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## Abstract

The present study examines whether participation in the rural non-farm sector employment or involvement in activity in rural non-farm economy (RNFE) has any poverty-reducing or vulnerability-reducing effect in Vietnam and India. To take account of sample selection bias associated with RNFE, we have applied treatment-effects model, a variant of Heckman sample selection model. It is found that log per capita consumption or log mean per capita expenditure (MPCE) significantly increased as a result of access to RNFE in 2002 and 2004 for Vietnam and in 1993-4 for India. This is consistent with poverty reducing role of accessing RNFE. However, in more recent years, this consumption poverty reducing effect disappeared. That is, it was no longer statistically significant in 2006 for Vietnam and MPCE slightly reduced due to access to RNFE in 2004-5 for India. Access to RNFE significantly reduces vulnerability in India, implying that diversification of household activities into non-farm sector would reduce such risks. However, in Vietnam, RNFE increased vulnerability in 2002, but the effect vanished in 2004 and 2006.

**Key Words:** Poverty, Vulnerability, Non-farm sector, Treatment Effects Model, Vietnam, India
**JEL Codes:** C21, C31, I32, O15

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# Does non-farm sector employment reduce poverty and vulnerability? Evidence from Vietnam and India

## 1.    Introduction

Across the developing world, it is well recognized that rural economies are not purely agricultural and farm households earn an increasing share of their income from non-farm activities. Traditionally, rural non-farm economy (RNFE) was considered to be a low-productivity sector diminishing over time where agricultural households simply supplement their income. But, since the late 1990s, its role in economic growth and poverty reduction began to be increasingly recognised given the increasing share of RNFE across developing countries (e.g. Lanjouw and Lanjouw, 2001, Haggblade, et al., 2010). The share of income from RNFE in total rural income varies - from 34% in Africa, to 47% in Latin America and 51% in Asia, but it is recognised that RNFE is becoming increasingly important in terms of its share and growth as well as potential roles in poverty reduction in Asia, particularly in emerging countries, such as China and India. Although most of the low and middle-income Asian countries traditionally relied on agriculture, they have undergone structural changes in recent years, due to industrialisation and globalisation as well as commercialisation of agriculture.

Within Asia, the share of income from RNFE varies from over 70% for the Philippines and Sri Lanka to below 40% for China, India and Nepal. With constraints on farm expansion and continuing growth of rural population, greater attention is thus being given to non-farm activities. Policy interest in RNFE arises not just because of its significance in generating incomes, but also because of its increasing importance in creating employment, especially for rural women and the poor.

Among Asian countries, the present study focuses on two countries – Vietnam and India, both of which experienced spectacular economic growth rate as well as poverty

reduction in recent years. These two countries are characterised by high average GDP per capita growth rate in 1990-2010 (Vietnam 5.8%; India 4.9%) and a decreasing share of agricultural value added in GDP (Vietnam 39% to 20%; India 29% to 16%). Poverty indices have declined during this period, but there is a variation in the speed of poverty reduction. While Vietnam experienced a faster poverty reduction in terms of headcount ratio based on US$1.25 (64% in 1993 to 21% in 2006, further down to 13% in 2008), the speed of poverty reduction has been relatively slow in India (49% in 1994 to 42% in 2005). As shown by Imai et al. (2012a, b) and Gaiha et al. (2012 a, b), the speed of improvement in nutritional indicators has been slow in India in recent years despite the country's economic growth. There is a need for investigating the reasons for diverse progress in income and non-income poverty focusing on household's livelihood strategies, including the choice of farm and non-farm employment. The present study will aim to provide insights into different pace of poverty reduction and vulnerability in these two countries.

The main hypothesis we examine is whether access to RNFE reduces poverty in rural areas in Vietnam and India. We focus only on rural areas because rural economy is distinct from urban economy in its structure and rural poverty is still predominant in these countries. We will use Vietnam Household Living Standards Survey (VHLSS) in 2002, 2004 and 2006 for Vietnam as well as National Sample Survey Data in 1993-4 and 2004-5 for India. Given the sample selection bias associated with access to RNFE or non-farm sector employment and the data structure where only large cross-sectional data are available and the panel data are not available[1], we will apply treatment effects model, a variant of Heckman two-step sample selection model (Heckman, 1979).

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[1] It is possible to construct a panel based on the intersections of different rounds of household cross-sectional data of VHLSS in Vietnam, but attrition bias is serious. See Imai et al. (2011) for details.

While the farm or agricultural sector has played a central role in these countries, the share of non-farm activities has increased significantly in recent years. However, detailed empirical studies estimating the direct and/or indirect effects of rural non-farm income or employment on poverty remain limited and the present study seeks to fill this gap. The rest of the paper is organised as follows. The next section reviews extant studies on the effects of non-farm sector on poverty in Vietnam and India. Section 3 briefly summarises the data sets we will use. Sections 4 and 5 discuss the specification of econometric models and results, respectively. Concluding observations are offered in the final section.

## 2.    The Literature

While the farm or agricultural sector has played a central role in Vietnam and India, the share of non-farm has increased significantly in recent years. However, formal empirical studies to estimate the direct and/or indirect effects of income or employment in non-farm sector employment on poverty are still few. On the direct effects, van de Walle and Cratty (2004) using VLSS data on Vietnam in 1993 and 1998 found significant effects of non-farm employment in reducing poverty. While van de Walle and Cratty (2004) claim that they consider the endogeneity of non-farm sector in reducing poverty, they simply estimated the share of hours worked in non-farm sector in total (or the probability of participating in non-farm sector) and poverty separately and compared the signs and statistical significance of coefficient estimates of explanatory variables without taking account of simultaneity. Thus their results are only suggestive of different covariates of non-farm employment and poverty. Informal evidence from India and Bangladesh suggests that indirect effects also matter, for example, the labour market tightening, or expansion of casual non-farm employment is strongly correlated with growth in agricultural wages. While building upon van de Walle and

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Cratty (2004), our proposed research applies improved methodologies to take account of the endogeneity issues to more comprehensive and recent data sets.

RNFE would be potentially important for breaking the poverty traps through various routes - such as lack of education and/or nutrition. For example, people who are educated at secondary school or higher are likely to have a higher probability of finding a job in rural non-farm sector (e.g. in trading, manufacturing office works) and their children tend to be more educated, which causes a 'virtuous' circle (e.g. Knight et al., 2009, 10). However, those who are not educated tend to be trapped in a 'vicious' circle. Likewise, undernourished people tend to be trapped in poverty as low nutritional levels imply low efficiency and high probability of being unemployed as predicted by the efficiency-wage hypothesis (e.g. Bliss and Stern, 1978, Dasgupta and Ray, 1986, 87). The poverty-nutrition hypotheses have been recently examined by Jha et al (2009) and Imai et al. (2012a) in the context of rural India. Reardon et al. (2000) also emphasises the barriers faced by poor households that prevent them from investing in non-farm assets, suggesting the existence of the poverty trap. That is, it is not an automatic process for poor agricultural households to enter into the non-farm sector. Unlike agricultural jobs, rural non-farm employment tends to be less physically intensive and requires lower calories, as the activity intensity determines the nutritional status in rural India Imai et al. (2012b). Since RNFE tend to better promote food security to the poor than farm employment (Owsu et al., 2011), the former has the potential to break the poverty trap.

## 3.    Data

*Vietnamese Data*

We will use Vietnam Household Living Standards Surveys (VHLSS) 2002, 2004, and 2006. The VHLSSs were initially implemented in 2002 to collect detailed household and commune level data. These are multi-topic household surveys with nationally representative household

samples. They commonly cover a wide range of issues, including household composition and characteristics (e.g. education and health); detailed record on expenditure for both food and non-food items, health and education; employment and labour force participation (e.g. duration of employment and the precise categories of occupations); income by sources (e.g. salary/wage, payment in cash and in kind, farm and non-farm production etc.); housing, ownership of assets and durable goods; and participation of households in anti-poverty programs. Commune level surveys collect data on demography, economic conditions, agricultural production, and non-farm employment, local infrastructure, public services such as education and health facilities.

*Indian Data[2]*

The NSS, set up by the Government of India in 1950, is a multi-subject integrated sample survey conducted all over India in the form of successive rounds relating to various aspects of social, economic, demographic, industrial and agricultural statistics. We use the data in the 'Household Consumer Expenditure' schedule, quinquennial surveys in the 50th round, 1993–94 and in the 61st round, 2004-05.[3] These form repeated cross-sectional data sets, each of which contains a large number of households across India.[4] The consumption schedule contains a variety of information related to mean per capita expenditure (MPCE), disaggregated expenditure over many items together with basic socio economic characteristics of the household (e.g., sex, age, religion, caste, and land-holding). To derive wages at the level of NSS region, we supplement the consumption schedule by Employment

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[2] This sub-section draws upon Imai (2011).

[3] We are not using 55th round in 1999-2000 as the consumption data in 55th round are not comparable with those in 50th or 61st round because of the change in recall periods. The consumption data are comparable between 50th round and 61st round.

[4] After dropping the households with missing observations in one of the explanatory variables, the number of households used for the estimation is 69206 and 78999 respectively for 50th and 61st rounds, respectively.

and Unemployment schedule because the consumption survey and the employment survey collect data on different households and can be linked only at the aggregate level (e.g. NSS region level).[5]

## 4. Methodologies

### (1) Treatment Effects Model

To estimate the effect of non-farm sector employment on poverty and vulnerability, we employ a version of treatment effects model. The main idea of treatment effects is to estimate poverty defined by household consumption per capita for two different regimes (de Janvry et al., 2005) - households participating only in the farm labour market and those participating in both farm and non-farm labour markets. It is a version of the Heckman sample selection model (Heckman, 1979), which estimates the effect of an endogenous binary treatment. This would enable us to take account of the sample selection bias associated with access to non-farm sector. In the first stage, access to non-farm sector is estimated by the probit model.[6] In the second, we estimate log of household consumption or vulnerability measure after controlling for the inverse Mills ratio which reflects the degree of sample selection bias.

The merit of treatment effects model is that sample selection bias is explicitly estimated by using the results of probit model. However, the weak aspects include (i) strong assumptions are imposed on distributions of the error terms in the first and second stages; (ii) the results are sensitive to choice of the explanatory variables and instruments; and (iii) valid instruments are rarely found in non-experimental data and if the instruments are invalid, the results will depend on the distributional assumptions.

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[5] Definitions of the variables of VHLSS and NSS data are provided in Appendix 1.
[6] For Vietnam we estimate access to non-farm sector by the probit model at individual levels and then estimate poverty (or log per capita real consumption or vulnerability) in the second. On the other hand, only household-level estimations are possible for India because of the data constraint. That is, we run the probit model at household levels for whether any household members have access to non-farm sector and then estimate the poverty equation in the second stage.

The selection mechanism by the probit model for accessing rural non-farm economy (RNFE) can be more explicitly specified as (e.g., Greene, 2003):

$$D_i^* = X_i \beta + u_i \qquad (1)$$

and $\quad D_i^* = 1 \quad if \ D_i^* = X_i \beta > 0$

$$D_i^* = 0 \ otherwise$$

where $\quad \Pr\{D_i = 1 | X_i\} = \Phi(\gamma' X_i)$

$$\Pr\{D_i = 0 | X_i\} = 1 - \Phi(\gamma' X_i)$$

$D^*$ is a latent variable. In our case, $D$ takes the value 1 if an ith individual has access to RNFE (non-farm employment or non-farm activity) and 0 otherwise and $X$ is a vector of individual, household and regional characteristics and other determinants at commune or community levels.[7] $\Phi$ denotes the standard normal cumulative distribution function.

Since available variables are different for Vietnam and India, we assume different specifications (or the choice of explanatory variables) for individual access to RNFE for $X_i$.

*Vietnam:*

$$D_i^* = D_i(W_i, M_i, E_i, H_h, L_h, R) \qquad (1)'$$

$W_i$: Real average hourly wage rate for the ith individual.

We assume here that the labour productivity proxied by average hourly wage rate is an important determinant of RNFE. That is, only high productivity worker with higher agricultural wages rate can participate in RNFE as an analogy of theory of workfare where only high productivity workers can participate in workfare scheme or higher waged workers

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[7] The estimation for (1) is made at individual levels, but we omit subscript for simplicity.

can afford exercising the 'real option' of switching from the agriculture labour marker to workfare or the non-farm labour market given the switching costs (Scandizzo et al., 2009).[8]

$M_i$ : Whether the $i^{th}$ individual is male.

$E_i$ : A set of dummy variables of educational attainment of the individual (whether he or she has no education; whether completed primary education; whether completed lower secondary education; whether completed upper secondary education; whether completed technical education; whether completed higher education).

$H_h$ : Household compositions/ characteristics (household size; the share of female members; dependency burden (the share of household members below 15 years or above 65 years; whether a household belongs to ethnic majority) for the $h^{th}$ household.

$L_h$ : Size of land (in hectare) owned by the household and its square for the $h^{th}$ household.

$R$ : A set of regional dummy variables (whether a household is located in red river delta region; northeast region; northwest region; north central coast region; south central coast region; central highlands region; north east south region; Mekong river delta region; central coast region; low mountains; and high mountains).

*India:*

Because of data limitations, a different set of explanatory variables is chosen as determinants of accessing RNFE.

$$D_h^* = D_h(W, H_h, E_h, L_h, B_h, R) \qquad (1)''$$

$\overline{W_i}$ : Wage rate estimated using employment data and aggregated for NSS region.[9]

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[8] Two issues should be discussed regarding the effects of wage rates on participation in RNFE. First, access to non-farm sector employment is likely to have an indirect effect of reducing consumption poverty of an agricultural household through increased agricultural wage rates. This would require the disaggregated non-farm and farm wages data (possibly over time), which neither VHLSS nor NSS data have. Second, related to the first point, the wage rate is endogenous. Due to the lack of instrument, we use the raw wage rate for VHLSS. While acknowledging the possibility that the potential endogeneity could potentially bias the coefficient estimates, we estimated the same model without wage rate, but the final results did not change. For NSS data, we use the estimated wage rate aggregated at NSS region level.

$H_h$: A set of variables indicating household composition, such as whether a household is headed by a female member, number of adult male or female members, dependency burden: the share of household members under 15 years old or over 60 years old).[10]

$E_h$: A set of variables on the highest level of educational attainment of household members (e.g. whether completed primary school, secondary school, or higher education).

$L_h$: Owned land as a measure of household wealth.

$B_h$: Social backwardness of the household in terms of (i) whether a household belongs to Scheduled Castes (SCs) and (ii) whether it belongs to Scheduled Tribes (STs).

$R$: A vector of state dummy variables.

The linear outcome regression model in the second stage is specified below to examine the determinants of poverty – as proxied by household consumption (log of MPCE for the Indian NSS data and log of per capita real household consumption for the Vietnamese VHLSS data) or vulnerability derived by Chaudhuri's (2003) method which captures the probability of household falling into poverty in the next period.[11] It is noted here that non-farm labour marker participation is estimated at individual level in the first stage of the treatment effects model, while poverty is estimated at household level (proxied by log per capita household consumption or household vulnerability) in the second stage. Two reasons justify this: one is limited individual earning data, and, the second is likely pooling of individual earnings. We use log household consumption and vulnerability measure as a measure of poverty because treatment effects model assumes that the dependent variable in the second stage is continuous and the standard binary measure of poverty (0 or 1) cannot be

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[9] The results for wage equations (based on NSS50-10 and NSS61-10) are given in Appendix 2. However, we have used wage rates only for NSS50. For NSS61, we have used the regional price because aggregate wage rate is automatically dropped due to the collinearity problem.

[10] Female headedness was dropped in all the regressions based on NSS50, because it consistently shows a counter-intuitive sign.

[11] The methodology will be discussed in the next subsection.

used. Moreover, as suggested by previous literature, households in India and Vietnam tend to be vulnerable to shocks (e.g. Imai et al, 2011; Gaiha and Imai, 2009). We denote household poverty – either log per capita household consumption or vulnerability - as $W_i$.

$$W_i = Z_h \gamma + \theta D_i + \varepsilon_i \qquad (2)^{12}$$
$$(u, \varepsilon) \sim \text{bivariate normal} [0,0,1,\sigma_\varepsilon,\rho].$$

where $\theta$ is the average net effect of access to RNFE. In case log per capita household consumption is estimated, the positive estimate for $\theta$ implies that accessing RNFE increases consumption and thus decreases poverty. In the case of vulnerability, the negative estimate for $\theta$ implies that RNFE decreases vulnerability.

Here $Z_h$ is a vector of determinants of $W$. For Vietnam this is estimated by:

$$Z_h = Z_h(I_h, H_h, L_h, R) \qquad (2)'$$

where $I_h$ is a vector of household head characteristics (educational attainment – defined the same way as in the equation (1); sex; married). $H_h$ (a vector of household characteristics), $L_h$ (land), and $R$ (a vector of regional characteristics) are same as those for equation (1)'.

For India, equation (2) is estimated by the same set of explanatory variables as in equation (1)'' except $W$.

$$Z_h = Z_h(H_h, E_h, L_h, B_h, R) \qquad (2)''$$

Using a formula for the joint density of bivariate normally distributed variables, the expected poverty for those with access to RNFE is written as:

$$E[W_i|D_i = 1] = \beta'Z_i + \theta + E[\varepsilon_i|D_i = 1]$$
$$= \beta'Z_i + \theta + \rho\sigma_\varepsilon \frac{\phi(\gamma'X_i)}{\Phi(\gamma'X_i)} \qquad (3)$$

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[12] For India equation (2) is $W_h = Z_h\gamma + \theta D_h + \varepsilon_h$ as the estimation is done at household level.

where $\phi$ is the standard normal density function. The ratio of $\phi$ and $\Phi$ is called the inverse Mill's ratio.

Expected poverty (or undernutrition or vulnerability) for non-participants is:

$$\begin{aligned} E[W_i | D_i = 0] &= \beta' Z_i + E[\varepsilon_i | D_i = 0] \\ &= \beta' Z_i - \rho \sigma_\varepsilon \frac{\phi(\gamma X_i)}{1 - \Phi(\gamma X_i)} \end{aligned} \tag{4}$$

The expected effect of poverty reduction associated with RNFE is computed as (Greene, 2003, 787-789):

$$E[W_i | D_i = 1] - E[W_i | D_i = 0] = \theta + \rho \sigma_\varepsilon \frac{\phi(\gamma X_i)}{\Phi(\gamma X_i)[1 - \Phi(\gamma X_i)]} \tag{5}$$

If $\rho$ is positive (negative), the coefficient estimate of $\theta$ using OLS is biased upward (downward) and the sample selection term will correct this. Since $\sigma_\varepsilon$ is positive, the sign and significance of the estimate of $\rho \sigma_\varepsilon$ (usually denoted as $\beta_\lambda$) will show whether there exists any selection bias. To estimate the parameters of this model, the likelihood function given by Maddala (1983, 122) is used where the bivariate normal function is reduced to the univariate function and the correlation coefficient $\rho$. The predicted values of (3) and (4) are derived and compared by the standard t test to examine whether the average treatment effect or poverty reducing effect is significant.

The results of treatment effects model will have to be interpreted with caution because the results are sensitive to the specification of the model or the selection of explanatory variables and/or the instrument. Also important are the distributional assumptions of the model. Despite these limitations, the model is one of the few available methods to control for sample selection bias and capable of yielding insights into whether access to RNFE leads to poverty reduction.

**(2) Vulnerability Measure**

It would be ideal to use panel data to derive household's vulnerability measures, but, in its absence, we can derive a measure of 'Vulnerability as Expected Poverty' (VEP), an *ex ante* measure, based on Chaudhuri (2003) and Chaudhuri, Jalan and Suryahadi (2002) who applied it to a large cross-section of households in Indonesia[13] and defined vulnerability as the probability that a household will fall into poverty in the future after controlling for the observable household characteristics. Accordingly, it takes the value from 0 to 1, and the higher the value of vulnerability measure, the higher is the probability of a household falling into poverty in the next period. Imai et al. (2011) derived and analysed Chaudhuri's vulnerability measure using the VHLSS data for Vietnam, and Imai (2011) derived it using the Indian NSS data. We will use these cross-sectional vulnerability measures subject to the caveat of estimating vulnerability from a single cross-section that cannot captures the effect of aggregate shocks affecting all the households in the sample area. The details of derivation of Chaudhuri's vulnerability measure is found on Appendix 3. Imai et al. (2011) and Imai (2011) provide a full set of results of vulnerability for Vietnam and India.

**4.     Econometric Results**

This section summarises the results of treatment effects model which are applied to estimate the effects of participation in RNFE (Rural Non-farm Economy) or non-farm sector employment. Vulnerability estimates based on VHLSS and NSS data are reported in Imai et al. (2011) and Imai (2011) and we highlight only the results of treatment-effects model.

Table 1 gives the results of treatment effects model applied to VHLSS data in 2002, 2004 and 2006. For each year, two different proxies for poverty have been tried as a

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[13]  See a summary by Hoddinott and Quisumbing (2003a, b) of methodological issues in measuring vulnerability.

dependent variable - log of per capita consumption and vulnerability. The second panel reports the results of the first stage probit model for whether an individual participates in the non-farm sector labour market and the first panel gives the results for OLS whereby log per capita consumption or vulnerability is estimated.

The second panel of Table 1 suggests that individual and household characteristics (e.g. individual productivity, individual education attainment, household composition, location) affect the probability of an individual participating in the non-farm sector labour market. For example, real hourly wage rate significantly increases the probability of participating in RNFE. Other variables show more or less expected results (e.g. lower educational attainment tends to decrease the probability of participating in RNFE (except 2006); belonging to ethnic majorities increase the probability (except 2006); locations affect the probability). $\rho\sigma_\varepsilon$ or $\beta_\lambda$ in the equation (3) is statistically significant only in the case of vulnerability in 2002. A relatively high estimate of $\rho$ (0.233) implies the high correlation between the first stage and the second stage equations in case of log per capita consumption in 2004 where $\beta_\lambda$ is not significant, but with a relatively high z value of 1.57. Use of treatment effects model is justified in these cases. Sample selection term is not significant in other cases.

The first panel of Table 1 shows the results of determinants of per capita consumption and vulnerability for 2002, 4 and 6. For example, size of household significantly decreases consumption in all the years and significantly decreases vulnerability in 2004 and 6. A household headed by an older head tends to have higher per capita consumption and lower vulnerability with non-linear effects. Higher dependency burden is associated with lower consumption and higher vulnerability. Education and location are important determinants of both consumption and vulnerability.

At the bottom of the table, ATE (average treatment effects) as well as ANF (average net effects) associated with the individual participation in RNFE are reported. The former is

the difference of the expected outcome for participants in RNFE and for non-participants after controlling for sample selection (as in equation (5), sum of ANF and sample selection term). The latter is the net effect which is purely associated with access to RNFE without controlling for sample selection. In order to evaluate the effect of access to RNFE on poverty after taking account of sample selection, we need to base our discussion on the former, not the latter (Imai, 2011).

In 2002, per capita consumption is significantly higher by 1.3% for participants in the non-farm labour market[14] than for non-participants after taking account of sample selection, which is consistent with the poverty reducing role of RNFE. Average net effect is 2.9% and significant (Column 1 of Table 1). In the same year, however, whilst RNFE significantly reduces vulnerability by 2.3% as a net effect, it increases the vulnerability by 0.16% on average after taking account of sample selection (Column 1). Admittedly, this is not large. In 2004, per capita consumption is significantly higher by 3.8% for non-farm labour market participants than for non-participants after controlling for sample selection, while vulnerability is also higher for non-farm labour market participants by 0.9%. In 2006, there are no statistically significant effects of access to RNFE either for consumption or vulnerability. However, these effects were weak or weaker in 2006.

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[14]It is noted that those self-employed are excluded from the sample.

**Table 1. The Results of Treatment Effects Model on the Effects of Individual Participation in Rural Non-Farm Economy (RNFE) for Vietnam on Poverty and Vulnerability for Vietnam**

| 2nd Stage (consumption; vulnerability) | 2002 | | | | 2004 | | | | 2006 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dependent Variable | log per capita consumption | | vulnerability | | log per capita consumption | | Vulnerability | | log per capita consumption | | vulnerability | |
| Explanatory Variables | Coef. | Z value | Coef. | Z value | Coef. | Z value | Coef. | Z value | Coef. | Z value | Coef. | Z value |
| Size of Household | -0.071 | (-36.74)** | 0.000 | (-0.08) | -0.099 | (-11.56)** | -0.005 | (-1.8) | -0.102 | (-15.45)** | -0.004 | -2.05 |
| Age of household head | -0.004 | (-2.58)** | 0.004 | (2.81)** | 0.022 | (2.80)** | -0.013 | (-4.97)** | -0.033 | (-5.28)** | 0.007 | 4.07 |
| Age squared | 0.000 | (6.08)** | 0.000 | (-3.39)** | 0.000 | (-2.12)* | 0.000 | (4.40)** | 0.000 | (7.11)** | 0.000 | -5.15 |
| Whether a household head is married | 0.219 | (19.69)** | 0.048 | (4.52)** | 0.128 | (2.34)* | 0.015 | (0.87) | 0.155 | (3.30)** | -0.008 | -0.57 |
| Share of female members | 0.116 | (7.15)** | -0.049 | (-3.12)** | -0.004 | (-0.06) | 0.081 | (3.71)** | 0.343 | (6.43)** | -0.060 | -3.98 |
| Dependency Burden (share of household members under 15 or above 60) | -0.530 | (-37.85)** | 0.023 | (1.74)† | -0.226 | (-5.26)** | 0.089 | (6.44)** | -0.221 | (-4.57)** | 0.256 | 18.75 |
| Whether a household belongs to ethnic majority | 0.238 | (21.95)** | -0.063 | (-5.88)** | 0.235 | (4.38)** | -0.420 | (-24.28)** | 1.317 | (88.27)** | -0.517 | -123.03 |
| Whether a head had no education | -0.124 | (-16.06)** | -0.029 | (-3.8)** | 0.063 | (0.70) | 0.080 | (2.74)** | -0.344 | (-2.98)** | 0.047 | 1.43 |
| Whether completed primary school | 0.024 | (2.87)** | -0.007 | (-0.92) | 0.063 | (2.27)* | -0.052 | (-5.73)** | 0.062 | (2.57)* | -0.035 | -5.12 |
| Whether completed lower secondary school | 0.302 | (25.13)** | 0.003 | (0.28) | 0.032 | (0.66) | -0.070 | (-4.45)** | 0.120 | (2.87)** | -0.056 | -4.77 |
| Whether completed technical school | 0.347 | (22.37)** | -0.114 | (-7.46)** | 0.282 | (6.55)** | -0.113 | (-8.10)** | 0.260 | (6.53)** | -0.138 | -12.31 |
| Whether completed higher school education | 0.571 | (20.24)** | -0.078 | (-2.81)** | 0.579 | (7.78)** | -0.089 | (-3.70)** | 0.567 | (7.21)** | -0.119 | -5.38 |
| Size of land (million hectare) | 6.788 | (22.86)** | -2.780 | (-9.86)** | 11.684 | (5.82)** | -2.521 | (-3.90)** | 12.494 | (7.12)** | -2.713 | -5.48 |
| Size of land squared | -9.951 | (-5.94)** | 7.770 | (5.27)** | -95.237 | (-5.84)** | 13.650 | (2.60)* | -92.456 | (-4.92)** | 21.653 | 4.09 |
| Whether located in red river delta region | -0.230 | (-23.88)** | -0.073 | (-7.66)** | -0.146 | (-3.46)** | 0.021 | (1.52) | -0.361 | (-12.21)** | 0.045 | 5.46 |
| Whether in North East region | -0.239 | (-17.54)** | -0.049 | (-3.76)** | -0.364 | (-7.00)** | 0.008 | (0.46) | -0.088 | (-1.94)† | -0.013 | -1.01 |
| Whether in North West region | -0.361 | (-17.46)** | -0.036 | (-1.86)† | -0.677 | (-8.58)** | 0.226 | (8.90)** | 0.112 | (1.89)† | 0.124 | 7.4 |
| Whether in North Central Coast region | -0.361 | (-29.85)** | -0.024 | (-2.06)* | -0.456 | (-9.00)** | 0.153 | (9.37)** | -0.519 | (-14.07)** | 0.173 | 16.6 |
| Whether in South Central Coast region | -0.105 | (-9.86)** | 0.134 | (12.77)** | 0.013 | (0.23) | -0.006 | (-0.33) | -0.259 | (-6.16)** | 0.022 | 1.84 |
| Whether in Central Highlands region | -0.197 | (-11.01)** | -0.134 | (-7.66)** | -0.477 | (-6.65)** | 0.026 | (1.12) | -0.271 | (-4.18)** | 0.014 | 0.74 |
| Whether in North East South region | 0.021 | (1.79)† | -0.083 | (-7.16)** | -0.134 | (-2.36)* | -0.031 | (-1.70)† | -0.047 | (-1.01) | -0.030 | -2.34 |
| Whether in Central Coast region | 0.061 | (3.43)** | -0.022 | (-1.32) | 0.016 | (0.23) | -0.104 | (-4.62)** | -0.511 | (-8.28)** | 0.017 | 0.99 |
| Whether in Inland Delta | 0.032 | (2.16)* | 0.018 | (1.25) | -0.318 | (-6.13)** | -0.100 | (-5.98)** | -0.413 | (-8.48)** | 0.019 | 1.37 |
| Whether in Hills | -0.058 | (-3.33)** | -0.038 | (-2.23)* | -0.150 | (-2.31)* | -0.103 | (-4.89)** | -0.459 | (-8.5)** | 0.028 | 1.82 |
| Whether in Low Mountains | 0.090 | (7.58)** | 0.046 | (3.98)** | 0.204 | (4.14)** | -0.118 | (-7.48)** | -0.332 | (-8.31)** | 0.026 | 2.32 |
| **Average Net Effect of accessing** | | | | | | | | | | | | |
| **Non-farm sector employment ($\hat{\theta}$)** | **0.029** | **(3.25)** | **-0.023** | **(-2.61)*** | **-0.110** | **(-1.36)** | **0.001** | **(0.03)** | **-0.029** | **(-0.57)** | **0.010** | **0.73** |
| Constant | 7.891 | (187.68) | 0.224 | (5.52) | 7.937 | (36.29) | 0.857 | (12.1) | 8.183 | (47.59) | 0.345 | 7.12 |
| **Non-farm sector participation equation** | (1st Stage) | | | | | | | | | | | |
| Real Hourly Wage Rate | 1.251 | (54.28)** | 1.242 | (47.75)** | 0.008 | (0.58) | 0.008 | (0.58) | 0.067 | (4.71)** | 0.067 | (4.71)** |
| Whether he or she is male | -0.230 | (-10.47)** | -0.233 | (-9.39)** | -0.087 | (-0.91) | -0.087 | (-0.91) | -0.175 | (-2.77) | -0.175 | (-2.77) |
| Whether a head had no education | -1.785 | (-21.27)** | -1.863 | (-18.94)** | -4.749 | (-0.04) | -4.749 | (-0.04) | -3.956 | (-0.03) | -3.956 | (-0.03) |
| Whether completed primary school | -1.306 | (-15.67)** | -1.387 | (-14.19)** | -4.160 | (-0.03) | -4.160 | (-0.03) | -3.949 | (-0.03) | -3.949 | (-0.03) |

| Variable | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Whether completed lower secondary school | -0.949 | (-11.33)** | -1.012 | (-10.31)** | -3.709 | (-0.03) | -3.709 | (-0.03) | -3.515 | (-0.03) | -3.515 | (-0.03) |
| Whether completed upper secondary school | -0.598 | (-6.75)** | -0.693 | (-6.69)** | -3.402 | (-0.03) | -3.404 | (-0.03) | -3.123 | (-0.03) | -3.123 | (-0.03) |
| Whether completed technical school | -0.092 | (-0.93) | -0.195 | (-1.71)** | -3.167 | (-0.02) | -3.166 | (-0.02) | -2.853 | (-0.03) | -2.853 | (-0.03) |
| Whether completed higher school education | - | | - | | -2.600 | (-0.02) | -2.600 | (-0.02) | -3.055 | (-0.03) | -3.055 | (-0.03) |
| Size of household | -0.009 | (-1.34) | -0.006 | (-0.81) | -0.016 | (-0.34) | -0.015 | (-0.33) | -0.012 | (-0.27) | -0.012 | (-0.27) |
| Share of female members | -0.036 | (-0.64) | -0.050 | (-0.77) | 0.985 | (2.65)* | 0.984 | (2.65)* | -0.134 | (-0.37) | -0.134 | (-0.37) |
| Dependency Burden | -0.111 | (-2.39)* | -0.125 | (-2.37)* | 0.191 | (0.79) | 0.189 | (0.79) | 0.014 | (0.05) | 0.014 | (0.05) |
| Whether belongs to Majorities | 0.127 | (3.17)** | 0.113 | (2.45)* | 0.048 | (0.14) | 0.048 | (0.14) | 0.017 | (0.19) | 0.017 | (0.19) |
| Whether in Red River Delta | 0.004 | (0.11) | -0.037 | (-0.96) | 0.058 | (0.28) | 0.058 | (0.28) | -0.106 | (-0.64) | -0.106 | (-0.64) |
| Whether in North East region | 0.045 | (0.9) | 0.026 | (0.47) | 0.643 | (2.15)* | 0.644 | (2.15)* | 0.377 | (1.14) | 0.377 | (1.14) |
| Whether in North West region | 0.210 | (2.69)** | 0.133 | (1.56) | 0.267 | (0.55) | 0.267 | (0.55) | -0.236 | (-0.58) | -0.236 | (-0.58) |
| Whether in North Central Coast region | 0.017 | (0.4) | 0.008 | (0.16) | 0.086 | (0.31) | 0.086 | (0.31) | 0.283 | (1.08) | 0.283 | (1.08) |
| Whether in South Central Coastal region | -0.012 | (-0.3) | -0.036 | (-0.8) | 0.517 | (1.61) | 0.517 | (1.61) | 0.279 | (0.92) | 0.279 | (0.92) |
| Whether in Central Highlands region | 0.069 | (1.03) | 0.015 | (0.2) | 0.163 | (0.37) | 0.163 | (0.37) | -0.186 | (-0.36) | -0.186 | (-0.36) |
| Whether North East South region | 0.083 | (1.92)† | 0.053 | (1.03) | 0.326 | (1.03) | 0.320 | (1.01) | 0.346 | (0.96) | 0.346 | (0.96) |
| Size of land (million hectare) | 0.407 | (0.36) | 0.028 | (0.02) | 29.663 | (2.03)* | 29.492 | (2.02)* | -0.634 | (-0.05) | -0.634 | (-0.05) |
| Size of land squared | -4.980 | (-0.75) | -4.335 | (-0.63) | -227.254 | (-2.28)* | -226.173 | (-2.27)* | -34.848 | (-0.30) | -34.848 | (-0.30) |
| Whether Central Coast Region | -0.039 | (-0.59) | -0.066 | (-0.89) | -0.330 | (-0.80) | -0.329 | (-0.80) | -0.133 | (-0.25) | -0.133 | (-0.25) |
| Whether Inland Delta Region | 0.039 | (0.69) | 0.018 | (0.28) | -0.167 | (-0.50) | -0.168 | (-0.50) | -0.438 | (-1.05) | -0.438 | (-1.05) |
| Whether in Hills | -0.028 | (-0.43) | -0.073 | (-0.98) | -0.503 | (-1.27) | -0.510 | (-1.29) | -0.523 | (-1.16) | -0.523 | (-1.16) |
| Whether in Low Mountains | 0.020 | (0.45) | 0.003 | (0.06) | -0.220 | (-0.68) | -0.220 | (-0.68) | -0.546 | (-1.59) | -0.546 | (-1.59) |
| Constant | 0.538 | (4.68) | 0.673 | (5.04) | 4.338 | (0.03) | 4.339 | (0.03) | 5.116 | (0.04) | 5.116 | (0.04) |
| $\hat{\beta}_\lambda$ | -0.009 | (-1.27) | 0.0124 | (1.92)† | 0.072 | (1.57) | 0.004 | (0.26) | 0.021 | 0.74 | -0.004 | -0.55 |
| $\hat{\rho}$ | -0.021 | | 0.0365 | | 0.233 | | 0.038 | | 0.082 | | -0.062 | |
| No. of Observations | 20848 | | 16031 | | 1427 | | 1426 | | 3136 | | 3136 | |
| Wald Chi$^2$(44) | 12604** | | 1010** | | 1275** | | 3030** | | 24293** | | 37998** | |

**Average Treatment Effect (ATE)**

| Variable | log per capita consumption | | Vulnerability | | log per capita consumption | | Vulnerability | | log per capita consumption | | vulnerability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Treat   With RNFE** | **7.789** | | **0.216** | | **8.129** | | **0.058** | | **8.207** | | **0.230** | |
| **Control   Without RNFE** | **7.776** | | **0.215** | | **8.092** | | **0.049** | | **8.193** | | **0.229** | |
| ATE ( $= \theta + \rho\sigma_\varepsilon \frac{\phi(\gamma X_i)}{\Phi(\gamma X_i)[1-\Phi(\gamma X_i)]}$ ) | 0.013 | | 0.0016 | | 0.038 | | 0.009 | | 0.014 | | 0.001 | |
| t value (  ) | (4.17)** | | (1.99)** | | (3.45)** | | (1.57) | | (0.78) | | (0.22) | |
| **Does RNFE Reduce Poverty (or Vulnerability) Significantly? (based on ANF)** | 0.029 (3.25)** | | -0.023 (2.61)* | | -0.110 (1.36) | | 0.001 (0.03) | | -0.029 (0.57) | | 0.010 (0.73) | |
| **Does RNFE Reduce Poverty (or Vulnerability) Significantly? (based on ATE)** | YES | | NO | | YES | | NO | | NO | | NO | |

In sum, we confirm that RNFE reduced consumption poverty in 2002 and 2004, but at the same time, consumption vulnerability (as a probability of falling into consumption poverty) slightly increased in these years. The results may suggest that RNFE opens up a new set of consumption bundles which others could not avail of.

Table 2 gives the results of treatment effects model for the Indian NSS data. As before, the second panel presents the results of participation equation (probit model). Female headedness negatively affects participation in NSS61 (in 2004-5).[15] Dependency burden is negative and significant, that is, the household with higher dependency burden is less likely to participate in the rural non-farm sector employment. Household headed by older head is more likely to participate in RNFE, with the non-linear effects. A household with more educated members tends to participate in RNFE. If the household has a larger land, the probability of participating in RNFE is smaller. Belonging to Scheduled Caste and Scheduled Tribes is also associated with lower probability of participating in RNFE. For NSS50, higher wages significantly lead to higher probability of participating in RNFE. The coefficient estimate for regional price is positive, but not statistically significant. The coefficient estimate of $\rho\sigma_\varepsilon$ or $\beta_\lambda$ is significant in all the cases except 'log MPCE' in 2004-5. There is a statistically significant sample selection bias in these cases.

The first panel of Table 2 reports the regression results of the first stage equation for log MPCE or vulnerability. We report the regression results only selectively. For instance, in contrast to Vietnam, dependency burden significantly increases log MPCE, but decreases vulnerability. In India, higher dependency seems to imply that households need to earn more per person, and thus they tend to consume more and to be less vulnerable. In 1993-4, a household with an older head tends to consume less, but is less vulnerable (with a strong non-linear effect in both cases). The signs of coefficient estimate are reversed in 2004-5. In

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[15] Because female headedness measured with error in NSS50, it was not used in the regression.

general, a household with a more educated household consumes more and is less vulnerable. As expected, the larger the size of the land a household owns, it consumes more and is less vulnerable. Belonging to Schedule Castes or Scheduled Tribes is associated with a lower level of consumption as well as a higher level of vulnerability.

We have summarised the results of ATE at the bottom of Table 2. It is confirmed that access to RNFE increases per capita consumption by 10% in 1993-4 on average, whilst it is reduced by 0.34 % in 2004-5. That is, the consumption increasing effect (or the effect of reducing consumption poverty) has weakened in recent years, which is consistent with evidence from Vietnam. However, contrary to the results of Vietnam, vulnerability was significantly reduced by participation in RNFE – by 5.96% in 1993-4 and by 2.89% (in terms of the probability of falling into poverty in the next period). This is a substantial reduction. It can be concluded that in India participation in RNFE is likely to reduce household vulnerability significantly.

**Table 2. The Results of Treatment Effects Model on the Effects of Participation in Rural Non-Farm Economy (RNFE) for Vietnam on Poverty and Vulnerability for India**

| | NSS 50 (1993-4) | | | | NSS 61 (2004-5) | | | |
| | log per capita MPCE | | Vulnerability | | log per capita MPCE | | Vulnerability | |
| | Coef. | Z value | Coef. | Z value | Coef. | Z value | Coef. | Z value |
|---|---|---|---|---|---|---|---|---|
| Whether a household is headed by a female member | - | - | - | - | 0.002 | (0.25) | -0.048 | (-12.13) |
| Number of adult female members | -0.307 | (-115.68)** | 0.132 | (99.62)** | -0.128 | (-56.3)** | 0.053 | (45.11)** |
| Number of adult male members | -0.276 | (-112.92)** | 0.128 | (105.21)** | -0.108 | (-41.53)** | 0.052 | (40.13)** |
| Dependency Burden (share of household members under 15 or above 60) | 2.208 | (218.74)** | -1.403 | (-277.95)** | 0.611 | (82.67)** | -0.216 | (-56.77)** |
| Age of household head | -0.963 | (-11.51)** | 0.987 | (23.59)** | 0.596 | (8.15)** | -0.194 | (-5.14)** |
| Age squared | 0.978 | (11.19)** | -0.886 | (-20.27)** | -0.248 | (-3.43)** | -0.049 | (-1.30) |
| The max. education of adult (Primary) | 0.065 | (7.73)** | -0.050 | (-11.81)** | 0.098 | (16.89)** | -0.081 | (-27.80)** |
| The max. education of adult (Middle) | 0.120 | (11.84)** | -0.114 | (-22.05)** | 0.244 | (46.1)** | -0.148 | (-55.67)** |
| The max. education of adult (>=Matriculates) | 0.184 | (11.59)** | -0.205 | (-24.51)** | 0.508 | (97.08)** | -0.193 | (-71.39)** |
| Land (0.1<=2.5 ha) (default: the landless) | 0.407 | (29.08)** | -0.176 | (-23.75)** | 0.056 | (4.63)** | -0.115 | (-20.71)** |
| Land (>2.5 ha) (default: the landless) | 0.206 | (12.08)** | -0.104 | (-12.18)** | 0.277 | (13.26)** | -0.215 | (-22.36)** |
| Whether a household belongs to SC (Scheduled Caste) | -0.136 | (-16.15)** | 0.090 | (20.97)** | -0.172 | (-26.01)** | 0.112 | (34.36)** |
| Whether a household belongs to ST (Scheduled Tribe) | -0.128 | (-20.43)** | 0.075 | (23.58)** | -0.132 | (-30.73)** | 0.072 | (32.58)** |
| **Average net effect of household member participation in non-farm sector employment ( $=\hat{\theta}$ )** | **0.796** | **(18.19)\*\*** | **-0.258** | **(-11.04)\*\*** | **-0.043** | **(-0.87)** | **-0.285** | **(-12.71)\*\*** |
| Constant | 7.982 | (231.37) | 1.056 | (60.83) | 9.602 | (278.11) | 0.366 | (22.28) |
| | | | | | | | | |
| Whether a household is headed by a female member | - | - | - | - | -0.389 | (-22.36)** | -0.389 | (-22.35)** |
| Number of adult female members | -0.020 | (-3.15)** | -0.020 | (-3.15)** | 0.021 | (2.84)** | 0.021 | (2.87)** |
| Number of adult male members | -0.019 | (-3.23)** | -0.019 | (-3.23)** | 0.091 | (13.09)** | 0.091 | (13.07)** |
| Dependency Burden (share of household members under 15 or above 60) | -0.091 | (-3.81)** | -0.091 | (-3.81)** | -0.097 | (-4.25)** | -0.098 | (-4.27)** |
| Age of household head | -0.514 | (-2.57)* | -0.514 | (-2.57)* | -0.476 | (-2.05)* | -0.476 | (-2.05)* |
| Age squared | 0.760 | (3.64)** | 0.760 | (3.64)** | -0.293 | (-1.25) | -0.293 | (-1.25) |
| The max. education of adult (Primary) | 0.267 | (14.88)** | 0.267 | (14.88)** | 0.182 | (12.0)** | 0.182 | (11.98)** |
| The max. education of adult (Middle) | 0.422 | (22.00)** | 0.422 | (22.00)** | 0.162 | (11.46)** | 0.162 | (11.45)** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| The max. education of adult (>=Matriculates) | 0.967 | (52.47)** | 0.967 | (52.47)** | -0.073 | (-4.44)** | -0.073 | (-4.44)** |
| Land (0.1<=2.5 ha) (default: the landless) | -1.002 | (-65.09)** | -1.002 | (-65.09)** | -0.642 | (-58.92)** | -0.643 | (-58.97)** |
| Land (>2.5 ha) (default: the landless) | -0.455 | (-11.81)** | -0.455 | (-11.81)** | -1.331 | (-58.51)** | -1.331 | (-58.53)** |
| Whether a household belongs to SC (Scheduled Caste) | -0.305 | (-16.49)** | -0.305 | (-16.49)** | -0.253 | (-14.94)** | -0.253 | (-14.92)** |
| Whether a household belongs to ST (Scheduled Tribe) | -0.132 | (-9.47)** | -0.132 | (-9.47)** | -0.031 | (-2.37)** | -0.031 | (-2.37)** |
| Predicted male wages (at NSS region) | 0.005 | (10.82)** | 0.005 | (10.82)** | - | - | - | - |
| Aggregate Price (at NSS region) | - | - | - | - | 0.008 | (1.07) | 0.008 | (1.08) |
| Constant" | -0.871 | (-11.18) | -0.871 | (-11.18) | 0.082 | (0.70) | 0.081 | (0.69) |
| $\hat{\beta}_\lambda$ | -0.403 | (-15.42)** | -0.403 | (-15.42)** | 0.023 | (0.78) | 0.151 | (11.23)** |
| $\hat{\rho}$ | -0.705 | - | -0.705 | - | 0.055 | - | 0.685 | - |
| No. of Observations | 69206 | | 69206 | | 78931 | | 78874 | |
| Wald Chi$^2$(73) [Wald Chi$^2$(95) for NSS61] | 107133** | | 138071** | | 59761** | | 45959*** | |

**Average Treatment Effect (ATE)**

| Variable | Log MPCE | Vulnerability | Log MPCE | Vulnerability |
|---|---|---|---|---|
| Treat   With RNFE | 8.880 | 0.5086 | 9.7703 | 0.0633 |
| Control   Without RNFE | 8.701 | 0.5682 | 9.7738 | 0.0921 |
| ATE ( $= \theta + \rho\sigma_\varepsilon \frac{\phi(\gamma X_i)}{\Phi(\gamma X_i)[1-\Phi(\gamma X_i)]}$ ) | 0.100 | -0.0596 | -0.0034 | -0.0289 |
| t value (  ) | (27.15)** | (-28.48)** | (-1.99)* | (-37.56)** |
| Average net effect (ANF) of RNFE ( $= \hat{\theta}$ ) | 0.796 (18.19)** | -0.258 (-11.04) | -0.043 (-0.87) | -0.285 (-12.71)** |
| Does RNFE Reduce Poverty (or Vulnerability) Significantly? (based on ATE) | YES | YES | NO | YES |

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**5.    Concluding Observations**

The present study examines whether participation in the rural non-farm sector employment or involvement in activity in rural non-farm economy (RNFE) has any poverty-reducing or vulnerability-reducing effect in Vietnam and India. To take account of sample selection bias associated with RNFE, we applied treatment-effects model, a variant of Heckman sample selection model.

It is found that log per capita consumption or log mean per capita expenditure (MPCE) significantly increased in 2002 and 2004 for Vietnam and in 1993-4 for India. This is consistent with poverty reducing role of accessing RNFE. However, in later years, this statistically significant consumption poverty reducing effect disappeared. That is, it was no longer statistically significant in 2006 for Vietnam and MPCE slightly reduced due to access to RNFE in 2004-5 for India.

Access to RNFE significantly reduces vulnerability in India. This is important as a significant number of households in rural India were found to be vulnerable to shocks in the future (e.g. weather shocks, illness of household members, macro-economic slowdown). Diversification of household activities into non-farm sector would reduce such risks. In sharp contrast, in Vietnam, RNFE significantly increased vulnerability in 2002, but the effect became statistically non-significant in 2004 and 2006.

As the results are mixed, we cannot offer a definitive conclusion, but some of the results on poverty and vulnerability are consistent with the recent views that non-farm sector plays a key role in helping poor agricultural households escape poverty, as emphasised by Knight et al. (2009, 2010) in the context of rural China. Policy interventions designed to help agricultural households diversify into non-farm sector activities (e.g. skill training; microfinance) would potentially reduce not only poverty but also vulnerability.

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## Appendix 1: Definitions of the Variables of VHLSS and NSS data

| Variable | Definition |
|---|---|
| **VHLSS Data** | |
| Rlconpc | log real per capita consumption expenditure in 2002 value |
| Headage | Age of household head |
| Headage2 | (Age of household head)2 |
| Married | Whether a household head has a spouse |
| Femaleshare | Share of female members |
| Femaleshare2 | (Share of female members)2 |
| Hhsize | Size of Household |
| Depburden | Ratio of dependency burden |
| Majorities | Whether a household belongs to ethnic majority |
| Noschooling_Head | Whether a household had no education |
| Primary_Head | Whether a household finished with primary school education |
| Lowersecon_Head | Whether a household finished with lower secondary school education |
| Uppersecon_Head | Whether a household finished with upper secondary school education |
| Technical_Head | Whether a household finished with technical school education |
| Higher_Head | Whether a household finished with higher school education |
| RedRiverDelta | Whether a household is located in red river delta region |
| NorthEast | Whether a household is located in northeast region |
| NorthWest | Whether a household is located in northwest region |
| NorthCentralCoast | Whether a household is located in north central coast region |
| SouthCentralCoast | Whether a household is located in south central coast region |
| CentralHighlands | Whether a household is located in central highlands region |
| NorthEastSouth | Whether a household is located in north east south region |
| MekongRiverDelta | Whether a household is located in mekong river delta region |
| CentralCoast | Whether a household is located in central coast region |
| Land | Size of Land (million hactare) |
| Land2 | (Size of Land)2 |
| **NSS Data (India)** | |
| Whether a household is headed by a female member | Whether a household is headed by a female member, (=1 if yes, =0 if no). |
| Number of adult female members | Number of adult female members (15 years old or above) in a household |
| Number of adult male members | Number of adult male members (15 years old or above) in a household |
| Dependency Burden | The share of children under 15 years old or adults over 60 years old in the total number of household members. |
| Age of household head | Age of household head (years) |
| Age squared | Square of age of household head |
| The max. education of adult (Primary) | The maximum level of educational attainment of adult member in the household is the completion of primary school. |
| The max. education of adult (Middle) | The maximum level of educational attainment of adult member in the household is the completion of middle school. |
| The max. education of adult (>=Matriculates) | The maximum level of educational attainment of adult member in the household is matriculates or higher. |
| Land (0.1<=2.5 ha) (default: the landless) | The area of owned land of the household is from 0,1 hectare to 2.5 hectare. |
| Land (>2.5 ha) (default: the landless) | The area of owned land of the household is larger than 2.5 hectare. |
| Land pc | The area of owned land per capita |
| Whether self-employed in non-agriculture | Whether the occupation type of the household head is self-employed in non-agriculture (=1 if yes, =0 if no).- default of the four choices is 'others'. |

| | |
|---|---|
| Whether agricultural labour | Whether the occupation type of the household head is agricultural labour (=1 if yes, =0 if no). |
| Whether non-agricultural labour | Whether the occupation type of the household head is labour in non-agriculture (=1 if yes, =0 if no). |
| Whether self-employed in agriculture | Whether the occupation type of the household head is self-employed in agriculture (=1 if yes, =0 if no). |
| Whether a household belongs to SC (Scheduled Caste) | Whether a household belongs to SC (Scheduled Caste) (=1 if yes, =0 if no). |
| Whether a household belongs to ST (Scheduled Tribe) | Whether a household belongs to ST (Scheduled Tribe) (=1 if yes, =0 if no). |
| RPW | Whether a household has access to Rural Public Works. |
| FFW | Whether a household has access to Food for Work Programme. |
| Predicted agricultural wage rate for males | Agricultural Wage Rate for male workers averaged at NSS region. |
| Poor | Whether the household per capita expenditure is under the national poverty line for rural areas. |
| poor (calorie based) | Whether the household is undernourished in terms of calorie intakes. |
| poor (protein based) | Whether the household is undernourished in terms of protein intakes. |
| Vulnerability Measure (based on 100% income poverty line) | Whether the household is vulnerable (based on 100% of the national poverty line). |
| Vulnerability Measure (based on 80% income poverty line) | Whether the household is vulnerable (based on 80% of the national poverty line). |
| Vulnerability Measure (based on 120% income poverty line) | Whether the household is vulnerable (based on 120% of the national poverty line). |

**Appendix 2: Wage Equations for male and female workers in rural areas based on NSS data in 1993 and 2004**

| | 1993 | | 2004 | |
|---|---|---|---|---|
| | Male wage | Female Wage | Male Wage | Female Wage |
| | Coef. | Coef. | Coef. | Coef. |
| | (t value) | (t value) | (t value) | (t value) |
| Land Owned | 0.349 | -0.324 | 0.00 | -0.082 |
| | (0.98) | (4.86)** | (2.39)* | (8.35)** |
| Scheduled Tribe (ST) dummy (ST=1, otherwise=0) | -322.569 | -1,018.14 | -121.41 | -108.96 |
| | (0.87) | (4.08)** | (9.13)** | (7.53)** |
| Scheduled Caste (SC) dummy (SC=1, otherwise=0) | -2,177.57 | -381.166 | - | - |
| | (7.95)** | (1.89) | | |
| non-agricultural self employment dummy (non-agricultural self employment=1 otherwise) | 7,216.57 | 2,324.92 | 1,859.26 | 566.23 |
| | (10.27)** | (5.49)** | (68.44)** | (21.97)** |
| agricultural self employment dummy (agricultural self employment=1 otherwise=0) | 7,899.48 | 5,204.41 | 2,196.08 | 880.79 |
| | (15.13)** | (14.37)** | (69.07)** | (22.83)** |
| Muslim dummy(Muslim=1, otherwise=0) | 746.744 | 185.894 | 113.494 | -330.9 |
| | (1.61) | (0.46) | (5.59)** | (10.79)** |
| Age | 662.822 | 204.695 | 139.625 | 49.933 |
| | (8.65)** | (3.65)** | (37.08)** | (10.15)** |
| Age$^2$ | -4.072 | -1.257 | -1.638 | -0.637 |
| | (4.17)** | (1.69) | (39.07)** | (10.24)** |
| Whether is literate, but has not completed primary school | 3,542.99 | 2,126.39 | 92.081 | -205.98 |
| | (12.71)** | (7.36)** | (5.10)** | (8.72)** |
| Whether mother completed primary school | 7,518.66 | 3,208.70 | 175.043 | -227.04 |
| | (23.01)** | (7.49)** | (9.45)** | (9.53)** |
| Whether mother completed middle school | 14,163.75 | 10,200.92 | 360.514 | -192.21 |
| | (29.57)** | (8.09)** | (19.49)** | (7.37)** |
| Whether completed secondary or higher secondary school | 35,055.00 | 38,201.86 | 810.913 | 201.04 |
| | (56.87)** | (26.88)** | (33.86)** | (5.63)** |
| Whether completed higher education | 57,151.06 | 53,253.26 | 1,473.09 | 1,004.51 |
| | **(47.65)** | **(17.32)** | **(64.15)** | **(20.43)** |
| Constant | -2,171.00 | 4,216.78 | -2,940.20 | -1,749.97 |
| | (1.50) | (4.18)** | (34.97)** | (16.65)** |
| Observations | 33720 | 15849 | 67168 | 59221 |

Robust z-statistics in parentheses

* significant at 5% level; ** significant at 1% level

**Appendix 3: Deriving Vulnerability Measure[16]**

Vulnerability measure as an expected poverty is specified as:

$$\text{VEP}_{it} \equiv V_{it} = \text{Pr}(c_{i,t+1} \leq z) \qquad \text{(A-1)}$$

where vulnerability of household i at time t, $V_{it}$, is the probability that the *i-th* household's

level of consumption at time t+1, $c_{i,t+1}$, will be below the poverty line, z.

Three limitations, amongst others, should be noted in our measure of vulnerability.

First, the present analysis is confined to a consumption (used synonymously with income)

threshold of poverty. Second, our measure of vulnerability in terms of the probability of a

household's consumption falling below the poverty threshold in the future is subject to the

choice of a threshold. Third, while income/consumption volatility underlies vulnerability, the

resilience in mitigating welfare losses depends on assets defined broadly-including human,

physical and social capital. A household with inadequate physical or financial asset or

savings, for example, may find it hard to overcome loss of income. This may translate into

lower nutritional intake and rationing out of its members from the labour market (Dasgupta,

1997; Foster, 1995). Lack of physical assets may also impede accumulation of profitable

portfolios under risk and generate poverty traps.

The consumption function is estimated by the equation (A-2).[17]

$$\ln c_i = X_i \lambda + e_i \qquad \qquad \text{(A-2)}$$

where $c_i$ is log of real per capita household consumption (for Vietnam) and mean per capita

consumption (MPCE) (i.e. food and non-food consumption expenditure) (for India) for the

household and $X$ is a vector of observable household characteristics and other determinants

of consumption. It is further assumed that the structure of the economy is relatively stable

over time and, hence, future consumption stems solely from the uncertainty about the

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[16] This Appendix is based on Imai (2011) and Imai et al. (2011).

[17] We have used White-Huber sandwich estimator to overcome heteroscedasticity in the sample.

idiosyncratic shocks, $e_i$. It is also assumed that the variance of the disturbance term depends on:

$$\sigma^2_{e,i} = X_i \theta \tag{A-3}$$

The estimates of $\beta$ and $\theta$ are obtained using a three-step feasible generalized least squares (FGLS)[18]. Using the estimates $\hat{\beta}$ and $\hat{\theta}$, we can compute the expected log consumption and the variance of log consumption for each household as follows.

$$E[\ln C_i | X_i] = X_i \hat{\beta} \tag{A-4}$$

$$V[\ln C_i | X_i] = X_i \hat{\theta} \tag{A-5}$$

By assuming $\ln c_i$ as normally distributed and letting $\Phi(\cdot)$ denote the cumulative density function of the standard normal distribution, the estimated probability that a household will be poor in the future (say, at time t+1) is given by:

$$\hat{VEP}_i \equiv \hat{v}_i = \hat{Pr}(\ln c_i < \ln z | X_i) = \Phi\left(\frac{\ln z - X_i \hat{\beta}}{\sqrt{X_i \hat{\theta}}}\right) \tag{A-6}$$

This is an *ex ante* vulnerability measure that can be estimated with cross-sectional data. Note that this expression also yields the probability of a household at time *t* becoming poor at *t+1* given the distribution of consumption at *t*.

A merit of this vulnerability measure is that it can be estimated with cross-sectional data. However, it correctly reflects a household's vulnerability only if the distribution of consumption across households, given the household characteristics at time t, represents time-series variation of household consumption. Hence this measure requires a large sample in which some households experience positive shocks while others suffer from negative

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[18] See Chaudhuri (2003), Chaudhuri et al. (2002), and Hoddinott and Quisumbing (2003b) for technical details.

shocks. Also, the measure is unlikely to reflect unexpected large negative shocks (e.g., Asian

financial crisis), if we use the cross-section data for a normal year.