Project design, village governance and infrastructure quality in rural China

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Abstract

Purpose – This paper aims to explain why the quality of infrastructure projects in rural China differs from village to village and how project quality is correlated with project design attributes and governance factors.

Design/methodology/approach – Using primary data collected by the authors on three types of infrastructure projects in villages across China, they created measures of project quality for each village. They then used both descriptive and multivariate approaches to examine how quality varies from village to village and factors correlated with quality.

Findings – Between-project within-village quality differences are small and project design has little explanatory power. Between-village variations are large. There are strong correlations between the ways villages govern themselves and project quality. The authors conclude that it is difficult to make good projects work in communities that lack good governance.

Originality/value – Disaggregated data on the quality of infrastructure (and its determinants) were collected by the authors to allow for variation in the type of infrastructure projects (roads, irrigation, and drinking water) and variation in village governance, making it possible to identify and contrast the effects of project design and village governance factors on project quality. As its chief contribution, this work identifies potential ways to improve the quality of infrastructure projects in rural development.

Keywords Quality, Project, Village, Infrastructure, Rural China, Project management, Rural areas, China

Paper type Research paper

In recent years, internationally, there has been a debate regarding what explains the differences in the quality of infrastructure that have been observed across regions around the world. For example, some scholars believe that project-specific characteristics are so important that appropriate project design can enable project to succeed in any

JEL classification – H41, H54, H71

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type of villages (Isham *et al.*, 1996; Khwaja, 2004). More recently, Olken (2007) found evidence that in Indonesia, the way an infrastructure project is monitored – a project-specific characteristic – matters in the creation of quality projects. In contrast, several village-specific factors have been forwarded in the literature as explanations for why infrastructure is of different quality across regions. For example, some studies have emphasized that sound governance may play a critical role in the success of public projects (World Bank, 1999; Easterly, 2002). Some scholars have emphasized the role of leadership (Casselli and Morelli, 2004) and have emphasized the role of certain dimensions of community heterogeneity (Romer, 2005). Other research has emphasized the roles of policy (World Bank, 2000). Obviously, whether good projects can succeed in communities that lack good governance, is still a debatable question.

A similar debate is ongoing in China. In fact, this debate – although not always framed in this precise way – is often centered on the question: what is the most important factor for assuring that a project that is built is of high quality – having a well designed project or implementing it in a well governed village? Wang (2006) and Zhao (2005), for example, stress the importance of:

- the type of procedure that is designed for soliciting project applications;
- the way that projects are designed; and
- how the progress of project implementation is monitored during construction.

A part of the literature also stresses the importance of keeping the ultimate user – in this case the local farm households – involved by creating ways to let them participate (another project design attribute) in the process (Guo, 2005; NDRC, 2006). Since China's funding agencies only formally monitor and evaluate a fraction of the projects that are implemented, it is important that upper level governments correctly design ways to initiate and implement infrastructure projects so that they can succeed in most of the villages in which they are implemented.

In contrast, another body of literature in China stresses that precisely because so little is expended on monitoring and evaluation that project design is not important (Lin, 2007). What is important is that projects are compatible with the interests of local residents, that projects have the participation in the process from local stakeholders and that the governing body (or bodies) of the community that is in charge of initiating, designing (or directing and approving the design) and implementing the project are legitimate, respected and function well. Other researchers emphasize the importance of having quality village governance, village leadership and other policies (Wu, 2006; Li, 2007; Liu *et al.*, 2009; Luo *et al.*, 2007, 2010). Although not stated in this way, we believe this body of work can be interpreted as saying that infrastructure projects can only succeed when they are implemented in villages with good governance.

While there has been considerable work debating the reasons that quality projects are found in some villages but not others (Guo, 2005; Zhao, 2005; Wang, 2006; Lin, 2007), most of these studies are anecdotes or case studies in nature. By contrast, there is almost a complete absence of empirical evidence on why the quality of infrastructure projects varies across communities. Almost certainly one of the major reasons for this paucity of empirical work is that disaggregated data on the quality of infrastructure (and its determinants) are rarely available, especially in developing countries. In fact, development economists have complained about the scarcity of disaggregated data when doing quantitative studies on the issues of public goods provision at the local level (Dethier, 1999; Bardhan, 2002). Empirical economists also have spent little time working with engineers who have long developed procedures for scoring and evaluating the quality of infrastructure projects (but who have little disciplinary interest in analyzing the determinants of quality across many different projects).

The overall goal of this paper is to measure the quality of infrastructure investments in rural China as well as to document the differences among projects and among villages in order to try to understand why the quality of infrastructure investments differs across space. We are particularly interested in analyzing the sources of the differences in the quality of projects by examining:

- whether or not the differences are due to project-specific characteristics (or henceforth, project design attributes); and/or
- whether or not the differences are due to village-specific (or henceforth, village or community governance) characteristics.

If it is found that project design attributes and/or village governance are driving the differences in the quality of infrastructure in rural China, we then want to identify which of the factors (which project design attributes or which facet of community governance) are most responsible for the differences. The ultimate goal is to answer the question, "Can good infrastructure projects succeed in villages that lack good governance?" Or, "Does community governance have to be improved before we can expect there to be a high quality infrastructure project – regardless of the initial design?"

The remainder of the paper is organized as follows. Section 2 presents the data used in this study. In Section 3 we focus on creating measures of project quality and then understand how quality varies across space. Section 4 uses descriptive approaches to examine whether the quality of infrastructure projects is correlated with project design attributes and governance factors in rural China. In Section 5 we review the empirical strategy that we will use. In Section 6 the results of multivariate analyses are discussed and the final section concludes.

Data

Our main empirical analysis draws information from the 2005 China Rural Governance Survey (2005 CRG Survey) undertaken by ourselves. In this survey, 100 villages were randomly selected from 50 towns in 25 counties from five provinces. The fieldwork team, made up of the authors and 30 graduate students and research fellows, chose the sample and implemented the survey.

The sample villages were selected according to a stratification procedure that included several steps. First, five provinces were each randomly selected to represent five of China's major agro-ecological zones: Jiangsu in the eastern coastal region; Sichuan in the southwest; Shaanxi in the northwest; Hebei in the central region; and Jilin in the northeast. Next, five counties were selected from each province, one from each quintile from a list of counties arranged in descending order of per capita gross value of industrial output (GVIO). GVIO was used on the basis of the conclusions of Rozelle (1996) which show that GVIO is one of the best predictors of standard of living and development potential and is often more reliable than rural net per capita income. Within each county, the survey team randomly chose two townships, one from each half of a list of townships arranged in descending order of per capita GVIO.

Finally, within each township, the survey team randomly chose two villages, following the same procedure as the township selection.

Four sets of variables from the 2005 CRG Survey were used in this study. These four sets of variables are used to measure project quality, project design attributes, project investment amounts and village governance characteristics (as well as other characteristics of the village).

Although villages in China invested in a variety of infrastructure projects (Luo *et al.*, 2006), we focus on three core infrastructure projects, roads/bridges, irrigation and drinking water. In our sample villages, these three types of projects account for more than half of total investment.

Quality of infrastructure projects in rural China

Data for measuring quality

We designed one block of the survey instrument to focus exclusively on the quality of investment. To collect the data on the quality of investment, two of the enumerators utilized an instrument that was designed by us in consultation with professional civil engineers to come up with a quality index for each project. Each evaluation form assessed two dimensions of each infrastructure project: an engineering dimension and a performance dimension. In attempting to describe each of these dimensions, we created a long list of project design attributes. Specifically, there were 40 attributes used on the form for each road project, 42 attributes for each irrigation project and 37 attributes for each drinking water project.

The form that we used to evaluate the quality of each core infrastructure project was created to look like a score sheet. A specific number of points were assigned to each attribute. The number of points was supposed to reflect the importance of the contribution of the attribute to the project's overall quality. For example, the depth of the road surface and the material used to construct the road surface was assigned 12.5 points (accounting for more than 10 percent of a road's quality). By contrast, the "line of the road," which was measured by the enumerator based on a visual inspection of "how straight" a road looks (or how symmetric the curves are), was only assigned four points. The number of points (or weights) was assigned this way because it was the opinion of our engineering consultants that the road surface was a more important factor in the quality of a road than whether or not the line of the road was straight or nicely curved. If a project's attributes all received full score, the score would add to 100[1].

Given the nature of any scoring exercise, we were quite concerned that, despite the effort put into creating the detailed evaluation form, there could possibly be a great deal of enumerator-specific subjectiveness in the assigning of scores to each attribute. To overcome this, we trained the enumerators intensively as a group, playing many "comparison games" that were designed to get every enumerator to assign the same (or nearly the same) number of points to each road's attributes when they were the same. We also created a detailed scoring manual that was used by each of the enumeration teams. Finally, the survey team took literally thousands of photographs of the projects. Using the photos, after the survey was completed we were able to look at the pictures of the projects and compare them against their scores. In this way, we were able to make adjustments to projects ex-post when they looked to be out of line with the projects that ranked immediately ahead and behind them.

Information about how the infrastructure project performed its function was also enumerated by the evaluation team. Households were randomly selected and asked about the performance and reliability of the roads, irrigation networks and drinking water systems. For example, in the case of roads enumerators asked the villagers how many days per year that a road was not usable (due to rain or mud or some other factor). Enumerators also asked if the flow of traffic was ever impeded because the road was too narrow or the surface impassable. In the case of the drinking water systems, enumerators used litmus test paper to test for acidity and glass test tubes to check for the clarity of water. As in the case of roads, enumerators also asked about reliability (e.g. how many months per year; days per month and hours per day did the drinking water system deliver water?). Enumerators also asked farmers about their perception of the irrigation system's reliability.

Constructing the measures

The most straightforward measure of quality that we created from our data, the raw score, was the simple sum of the scores of each of the project attributes. Therefore, the raw score ranged from 0 to 100. In some projects, however, the scope of work only involved a subset of the attributes of a project. In this case the project's score was standardized so it too ranged between 0 and 100 points. The standardization was accomplished by dividing the sum of the score given by the enumerators by the total number of points available for the attributes that were relevant to the project. For example, if an irrigation project only involved replacing the pump (worth 15 points if the attribute was judged to meet the criteria for a full score), intake gates (two points) and main head-works (eight points), the total possible points would be 25. Such a project would have nothing to do with the rest of the irrigation system (e.g. the tertiary canals, outlet gates to farmer fields and/or the drainage system – worth 75 points). Because of this partial nature, there was no way that points could be assigned for these other attributes. In such cases we standardized the score by dividing the sum of the points assigned to each of the relevant attributes by the total maximum number of points for the attributes (had they been given a full score). For example, in the case of the partial irrigation project, if the enumerator decided that the scores assigned to the three relevant attributes added to 20, score would be 20/25*100, or 80 points. In the rest of the essay we call this measure (which is the main dependent variable used in our analysis) the standard raw score.

Accounting for the "degree of difficulty". For a number of reasons, we believe the standard raw score measures may not always account for the complete context within which a project is designed and implemented. In other words, in some places projects are difficult to implement; in other places they are relatively easy. Some projects are simple in design; others are relatively complicated. In some places villagers and their leaders have to work hard to implement a project; in others they are given a "turn-key" operation and the villagers benefit from a project without any effort on their own collective account. As a consequence, it is possible that the standard raw score measure of quality is a function of either the environment of a village's infrastructure project and/or the complexity of the project[2]. In such a case the standard raw scores would not be comparable among all villages in our sample (in terms of being able to compare the ability of villages to implement quality projects).

Because of these concerns, we developed an alternative measure of quality. To create this measure, we began with the standard raw score of a project, and in the same way that an Olympic diving judge adjusts the score for the difficulty of the dive, we adjusted the investment project's quality measure for three elements:

(1) the degree of physical or geographical difficulty facing those charged with project construction;

(2) the complexity of the project; and

(3) the degree to which local residents participated in the design and implementation of the project.

In other words, we sought to make our measures of quality more sensitive to the context within which each project was designed and implemented. In the rest of the paper, the alternative measure is called the adjusted score. Compared to standard raw score, adjusted score has the advantage of being more comparable across villages.

Also in the same way that Olympic diving scores are created, the adjusted measure is created by applying additive weights to the standard raw score. Each of the three adjustment elements – one for physical/geographical difficulty; one for complexity; and one for local participation – ranged from 1 to 1.5. The higher the additive weight, the more physically challenging the terrain (or the more complex was the project or the more autonomous was the village's effort). Enumerators assigned weights on the basis of a criteria sheet that were also designed in discussions with our engineering consultants. Because standard raw scores (SRS) ranged between 0 and 100, adjusted scores (AS) of quality ranged from 0 to 450 ($AS = SRS*(1.5 + 1.5 + 1.5)$).

Quality of rural China's infrastructure projects

Regardless of our measure of quality, the 2005 CRG Survey data showed the quality of infrastructure projects in rural China increases slightly during the sample period. From 1998 to 2003, the standard raw scores of infrastructure projects increased from 70 to 74 (Table I). Similar results are found when using the adjusted scores. During the same time period, the adjusted scores increase from 262 to 272. Hence, using either the standard raw score or adjusted score measures, our approach to measuring quality does not support the conclusions of others (Yang *et al.*, 2005; Zhao, 2005; Huang and Xia, 2006) that claim quality was suffering during the recent period of investment expansion. Moreover, we find that the scores rise in provinces – although at different rates in different provinces when looking at the quality of infrastructure projects over time by province (Table I).

Examining the heterogeneity of infrastructure quality across space

In addition to the rising quality of infrastructure over time in rural China, the 2005 CRG Survey data show that, in general, there are differences in the quality of infrastructure

	Standard raw score		Adjusted score	
Starting year of infrastructure project	1998/1999	2003/2004	1998/1999	2003/2004
All sample	70	74	262	272
Jiangsu	70	75	248	267
Sichuan	65	71	237	263

Source: Authors' survey

Table I. Increase in the quality of infrastructure over time projects across our sample. In looking at different distributions of infrastructure projects, we see that while the standard raw scores of a typical infrastructure projects is 75 out of 100 points, some projects score as low as 30 points whereas others score as high as 96 points. The large variation in the quality of infrastructure projects is obvious when examining the shape of the distribution of standard raw scores (Figure 1, Panel A). Similarly, large variations in the quality of infrastructure investments can be observed when examining the distribution of adjusted scores (Appendix Figure A1, Panel A).

Variations in the quality of infrastructure projects are even greater when we examine the distribution of standard raw scores by project type. For example, when we look at roads, the most common type of core infrastructure projects in our sample, while the standard raw score of a typical road is 76 points, some road projects can score as low as 40 points whereas other roads score as high as 95 points. As was documented in the Ministry of Communications communiqué (MoC, 2007), the scatter plot of standard raw scores of road projects demonstrates the heterogeneity in the quality of roads across villages (Figure 1, Panel B). Our descriptive analysis also shows considerable differences in the quality when examining the other two types of core infrastructure projects. Specifically, irrigation projects in our sample have an average standard raw score of 69 points with a wide range from 28 to 92 points. For drinking water projects, the average standard raw score is 78 points with a range from 46 to 95 points. These heterogeneities are well illustrated by the distributions of standard raw scores (Figure 1, Panel B) as well as the adjusted scores (Appendix Figure A1, Panel B) of each of the three types of core infrastructure projects.

A further breakdown of the data demonstrates that there are systematic patterns to the raw variations documented above. For example, our descriptive statistics show that there are systematic differences among regions. While the standard raw score of a typical infrastructure project is 89 out of 100 points in rural Jilin, it is only 65 points in rural Shaanxi. The standard raw scores of the other sample provinces are 76 points for Jiangsu; 74 points for Hebei and 71 points for Sichuan. In addition, within provinces there are also substantial differences in the quality of infrastructure among the sample villages. According to our data, in Hebei province, while the standard raw score of a typical infrastructure project is 74 points, it ranges as widely as from 28 points to 92 points (Figure 1, Panel C). The ranges in the other provinces are similar (e.g. 36-96 points in Sichuan; 44-96 points in Shaanxi)[3].

Descriptive analysis

In total there were two special parts of the survey that measured project design attributes. Both parts of the survey focused exclusively on each village's core projects (i.e. roads, irrigation and drinking water). If a village implemented more than three core projects during the sample period (1998-2004), three projects were randomly chosen. This was the case in two of our villages. In seven villages there were exactly three core projects. There were only two core projects in 36 villages; and in 55 villages there was only one or zero core project.

After the core projects of interest were identified, enumerators asked the village leader a series of questions about each project's design attributes. The content of the survey covered:

- scope of the project;
- project initiation and application;

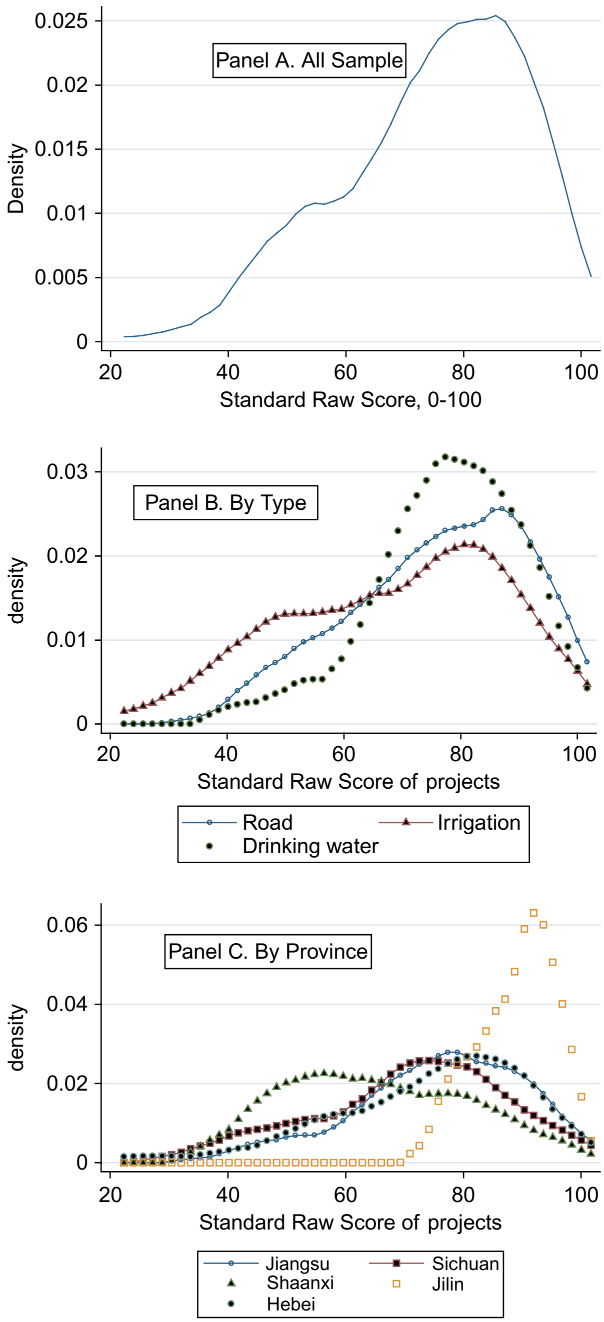

Figure 1.
Distribution of the quality of infrastructure projects, standard raw score

- project design; and
- project implementation and monitoring.

Scope of the project. Enumerators asked questions about the exact date of execution of the project from project initiation until its completion (project age), the total expenditures on the project (measured in yuan – total project expenditure), the sources of the funding (which was divided into three types – solely from above; solely from the village; and jointly funded), and the size of the project in physical terms (e.g. kilometers of road)[4].

Initiation and application of the project. Information collected on this dimension included who initiated the project (local residents or upper level governments), who applied for the project (no application; applied for by upper level government; and applied for by the village administrative committee and the village Communist Party committee, henceforth, two committees)[5]. We also elicited information about whether other villages were competing and applying for the same type of project when our sample village was applying[6].

Project design. Enumerators asked questions about who designed a project. The answers to this question included: the village leadership (or the village's two committees); an official from an upper level government unit; or some other entity, such as a contractor. These answers allowed us to create two dummy variables, one indicating whether a project was designed by the village leadership (committee design) and another variable indicating whether a project was designed by an official from an upper level government unit (government design).

Project implementation and monitoring. The information collected for this category of project attributes (who implemented the project; and who monitored the project) included information collected from several different actors in the local economy. In trying to understand who actually implemented the project, we surveyed the villagers themselves as well as government officials. If the villagers were in charge of implementation by themselves, we created a variable called villager implementation (equals to one if the villagers implemented the project by themselves; zero otherwise). If the government implemented the project by themselves (without the help of villagers), we created a variable called government implementation (equals one if only the government implemented the project; zero otherwise). The other category of implementation included joint implementation or those projects that were implemented jointly by both villagers and government officials.

We also asked villagers and government officials about monitoring of the projects. In the same way that we created two variables about project implementation, we created two variables about monitoring. If the villagers were in charge of monitoring by themselves, we created a variable called villager monitoring (equals to one if the villagers monitored the project by themselves; zero otherwise). If the government monitored the project by themselves (without the help of villagers), we created a variable called top-down monitoring (equals one if only the government monitored the project; zero otherwise). The other category of monitoring (which was the excluded category) included joint monitoring or those projects that were monitored jointly by both villagers and government officials.

In another independent part of our survey two of the enumeration team members were assigned to carry out a survey that sought information on project design attributes from the villagers themselves. We added this survey because, while village leaders were familiar with all of the projects (and, we believe, generally answered honestly and accurately), we were worried that in the case of some questions there might be a tendency to exaggerate (such as, when asked about the extent to which they – as village leaders and project leaders – involved farmers in the decision making process). We also were concerned that village leaders might purposely avoid telling enumerators about failed projects. To get the input of villagers, eight households were randomly selected from each village. In total, 800 households were interviewed in the 100 villages. In addition to the attributes of each project, we also asked whether or not a household participated in a project, which allowed us to create a variable (household participation) that was generated as the proportion of the eight households whose opinions were sought about the project (e.g. if two of the eight sample households participated, the value of the variable for that village would be 0.25). Household members were also queried about their contribution of in-kind labor (days per household per project – household labor contribution). In the rest of the analysis we are going to categorize these household variables as project implementation characteristics and include them together with variables measuring project implementation characteristic using information from the village leader survey. The definition, mean and standard deviation of each of the project design attribute variables are presented in Appendix Table AI.

Data for capturing village governance and other characteristics

The village governance part of the survey generated five types of village governance variables:

(1) village governance (*per se*);
(2) variables measuring the nature of the village leadership;
(3) variables measuring the policy environment in which the village was operating;
(4) variables measuring the intensity of the connections that villages had with the policy officials outside of their village; and
(5) other village characteristics.

Village governance. After creating a list of all leaders that had been in office since 1991, we asked how each leader took office – by direct election or by appointment. As it turned out, answering this question and creating a variable was complicated. In some villages leaders were directly elected by villagers through ballots. If this occurred, and if there were at least two candidates for the position, these village leaders were said to be "elected by direct election." In other villages leaders were either appointed by the village committee or nominated by the villager representative body or directly appointed by officials from the township government. Such village leaders were deemed "appointed." In our analysis, we used these definitions to create a dummy variable called directly elected, which was equal to 1 if a village's leader was directly elected and equal to 0 if appointed.

Nature of village leadership. The questions to elicit information on the nature of the village leadership mostly focused on two of the village's most important leaders – the elected or appointed "village leader" (who heads the village's administrative committee) and the village party secretary (who is the head of the village's Communist Party committee). Enumerators collected information about the exact dates in which each leader acceded to his/her office and the exact date in which he/she left office, each leader's age (leader age – in years), his or her level of education (leader education – in years), the job that he/she held before taking office (leader job which was measured as a dummy variable equaling 1 if the leader was a full-time farmer before accession to office and 0 otherwise), the experience that he/she had held in the village before taking office (leader experience – in years), and whether or not he/she was party members of the Communist Party (100 percent of party secretaries, of course, were; 76 percent of village leaders were)[7]. In total we used these data to define nine village leadership variables – five for the village leader and four for the party secretary.

Policy environment. Information on the policy environment included the exact date of the start of Tax for Fee reform in each village and the number of regulations through which the township government managed its villages in terms of fiscal management and administration. The following three policy variables were created: a dummy variable indicating whether a project was started before the start of the Tax for Fee reform (before tax for fee); an index measuring the intensity of regulation by upper level officials over villagers (administrative regulation index); and an index measuring the degree of financial oversight exercised by upper level officials over villagers (fiscal regulation index)[8].

Connections of the village with cadres outside the village. Enumerators asked village leaders how many villagers who were born and raised in the village were currently working as cadres in township or county government agencies (outside of the village). With this information, we created a variable (measured in the number of people, 1, 2, 3, etc.) to measure the intensity of connections that villages had with the leadership outside of their villages (connections).

Basic village characteristics. Basic village characteristics were also collected and used to create the following six variables: the amount of land available for cultivation in each village (per capita land), the proportion of households with family businesses (business households), the proportion of households that had at least one member in the migrant labor force (migrant households), the level of debt that a village owed – on a per capita basis (per capita debt), the proportion of the village's total population that belonged to an ethnic minority (minority population) and the distance (in kilometers) from the office of the village committee to the township seat (remoteness). The definitions, means and standard deviations of these village governance and other characteristics are presented in Appendix Table AII.

Do project design attributes correlate with quality?

In order to examine whether or not project design attributes have any impact on the quality of infrastructure projects in rural China, we first examine descriptive relationships between some of these variables and the quality of infrastructure projects. We have carried out this descriptive analysis using both standard raw scores and adjusted scores. In briefest terms, our results are robust to the choice of dependent variable; the results are essentially the same using either of the measures. For brevity, we will discuss the results using standard raw scores only.

Interestingly, few descriptive cross tabulation statistics between the quality of infrastructure projects and project design attributes can be identified as indicating that there is either a positive or negative relationship. One exception, and the most prominent project design attribute that is correlated with infrastructure quality in our descriptive statistics, is investment size. When examining the relationship between investment size and the standard raw score of a project, there is a clear pattern. As projects move from the lowest quartile (when projects are ranked in terms of thousands of yuan) to the highest quartile, the standard raw score of the project ranges from 67.5 to 84.8 points (Table II, Section 1).

Project scope (1)	Lowest quarter	Mid-low quarter	Mid-high quarter	Highest quarter
1. Total project expenditure	67.5	70.4	76.2	84.8
2. Project age	77.6	70.6	76.0	72.7
Project scope (2)			*No*	*Yes*
3. Village funded only			76.7	72.5
4. Above funded only			74.5	75.5
Project initiation and application			*No*	*Yes*
5. Government initiation			73.0	79.9
6. Committees application			76.9	72.5
7. Government application			72.4	83.0
8. Competitive application			73.1	76.1
Project design			*No*	*Yes*
9. Committees design			76.5	71.9
10. Government design			72.9	77.4
Project implementation and Monitoring			*No*	*Yes*
11. Committee leading implementation			79.2	71.5
12. Villager implementation			77.2	65.8
13. Government implementation			70.0	79.0
14. Top-down monitoring			72.4	80.1
Farmer participation	*0*	*0-1/3*	*1/3-3/4*	*> 3/4*
15. Household participation	73.7	74.5	76.1	74.9
16. Household labor contribution	76.8	74.8	72.2	66.5

Source: Authors' survey

Table II. Cross tabulations between project design attributes and standard raw score

This pattern suggests that, at least according to these descriptive findings, one of the reasons that infrastructure projects are of different quality may be due to the investment size. A locally weighted regression and smoothing scatter plots (or LOWESS) nonparametric analysis of the relationship (Figure 2) shows the same pattern. There are, of course, two (not necessarily competing) explanations for these findings. One is that there is some sort of quality-economies of scale. The other is more simply that quality is expensive.

Surprisingly, when looking at the relationship between project design attributes and quality in the rest of our data, we find few other cases of obvious patterns of positive or negative correlation. For example, when examining the cross tabulations between measures of farmer participation and the quality of infrastructure projects, we find little pattern to the data in the descriptive statistics (Table II, Sections 15 and 16). This absence of correlation suggests that policies of trying to improve the quality of infrastructure projects through increasing farmer participation in the investment process may not work – at least in the core projects of our sample areas. In fact, when looking at the descriptive patterns between variables that are measuring project scope and quality (Sections 1-4); variables that are measuring project application and initiation and quality (Sections 5-8); variables that are measuring project design and quality (Sections 9-10); and variables that are measuring project implementation and monitoring and quality (Sections 11-14), there is no apparent pattern among most of the variables. At least according to our descriptive data, with the exception of a finding that suggests more expensive projects do buy quality, we are finding little evidence that project design attributes can make a project succeed.

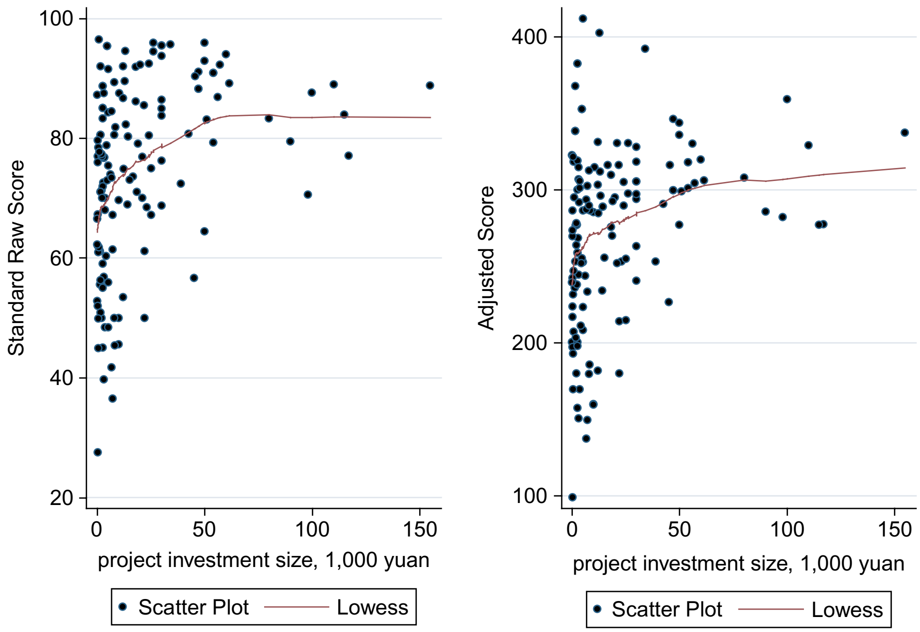

Figure 2.
Nonparametric relationship between investment size and quality of infrastructure projects, standard raw score

Do village governance variables correlate with quality?

Descriptive analysis shows that one of the village governance characteristics – the measure of direct elections – is correlated with the quality of infrastructure projects[9]. When comparing the quality of infrastructure projects between villages with directly elected leaders and those with appointed leaders, we see a positive relationship (Table III, Section 1). As projects move from villages with appointed leaders to those with directly elected leaders, the standard raw score of the project ranges from 72.9 points to 75.4 points. This rise suggests that village governance may be related (at least a little bit) with the observed variation in the quality of infrastructure projects.

In contrast, when examining the relationship between the number of fellow villagers who were born and raised in the village but work in government agencies (at the township or county level), there is a surprising pattern to the data. As villages move from having no villagers to having more than five fellow villagers work in government agencies, the standard raw score actually fell from 77.5 to 70.4 points. While this was hard to explain ex-ante, during interviews with village leaders, we heard that although connections might help villages get more projects from above to invest in infrastructure, it does not necessarily help villages build better quality infrastructure. When asked why, village leaders sometimes said that cultivating and fostering connections takes up so much time, resources and effort that they do not have enough time and efforts to build better projects (or that their connections do not always come through with any more than trivial funding – forcing villages to cut corners during implementation). If this is true, this suggests that when villages try to improve the quality of their infrastructure through informal connections, in the final analysis it might turn out to undermine infrastructure quality[10].

Village governance	*No*	*Yes*		
1. Directly elected	72.9	75.4		
Village leadership	*< 31 years*	*30-40 years*	*40-45*	*> 45*
2. Leader age	79.4	75.4	72.6	74.0
3. Secretary age	73.5	76.1	71.0	75.7
	< 7	*7-9*	*10-12*	*> 12*
4. Leader education	78.2	73.9	73.1	83.5
5. Secretary education	73.5	74.4	75.7	69.0
	No	*Yes*		
6. Leader job	78.0	69.7		
7. Secretary job	77.1	68.8		
8. Leader experience	75.5	74.1		
9. Secretary experience	74.3	74.6		
10. Party member	75.1	74.4		
Policy environment	*No*	*Yes*		
11. Before tax for fee	75.4	72.2		
	< 1	*1*		
12. Administrative regulation index	73.1	76.8		
13. Fiscal regulation index	70.7	76.6		
	0	*1-2*	*3-5*	*> 5*
14. Connection	77.5	75.1	75.4	70.4
Other characteristics	*Lowest quarter*	*Mid-low quarter*	*Mid-high quarter*	*Highest quarter*
15. Per capita land	70.6	75.1	77.2	75.7
16. Business households	70.3	73.0	77.4	77.9
17. Migrant households	74.7	72.4	76.6	74.5
	0	*0-30*	*30-100*	*> 100*
18. Per capita debt	74.5	72.0	71.0	80.0
	0	*0-0.25*	*> 0.25*	
19. Minority people	71.0	74.4	85.7	
	< 2	*2-4*	*4-6*	*> 6*
20. Remoteness	76.6	78.8	70.9	73.4

Source: Authors' survey

Table III. Cross tabulations between village governance characteristics and standard raw score

In addition to direct elections and connections, our descriptive data show clearly several village characteristics also are associated with the quality of infrastructure. In particular, projects from villages with fulltime-farmer-turned leaders tend to have lower quality than those otherwise (Table III, Sections 6 and 7). By contrast, projects from villages with more self-employed private entrepreneurs have slightly better projects (Section 16). While there are a number of reasons why such patterns may emerge, they also are consistent with story in which those with economic interests in running self-employed business welcome better quality infrastructure.

Multivariate analysis: models and estimations

To more convincingly identify whether project design attributes can affect the quality of infrastructure projects, we use a series of regression exercises. To implement this strategy, we begin with the baseline empirical specification:

$$Q_{ij} = a_0 + a_1 PDA_{ij} + \varepsilon_{ij} \quad (1)$$

where Q_{ij} denotes the quality (standard raw score) of project j in village i. *PDA* is a vector of project design attributes, which is composed of the 16 attributes that are categorized into variables measuring project scope; project application and initiation; project design, and project implementation and monitoring. The terms a_0 and a_1 are parameters to be estimated and ϵ is the error term. The parameter a_1 measures the relationship between *PDA* and *Q*. In the initial run of the regression, we use an ordinary least squares (OLS) estimator. Throughout our analyses, we also include two project type dummy variables to capture the difference among the three types of core infrastructure projects (roads and irrigation with drinking water as the base).

We recognize that there are a number of variables at the community level that might be correlated with both project quality and project design attributes. For example, any variable measuring how functional local village governance is (e.g. whether the village is well-run from a leadership point of view or not) might be one reason that projects are high (or low) quality. Leaders that are responsible for well-run villages might also be responsible for the particular design of a village's project. In such a case, any measured positive effect of project design attributes might be due – at least in part – to the nature of the village's governance and not solely due to the project design attributes. In contrast, it could be that when villages are well run (poorly run), upper level leaders put fewer (more) demands on the village leadership and simply allow them to execute their projects without a formal or comprehensive set of plans (with a more strict set of project design attributes) for the project. In this case, the correlations with these village governance characteristics might be obscuring an otherwise positive relationship between project design attributes and quality. As a result of the possible effect of unobserved community governance characteristics on the measured coefficients in equation (1), we also will estimate:

$$Q_{ij} = a_0 + a_1 PDA_{ij} + \mu_{ij} + \varepsilon_{ij} \quad (2)$$

where all of the variables and parameters in equation (2) are the same as those in equation (1) except that we have added village fixed effects denoted by μ_i. In specific, μ_i is a vector of 86 village dummy variables – one for each village in our sample that has at least one core infrastructure project delivered to their village during the study period. We include μ_i to hold constant all community level (and above) effects. The results of the parameter estimates of equation (2), in fact, should provide us with a set of convincing findings on the causal relationship between project design attributes and quality. The estimated coefficients will be reflecting the within-village variation of project quality that are due to the within-village variation of project design attributes and will not be affected by any village governance factors (in our sense of the term – that is, any other village-specific factors).

To more convincingly identify what village governance characteristics can affect the quality of infrastructure, we begin with the baseline empirical specification:

$$Q_{ij} = a_0 + a_1 PDA_{ij} + a_2 VGC_i + \varepsilon_{ij} \quad (3)$$

where all of the variables and parameters in equation (3) are the same as those in equation (1) except that we have added a vector of village governance characteristics denoted by VGC_i and, a_2, a vector of parameters associated with VGC_i. In specific, VGC_i, is a vector of 20 village governance variables that we defined at the previous section[11]. The results of the parameter estimates (a_2) of equation (3) should at least provide us with a set of findings that describe the correlation between village governance characteristics and infrastructure quality.

Accounting for the endogeneity of direct elections

While in the first step of our strategy, we ignore the possible presence of endogeneity, it is possible that the coefficient on the direct election variable is biased from several sources[12]. In order to account for the endogeneity of the direct election variable, in the second step of our strategy, we adopt an instrumental variable (IV) approach. While the village has considerable authority over and plays a role in deciding how its leaders are elected, policy also plays a role. Our strategy relies on the assumption that election rules and effort exerted by the part of the township/county government responsible for managing village elections will have some effect on the propensity of the village to elect its leader. There is no reason to believe, however, that the effort of this part of the township/county government apparatus will have any independent effect on the quality of infrastructure quality.

To measure the effect of the township government on the election process we use two variables from our data. During the survey, enumerators asked local officials and villages whether or not the township election committee had a rule about whether or not the slate of village candidates needed to have the official approval of township leadership. Our logic is that such a rule may increase the probability that there be an appointed village leader since the township government election committee is taking control away from the village and reducing the choice (decision-making powers) of the village. In other words, when this rule is in place it gives upper-level officials more control over the election and will diminish the interest of villagers in the election process, which will increase the probability that they will not be willing to go through the time-consuming procedure (and the village will end up with an appointed leader). Control over the nomination process also was often a way in which the township could directly appoint a leader (by approving one candidate but not the other – which essentially left only one candidate on the ballet – a township appointee). Of the elections that were held in our sample villages, 71 percent of the nomination slates in the villages were subject to the approval of the township.

Enumerators also asked the township informant how many official meetings were convened to plan village elections. Specifically, they made a count of the number of meetings in each village that were attended by both township/county officials and village leaders during the period of time between the official notification of a new round of elections (which came down from the county's bureau of civil affairs) and the day of the election. The logic of this variable is that the more meetings that were held, the more closely the village would have to follow county election protocol (which was designed to end in a successful direct election). On average, township and county officials held 5.89 meetings, ranging from two to 32. The correlation coefficient between the number of meeting variable and direct election also was significant at the one percent level.

Results: can projects be designed to work in any villages?

The most striking finding after running the regressions according to our empirical strategy is that there is little effect of the project scope, project application and initiation, project design or project implementation on project quality. Even when running the OLS version of the model (equation (1)) only two out of the 32 coefficients are significantly different than zero (Table IV, Columns 1 and 4). This is true when we use either the standardized score or the adjusted score. The lack of significant findings using the basic OLS version of the equations makes the multivariate versions of the analyses consistent with the descriptive findings that were discussed above.

	Dependent variable: quality score of projects					
	SRS			AS		
	OLS (1)	Village dummies (2)	Fixed effects (3)	OLS (4)	Village dummies (5)	Fixed effects (6)
Project scope						
1. Total project expenditure	0.013	0.018	0.018	0.057	0.085	0.085
	(3.13)***	(1.52)	(2.09)**	(3.64)***	(1.83)*	(2.45)**
2. Project age	0.028	0.080	0.080	−0.045	0.193	0.193
	(0.55)	(0.57)	(0.68)	(0.24)	(0.35)	(0.40)
3. Village funded only	0.502	−2.237	−2.237	−10.810	−17.904	−17.904
	(0.16)	(0.37)	(0.39)	(0.89)	(0.68)	(0.76)
4. Above funded only	1.292	2.029	2.029	17.672	6.550	6.550
	(0.30)	(0.25)	(0.23)	(1.01)	(0.19)	(0.18)
Initiation and application						
5. Government initiation	−3.015	−11.092	−11.092	−14.602	−44.682	−44.682
	(0.75)	(1.28)	(1.63)	(1.05)	(1.27)	(1.59)
6. Committees application	−0.792	−1.490	−1.490	−8.263	−29.159	−29.159
	(0.21)	(0.16)	(0.22)	(0.58)	(0.70)	(1.02)
7. Government application	5.458	5.523	5.523	13.999	−11.744	−11.744
	(1.15)	(0.49)	(0.66)	(0.80)	(0.25)	(0.34)
8. Competitive application	−2.384	4.889	4.889	−10.695	12.188	12.188
	(0.87)	(0.58)	(0.77)	(1.05)	(0.37)	(0.47)
Project design						
9. Committee design	1.614	2.075	2.075	−1.879	9.112	9.112
	(0.45)	(0.23)	(0.26)	(0.13)	(0.25)	(0.27)
10. Government design	1.819	3.514	3.514	1.042	18.645	18.645
	(0.53)	(0.53)	(0.50)	(0.08)	(0.66)	(0.64)
Implementation/monitoring						
11. Village leading implementation	−3.672	−4.435	−4.435	−3.160	−5.666	−5.666
	(1.23)	(0.60)	(0.68)	(0.29)	(0.19)	(0.21)
12. Villagers implementation	−5.213	7.727	7.727	−16.719	34.646	34.646
	(1.24)	(0.68)	(0.90)	(1.06)	(0.72)	(0.98)
13. Government implementation	4.023	4.439	4.439	4.939	21.995	21.995
	(1.35)	(0.52)	(0.65)	(0.41)	(0.65)	(0.79)
14. Above government in charge of project monitoring, 1 – yes	1.794	−5.716	−5.716	−6.464	−23.718	−23.718
	(0.54)	(0.58)	(0.76)	(0.54)	(0.64)	(0.77)
Farmer participation						
15. Household participation	2.901	2.471	2.471	27.735	34.509	34.509
	(0.56)	(0.13)	(0.16)	(1.29)	(0.43)	(0.56)

(*continued*)

Table IV.
Impacts of project design attributes on infrastructure quality

	Dependent variable: quality score of projects					
	SRS			AS		
	OLS (1)	Village dummies (2)	Fixed effects (3)	OLS (4)	Village dummies (5)	Fixed effects (6)
16. Household labor contribution	−3.660	−6.155	−6.155	4.631	−35.874	−35.874
	(0.59)	(0.43)	(0.44)	(0.21)	(0.60)	(0.63)
Project type						
Road project	5.352	4.997	4.997	18.446	16.841	16.841
	(1.41)	(0.77)	(1.03)	(1.38)	(0.65)	(0.85)
Drinking water project	9.085	11.951	11.951	46.895	55.807	55.807
	(2.20)**	(1.17)	(1.62)	(2.82)***	(1.19)	(1.84)*
Constant	67.164	55.265	63.764	257.176	208.785	244.364
	(10.68)***	(3.73)***	(6.60)***	(9.81)***	(3.31)***	(6.15)***
Number of village dummies		87			87	
R^2	0.28	0.80	0.38	0.25	0.75	0.40

Notes: Significant at: *10, **5 and ***1 percent; robust *t*-statistics in parentheses; there are 143 observations
Source: Authors' survey

Table IV.

Even more importantly, since we believe we have convincingly controlled for endogeneity and have a credible identification strategy, the same overall conclusion can be drawn from the multivariate analysis when we run a village fixed effects model from equation (2). In general, project design attributes do not seem to have much explanatory power on the differences in quality among projects within the same villages (Table IV, Columns 2-3 and 5-6). Out of the 96 coefficients in Table IV, only eight of them are statistically significant (and the coefficient of only one of the variables – total project expenditure – is statistically significant in 5 of 6 Columns, a point which we will discuss more below). Most importantly, in Table IV, with the exception of the coefficient on the total project expenditure variable, none of the coefficients is significant. Hence, especially when we account for village fixed effects, it would appear that any effort or time spent in trying to design projects in a way that will ensure project success might well be wasted (at least so far in rural China and at least in our sample villages).

Total expenditure and quality

There is only one prominent exception in our analyses. The coefficient on the project total expenditure variable is positive and statistically significant in all of the models that we have run (Row 1, Table IV). The total amount expended on a project appears consistently to be associated with its quality, a result that is also consistent with what we found in the descriptive analysis. The direct interpretation of this coefficient is that larger projects are higher quality. While we explore more the meaning of this coefficient in the next paragraph, there is a possible effect that could have potential policy implications. If the results show that the variable is measuring some economies of scale effect, government officials who want to improve project quality might consider scale (that is doing larger projects) when they are designing and allocating infrastructure investment funds[13].

The problem with understanding the exact meaning of the coefficient on the total project expenditure variable in Table IV is that we used "value" (measured in yuan) for the metric of this variable. Therefore, it is impossible to know if this variable is capturing some pure economies of scale with respect to quality or if it is simply that more funding buys higher quality. To try to distinguish between these two interpretations, we focus on the subset of villages that invested in roads since we are able to include a physical measure of roads (in kilometers – project physical size)[14]. Using this variable (together with total project expenditure), we can seek to isolate the true "economies of scale" effect from the "price" effect.

When seeking to "decompose" the coefficient of the total project expenditure into its component parts, we find that whether we control for project physical size or not, the coefficients on the total project expenditure variable are exactly the same (Appendix Tables AIII and AIV, Columns 1 and 2). This is true whether we do OLS or village fixed effects. One interpretation of this is that, holding the economies of scale constant (which do NOT affect project quality), the greater the total expenditure, the higher the quality. In simplest terms, this would imply that what we are observing is purely a price effect. If those involved in the investment project are willing to spend more money (given everything else held constant – including the size of the project), the project is of higher quality. While somewhat interesting, the direct policy implications are fairly limited except to note that there is no easy way to get higher quality by project design other than allocating more funds.

So do project characteristics matter? Notwithstanding the impact of project size (which is not really a project design attribute in the strictest sense of the word), we believe it is safe to conclude – at least in our sample villages – the ways that projects are initiated, designed and implemented – do not have a significant effect on project quality. This means, of course, that policy makers (or those in charge of implementing quality projects) are not going to be able to rely on project design to meet their quality goals. For the researcher, it raises another puzzle. If project design attributes are not behind the observed variation in project quality, what is? We continue to examine this question below.

Within-village or between-village? Decomposing variations in project quality

To seek a better understanding of why project characteristics do not seem to have a large explanatory effect on quality, in this subsection we perform a number of empirical exercises to try to identify if most of the variation in project quality is coming from within-village or between-village variations. The logic of trying to do so is related to the fact that we are not finding a lot of effect of project design attributes on project quality. If only a small share of the variation is among projects within villages, it may not be surprising that project design characteristics do not matter and may point to other sources that might be the driving forces (e.g. village governance characteristics).

The first exercise is carried out by running two sets of regressions. In fact, the first set of regressions is essentially a village fixed effects model and we report the results in Table IV. In this regression, we are explaining project quality as a function of project design attributes (which attempt to account for the part of the total variation in project quality that is a function of within-village variation), while holding all other village-specific characteristics (or all between-village differences) constant by including a set of village dummy variables. The second set of regressions is identical to the first set except that we drop all of the project characteristics. In other words, in the second set of regressions we regress project quality on a set of village dummies and nothing else. By comparing the goodness of fit of the two sets of regression, we can learn something about the relative importance of between-project/within-village variability and between-village variability.

Table V provides a summary of the goodness of fit statistics for these two sets of regressions. It is clear from the analysis of the goodness of fit statistics that when project design attributes are included and when project design attributes are not included, the goodness of fit changes relatively little. Even though 16 project design attributes are dropped, the R^2 only falls by an average of 0.12 points for the equations that use standard raw scores as the dependent variable (and by 0.15 for those that use adjusted scores as the dependent variable). When we run an F-test of the joint significance of the project characteristics, we find that they are not significant (when we exclude the project size variable)[15].

In addition, we also performed an alternative variation decomposition analysis. To implement this analysis, we use the "ineqdeco" package in Stata and repeat the empirical exercise using a number of different measures (including six types of decomposable measures of variation – three types of generalize entropy classes of measures and three types of Atkinson class measures). In undertaking this analysis, we are able to demonstrate that from 64 percent (64.3) to 72 percent (72.1) of the total variation in project quality is due to between-village differences (Table VI).

Table V. Summary of goodness of fit from alternative specifications

Specifications	Goodness of fit (R^2) Standard raw score equation	Adjusted score equation
Project design attributes only	0.28	0.25
Project design attributes + village FE	0.38	0.40
Project-specific characteristics + village dummies	0.80	0.75
Village dummies only	0.68	0.60

Source: Authors' survey

Table VI. Decomposition of infrastructure quality differences, between-village difference versus within-village difference

Difference measure	Over-all difference (1) = (2) + (3)	Between-village difference (2)	Within-village difference (3)	Between as a percentage of overall (4) = [(2)/(1)]*100
GE(0)	0.0249	0.01601	0.00889	64.3
GE(1)	0.02266	0.01502	0.00763	66.3
GE(2)	0.02116	0.01433	0.00684	67.7
A(0.5)	0.0118	0.00796	0.00387	67.5
A(1)	0.0246	0.01694	0.00779	68.9
A(2)	0.05354	0.03862	0.01552	72.1

Notes: GE(a) is the generalized entropy class whereas A(a) is the Atkinson class A(a); GE(0) is the mean logarithmic deviation, GE(1) is the Theil index, and GE(2) is half the square of the coefficient of variation
Source: Authors' survey

Do village governance and other characteristics matter?

In this sub-section we try to go beyond knowing if village factors (again: henceforth known as village governance factors, for the sake of brevity), in general, are important and, if they are important, seek to identify which factors matter in terms of project quality. The results of the multivariate analysis using specification (equation (3)) demonstrate that the model which controls for both village governance characteristics and project design attributes performs relatively better than the model with only project design attributes. For the version of the model that uses standard raw scores as the dependent variable, the goodness of fit measure, the R^2, increases from 0.28 to 0.47; it increases from 0.25 to 0.39 for the version of model that uses adjusted scores as the dependent variable (Table VII). The coefficients on most of the project design attributes are consistent with what were estimated in equation (1) where only project design attributes are controlled for (i.e. almost none of them were significant).

By far the most important finding is, unlike in the case of project design attributes, there are some effects of village governance variables on project quality. One of the most important findings in Table VII is that direct elections matter in explaining the observed variation in infrastructure quality. In particular, the coefficient on the directly elected dummy variable is positive and significant under OLS regression (Table VII, Row 1). This is true when we use either the standard raw score or the adjusted score. If this finding stands up to more rigorous identification, we can say that direct elections help improve the quality of infrastructure projects in rural China.

In addition to the direct election variable, some control variables at the village level also are significant. For example, the coefficients on the variable measuring the intensity of connections that exist between a village and the government outside the village are significant in almost every one of the multivariate exercises (when using equation (3) – Table VII, Row 14). In particular, projects undertaken in villages that have more connections in government agencies outside the village tend to be of lower quality. This is true when we use standard raw score or adjusted score. As discussed above, one possible explanation might be that village leaders that rely on connections are unable to spend enough time on the design and implementation of the projects[16].

Results from instrumental variable approach

In contrast to what we found in the OLS regressions, the estimated coefficients of the direct election variables in the infrastructure quality equations, although positive in sign in both regressions, are not significant in the IV regressions (Table VII, Row 1). This means that after controlling for the endogeneity of the election process, there appears to be little effect of direct elections on the quality of infrastructure projects, at least in our sample villages. It is also worth noting that the coefficients of the other control variables that were significant in the baseline OLS regressions continue to be significant in the IV regressions. Thus, although we show that between-village variation is more important than within-village variation, we are unable to show that this between-village variation is being caused by village governance. We do find a strong correlation between village governance and infrastructure quality – based on both the descriptive statistics and the OLS regressions. Unfortunately, we were unable to convincingly identify the effect using our IV approach. There are two explanations of this. One is that, in fact, there is no relationship and the observed correlations are being caused by some unobserved factors that are correlated with both village elections and project quality (which is removed

	Dependent variable: quality score of project			
	OLS		IVs	
	SRS	AS	SRS	AS
Village governance				
1. Directly elected	5.689	25.011	13.915	97.772
	(1.76)*	(1.96)*	(0.69)	(1.10)
Village leadership				
2. Leader age	− 0.151	− 0.566	− 0.238	− 1.330
	(0.91)	(0.83)	(0.86)	(1.09)
3. Leader education	− 1.006	− 1.702	− 0.477	2.978
	(1.90)*	(0.79)	(0.33)	(0.47)
4. Leader job	− 5.719	− 6.477	− 5.018	− 0.279
	(1.94)*	(0.54)	(1.37)	(0.02)
5. Leader experience	− 1.084	− 6.613	− 1.128	− 7.005
	(0.38)	(0.57)	(0.38)	(0.53)
6. Party member	1.773	6.545	− 0.133	− 10.322
	(0.55)	(0.50)	(0.02)	(0.41)
7. Secretary age	0.008	0.260	− 0.002	0.167
	(0.05)	(0.40)	(0.01)	(0.22)
8. Secretary education	0.544	− 0.040	0.409	− 1.231
	(0.80)	(0.01)	(0.56)	(0.38)
9. Secretary job	− 3.275	− 6.680	− 2.660	− 1.238
	(0.95)	(0.50)	(0.69)	(0.07)
10. Secretary experience	− 2.097	− 4.973	− 0.884	5.755
	(0.49)	(0.31)	(0.18)	(0.27)
Village policy environment				
11. Before tax for fee	− 2.290	− 18.840	− 2.348	− 19.351
	(0.45)	(0.92)	(0.50)	(0.93)
12. Administrative regulation index	6.962	28.239	10.614	60.547
	(1.43)	(1.45)	(1.03)	(1.33)
13. Fiscal regulation index	11.710	43.877	7.907	10.240
	(1.03)	(0.94)	(0.59)	(0.17)
14. Connection	− 0.707	− 3.085	− 0.784	− 3.765
	(1.68)*	(1.95)*	(1.70)*	(1.84)*
Other characteristics of villages				
15. Per capita land	1.120	7.090	1.384	9.425
	(1.31)	(1.98)*	(1.23)	(1.89)*
16. Business households	0.158	0.579	0.124	0.281
	(0.91)	(0.89)	(0.64)	(0.33)
17. Migrant households	− 0.045	0.003	− 0.046	0.000
	(1.00)	(0.02)	(0.90)	(0.00)
18. Per capita debt	− 0.004	− 0.011	− 0.005	− 0.017
	(2.53)**	(1.70)*	(1.68)*	(1.34)
19. Minority people	0.141	− 0.115	0.107	− 0.412
	(2.09)**	(0.46)	(0.83)	(0.72)
20. Remoteness	− 0.379	− 1.422	− 0.445	− 2.006
	(0.98)	(0.93)	(0.95)	(0.97)
Project design attributes				
21. Total project expenditure	0.015	0.068	0.016	0.077
	(3.65)***	(4.20)***	(2.74)***	(2.95)***
22. Project age	0.060	0.199	0.037	− 0.006
	(0.64)	(0.53)	(0.35)	(0.01)

(*continued*)

Table VII. Impacts of village governance characteristics on infrastructure quality

	Dependent variable: quality score of project			
	OLS		IVs	
	SRS	AS	SRS	AS
23. Village funded only	0.575	−9.817	0.468	−10.757
	(0.17)	(0.72)	(0.13)	(0.69)
24. Above funded only	3.203	21.765	5.350	40.754
	(0.73)	(1.22)	(0.75)	(1.30)
25. Government initiation	−3.067	−15.583	−3.972	−23.593
	(0.90)	(1.17)	(0.85)	(1.14)
26. Committee application	−3.571	−21.123	−5.973	−42.371
	(0.92)	(1.32)	(0.86)	(1.38)
27. Government application	9.488	22.168	11.167	37.020
	(1.96)*	(1.16)	(1.66)	(1.24)
28. Competitive application	−0.872	−7.230	−0.550	−4.388
	(0.30)	(0.64)	(0.18)	(0.33)
29. Committee design	−3.802	−16.156	−3.042	−9.436
	(0.95)	(1.01)	(0.71)	(0.50)
30. Government design	−0.443	−0.190	0.716	10.063
	(0.11)	(0.01)	(0.15)	(0.48)
31. Village leading implementation	−0.448	3.882	−0.438	3.966
	(0.14)	(0.29)	(0.13)	(0.27)
32. Villager implementation	0.081	−1.812	−0.650	−8.283
	(0.02)	(0.11)	(0.15)	(0.43)
33. Government implementation	3.208	3.698	3.590	7.084
	(0.98)	(0.28)	(1.02)	(0.46)
34. Top-down monitoring	−0.157	−12.877	−1.606	−25.692
	(0.05)	(0.97)	(0.32)	(1.16)
35. Household participation	1.421	30.417	−0.490	13.511
	(0.20)	(0.99)	(0.05)	(0.34)
36. Household labor contribution	0.820	15.946	1.436	21.396
	(0.13)	(0.65)	(0.20)	(0.68)
Road project	2.951	9.690	1.116	−6.539
	(0.77)	(0.66)	(0.20)	(0.26)
Drinking water project	8.393	41.889	6.403	24.281
	(1.95)*	(2.30)**	(0.98)	(0.84)
Constant	66.385	226.281	65.272	216.440
	(3.41)***	(2.88)***	(3.32)***	(2.49)**
R^2	0.47	0.39	0.44	0.21
Over-identification test				
Sargan N*R^2-test-χ^2(1)			0.85	1.82
			(0.356)	(0.178)
Sargan (N − L)*R^2-test-χ^2(1)			0.62	1.32
			(0.431)	(0.250)
Basmann test-χ^2(1)			0.62	1.33
			(0.432)	(0.250)
Sargan pseudo-F-test F(1,104)			0.62	1.32
			(0.433)	(0.253)
Basmann pseudo-F-test F(1,103)			0.62	1.33
			(0.434)	(0.252)

Notes: Significant at: *10, **5 and ***1 percent; robust t-statistics in parentheses; there are 143 observations
Source: Authors' survey

Table VII.

when we run the IV regressions). However, it also is possible that there is a causal relationship, but due to weak instrumental variables or because our sample size is too small, we cannot statistically measure the causality. We do believe, however, that our research is important and suggests that more research is needed if we want to convincingly establish this causal relationship.

Summary and conclusions

In this paper, we have used data that we collected to create profiles of the quality of infrastructure in rural China as well as to document the differences among projects and among villages. The main question that we are interested in exploring is: "Can good infrastructure projects succeed in villages that are lack of good governance?" Our short answer to this question is that good infrastructure cannot succeed in villages that lack good governance, and community governance has to be improved before people can expect there to be a high quality infrastructure project. In fact, using both descriptive and multivariate analyses, we have found that few project design attributes matter in explaining the observed variation in infrastructure quality. By contrast, we found several factors at the village level, particularly the way that a village selected their leader, had a strong correlation with the quality of infrastructure projects in rural China. In addition, we also find that the greater the total expenditure, the higher the quality.

The results of our study suggest that shifts in policies that promote elections, while slow in getting started and not universal, appear to be creating an atmosphere that is conducive for infrastructure quality. When villages elect their own leader, for some reason, there is a significant improvement that arises in the quality of infrastructure projects in the village. If the quality of infrastructure in rural China can be raised by improvements in the ways that villages choose their leaders, continuing reforms to provide local leaders with more legitimacy may lead to an even more vibrant village development environment.

Notes

1. English translations of the forms for roads, irrigation and drinking water projects are available from the authors upon request.
2. A simple example can illustrate the importance of accounting for the difficulty factors. If we merely use the standard raw score, a village might be penalized for attempting a complex project (e.g. a road network linking all small groups in the village together). The penalty would be even more severe if the village were located in a physically challenging environment (e.g. in a mountainous area). In contrast, a village implementing a simple project (e.g. a short segment of a feeder road linking a nearby county road to the village office) in a village that was located on a plain would have an easier time achieving a higher score.
3. Similar variations are also found when examining the distributions of adjusted scores by province in our sample (Appendix Figure A1, Panel C).
4. Based on this information about the funding sources of project, we created two dummy variables: one dummy variable indicating whether a project was solely funded by village (village funded only, 1 – yes, 0 – no); the other indicating whether a project was solely funded by above (above funded only, 1 – yes, 0 – no). The survey was carried out in April, 2005. So project age was measured by the number of months lapsed from the completion of a project until April 2005. In other words, as of April 2005, how old was a project in months?

5. With this information we created a dummy variable indicating whether a project was initiated by an official from some upper level of government (government initiation, 1 – yes, 0 – no).
6. Three project application variables were created out of questions asked as a part of this sub-block. These are a dummy variable indicating whether a project was applied for by a village's leadership or "two committees" (committee application, 1 – yes, 0 – no); a dummy variable indicating whether a project was applied for by an official from some upper-level government unit (government application, 1 – yes, 0 – no); and a dummy variable indicating whether other villages were competing for and applying for the same type of projects at the time when our sample village was applying for the project (competitive application, 1 – yes, 0 – no).
7. By comparing the exact dates of entry and exist of village leaders again the exact start and completion date of infrastructure projects in the same village, we were able to match village leader information with projects information to find out who were in office when a project was being constructed in the village.
8. We created our two measures of administrative regulation and fiscal oversight with information from a block in the survey instrument that asked the village leader about whether or not his/her village was subject to certain regulations/policy directives instigated from above. The three administrative regulations included: (a) whether or not townships assigned township cadres to be permanently stationed in the village (or at least visit them on a regular basis); (b) whether or not townships had village leaders on the payroll of the township; and (c) whether or not there were formal restrictions on the amount of corvee labor that villages could levy on villagers. The index ran from 0 to 0.33 to 0.67 to 1.00, depending on the number of the regulations that villages faced (i.e. the number of policies that are implemented in their villages divided by three). The three financial oversight policies were: (a) whether or not townships managed the village's accounting books; (b) whether or not townships demanded that village accountants attended accounting training courses; and (c) whether or not townships required villages to publicly post their village income and expenditures (and asset/debt) statements on a regular basis.
9. We have carried out the same descriptive analysis using adjusted scores. As the results are essentially the same, they are not reported.
10. Alternatively, it could be that the more capable villagers advance to higher levels of administration leaving weaker villagers to carry out the community activity.
11. Specifically, VGC_i includes (a) one village governance variable: a dummy variable indicating whether the village leader was directly elected or not; (b) nine village leadership variables: the village leader's age, a dummy variable indicating whether the village leader was a full-time farmer before acceding to office, a dummy variable indicating whether the village leader served in a role as a cadre in the village before acceding to office, a dummy variable indicating whether the village leader was a CPC member, the party secretary's age, a dummy variable indicating whether the party secretary was a full-time farmer before acceding to office, and a dummy variable indicating whether the party secretary served in a role as a cadre in the village before acceding to office; (c) three village policy environment variables: a dummy variable indicating whether a project was started before Tax for Fee reform; an administrative regulation index, and a fiscal regulation index; (d) a variable indicating how many villagers were in the government outside the village (or a connection variable); (e) six other village characteristics: per capita land, percent of households with a family business, percent of households with at least one family member being a migrant worker, per capita debt of the village, percent of ethnic minority population, and the remoteness of the village from township seat.

12. First, it is possible that there is reverse causality. Directly elected village leaders may not only generate better infrastructure; infrastructure quality could make it attractive enough to become village leader so more candidates would find it worth it to announce their candidacy and compete for a leadership position. Second, there could be a set of unobserved factors that both affect the quality of infrastructure projects and are correlated with the presence of direct elections. In either of these cases, the coefficient on the direct election variable could be biased.
13. While it is beyond the scope of the paper to explain these economies of scale (of quality with respect to project size), there are at least two possible explanations. First, it may be that when projects are larger, there is more time to learn. The average quality of a project may rise over time as those charged with implementing and monitoring it become better at the ways that the project can be made higher quality. Second, it is possible that when funds are tight (project sizes are small), efforts are made to stretch the size of the project beyond its original planned boundaries. In other words, it might be that project quality is being reduced in order to get higher quantity. Such a compromise is less needed when projects are larger. It could be there are other factors that are contributing to this result. Future researchers may want to focus on this finding.
14. The strategy here is to run a new model using OLS and fixed effects. The new model will include project physical size in addition to total project expenditure. In doing so, we believe the coefficient on the project size variable will hold constant the economies of scale effect, leaving the "price" effect embodied in the total project expenditure variable's coefficient. It is these new models that are reported in Appendix Table AIV. Although we do not show the results, we also ran one additional model, replacing both project total expenditure and project physical size with a variable constructed as the ratio of the two (project total expenditure/project physical size), which we can call project unit cost. When doing so using the fixed effects model, we find that the coefficient is significant, giving additional support to our finding that what we are really looking at is not economies of size, but really just a price effect – if more is allocated to a project, ceteris paribus, the quality rises marginally.
15. The F-test statistics and p-value are 0.25 and 0.9973, respectively, when using standard raw scores as the dependent variable. The F-test statistics and p-value are 0.52 and 0.9134, respectively, when using adjusted scores as the dependent variable.
16. Although the results of the multivariate analysis of the impacts of village governance characteristics on infrastructure quality are consistent with the descriptive statistics (as discussed above), there are exceptions. For example, in the descriptive analysis we found evidence that fulltime-farmer-turned local leaders may not be good for infrastructure quality. In the multivariate analysis, while we found evidence of such a negative correlation when using the standard raw scores as the dependent variable, this was not so when using the adjusted scores (Table VII, Row 4). Similarly, while we found evidence that projects from villages with a higher proportion of ethnic minorities tend to be better in the descriptive analysis and when using standard raw scores as the dependent variable, this was not so when using the adjusted scores as the dependent variable (Row 19).

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(The Appendix follows overleaf.)

Appendix

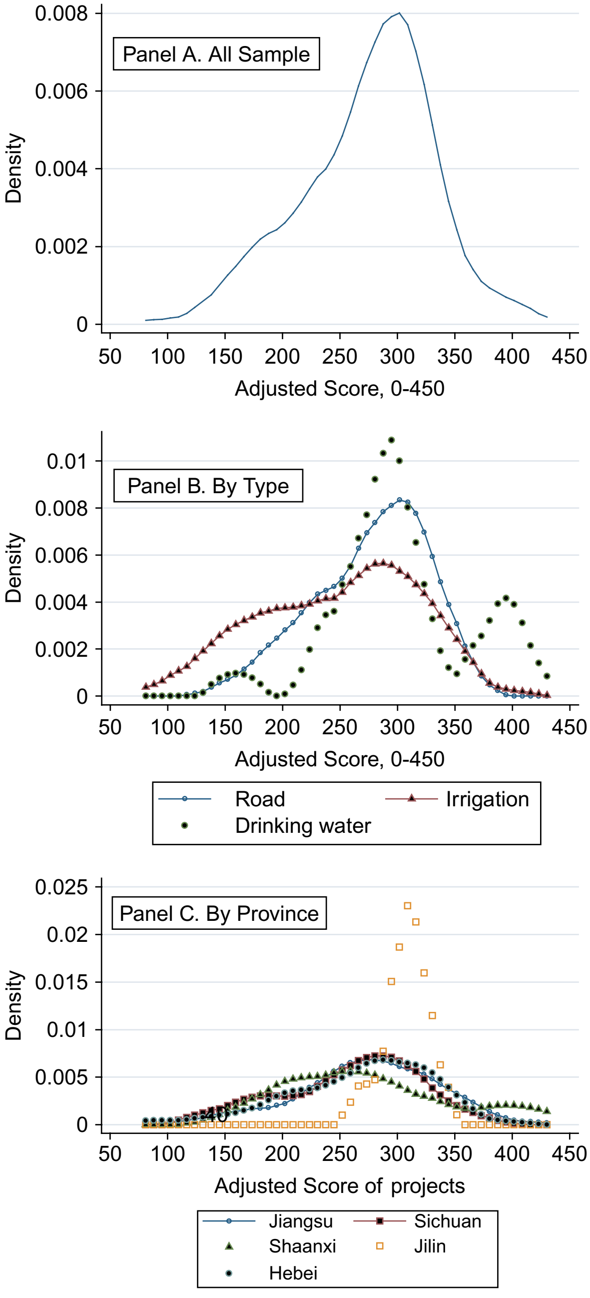

Figure A1.
Distribution of the quality of infrastructure projects, adjusted score

Variable name	Variable definition	Mean	SD
Project quality			
Standard raw score	Standard raw score, 0-100	74.58	15.398
Adjusted score	Adjusted score, 0-450	274.33	57.332
Project scope			
Total project expenditure	Investment size, 1,000 Yuan	19.90	27.526
Project age	Project age month	23.73	24.114
Village funded only	Project funded by village only? 1 – yes	0.50	0.502
Above funded only	Project funded by above only? 1 – yes	0.11	0.316
Project initiation and application			
Government initiation	Project initiated by upper level government? 1 – yes	0.23	0.423
Committees application	Project applied by two committees? 1 – yes	0.53	0.501
Government Application	Project applied by upper-level government? 1 – yes	0.21	0.409
Competitive application	Other villages were also applying for this type of project? 1 – yes	0.50	0.502
Project design			
Committee design	Project designed by two committees? 1 – yes	0.41	0.494
Government design	Project designed by upper-level government? 1 – yes	0.37	0.485
Project implementation and monitoring			
Committee leading implementation	Two committees in charge of project implementation? 1 – yes	0.60	0.491
Villager implementation	Project implemented by villagers? 1 – yes	0.23	0.423
Government implementation	Project implemented by upper level government agencies? 1 – yes	0.51	0.502
Top-down monitoring	Upper level government monitored the project? 1 – yes	0.29	0.454
Farmer participation			
Household participation	Percentage of households whose opinion was sought	0.22	0.223
Household labor contribution	Percentage of households who contribute corvee labor to the project	0.22	0.269
Project type dummies			
Road project	Road project? 1 – yes	0.59	0.494
Drinking water project	Drinking water project? 1 – yes	0.17	0.375
No. of obs.			143

Source: Authors' survey

Table AI. Definition and summary statistics of project quality and project design attributes

Table AII.
Definition and summary statistics of village governance and other characteristics

Variable	Variable definition	Mean	SD
Village governance			
Directly elected	Village leader directly elected by villagers? 1 – yes	0.66	0.47
Village leadership			
Leader age	Village leader's age, year	42.17	7.891
Leader education	Village leader's education, year	9.32	2.661
Leader job	Village leader was a full-time farmer before taking office? 1 – yes	0.41	0.494
Leader experience	Village leader was a cadre at the village level before taking office? 1 – yes	0.64	0.481
Party member	Village leader was a member of the Communist Party of China? 1 – yes	0.76	0.427
Secretary age	Party secretary's age, year	41.28	7.683
Secretary education	Party secretary's education, year	9.78	2.272
Secretary job	Party secretary was a full-time farmer before taking office? 1 – yes	0.31	0.463
Secretary experience	Party secretary was a cadre at the village level before taking office? 1 – yes	0.83	0.375
Policy environment			
Before tax for fee	Project started before the tax for fee reform? 1 – yes	0.27	0.443
Administrative regulation index	Proportion of regulation policies that the township set on the village, 0-1	0.67	0.296
Fiscal regulation index	Proportion of fiscal management policies that the township set on the village, 0-1	0.90	0.152
Contact			
Connection	Number of fellow villagers who were born and raised up in the village and now work at the township and above government agencies, person	3.29	3.346
Other characteristics			
Per capita land	Per capita land, mu/person	2.00	1.694
Business households	Percentage of households that have family business	3.72	9.633
Migrant households	Percentage of households that have at least one member as migrant worker outside of the village	10.94	10.863
Per capita debt	Per capita debt, yuan/person	179.10	719.507
Minority people	Percentage of ethnic minority population	3.57	14.625
Remoteness	Distance from village committee to township government seat, km	4.64	3.658

Source: Authors' survey

Dependent variable: standard raw score of road project	(1)	(2)
Project scope		
1a. Total project expenditure	0.008 (2.09)**	0.008 (1.84)*
1b. Physical size, km		0.056 (0.09)
2. Project age	−0.007 (0.10)	−0.007 (0.10)
3. Village funded only	−0.304 (0.08)	−0.327 (0.08)
4. Above funded only	8.601 (2.13)**	8.622 (2.10)**
Project initiation and application		
5. Government initiation	−1.311 (0.24)	−1.305 (0.23)
6. Committees application	0.858 (0.19)	0.816 (0.18)
7. Government application	3.661 (0.63)	3.698 (0.63)
8. Competitive application	−2.712 (0.84)	−2.709 (0.84)
Project design		
9. Committees design	5.938 (1.44)	6.103 (1.46)
10. Government design	6.519 (1.86)*	6.649 (1.90)*
Project implementation and monitoring		
11. Village leading implementation	−3.953 (1.32)	−4.026 (1.24)
12. Villagers implementation	−8.196 (1.43)	−8.249 (1.44)
13. Government implementation	4.248 (1.26)	4.280 (1.24)
14. Top-down monitoring	5.181 (1.70)*	5.145 (1.65)
Farmer participation		
15. Household participation	1.623 (0.31)	1.783 (0.32)
16. Household labor contribution	−9.427 (1.57)	−9.535 (1.52)
Constant	70.900 (8.95)***	70.692 (9.13)***
Observations	84	84
R^2	0.47	0.47

Notes: Significant at: *10, **5 and ***1 percent; robust *t*-statistics in parentheses
Source: Authors' survey

Table AIII.
Results from alternative specifications about the impact of project expenditure on road quality, OLS

Dependent variable: standard raw score of road project	(1)	(2)
Total project expenditure	0.012 (9.76)***	0.012 (5.64)***
Length of a road, km		−0.271 (0.32)
Constant	73.318 (203.18)***	74.005 (33.97)***
Observations	84	84
Number of village	72	72
R^2	0.90	0.90

Notes: Significant at: *10, **5 and ***1 percent; absolute value of *t*-statistics in parentheses
Source: Authors' survey

Table AIV.
Results from alternative specifications about the impact of project expenditure on road quality, village fixed effects

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