.209	(0.578)
Binh Duong province	-1.525	(0.597)	-2.539	(0.791)
Dong Nai province	-0.698	(0.496)	-0.576	(0.530)
Ban Ria-Vung Tau province	-1.488	(0.575)	-2.916	(0.822)
Dong Thap province	-0.683	(0.429)	-1.441	(0.521)
Tra Vinh province	-1.166	(0.483)	-1.360	(0.569)
Soc Trang province	-1.580	(0.657)	-1.434	(0.775)
Age	0.074	(0.040)	0.225	(0.047)
Age of spouse	-0.033	(0.015)	-0.048	(0.017)
Ratio of females in HH	1.310	(0.433)	1.305	(0.487)
Ratio of students in HH	1.193	(0.395)	1.252	(0.446)
Age squared/1000	-1.444	(0.473)	-3.729	(0.583)
Percentage of bare rock surface in district	0.020	(0.015)	0.023	(0.017)
Distance from district town to a city*	-0.027	(0.011)	-0.034	(0.012)
Distance from district town to a city **	0.021	(0.011)	0.035	(0.012)
Total length of road in district	-0.676	(0.338)	-1.850	(0.396)
Average annual sunshine duration	0.480	(0.274)	1.428	(0.302)
SDBR from district town to a city*	0.015	(0.008)	0.019	(0.008)
SDBR from district town to a city**	-0.011	(0.008)	-0.020	(0.009)
Constant	-0.204	(1.099)	-5.401	(1.251)

Obs	3764	
χ^2_{88}	483.70	
$\widetilde{\Delta a}_{UL}$	0.012	0.038
$\widetilde{\Delta a}_{FL}$	1.777	1.766
$\widetilde{\Delta a}_{DSDT}$	-0.108	-0.109

Note: *city with population greater than 250,000
**city with population greater than 1,000,000.

Table 16 Employment status equations for rural/female/unskilled

Description	Wage-earner		Self-employed	
	Est.	SE	Est.	SE
Age of spouse squared/1000	1.483	(0.237)	1.594	(0.370)
Head's child	-1.306	(0.385)	-1.076	(0.553)
Not immediately related to head	-1.572	(0.288)	-1.645	(0.492)
Never married	0.941	(0.306)	1.381	(0.432)
Literate	0.404	(0.149)	0.212	(0.248)
Head's religion is Catholic	0.598	(0.278)	0.645	(0.469)
Head has no religion	0.470	(0.144)	0.375	(0.227)
House is 3-9 years old	-0.272	(0.139)	0.433	(0.258)
Water from rain	0.379	(0.252)	0.447	(0.431)
Flushing toilet	0.967	(0.382)	1.926	(0.810)
Non-• ushing toilet	0.922	(0.364)	0.883	(0.800)
Head has at least some education	0.354	(0.182)	-0.215	(0.282)
Head has at least 8 years of education	0.613	(0.236)	0.830	(0.457)
Max. educ., at least 5 years	0.159	(0.168)	-0.455	(0.260)
Max. educ., at least 8 years	-0.282	(0.181)	-0.261	(0.351)
Age	0.184	(0.036)	0.178	(0.057)
Age of spouse	-0.082	(0.014)	-0.092	(0.022)
Age squared/1000	-2.974	(0.412)	-3.393	(0.709)
Distance from district town to city*	0.012	(0.007)	-0.070	(0.018)
Distance from district town to a city**	-0.003	(0.001)	-0.005	(0.002)
Elevation of district town	0.600	(0.357)	-2.718	(1.156)
Average annual humidity duration	0.009	(0.005)	-0.032	(0.010)
SDBR from district town to a city***	0.001	(0.000)	0.002	(0.001)
Total area over 1500m in district	0.066	(0.053)	-0.195	(0.196)
Constant	-10.581	(4.782)	28.744	(9.695)
Obs	2302			
χ^2_{48}	539.72			
$\widetilde{\Delta a}_{UL}$	0.012		0.034	
$\widetilde{\Delta a}_{FL}$	0.219		0.226	
$\widetilde{\Delta a}_{DSDT}$	-0.059		-0.058	

Note: *city with population greater than 10,000
**city with population greater than 250,000
***city with population greater than 1,000,000.

Table 17 Employment status equation for rural/female/skilled

Description	Wage-earner		Self-employed	
	Est.	SE	Est.	SE
Head's child	-1.552	(0.413)	-1.087	(0.542)
Not immediately related to head	-1.053	(0.386)	-0.556	(0.483)
Never married	0.943	(0.306)	1.882	(0.399)
Moved within 5 years from rural area	-0.885	(0.334)	-0.373	(0.465)
Head's religion is Catholic	-0.447	(0.252)	-1.599	(0.376)
Head's religion is other than none/Buddhism/Catholic	0.433	(0.410)	1.015	(0.473)
Electricity available	0.301	(0.175)	0.418	(0.229)
House is 3-9 years old	-0.115	(0.141)	-0.278	(0.175)
At least 10 years of education	-0.289	(0.218)	0.964	(0.241)
Head is married	-1.397	(0.532)	-2.117	(0.745)
Nghe An province	0.408	(0.362)	1.360	(0.440)
Ha Tinh province	1.323	(1.027)	1.144	(1.122)
Da Nang province	-1.698	(0.730)	-1.493	(1.055)
Ho Chi Minh City	-1.856	(0.371)	-0.346	(0.422)
Dong Nai province	-0.726	(0.395)	0.739	(0.491)
Ban Ria-Vung Tau province	-1.030	(0.562)	-0.862	(0.870)
Age	0.184	(0.041)	0.327	(0.054)
HH size	0.308	(0.156)	0.311	(0.210)
Head's age	0.014	(0.010)	0.011	(0.012)
Ratio of dependents in HH	-1.015	(0.544)	-1.477	(0.677)
Ratio of females in HH	1.043	(0.432)	0.700	(0.535)
Ratio of children in HH	-1.382	(0.614)	-1.921	(0.747)
Ratio of students in HH	2.710	(0.504)	2.711	(0.637)
Age squared/1000	-2.794	(0.501)	-4.604	(0.698)
HH size squared/1000	-0.026	(0.012)	-0.027	(0.016)
Distance from district town to a city*	-0.110	(0.029)	-0.103	(0.034)
Elevation of district town	1.987	(0.782)	1.089	(0.921)
Proportion of somewhat steep slope (8-15%)	0.025	(0.010)	0.013	(0.012)
SDBR from district town to a city*	0.079	(0.020)	0.053	(0.024)
Mean distance to main road in district	-0.200	(0.038)	-0.081	(0.048)
Length of navigable river in district (km)	-0.004	(0.004)	-0.011	(0.005)
Constant	-1.563	(0.909)	-6.095	(1.187)
Obs	3476			
$\widetilde{\chi}^2_{62}$	538.73			
$\widetilde{\Delta a}_{UL}$	0.015		0.029	
$\widetilde{\Delta a}_{FL}$	1.976		1.969	
Δa_{DSDT}	-0.084		-0.075	

Note: *city with population greater than 10,000.

Table 18 Employment status equation for urban/male/unskilled

Description	Wage-earner		Self-employed	
	Est.	SE	Est.	SE
Literacy	2.573	(0.821)	2.552	(0.790)
Head's ethnicity is Kinh	-2.395	(0.901)	-2.271	(0.849)
Semi-permanent house	1.773	(0.621)	1.889	(0.663)
Water from rain	2.529	(1.649)	2.349	(1.834)
Water from well	1.124	(0.886)	1.318	(0.895)
Non-flushing toilet	3.397	(1.008)	3.130	(1.021)
Head has at least some education	-1.791	(0.848)	-2.230	(0.842)
House is 3-9 years old	1.102	(0.703)	1.394	(0.743)
Spouse has at least 5 years of education	-1.486	(0.793)	-1.143	(0.815)
Max. educ. in HH, at least 8 years	-0.979	(0.602)	-0.696	(0.619)
Age	0.392	(0.119)	0.469	(0.131)
HH owns house	-2.960	(1.454)	-4.033	(1.316)
Age squared/1000	-5.153	(1.540)	-7.475	(1.828)
Area (km^2)	0.098	(0.026)	0.090	(0.027)
Percentage of natural forest	0.187	(0.071)	0.221	(0.070)
Distance from district town to a city*	-2.494	(0.665)	-2.479	(0.666)
Distance from district town to a city**	0.525	(0.190)	0.562	(0.191)
Distance from district town to a city***	-0.403	(0.160)	-0.434	(0.159)
Total length of roads in district	-0.060	(0.017)	-0.061	(0.017)
Average elevation of district	-0.101	(0.029)	-0.071	(0.030)
Elevation of district town	0.193	(0.053)	0.165	(0.054)
Percentage of moderate slope in district (4-8%)	-2.367	(0.734)	-2.205	(0.755)
Average annual precipitation	6.330	(5.433)	9.233	(5.451)
Average annual temperature	-0.391	(0.168)	-0.242	(0.180)
Average annual humidity duration	-0.555	(0.225)	-0.353	(0.243)
SDBR from district town to a city#	-0.888	(0.244)	-0.786	(0.253)
SDBR from district town to a city*	2.003	(0.538)	1.949	(0.538)
SDBR from district town to a city**	-0.340	(0.126)	-0.368	(0.126)
SDBR from district town to a city***	0.314	(0.122)	0.329	(0.122)
Constant	650.906	(267.341)	403.054	(288.711)
Obs	225			
$\widetilde{\chi}^2_{58}$	213.54			
$\widetilde{\Delta a}_{UL}$	0.085		0.112	
$\widetilde{\Delta a}_{FL}$	0.644		0.638	
$\widetilde{\Delta a}_{DSDT}$	-0.023		-0.029	

Note: #city with population greater than 50,000
*city with population greater than 100,000
**city with population greater than 250,000
***city with population greater than 1,000,000.

Table 19 Employment status equation for urban/male/skilled

Description	Wage-earner		Self-employed	
	Est.	SE	Est.	SE
Never married	-1.206	(0.274)	-0.530	(0.267)
Divorced/separated/widowed	-1.597	(0.398)	-1.469	(0.435)
Moved within 5 years from urban area	-0.769	(0.318)	-0.661	(0.299)
Moved within 5 years from rural area	-0.655	(0.392)	-0.879	(0.397)
Head's ethnicity is Kinh	-0.354	(0.319)	-0.403	(0.318)
Electricity available	0.606	(0.580)	1.091	(0.670)
HH has TV	0.616	(0.213)	0.570	(0.213)
House is 3-9 years old	-0.556	(0.241)	-0.400	(0.242)
At least college education	0.498	(0.344)	1.649	(0.329)
Head at least 10 years of education	-0.427	(0.203)	-0.237	(0.204)
Spouse at least 10 years of education	0.551	(0.413)	0.486	(0.417)
Spouse at least secondary completed	-0.837	(0.456)	-0.801	(0.459)
Max. educ., at least secondary	0.430	(0.223)	0.445	(0.230)
Thai Nguyen province	-1.089	(0.480)	-0.497	(0.447)
Thanh Hoa province	1.778	(0.842)	2.062	(0.851)
Age	0.124	(0.042)	0.255	(0.043)
HH owns house	0.688	(0.235)	0.192	(0.225)
Ratio of students in HH	1.382	(0.426)	1.129	(0.432)
Age squared/1000	-2.036	(0.490)	-3.920	(0.511)
Constant	-1.330	(1.106)	-3.663	(1.158)
Obs	1830			
χ^2_{38}	338.24			
Δa_{UL}	0.059		0.071	
$\widetilde{\Delta a}_{FL}$	0.264		0.261	
$\widetilde{\Delta a}_{DSDT}$	-0.050		-0.050	

Table 20 Employment status regression for urban/female/unskilled

Description	Wage-earner		Self-employed	
	Est.	SE	Est.	SE
Never married	0.404	(0.442)	1.153	(0.509)
Divorced/separated/widowed	-0.516	(0.309)	0.397	(0.480)
Literate	0.415	(0.296)	0.874	(0.472)
Head has no religion	-0.281	(0.243)	-0.431	(0.334)
Head's ethnicity is Kinh	1.247	(0.314)	0.407	(0.392)
House is 6+ years old	-0.322	(0.266)	-0.366	(0.387)
Electricity available	0.655	(0.524)	1.637	(0.945)
House is 3-9 years old	1.269	(0.286)	0.541	(0.439)
Head, at least some education	0.916	(0.371)	0.910	(0.517)
Max educ., at least 10 years	-0.745	(0.262)	-0.884	(0.403)
Age	0.199	(0.061)	0.293	(0.084)
Ratio of dependents in HH	-1.806	(0.792)	-1.633	(1.134)
Ratio of students in HH	2.696	(0.923)	1.440	(1.230)
Age squared/1000	-2.223	(0.711)	-4.171	(1.069)
Constant	-5.979	(1.471)	-8.046	(1.983)
Obs	458			
χ^2_{28}	143.46			
$\widetilde{\Delta a}_{UL}$	0.040		0.046	
$\widetilde{\Delta a}_{FL}$	0.162		0.150	
$\widetilde{\Delta a}_{DSDT}$	-0.071		-0.069	

Table 21 Employment status equations for urban/skilled/female

Description	Wage-earner		Self-employed	
	Est.	SE	Est.	SE
Age of spouse squared/1000	-0.332	(0.279)	-0.455	(0.292)
Spouse	-0.598	(0.190)	-0.693	(0.216)
Not immediately related to head	-0.542	(0.218)	-0.289	(0.227)
Never married	0.226	(0.220)	0.838	(0.231)
Head's religion is Catholic	0.222	(0.291)	0.406	(0.305)
Head's religion is other than none/Buddhism/Catholic	-0.556	(0.457)	-1.076	(0.583)
Temporary house	-1.163	(0.576)	-0.888	(0.625)
House is 3-9 yrs old	-0.299	(0.140)	-0.327	(0.154)
At least 8 years of education	0.217	(0.147)	0.465	(0.171)
Head has at least college education	-0.524	(0.385)	1.254	(0.348)
Spouse has at least some education	-0.524	(0.456)	-0.843	(0.466)
Max. educ., at least college education	-0.225	(0.215)	0.429	(0.233)
Age	0.234	(0.038)	0.312	(0.044)
HH size	-0.050	(0.034)	-0.047	(0.037)
Log of the living area	-0.151	(0.138)	-0.281	(0.151)
Age of spouse	0.035	(0.022)	0.042	(0.023)
Ratio of children in HH	-0.449	(0.484)	-1.324	(0.539)
Ratio of students in HH	1.187	(0.429)	1.319	(0.472)
Age squared/1000	-0.003	(0.000)	-0.005	(0.001)
Arable land in district (km^2)	-0.002	(0.002)	-0.003	(0.002)
Logarithmic population of district	-0.558	(0.086)	-0.294	(0.096)
Distance from district town to a city*	0.075	(0.049)	0.084	(0.055)
Distance from district town to a city***	0.008	(0.003)	0.017	(0.004)
Length of main road (km)	0.006	(0.004)	0.014	(0.004)
SDBR from district town to a city**	0.004	(0.001)	0.002	(0.001)
SDBR from district town to a city***	-0.006	(0.003)	-0.012	(0.003)
Mean distance to main road in district	-0.423	(0.189)	-0.309	(0.209)
Constant	3.975	(1.295)	-0.127	(1.450)
Obs	1899			
$\widetilde{\chi^2_{54}}$	556.96			
$\widetilde{\Delta a_{UL}}$	0.041		0.069	
$\widetilde{\Delta a_{FL}}$	0.187		0.186	
$\widetilde{\Delta a_{DSDT}}$	-0.029		-0.031	

Note: *city with population greater than 10,000

**city with population greater than 250,000

***city with population greater than 1,000,000.

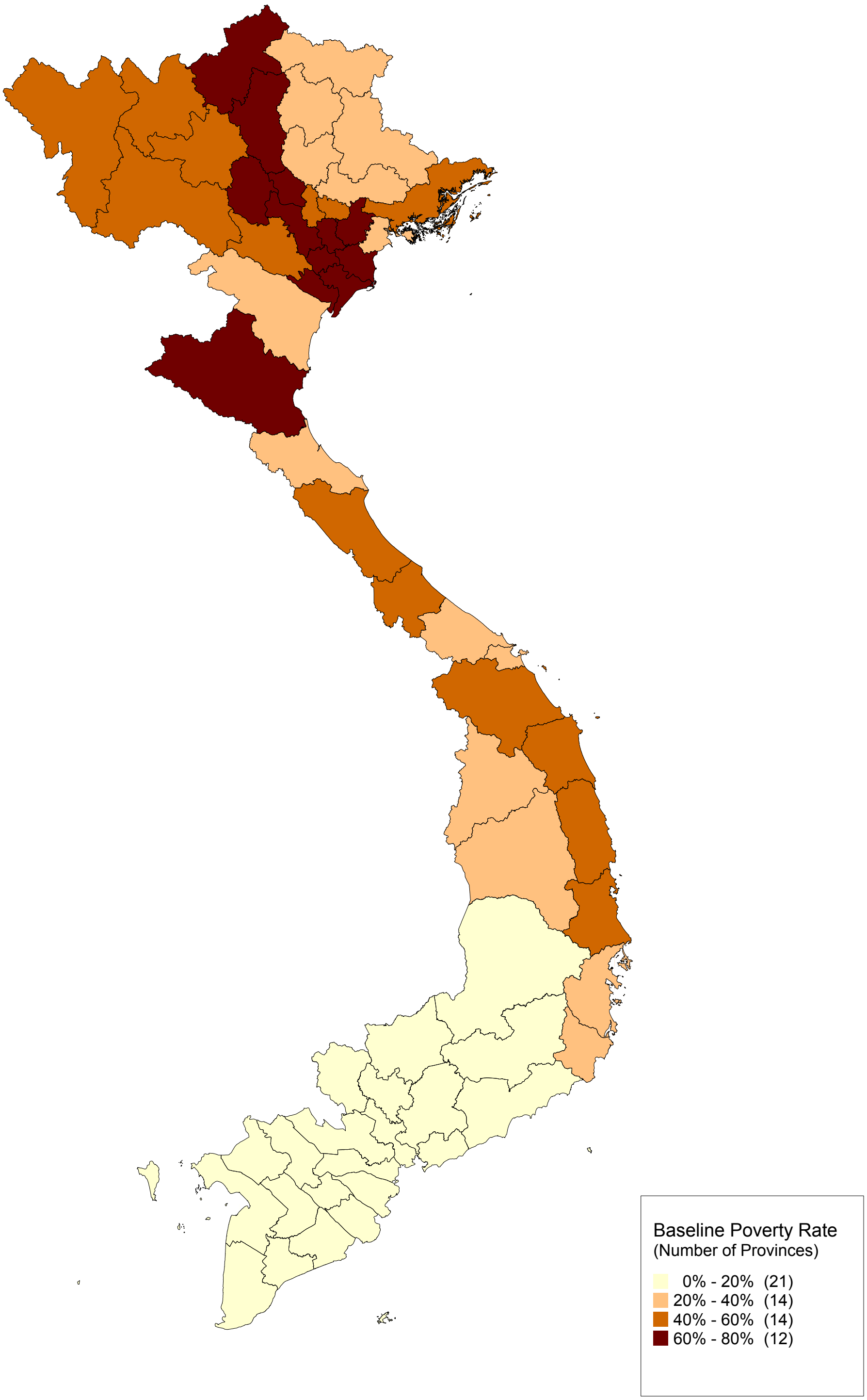

Figure 1: Baseline income poverty map.

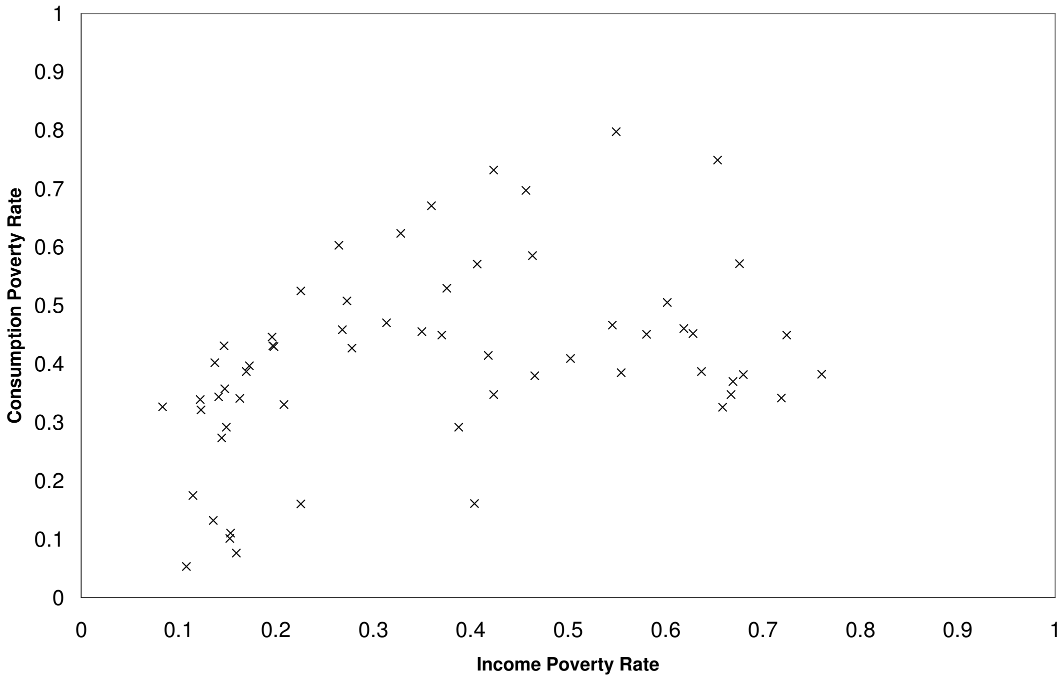

Figure 2: Scatter plot for provincial-level income poverty vs consumption poverty.

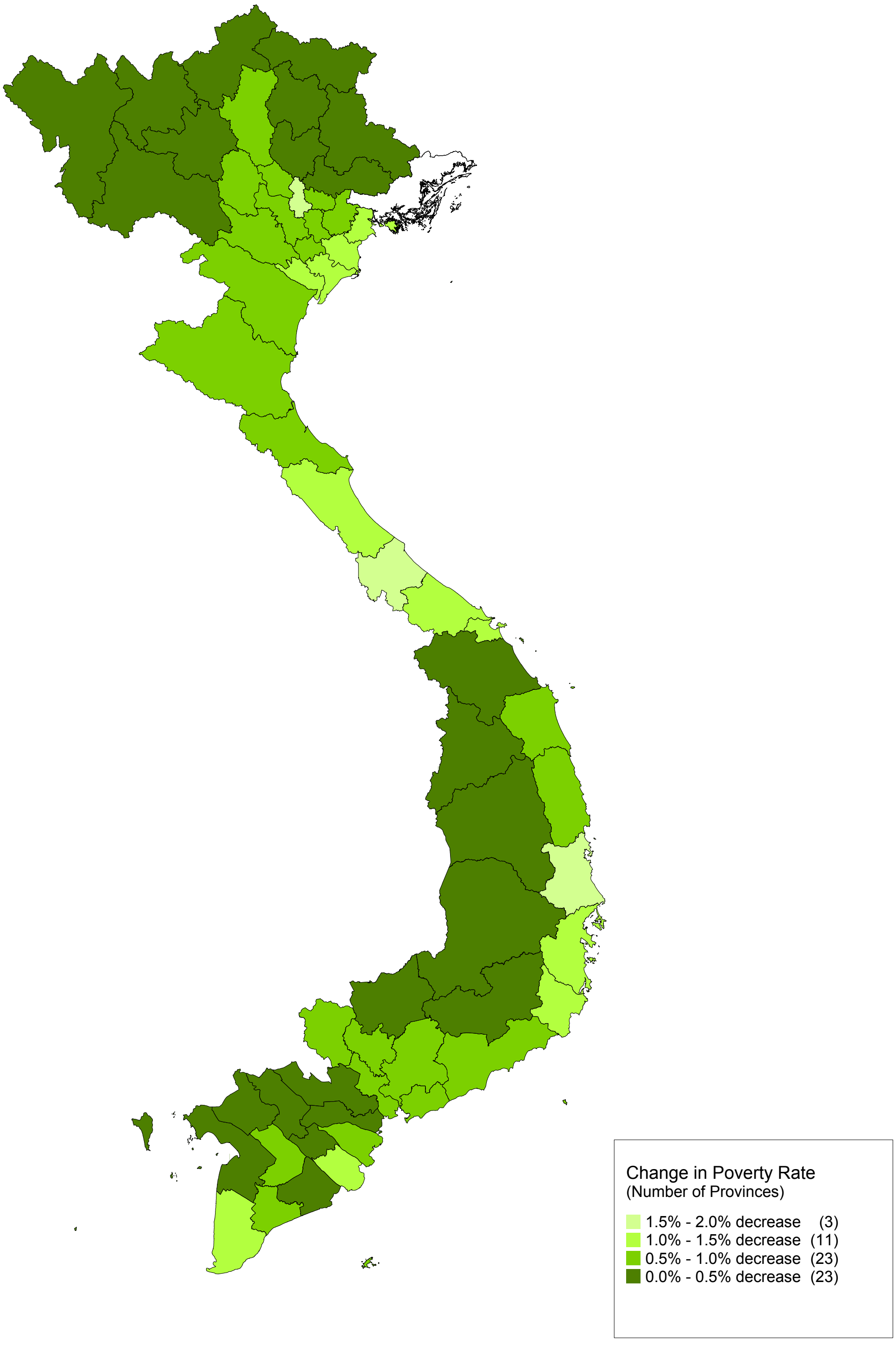

Figure 3: The change in provincial-level poverty rates under the UL scenario.

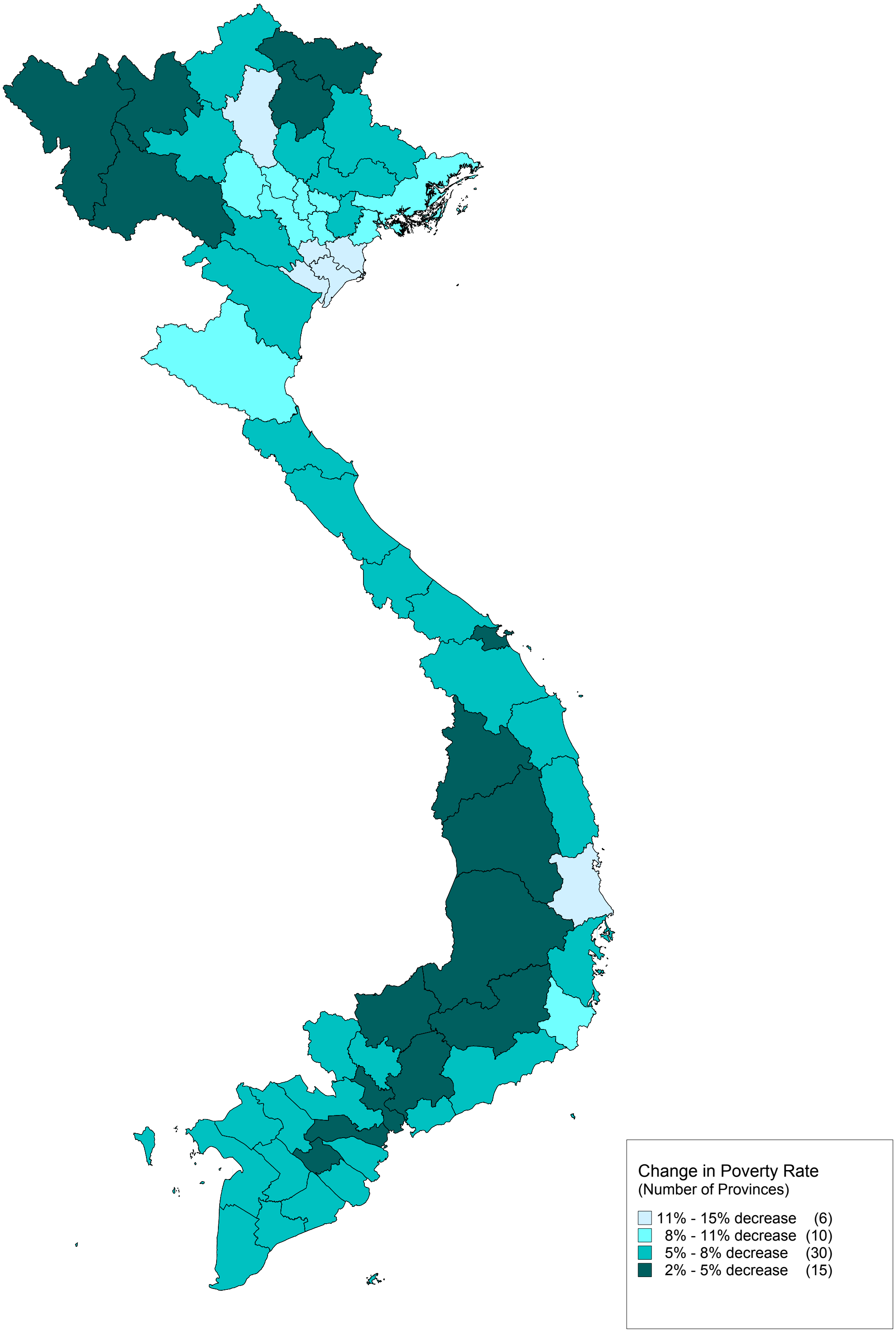

Figure 4: The change in provincial-level poverty rates under the FL scenario.

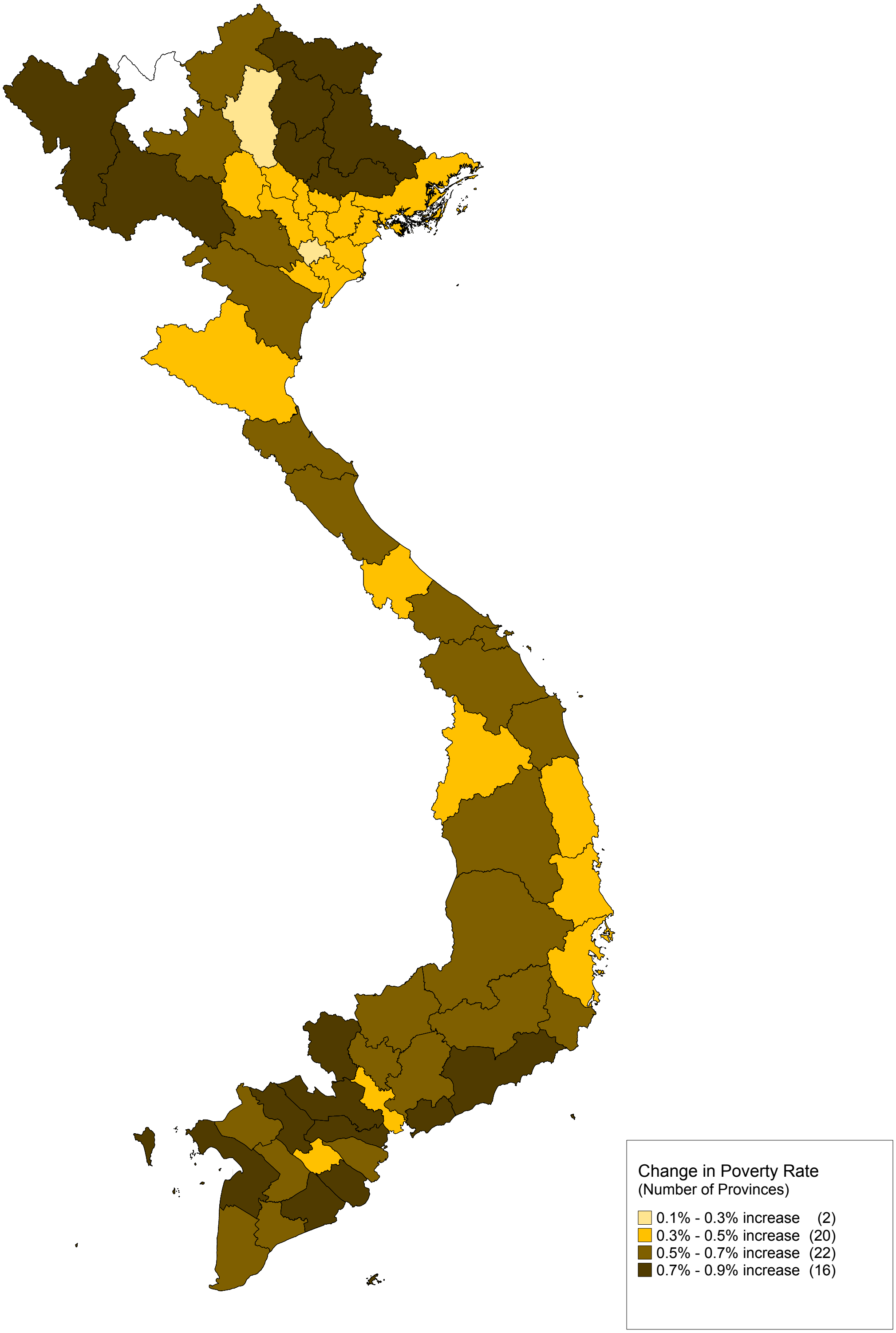

Figure 5: The change in provincial-level poverty rates under the DSDT scenario.

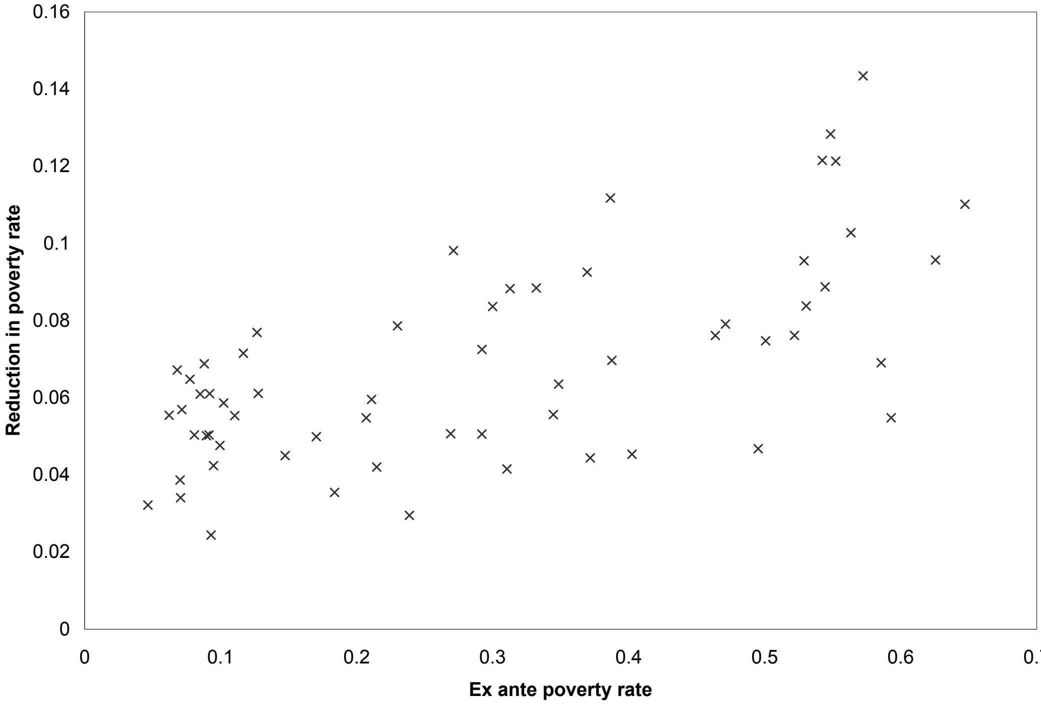

Figure 6: *Ex ante* poverty rate versus reduction in poverty rate at the provincial level (n=61).