Impacts of infrastructure development on household welfare: an analysis for the case of Ngoc Hoi district, Kon Tum of Vietnam

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Abstract. The study assesses the effects of two community-level infrastructure development projects conducted in most villages in the border district Ngoc Hoi of Kon Tum province. The analysis is based on the combining household and community level survey data using the matched difference-in-difference (DD) method. Our results indicate that improvement in school and road infrastructure produce welfare gains for household at the village and country level as well. The implication from the study is to help government to consider which should be invested in order to boost economic growth and improve people welfare.

1. Introduction

Kon Tum is one of five provinces\(^{(1)}\) of the Central Highlands (or Tay Nguyen) of Vietnam, characterized by a large share of population of ethnic minorities such as the people of Malayo-Polynesian languages (Jarai, Ede) and the people of Mon-Khmer languages (Bahna and K’hor). The province borders with Laos and Cambodia, and its economy is primarily agricultural. The strong potential of the province is basalt soil with average altitude of 500 - 600 meters, suitable for industrial crop production such as coffee, cacao, pepper, white mulberry, cashew and rubber plant. Despite this potentiality, dating back to few years ago, rural areas in Kon Tum used to suffer severely from an increasing marginalization and impoverishment, worsening access to roads, information, energy, healthcare facilities, schools and markets. Degradation of health and education facilities was more clear in rural than in urban in Kon Tum province that has negatively affected people livelihood and welfare.

Recognizing the importance of the infrastructure in economic development and household welfare improvement, the government of Vietnam recently paid more attention to improve infrastructure in the region and in Kon Tum province as well with the aim of giving more opportunities and chances for households in rural area to improve their general living condition. Empirical evidence shows that the improvement in infrastructure in

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\(^{(1)}\) Others are Gia Lai, Dak Lak, Dak Nong and Lam Dong.
Kon Tum has brought about positive changes in people living standards and their social status as well. In order to evaluate the changes, this paper aims at assessing the impacts of the improvement in infrastructure on household welfare in rural Kon Tum. More precisely, we investigate the welfare impact of various types of rural infrastructural development projects in the area and evaluate targeting of projects, and attempt to provide evidence on whether people in that area benefit from such programs and interventions. Especially, the study will focus on the village level, in the Ngoc Hoi district, a border district that locates in the Bo Y Border Gate Economic Zone that belongs to the Vietnam-Laos-Cambodia (VLC) Development Triangle. The Bo Y Border Gate Economic Zone (BGEZ) is constructed in the Bo Y International Border Gate (IBG).

The interest in assessing and evaluating the effectiveness of the infrastructural improvement projects has been stemming from the increasing popularity of such projects for channeling development assistance. Several recent papers pay attention on measuring the effects of improved infrastructure on various dimensions of welfare. Glewwe (1999), Hanushek (1995), and Kramer (1995) consider the impacts of school infrastructural projects in the works. Jacoby (2002) and van de Walle and Cratty (2002) evaluate the effects of road improvements on welfare. The effects of the improvements in water and sanitation facilities are analyzed by Jalan and Ravallion (2003), Le at al., (1997), Brokerhoff and Derose (1996). All these studies have found evidences that show positive impacts of infrastructural improvements on community and household welfare in each case of the study.

Based on the infrastructural condition and infrastructure development projects conducted in the studied area, our analysis will be done for two periods: 2002 and 2006 and relies on a coverage of all infrastructure development programs in the Ngoc Hoi District, Kon Tum province that relevant to forty thirty-selected village under the study. We also aim at examining both direct and indirect effects in which projects affect the wellbeing of the population in these villages. In addition, based on the data available we conduct a number of tests to assess the positive impacts of some infrastructure projects on a wide range of welfare outcomes focusing on only two types of infrastructure projects implemented in the area such as school infrastructure and road development projects.

The paper is structured as follows. The next section elaborates the different types of investment projects on infrastructure conducted in Ngoc Hoi district, Kon Tum province, including those that are implemented in the area of the VLC development triangle that may have affected socio-economic condition for the selected hamlets and household welfare in studied villages. The data used for this analysis will be described in section 3, which is followed by the discussion of the methodology for impact evaluation in section 4. Section 5 is used to discuss the empirical results of the impact assessment. Finally, section 6 concludes the research.

2. Community-based infrastructure development projects in Ngoc Hoi, Kon Tum

Infrastructure development projects to be considered in our study include projects for rehabilitating of existing infrastructure facilities and the construction of the new facilities that are carried out in Ngoc Hoi. These projects are both financed by the Government of Vietnam (GOV) and international donors like World Bank (WB), Asian Development Bank (ADB) and many other

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(2) 2000 is considered the before period which means that there was no intervention and treatment applied, while 2006 is the after period in which there was some treatment and intervention in infrastructure were applied.

(3) For school infrastructure, because we considered village level, so for the present study we examine infrastructure for primary school and all indicators of primary education only.
Ngoc Hoi of Kon Tum is the border and remote district that attract large attention from the government of Vietnam and the international donors as well. In its agenda, Vietnam has planned to improve infrastructure for the remote and borders areas in order to boost up economic in those regions. Therefore, Ngoc Hoi is the district that received many investment projects to improve education, road, health and other basic needs in order to help boosting economic condition of this area. In addition, Ngoc Hoi locates in the VLC Development triangle, so there are many infrastructure projects accrue to this site. That is why, since 2000, general infrastructure in the district has significantly improved that likely improve living standard in particular and welfare in general for the people living in the district.

3. Data

In this study, the analysis is based on data extracted from the Vietnam Household Living Standard Survey (VHLSS) firstly conducted in 1992 - 1993 by the Vietnam General Statistical Office (VGSO) with the statistical support from World Bank. Then, the survey was conducted every 5 years until 2000. Since then, it was conducted in every four years. The survey was conducted at both household level and community level. The survey collected information on household and community relating to household economy and community infrastructure. All the information relating to data requirement for our analysis was extracted from this survey for 2002 and 2006.

4. Methodology

Theoretically, a measure of the impact of an intervention is the difference between the observed outcome for a group of beneficiaries and the (counterfactual) outcome for the same group without the benefit of intervention. Because counterfactual is never observed, the challenge of the evaluation job is to find the plausible proxies for such unobserved outcomes. We resolve this challenge by comparing outcomes for beneficiaries with the outcomes for an appropriate comparison group. Both groups should have similar characteristics. These characteristics would influence both the outcomes of an intervention and group selection into the program.

The village selection for the intervention (infrastructure development) is done based on the preferences of a community on the requirement of a project-implementing agency taking into account the state of infrastructure in the hamlets or regional characteristics. Thus, villages are chosen based on characteristics, both observable and unobservable that could be correlated with the expectation outcomes of a project. Because of such non-random placement, a simple comparison of outcomes between villages that benefit from infrastructure development projects and those without projects would not measure correctly the impact of an intervention.

So, if selection of a village into a project is based mainly on observable characteristics, we can use propensity-score matching (PSM) method to remove the selection bias due to differences between villages with and without projects (Rubin, 1973). However, some unobserved characteristics of the village that

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(4) Due to constraint about the length of the paper, we will not discuss this method here. For more details about the method, please refer to Rubin (1973).
correlate with project outcomes might also correlate with project placement. This correlation may cause bias in the estimation of project impact. For instance, an active parent group might lobby the village authorities to pursue an infrastructure project for school, and at the same time, parent participation in the education process could positively affect school outcome of their children. In this case, the effectiveness of the school project will be overestimated if the evaluation procedure does not take into account the differences in parental activities between treated and control villages.

Under the assumption that pre-intervention differences between the control and treated villages are the results omitted variables that do not change over time in their impact on outcomes, we can use the difference in difference (DD) method to correct the possible bias. In the DD method, the pre-project difference in outcomes may be subtracted from the post-project differences for same village. The underlying assumption of the DD method is that the time trend in the control group is an adequate proxy for the time trend that would have occurred in the treated group in the absence of an intervention.

In this study we use the matched DD method, which is a combination of the PSM and DD. Using this method, first we match villages from the control and treatment groups using PSM. This matching removes the selection due to differences in time-invariant unobserved characteristics between the two groups. To assess the impact of a project, we compare the changes in the outcome indicators between matched hamlets from treatment and control groups.

According to Chen and Ravallion (2003), outcome measure \( I_{it} \) for a project in \( i \)'th treated village \((D_i=1)\) at time \( t \) can be defined as:

\[
(I_{it} / D_i = 1) = I_{it}^* + B_{it} + \varepsilon_{it} (i = 1, ..., N; t = 0,1) \tag{1}
\]

where \( I_{it}^* \) is the counterfactual outcome for a treatment village if the program had not been implemented, \( B_{it} \) is the benefit or gain in an outcome attributable to a project, and \( \varepsilon_{it} \) is a mean-zero error term uncorrelated with the project placement. While the counterfactual outcome is unobservable, its estimates \( \hat{I}_{it}^* \) could be obtained from a comparison group.

However, mismatching arising from differences in unobserved characteristics between treated and control villages may bias this estimate. If the selection bias is time-invariant and separable, it could be removed from the estimate by taking differences over time. The mean difference-in-difference for the outcome is estimated by taking the expectation of (1) over all \( N \) as:

\[
E[(I_{it} - \hat{I}_{it}^*) - (I_{i0} - \hat{I}_{i0}^*) / D_i = 1] = E[(B_{it} - B_{i0}) / D_i = 1] \tag{2}
\]

**Impact indicators**

In order to analyze the impact, we need to construct and clarify impact indicators for

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For this combined method’s details, please refer to Heckman et al., (1998) and Heckman et al. (1997).

(6) The observations from control and treatment groups are matched with replacement. Thus, more than one village from the treatment group could be matched with a village in the control group (Dehejia and Wahba 1999).
evaluation. As we may all know, any infrastructure project has spillover welfare impacts for the households affected by a project. So, to assess the impact of a project one should track changes across different welfare dimensions. Thus, several indicators need to be constructed for each type of intervention and the choice of these indicators are determined by the practicalities of the evaluation and data collection. Impact or outcome indicators have to be measurable with the data used, and be link directly to the intervention.

The outcome indicators may be complemented by output indicators that measure the progress towards the implementation of the project. The difference between output and outcome indicators is that outcome indicators are directly link to the project objectives while the output indicators are related to the mean of achieving these objectives. For example, the output of a school infrastructure project could be an increase in the school facilities such as number of classes, number of desks, etc. while outcome of the project may be the increase in school enrolment rate. However, in many circumstances output and outcomes can coincide or be measured by similar indicators.

As mentioned above, in this study we analyze two types of infrastructure development projects: school development and road development. We expect these interventions would have a number of positive effects on household living standard. We will use measures of these effects as impact indicators.

Two sets of indicators are calculated for each project. Both are derived from the VLSS, but the first is on the village level and the second is on the household level. Both indicators measure changes between 2002 and 2006.

Our main indicators for two types of projects under consideration are provided in Table 1. The design of an indicator set in this study aim to measure (i) project-specific outcomes (such as changes in school enrolment for school projects), (ii) changes in private input related to a project (such as transportation expenditures for road projects), (iii) the indirect economic effects (such as changes in the Small and Medium Enterprises (SME) resulting from road projects). Figures reported in Table 1 are simple average across all villages in the sample calculated at the beginning and at the end of the time frame chosen for the analysis.

5. Result discussion and analysis

In this section, we conduct two types of analysis. First, the explanatory analysis is based on the data and is given in section 5.1. Then, section 5.2 will discuss and analyze the empirical results based on the estimates from using above model applied to our village-level data.

5.1. Data explanatory analysis

The indicators for evaluation are reported from column 2 to 3 for the beginning period chosen for analysis, from column 4 to 5 for the end period, and the last column reports changes (differences) in the main outcome indicators.

Most indicators reported in Table 1 show the positive effects caused by the school and road project in Ngoc Hoi district, except the indicator “drop during the year” which its mean increased in 2006 from a lower level in 2002. However, the indicators also reflect a bad reality in school enrolment and attendance, and quality of road. Only 43.2% of villages had all school age children in schools in 2002; this rate got better to 67.1% by 2006 but it still very low. The data also reveal that, in average, around 9% of children in an average village left school during the year in 2000. These indicators got deteriorated for all villages in 2006 when the rate reached to 11%. Further, only 35.5% of villages thought the government budget spent on education was adequate in 2002, and this rate marginally increased in 2006 when only
36.2% of villages thought the expenditure for education was adequate.

In 2002, as many as 90.2% of villages reported that the quality of their main road was inadequate. This indicator improved very significantly by 2006, but 65.1% of villages still complained about the road quality. In as many as 55.2% of villages reported to think that the time to travel and means of transport from their villages to the district center are convenient. This indicator further improved in 2006 when 75.6% of villages considered the time to travel to district centre have reduced significantly and means of transport to the center were convenient.

5.2. Empirical result analysis

In this section, we discuss the results of impact assessment analysis for development of road infrastructure and school projects.

Road development projects

Road development projects include those that construct new road and the rehabilitation works. The road development works often means pavement of existing roads, restoration of road structure damaged or destroyed by natural disasters, widening of road and building new road. The road development could reduce the time spent commuting and ease access to market places. This may lead to an increase in the value of productive assets owned by households that could improve household’s well-being. Investments in road are likely to generate new income opportunities for farm households. Several labor markets studies have identified off-farm employment as the key driving force of welfare changes (Yemtsov, 2001; Bernabe, 2002). But access to rural labor and product markets appears to be an important constraint to disseminating the benefits of economic growth in rural Vietnam in general and in Kon Tum in particular.

The estimation results for road development projects are reported in Table 2. The most immediate indicator of a road project outcome - time spent commuting to the district centre shows a reduction by 25.19 minutes in villages with projects as opposed to only 18.32 minutes in the unmatched control group and 17.48 minutes in the PSM control sample. These differences however are not statistically significant. The change in indicators that are linked to the economic impact of the projects is more pronounced. The share of village with active small and medium enterprises has increased in project villages. This impact is significant when compared with unmatched control group. Another indicator show the indirect economic impact of the road projects is the off-farm employment, which increased in the villages with projects by around 3% in treatment groups compared with control groups. The last indicator - changes in the subjective assessment of the road quality fails to react to road development intervention.

As estimates suggest and as we noted earlier, the effects of the road development projects could be difficult to capture, but we find some indication of positive changes due to projects: an increase in number of small and medium enterprises, the reduction in commuting time and increase in off-farm employment in the villages. In addition, there may be many more other benefits but we did not explore in this study such as more opportunity to access to market, reduction in road accident rate, etc.

School development projects

In this section, we include all school development projects include new projects as well as rehabilitation projects. School projects focus on new construction of school and
improving school buildings such as repairing roofs, windows and floors, replacing and installing new facilities and teaching equipments. These projects may yield several kinds of benefits to the community. School development projects may positively impact school enrolment and attendance rates - the indicators most often used in the Social Investment Fund impact evaluation studies (for example, among others, Newman et al., 2000; Chaise, 2002). Increase in the government spending on education can be used as an indicator of positive public response to investment in school development, and subjective assessments of schooling conditions provide a useful check for the results based on objective measures.

The DD estimation of the impact of school development projects is shown in Table 3 for unmatched and PSM constructed control groups. Three outcome indicators are reported. The first indicator shows that the share of villages reporting that all children are presently enrolled in school and are attending classes increased between 2002 and 2006. In the matched comparison the average change in the outcome indicator is the same for the treatment and control groups and show that school enrolment ceased to be universal in 5.2% of the villages. Another indicator, the number of pupils in village schools, gives a different picture. Slightly more than 30% (31.6%) of project villages the number of pupils has increased compared to just over 20% (23.8%) of non project villages in the unmatched sample.

The matched comparison shows an even larger, statically significant difference. The number of school completion (graduates) increased in 34.5% of the villages with the development projects\(^7\). This outcome proves a significant improvement over the changes in number of graduates in villages without projects (23.6%). It is surprised finding in the case of indicator: drop during the year in the

\(^7\) We define the change in the number of graduates in the village as a ratio of the number of graduates in 2006 and 2002.

match comparison, the number of pupils left school during the year 2000 increased in 6.3% of the villages with the development projects while it is only 3.1% of villages without the projects.

The changes in outcome indicators point to a positive long-term effects of the school development projects. In villages with projects, school enrolment rate increased by 5.8% between 2002 and 2006. Enrolment rate decreased in control group villages for both the matched and unmatched PSM estimation. However, the difference in changes in this outcome is significant at 10% level in the unmatched estimation (p=0.079) but only marginally significant in the case of matched estimate (p=0.112). Despite overall improvement in the objective schooling indicators, the development of schooling projects could not meet the expectation of the parent assessment of schooling condition with more percent age of villages have households show their unsatisfactory towards schooling condition in both treatment and control sample in both matched and unmatched estimates. The indicator expenditure on schooling suggests an increase in government spending on education.

Like the case of road development projects, effects of the school projects may be difficult to realize, but there are some sign of improvement as the positive indication of changes due to project: increase in enrolment rate, increase in graduate pupil and increase in number of pupils. All these positive changes could contribute to economic growth and then to people welfare as education is considered to be one of the most important determinants of economic growth.

6. Conclusions

The study assesses the impacts of infrastructure development, especially the development of school infrastructure and road infrastructure in rural Ngoc Hoi district of Kon Tum province. It evaluates the effects of various community-level projects on household welfare.
Our results show that the improvement in road infrastructure could lead to positive changes in household well-beings and socio-economic conditions as the results show increase in number of small and medium enterprises, the reduction in commuting time and increase in off-farm employment in the villages. For school development projects, the findings indicate that the improvement in school infrastructure produce important gains in school enrolment rate, raise school attendance.

Findings of this study would provide a very strong evidence for the government of Vietnam as well as some international donors like World Bank, IMF, ADB to consider spending moneys on rural and other less-privilege regions on basic infrastructures for education, road, health and water, etc. because the improvement in all infrastructure could help boosting economic growth, creating more employment and then improving household welfare in the targeted regions.

Table 1. Summary statistics for main outcome indicators (N=35)

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std.Dev.</td>
<td>Mean</td>
</tr>
<tr>
<td>All children are enrolled in school</td>
<td>0.582</td>
<td>0.526</td>
<td>0.671</td>
</tr>
<tr>
<td>Number of pupils</td>
<td>28.6</td>
<td>24.9</td>
<td>35.1</td>
</tr>
<tr>
<td>Number of graduates</td>
<td>0.8</td>
<td>0.61</td>
<td>0.9</td>
</tr>
<tr>
<td>School enrolment rate</td>
<td>0.735</td>
<td>0.068</td>
<td>0.816</td>
</tr>
<tr>
<td>Drop during the year</td>
<td>0.09</td>
<td>0.26</td>
<td>0.11</td>
</tr>
<tr>
<td>Unsatisfactory school condition</td>
<td>0.68</td>
<td>0.56</td>
<td>0.67</td>
</tr>
<tr>
<td>Expenditure on schooling b)</td>
<td>0.356</td>
<td>0.213</td>
<td>0.362</td>
</tr>
<tr>
<td>Subjective assessment of road</td>
<td>0.902</td>
<td>0.312</td>
<td>0.651</td>
</tr>
<tr>
<td>Travel time to district center</td>
<td>0.552</td>
<td>0.219</td>
<td>0.756</td>
</tr>
<tr>
<td>Number of small enterprises</td>
<td>0.061</td>
<td>0.059</td>
<td>0.072</td>
</tr>
<tr>
<td>Off-farm employment for adult</td>
<td>0.082</td>
<td>0.076</td>
<td>0.119</td>
</tr>
</tbody>
</table>

Note:

b) Expenditure on schooling refers to national budget spent on education.

Table 2. Difference-in-difference estimate of the average impact of road projects

<table>
<thead>
<tr>
<th></th>
<th>Unmatched sample</th>
<th>Matched sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment</td>
<td>Control</td>
</tr>
<tr>
<td>Subjective assessment of road</td>
<td>-0.361</td>
<td>-0.317</td>
</tr>
<tr>
<td>Travel time to district center</td>
<td>-25.19</td>
<td>-18.32</td>
</tr>
<tr>
<td>Number of small enterprises</td>
<td>0.028</td>
<td>0.015</td>
</tr>
<tr>
<td>Off-farm employment for adult</td>
<td>0.003</td>
<td>-0.001</td>
</tr>
</tbody>
</table>

Table 3. Difference-in-difference estimates of the average impact of school projects

<table>
<thead>
<tr>
<th></th>
<th>Unmatched sample</th>
<th>Matched sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment</td>
<td>Control</td>
</tr>
<tr>
<td>All children are enrolled in school</td>
<td>0.052</td>
<td>0.108</td>
</tr>
<tr>
<td>If number of pupils increased</td>
<td>0.316</td>
<td>0.238</td>
</tr>
<tr>
<td>If number of graduates increased</td>
<td>0.345</td>
<td>0.336</td>
</tr>
<tr>
<td>School enrolment</td>
<td>0.048</td>
<td>-0.006</td>
</tr>
</tbody>
</table>
Drop during the year   0.063  0.002  0.069  0.063  0.031  0.035
Unsatisfactory school condition  -0.217 -0.014  0.058 -0.217 -0.013  0.061
Expenditure on schooling         1.162  1.011  0.679  1.162  1.368  0.816

References


