

THE IMPACT OF INVESTMENT IN COMMUNE INFRASTRUCTURE ON HOUSEHOLD PERFORMANCE IN VIETNAM RURAL AREAS

*

NGUYEN Duc Hung¹

ABSTRACT

In the paper, we try to measure the impact of investment in the commune infrastructure on household performance. The panel models with fixed effects are applied for the two-year VHLSS panels in 2010 and 2012 at both household and commune levels. Besides, the quantile regressions are applied to determine the impact of investment in the commune infrastructure on different groups of household income. We found that although investment in the commune infrastructure has no impact on household poverty incidence, it affects the intensity of household poverty, which means that it can make the poor less poor. The empirical evidence also shows that investment in infrastructure at commune level has a positive influence on household activities in the nonfarm sector, and then makes an improvement in household income. However, we only found its positive impact on middle-income and high-income households, while we did not find the evidence on its impact on poor households. Rich households get a higher level of benefits from investment projects in the commune infrastructure compared to poor households.

Key words: investment in commune infrastructure; intensity of employment; household income; poverty reduction.

¹ MA in Development Economics, email: nguyenduchung.neu@gmail.com

INTRODUCTION

In Vietnam, the efficiency of public investment is an emerging topic, investment in infrastructure in particular. Both researchers and policymakers paying a lot of attention to the context of economy restructure. It is particularly noticeable in recent years because it was considered as a critical story in the programme of restructuring public investment. Contrary to the ongoing story, there is few evidence on the influence and the mechanism channel of investment in the commune infrastructure on social development such as household income and poverty in the literature in the context of Vietnam.

The expansion of public investment in infrastructure in the past decade has significantly improved technical infrastructure, promoted economic growth, and contributed to improving the quality of life and poverty reduction. At the local level, the positive role of public investment in infrastructure has been recently recorded in the Vietnam Household Living Standard Survey (VHLSS). The investment projects are primarily focused on constructing roads to district/provincial, communal roads, bridges, expanding irrigation, solidification canals, electricity, clean water, health clinics, schools, reclamation of arable land, etc. Besides, the investment has also focused on rural areas with poor infrastructure development such as Northwest and North Central. For example, investigating the dynamics of sustainable poverty reduction, Giang and Thanh (2012) have reported a significant improvement in the network of rural infrastructure and enhanced access to socio-economic services, market, and information since the early 1990s of the last century. Many rural communities and remote areas have accessed to better roads and bridges conditions; construct new irrigation system; rapid expansion of communication services and information technology in rural areas.

However, the rapid growth of investment in infrastructure in recent years has also led to the situation that the ministries and authorities approved too many projects that excess the funding ability of budget, and thus the public investment plan were cut out each year. This turns out public investment was spreading, passive, extended construction time, wasting, loss, and then the effectiveness of public investment has reduced. At the same time, the government was unable to concentrate public investment resources on finishing the important infrastructure projects (Report of the Government No. 206/BC-CP, 2011). In addition, the general programme of restructuring the economy and transforming the current growth model are facing a lot of difficulties and implementing slowly compared with the plan. The public investment has remained rampant in recent periods adding more challenges to these difficulties. The approval of too many investment projects exceeding the budget possibility makes indebtedness in local construction. Legal enforcement of restructuring public investment is low, only stop in the Directive of the Prime Minister (Directive No. 1792/CT-TTg). This situation has led to the productivity of public investment fell sharply, the negative impact on the macroeconomic stability and growth potential.

It is undeniable the positive role of public investment in infrastructure development and support for economic development. However, in addition to the rampant investment and low productivity, it also

causes certain macroeconomic risks. In Vietnam, the studies that investigate the optimal size of the public investment and its impact on micro-entities, especially the household level, is still a vacant area. The deficiency may explain why the strategic planning of public investment is the lack of a solid foundation and practice in implementation.

Therefore, this research is implemented to fill the gap in the literature. It may also provide an empirical evidence for the process of policy making in Vietnam. In this study, we examine public investment in terms of investment in the commune infrastructure in Vietnam rural areas. We attempt to use a quantitative approach to measuring the impact of investment in the commune infrastructure on household income and poverty. In particular, its impact on household income disparity is also examined in the empirical regression models. Given the objectives, the research is designed to investigate and answer the main questions: Whether the investment in the commune infrastructure improves the household income and then reduces the poor household rate in Vietnam rural areas? How does the investment in the commune infrastructure influence on employment in the nonfarm sector and the different groups of household income? Whether the investment in the commune infrastructure is effective in household income improvement and household poverty reduction in Vietnam rural areas? What are the policy implications for policy makers intended to improve the productivity of public investment and household welfare, Vietnam rural areas in particular?

In order to answer the research questions, the major following hypotheses should be tested in the paper: The investment in the commune infrastructure has a positive impact on household income in Vietnam rural areas. The investment in the commune infrastructure stimulates household activities in the nonfarm sector in Vietnam rural areas. The investment in the commune infrastructure helps to reduce the household poverty in Vietnam rural areas. The investment in the commune infrastructure follows the rule of diminishing return to scale, and then its square has a negative sign at traditional levels of significance. The influence of investment in the commune infrastructure is different between groups of household income, and widens the household income gap in Vietnam rural areas.

LITERATURE REVIEW

Living standards improvement and poverty reduction are always a challenge to countries, especially for developing countries. The poor often does not have necessary resources to access to the services provided by the private sector. Hence, the involvement of government is necessary to solve this problem. Through public investment instrument, the government can make an improvement in the incomes of the people and improve the quality of public services required.

Public investment is considered as an instrument to improve the inequality and poverty reduction through income redistribution and infrastructure development, thus increase access to economic opportunities. According to Benin and Randriamamonjy (2008), poverty is a vicious circle. Poverty leads to poor health, low labor productivity, and thus leads to lower income. To solve this problem, there should

be the involvement of the government in the provision the minimum public services such as health and education to meet the needs of the people. Besides, Seneviratne and Yan Sun (2003) indicated that the development of infrastructure system promotes social equality through increasing access to employment opportunities. In addition, the redistribution of income can help to improve the resources invested in human capital and infrastructure to low-income groups and the inability to access capital (Perotti, 1994).

The public investment helps to improve the incomes and reduce poverty through human capital accumulation, promote private investment, increase aggregate demand and savings (Anderson, Renzio, and Levy, 2006). Specifically, the public investment, e.g. the public investment in education and health, has positive effects on human capital accumulation through improving access to public services for low-income and poor groups. In developing countries, public investment is used as an instrument to support the development in the private sector through improving the quality of infrastructure and the provision of services to the private sector. In addition, the public investment contributes to stimulating aggregate demand through increasing government expenditures, and gross savings by improving incomes.

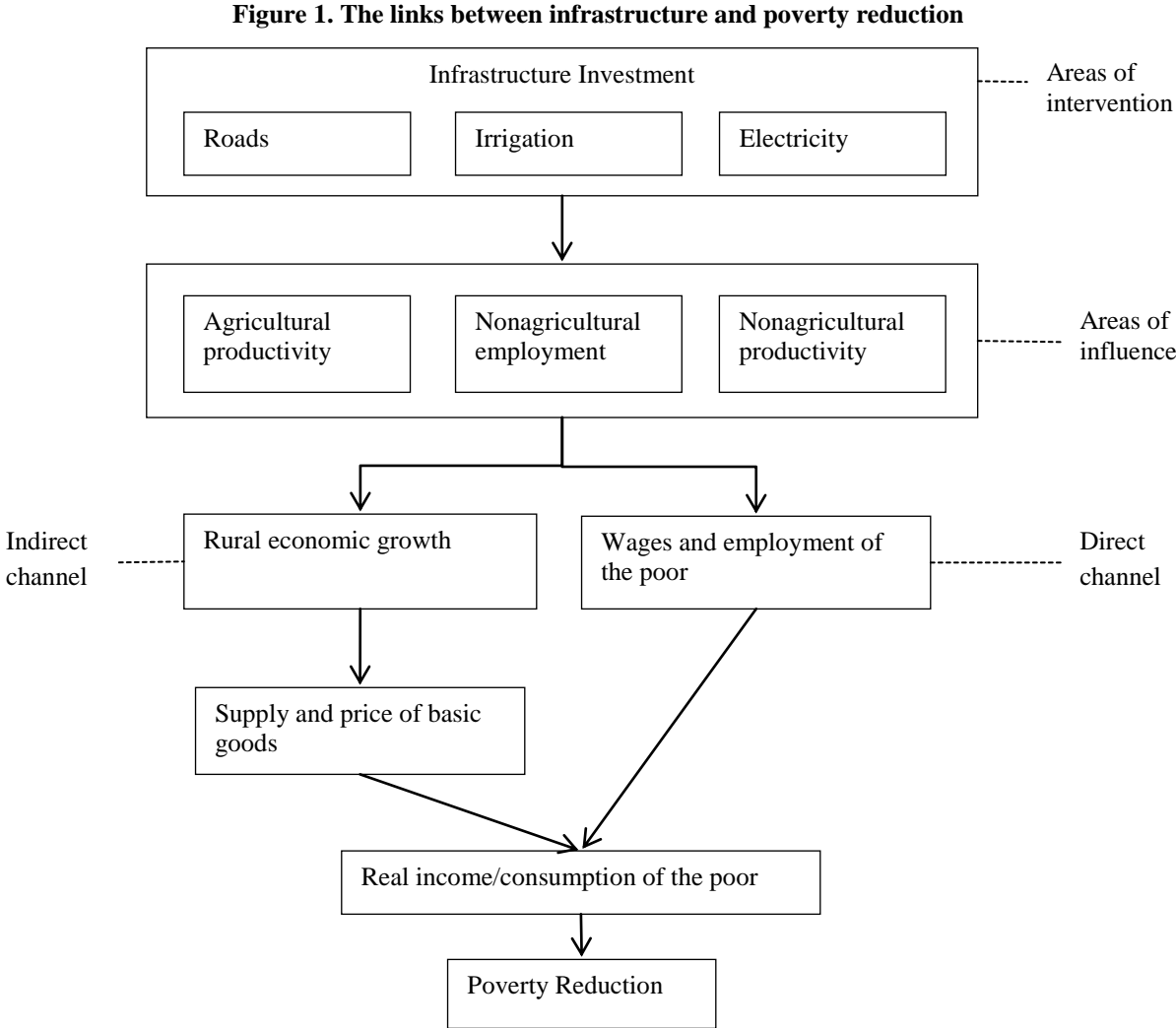
Anderson *et al.*, (2006) showed that public investment brings changes in the quantity and quality of public services and infrastructure in rural areas. In particular, rural areas are often underdeveloped. The quality of infrastructure and public services is low. Besides, people have fewer opportunities to access services provided by the private sector because the private sector is weak and underdeveloped. Therefore, public investment in education, health and transport have positive impacts on household income and poverty reduction through improving access to the economic achievements of the people in the rural areas.

Experimentally, the literature at the macro level has provided an evidence of the positive impact of public investment in improving household income through the development of infrastructure and provision of services public. For example, Benin and Randriamamonjy (2008) indicated that significant improvements in sanitation, health and education have led to an increase in household income, and thus helped to reduce the incidence of poverty in African nations. For the case of Malaysia in the period 1970-2008, Mukaramah, Jalil and Bakar (2011) noted that the government transfers and public expenditures on education have a strong impact on household income. In particular, in the case of China, Xiao Yuan Dong (2000) found that public investment has the strongest marginal effects on least developed households.

Public investment can also affect the allocation of asset and wealth, and thus has an indirect impact on human capital accumulation. Perotti (1994) provided the evidence that the impact of wealth allocation creates a higher level of investment in human capital and infrastructure. However, this study also showed that the improvement of the capital market might also reduce the impact of income allocation to investors.

Meanwhile, Seneviratne and Yan Sun (2003), who studied the case of the ASEAN-5 in the period 1980-2010, showed that only public investment is not enough to influence the income distribution. It needs other factors such as educational development, employment in the formal sector and the financial system.

Empirically, the literature focuses on public investment in physical infrastructure and poverty reduction. Agricultural productivity, nonagricultural employment, and nonagricultural productivity are usually considered as the main determinants of rural poverty. The analytical framework is summarized in Figure 1.



Source: Ali and Pernia (2003).

In general, the empirical literature does not trace in detail the relationships described above. It focuses on measuring the impact of a type of infrastructure investment on an interesting indicator such as nonfarm employment, earnings or poverty. In particular, there are a number of empirical studies found the positive impact of roads on poverty reduction through the channel of economic growth, e.g., Kwon (2000) and Balisacan, Pernia, and Asra (2002) in the case of Indonesia, Balisacan and Pernia (2002) on Philippines, Fan *et al.* (2002) in China. Related to China case, Jalan and Ravallion (2002) indicated that an increase of 1% in kilometers of roads per capita leads to a household consumption expansion by 0.08%.

The empirical evidence on the impact of investment in a rural irrigation system on the poor is more significant than those in a road system. The poor gets more benefits in comparison to the nonpoor. For example, Bhattarai *et al.* (2002), analyzing the case of India, Philippines, Thailand, and Viet Nam, indicated that poverty incidence is primarily lower in irrigated areas than unirrigated areas. In the case of China, Fan, Zhang and Zhang (2002) found that investment in irrigation contributes to poverty reduction through stimulating the growth in the agricultural sector. Because, it directly affects the farm productivity and the income growth of the poor, and then it indirectly impacts on nonfarm employment. A 1% increase in irrigation contributes to a 0.31% increase in the incomes of the poor (Balisacan and Pernia, 2002).

The investment in electricity also stimulates significantly the growth of the nonfarm sector and poverty reduction in rural areas. For example, Fan *et al.* (2002) estimated the elasticity of 0.42 between electricity investment and poverty reduction in the case of China. Each 10,000 yuan spent on the development of electricity leads to 2.3 persons getting out of poverty incidence. Balisacan *et al.* (2002) provided evidence in Indonesia that electric investment in rural areas helps to increase the nonfarm employment and the incomes of the poor. Balisacan and Pernia (2002) attained similar results that investment in electricity positively impacts on the poor's through growth channel, but effects from the direct channel are unclear for the poorest group and clearer for the upper groups. Songco (2002) also recorded that rural electrification projects were significantly reducing poverty incidence in Bangladesh and India.

Despite there are many studies on the effects of investment in infrastructure to income and poverty in rural areas, there are few studies on its different effects on benefits and inequality between population groups. Besides, the attained evidence remains controversially. For example, Jacoby (1998) provided the evidence that investment in rural road networks brings substantial benefits. Where the poor group attains considerable share, but this share is not large enough to significantly reduce income inequality in comparison with other groups. The question is whether the benefits of a road project for the poor than the nonpoor are large enough to reduce overall income inequality.

In the case of Vietnam, empirical studies have shown that investments in infrastructure have important contributions to household income improvement and poverty reduction in rural areas. Glewwe *et al.* (2000) revealed that the probability of escaping the poverty of poor households living in rural communes with paved roads are higher 67% than those in the communes without paved roads. Van de Walle and Cratty (2002) found that a rural road rehabilitation project funded by World Bank has the strongest positive impact on the poorest households. The poorest household group also gets a higher level of benefits from an investment in a rural irrigation system in comparison to the richest one, an increase of 4.5% of household expenditure compared with 0.1% rise (Van de Walle, 1998). Van de Walle (2000) continued to indicate that investment in irrigation results in an improvement in return to education of all

household heads and then leads to an increase of 36% in crop income of irrigated farms compared to unirrigated farms.

The impact of investment in rural infrastructures such as roads and irrigation systems is positive in household income improvement and poverty reduction. However, the overall impact of investment in the commune infrastructure on the different household groups living in rural areas has not still investigated in the literature. Given these issues, in addition to the investigation about the impact of public investment in the commune infrastructure on household income and employment in Vietnam rural areas, the author also focuses on its impacts on the different groups of household income.

METHODOLOGY, VARIABLES AND DATA

Modelling its influence on household income and employment intensity

The regression models are first estimated with the household dataset. The OLS models are estimated to get initial results for reference purpose. The random effects (RE) models are estimated in comparison to the OLS models. Then, the Hausman Test is employed to choose the better one among the fixed effects (FE) models and the RE models. The FE models are expected to choose due to the technical characteristics and advantages. They capture the unobserved characteristics that are time-invariant leading to the income difference between households. Empirically, the FE model can be presented as follows:

$$\begin{aligned}
 hhinc_{it} = & \alpha_{10} + \alpha_{11}cominv_{i,t-1,t-2} + \alpha_{12}cominv_{i,t-1,t-2}^2 \\
 & + \sum_j \alpha_{13j}hhchar_{jit} + \sum_j \alpha_{14j}comchar_{jit} + \sum_j \alpha_{15j}S_{jt} + \alpha_{16}\tau_t + \alpha_{17}v_i + e_{1it},
 \end{aligned} \tag{1}$$

where α is the vector of estimated parameters; $hhinc$ is measured by monthly household income; $cominv$ is the average annual investment in the commune infrastructure within last two years (at time $t-1$ and $t-2$) and $cominv^2$ is its square; $hhchar_j$ and $comchar_j$ are the vectors of variables that capture the time-variant characteristics of household head (e.g., age, age squared, the education of household head, household size) and the time-variant characteristics of commune (e.g., the number of household businesses in the commune, post office, market, crafts); S_j is the main sources of finance funding for the investment projects in the commune infrastructure. This vector of variables may not be included in the empirical regressions; τ is a time dummy capturing the effects over time and; v captures the time-invariant factors and finally e is error terms.

We also examine the indirect channel effect to the household income as described by the framework. The investment in the commune infrastructure enhances household activities in the nonfarm sector and reduces household activities in the farm sector. This channel is investigated through two key dependent variables relating to the participation of rural households in farm and nonfarm sectors ($hhnonfarm_j$). The first dependent variable is the number of household members participating in farm or nonfarm sectors. The second one is a number of working hours in farm or nonfarm sectors. Similarly, the FE model can be presented as follows:

$$\begin{aligned} \overline{hhnonfarm}_{jit} &= \alpha_{20} + \alpha_{21} \overline{cominv}_{i,t-1,t-2} + \alpha_{22} \overline{cominv}^2_{i,t-1,t-2} \\ &+ \sum_j \alpha_{23j} \overline{hhchar}_{jit} + \sum_j \alpha_{24j} \overline{comchar}_{jit} + \sum_j \alpha_{25j} S_{jt} + \alpha_{26} \tau_t + \alpha_{27} \Lambda_i + e_{2it}. \end{aligned} \quad (2)$$

With the commune panel dataset, we go further to investigate the impact of investment in the commune infrastructure on household income and poor household rate. The time-invariant factors across communes are captured by running equation (1) and equation (2) using commune panel and including commune fixed effects as follows:

$$\begin{aligned} \overline{hhinc}_{it} &= \beta_{10} + \beta_{11} \overline{cominv}_{i,t-1,t-2} + \beta_{12} \overline{cominv}^2_{i,t-1,t-2} \\ &+ \sum_j \beta_{13j} \overline{hhchar}_{jit} + \sum_j \beta_{14j} \overline{comchar}_{jit} + \sum_j \beta_{15j} S_{jt} + \beta_{16} \tau_t + \beta_{17} \Lambda_i + \varepsilon_{1it} \end{aligned}, \quad (3)$$

$$\begin{aligned} \overline{hhnonfarm}_{jit} &= \beta_{20} + \beta_{21} \overline{cominv}_{i,t-1,t-2} + \beta_{22} \overline{cominv}^2_{i,t-1,t-2} \\ &+ \sum_j \beta_{23j} \overline{hhchar}_{jit} + \sum_j \beta_{24j} \overline{comchar}_{jit} + \sum_j \beta_{25j} S_{jt} + \beta_{26} \tau_t + \beta_{27} \Lambda_i + \varepsilon_{2it} \end{aligned}, \quad (4)$$

where β is the vector of estimated parameters, Λ is commune fixed-effects, and ε is the vector of error terms. In equation (3), the variable \overline{hhinc} is the average monthly income of a household in the commune. The vector of variables $\overline{hhnonfarm}_j$ is calculated as on average at the commune level. Similarly, other variables capturing household characteristics are computed as similar ways representative for a typical household in the commune. The impact of investment in the commune infrastructure on poverty, measuring by the poor household rate in the commune ($hhpoor$), is analyzed by the following equation.

$$\begin{aligned} \overline{hhpoor}_{jit} &= \beta_{30} + \beta_{31} \overline{cominv}_{i,t-1,t-2} + \beta_{32} \overline{cominv}^2_{i,t-1,t-2} \\ &+ \sum_j \beta_{33j} \overline{hhchar}_{jit} + \sum_j \beta_{34j} \overline{comchar}_{jit} + \sum_j \beta_{35j} S_{jt} + \beta_{36} \tau_t + \beta_{37} \Lambda_i + \varepsilon_{3it} \end{aligned}, \quad (5)$$

Equations from (1) to (5) can be estimated by OLS method, but the estimation results may be biased due to unobserved characteristics and uncontrolled random factors in the models. To overcome these problems, we take the post estimation to choose between the OLS model and the RE model, and compare the RE model and the FE model. Hausman test, in particular, is then performed to choose between the FE model and the RE model with established panel datasets.

The quantile regression models are used to investigate the impact of public investment on household income distribution across households and communes as introduced by Koenker and Bassett (1978). These models allow investigating the impact of public investment on different levels in income distribution. To simplify, by rewriting the right-hand side of equations from (1) to (5) as $\beta_z X_{zit}$, we can write the model as follows:

$$Quant_{\theta}(hhinc_{it}) / (\beta_z X_{zit}) = \beta_z X_{\theta}. \quad (6)$$

Where $Quant_{\theta}$ denotes conditional quintile (θ) of $hhinc_{it}$ and X_{zit} are the conditional vectors of variables with the assumption that $Quant_{\theta}(u_{\theta i}) / X_{zit} = 0$ and $u_{\theta i}$ is error terms. The estimated result

$\hat{Quant}(hhinc_{it} | X_{zit}) = \hat{\beta}_{z\theta} X_{zit}$ shows how the conditional expectation of household income follows increasing of θ along the distribution. The quintile parameters thus explain the marginal movements of conditional quintiles in respect to marginal movements in explanatory variables.

The quintile regression models are similar to the Ordinary Least Square models; however, the conditional expectation of dependent variable is allowed to vary according to its distribution across quintiles. Its advantages are to allow statistical inference similar to the traditional regression approach based on minimizing the squared error terms. Simultaneously, they have the characteristics as invariance and robustness.

Modelling its influence on household poverty

We apply a logit model with fixed effects to model the influence of investment in the commune infrastructure on household poverty incidence. Where dependent variable is a binary variable that takes the value of one if a household was counted as a poor household and zero otherwise. For the advance of panel data, all time-invariant and unobserved effects are controlled by fixed effects. For simplicity the model, which fits via maximum likelihood the fixed-effects model, can be modeled as follows.

$$\Pr(Y_{it} = 1 | x_{it}, c_i) = P(X_{it}\beta + c_i + \mathcal{G}_{it}) \quad (7)$$

for v_i are i.i.d, $N(0, \sigma_c^2)$, and $P(\square) = \{1 + \exp(-\square)\}^{-1}$. \mathcal{G}_{it} are i.i.d. logistic distributed with mean zero and variance $\sigma_g^2 = \pi^2 / 3$, independently with v_i . Where β is the vector of parameters to be estimated in the model and X is the vector of explanatory variables.

Based on the methodology of Foster, Greer and Thorbecke (Foster *et al.*, 1984), the class of poverty measures is denoted as

$$P_\alpha = \frac{1}{N} \sum_{i=1}^q \left(\frac{Z - Y_i}{Z} \right)^\alpha \quad (8)$$

where N is the size of the sample, Y_i is income per capita of the i th household,² Z is the poverty line, q is the number of poor households with income per capita below Z and α is the Poverty Aversion Parameter Index, which takes the values of 0, 1 and 2 representing the incidence of poverty (or headcount index), poverty gap (or the depth of poverty) and severity of poverty.

Because the intensity of poverty is a fractional response variable taking the limited values from zero to 1, i.e., $0 \leq Y \leq 1$, the fractional regression model with fixed effects proposed by Papke and Wooldridge (2008) is employed to measure the influence of investment in the commune infrastructure instead of logit model with fixed effects. This model is an appropriate approach because it overcomes commonly problems related to the models with limited dependent models such as TOBIT and LOGIT. It can be estimated by the quasi-maximum likelihood estimator, with heteroscedasticity-robust asymptotic variance.

² In the study, we also use the variable of household expenditure per capita to compute the poverty status of households as introduced by GSO-WB (2012).

Similar to Bhaumik *et al.* (2006), we argue that, if a factor affects the probability of a household falling into poverty, it also affects the intensity of poverty. Thus, we used the same variables as the determinants of household poverty incidence. This argument is also mentioned in Tran *et al.* (2015) in which the authors investigated the determinants of poverty incidence and intensity among ethnic minorities in the Northwest region of Vietnam.

Given the advantage of fractional logit model with fixed effects, the models are also used to estimate the coefficients measuring the marginal effects of investment in the commune infrastructure on the intensity of employment, i.e., dependent variables take values in the interval [0, 1]. The estimated results are used to compare with the results from the fixed effects models.

Data and variables

Processing data

VHLSS had been surveyed in 1992-1993 for the first time and the second time was implemented in 1997-1998. Since 2002 up to now, it has biennially surveyed. At the time of the investigation, the newest VHLSS was the VHLSS in 2012. The study thus uses data from two Surveys of Household Living Standards in 2010 and 2012.

VHLSS in 2010 deployed across the country with the sampling of 69360 households in 3133 scale communes/wards representative for national, regional, urban areas, rural areas and cities directly under the Central Government. VHLSS in 2012 was conducted on the scale of 63 provinces and municipalities directly under the Central Government. Of 69360 surveyed households in 2010, 22365 households were asked about income; 37596 households were asked about income and other issues; 9399 households were asked about income, expenditure and other issues. In a similar approach, VHLSS 2012 includes a sampling of 46996 households that was selected by GSO from the 3133 communes/wards, where 9399 households were asked full information about income, expenditure and other issues. By information advantages, the sample of 9399 households in two rounds of VHLSS would be used in the study. The VHLSS 2012 has 50% of households (equivalent to around 4700 households) were selected from the 2010 survey.

Three panel datasets at household and commune levels are established for the study. Fundamentally, the panel dataset is matched by using the method introduced by GSO. The household panel is conducted by three steps. First, the household-level data is extracted from the Household Questionnaire in the VHLSS database in 2010 and 2012. Similarly, the commune-level data is extracted from Commune Questionnaires in the VHLSS database in 2010 and 2012. In each year, the variables of household characteristics are then merged with the variables of commune characteristics. Finally, the two-year household panel is established by the GSO's matching method. Accordingly, we obtain the household panel covering 2118 observations, with 1059 households surveyed in 2010 and 1059 those households resurveyed in 2012.

The commune panel is established by a method similar to the household panel. However, the variables of household characteristics are computed representative for a typical household in the commune before matching to make the commune panel. Finally, We attain the commune panel including 772 commune-level observations, of which, 386 observations are present in both two surveys.

Table 1: Survey samples using in the study

Panel	Number of observations in 2010 or 2012	Total observations in the two-year panel
Household panel	1059	2118
Commune panel	386	772

Source: The author' calculation.

The descriptive statistics for all panels is presented in Appendix.

Variable and measurement

The household-level variables are extracted from the Household Questionnaire and the Personal Questionnaire in VHLSS database in 2010 and 2012. They capture the household characteristics such as household size and the characteristics of household head including age and educational attainment measured by the number of years of schooling. The commune-level variables are defined as the definition of the Commune Questionnaire such as the number of businesses, the availability of infrastructure including the post office and inter-communal market. These variables are also extracted from the database of VHLSS in 2010 and VHLSS 2012.

For the key dependent variable, the household income variable is adjusted to inflation to exclude the effect of the price factor. It is adjusted to inflation to the point of time 01 January 2010. We try to remove the extraordinary components of household income to exactly measure the impact of key dependent variable on household income. We define the household income including the earnings generated within the local area. The sources of transfer income or the earnings derived from outside the province are not covered in the variable of household income. Thus, the household's sources of temporary and extraordinary income are excluded such as funerals, weddings, cash, and noncash transfers from people outside the household. The final variable of real household income only includes all the earnings from wages, salaries, and agricultural and non-agricultural revenues after excluding costs.

The information in Section 5 of the Commune Questionnaire is employed to exploit information and evaluate the impact of investments in the commune infrastructure on household incomes and poverty reduction in rural areas. The variable of average investment in the commune infrastructure within past two years was computed and extracted from the question 31 to 36. Where, the author only keeps the Commune that has full information about investment projects in the commune infrastructure in the past two years. To eliminate the price effects, this variable is then adjusted for inflation to early 2008 before making household and commune panels.

All the variables of household income and investment in the commune infrastructure are expressed in terms of natural logarithm before estimation due to its significance in both technical analysis and statistical inference. A brief description of key variables that would be employed in the empirical models is presented in Table 2.

Table 2: Brief description of key variables³

Variable definition and measure	Unit	Available in household panel	Available in the commune panel
<i><u>Dependent variables</u></i>			
The rate of poor household in the commune	%		x
Poor household ^a	Dummy ^b	x	
Poverty gap	%	x	
Intensity of poverty		x	
Monthly household income	Th. vnd	x	x
The number of members working in nonfarm activities	Person	x	x
The number of members working in farm activities	Person	x	x
The number of nonfarm-working hours per month	Hours	x	x
The number of farm-working hours per month	Hours	x	x
The ratio of members working in nonfarm activities to household size	%	x	x
The ratio of members working in farm activities to household size	%	x	x
The ratio of nonfarm-working hours to total working hours	%	x	x
The ratio of farm-working hours to total working hours	%	x	x
<i><u>Household characteristics</u></i>			
Age of household head	Year	x	x
Squared age of household head		x	x
Household size	Person	x	x
Proportion of dependents in household ^c	%	x	x
Education of household head	Schooling Year	x	x
<i><u>Household Assets/Wealth</u></i>			
Total land area per capita	m ² /person	x	x
Total asset value per capita	Th. vnd /person	x	x
<i><u>Commune characteristics</u></i>			
Average annual investment in the commune infrastructure within past two years	Th. vnd	x	x
Have post office in the commune	Dummy ^b	x	x
Have market in the commune	Dummy ^b	x	x
Have crafts in the commune	Dummy ^b	x	x
Number of businesses in the commune	Business	x	x

Source: The author's calculation.

³ The Table summarizes key variables which are captured in the empirical models, but not included time-invariant variables such as gender of household head, geography etc. ^b the poverty incidence of household is calculated by the updated GSO-WB poverty line for 2010, i.e. VND 653,000 per person per month (US \$2.26 per person per day, 2005 PPP). ^a indicates dummy variables (1 = Yes; 0 = Otherwise). ^c dependents include young dependents (members under 15) and old dependents (female members above 59 and male members above 64).

EMPIRICAL RESULTS AND ANALYSIS

The findings from empirical models with household panel data

Household income and employment intensity

The post-estimation tests are implemented for all panel estimation models to choose the best model. Hausman Test suggests that the FE model should be used in statistical analysis and inference. As mentioned, panel data allows the FE model to capture the time-invariant effects at the levels of household and commune. The time-invariant characteristics of household and commune, e.g. the gender of household head and geographical dummies, are consequently not statistically significant. These variables are thus excluded from the empirical estimation models.

The fixed effects model is expected to use, and it is appropriate for empirical analysis based on post-estimation tests although the post-estimation tests suggest random effects model in some cases. The post-estimation tests suggest that the empirical models have heteroskedasticity problems. Hence, the variance is reestimated by the robust command after attaining estimation results from FE models. Finally, the estimation results are displayed in Table 3 attaining from household panel dataset with panel models after controlling household fixed effects and calculating the robust estimate of variance.

First, in the income channel, the results show that investment in the commune infrastructure has a positive impact on household income at 5% level of significance. Investment in the commune infrastructure such as building a new road can lead to an improvement in household income. The results show that the impact of public investment in the commune infrastructure on household income has nonlinear effects. These findings are consistent with economic theory on public investment.

Investment projects in the commune infrastructure, which completed from one to two years ago, have a positive influence on household income. Marginal effects increase along with the scale of investment and the peak reaches the threshold of 442.413 VND million (calculated according to the price in 1st January 2010). If the scale of public investment in infrastructure at commune level exceeds this threshold, the impact of commune-level investment in infrastructure will change from positive effects to negative effects. In the study sample, around 77.2% of 386 communes in 2010 and approximately 80.1% of 386 communes in 2012 have the scale of investment exceeding the threshold.

In order to investigate the influence of commune-level investment in infrastructure on the groups of household income, the two subsamples are established to represent for lower-income household and upper-income household groups. The estimation results are presented in Table 3, at columns (5) and (6). The author does not detect the effect of public investment in infrastructure at commune level on the lower-income household group while it strongly has influence and significance for the upper-income household group. It means that the lower income households are less likely to get benefits from investment projects in the commune infrastructure.

The quartiles models are employed to dig deep investigation about the impact of commune-level investment in infrastructure on household income disparity. The estimation results for three groups of household income (High-, Medium-, and Low-income households) are displayed in Table 3, at columns (7), (8), and (9). We also do not find empirical evidence on the impact of investment in the commune infrastructure on Low income households, whereas its impact on Medium income households is significant at 10% level of significance and 5% level of significance for High-income households. Specifically, 1% increases in investment in the commune infrastructure can lead an improvement of 0.125% in the income of rich households.

Moreover, regarding time-variant household characteristics, the author found evidence about the positive influence of household head education and the nonlinear influence of age of household head on household income at traditional levels of significance after controlling for commune fixed effects. Besides, household size also has a positive influence. These findings are consistent with the fact that the total income of household will increase in a larger household size. We also find the evidence for the positive influence of time-variant characteristics at commune level such as the number of businesses, markets, and post offices.

As mentioned above, investment in the commune infrastructure strengthens infrastructure system and creates more economic opportunities for people in rural areas. To be more specific, the commune-level investment in infrastructure enhances household activities in the nonfarm sector and reduces household activities in the farm sector. This channel is investigated through two key dependent variables relating to the participation of rural households in farm and nonfarm sectors. The first dependent variable is the number of household members participating in farm or nonfarm sectors. The second one is a number of working hours in farm or nonfarm sectors.

The estimated results attained from the empirical models are summarized in Table 4 and Table 5 above. The findings support our hypothesis on a positive relationship between the commune-level investment in infrastructure and household activities in the nonfarm sector. The coefficients of interest are significant at 5% level of significance. The author also finds that public investment in infrastructure at commune level has nonlinear effects on nonfarm activities of households. An increase in the commune-level investment in infrastructure can lead to an increase in the total number of household members and working hours in the nonfarm sector. However, its marginal effects will gradually decrease along with the increase in the scale of public investment.

Table 3: The Impact of public investment in the commune infrastructure on household income in rural area

VARIABLES	Log of monthly household income								
	OLS	RE	FE	Between effects	FE with robust		QUARTILES MODEL		
	(1) General household sample	(2) General household sample	(3) General household sample	(4) General household sample	(5) Upper income household group	(6) Lower income household group	(7) High income group	(8) Medium income group	(9) Low income group
Year dummy	0.339*** (0.029)	0.351*** (0.022)	0.397*** (0.026)	0.365*** (0.062)	0.310*** (0.038)	0.205* (0.109)	0.354*** (0.038)	0.316*** (0.035)	0.369*** (0.037)
Log of public investment in infrastructure	0.104** (0.047)	0.104** (0.044)	0.078 (0.055)	0.142** (0.071)	0.145* (0.075)	0.051 (0.073)	0.121** (0.071)	0.080* (0.054)	0.028 (0.063)
Square of log of public investment in infrastructure	-0.004** (0.002)	-0.004** (0.002)	-0.003 (0.002)	-0.006* (0.003)	-0.007** (0.003)	-0.001 (0.003)	-0.005** (0.003)	-0.003# (0.002)	-0.001 (0.003)
Constant	3.341*** (0.368)	3.689*** (0.375)	6.682*** (1.310)	3.106*** (0.507)	4.899*** (1.661)	11.660*** (4.382)	4.057*** (0.451)	3.500*** (0.445)	3.781*** (0.514)
Control for selectivity term	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control for household fixed effects	No	No	Yes	Yes	Yes	Yes	na	na	na
Control for commune fixed effects	No	No	No	No	No	No	na	na	na
Observations	1,314	1,314	1,314	1,314	724	590	1,314	1,314	1,314
R-squared	0.561		0.497	0.580	0.372	0.462	na	na	na
Number of hhid		773	773	773	511	443	na	na	na

Unweighted estimation with robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, # p<0.15

Source: Calculated by the author.

Table 4: The Impact of public investment in the commune infrastructure on nonfarm participation of rural households

VARIABLES	Number of household members participating in the nonfarm sector				Log of the number of hours worked in the nonfarm sector			
	OLS	RE	FE	FE with robust	OLS	RE	FE	FE with robust
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	nonfarm	nonfarm	nonfarm	nonfarm	ln_hours_nonfarm	ln_hours_nonfarm	ln_hours_nonfarm	ln_hours_nonfarm
Year dummy	-0.060 (0.051)	-0.027 (0.037)	0.026 (0.043)	0.026 (0.046)	-0.072* (0.038)	-0.061** (0.031)	-0.042 (0.039)	-0.042 (0.035)
Log of public investment in infrastructure	0.130 (0.085)	0.142* (0.074)	0.154* (0.091)	0.154* (0.093)	0.003 (0.064)	0.006 (0.062)	0.060 (0.092)	0.060 (0.079)
Square of log of public investment in infrastructure	-0.005 (0.004)	-0.005* (0.003)	-0.006* (0.004)	-0.006* (0.004)	0.000 (0.003)	0.000 (0.003)	-0.001 (0.004)	-0.001 (0.003)
Constant	-0.376 (0.665)	-0.029 (0.658)	-2.457 (2.173)	-2.457 (2.224)	5.205*** (0.522)	5.063*** (0.538)	3.454** (1.701)	3.454*** (1.315)
Control for selectivity term	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control for household fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Control for commune fixed effects	No	No	No	No	No	No	No	No
Observations	1,287	1,287	1,287	1,287	806	806	806	806
R-squared	0.311		0.225	0.225	0.227		0.146	0.146
Number of hhid		764	764	764		523	523	523

Unweighted estimation with robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Source: Calculated by the author.

Table 5: The Impact of public investment in the commune infrastructure on farm participation of rural households

VARIABLES	Number of household members participating in the farm sector				Log of the number of hours worked in the farm sector			
	OLS (1)	RE (2)	FE (3)	FE with robust (4)	OLS (5)	RE (6)	FE (7)	FE with robust (8)
	farm	farm	farm	farm	ln_hours_far m	ln_hours_far m	ln_hours_far m	ln_hours_far m
Year dummy	0.023 (0.055)	-0.006 (0.039)	-0.002 (0.046)	-0.002 (0.046)	-0.052 (0.051)	-0.067 (0.044)	-0.216*** (0.070)	-0.216*** (0.065)
Log of public investment in infrastructure	-0.086 (0.091)	-0.174** (0.078)	-0.238** (0.096)	-0.238** (0.108)	0.188** (0.082)	0.208*** (0.079)	0.132 (0.119)	0.132 (0.115)
Square of log of public investment in infrastructure	0.004 (0.004)	0.007** (0.003)	0.010** (0.004)	0.010** (0.004)	-0.008** (0.003)	-0.009*** (0.003)	-0.007 (0.005)	-0.007 (0.005)
Constant	-0.567 (0.711)	-0.544 (0.709)	4.694** (2.283)	4.694* (2.410)	3.066*** (0.658)	2.737*** (0.674)	3.349 (5.428)	3.349 (6.375)
Control for selectivity term	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control for household fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Control for commune fixed effects	No	No	No	No	No	No	No	No
Observations	1,287	1,287	1,287	1,287	989	989	989	989
R-squared	0.331		0.087	0.087	0.261		0.084	0.084
Number of hhid		764	764	764		636	636	636

Unweighted estimation with robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Source: Calculated by the author.

Table 6: The impact of investment in the commune infrastructure on household poverty in rural area

VARIABLES	MODELS WITH PANEL DATA						
	FRACTIONAL LOGIT				LOGIT	FRACTIONAL LOGIT	
	Proportion of hh member working in the nonfarm sector	Proportion of household member working in the farm sector	Proportion of working hours in the nonfarm sector	Proportion of working hours in the farm sector	Household poor incidence	Household poverty gap	Household intensity of poverty
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	rate_nonfarm	rate_farm	rate_hours_no_nfarm	rate_hours_farm	wbgso_poor	poverty_gap	poverty_severity
Year dummy	-0.073 (0.055)	0.027 (0.052)	-0.023 (0.075)	0.023 (0.075)	-1.418 (1.165)	0.075 (0.116)	0.133 (0.155)
Log of public investment in infrastructure	0.237** (0.113)	-0.235** (0.099)	0.115 (0.147)	-0.115 (0.147)	-1.168 (2.008)	-0.308* (0.174)	-0.375 ^{\$} (0.229)
Square of log of public investment in infrastructure	-0.009* (0.005)	0.010** (0.004)	-0.004 (0.006)	0.004 (0.006)	0.029 (0.072)	0.012 ^{\$} (0.007)	0.015 ^{\$} (0.009)
Constant	-1.817* (0.999)	-0.880 (0.927)	1.035 (1.311)	-1.035 (1.311)		3.886*** (1.316)	3.656** (1.829)
Control for selectivity term	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control for household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control for commune characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,287	1,287	1,287	1,287	146	189	189
Number of hhid	764	764	764	764	73	154	154

Unweighted estimation with robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, ^{\$} p<0.12

Source: Calculated by the author.

Household poverty

The estimated results by logit model with fixed effects and fractional logit model with fixed effects for the impact of investment in the commune infrastructure on household poverty in rural area are presented in Table 6, at column (5), (6) and (7). We do not find the evidence on the impact of investment projects in infrastructure completed within two previous years on the incidence of household poverty in local communes. Although it has no impact on household poverty incidence, we found that it affects the intensity of poverty. This finding is not strong enough, but it suggests that investment in the commune infrastructure can make the poor less poor.

The results address a nonlinear relationship between average annual investment in the commune infrastructure completed within past two years and the intensity of household poverty in the commune. The estimated coefficients are statistically significant at 12% level of significance. The reduction of household poverty intensity can be an outcome of investment in the commune infrastructure after employment intensity in the nonfarm sector and household income improved.

The empirical results support our hypotheses that, through direct and indirect channels, investment in the commune infrastructure strengthens infrastructure system and creates more economic opportunities for people in rural areas. This investment improves household incomes by enhancing household activities in the nonfarm sector and reducing household activities in the farm sector. Consequently, it may make a contribution to poverty reduction in the commune in rural areas.

The findings from empirical models with commune panel data

The findings from empirical models with commune panel dataset are consistent with the findings from empirical models with household panel dataset. On the one hand, investment in the commune infrastructure has significantly positive impact on household income at 10% level of significance. The relationship between investment in the commune infrastructure and household income, on the other hand, follow a U-turned curve, i.e., the marginal effect of public investment is diminishing along with the scale of public investment.

The threshold of public investment in the commune infrastructure is recognized at the magnitude of 729.416 VND million (the value of VND on 01 January 2008). If the annual investment of a commune in infrastructure exceeds this threshold, it does not help to improve household income or even lead to an adverse influence on household performance. This threshold is much less than the threshold attained from the household panel, with the magnitude of 14.65 VND billions. In the study sample, around 67.6% of 386 communes in 2010 and approximately 68.7% of 386 communes in 2012 have the scale of investment exceeding this threshold.

Similar to the findings from the household panel, the empirical results suggest that investment in the commune infrastructure has a positive impact on Medium- and High-income households (middle income and rich households), while it seems not to have a positive impact on low-income households.

Specifically, at 10% level of significance, 1% increase in investments in the commune infrastructure can promote the income of the rich household group by roughly 0.15% and 0.12% for the middle-income household group. In contrast, the estimated coefficient reflecting the impact of investments in the commune infrastructure on low-income households is not statistically significant. This may be due to that poor households tend to have fewer resources to able to utilize economic opportunities created from public projects in infrastructure at commune level.

For the impact of public investment on household poverty rate in the commune, we do not find the evidence on the impact of investment projects in infrastructure completed within two previous years on household poverty in local communes. However, the results seem to suggest a nonlinear relationship between average annual investment in the commune infrastructure completed within past two years and poor household rate in the commune (see column 8-11 in Table 6). The estimated coefficients are statistically insignificant at traditional levels of significance. This may be due to the lagged influence of investment in the commune infrastructure on commune poverty rate. Local poverty reduction in the commune is an indirect outcome after household income improved. It means that the public investment in commune infrastructure has first impact on household income and then poverty reduction.

If the volume of investment in the commune infrastructure is small, it has a U-turned curve relationship with the poor household rate in the commune. That is, an increase in the small scale of public investment in the commune infrastructure may have a positive impact on household poverty through the channel household income improvement. However, if the scale of public investment in the commune infrastructure is exceeded a certain threshold, an increase in its scale does not help to improve the local poverty situation.

In addition, the funding resources allocated to public investment projects in the commune infrastructure from central and provincial authorities are less effective, while the funding sources from commune level and institutions in private sector are more effective in improving household income and reducing household poverty rate at local level (see equation (6), Table 5).

Table 7: The Impact of investment in the commune infrastructure on average household income and the poor household rate in the commune

VARIABLES	Log of monthly household income on average							Rate of poor household in the commune			
	OLS	RE	FE	FE with robust	QUARTILES MODEL			OLS	RE	FE	FE with robust
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	General household sample	General household sample	General household sample	General household sample	Low-income household group	Medium household income group	High-income household group	General commune sample	General commune sample	General commune sample	General commune sample
Year dummy	0.500*** (0.041)	0.479*** (0.023)	0.465*** (0.023)	0.465*** (0.023)	0.499*** (0.056)	0.514*** (0.050)	0.427*** (0.051)	0.000 (0.011)	0.009* (0.005)	0.011** (0.005)	0.011** (0.005)
Log of public investment in infrastructure	0.096 (0.065)	0.091* (0.049)	0.108* (0.056)	0.108* (0.060)	-0.031 (0.109)	0.110* (0.065)	0.139* (0.080)	-0.004 (0.017)	-0.002 (0.012)	-0.003 (0.013)	-0.003 (0.016)
Square of log of public investment in infrastructure	-0.004 (0.003)	-0.004* (0.002)	-0.004* (0.002)	-0.004* (0.002)	0.001 (0.005)	-0.005* (0.003)	-0.006* (0.003)	0.000 (0.001)	0.000 (0.000)	0.000 (0.001)	0.000 (0.001)
Constant	6.864*** (0.386)	6.984*** (0.301)	7.042*** (0.349)	7.042*** (0.373)	7.143*** (0.617)	6.805*** (0.409)	6.922*** (0.485)	0.115 (0.104)	0.145** (0.072)	0.192** (0.078)	0.192** (0.092)
Control for selectivity term	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control for household fixed effects	No	No	na	na	na	na	na	No	No	na	na
Control for commune fixed effects	No	No	Yes	Yes	na	na	na	No	No	Yes	Yes
Observations	563	563	563	563	563	563	563	562	562	562	562
R-squared	0.311		0.652	0.652				0.038		0.039	0.039
Number of hhcom		325	325	325					325	325	325

Unweighted estimation with robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Source: Calculated by the author.

DISCUSSIONS, LIMITATIONS AND CONCLUDING REMARKS

Key findings and concluding remarks

We found that investment projects in the commune infrastructure, which completed from one to two years ago, have a positive influence on household income. Investment in the commune infrastructure such as building a new road can lead to an improvement in household income. However, its marginal effects follow the rule of diminishing returns to scale, i.e., the marginal effect is diminishing along with the scale of public investment. The certain threshold is recognized at the magnitude of 729.416 VND million for the commune panel dataset (calculated according to the price on 01 January 2008). This threshold is relatively higher than the threshold attained from the household panel dataset, with 442.413 VND million.

Investment projects in the commune infrastructure strengthen the rural infrastructure system and create more economic opportunities for people in rural areas. The findings show a positive relationship between investment in the commune infrastructure and household activities in the nonfarm sector. The author also finds that public investment in the commune infrastructure has nonlinear effects on household activities in both the nonfarm sector and the farm sector.

We found that although public investment has no impact on household poverty incidence, it affects the intensity of household poverty, which means that it can make the poor less poor. The empirical evidence also shows that investment in infrastructure at commune level has a positive influence on household activities in the nonfarm sector, and then makes an improvement in household income. However, it only has a positive impact on middle-income and high-income households, while it is not found the evidence on its impact on poor households. Specifically, 1% increase in investment in the commune infrastructure can promote the income of the rich households by roughly 0.15% and 0.12% for middle-income households. This result may reflect the fact that, in comparison to rich households, poor households tend to have fewer resources to able to utilize economic opportunities created from investment projects in the commune infrastructure.

For the influence on the poor household rate in the commune, we found a nonlinear relationship between average investment in the commune infrastructure completed within last two years and poor household rate in the commune. However, the estimated coefficients are statistically insignificant at traditional levels of significance. This may be due to the lagged influence of public investment in the commune infrastructure on commune poverty rate. Local poverty reduction in the commune is an indirect outcome after household income improved.

Finally, the effect of funding sources for investment projects in the commune-level infrastructure is also investigated in the empirical models. In contrast, the funding resources from local authorities, commune level, in particular, are more effective in improving household income in rural areas than the central government. These findings imply that the effectiveness of public investment in rural infrastructure will be more effective if the government encourages the involvement of local people and partners.

In summary, we try to measure the impact of public investment in the commune infrastructure on household income and poverty. The panel models with fixed effects are applied for the two-year VHLSS panels in 2010 and 2012 at both household and commune levels. Besides, the quantile regressions are applied to determine the impact of investment in the commune infrastructure on different groups of household income. We found that the impact of investment in the commune infrastructure on household income follows the rule of diminishing return to scale. The investment in the commune infrastructure helps to stimulate nonfarm activities, improve household income, and then contribute to reduction the intensity of household poverty in Vietnam rural areas. The marginal effects of investment in the commune infrastructure are different between the groups of household income. The investment in the commune infrastructure widens the household income gap between the rich household group and the poor one in Vietnam rural areas.

Limitations and further research

While the national policy of public investment in infrastructure is considered as the lack of effectiveness, the public investment in the commune infrastructure is effective in household income improvement and poverty reduction in Vietnam rural areas. Investment in the commune infrastructure helps to improve household income for rural people and promote employment shifted from farm activities to non-farm activities, and, therefore, it can reduce the intensity of household poverty though it does not affect household poverty incidence.

Indeed, investment in infrastructure can only improve household income if it is controlled under a certain threshold. This implies that the government should continue to review public investment projects that are being implemented. For future investment projects, public investments in rural infrastructure need to exploit fully social resources. Utilizing social resources not only saves the government budget, but also increases the efficiency of public investment projects in the commune infrastructure, and thus helps to improve the overall social welfare.

However, the findings intended to apply for policy purposes should be cautious due to potential measurement issues and endogenous variables. Measures of poverty at commune level may not best represent for local poverty because we used poverty information available in the Commune questionnaire of VHLSS. Although tried, it is difficult to separate household income generating within the commune. On the other hand, endogenous problems may emerge due to the concentration of public investment. Public investments could be concentrated in poorer areas and likely that it is the cause of the negative sign of coefficient estimated.

For further research, we expect to dig deep investigation the effectiveness and impact of investment in the commune infrastructure on household performance and poverty through the analysis of transmission channels and the measurement of appropriate dependent variables. Besides, VHLSS should be used to make a three-round panel from 2010 to 2014. We also expect to apply an appropriate approach for calculating the poverty at commune level. The potential results may have important implications for both academic and policy sides.

REFERENCES

- Ahmed, H., and Miller, S. (2000). "Crowding-out and crowding-in effects of the components of Government expenditure," *Contemporary Economic Policy*, 18 (1), 124-133.
- Aschauer, D. A. (1989). "Is public expenditure productive?," *Journal of Monetary Economics*, 23:177-200.
- Asian Development Bank (2001). "Paving the way to poverty reduction through better roads. ADI Series No. 3, Operations and Evaluation Department, Asian Development Bank, Manila.
- Asian Development Bank (2002). "Impact of rural roads on poverty reduction: A case study-based analysis," IE-68, Operations Evaluation Department, Asian Development Bank, Manila.
- Balisacan, A. M., and E. M. Pernia (2002). "Probing beneath cross-national averages: Poverty, inequality, and growth in the Philippines," ERD Working Paper Series No. 7, Economics and Research Department, Asian Development Bank, Manila.
- Balisacan, A. M., E. M. Pernia, and A. Asra (2002). "Revisiting growth and poverty reduction in Indonesia: What do subnational data show?," ERD Working Paper Series No. 25, Economics and Research Department, Asian Development Bank, Manila.
- Barro, R. (1990). "Government spending in a simple model of endogenous growth," *Journal of Political Economy*, 98:S103-S125.
- Bhattarai, M., R. Sakhitavadivel, and Intizar Hussain (2002). "Irrigation impacts on income inequality and poverty alleviation," *International Water Management Institute Working Paper 39*, Colombo.
- Bhaumik, S.K., Gang, I.N. and Yun, M.S. (2006). "A note on poverty in Kosovo," *Journal of international development*, 18 (8), 1177- 1187.
- Bùi Trinh (2009). "Hiệu quả đầu tư của các khu vực kinh tế thông qua hệ số ICOR," *Thematic Report for Vietnam Institute of Economic*.
- Bùi Trinh (2011). "Đánh giá hiệu quả đầu tư," retrieved on 22 July 2014 from <http://www.thesaigontimes.vn/65864/Danh-gia-ve-hieu-qua-dau-tu.html>
- DFID (2002). *Making the Connections: Infrastructure for Poverty Reduction*, London.
- Everhart, S. S., and Sumlinski, M. A. (2000). "Trends in Private Investment in developing countries, Statistics for 1970 to 2000," IFC Discussion Paper, 44, Washington, D.C.
- Fan, S., L. X. Zhang, and X. B. Zhang (2002). *Growth, Inequality, and Poverty in Rural China: The Role of Public Investments*. Research Report 125, International Food Policy Research Institute, Washington, D.C.
- Foster, J., Greer, J. and Thorbecke, E. (1984). "A class of decomposable poverty measures," *Econometrica: journal of the econometric society*, 52 (3), 761- 766.
- Ghura, D., and Goodwin, B. (2000). "Determinants of Private Investment: a cross-regional empirical investigation," *Applied Economics*, 32, 1819-1829.
- Glewwe, P., M. Gragnolati, and H. Zaman (2000). "Who gained from Vietnam's boom in the 1990s? An Analysis of Poverty and Inequality Trends," *World Bank Working Paper 2275*, Washington, D.C.
- Greene, J., and Villanueva, D. (1991). "Private investment in developing countries: an empirical analysis," *IMF Staff Papers*, 38 (1), 33-58. Washington, D.C.
- Hadjimichael, MT, and Ghura, D. (1995). "Public policies and private savings and Investment in Sub-Saharan Africa: an empirical investigation," *IMF Working Paper*, 19, Washington, D.C.
- Hansen, N. M. (1965). "The structure and determinants of local public investment expenditures," *Review of Economics and Statistics*, 47:150-62.

- Jacoby, H. G. (1998). "Access to markets and the benefits of rural roads: A nonparametric approach," World Bank, Washington D.C. Processed.
- Jalan, J., and M. Ravallion (2002). "Geographic poverty traps? A micro model of consumption growth in rural China," *Journal of Applied Econometrics* 17(4):329-46.
- Koenker, R., and Bassett, G. (1978). "Regressions quantiles," *Econometrica*, 46:33–50.
- Kwon, E. K., (2000). "Infrastructure, growth, and poverty reduction in Indonesia: A cross-sectional analysis," Asian Development Bank, Manila. Processed.
- Martin, P. (1999). "Public policies, regional inequalities and growth," *Journal of Public Economics*, 73:85–105.
- Martin, P., and Rogers, C. A. (1995). "Industrial location and public infrastructure," *Journal of International Economics*, 39:335–51.
- Munnell, A. (1990a). "Why has productivity growth declined? Productivity and public investment," *New England Economic Review*, January–February, 3–22.
- Munnell, A. (1990b). "How does public infrastructure affect regional economic performance?," *New England Economic Review*, September–October, 11–32.
- Nguyễn Tam Giang và Hoàng Xuân Thành (2012). "Long-run drivers of poverty reduction in Vietnam between 1992 and 2011," Technical research for Vietnam Poverty Assessment Report 2012, Hanoi.
- Odedokun, M. O. (1997). "Relative effects of public versus private spending investment on economic efficiency and growth in developing countries," *Applied Economics*, 10 (28), 1325 -1336.
- Papke, L.E. and Wooldridge, J.M. (2008). "Panel data methods for fractional response variables with an application to test pass rates," *Journal of Econometrics*, 145 (2008), 121–133.
- Pho Thi Kim Chi *et.al* (2013). "Hiệu quả đầu tư công: Nhìn từ tác động của nó đến tăng trưởng kinh tế". National Center for Socio-Economic Information and Forecast.
- Songco, J., (2002). "Do rural infrastructure investments benefit the poor?," World Bank Working Paper 2796, Washington, D.C.
- Tuyen Quang Tran, Son Hong Nguyen, Huong Van Vu & Viet Quoc Nguyen (2015). "A note on poverty among ethnic minorities in the Northwest region of Vietnam," *PostCommunist Economies*, 27:2, 268-281, DOI: 10.1080/14631377.2015.1026716.
- Tô Trung Thành (2012). "Đầu tư công 'lấn át' đầu tư tư nhân? – Góc nhìn từ mô hình thực nghiệm VECM," Vietnam central for Economic and Policy Research, Working paper, NC-27.
- Van de Walle (2000). "Are returns to investment lower for the poor?," World Bank Working Paper 2425, Washington, D. C.
- Van de Walle, D. (1998). "Infrastructure and poverty in Vietnam," In D. Dollar, P. Glewwe, and J. Litvack, eds., *Household Welfare and Vietnam Transition*. World Bank, Washington, D.C.
- Van de Walle, D., and D. Cratty (2002). "Impact evaluation of a rural road rehabilitation project," World Bank, Washington D.C. Processed.
- Vũ Tuấn Anh (2010). "Tóm tắt về tình hình đầu tư công ở Việt Nam trong mười năm qua," *Kỷ yếu hội thảo đầu tư công*, Huế 28-29/12/2010.
- World Bank (1994). "World development report 1994: Infrastructure and development," New York: Oxford University Press.
- World Bank (2012). "Vietnam Poverty Assessment Report 2012: well begun, not yet done – Vietnam's remarkable progress on poverty reduction and the emerging challenges," Hanoi.

APPENDIX

Appendix 1: Descriptive statistics for household panel

VARIABLES	2010		2012	
	Mean	Std	Mean	Std
HOUSEHOLD PANEL				
<i>Dependent variables</i>				
Poor household	0.24	0.42	0.16	0.36
Poverty gap	0.26	0.17	0.22	0.16
Monthly household income	4,251.75	4,074.23	6,634.67	5,383.21
Monthly income per capita	354.31	339.52	552.89	448.60
The number of members working in nonfarm activities	1.04	1.09	1.08	1.12
The number of members working in farm activities	1.49	1.29	1.47	1.21
The number of nonfarm-working hours per month	183.48	204.33	187.73	205.24
The number of farm-working hours per month	161.66	179.18	157.40	167.69
The ratio of members working in nonfarm activities to household size	0.27	0.29	0.28	0.28
The ratio of members working in farm activities to household size	0.39	0.32	0.40	0.32
The ratio of nonfarm-working hours to total working hours	0.47	0.43	0.48	0.42
The ratio of farm-working hours to total working hours	0.53	0.43	0.52	0.42
<i>Household characteristics</i>				
Age of household head	49.6	13.9	51.0	13.8
Household size	4.0	1.6	3.9	1.6
Proportion of dependents in household	0.34	0.29	0.35	0.30
Education of household head	7.16	3.97	7.30	3.84
<i>Household Assets/Wealth</i>				
Total land area per capita	1,878.66	2,590.38	1,953.45	2,762.44
Total asset value per capita	4,356.46	6,448.67	6,165.87	9,203.57
<i>Commune characteristics</i>				
Average annual investment in the commune infrastructure within past two years	2,544,749	3,899,142	3,314,022	7,472,225
Have post office in the commune	0.51	0.50	0.52	0.50
Have market in the commune	0.66	0.47	0.66	0.47
Have crafts in the commune	0.14	0.34	0.12	0.32
Number of businesses in the commune	117.76	308.84	103.87	274.34
Observations	1,059		1,059	

Source: Calculated by the author from VHLSS in 2010 and 2012.

Appendix 2: Descriptive statistics for commune panel

Variables	2010		2012	
	Mean	Std	Mean	Std
COMMUNE PANEL				
The rate of poor household in the commune (%)	0.15	0.15	0.17	0.17
The average number of household members working in nonfarm activities in the commune	0.99	0.86	1.05	0.85
The average number of household members working in farm activities in the commune	1.38	1.02	1.35	0.95
The average number of nonfarm-working hours of household per month in the commune	181.82	145.69	183.64	145.69
The average number of farm-working hours of household per month in the commune	150.78	137.02	149.71	130.67
The average ratio of household member to household size working in nonfarm activities in the commune	0.26	0.23	0.27	0.21
The average ratio of household member to household size working in farm activities in the commune	0.35	0.25	0.35	0.24
The average ratio of nonfarm-working hours of household to total working hours of household in the commune	0.53	0.34	0.53	0.33
The average ratio of farm-working hours of household to total working hours of household in the commune	0.47	0.34	0.47	0.33
Observations	386		386	

Source: Calculated by the author from VHLSS in 2010 and 2012.

Appendix 3: Poverty situation in Vietnam

	1993	1998	2002	2004	2006	2008	2010	2012
POVERTY RATE								
Average whole country	58.1	37.4	28.9	19.5	16	14.5	20.7	13.0
Average rural areas	66.4	45.5	35.6	25	20.4	18.7	27.0	17.1
Kinh-Hoa	53.9	31.1	23.1	13.5	10.3	8.9	12.9	7.5
Minorities	86.4	75.2	69.3	60.7	52.3	50.3	66.3	50.6
POVERTY GAP							(*)	(**)
Average whole country	18.4	9.5	7	4.7	3.8	3.5	na	3.139
Average rural areas	21.5	11.6	8.7	6.1	4.9	4.6	na	4.211
Kinh-Hoa	16	7.1	4.7	2.6	2	1.7	2.7	1.379
Minorities	34.7	24.1	22.8	19.2	15.4	15.1	24.3	15.075

Note: Follow WB-GSO's poverty line.

(*) Table 2.5 (p.49)/Table 3.5 (p.68), "Well begun not yet done" (WB, 2012).

(**) Computed from VHLSS 2012 with "poverty line" = 9.887.046 vnd (adjusted for CPI from 'poverty line 2010' = 653.000 vnd/person/month = 12*653.000 vnd/person/year; and CPI_2011=18.13%; CPI_2012=6.81%)

Source: Calculated by the author from VHLSS 1993-2012.