Economics
The Open-Access, Open-Assessment E-Journal

Discussion Paper
No. 2016-40 | September 15, 2016 | http://www.economics-ejournal.org/economics/discussionpapers/2016-40

Impacts of Rural Road on Household Welfare in Vietnam: Evidence from a Replication Study

Cuong Nguyen

Abstract
Recently, there is a call for replication research to validate empirical findings, especially findings important for development policies. Thus, this study tried to replicate estimation results from Mu and van de Walle ("Rural Roads and Local Market Development in Vietnam" published in *Journal of Development Studies* 2011). Overall, the author is able to replicate the most estimates from Mu and van de Walle. He finds the positive effect of rural road on local market development. In addition to the pure replication, the author also estimates the effect of the road project on additional outcomes including access to credit and migration, but do not find significant effects on these outcomes.

(Submitted as Replication Study)

Note by the editor: The findings should be viewed as tentative until the paper has completed the review process and been published as an article.

JEL H43 O12 C14
Keywords Replication; impact; evaluation; propensity; score; matching; rural; road; Vietnam

Authors
Cuong Nguyen, ✉ National Economics University, Hanoi, Viet Nam, cuongwur@gmail.com

Citation Cuong Nguyen (2016). Impacts of Rural Road on Household Welfare in Vietnam: Evidence from a Replication Study. Economics Discussion Papers, No 2016-40, Kiel Institute for the World Economy. http://www.economics-ejournal.org/economics/discussionpapers/2016-40

Received August 16, 2016 **Accepted as Economics Discussion Paper** September 14, 2016
Published September 15, 2016

1. Introduction

In the recent years, there are a remarkably increasing number of empirical socio-economic studies. Empirical studies are important for not only researchers but also policy makers in designing socio-economic policies. Most empirical studies rely on large-scale data sets and econometric methods to test research hypotheses. Findings from empirical studies depend heavily on the methodology selection and how data are analysed. Even using the same method and data sets, there can be different ways that researchers can define and select variables for model estimation, and as a result these different ways can lead to different findings and policy recommendations. Thus, there is a call for replication research to validate empirical findings, especially findings important for development policies (Brown et al., 2014). Replication research not only confirms the validity of replicated studies but also raises the importance of analyzing, documenting and keeping empirical data during the research.

In this study, I tried to replicate the study of Mu and Van de Walle entitled "Rural Roads and Local Market Development in Vietnam" published in *Journal of Development Studies* 47, no. 5 (2011), pages 709-34. [1] Mu and Van de Walle (2011) aim to measure the effect of rural roads on local market development in Vietnam. They test a hypothesis called 'transport-induced local-market development' using data from surveys of Vietnam Rural Transport Project I and double differences with propensity score matching methods. They conclude that rural roads increase local market development. Using regressions, they also find that heterogeneity in the impact of rural roads. The impact of rural roads tends to be higher for the poorer communes since the poorer communes have low base levels of market development.

There are several reasons for selection of this study for replication. Firstly, rural roads play a crucial role in the socio-economic development of rural areas (World Bank,

[1] Two related papers of this article are:
Van de Walle, D. and Mu, R. (2007) Fungibility and the flypaper effect of project aid: micro-evidence for Vietnam. Journal of Development Economics, 84(2), pp. 667–685.
Mu, R. and van de Walle, D. (2007) Rural roads and local market development in Vietnam. Policy Research Working Paper No. 4340, Development Research Group, World Bank, Washington, DC.

1994; Gannon and Liu, 1997; Lipton and Ravallion, 1995; Jalan and Ravallion, 2001). Jalan and Ravallion (2001) point out that rural road is a necessary element for fostering rural income growth and reducing poverty. Rural roads can increase household income, including both farm and non-farm income. Rural roads increase agricultural productivity by reducing transportation costs, increasing access to advanced technology, increasing capital and enabling the employment of labour from outside local areas. In addition, rural roads can also increase non-farm production and non-farm employment opportunities for local people. Mu and Van de Walle (2011) provide important finding on the important role of rural road in nonfarm employment and market development. Until the end of 2013, according to the Google Scholar citation system, this paper (together with the working paper version) has been cited in 125 studies. It is important to validate its estimates and results using the original data sets.

Secondly, there are a large number of arguments that local market development can increase household welfare. However, there is little if anything known about the effect of public investment in transport on local market development. Most empirical studies focus on the effect of rural road on household income and find a positive effect of rural roads on non-farm income e.g., Balisacan et al. (2002), Fan et al. (2002), Corral and Reardon (2001), Escobal (2001), Nguyen (2011).[2] Thus, Mu and van de Walle (2011) provide important evidence on the effect of rural roads on local market development. As known, market accessibility is an important channel though which rural road can help local people improve non-farm activities, income and consumption, expenditure.

Thirdly, Vietnam is a developing country with more than two-thirds of the population living in rural areas and 95 percent of the poor are living in rural areas. An important poverty reduction program in Vietnam is to improve infrastructures for rural areas, especially those with a high poverty rate and a higher proportion of ethnic minorities. State and international agencies work continuously to improve and maintain

[2] A review on empirical studies of the impact of rural roads can be found in Ali and Pernia (2003).

infrastructures, including roads.[3] In Mu and van de Walle (2011), rural roads are found to be an important factor in local market development and the effect of rural roads is higher for the poor areas. This finding is very important for policy makers in designing poverty reduction programs in Vietnam.

Fourthly, the findings from Mu and van de Walle (2011) can be used for other developing countries, especially for some Asian developing countries, such as the Philippines, Indonesia, Lao, and Cambodia, with a similar economic structure as Vietnam. Rural roads can help local market development in the short-run, as a result enhancing nonfarm employment, increasing income and reducing poverty in the long-run.

In this study, I firstly conduct the pure replication of the study of Mu and Van de Walle (2011). Mu Ren and Dominique van de Walle provided us with the raw original data sets, which allow us to replicate their published estimates. The pure replication includes the following basic steps: Reconstruct all variables used in the study; Recalculate descriptive statistics of all the variables using the raw data; Re-estimate results in the original study using the original specifications.

Secondly, I also conducted so-called statistical replication to examine the sensitivity of the impact estimates to different sets of covariates and bandwidth used in the propensity score matching. One of key issues in propensity score matching method is to select covariates and bandwidth, and there are no standard criteria for this selection. Difference selections produce different comparison groups, and as a result different estimates of the program impacts. Thus it's important to investigate whether the main findings from an empirical study are robust to different model specifications.

Thirdly, I will go beyond the outcomes that are considered in Mu and Van de Walle (2011) (including market accessibility, non-farm employment and child education), and estimate the effect of the road project on additional outcome variables including

[3] According to Donnges and others (2007), Viet Nam had a rural road network consisting of approximately 175,000 kilometres in 2007. Around 73 percent of rural villages can be accessed by a good road (tar on gravel) (according to Viet Nam Household Living Standard Survey in 2010).

access to credit and migration.[4] These outcomes are important for livelihood and non-farm diversification of rural households, and can provide policy-relevant findings.

The report is structured into five sections. The second section describes the method and data in Mu and van de Walle (2011). The third section presents the pure replication results. The fourth section presents results from statistical replication. Finally, the fifth section concludes.

2. Data and methods in Mu and van de Walle (2011)

Mu and van de Walle (2011) assess the impact of the Vietnam Rural Transport Project I which implemented the rehabilitation of 5,000 kilometers of rural roads in communes in 18 provinces in Vietnam. The project was implemented during 1997-2001. Data used in Mu and van de Walle (2011) were collected before and after the project. This data set is called the 'Survey of Impacts of Rural Roads in Vietnam' (SIRRV). More specifically, a panel data of 3000 households in 200 communes were conducted in 1997, 1999, 2001 and 2003. 15 households were sampled from each commune. There are 100 communes in the project areas, and 100 communes from the non-project areas. Mu and van de Walle (2011) use commune data sets in 1997 (the baseline survey), 2001 and 2003 (the mid-term and endline surveys) for impact evaluation.

The endogeneity bias in the impact evaluation of the Vietnam Rural Transport Project I can happen because the project placement is not random. Provinces were allowed to select communes for the projects and the road links to be rehabilitated. There are several criteria for selection of communes and road links such as cost, population density, share of ethnic minority population. However, these criteria are not well documented in the project documents, and it is not clear how the selection process actually happened (Mu and van de Walle, 2011). For most large-scale projects in Vietnam, it is very difficult to conduct a randomization or well-defined regression discontinuity impact evaluation

[4] There are no data on consumption expenditure in the data set.

(Nguyen, 2012). To solve the problem of endogeneity, Mu and van de Walle (2011) used the difference-in-difference estimator. This method controls the difference in outcomes between the treatment and control groups caused by observed variables and the time-invariant difference caused by unobserved variables. In other words, it assumes that the difference in no-project outcomes between the treatment and control groups (once observed variables are controlled for) was the same before and after the project.

Mu and van de Walle (2011) combine the difference-in-difference (DD) with propensity score matching to estimate the effect of the rural road project on communes' market development. They estimate the Average Treatment Effect on the Treated. According to their denotation, the estimator is expressed as follows:

$$DD = \sum_{N_P} DD_i / N_P \qquad (1)$$

where:

$$DD_i = \left(Y_{i1}^{P} - Y_{i0}^{P}\right) - \sum_{j} W_{ij}\left(Y_{j1}^{NP} - Y_{j0}^{NP}\right) \qquad (2)$$

DD_i is the estimate for the project commune *i*. *P* and *NP* denote the treatment (project commune) and control (non-project commune), respectively. Subscript `1' and `0' denote the outcome after and before the project, respectively. *W* is weights applied to the comparison communes when they are matched with the treatment communes.

Mu and Van de Walle (2011) use the kernel propensity score matching (Heckman et al., 1997) and propensity score-weighted difference-in-differences (Hirano and Imbens, 2002; Hirano et al., 2003) to estimate the impact. A logit regression is used to predict the propensity score. Control variables are commune characteristics in the base year, 1997. The list of control variables is presented in Appendix. The list of outcome variables is presented in Table 2 in the next section.

After estimating the effect of the rural roads on outcomes for each commune (i.e., DD_i), Mu and van de Walle (2011) run regression of DD_i on commune characteristics variables to examine whether the effect of rural roads varies across communes of different characteristics as follows:

$$DD_i = \alpha + X_i\beta + \varepsilon_i, \qquad (3)$$

where DD_i is the estimated impact on an outcome for commune *i*, and X_i is a vector of explanatory variables of commune *i*.

3. Replication results

In this section, I aim to conduct pure replication of the results from Mu and Van de Walle (2011). The pure replication includes the three following basic steps: (i) Reconstruct all variables used in the study; (ii) Recalculate descriptive statistics of all the variables using the raw data; and (iii) Re-estimate results in the original study using the original specifications.

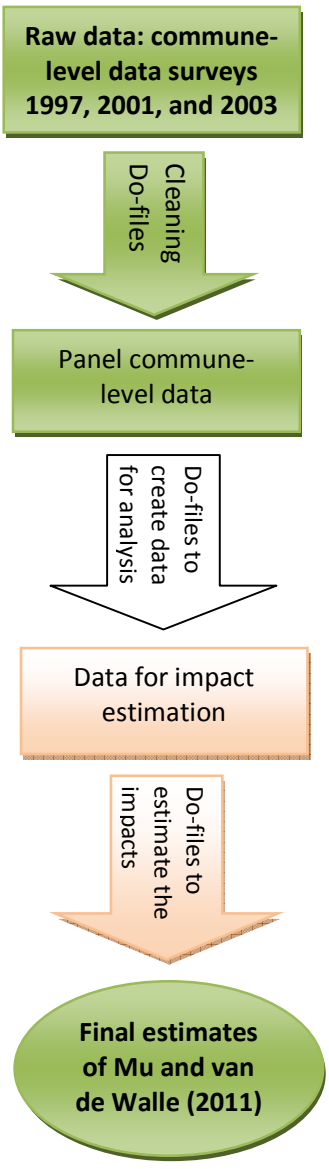
3.1. Raw data sets and do-files

As mentioned, Mu and van de Walle (2011) use commune data sets in 1997 (the baseline survey), 2001 and 2003 (the mid-term and endline surveys) for impact evaluation of the rural road project. The original authors (Mu and Van de Walle) are very generous to provide me with not only the raw original data sets but also their analysis do-files (they used Stata for analysis). These data sets and do-files are used for estimation for not only the Mu and van de Walle (2011) but also Van de Walle and Mu (2007). The authors mentioned that they sent all the data and do-files available in their current computers. However, since the analysis was conducted by the authors very long time ago (before 2007), do-files that are used to estimate results of Mu and van de Walle (2011) are not fully available. It means that I cannot simply re-run the do-files sent by Mu and van de Walle to replicate the results of Mu and van de Walle (2011), since some do-files are missing.

Figure 1 summaries the data sets and do-files provided by Ren Mu and Dominique van de Walle. The ‘green’ shapes mean that data or do-files are fully available, while the

'pink' shapes mean that data or do-files are just partially available. The 'white' shape, i.e., 'Do-files to create data for analysis', is not available. Running 'Do-files to estimate the impacts' (pink shape) using 'Data for impact estimation' (pink shape) does not produce the results of Mu and van de Walle (2011), since some do-files as well as data variables are missing. I checked all the available do-files including do-files to create data sets and do-files to estimate the project impact, and find no problems.

Figure 1: Data sets and do-files



3.2. Reconstruct all variables and recalculate descriptive statistics

In the next step, I use the raw data sets provided by the authors to create the outcome variables and the control variables that are used to estimate the project impact. Table 1 replicates Table 1 in Mu and van de Walle (2011). After checking the do-files, data and questionnaires carefully, I still cannot produce the same estimates as Table 1 in Mu and van de Walle (2011). The Table 1 below adds the column reporting the percentage difference in the outcome means between the replication and the original paper. Variables with zero percent difference have the same values as the original papers. There are 12 variables that are the same. There are four variables that differ more than 10% from those from the original papers. For the remaining seven variables, the difference in the mean is less than 10%.

Table 1. Mean baseline characteristics and outcome variables for communes classified by median household per capita consumption (log)

Commune characteristics	Variable type	Below median (1)	Above median (2)	Difference	Difference between these and the original paper (%)
Typology: mountain	Binary	0.70	0.33	0.37***	0%
Distance to closest central market (km)	Continuous	16.09	10.46	5.63***	< 10%
Share of households owning motorcycles	Continuous	6.32	10.00	-3.68***	< 10%
Population density	Continuous	2.14	5.20	-3.06***	< 10%
Ethnic minority share	Continuous	0.67	0.20	0.48***	0%
Adult illiteracy rate	Continuous	0.11	0.03	0.07***	> 10%
Flood and storm prevalence	Binary	0.60	0.64	-0.04	0%
Credit availability	Binary	0.27	0.30	-0.03	> 10%
North provinces	Binary	0.54	0.66	-0.12*	0%
Transportation accessibility	Binary	0.23	0.31	-0.09***	0%
Road density	Continuous	0.01	0.02	-0.01***	0%
Market availability	Binary	0.31	0.66	-0.35***	< 10%
Market frequency	Discrete	0.72	1.43	-0.71***	0%
Shop	Binary	0.39	0.58	-0.19***	0%
Bicycle repair shop	Binary	0.54	0.88	-0.34***	< 10%
Pharmacy	Binary	0.34	0.75	-0.41***	0%
Restaurant	Binary	0.23	0.44	-0.21***	0%
Women's hair dressing/ Men's barber	Binary	0.33	0.74	-0.41***	> 10%
Men and women's tailoring	Binary	0.56	0.92	-0.36***	< 10%
% farm households	Continuous	93.64	86.34	7.29***	0%

Commune characteristics	Variable type	Below median (1)	Above median (2)	Difference	Difference between these and the original paper (%)
% trade households	Continuous	1.17	1.70	-0.53*	0%
% service sector households	Continuous	0.69	1.08	-0.39	< 10%
Primary school completion (less than 15 years)	Continuous	53.78	68.89	-15.11***	> 10%
Secondary school enrolment rate	Continuous	76.81	94.13	-17.32***	< 10%

**significant at 5 per cent level or higher; *significant at 10 per cent level.

This Table replicates the estimates of Table 1 in Mu and van de Walle (2011). The definition of variables and sample is the same as the Mu and van de Walle (2011).

Next, I estimated the outcome variables for the years 1997, 2001 and 2003. Table A.1 in Appendix replicates the results of Table 2 in Mu and van de Walle (2011). The outcomes are estimated for communes within the common support of the predicted propensity scores. In Mu and van de Walle (2011), there are 94 project and 95 non-project communes on common support. In this study, I estimated the propensity score using the same model specification. However, the regression results are not the same (see the next section for detailed presentation). As a result, the predicted propensity score are not the same, and the common support is different from Mu and van de Walle (2011). There are 85 project and 83 non-project communes on common support. The mean outcomes of project and non-project communes cannot be the same as those in Mu and van de Walle (2011) due to different common supports. However, the difference in the replicated results and the original results are not large.

I found a variable of the predicted propensity score in the data sets sent by Mu and Van de Walle. Using this propensity score, I am able to define the common support as Mu and van de Walle (2011) (including 94 project and 95 non-project communes). Using this common support, I re-estimated outcomes of project and non-project communes, and reported the results in Table A.2 in Appendix. Now, there are five outcome variables (highlighted in green color) which have the same value as the original paper.

There is a problem of the variable 'Primary school completion (< 15 years)' which has very high values in 1997 but low values in 2001 and 2003. My estimates of 'Primary school completion (< 15 years)' for 2001 and 2003 are close to the estimates in Mu and van de Walle (2011). However, my estimate for 1997 is substantially higher than that in Mu and van de Walle (2011). I checked the data set carefully, but cannot find the reason

for this problem. A possible reason for the difference might be that the raw data sets that Mu and Van de Walle provided for me are not the same raw data sets used for Mu and van de Walle (2011). Data collectors sometime clean and update cleaned data sets. As a result, different versions of data sets might exist.

3.3. Re-estimate results in the original study using the original specifications

After constructing variables and producing descriptive analysis, I estimate the impact of the rural road project on commune outcomes using the original specifications. The first step is to estimate the propensity score using logit regression. The logit estimation is presented in Van de Walle, D. and Mu, R. (2007) 'Fungibility and the flypaper Effect of Project Aid: Micro-Evidence for Vietnam', *Journal of Development Economics,* 84(2), pp. 667-685. I am not able produce the same logit result as Van de Walle and Mu (2007). The summary statistics of the explanatory variables (covariates) in the logit regression is presented in Table A.3 in Appendix. In Van de Walle and Mu (2007), the number of observations is 200. The number of observation in this logit regression is 198. There are missing values in some variables, and I do not know how these missing values are treated in Van de Walle and Mu (2007). In this replication study, I dropped two observations with missing values. It means that these dropped two communes are not used for impact estimation. In the logit regression (Table A.4 in Appendix), most explanatory variables have the same sign and close point estimates as the original paper of Van de Walle and Mu (2007). Since the logit regression results are different, the predicted propensity scores are also different from the original paper.

The Figure A.1 in Appendix presents the predicted propensity score for the treatment (project communes) and control groups (non-project communes). There are 85 project and 83 non-project communes on common support. This is difference from Mu and van de Walle (2011), in which there are 94 project and 95 non-project communes on common support.

Tables 2 and 3 present the impact estimation of the rural road project using the original specifications and methods (these estimates replicate Table 3 in Mu and van de Walle 2011). In Stata, I used the command 'psmatch2' like Mu and van de Walle 2011. Mu and van de Walle (2011) used the default bandwidth which is 0.06 in the kernel propensity score matching. The original estimates in Mu and van de Walle (2011) are also

reported in Tables 2 and 3 for comparison. The replicated estimates are not the same as the original paper, since the predicted propensity score as well as the common support are different. However, most of the impact estimates for 2003 have the same sign as the impact estimates in the original paper.

As mentioned, I found a variable of the predicted propensity score in the data sets sent by Mu and Van de Walle. I used this predicted propensity score variable to estimate the effect of the project on the five outcome variables that have the same value as the original paper. Table 4 presents results of this analysis. I cannot replicate the impact estimates for the year 2001. However, for the year 2003, I am able to replicate the same impact estimates as the original paper. It means that the difference between the replicated results and the original results lie in the construction of variables, not in the methodology.

An interesting analysis in Mu and van de Walle (2011) is to examine the determinants of heterogeneous impacts of the rural road project. More specifically, after estimating the effect of the rural roads on outcomes for each commune, Mu and van de Walle (2011) run OLS regressions of these specific impact estimates on commune characteristics variables to examine whether the effect of rural roads varies across communes of different characteristics. Overall, they find that some evidence on heterogeneity in the impact of rural roads. The impact of rural roads tends to be higher for the poorer communes since the poorer communes have low base levels of market development.

In this study, I also run regressions of the predicted impact of the rural project on explanatory variables using commune-level data. The regression results are presented in Tables from A.5 to A.10 in Appendix. None of our estimates are the same as Mu and van de Walle (2011), since there common supports are different and some of control variables are also different. However, most of the replicated estimates have the same sign as the point estimates in Mu and van de Walle (2011).

Table 2. Impacts of road rehabilitation/building for year 2001

	Simple DD			PS kernel matched DD			PS weighted DD		
Outcomes	DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS weighted DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Market									
Market availability	-0.01	-0.16	0.00	0.03	0.91	0.03	0.03	0.85	0.04
Market frequency	0.07	0.49	0.01	0.14	1.57	0.08	0.15	1.44	0.10
Shop	-0.05	-0.57	-0.02	-0.13	-1.23	0.01	-0.15	-1.35	0.08
Bicycle repair shop	-0.09	-1.60	-0.08*	-0.06	-1.26	-0.06	-0.06	-1.04	-0.04
Pharmacy	0.09	1.44	0.08	0.05	0.70	0.04	0.04	0.57	-0.06
Restaurant	0.11*	1.89	-0.03	0.13*	1.69	-0.01	0.14*	1.94	-0.01
Women's hair dressing/ Men's barber	0.02	0.33	-0.04	0.06	0.73	-0.07	0.06	1.05	-0.07
Men and women's tailoring	0.01	0.19	0.12	0.00	0.04	0.11	0.00	0.08	0.10
Employment: % households whose main occupation is:									
% farm households	-0.77	-0.47	0.04	-0.73	-0.45	0.05	-0.42	-0.29	0.03
% trade households	0.10	0.23	-0.05	-0.23	-0.34	0.03	-0.59	-0.68	0.03
% service sector households	-0.65	-1.61	-0.06	-0.18	-0.40	-1.54	0.07	0.14	-1.03
School enrolments									
Primary school completion (< 15 years)	-3.71	-0.65	0.00	1.82	0.27	0.15**	4.08	0.65	0.25**
Secondary school enrolment rate	-0.52	-0.16	0.06	1.03	0.33	0.10	0.56	0.19	0.25

This Table replicates the estimates of Table 3 in Mu and van de Walle (2011).
Notes: The sample consists of the 85 project and 83 non-project communes on common support as determined by propensity score matching. T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.
Standard errors of weighted DD estimations are robust to heteroskedasticity and serial correlation of communes within the same district.

Table 3. Impacts of road rehabilitation/building for year 2003

	Simple DD			PS kernel matched DD			PS weighted DD		
Outcomes	DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS weighted DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Market									
Market availability	0.07	1.27	0.09*	0.08**	2.28	0.08*	0.08**	2.00	0.09**
Market frequency	0.16	1.02	0.19	0.18	1.60	0.23*	0.18	1.28	0.25**
Shop	-0.05	-0.71	0.03	-0.14	-1.52	0.08	-0.17*	-1.70	0.14
Bicycle repair shop	-0.05	-0.94	-0.04	-0.05	-0.73	0.02	-0.05	-0.92	0.03
Pharmacy	0.14*	1.93	0.14*	0.16*	1.74	0.12	0.14	1.54	0.16
Restaurant	0.08	0.83	0.05	0.04	0.47	0.01	0.04	0.36	0.05
Women's hair dressing/ Men's barber	0.05	0.95	0.14*	0.08	1.04	0.18**	0.08	1.31	0.20**
Men and women's tailoring	0.03	0.56	0.09	0.03	0.42	0.10	0.02	0.36	0.12*
Employment: % households whose main occupation is:									
% farm households	-2.10	-1.35	-1.99	-2.49	-1.56	-2.04*	-2.81**	-2.11	-2.06**
% trade households	0.70	1.41	0.57	0.80	1.47	0.36	0.70	1.22	0.58
% service sector households	0.75**	2.40	1.01*	1.09**	2.16	1.68**	1.31*	2.04	1.72**
School enrolments									
Primary school completion (< 15 years)	2.52	0.37	0.04	10.13	1.45	0.17**	9.89	1.35	0.30**
Secondary school enrolment rate	-0.92	-0.31	0.10**	0.58	0.20	0.05	0.35	0.13	0.07*

This Table replicates the estimates of Table 3 in Mu and van de Walle (2011).
Notes: The sample consists of the 85 project and 83 non-project communes on common support as determined by propensity score matching. T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.
Standard errors of weighted DD estimations are robust to heteroskedasticity and serial correlation of communes within the same district.

Table 4. Impacts of road rehabilitation/building for year 2003

Outcomes	Simple DD			PS kernel matched DD			PS weighted DD		
	DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS weighted DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Impacts in 2001									
Market availability	-0.00	-0.09	0.00	0.04*	1.90	0.03	0.04	1.06	0.04
Bicycle repair shop	-0.08*	-1.76	-0.08*	0.01	0.26	-0.06	-0.04	-0.76	-0.04
% farm households	-0.28	-0.18	0.04	-1.02	-0.62	0.05	1.31	0.79	0.03
% trade households	-0.06	-0.14	-0.05	0.18	0.16	0.03	-1.03	-0.94	0.03
% service sector households	-0.68	-1.60	-0.06	0.84*	2.05	-1.54	0.10	0.26	-1.03
Impacts in 2003									
Market availability	0.09*	1.83	0.09*	0.08*	1.85	0.08*	0.09**	2.19	0.09**
Bicycle repair shop	-0.04	-0.89	-0.04	0.02	0.37	0.02	0.03	0.58	0.03
% farm households	-1.99	-1.25	-1.99	-2.04*	-1.67	-2.04*	-2.06*	-1.87	-2.06**
% trade households	0.57	1.26	0.57	0.36	0.71	0.36	0.58	1.35	0.58
% service sector households	1.01**	2.52	1.01*	1.68***	2.43	1.68**	1.72***	3.10	1.72**

This Table replicates the estimates of Table 3 in Mu and van de Walle (2011).

Notes: The sample consists of the 94 project and 95 non-project communes on common support as determined by propensity score obtained from the original paper. T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.
Standard errors of weighted DD estimations are robust to heteroskedasticity and serial correlation of communes within the same district.

4. Statistical replication

After conducting pure replication, I conducted the so-called statistical replication. In the statistical replication, I conduct the two extensions: Sensitivity analysis of covariates and bandwidth selection and analysis of the effect of the road project on additional outcome variables

4.1. Sensitivity analysis of covariates and bandwidth selection

Analysis methods

The main advantage of propensity score matching is that it does not rely on assumptions functional forms of outcomes. However, the point estimates as well as the standard errors of the propensity score matching estimators can be sensitive to the selection of control variables used in the logit (or probit) model to estimate the propensity score. The estimates might be also sensitive to magnitude of bandwidth in kernel matching. Thus, in the replication study, I also examine the sensitivity of the impact estimates to different bandwidths used in kernel matching.

The list of control variables (covariates) used in Mu and van de Walle (2011) is presented in Appendix. Variables that affect outcomes and program selection should be controlled in propensity score estimation. Obviously, variables which affect both the program participation and outcomes should be included the propensity score model (e.g., Ravallion, 2001; Caliendo and Kopeinig, 2008). Bryson, Dorsett, and Purdon (2002) argue that inclusion of irrelevant variables can increase the standard error of estimates. Zhao (2008) finds that overspecification of the model of the propensity score can bias impact estimates. However, using simulation Nguyen (2012) shows that efficiency in estimation of the Average Treatment Effect on the Treated can be gained if all the variables in the outcome equation are included in the estimation of propensity scores.

A challenge in measuring the impact of Vietnam Rural Transport Project I is that the project selection is not fully observed. Although there are several criteria for selection of communes and road links such as cost, population density, share of ethnic minority population, the actual selection of the project communes is not clear and documented (Mu and van de Walle, 2011). In addition, there are a number of outcomes, and different outcomes can be affected by different explanatory variables. Thus Mu and van de Walle (2011) control variables that are important for program selection and other variables that can affect the program selection and outcomes. The control variables are listed in the Appendix.

In the replication study, I can examine the sensitivity of the program impact to two additional sets of control variables as follows:

(i) Add pre-treatment outcomes to the logit regression of the program selection. Pre-treatment outcome can be used as control in the regression of the propensity score to reduce the difference in outcomes between the treatment and control groups in the baseline (Dehejia and Wahba, 1998; Smith and Todd, 2005).

(ii) Limit covariates to those that are statistically significant in the logit regression of the program selection. Several control variables are statistically significant in Mu and van de Walle, (2011). They can be dropped, since these variables might affect the quality of matching of the key variables (Bryson, Dorsett, and Purdon, 2002; Zhao, 2008).

I can also examine the sensitivity of the program impact estimates to the selection of bandwidth. Mu and van de Walle (2011) used the default bandwidth which is 0.06 in the kernel matching. In the study, I can use other bandwidth, e.g., 0.01, 0.03 and 0.09 for robust analysis. In addition, I can use a cross-validation method - a widely-used selection method of bandwidth in propensity score matching (Frolich, 2004; Galdo, 2010). This method selects the bandwidth as follows:

$$h^{CV} = \arg\min_h \left(\frac{1}{n_0} \sum_{j=1}^{n_0} \left(y_{0j} - \hat{m}_{-j}(p_j, h) \right)^2 \right), \qquad (4)$$

where n_0 is the number of control units, y_{0j} is the outcome of the control unit *j*, $\hat{m}_{-j}(p_j, h)$ is the estimated conditional mean for the control unit *j* at the propensity score p_j using all the control units within the bandwidth but except unit *j*. The bandwidth that has the smallest value of h^{CV} will be selected.

Empirical results

Table 5 presents the impact estimates of the road project using difference-in-differences with propensity score kernel matching method. It replicates the PS kernel matched DD estimates in Table 2 and Table 3. The difference between the estimation method in Table 5 and the estimation method in Tables 2 and 3 is that the propensity scores used in Table 5 are estimated using not only the covariates but also the baseline outcome variable (variable in 1997). For each outcome, the corresponding baseline variable is added to the logit regression. Thus the logit model differs for different outcomes. Although the results are not the same as Mu and van de Walle (2011), most impact estimates have the same sign as Mu and van de Walle (2011). Similar to Mu and van de Walle (2011), the effect of the project on market and the percentage of farming households is statistically significant.

Table 5: Estimated impact of the road project using PS kernel matched DD: baseline outcome variable is controlled in estimating propensity scores

	2001			2003		
Outcomes	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Market availability	0.029	0.771	0.03	0.084**	2.260	0.08*
Market frequency	0.119	1.298	0.08	0.199*	1.803	0.23*
Shop	-0.080	-0.618	0.01	-0.115	-0.905	0.08
Bicycle repair shop	-0.012	-0.273	-0.06	0.020	0.438	0.02
Pharmacy	0.035	0.377	0.04	0.098	0.789	0.12
Restaurant	0.103	1.546	-0.01	0.003	0.029	0.01
Women's hair dressing/ Men's barber	0.071	1.038	-0.07	0.078	1.184	0.18**

Outcomes	2001			2003		
	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Men and women's tailoring	0.026	0.523	0.11	0.039	0.674	0.10
% farm households	-0.263	-0.182	0.05	-3.293*	-1.872	-2.04*
% trade households	-1.575	-1.596	0.03	0.514	1.130	0.36
% service sector households	0.524	0.950	-1.54	2.273	2.562	1.68**
Primary school completion (< 15 years)	9.670*	1.777	0.15**	12.483**	1.992	0.17**
Secondary school enrolment rate	0.594	0.115	0.10	1.245	0.276	0.05

Notes: The sample consists of project and non-project communes on common support as determined by propensity score matching. T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
The propensity scores are estimated using logit models which include covariates as Table A.2 in Appendix and also outcome variables.
** significant at 5 per cent level or higher; * significant at 10 per cent level.

In Table 6, the propensity scores are estimated using the logit regressions in which only covariates significant at the 10% level are kept. Table A.14 in Appendix presents the logit regression corresponding to outcome variables. The results show that most estimates have the same sign as those in Mu and van de Walle (2011). However, the effect is not significant for almost all outcomes.

Table 6: PS kernel matched DD: only covariates and baseline outcome variable which are significant at the 10% level are controlled in estimating propensity scores

Outcomes	2001			2003		
	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Market availability	0.000	0.004	0.03	0.064	1.198	0.08*
Market frequency	0.049	0.336	0.08	0.154	1.016	0.23*
Shop	0.001	0.014	0.01	-0.027	-0.316	0.08
Bicycle repair shop	-0.036	-0.703	-0.06	-0.013	-0.241	0.02
Pharmacy	0.044	0.554	0.04	0.063	0.732	0.12
Restaurant	0.100*	1.679	-0.01	0.050	0.492	0.01
Women's hair dressing/ Men's barber	0.045	0.639	-0.07	0.038	0.514	0.18**
Men and women's tailoring	0.040	0.790	0.11	0.022	0.361	0.10
% farm households	0.138	0.092	0.05	-1.349	-0.883	-2.04*
% trade households	-0.409	-0.703	0.03	0.317	0.677	0.36

Outcomes	2001			2003		
	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)
% service sector households	-0.271	-0.736	-1.54	1.194**	1.976	1.68**
Primary school completion (< 15 years)	2.530	0.411	0.15**	6.056	1.169	0.17**
Secondary school enrolment rate	1.610	0.458	0.10	2.680	0.869	0.05

Notes: The sample consists of project and non-project communes on common support as determined by propensity score matching. The propensity scores are estimated using logit models in Table A.3 in Appendix.
T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.

As mentioned, Mu and van de Walle (2011) used the default bandwidth which is 0.06 in the kernel matching. There are no standard criteria to select bandwidth. Using a large bandwidth results in a larger number of matched control. It reduces the standard error, but increase potential bias, since I can match a participant with a very different non-participant. On the contrary, using a small bandwidth can reduce the bias but increase the standard error of the impact estimates. I can vary the bandwidth to examine whether the impact estimates are sensitive to different bandwidths. In Tables from A.11 to A.13, I used other bandwidth, e.g., 0.01, 0.03 and 0.09 for robust analysis. Three bandwidth schemes produce the same sign of the effect estimates of the project in 2003. However, the significance is slightly different between the three bandwidth schemes. For example, the effect of the road project on market availability is not significant using bandwidth of 0.01, while the effect of the road project on market availability is significant using bandwidths of 0.03 and 0.09.

Finally, Table 7 presents the estimates when optimal bandwidth is used (Frolich, 2004; Galdo, 2010). For each outcome, a bandwidth is estimated so that the difference in baseline outcomes between the treatment and control communes is minimized. The results are quite similar as those estimated using other bandwidths.

Table 7: PS kernel matched DD: Optimal bandwidth

Outcomes	2001			2003		
	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Market availability	0.026	0.692	0.03	0.081**	2.201	0.08*
Market frequency	0.116	1.269	0.08	0.194*	1.782	0.23*
Shop	-0.058	-0.645	0.01	-0.083	-0.955	0.08
Bicycle repair shop	-0.050	-0.726	-0.06	-0.025	-0.306	0.02
Pharmacy	0.068	1.126	0.04	0.108*	1.727	0.12
Restaurant	0.087	1.542	-0.01	0.058	0.725	0.01
Women's hair dressing/ Men's barber	0.040	0.677	-0.07	0.048	0.828	0.18**
Men and women's tailoring	0.016	0.324	0.11	0.020	0.380	0.10
% farm households	-0.677	-0.440	0.05	-3.623	-1.935	-2.04*
% trade households	-0.066	-0.168	0.03	0.436	0.979	0.36
% service sector households	0.593	0.926	-1.54	2.447**	2.505	1.68**
Primary school completion (< 15 years)	4.230	0.805	0.15**	9.605	1.628	0.17**
Secondary school enrolment rate	2.480	0.614	0.10	1.632	0.488	0.05

Notes: The sample consists of 85 project and 83 non-project communes on common support as determined by propensity score matching. The propensity score is estimated by the logit model in Table A.2 in Appendix.
T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.

4.2. Additional outcome variables

Mu and van de Walle (2011) focus on the effect of the road project on market development, employment and education. Roads are very important for rural economy. Thus in this study, I examine the effect of the road project on additional outcome variables using the same method and data used by Mu and van de Walle (2011). The surveys contain very detailed data on commune living standards. The outcome variables are selected based on the data availability. The road project is also expected to have a significant effect on these outcomes.

The first outcome is the access to credit. Distance to banks and a credit institution is negatively correlated with the access to credit in Vietnam (Nguyen, 2008). Rural roads

are expected to reduce the distance to lenders and increase the credit access of households. The second outcome is the migration, out-migration and in-migration. Roads can reduce the cost of mobility and increase migration (Lucas, 2001).

Tables 8 and 9 present the impact estimates of the project on credit and migration using the same three methods as Mu and van de Walle (2011). Overall, there are no significant effects of the road project on credit access and migration of households in project communes.

Table 8: Impact of the road project on credit and migration in 2001

	Simple DD		**PS kernel matched DD**		**PS weighted DD**	
	Estimates	t-ratio	Estimates	t-ratio	Estimates	t-ratio
Number of credit sources available in communes	-0.050	-0.330	-0.090	-0.410	-0.148	-0.841
There is a branch of Agricultural Bank in commune	0.082	1.501	0.055	0.739	0.071	1.317
Number of households borrowing from a credit source	192.8**	1.997	139.1	1.098	95.05	0.676
% households in commune who borrowing from a credit source	8.171	1.367	6.992	1.109	5.393	0.723
Loan size per borrowing household (million VND)	-0.722	-1.093	-0.455	-0.815	-0.426	-0.521
There are private lenders in commune	-6.166	-0.671	1.685*	0.187	2.704	0.260
Percentage of people leaving commune temporarily	0.100	0.230	-0.096	-0.163	-0.191	-0.348
Percentage of men leaving commune temporarily	-0.041	-0.062	-0.255	-0.298	-0.349	-0.411
Percentage of women leaving commune temporarily	0.210	0.857	0.032	0.094	-0.057	-0.201
Percentage of households having member permanently leaving	1.015	0.906	1.789	1.069	2.115	1.189
Percentage of people coming to commune temporarily	0.006	0.018	-0.218	-0.885	-0.368	-1.384
Percentage of households coming to commune permanently	0.005	1.349	0.004	1.160	0.003	0.961

Notes: The sample consists of 85 project and 83 non-project communes on common support as determined by propensity score matching. The propensity score is estimated by the logit model in Table A.2 in Appendix.
T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.

Table 9: Impact of the road project on credit and migration in 2003

	Simple DD		PS kernel matched DD		PS weighted DD	
	Estimates	t-ratio	Estimates	t-ratio	Estimates	t-ratio
Number of credit sources available in communes	0.230	1.495	0.196	0.712	0.109	0.487
There is a branch of Agricultural Bank in commune	-0.036	-0.692	-0.013	-0.216	-0.001	-0.009
Number of households borrowing from a credit source	262.8*	1.909	236.5	1.590	192.4	1.125
% households in commune who borrowing from a credit source	10.400	1.613	9.307	1.267	7.416	0.887
Loan size per borrowing household (million VND)	41.243	1.010	0.975	0.876	41.167	1.009
There are private lenders in commune	-9.639	-0.920	-1.566	-0.143	-3.774	-0.388
Percentage of people leaving commune temporarily	-0.087	-0.218	-0.403	-0.818	-0.562	-1.265
Percentage of men leaving commune temporarily	-0.337	-0.611	-0.693	-1.067	-0.895	-1.535
Percentage of women leaving commune temporarily	0.174	0.588	-0.111	-0.288	-0.219	-0.630
Percentage of households having member permanently leaving	1.461	1.445	2.011	1.285	2.233	1.263
Percentage of people coming to commune temporarily	-0.437	-0.883	-0.989*	-1.645	-1.156	-1.560
Percentage of households coming to commune permanently	0.002	1.060	0.001	1.208	0.001	0.815

Notes: The sample consists of 85 project and 83 non-project communes on common support as determined by propensity score matching. The propensity score is estimated by the logit model in Table A.2 in Appendix.
T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.

5. Conclusions

Rural road is one of key factors for the rural development. Mu and van de Walle (2011) is an influential study which finds a positive effect of rural road in local market development in Vietnam. In this study, I tried to replicate the estimates of Mu and van de Walle (2011) using the raw data sets provided by the authors. I am able to produce quite similar results as the original paper. However, several estimates are not the same as those from the original paper. A possible reason for the difference in that the raw data sets that Mu and Van de Walle provided for me might not be the same raw data sets used for Mu and van

de Walle (2011). Data collectors sometime clean and update cleaned data sets. As a result, different versions of data sets might exist.

In addition to the pure replication, I conducted the so-called statistical replication. In the statistical replication, I conducted the two extensions: Sensitivity analysis of covariates and bandwidth selection and analysis of the effect of the road project on additional outcome variables. It finds that the impact estimates of the road project are not sensitive to the selection of bandwidth in kernel propensity score matching. However, using only covariates which are significant in the logit regression tends to reduce the statistical significance of the impact estimates. Finally, there are no significant effects of the road project on credit access and migration of households in project communes.

Overall, I find similar findings on the impact of the rural road project as Mu and van de Walle (2011). It indicates that the positive effect of rural road on local market development. Thus, the government can provide investment in rural roads to improve local market and welfare.

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Appendix

Figure A.1. Predicted propensity score

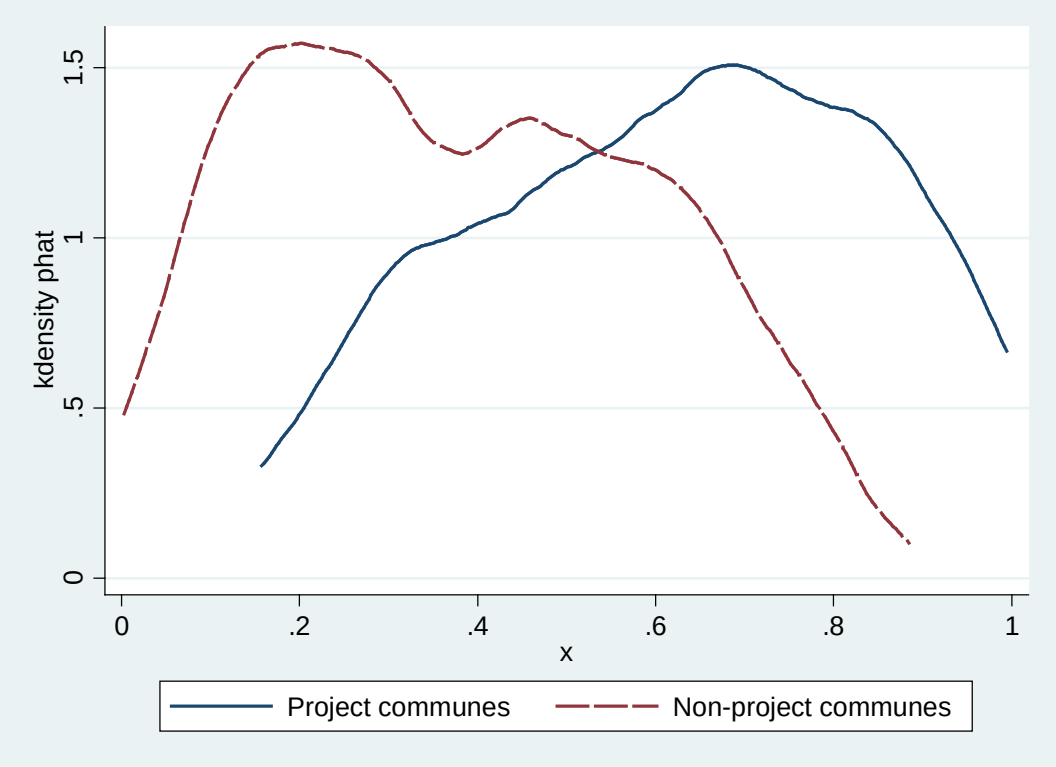

Table A.1. Outcome variable means: using the same propensity score estimated from the replication study

Variable	1997			2001			2003		
	Project	Non-project	Difference between these and the original paper (%)	Project	Non-project	Difference between these and the original paper (%)	Project	Non-project	Difference between these and the original paper (%)
Local market development									
Market availability	0.51	0.45	< 10%	0.57	0.52	< 10%	0.61	0.48	< 10%
Market frequency	1.09	0.98	< 10%	1.35	1.17	< 10%	1.39	1.11	< 10%
Shop	0.53	0.46	< 10%	0.76	0.75	< 10%	0.74	0.72	< 10%
Bicycle repair shop	0.75	0.65	< 10%	0.80	0.78	< 10%	0.86	0.81	< 10%
Pharmacy	0.52	0.52	< 10%	0.68	0.59	< 10%	0.66	0.52	< 10%
Restaurant	0.32	0.35	< 10%	0.46	0.39	< 10%	0.49	0.45	< 10%
Women's hair dressing/ Men's barber	0.54	0.52	> 10%	0.74	0.70	> 10%	0.76	0.69	> 10%
Men and women's tailoring	0.76	0.71	> 10%	0.82	0.76	< 10%	0.84	0.75	< 10%
Employment: % households whose main occupation is:									
% farm households	90.31	90.85	< 10%	90.18	91.50	< 10%	87.57	90.22	< 10%
% trade households	1.18	1.34	< 10%	1.62	1.69	< 10%	3.13	2.59	< 10%
% service sector households	0.97	0.52	< 10%	1.36	1.55	< 10%	2.80	1.61	< 10%
School enrolments (%)									
Primary school completion (< 15 years)	62.19	60.70	> 10%	29.77	31.98	> 10%	39.00	34.99	> 10%
Secondary school enrolment rate	86.53	84.30	> 10%	93.58	91.87	> 10%	94.53	93.21	> 10%

This Table replicates the estimates of Table 2 in Mu and van de Walle (2011).

Notes: The sample consists of the 94 project and 95 non-project communes on common support as determined by propensity score matching. Many outcome variables are dichotomous referring to whether the outcome is present in the commune. The exceptions are: market frequency which takes the values 0 for no market, 1 for once per week or less, 2 for more than once a week, and 3 for permanent market; the percentage of households in various occupations refers to their main source of income; the primary completion rate is defined as the share of children aged 15 years and under who completed primary school; the secondary school enrolment rate is the share of children who graduated from primary school in the previous year who are enrolled in secondary school.

Table A.2. Outcome variable means: using the same propensity score variable Mu and van de Walle (2011)

Variable	1997			2001			2003		
	Project	Non-project	Difference between these and the original paper (%)	Project	Non-project	Difference between these and the original paper (%)	Project	Non-project	Difference between these and the original paper (%)
Local market development									
Market availability	0.51	0.44	0%	0.57	0.51	0%	0.62	0.46	0%
Market frequency	1.07	1.00	< 10%	1.30	1.17	< 10%	1.38	1.08	< 10%
Shop	0.54	0.44	< 10%	0.79	0.73	< 10%	0.76	0.71	< 10%
Bicycle repair shop	0.76	0.65	0%	0.80	0.78	0%	0.87	0.81	0%
Pharmacy	0.55	0.53	< 10%	0.70	0.62	< 10%	0.66	0.52	0%
Restaurant	0.33	0.33	< 10%	0.48	0.39	< 10%	0.49	0.43	< 10%
Women's hair dressing/ Men's barber	0.53	0.51	> 10%	0.74	0.69	> 10%	0.77	0.68	> 10%
Men and women's tailoring	0.76	0.72	> 10%	0.82	0.75	< 10%	0.82	0.75	< 10%
Employment: % households whose main occupation is:									
% farm households	89.53	90.67	0%	89.65	91.07	0%	87.02	90.15	0%
% trade households	1.45	1.41	0%	1.73	1.75	0%	3.17	2.56	0%
% service sector households	1.12	0.54	0%	1.42	1.51	0%	3.20	1.60	0%
School enrolments (%)									
Primary school completion (< 15 years)	62.93	60.20	> 10%	31.22	31.81	> 10%	38.55	34.85	> 10%
Secondary school enrolment rate	86.64	84.89	> 10%	93.20	92.14	> 10%	94.52	93.41	> 10%

This Table replicates the estimates of Table 2 in Mu and van de Walle (2011).

Notes: The sample consists of the 85 project and 83 non-project communes on common support as determined by propensity score matching. Many outcome variables are dichotomous referring to whether the outcome is present in the commune. The exceptions are: market frequency which takes the values 0 for no market, 1 for once per week or less, 2 for more than once a week, and 3 for permanent market; the percentage of households in various occupations refers to their main source of income; the primary completion rate is defined as the share of children aged 15 years and under who completed primary school; the secondary school enrolment rate is the share of children who graduated from primary school in the previous year who are enrolled in secondary school.

Table A.3. Summary statistics of explanatory variables in Logit regression of commune participation in the project

Explanatory variables	Obs.	Mean	Std. Dev.	Min	Max
Terrain: Coast					
Mountains	200	0.5150	0.5010	0	1
Uplands	200	0.1800	0.3852	0	1
Plains	200	0.2550	0.4370	0	1
Province: Tra Vinh					
Lao Cai	200	0.1500	0.3580	0	1
Thai Nguyen	200	0.2000	0.4010	0	1
Nghe An	200	0.2500	0.4341	0	1
Binh Thuan	200	0.1250	0.3315	0	1
Kon Tum	200	0.1250	0.3315	0	1
Population (log)	199	8.5394	0.7088	6.86	10.15
Population density (log)	199	0.6083	1.3208	-2.51	3.00
Minority population share	199	0.4338	0.3974	0	1
National road passes through commune	200	0.3700	0.4840	0	1
Railway passes through commune without stop	200	0.1350	0.3426	0	1
Waterway passes through commune	200	0.2200	0.4153	0	1
Distance to province center (km) (log)	200	48.823	37.627	2	160
Commune has a passenger transport service	200	0.6150	0.4878	0	1
Share of households engaged in non-agricultural activities	200	0.0506	0.1226	0	1.00
Share of population working in government	199	0.0027	0.0049	0	0.04
Share of population working in private enterprises	199	0.0028	0.0165	0	0.19
Share of population working in state enterprises	199	0.0006	0.0024	0	0.02
Share of crop land	198	0.3191	0.2715	0.003	0.87
Share of perennial crop land	198	0.0544	0.0800	0	0.39
Land rental market exists in commune	200	0.4300	0.4963	0	1
Number of production organizations	200	1.2450	2.2383	0	14
Commune has a radio broadcasting station	200	0.2000	0.4010	0	1
Commune has a market	200	0.4850	0.5010	0	1
Agricultural crop land adversely affected by natural disaster (1996)	200	0.6200	0.4866	0	1
Commune has an agricultural bank	200	0.1300	0.3371	0	1
Number of official credit sources	200	2.2950	1.2270	0	5
Enrollment rate for children age 6 to 15	200	85.435	19.237	0	100
Commune has a lower secondary school	200	0.7350	0.4424	0	1
Predicted consumption per capita (log)	200	7.6354	0.2766	6.91	8.14
Share of households owning motorcycles	200	8.1613	8.3419	0	49.70
Road density (commune and district level roads)	199	0.0178	0.0235	0	0.16
Share of earth and car impassable roads in total road km	200	0.3752	0.3032	0	1

Table A.4. Logit regression of commune participation in the project

Explanatory variables	Coeff.	Std. Err.	Same sign as Van de Walle, D. and Mu, R. (2007)
Terrain: Coast	*Reference*		
Mountains	-0.331	1.194	Yes
Uplands	0.029	0.962	Yes
Plains	-0.834	1.047	Yes
Province: Tra Vinh	*Reference*		
Lao Cai	0.762	1.244	Yes
Thai Nguyen	0.699	1.162	Yes
Nghe An	1.296	1.211	Yes
Binh Thuan	1.226	1.079	Yes
Kon Tum	3.007***	1.046	Yes
Population (log)	0.814*	0.424	Yes
Population density (log)	0.536	0.411	Yes
Minority population share	2.608**	1.139	Yes
National road passes through commune	-1.827***	0.559	Yes
Railway passes through commune without stop	1.492*	0.772	Yes
Waterway passes through commune	0.343	0.551	Yes
Distance to province center (km) (log)	-0.006	0.0097	Yes
Commune has a passenger transport service	0.396	0.426	No
Share of households engaged in non-agricultural activities	0.371	1.407	No
Share of population working in government	-0.639*	0.365	Yes
Share of population working in private enterprises	-0.265*	0.155	Yes
Share of population working in state enterprises	0.711	0.741	Yes
Share of crop land	1.145	2.187	Yes
Share of perennial crop land	-1.899	3.552	No
Land rental market exists in commune	0.333	0.455	Yes
Number of production organizations	0.012	0.083	Yes
Commune has a radio broadcasting station	-1.079**	0.452	Yes
Commune has a market	0.338	0.431	Yes
Agricultural crop land adversely affected by natural disaster (1996)	0.202	0.448	Yes
Commune has an agricultural bank	0.977**	0.431	No
Number of official credit sources	-0.407***	0.152	Yes
Enrollment rate for children age 6 to 15	-0.012	0.018	Yes
Commune has a lower secondary school	0.167	0.626	Yes
Predicted consumption per capita (log)	1.030	1.159	Yes
Share of households owning motorcycles	0.076**	0.036	No
Road density (commune and district level roads)	-12.21	11.40	Yes
Share of earth and car impassable roads in total road km	1.102	0.712	Yes
Constant	-15.96*	9.418	Yes
Observations	198		
Pseudo R2	0.204		

Table A.5. Impact heterogeneity: market and market frequency

Explanatory variables	Market			Market frequency		
	Model 1	Model 2	Same sign as the original paper	Model 1	Model 2	Same sign as the original paper
1997 value	-0.236**	-0.234**	Yes	-0.265**	-0.283**	Yes
	(-3.07)	(-4.36)		(-3.22)	(-3.86)	
Distance to central district	0.006	0.003	Yes	0.008		No
	(1.57)	(0.87)		(0.53)		
North province	-0.011		Yes	-0.208	-0.202	Yes
	(-0.16)			(-1.07)	(-1.15)	
Typology: mountain	0.038		Yes	0.229		Yes
	(0.27)			(0.54)		
Flood and storm prevalence	0.123**	0.133**	No	0.553**	0.612**	No
	(2.04)	(2.58)		(2.90)	(3.74)	
Population density	-0.098		No	0.72		No
	(-0.09)			(0.18)		
Ethnic minority share	-0.082		Yes	-0.131		Yes
	(-0.55)			(-0.30)		
Adult illiteracy rate	0.018		Yes	0.049		Yes
	(0.060)			(0.07)		
Share of households owning motorcycles	1.057**	1.363**	Yes	2.143	2.210**	Yes
	(2.10)	(2.90)		(1.43)	(1.99)	
Credit availability	0.305*	0.328	Yes	1.018	0.974*	Yes
	(1.74)	(1.60)		(1.47)	(1.70)	
Length of road rehabilitated/100	-0.014		Yes	-0.032	-0.017**	Yes
	(-1.52)			(-1.16)	(-2.19)	
Length squared/10000	0.01		Yes	0.019		Yes
	(0.50)			(0.31)		
Month since project completion/100	0.044	0.018	Yes	0.165**	0.172**	Yes
	(1.63)	(0.96)		(2.34)	(2.72)	
Month squared/10000	-0.045*	-0.02	Yes	-0.174**	-0.183**	No
	(-1.71)	(-1.10)		(-2.51)	(-2.92)	
Constant	-0.976	-0.505	Yes	-3.689**	-3.792**	Yes
	(-1.52)	(-1.03)		(-2.01)	(-2.51)	
R-squared	0.42	0.39		0.41	0.39	

This Table replicates the estimates of Table 4 in Mu and van de Walle (2011).

Notes: The dependent variables are the 85 estimated commune specific impacts for 2003. Standard errors are clustered at the district level of which there are 29. T-statistics are given in parentheses. **significant at 5 per cent level or higher; *significant at 10 per cent level. Market is a zero/one dummy for whether a market exists in the commune. Market frequency takes the value 0 for no market; 1 for once a week or less; 2 for more than once a week and 3 for permanent market.

Table A.6. Impact heterogeneity: shop and bicycle repair shop

Explanatory variables	Shop			Repair		
	Model 1	Model 2	Same sign as the original paper	Model 1	Model 2	Same sign as the original paper
1997 value	-0.962**	-0.969**	Yes	-0.738**	-0.729**	Yes
	(-7.01)	(-8.03)		(-6.27)	(-6.48)	
Distance to central district	0.004		Yes	-0.003		Yes
	(0.52)			(-0.83)		
North province	-0.084		Yes	-0.012		Yes
	(-0.67)			(-0.18)		
Typology: mountain	0.033		Yes	-0.016		No
	(0.17)			(-0.28)		
Flood and storm prevalence	-0.264**	-0.218**	Yes	0.111	0.106*	Yes
	(-2.37)	(-2.23)		(1.54)	(1.68)	
Population density	2.100	1.381	Yes	0.242		Yes
	(1.11)	(1.00)		(0.29)		
Ethnic minority share	0.451**	0.483**	Yes	-0.047		Yes
	(2.12)	(3.22)		(-0.37)		
Adult illiteracy rate	-1.196**	-1.207**	Yes	-0.477	-0.589	Yes
	(-2.23)	(-2.48)		(-1.16)	(-1.49)	
Share of households owning motorcycles	-0.819		No	0.716*	0.714*	Yes
	(-0.92)			(1.72)	(1.80)	
Credit availability	0.983**	0.894**	No	-0.053		Yes
	(2.60)	(2.32)		(-0.28)		
Commune has a market in 1997	0.161	0.123	Yes	0.115**	0.132**	Yes
	(1.18)	(1.15)		(2.16)	(2.35)	
Length of road rehabilitated/100	-0.009		Yes	-0.005	-0.010**	Yes
	(-0.53)			(-0.39)	(-3.34)	
Length squared/10000	0.015		Yes	-0.006		No
	(0.33)			(-0.19)		
Month since project completion/100	0.068*	0.057	Yes	0.063**	0.062**	Yes
	(1.69)	(1.34)		(2.17)	(2.55)	
Month squared/10000	-0.064	-0.054	Yes	-0.063**	-0.061**	Yes
	(-1.60)	(-1.29)		(-2.26)	(-2.65)	
Constant	-1.681	-1.448	No	-0.957	-1.008	No
	(-1.63)	(-1.34)		(-1.29)	(-1.57)	
R-squared	0.58	0.57		0.62	0.61	

This Table replicates the estimates of Table 5 in Mu and van de Walle (2011).

Note: The dependent variables are the 85 estimated commune specific impacts for 2003. Standard errors are clustered at the district level of which there are 29. T-statistics are given in parentheses. **significant at 5 per cent level or higher; *significant at 10 per cent level. All outcomes refer to availability in the commune.

Table A.7. Impact heterogeneity: Pharmacy and Restaurant

Explanatory variables	Pharmacy			Restaurant		
	Model 1	Model 2	Same sign as the original paper	Model 1	Model 2	Same sign as the original paper
1997 value	-0.656**	-0.660**	Yes	-0.614**	-0.570**	Yes
	(-4.61)	(-5.38)		(-4.59)	(-5.82)	
Distance to central district	-0.002		Yes	-0.006	-0.003	Yes
	(-0.36)			(-0.83)	(-0.44)	
North province	0.095		Yes	0.171		Yes
	(0.84)			(1.21)		
Typology: mountain	-0.094		No	0.019		Yes
	(-0.61)			(0.10)		
Flood and storm prevalence	-0.095		Yes	0.023		No
	(-0.73)			(0.18)		
Population density	0.858		Yes	-1.017		Yes
	(0.57)			(-0.37)		
Ethnic minority share	0.043		No	0.068		Yes
	(0.21)			(0.36)		
Adult illiteracy rate	-0.788	-0.910**	Yes	-0.376		Yes
	(-1.51)	(-2.34)		(-0.54)		
Share of households owning motorcycles	0.369	0.483	Yes	-0.454	-0.826	No
	(0.36)	(0.77)		(-0.57)	(-1.25)	
Credit availability	0.295		Yes	-0.022		Yes
	(0.80)			(-0.05)		
Commune has a market in 1997	0.304**	0.348**	Yes	0.242**	0.258**	No
	(2.53)	(3.07)		(2.58)	(2.72)	
Length of road rehabilitated/100	-0.009	-0.004	Yes	0.009		Yes
	(-0.66)	(-1.03)		(0.60)		
Length squared/10000	0.010		Yes	-0.012		Yes
	(0.30)			(-0.35)		
Month since project completion/100	0.055	0.042	Yes	0.035	0.015**	No
	(1.33)	(1.14)		(0.76)	(2.95)	
Month squared/10000	-0.055	-0.042	Yes	-0.022		No
	(-1.37)	(-1.17)		(-0.47)		
Constant	-0.881	-0.605	No	-1.110	-0.565*	Yes
	(-0.88)	(-0.69)		(-1.02)	(-1.73)	
R-squared	0.50	0.44		0.44	0.39	

This Table replicates the estimates of Table 5 in Mu and van de Walle (2011).

Note: The dependent variables are the 85 estimated commune specific impacts for 2003. Standard errors are clustered at the district level of which there are 29. T-statistics are given in parentheses. **significant at 5 per cent level or higher; *significant at 10 per cent level. All outcomes refer to availability in the commune.

Table A.8. Impact heterogeneity: Service availability

Explanatory variables	Pharmacy			Restaurant		
	Model 1	Model 2	Same sign as the original paper	Model 1	Model 2	Same sign as the original paper
1997 value	-0.857**	-0.818**	Yes	-0.853**	-0.849**	Yes
	(-8.13)	(-8.81)		(-6.28)	(-7.03)	
Distance to central district	-0.002	-0.000	Yes	0.002		No
	(-0.35)	(-0.10)		(0.32)		
North province	-0.213*	-0.154*	Yes	-0.011		Yes
	(-1.73)	(-1.94)		(-0.14)		
Typology: mountain	0.110		Yes	-0.076	-0.092	No
	(0.78)			(-0.96)	(-1.13)	
Flood and storm prevalence	0.037		Yes	-0.063		Yes
	(0.33)			(-0.85)		
Population density	2.711*	2.415**	Yes	-0.080		No
	(1.72)	(2.15)		(-0.08)		
Ethnic minority share	-0.156		Yes	-0.212	-0.203	Yes
	(-0.89)			(-1.50)	(-1.54)	
Adult illiteracy rate	-0.671	-0.615	Yes	-1.078**	-1.011**	Yes
	(-1.17)	(-1.36)		(-2.21)	(-2.37)	
Share of households owning motorcycles	0.993*	1.015**	Yes	0.470	0.613*	Yes
	(1.69)	(2.75)		(1.24)	(1.72)	
Credit availability	0.224		Yes	0.344	0.312*	Yes
	(0.78)			(1.57)	(1.80)	
Commune has a market in 1997	0.092	0.093	Yes	0.055		Yes
	(0.94)	(1.12)		(0.79)		
Length of road rehabilitated/100	0.003	-0.005	Yes	-0.005	-0.006**	No
	(0.21)	(-1.14)		(-0.42)	(-2.01)	
Length squared/10000	-0.011		Yes	-0.001		Yes
	(-0.31)			(-0.02)		
Month since project completion/100	0.000		Yes	0.077**	0.080**	Yes
	(0.00)			(2.60)	(2.26)	
Month squared/10000	-0.001		Yes	-0.077**	-0.080**	Yes
	(-0.05)			(-2.74)	(-2.38)	
Constant	0.495	0.514**	Yes	-1.041	-1.078	No
	(0.67)	(3.54)		(-1.35)	(-1.26)	
R-squared	0.58	0.55		0.63	0.62	

This Table replicates the estimates of Table 6 in Mu and van de Walle (2011).

Note: The dependent variables are the 85 estimated commune specific impacts for 2003. Standard errors are clustered at the district level of which there are 29. T-statistics are given in parentheses. **significant at 5 per cent level or higher; *significant at 10 per cent level. All outcomes refer to availability in the commune.

Table A.9. Impact heterogeneity: Employment

Explanatory variables	Farming			Services			Trade		
	Model 1	Model 2	Same sign as the original paper	Model 1	Model 2	Same sign as the original paper	Model 1	Model 2	Same sign as the original paper
1997 value	-0.118	-0.118*	Yes	-0.308	-0.235	Yes	-0.315	-0.198	Yes
	(-1.55)	(-1.70)		(-0.86)	(-0.67)		(-0.92)	(-0.64)	
Distance to central district	-0.010		Yes	-0.090	-0.099	Yes	-0.014		Yes
	(-0.08)			(-1.07)	(-1.37)		(-0.24)		
North province	-2.474	-2.712	Yes	1.172	1.732	Yes	-1.985**	-1.170	Yes
	(-1.25)	(-1.51)		(0.97)	(1.25)		(-1.96)	(-1.29)	
Typology: mountain	-2.086		Yes	-1.744	-2.829**	Yes	0.820		Yes
	(-0.66)			(-1.08)	(-2.22)		(0.44)		
Flood and storm prevalence	-2.534	-3.189*	Yes	2.401*	2.713*	Yes	-0.140		No
	(-1.17)	(-1.91)		(1.79)	(1.65)		(-0.13)		
Population density	-37.572	-21.625	Yes	28.058		Yes	28.536		Yes
	(-0.87)	(-0.80)		(0.79)			(0.92)		
Ethnic minority share	0.313		Yes	0.132		Yes	0.906		No
	(0.08)			(0.07)			(0.55)		
Adult illiteracy rate	3.369		Yes	5.120	5.318	No	-3.947	-4.938*	No
	(0.41)			(0.90)	(1.14)		(-0.88)	(-1.67)	
Share of households owning motorcycles	-12.164	-11.355	Yes	23.844**	23.250**	Yes	12.545	11.471*	Yes
	(-0.79)	(-0.72)		(2.83)	(3.16)		(1.64)	(1.73)	
Credit availability	2.259	3.202	Yes	-8.094**	-9.260**	Yes	-4.298	-4.783*	Yes
	(0.39)	(0.51)		(-2.16)	(-2.59)		(-1.56)	(-1.76)	
Commune has a market in 1997	-2.765	-2.543*	Yes	-0.476		Yes	1.612*	1.486*	Yes
	(-1.52)	(-1.69)		(-0.33)			(1.76)	(1.93)	
Length of road rehabilitated/100	-0.006		Yes	0.038		No	0.002		Yes
	(-0.03)			(0.20)			(0.02)		

Explanatory variables	Farming			Services			Trade		
	Model 1	Model 2	Same sign as the original paper	Model 1	Model 2	Same sign as the original paper	Model 1	Model 2	Same sign as the original paper
Length squared/10000	-0.078		No	-0.030		No	-0.020		Yes
	(-0.21)			(-0.08)			(-0.11)		
Month since project completion/100	0.324	-0.015	Yes	0.532	0.569*	Yes	0.410	0.295	Yes
	(0.41)	(-0.22)		(1.22)	(1.65)		(1.04)	(0.96)	
Month squared/10000	-0.324		Yes	-0.662	-0.686**	Yes	-0.439	-0.317	Yes
	(-0.41)			(-1.59)	(-1.98)		(-1.15)	(-1.10)	
Constant	7.292	14.134*	Yes	-8.280	-7.830	Yes	-8.649	-4.857	Yes
	(0.34)	(1.91)		(-0.74)	(-0.93)		(-0.87)	(-0.61)	
R-squared	0.21	0.19		0.29	0.27		0.19	0.16	

This Table replicates the estimates of Table 7 in Mu and van de Walle (2011).

Note: The dependent variables are the 85 estimated commune specific impacts for 2003. Standard errors are clustered at the district level of which there are 29. T-statistics are given in parentheses. **significant at 5 per cent level or higher; *significant at 10 per cent level. All outcomes refer to availability in the commune.

Table A.10. Impact heterogeneity: Schooling

Explanatory variables	Secondary school enrolment			Primary school completion		
	Model 1	Model 2	Same sign as the original paper	Model 1	Model 2	Same sign as the original paper
1997 value	-0.915**	-0.961**	Yes	-0.999**	-0.932**	Yes
	(-8.96)	(-14.47)		(-9.83)	(-8.91)	
Distance to central district	0.068		No	-0.190		Yes
	(0.39)			(-0.40)		
North province	2.052	3.268	No	7.322	5.700	Yes
	(0.79)	(1.58)		(0.76)	(0.95)	
Typology: mountain	1.061		No	-6.896		Yes
	(0.27)			(-0.66)		
Flood and storm prevalence	1.703		No	16.182**	16.717**	Yes
	(0.66)			(2.49)	(2.87)	
Population density	7.611		No	58.566		Yes
	(0.22)			(0.46)		
Ethnic minority share	-5.906	-6.363*	Yes	3.152		Yes
	(-1.50)	(-1.88)		(0.26)		
Adult illiteracy rate	7.168		No	43.797	21.340	No
	(0.46)			(1.22)	(0.93)	
Share of households owning motorcycles	-8.500	-8.096	No	97.884*	94.383*	Yes
	(-0.55)	(-0.50)		(1.66)	(1.94)	
Credit availability	3.814	5.519	Yes	4.141		No
	(0.60)	(0.97)		(0.22)		
Commune has a market in 1997	1.940	1.720	Yes	9.817	9.344	Yes
	(0.86)	(0.98)		(1.29)	(1.42)	
Length of road rehabilitated/100	-0.024	-0.173*	Yes	-0.633	-0.368	No
	(-0.10)	(-1.85)		(-0.73)	(-1.35)	
Length squared/10000	-0.286		No	0.327		No
	(-0.45)			(0.16)		
Month since project completion/100	-0.192	0.084	No	0.188		No
	(-0.25)	(0.82)		(0.07)		
Month squared/10000	0.274		No	-0.422		No
	(0.37)			(-0.16)		
Constant	80.464**	81.035**	Yes	52.136	45.989**	Yes
	(3.93)	(9.67)		(0.76)	(3.50)	
R-squared	0.87	0.86		0.71	0.67	

This Table replicates the estimates of Table 8 in Mu and van de Walle (2011).

Note: The dependent variables are the 85 estimated commune specific impacts for 2003. Standard errors are clustered at the district level of which there are 29. T-statistics are given in parentheses. **significant at 5 per cent level or higher; *significant at 10 per cent level. All outcomes refer to availability in the commune.

Table A.11: PS kernel matched DD: bandwidth = 0.01

Outcomes	2001			2003		
	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Market availability	0.023	0.537	0.03	0.068	1.380	0.08*
Market frequency	0.124	0.941	0.08	0.137	0.930	0.23*
Shop	-0.203	-1.617	0.01	-0.194*	-1.827	0.08
Bicycle repair shop	-0.057	-1.027	-0.06	-0.044	-0.626	0.02
Pharmacy	0.096	1.337	0.04	0.260**	2.367	0.12
Restaurant	0.145**	2.007	-0.01	0.089	0.829	0.01
Women's hair dressing/ Men's barber	0.077	1.032	-0.07	0.102	1.373	0.18**
Men and women's tailoring	0.012	0.248	0.11	0.034	0.585	0.10
% farm households	-1.961	-0.943	0.05	-3.035	-1.418	-2.04*
% trade households	0.064	0.083	0.03	1.218	1.582	0.36
% service sector households	-0.044	-0.086	-1.54	1.353**	2.306	1.68**
Primary school completion (< 15 years)	7.150	0.850	0.15**	13.848**	1.943	0.17**
Secondary school enrolment rate	2.948	0.834	0.10	0.837	0.290	0.05

Notes: The sample consists of 85 project and 83 non-project communes on common support as determined by propensity score matching. The propensity score is estimated by the logit model in Table A.2 in Appendix.
T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.

Table A.12: PS kernel matched DD: bandwidth = 0.03

Outcomes	2001			2003		
	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Market availability	0.028	0.776	0.03	0.079**	2.003	0.08*
Market frequency	0.137	1.398	0.08	0.171	1.477	0.23*
Shop	-0.173	-1.553	0.01	-0.178*	-1.850	0.08
Bicycle repair shop	-0.059	-1.152	-0.06	-0.038	-0.575	0.02
Pharmacy	0.074	1.030	0.04	0.206*	1.883	0.12
Restaurant	0.139**	1.946	-0.01	0.073	0.795	0.01
Women's hair dressing/ Men's barber	0.068	0.894	-0.07	0.092	1.231	0.18**
Men and women's tailoring	0.004	0.080	0.11	0.033	0.551	0.10
% farm households	-1.208	-0.686	0.05	-2.782	-1.529	-2.04*
% trade households	-0.191	-0.244	0.03	1.069	1.544	0.36
% service sector households	-0.032	-0.068	-1.54	1.330**	2.439	1.68**
Primary school completion (< 15 years)	4.141	0.551	0.15**	11.986*	1.718	0.17**
Secondary school enrolment rate	1.565	0.526	0.10	0.890	0.308	0.05

Notes: The sample consists of 85 project and 83 non-project communes on common support as determined by propensity score matching. The propensity score is estimated by the logit model in Table A.2 in Appendix.
T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.

Table A.13: PS kernel matched DD: bandwidth = 0.09

Outcomes	2001			2003		
	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)	PS kernel matched DD	t-ratio	Original estimates in Mu and van de Walle (2011)
Market availability	0.028	0.819	0.03	0.082**	2.196	0.08*
Market frequency	0.134	1.430	0.08	0.173	1.503	0.23*
Shop	-0.103	-1.011	0.01	-0.115	-1.272	0.08
Bicycle repair shop	-0.071	-1.373	-0.06	-0.058	-0.813	0.02
Pharmacy	0.045	0.601	0.04	0.140*	1.681	0.12
Restaurant	0.129	1.614	-0.01	0.038	0.393	0.01
Women's hair dressing/ Men's barber	0.047	0.627	-0.07	0.069	0.926	0.18**
Men and women's tailoring	0.000	0.003	0.11	0.022	0.329	0.10
% farm households	-0.534	-0.341	0.05	-2.263	-1.527	-2.04*
% trade households	-0.161	-0.261	0.03	0.692	1.343	0.36
% service sector households	-0.325	-0.759	-1.54	0.877*	1.890	1.68**
Primary school completion (< 15 years)	0.552	0.086	0.15**	8.896	1.260	0.17**
Secondary school enrolment rate	0.915	0.293	0.10	0.607	0.205	0.05

Notes: The sample consists of 85 project and 83 non-project communes on common support as determined by propensity score matching. The propensity score is estimated by the logit model in Table A.2 in Appendix.
T-ratio of kernel matching is obtained from bootstrapping (100 repetitions).
** significant at 5 per cent level or higher; * significant at 10 per cent level.

Table A.14. Logit regression of commune participation in the project using stepwise backward selection

Explanatory variables	Dependent variable is commune participating into the project. The logit regression corresponds to the following outcomes												
	Market availability	Market frequency	Shop	Bicycle repair shop	Pharmacy	Restaurant	Women's hair dressing/ Men's barber	Men and women's tailoring	% farm household	% trade household	% service sector household	Primary school completion (< 15 years)	Secondary school enrolment rate
Railway passes through commune without stop	1.590***	1.590***	1.632***	1.590***	1.590***	1.590***	1.590***	1.590***	1.590***	1.590***	1.748***	1.111**	1.538***
	(0.554)	(0.554)	(0.556)	(0.554)	(0.554)	(0.554)	(0.554)	(0.554)	(0.554)	(0.554)	(0.563)	(0.511)	(0.571)
Commune has a radio broadcasting station	-0.791*	-0.791*	-0.827*	-0.791*	-0.791*	-0.791*	-0.791*	-0.791*	-0.791*	-0.791*	-1.068**	-0.811*	-0.906**
	(0.432)	(0.432)	(0.432)	(0.432)	(0.432)	(0.432)	(0.432)	(0.432)	(0.432)	(0.432)	(0.458)	(0.418)	(0.457)
Baseline outcome: shop			0.653*										
			(0.357)										
Share of households owning motorcycles	0.060**	0.060**	0.059**	0.060**	0.060**	0.060**	0.060**	0.060**	0.060**	0.060**	0.060**	0.044**	0.086***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.024)	(0.023)	(0.028)
Number of official credit sources	-0.285**	-0.285**	-0.324**	-0.285**	-0.285**	-0.285**	-0.285**	-0.285**	-0.285**	-0.285**	-0.330**	-0.293**	-0.303*
	(0.141)	(0.141)	(0.145)	(0.141)	(0.141)	(0.141)	(0.141)	(0.141)	(0.141)	(0.141)	(0.146)	(0.143)	(0.155)
Minority population share	1.410**	1.410**	1.356**	1.410**	1.410**	1.410**	1.410**	1.410**	1.410**	1.410**	1.453**		1.602**
	(0.639)	(0.639)	(0.637)	(0.639)	(0.639)	(0.639)	(0.639)	(0.639)	(0.639)	(0.639)	(0.644)		(0.676)
National road passes through commune	-1.611***	-1.611***	-1.776***	-1.611***	-1.611***	-1.611***	-1.611***	-1.611***	-1.611***	-1.611***	-1.660***	-1.641***	-1.312***
	(0.412)	(0.412)	(0.430)	(0.412)	(0.412)	(0.412)	(0.412)	(0.412)	(0.412)	(0.412)	(0.420)	(0.443)	(0.436)
Binh Thuan province	1.468**	1.468**	1.515**	1.468**	1.468**	1.468**	1.468**	1.468**	1.468**	1.468**	1.583**	1.118*	2.352***
	(0.613)	(0.613)	(0.624)	(0.613)	(0.613)	(0.613)	(0.613)	(0.613)	(0.613)	(0.613)	(0.615)	(0.613)	(0.816)
Population (log)	0.792**	0.792**	0.665**	0.792**	0.792**	0.792**	0.792**	0.792**	0.792**	0.792**	0.791**	0.646**	0.629*
	(0.323)	(0.323)	(0.330)	(0.323)	(0.323)	(0.323)	(0.323)	(0.323)	(0.323)	(0.323)	(0.329)	(0.272)	(0.336)
Population density (log)	0.380*	0.380*	0.382*	0.380*	0.380*	0.380*	0.380*	0.380*	0.380*	0.380*	0.381*		0.527**
	(0.197)	(0.197)	(0.197)	(0.197)	(0.197)	(0.197)	(0.197)	(0.197)	(0.197)	(0.197)	(0.195)		(0.211)
Baseline outcome: % households with main occupation of service											0.213*		
											(0.116)		
Commune has a passenger transport service												0.744*	
												(0.385)	

Explanatory variables	Dependent variable is commune participating into the project. The logit regression corresponds to the following outcomes												
	Market availability	Market frequency	Shop	Bicycle repair shop	Pharmacy	Restaurant	Women's hair dressing/ Men's barber	Men and women's tailoring	% farm household	% trade household	% service sector household	Primary school completion (< 15 years)	Secondary school enrolment rate
Share of earth and car impassable roads in total road km													1.099*
													(0.626)
Commune has an agricultural bank													0.897*
													(0.529)
Share of population working in government													-7,079.2*
													(3,992.6)
Constant	-7.075**	-7.075**	-6.135**	-7.075**	-7.075**	-7.075**	-7.075**	-7.075**	-7.075**	-7.075**	-7.100**	-5.154**	-6.501**
	(2.766)	(2.766)	(2.799)	(2.766)	(2.766)	(2.766)	(2.766)	(2.766)	(2.766)	(2.766)	(2.813)	(2.215)	(2.894)
Observations	198	198	198	198	198	198	198	198	198	198	198	190	187
R2	0.130	0.130	0.142	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.147	0.108	0.152

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Original authors' feedback on "Impacts of Rural Road on Household Welfare in Vietnam: evidence from a Replication Study"

This paper reports on a replication of our 2011 study "Rural roads and local market development in Vietnam" by Ren Mu and Dominique van de Walle, Journal of Development Studies 47(5) 2011.

Replication studies are dependent on the availability of a certain amount of documentation on what was done in the original study. But this too applies to one's ability to judge a replication study. It is difficult for the reader to judge the replication given the paucity of detail on what was done exactly, including how variables were constructed.

The replication focuses primarily on the (very) small differences found in the attempt to replicate. The key discrepancies appear to arise from the following two factors.

The first important difference is that the replication uses 198, not 200 observations for the PSM logit regression. This means that the propensity scores and the common support are slightly different, so that different estimates result. The differences are fairly small and it is no surprise that they are there. The author notes that he drops the 2 communes due to missing values in some explanatory variables. He doesn't say which variables have missing values. But, based on the data we have, two variables – the share of crop land and share of perennial crop land – have missing values for two observations in 1997. Assuming that these are attributes that are relatively sticky over time and given that they are not of interest as outcomes, we replaced these with the values for the same communes in 1999 and were able to run the regression with 200 observations. This seems the obvious thing to do. We suspect that if the authors of the replication study had done so then the replication would have been more exact.

The second key difference stems from the author's different definition of a few outcome variables. We were able to find all the necessary variables and reproduce the same numbers as in the published article for adult illiterate, credit availability, men's barber, women's hair dressing, primary school completion and secondary school enrolment rate (the variables that differ). We have no idea why the replication study could not get the same numbers. We had men's barber and women's hair dressing coded separately while the replication has them as one variable. The primary school completion in the replication study is way too high and has a puzzling decreasing time trend. Ours started with about 31% in 1997 and increased to 37% in 2003, which seems a more sensible trend, given the time and context. We suspect there are errors in the replication study, but beyond these observations it is hard to say what they might be.

In sum, the replication is using a different sample (based on a different PSM logit regression) and occasionally differently defined variables. It is no wonder that the results are not exactly the same. It is difficult for us to say much more about the replication.

As well as presenting its own estimated variable means and estimated impacts, the paper reports the difference between its replicated estimates and those given in the original paper by noting the difference between them as 0%, <10% or >10% difference. Although most estimates have 0 or less than 10% difference between them, this way of presenting the results tends to exaggerate the differences.

For example, in one case the author reproduces the original table 1 which gives mean baseline characteristics for communes classified by median household per capita consumption, and gives his own version (also as Table 1). In most cases, the means are the same. In many of the <10% difference cases, the differences are miniscule and look like they could be due to rounding off errors. For example, for Market availability, this paper reports 0.31 and 0.66 compared the original paper's 0.32 and 0.63. For bicycle repair shop, it is 0.54 and 0.88 versus 0.53 and 0.88. In only four cases, the means are very different and are undoubtedly defined differently. As noted above, in the case of women and men's hairdressing services, the variable is aggregated while the original paper reported them separately. For the other three, different definitions have clearly been used by the original study and the replication.

The results part note in various places (e.g. page 12, page 18, page 19) that "most of the impact estimates replicated in this study have the same sign" as in the original study. That too gives the wrong impression. Not only are they of the same sign, they are often the same or extremely similar. The paper exaggerates small differences.

In the end, the paper concludes that the differences are due to differences in the construction of the variables and not due to methodological issues. What is remarkable is how little the qualitative conclusions alter and this is surely notable. The replication finds no faults with any of the do files or the methods used. The only problem is with some of the data cleaning documentation. The replication study might also comment on the degree to which the original paper provides details on definitions and what it has done. It is obviously not perfect but compared to most published papers it is quite detailed. We would like to see the paper focus not only on the very small differences but the incredible similarity of the results.

The replication tests sensitivity of the original results to changing the bandwidth in the kernel matching and to adding different covariates to the logit model used to compute the propensity scores. None of these tweaks changes the results. However, we are not sure that what is done in the second change makes much sense. First, the baseline value of each outcome variable is added singly to the logit model and propensity scores (PS) computed. Thus a different logit model and PS are estimated for each outcome. Common support presumably alters at times too. This seems a very strange thing to do. First, the original logit already contains baseline proxies for most outcome variables. Second, the PS is meant to estimate the probability of each commune getting the road project. This will clearly not vary by outcome variable. Finally a balancing test showed that baseline outcomes are similar after matching. The paper has not followed standard practice in these respects.

The paper also argues that the logit should be pruned of all covariates that have lower than 10% statistical significance citing a paper that argues that "inclusion of irrelevant variables can increase the standard error of the estimates." But the fact that a covariate is not statistically significant does not imply that it is irrelevant. Clearly the characteristics of poor Vietnamese communes in 1997 are likely to have been highly correlated and as a result insignificant in the logit model. This does not mean that they should be excluded. One would need to be very careful in deciding what attributes were or were not relevant.