Local governance and the quality of local infrastructure: Evidence from village road projects in rural China

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ABSTRACT

Research has shown that allowing local communities to elect their own leaders increases local infrastructure investment. However, much less is known about the effects of local governance reform on the quality of local infrastructure. This paper examines the effects of governance reform implemented in rural Chinese villages on the quality of village road projects. We conduct surveys in 101 rural villages and collect data related to the implementation of the reform over the last two decades. We also measure the quality of over 550 village road projects completed in these villages. Using fixed effects and instrumental variable estimation methods, we find that the implementation of village governance reform increases the quality of village road projects. We also find evidence supporting the following effect mechanisms: (1) village leaders become younger and more educated, (2) high quality road projects increase incumbent leaders' re-election chances, and (3) village residents participate more actively in the management and monitoring of village road projects.

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1. Introduction

In China, Vietnam, and several other former Socialist countries that have been ruled by authoritarian governments, leaders of local communities are increasingly elected by local community members (Rozelle, 1994; Oi and Rozelle, 2000; Gandhi and Lust-Okar, 2009; Malesky and Schuler, 2013). An important question is how this change in local governance structure affects the provision of local infrastructure. Research has typically shown that introducing local elections increases the *level* of local infrastructure investment (Zhang et al., 2004; Luo et al., 2007, 2010; Wang and Yao, 2007; Martinez-Bravo et al., 2011, 2014). However, to our knowledge no research has examined whether introducing local elections also improves the *quality* of local infrastructure projects.

The quality of local infrastructure projects is crucial for economic development (World Bank, 1994, 2003; OECD, 2007; United Nations Human Settlements Programme, 2011; Asian Development Bank, 2012). Improved road quality, for example, has been shown to raise agricultural output, reduce agricultural price distortion, expand domestic trade, and promote local markets (Minten and Kyle, 1999; Jacoby, 2000; Buys et al., 2010; Mu and van de Walle, 2011). Access to

high quality roads also helps to alleviate rural poverty, increase household consumption, improve access to off-farm employment, and raise school enrolment (Gibson and Rozelle, 2003; Warr, 2005; Dercon et al., 2009; Khandker et al., 2009; Yamauchi et al., 2009; Gibson and Olivia, 2010; Qiao et al., 2014; Gonzalez-Navarro and Quintana-Domeque, 2015).

However, in many developing countries the quality of local infrastructure projects is still poor (Briceño-Garmendia et al., 2004; Straub, 2008).[1] Given the continuing efforts in many developing countries to promote self-governance at the local community level, it is natural to ask whether and how the implementation of local governance reforms affects the quality of local infrastructure projects. Are the effects positive and large? Are the effects consistent with findings on local governance reform and the level of local infrastructure investment? What are the underlying mechanisms?

We believe that the major challenge in answering these research questions is the lack of appropriate data from suitable research/policy

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[1] The quality of local infrastructure is reportedly poor in a range of areas such as drinking water and irrigation (Duflo and Pande, 2007; Del Carpio et al., 2011; Dillion, 2011), electricity and telecommunications (Dinkelman, 2011; Shaun, 2015), and local roads (Gibson and Rozelle, 2003; Gibson and Olivia, 2010; Qiao et al., 2014; Gonzalez-Navarro and Quintana-Domeque, 2015).

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contexts. To answer these questions, a researcher needs to obtain reliable scientific quality measures related to a large number of local infrastructure projects. Furthermore, a researcher needs these measures to be available in different communities in which local governance reform has recently been introduced. In addition, the reform has to be implemented in different communities at different times so that some communities elect their leaders earlier than others.

Two sets of policy efforts by the Chinese government over the past two decades provide suitable context for data collection. First, starting in the late 1990s the Chinese government introduced a new wave of governance reform in rural areas to promote self-governance of rural villages (henceforth *village governance reform*). The Chinese government normalized the village electoral system to make elections more open, competitive, and accountable to local communities (O'Brien and Han, 2009). As China is geographically large and has over 600,000 rural villages, the government rolled out the reform gradually over the past two decades, and different villages were asked to implement the reform in different years (Unger, 2002; Martinez-Bravo et al., 2011, 2014). In this process, higher-level government officials issued reform mandates to the villages. The villages usually had little influence on the timing or details of the reform.

Second, also starting in the late 1990s, the Chinese government launched a large-scale infrastructure investment program to promote rural development (Zhang et al., 2006; Wong et al., 2013). The government provided funding for rural villages to build and upgrade different kinds of infrastructure projects (People's Daily, 2006; Xinhua News, 2010). In these efforts, village leaders took up important tasks, for instance in securing funding from the government and managing the project construction work (Wong et al., 2013). As such, the village governance structure, which is very likely to affect the selection of local leaders and the incentives and accountability system those leaders face, may ultimately affect the quality of village infrastructure projects (Zhang et al., 2006; Wong et al., 2013).

As village road projects have been the most popular kind of infrastructure project in rural Chinese villages, the goal of this study is to evaluate whether and how the implementation of village governance reform affects the quality of village road projects in rural China.[2] We collected a unique dataset by conducting three waves of survey in 101 rural villages randomly selected from five Chinese provinces. In our survey, we documented the timing of village governance reform implementation for our sample villages. We also measured the quality of all village road projects in those villages. In addition, we collected detailed information about the villages, village leaders, and village road projects.

We consider China's implementation of village governance reform to be a quasi-natural policy experiment that upper-level governments have introduced in different rural villages at different times.[3] Our basic estimation approach is a fixed effect model that is analogous to a difference-in-differences setup. Multiple road projects took place in each of our sample villages over the study period. More importantly, for many of our sample villages, some projects were started and completed before and after the implementation of village governance reform. Therefore, we first estimate the effects of village governance reform by controlling for two sets of fixed effects: (1) village fixed effects that account for unobserved time-invariant heterogeneities across villages and (2) project year fixed effects that account for year-specific macroeconomic factors. We also control for various village and road project characteristics in our regressions.

To more confidently identify the causal effects of the reform, we take further steps to address several potential endogeneity concerns. First, we include a set of location-specific time trends in our model to account for possible diverging trends in road quality across locations. Second, we conduct sensitivity checks using different subsamples to show that our estimates are robust to possible selective timing of reform implementation across villages. Lastly, using institutional factors that are most plausibly exogenous to the village road projects, we conduct a set of instrumental variable (IV) estimations to address possible time-varying unobserved factors at the village level.

Overall, we find strong and consistent evidence that the implementation of village governance reform increases the quality of village road projects. Our FE and IV estimates report an increase in road quality by 0.6 to 1.3 standard deviations of our quality measure, and these results are robust across different sensitivity checks. In examining the mechanisms, we find that village leaders are generally younger and more educated (and possibly more able) after the reform. In addition, while turnover of village leaders is more frequent after the reforms, high-quality village road projects increase the chance that incumbent leaders are re-elected. Moreover, we find that village residents more often participate in the management and monitoring of road projects after reform. However, the improvement in road quality is not caused by a decrease in the number or length of village road projects (i.e., the extensive margin of road investments) or an increase in the unit cost of the projects (i.e., the intensive margin of road investments).

The rest of this paper is organized as follows. Section 2 provides an overview of village governance reform and road investment in China. Section 3 describes our research methodology, which includes the sampling method, data collection, and statistical method. Section 4 presents our descriptive findings and main estimation results. Section 5 discusses several endogeneity concerns and presents results obtained from several robustness checks and instrumental variable (IV) estimations. Section 6 further examines four different possible mechanisms. Section 7 discusses the results and concludes the paper.

2. Village governance reform and village road development in rural China

2.1. Village governance reform in rural China

Rural villages in China are governed by village administrative organizations called *village committees*. Village committees are de facto village government entities that run their own budgets. They are directly responsible for all administrative duties in the village, including the provision of infrastructure projects (Guo and Bernstein, 2004; Martinez-Bravo et al., 2014).[4] The committees comprise a leader and typically two to six other administrative officers. For many years, county and township governments appointed members of the village committees. In 1987, the National People's Congress passed the "Organic Law of the Village Committees (OLVC)" and introduced local elections in China's rural villages (Rozelle, 1994; Oi and Rozelle, 2000). The Law stated that members of the village committees should be elected by local villagers once every three years and should report to a *village*

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[2] This study does not examine the welfare effects of the implementation of village governance reform or the welfare effects of village road projects. We leave these analyses to other studies (see Chattopadhyay and Duflo, 2004; Foster and Rosenzweig, 2005; Shen and Yao, 2008; Martinez-Bravo et al., 2011, 2014).

[3] Governance structure is complex. Therefore, unlike Olken (2007, 2010), we lack the capacity to conduct a randomized controlled trial and ask different rural villages to implement the village governance reform at different times.

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[4] Similar to the case in the upper-level governments, the village administrative branch is supervised by a village-level leadership of the Chinese Communist Party called the *village party branches*. The village party branches, however, are mainly responsible for organizing party activities in the village and overseeing politically driven village policies (e.g., the implementation of the One Child Policy). Therefore, in this study we focus our attention on the village committees and examine only how their governance reform affects the quality of village road projects. We consider that the role of village party branches in the village road projects is limited, and we only evaluate their role in our supplementary analysis.

assembly of all adult villagers. However, the Law was largely a general policy directive to guide further experimental trials and provided only limited details on candidate nomination procedures and the village electoral system (O'Brien, 1994; Li and O'Brien, 1999). Consequently, county and township governments still maintained considerable control over these village elections. In many cases, they could intervene in candidate nominations and determine who was elected (Oi and Rozelle, 2000; Tan, 2004).

In 1998, the National People's Congress substantially revised the Organic Law to weaken the influence of county and township governments on village elections and make the elections more open, competitive, and accountable to the village communities (O'Brien and Han, 2009). The revised Organic Law included detailed requirements for candidate nomination procedures and village electoral systems so that they could be more strictly and uniformly implemented (O'Brien and Zhao, 2011).[5] In the following years, each province of China announced its own "Provincial Measures for Implementing the Organic Law of Village Committees" to provide further mandates and instructions for reform implementation (O'Brien and Zhao, 2011). Counties and townships followed suit. Given China's size and gradualist approach to reform, the messages were delivered to different rural villages at different times and the timing of reform implementation varied across villages. By the end of 2010, almost all rural villages in China had completed this wave of reform.

2.2. Village road development in rural China

Over the past two decades, the Chinese government also launched a large-scale infrastructure investment program in rural areas. Village road projects were the most common kind of investment (Liu et al., 2009; Wong et al., 2013). In the years from 2001 to 2009, for instance, China spent over 1 trillion yuan to build and upgrade over 2 million kilometers of rural roads (People's Daily, 2006; Xinhua News, 2010). By the end of 2009, nearly 80% of all rural villages in China had immediate access to paved roads that were connected to nearby towns or townships. As village road projects benefit almost everyone in the community, they are believed to have a high rate of investment return (Fan and Hazell, 2001; Fan and Chan-Kang, 2008).

Village leaders often played a crucial role in important stages of the village road projects (Zhang et al., 2006; Wong et al., 2013). Village leaders were responsible for collecting views from village residents on potential projects and developing project plans. They were also responsible for submitting applications to the government and competing with other villages for government funding. In many cases, village leaders were also responsible for managing and monitoring the projects and engaging local villagers for community participation. Finally, as the governments typically provide only partial funding for these road projects, village leaders often needed to solicit financial contributions and in-kind labor inputs from the villagers. Therefore, the village governance system (which determines the selection, incentives, and accountability system of the village leaders) can greatly affect the quality of village road projects.

3. Research methodology

In this study, we make use of the timing variation in the implementation of village governance reform to estimate the overall effects of the reform on the quality of village road projects. We designed the China Rural Governance (CRG) Survey and collected our own data from 101

rural villages located in 50 townships, 25 counties, and 5 provinces of China. We conducted three survey waves in these villages and combined them into a panel dataset for analysis.

3.1. Sampling method

We aimed to obtain a nationally representative village sample.[6] First, we put China into five major agro-ecological zones and randomly selected one province from each of the zones. In this step, we selected Jiangsu (Eastern Coastal), Sichuan (Southwest), Shaanxi (Northwest), Hebei (Central), and Jilin (Northeast). We then randomly selected five counties in each of the five provinces and obtained a total of 25 sample counties. We further selected two townships in each of the 25 sample counties and two villages in each of the 50 sample townships. As one sample village split early in our study period, our final study sample contained 101 rural villages.[7]

3.2. Data collection

Our fieldwork team visited all of the 101 sample villages three times (in April 2005, April 2008, and April 2012) and conducted in-depth interviews with the leaders of the villages. In each survey wave, we collected detailed information about the villages and their elections, leaders, and road projects. Specifically, we asked the village leaders to enumerate all of the village road projects in the past few years. We then physically visited these road projects and used our road quality evaluation scheme to evaluate the quality of each individual project.

3.2.1. Main outcome variable: the measurement of village road quality

This study required an approach that would produce reliable and comprehensive quality measures of village road projects.[8] Specifically, we needed an approach that would evaluate the quality of road projects that were constructed in different villages and in different years. Therefore, before our fieldwork, we worked with professional civil engineers and local government transportation agencies to develop a detailed road quality evaluation scheme.[9]

Appendix A outlines our road quality evaluation scheme. It involved an assessment of over 20 quality attributes for each village road project and guidelines for the score allocation for each attribute. These attributes were grouped under four different categories. We believe that these categories together can comprehensively describe the quality of a village road project. Using our evaluation scheme, there were four partial road quality scores for each village road project: (1) the quality score of the road alignment and cross-section (0 to 20 points); (2) the quality score of the road bed (0 to 20 points); (3) the quality score of the road

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[5] Some of the important requirements explicitly stated in the revision of the Organic Law are as follows: (1) candidate nominations should be open to all villagers over 18 years old, (2) the village election should be competitive and there should be multiple candidates for the village leader position, (3) secret ballots should be used, (4) votes should be cast by at least half of eligible village voters, and (5) candidates should obtain over half of the votes to be elected.

[6] This village sample is a subset of the villages studied in Zhang et al. (2006). The sample is also the same as that used in Wong et al. (2013).

[7] To obtain a sample that is representative of different standards of living in each selected province, we use the per capita gross value of industrial output (GVIO) measure to conduct stratified random sampling. We use this measure because it is one of the best predictors of living standards in China (Rozelle, 1996). In selecting our county sample, we first put all of the counties of each selected province into quintiles according to their per capita GVIO. We then randomly select one county from each quintile. We follow similar steps when sampling townships and villages.

[8] This study considers paved road projects only (i.e., asphalt, concrete, and gravel road projects). We omit dirt road projects because the quality standards for dirt road projects are considerably different.

[9] Previous attempts to describe and measure road project quality typically use rough measures that fail to capture the full range of quality variations across different projects. For example, Minten and Kyle (1999) simply categorize rural roads in former Zaire into paved roads and unpaved roads. Fan and Chan-Kang (2008) only calculate the total mileage of high quality roads (those officially classified as expressways and top classed roads) and also the total mileage of low quality roads (those classified otherwise) at China's provincial level. Warr (2005) instead ignores quality variations between road projects within rural villages and simply classifies villages in Laos into those with road access in all weather conditions, those with road access only in dry weather, and those with no road access at all. However, the actual quality variations between road projects are certainly more sophisticated than the aforementioned methods indicate. For example, there are high- and low-quality paved roads.

surface (0 to 50 points); and (4) the quality score of the attributes for road safety (0 to 10 points). We added these four scores together to obtain a continuous measure of the overall project quality, namely the comprehensive road quality score (0 to 100 points).[10]

3.2.2. Main explanatory variable: the implementation of village governance reform

In each wave of our survey, we asked the village leaders whether upper-level governments had already issued mandates to the village to normalize the election of the village committee (i.e., in accordance with the 1998 revised Organic Law). If the answer was yes, we further asked for the year in which the governance reform was implemented in the village. Using this information, we constructed a dummy variable that could represent the status of the reform when the road project started, namely *project started after village governance reform*. The variable equals one (1) if a village road project started at the time when the village leader was elected after the implementation of village governance reform, and zero (0) otherwise.

3.2.3. Control variables: village and project characteristics

In our survey, we collected other information about the villages and village road projects and included them as control variables in our analyses. Specifically, in our regressions we accounted for the size of the village population and the level of per capita rural income in the village (henceforth *village characteristics*). We also accounted for several project factors (henceforth *project characteristics*) such as the length of the village road project, the pavement material (asphalt, concrete, or gravel), and whether the project was a brand new road or an upgrade/extension of an existing road. In addition, we measured the topology and complexity of each road project and accounted for them in our analysis.[11]

3.3. Statistical method

As there were multiple road projects for each of our sample villages over our study period, and projects that occurred before and after the implementation of village governance reform, we obtain our first estimate of the reform effect using a fixed effect model that is analogous to a difference-in-differences setup. Specifically, when estimating the effects of the reform on the quality of village road projects, we control for two sets of fixed effects: (1) village fixed effects that account for unobserved time-invariant heterogeneities across villages and (2) project year fixed effects that account for year-specific environmental factors.[12] We use robust estimates of standard errors with the clustering of

observations within village. The basic FE model is as follows:

$$\text{Road Quality}_{ijt} = a_0 + a_1 * \text{Project Started After Village Reform}_{ijt} + a_2 * \text{Survey Wave}_{ijt} + \mu_j + \mu_t + e_{ijt}. \tag{1}$$

In this model, *road quality$_{ijt}$* is the comprehensive road quality score of village road project i in village j started in year t. The variable *project started after village reform$_{ijt}$* is our main explanatory variable of interest. We include a set of *survey wave$_{ijt}$* dummy variables in the regression model to indicate the survey wave in which the project was enumerated. We also include *village fixed effects*, μ_j, and *project year fixed effects*, μ_t, to specify the model in a difference-in-differences setup. We hope that the estimate for the parameter a_1 can provide evidence of the overall effect of the implementation of village governance reform on the quality of village road projects.

We also refine model (1) to address two sets of endogeneity concerns in our estimation. First, we control for several *village characteristics* and *project characteristics* (as discussed before) to account for factors that may explain the variations in village road quality and confound results. Second, we control for location-specific time trends to account for possible trending factors that may affect road quality differently by location (e.g., location-specific trends in construction technology or other institutional development). The refined model is expressed as follows:

$$\text{Road Quality}_{ijkt} = a_0 + a_1 * \text{Project Started After Village Reform}_{ijkt} + a_2 * \text{Project Characteristics}_{ijkt} + a_3 * \text{Village Characteristics}_{ijkt} + a_4 * \text{Survey Wave}_{ijkt} + \mu_j + \mu_t + \mu_k * t + e_{ijkt}. \tag{2}$$

In this model, k represents the province or county and $\mu_k * t$ represents the set of province- or county-specific time trends. We hope that this model can give us a better estimate of the overall effects of village governance reform implementation on village road quality.

4. Empirical results

4.1. Descriptive statistics

Our data show that there are large variations in the timing of village governance reform implementation across the sample villages (Fig. 1). Before 1998, a few of our sample villages (about 10%) had already held village elections in ways that satisfied the conditions stipulated in the 1998 revised Organic Law. These villages can thus be considered pioneers in village governance reform. Since then, more of our sample villages implemented the reform and held village elections in accordance with the revised Organic Law. Specifically, in the next several years different provincial governments issued further mandates and instructions to rural villages to carry out governance reform.[13] By 2005, over 90% of our sample villages had adopted the new village governance system. By 2010, the wave of reform was essentially completed.

We identify 563 village road projects in our sample villages across the three survey waves (Table 1). The average number of road projects per village is thus about 5.6. Almost all of our sample villages had three or more road projects during our study period (online Appendix Table 1). Fig. 2 shows that these village road projects were carried out in different years with respect to the year of governance reform.[14] When

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[10] We took steps to minimize enumerator-specific subjectiveness in the score assignment. Before our fieldwork, we trained our enumerators as a group using comparison games and guided them to assign nearly the same scores to the same quality attributes. We also provided our enumerators with a detailed scoring manual for reference. Finally, we required our enumerators to take photographs of each village road project. After our fieldwork, we compared the assigned scores against the photographs and made score adjustments when necessary.

[11] We created two indices for the measurement and converted the indices into two series of dummy variables in our analyses (i.e., three dummy variables for each index). For project topography, the index was set to one (1) for projects located on sites that are essentially flat and wide open, two (2) for projects located on sites with some difficulties in contour and terrain, three (3) for projects located on sites with more challenges, and four (4) for projects located on the toughest sites. Likewise, for project complexity, the index was set to one (1) for projects that affected village activities minimally, two (2) for those affecting only some part of the villages, three (3) for those causing more interruption to the village, and four (4) for those that caused the most disturbances.

[12] We use the start year of the road projects for the construction of these project year fixed effects. We also conduct alternative analysis using the completion year of the projects. However, because the average project duration was only five months, most of the projects were started and completed in the same calendar year. The results are therefore essentially the same.

[13] The provincial legislature of Hebei and Shaanxi passed their "Provincial Measures for Implementing the Organic Law of Village Committees" in 1999, followed by the provincial legislature of Jiangsu and Sichuan in 2001, and finally by the provincial legislature of Jilin in 2004.

[14] Of the 563 village road projects in our sample, 159 were enumerated in our 2005 survey, 259 in our 2008 survey, and 145 projects in our 2012 survey. Furthermore, 106 were asphalt road projects, 287 were concrete road projects and 170 were gravel road projects. Finally, 323 were brand new road projects and 240 were road extension/upgrade projects.
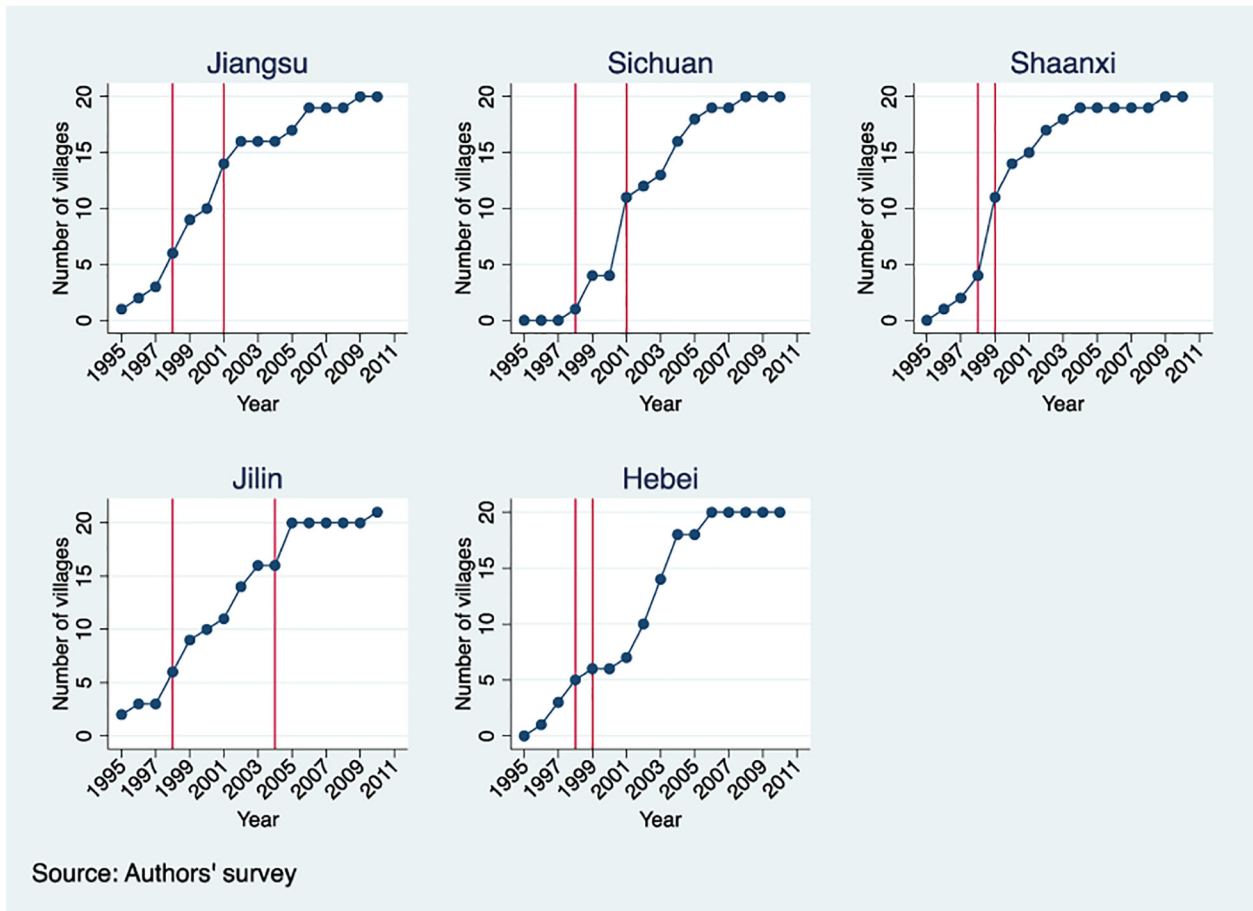
Fig. 1. Cumulative number of sample villages implementing the village governance reform by province. Note: The first vertical line in each sub-figure indicates the year of 1998 which was the year of the revision of the Organic Law of the Village Committees by China's national legislature. The second line in each sub-figure indicates the year of the announcement of "Measures for Implementing the Organic Law of Village Committees" in each of the provinces.

Table 1
Summary statistics of sample village road projects and sample villages.
Data source: Authors' survey.

	N	Mean	S.D.	Min	Max
Dependent variables					
Comprehensive road quality scores (100 points max), of which	563	76.5	14.0	36.7	99.2
Quality scores of the road alignment and cross-section (20 points max)	563	14.9	3.5	5.2	20.0
Quality scores of the road bed (20 points max)	563	15.5	3.4	5.0	20.0
Quality scores of the road surface (50 points max)	563	38.9	8.4	20.1	50.0
Quality scores of the attributes for road safety (10 points max)	563	7.1	1.7	3.0	9.9
Key explanatory variable					
Project started after village reform (Y = 1; N = 0)	563	0.80	0.40	0	1
Project characteristics					
Length of road project (km)	563	1.94	2.22	0.05	20
Asphalt road dummy (Y = 1; N = 0)	563	0.19	0.39	0	1
Concrete road dummy (Y = 1; N = 0)	563	0.51	0.50	0	1
Road extension and upgrade dummy (Y = 1; N = 0)	563	0.43	0.49	0	1
Project topography index (1: least challenging; 4: most challenging)	563	2.01	1.05	1	4
Project complexity index (1: least challenging; 4: most challenging)	563	1.80	1.03	1	4
Village characteristics					
Village population in 1997 (in 1000 persons)	101	1.46	0.91	0.26	5.8
Village per capita income in 1997 (in 1000 yuan)	101	2.73	1.16	0.60	5.7

we normalize the year of reform implementation to zero as the base year for comparison, we find that some projects took place before the implementation of reform (about 20%) and some afterwards (about 80%).
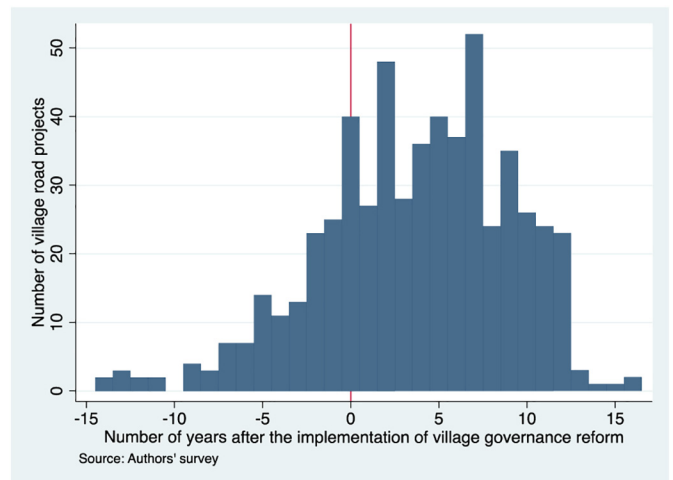

Fig. 2. Number of village road projects started before and after the implementation of village governance reform.
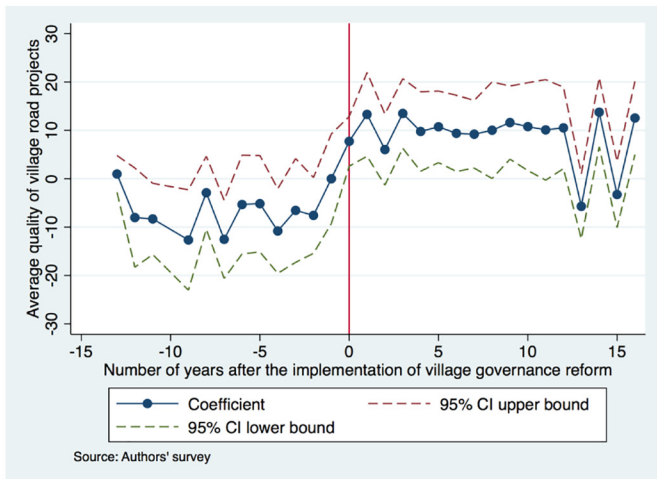
Fig. 3. Average quality of village road projects started before and after the implementation of village governance reform. Note: For illustration purpose, the average quality of village road projects started in the year right before the implementation of village governance reform (−1) is normalized to zero.

Fig. 3 provides descriptive evidence that the implementation of village governance reform increases the quality of village road projects in rural China.[15] When we examine the average quality of village road projects before and after the implementation of governance reform, we find that projects started after the reform implementation are generally higher in quality. A simple visual comparison suggests that the average quality gap between the two types of road projects is around 10 points.

Table 1 presents the summary statistics of other main variables used in this study.

4.2. Multivariable results

We conduct a series of regression analyses to estimate the effects of village governance reform implementation on the quality of village road projects. Table 2 reports our first set of estimation results. When we estimate model (1) and control only for village fixed effects and project year fixed effects, the point estimate on the variable *Project Started After Village Reform* variable is 14.3 and is highly statistically significant from zero (Column 1). As the standard deviation of the comprehensive road quality score variable is 14 points, the quality improvement due to the implementation of village governance reform is large (at 1 standard deviation).

When we control for several project and village characteristics in the regression, the point estimate drops to 9.7 points (Column 2). The result suggests that project and village covariates help to explain the variations in village road quality. We obtain similar estimates when we further account for province- or county-specific time trends in our regression analysis (i.e., estimating model (2)). The estimates are 8.9 and 8.8, respectively (Columns 3 and 4), and are about two thirds of

the standard deviation of our quality measure. As the estimates are only one point lower than the estimate reported in Column 2, we believe the concern about differential quality time trends across locations is minor.[16]

5. Endogeneity concerns and robustness checks

The validity of our estimation strategies depends on one important condition: variations in the timing of village reform implementation were largely random. When upper-level governments issued mandates to different rural villages in different years to implement the reform, they did not decide the timing of the reform based on the socioeconomic conditions of the villages.

We directly evaluate this condition by analyzing the determinants of the timing variations in governance reform implementation. Our survival analysis shows no statistical associations between the timing of governance reform implementation and a large number of major village characteristics.[17] Therefore, at least from a statistical point of view, we cannot reject the condition that supports the validity of our estimation strategy. Other studies examining China's rural village elections have also discussed and debated this aspect (Martinez-Bravo et al., 2011, 2014).

We also conduct three robustness checks on model (2) to evaluate whether the effect estimates are robust across different subsamples. In the first robustness check, we omit villages that implemented the governance reform very early or very late in each of our sample provinces (i.e., those that could draw special attention). Second, for all of our sample villages, we evaluate only projects in the office term right before, and just after, governance reform implementation (i.e., resembling a regression discontinuity design estimation approach). Third, we evaluate only the last project that occurred before reform implementation, and the first project that occurred after (i.e., a restricted version of the second robustness check). The results from these robustness checks are all close to those presented in Table 2. The point estimates on the *project started after village reform* variable range from 8.9 to 10.7 and are all statistically significant from zero (see online Appendix Table 3). Overall, our estimates are robust to concerns about selective timing in the implementation of governance reform by villages.

5.1. Instrumental variable estimations

As our research design is observational in nature, one may still argue that our *explanatory* variable, *project started after village reform*, is endogenous due to possible time-varying unobserved factors at the village level. We attempt to address this endogeneity concern using an instrumental variable (IV) estimation method. To do so, we make use of some institutional features of China to develop two interaction-based instrumental variables that strongly correlate with the timing of village reform implementation and have no plausible independent effect on village road quality.

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[15] Online Appendix Fig. 1 shows that we are able to use our road quality evaluation scheme to measure the variability of village road quality across our sample road projects. The distribution of the comprehensive road quality scores of all of our sample projects is not very different from a bell curve. The best road projects in our sample receive scores that are almost perfect (i.e., over 95 points), and the worst road projects receive scores of <40 points. As the average and standard deviation of the comprehensive road quality scores in the full project sample are 76.5 and 14 points, respectively, the best road projects are about 1.5 standard deviations above the average and the worst road projects are >2 standard deviations below.

[16] We also conduct similar estimations using the four components of comprehensive road quality scores as the outcome variables (i.e., the four partial road quality scores). The results are consistent with those in Table 2 and are reported in online Appendix Table 2. In further analysis, we also find statistical evidence that the effect of governance reform on village road quality is larger in the reform year and following year. The effect of the reform is still positive, large, and statistically significant afterward. For the sake of brevity, we do not report these results.

[17] Our survival analysis shows no statistical associations between the timing of implementing the governance reform across villages and the following characteristics of the villages in 1998: (1) village population, (2) share of Han population in the village, (3) number of total labor in the village, (4) amount of nonfarm labor in the village, (5) per capita rural income of the village, (6) size of farmland in the village, (7) village distance to the nearest township, (8) share of households with electricity in the village, (9) share of households with tapped water in the village, (10) number of primary schools in the village, and (11) whether the village had access to paved roads. For the sake of brevity, we do not report these results.

Table 2
FE estimates of the effect of implementing village governance reform on village road quality. Data source: Authors' survey.

	Dependent variable: comprehensive road quality scores (100 points max)			
	FE	FE	FE	FE
	(1)	(2)	(3)	(4)
Project started after village reform (Y = 1; N = 0)	14.26***	9.72***	8.90***	8.84***
	(2.37)	(1.88)	(1.84)	(2.04)
Project characteristics	N	Y	Y	Y
Village characteristics	N	Y	Y	Y
Survey wave dummies	Y	Y	Y	Y
Village FE & Project year FE	Y	Y	Y	Y
Project year province time trend	N	N	Y	N
Project year county time trend	N	N	N	Y
N	563	563	563	563
R^2	0.36	0.54	0.56	0.61

Note: Project characteristics include length of the road project, asphalt road dummy, concrete road dummy, project extension and upgrade dummy, project topology index, and project complexity index. Village characteristics include village population and village per capita income. Robust standard errors, clustered at the village level, are reported in parentheses.
***, **, and * indicate statistical significance from zero at the 1, 5, and 10% levels.

Our instrumental variables are developed from two sets of institutional factors. First, given that China is geographically large and has over 600,000 rural village communities, the 1998 revision of the Organic Law and the later announcements of implementation measures by provincial governments can be viewed as high-level policy shocks to any specific rural village in China. While these high-level policy shocks ultimately led to the implementation of village governance reform across China, in principle they should have had no direct effect on the quality of village road projects. Therefore, we construct two policy-based variables at the project level: (1) project in office term started after national legislation and (2) project in office term started after provincial legislation.[18]

Second, as rural villages were all asked by upper-level governments to implement the governance reform, the reform status of the villages should correlate with each other. However, given China's size, the reform status of distant villages should have no direct effects on the road quality of one specific village. Therefore, we construct two status-based variables at the project level: (1) share of sample villages in other sample provinces that had implemented governance reform by the year of the project and (2) share of sample villages in other counties of the same province that had implemented governance reform by the year of the project.[19]

We then construct two interaction-based instrumental variables using these two sets of institutional factors. The first instrumental variable is a nation-based variable defined as project in office term started after national legislation * share of sample villages in other sample provinces that had implemented governance reform by the year of the project. The second instrumental variable is a province-based variable defined as project in office term started after provincial legislation *

share of sample villages in other counties of the same province that had implemented governance reform by the year of the project. We use these two interactive variables as instruments for the variable project started after village reform. Specifically, as these instrumental variables are constructed from institutional factors that are either well above the village level or are distant from any specific village, they would not correlate with possible time-varying unobserved factors at the village level.[20]

Table 3 reports the IV estimation results. The first-stage estimation shows that the two instrumental variables correlate strongly with the instrumented variable (Column 1). The point estimates on the two instrumental variables are positive, large, and highly statistically different.[21] The results in the second-stage estimation are consistent with (and stronger than) those obtained from the FE estimations before. The IV estimate on the *Project started after village reform* variable is 18.1 (at 1.3 standard deviation of the quality measure) and is also highly statistically significant (Column 2). Overall, these IV results provide evidence that our results are robust to possible time-varying unobserved factors at the village level.

6. Potential mechanisms

Following our results, we make use of other data collected from the survey to examine how the implementation of village governance reform increases the quality of village road projects. We examine four different potential mechanisms: (a) meritocratic selection of village leaders; (b) better accountability of village leaders; (c) higher levels of community participation; and (d) extensive and intensive margins of village road investments.

6.1. Meritocratic selection of village leaders

Villagers may be better than upper-level government officials at selecting competent village leaders (Persson and Tabellini, 2002; Besley, 2006; Besley and Reynal-Querol, 2011). After the implementation of the reform, the nomination of village leader candidates became fully open to the village communities. As village communities are small, residents frequently interact with their leaders and potential future leaders. Compared with government officials who are usually far away from the villages, village residents may be better at identifying and selecting competent local leaders. They may also choose leaders that better contribute to infrastructure projects in the village.

We examine this potential mechanism by analyzing the effects of the implementation of village governance reform on different attributes of the village leaders. We first construct the variable *Village leader elected after reform* to represent whether the leader was elected before or after the reform implementation.[22] We then use several attributes of the village leaders as the outcome variables: (a) the age of the leader at the start of his or her office term, (b) the years of schooling of the leader, (c) whether the leader serves concurrently as the secretary of

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[18] The first variable equals one (1) if a road project occurred in an office term that started after the national announcement of the revised Organic Law in 1998. The variable equals zero (0) if otherwise. Similarly, the second variable equals one (1) if a road project occurred in an office term that started after the announcement of reform implementation measures by its province. The variable equals zero (0) if otherwise.

[19] For a given road project in a sample village, the first variable measures the share of all sample villages in the other four sample provinces (i.e., the share out of eighty sample villages) that had implemented the governance reform by the year of that road project. The second variable measures the share of all sample villages in the other four sample counties of the province (i.e., the share out of sixteen sample villages) that had implemented the governance reform by the year of that road project. We need to exclude the four sample villages in the same county because villages in the same county may compete for the same pool of government funding for village road projects. They are also monitored by the same county government.

[20] We use these two interaction-based instrumental variables because there are rich variations in the variables across villages and over time for the road projects. We also conduct IV estimations using either the two policy-based variables alone or the two status-based variables alone as the instruments. The estimates for the effect of the reform implementation on village road quality are similar. However, the policy-based variables alone only have limited variations across location and over time (but pass both the weak identification and over-identification tests). The two status-based variables alone only pass the weak identification test at the 10% level.

[21] The two interactive IVs pass both the weak identification and over-identification tests. In the weak identification test, the Cragg-Donald Wald F-statistic is 68.7 and is much larger than the Stock-Yogo weak identification test critical value at 10% maximal IV size (at 19.93). Therefore, the IVs are not weak. In the over-identification test, the Sargan statistic and Hansen's J chi-square statistics are both smaller than the corresponding critical values. Therefore, we cannot reject the null hypothesis that the IVs are valid.

[22] The variable equals one (1) if the leader was elected after the reform (i.e., through more open and competitive elections) and equals zero (0) if otherwise (i.e., through government-controlled elections).

Table 3
IV estimates of the effect of implementing village governance reform on village road quality.
Data source: Authors' survey.

	Project started after village reform (Y = 1; N = 0)	Comprehensive road quality scores (100 points max)
	(1)	(2)
Project in office term started after national legislation (Y = 1; N = 0) * Share of sample villages in other sample provinces implemented governance reform	1.91*** (0.18)	
Project in office term started after provincial legislation (Y = 1; N = 0) * Share of sample villages in other counties of the same province implemented governance reform	0.39*** (0.07)	
Project started after village reform (Y = 1; N = 0)		18.06*** (3.44)
Project characteristics	Y	Y
Village characteristics	Y	Y
Survey wave dummies	Y	Y
Village FE & project year FE	Y	Y
Project year county time trend	Y	Y
N	563	563
R^2	0.78	0.58

Note: Project characteristics include length of the road project, asphalt road dummy, concrete road dummy, project extension and upgrade dummy, project topology index, project complexity index, and project started in the final year of an office term dummy. Village characteristics include village population and village per capita income. Robust standard errors, clustered at the village level, are reported in parentheses.

***, **, and * indicate statistical significance from zero at the 1, 5, and 10% levels.

village party branch, (d) whether the leader has served as a member of the village committee before, (e) whether the leader is a member of the Chinese Communist Party, and (f) whether the leader's reported prior income is higher than that of an average villager. We conduct these analyses using both FE and IV models (modified from those explored in the previous sections).[23]

Table 4 presents the FE and IV estimation results. We find statistical evidence that after the implementation of village governance reform, younger leaders were elected (3.2 years younger in the FE model and 6.5 years in the IV model) and the leaders also had more education (1.0 year in the FE model and 2.2 years in the IV model). We find no statistical difference in the other leader attributes. Overall, our results show that the implementation of village governance reform allows villagers to elect leaders who are more likely to bring changes in the village.[24] Our results are also consistent with those of other studies (Luo, 2010; Martinez-Bravo et al., 2014).

6.2. Better accountability of village leaders

In rural China, village leaders do not have office term limits and can always choose to run for reelection. Therefore, another possible mechanism is that village residents hold elected leaders more accountable for the provision of infrastructure when they vote in the next election (Barro, 1973; Besley and Case, 1995; Persson and Tabellini, 2002; Besley and Coate, 2003; Faguet, 2004; Foster and Rosenzweig, 2005; Besley, 2006; Bardhan and Mookherjee, 2006; Martinez-Bravo et al., 2011, 2014; de Janvry et al., 2012). Specifically, villagers might vote for current leaders again if the quality of village road projects is perceived to be high, or for other candidates if projects have been of poor quality.[25]

We examine this mechanism by analyzing the turnover of village leaders. Specifically, we analyze whether the implementation of village governance reform affects the likelihood that village leaders are returned to office for another term. We also evaluate whether the average quality of village road projects (weighted by the length of road projects started in an office term) affects this likelihood. We further analyze whether average road project quality matters after the implementation of village governance reform.

Table 5 presents our estimation results.[26] We find that village elections become more competitive after the implementation of village governance reform. Incumbent leaders are 13–23% less likely to be re-elected for another term after the reform implementation (Row 1). Our results also show that before the reform implementation, road project quality did not help incumbent leaders get reelected (or reappointed) in government-controlled elections (Row 2). However, after the reform implementation, an increase in the quality score by 1 standard deviation (or 14 points) raises the chance that incumbent leaders are reelected by about 5.5% (Row 3). The effect is statistically significant at the 5% level.[27]

6.3. Higher level of community participation

The reform implementation can increase the quality of village road projects through a higher level of community participation in village affairs. Specifically, as village leaders are no longer appointed by upper level governments and are more accountable to village residents, village leaders may need to actively engage the village community and increase community participation in village affairs.[28] Villagers can participate in village affairs in China in two main ways. First, they can participate in village assemblies,

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[23] These leader attributes are those that can be more objectively enumerated. Villagers may also better evaluate other leader attributes that are more qualitative in nature (e.g., charisma, communication skills, and political capital). Unfortunately, we do not have data for these attributes. In addition, due to budgetary concerns we do not have data related to other nominated candidates. Therefore, we limit our analysis to selected attributes of the elected leaders only.

[24] We also conduct further regression analysis to estimate the effect of the implementation of village governance reform on the quality of village road projects while accounting for the characteristics of village leaders and also those of village party secretaries (see online Appendix Table 4). While we find negative estimates on the age of village leaders and positive estimates on the years of schooling of village leaders, these estimates are not statistically different from zero. Also, the estimates on the same two characteristics of village party secretaries are both essentially zero.

[25] This is probably not the case before the governance reform because officials in upper-level governments, who largely appoint village leaders through controlled elections, are usually far away from the village. When government officials select an individual as leader for the next term (or who can run for the next election), they may evaluate only performance indicators that are more quantifiable (Whiting, 2000; Tsui and Wang, 2004). They may neglect the quality of village road projects due to its less tangible nature.

[26] We only conduct FE estimation for the analysis because we do not have enough instrumental variables for IV estimations. Therefore, our explanatory variables may raise endogeneity concerns, and our results are mainly suggestive.

[27] Our further analysis shows that the quality of village road projects in the year before the next election is not statistically different from those in the first two years of the office term. This is true both before and after the implementation of village governance reform. Therefore, we find no evidence of manipulation in the quality of village road projects throughout the office term (Nordhaus, 1975; Rogoff, 1990; Persson and Tabellini, 2002; Besley, 2006; Ferraz and Finan, 2011).

[28] In fact, some researchers have shown that community participation increases the provision of local public goods (Olken, 2007, 2010; Ferraz and Finan, 2008; Park and Wang, 2010). However, to the best of our knowledge, no study has empirically examined whether local governance reform can also increase the level of community participation.

Table 4

FE and IV estimates of the effect of implementing village governance reform on village leader characteristics.
Data source: Authors' survey.

	Age at the start of office term	Years of schooling	Also serving as village party secretary (Y = 1; N = 0)	Former member of village committee (Y = 1; N = 0)[a]	Communist party member (Y = 1; N = 0)[a]	Prior income higher than village average (Y = 1; N = 0)[a]
	(1)	(2)	(3)	(4)	(5)	(6)
Mean of dependent variables	47.22	10.44	0.44	0.63	0.67	0.58
Panel A: FE estimations						
Village leader elected after reform (Y = 1; N = 0)	−3.17*** (0.67)	0.96*** (0.20)	0.15* (0.08)	0.05 (0.10)	0.01 (0.09)	−0.02 (0.10)
Village characteristics	Y	Y	Y	Y	Y	Y
Village FE & turnover year FE	Y	Y	Y	Y	Y	Y
Turnover year county time trend	Y	Y	Y	Y	Y	Y
N	505	505	505	404	404	404
R²	0.19	0.59	0.06	0.20	0.10	0.08
Panel B: IV estimations						
Village leader elected after reform (Y = 1; N = 0)	−6.46*** (1.32)	2.23*** (0.49)	−0.05 (0.17)	0.04 (0.23)	−0.01 (0.24)	0.03 (0.24)
Village characteristics	Y	Y	Y	Y	Y	Y
Village FE & turnover year FE	Y	Y	Y	Y	Y	Y
Turnover year county time trend	Y	Y	Y	Y	Y	Y
N	505	505	505	404	404	404
R²	0.13	0.55	0.05	0.20	0.10	0.08

Note: Village characteristics include village population and village per capita income. Linear probability model is used in column 3 to 6. Robust standard errors, clustered at the village level, are reported in parentheses.
***, **, and * indicate statistical significance from zero at the 1, 5, and 10% levels.
[a] Due to budgetary reasons, we only have data on the dependent variables on or before the year of 2008.

the highest governance body in the village. These assemblies provide a platform for community discussion of village affairs, and village leaders report their duties there. Second, they can participate in occasional public meetings to obtain updates from village leaders about village affairs. They can offer their views and participate in the management and monitoring of village projects.

We examine whether the implementation of village governance reform increases the level of community participation in village road projects through these two participation channels. First, we construct a dummy variable, *Project discussed in village assembly,* which equals

one (1) if the village road project was discussed in the village assembly, and zero (0) otherwise. Second, we construct another dummy variable, *Village participation in project management,* which equals one (1) if villagers can participate in project management and monitoring through public meetings, and zero (0) otherwise. We use them as the outcome variables of our analysis.

Table 6 reports results obtained from both FE and IV regression analyses. Overall, our results show that the implementation of village governance reform greatly increases the level of community participation in village road projects. After the reform implementation, villagers are

Table 5

FE estimates of the effect of village road quality on whether village leaders stayed in the next office term.
Data source: Authors' survey.

	Dependent variable: village leader staying in the next office term (Y = 1; N = 0)		
	(1)	(2)	(3)
	FE	FE	FE
Village leader elected after reform (Y = 1; N = 0)	−0.13* (0.07)	−0.13* (0.07)	−0.23*** (0.08)
Weighted average of comprehensive road quality scores in an office term		0.000 (0.001)	−0.002 (0.001)
Village leader elected after reform * weighted average of comprehensive road quality scores in an office term			0.003** (0.002)
Village characteristics	Y	Y	Y
Village leader characteristics	Y	Y	Y
Village FE & turnover year FE	Y	Y	Y
N	505	505	505
R²	0.13	0.13	0.14

Note: Village characteristics include village population and village per capita income. Village leaders' characteristics include age, years of schooling. Linear probability model is used in the table. Robust standard errors, clustered at the village level, are reported in parentheses.
***, **, and * indicate statistical significance from zero at the 1, 5, and 10% levels.

Table 6
FE and IV estimates of the effect of implementing village governance reform on community participation in the village road projects.
Data source: Authors' survey.

	Project discussed in the village assembly (Y = 1; N = 0)	Village participation in the project management (Y = 1; N = 0)
	(1)	(2)
Mean of dependent variables	0.53	0.50
Panel A: FE estimations		
Project started after village reform (Y = 1; N = 0)	0.52*** (0.09)	0.40*** (0.09)
Survey wave dummies	Y	Y
Village characteristics	Y	Y
Village FE & project year FE	Y	Y
Project year county time trend	Y	Y
N	563	563
R²	0.36	0.23
Panel B: IV estimations		
Project started after village reform (Y = 1; N = 0)	0.56*** (0.16)	0.50*** (0.16)
Survey wave dummies	Y	Y
Village characteristics	Y	Y
Village FE & project year FE	Y	Y
Project year county time trend	Y	Y
N	563	563
R²	0.36	0.23

Note: Village characteristics include village population and village per capita income. Linear probability model is used in this table. Robust standard errors, clustered at the village level, are reported in parentheses.
***, **, and * indicate statistical significance from zero at the 1, 5, and 10% levels.

over 50% more likely to discuss the projects in village assemblies (Column 1). They are also 40–50% more likely to participate in project management and monitoring through occasional public meetings (Column 2).

6.4. Extensive and intensive margins of village road investments

One other possible explanation for our main findings relates to changes in the way village road investments are made. Is the increase in village road quality a result of a reduction in the number or length of village road projects (i.e., extensive margins for village road quality)? Is the quality improvement caused by a higher level of road investment at the project level (i.e., intensive margins)?

We first examine the effect of reform implementation on road investment at the village level. We use the following village-level outcome variables in our analysis: (1) number of village road projects in an office term, (2) total length of all village road projects in an office term, and (3) total cost of all village road projects in an office term. Table 7 reports our results. Both our FE and IV estimations show that the implementation of village governance reform increases the number and total length of village road projects in an office term (Columns 1 and 2). The villages also are able to obtain more funding for these projects after the reform (Column 3). Therefore, we find no evidence that village reform implementation reduces the number or length of village road projects.

We then examine the effect of the reform implementation on village road investments at the project level using several different project-level outcome variables. Table 8 reports our estimation results using both FE and IV models. Overall, we find almost no statistical evidence that the reform implementation affects different aspects of village road projects. While the estimates of the total cost of project and the unit cost of project (i.e., total cost of project divided by road length) are both positive, the estimates are statistically insignificant (Columns 1 and 2). The estimates of the share of project cost that villages receive from higher-level governments are positive but statistically significant only in the FE model (Column 3). The implementation of reform does not affect other aspects of the projects (e.g., the number of days of local in-kind labor contribution, the duration of the project work, and the budget control and debt financing of the projects, as

Table 7
FE and IV estimates of the effect of implementing village governance reform on village road investments at the village level.
Data source: Authors' survey.

	Dependent variables		
	Number of village road projects started in an office term	Total length of all village road projects started in an office term (in km)	Total cost of all village road projects started in an office term (10,000 yuan)
	(1)	(2)	(3)
Mean of dependent variable	1.04	2.03	25.91
Panel A: FE estimations			
Village leader elected after reform (Y = 1; N = 0)	0.53*** (0.13)	0.96*** (0.24)	17.46*** (2.51)
Village characteristics	Y	Y	Y
Village FE and turnover Year FE	Y	Y	Y
N	505	505	505
R²	0.05	0.05	0.08
Panel B: IV estimations			
Village leader elected after reform (Y = 1; N = 0)	0.77*** (0.19)	0.86*** (0.30)	20.14*** (3.89)
Village characteristics	Y	Y	Y
Village FE and turnover year FE	Y	Y	Y
N	505	505	505
R²	0.04	0.05	0.08

Notes: Village characteristics include village population and village per capita income. Robust standard errors, clustered at the village level, are reported in parentheses.
***, **, and * indicate statistical significance from zero at the 1, 5, and 10% levels.

Table 8
FE and IV estimates of the effect of implementing village governance reform on village road investments at the project level.
Data source: Authors' survey.

	Dependent variables						
	Total cost of project (in 10,000 yuan)	Unit cost of project (in 10,000 yuan per km)	Share of project cost received from above	Total local in-kind labor used (in person-day)	Duration of project work (in months)	Project exceeded budget (Y = 1; N = 0)	Project incurred debt finance (Y = 1; N = 0)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mean of dependent variables	25.07	22.88	0.58	818.47	5.45	0.19	0.23
Panel A: FE estimations							
Project started after village reform (Y = 1; N = 0)	3.91 (2.78)	3.18 (4.36)	0.28*** (0.08)	69.92 (153.61)	−0.08 (0.36)	−0.07 (0.10)	0.07 (0.09)
Project characteristics	Y	Y	Y	Y	Y	Y	Y
Village characteristics	Y	Y	Y	Y	Y	Y	Y
Survey wave dummies	Y	Y	Y	Y	Y	Y	Y
Village FE & project year FE	Y	Y	Y	Y	Y	Y	Y
Project year county time trend	Y	Y	Y	Y	Y	Y	Y
N	563	563	563	563	563	563	563
R^2	0.40	0.13	0.17	0.27	0.09	0.08	0.09
Panel B: IV estimations							
Project started after village reform (Y = 1; N = 0)	4.41 (5.42)	1.01 (14.76)	0.13 (0.15)	103.28 (315.61)	1.22 (0.79)	0.10 (0.17)	0.07 (0.19)
Project characteristics	Y	Y	Y	Y	Y	Y	Y
Village characteristics	Y	Y	Y	Y	Y	Y	Y
Survey wave dummies	Y	Y	Y	Y	Y	Y	Y
Village FE & project year FE	Y	Y	Y	Y	Y	Y	Y
Project year county time trend	Y	Y	Y	Y	Y	Y	Y
N	563	563	563	563	563	563	563
R^2	0.40	0.12	0.16	0.27	0.06	0.07	0.09

Note: Project characteristics include road length, asphalt road dummy, concrete road dummy, extension or reconstruction dummy, project topology index and project complexity index. Village characteristics include village population and village per capita income. Linear probability model is used in column 6 and 7. Robust standard errors, clustered at the village level, are reported in parentheses.
***, **, and * indicate statistical significance from zero at the 1, 5, and 10% levels.

outlined in Columns 4–7).[29] Therefore, we believe that the improvement in village road quality is not caused by an increase in village road investment at the project level.

7. Discussion and conclusion

To the best of our knowledge, this study is the first to empirically examine the effects of local governance reform on the quality of local infrastructure projects. We examine the unique policy context of village governance reform and village road investment in China over the past two decades. Specifically, due to China's size and its gradualist approach to reform, rural villages in China implemented the governance reform in different years, and the reform mandates issued by upper-level governments can largely be viewed as random policy shocks to the villages. We select a nationally representative sample of 101 rural villages from five Chinese provinces and collect detailed data from these villages through three survey waves. Specifically, we document the pace and other details of the implementation of village governance reform and use a proprietary road quality evaluation scheme to measure the quality of over 550 village road projects.

As there are multiple road projects for each of our sample villages, we estimate the effects of reform on village road quality by controlling for two sets of fixed effects: (1) village fixed effects that account for unobserved time-invariant heterogeneities across villages, and (2) project year fixed effects that account for year-specific macroeconomic factors. We also control for various village and road project characteristics in our regressions. Our results show that the implementation of village governance reform greatly improves the quality of village road projects. The increase in road quality is large—about two thirds of a standard deviation of our road quality measure. We further conduct a number of sensitivity checks and a set of instrumental variable regression analyses to show that our results are robust to several different endogeneity concerns.

In examining the mechanisms that can explain these findings, we find that villagers tend to select leaders who are younger and more educated after reform implementation. Also, village elections become more competitive, and higher village road quality increases the chance that incumbent leaders will be reelected. Furthermore, we find that the implementation of village governance reform greatly increases the level of community participation in village road projects. However, we find no evidence that the increase in village road quality is driven by a decrease in the number or length of village road projects at the village level or an increase in the village road investment at the project level.

Our study examined how important the three mechanisms are in improving the quality of village road projects. However, we do not yet know whether these mechanisms complement or substitute for each other and whether dynamic interactions exist between them. Given the importance of local infrastructure quality and the increasing election of leaders by local community members, further research on local governance and the quality of local infrastructure projects is needed.

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[29] We also estimate for the *productivity* of village road quality by controlling for the *Unit cost of project* variable in our estimations of the effect of the implementation of village governance reform on the quality of village road projects. The estimated effect of the reform (FE estimate at 8.8 and IV estimate at 18.0; both highly statistically significant) are similar to those reported in Tables 2 and 3 (see online Appendix Table 5). The coefficients on *Unit cost of project*, however, are not statistically different from zero. Therefore, our results suggest that the productivity of village road quality increases after the implementation of governance reform.

Acknowledgments

Appendix A

Road quality evaluation scheme.
Notes: Point allocation scheme is included as a reference. Enumerators can assign points that best describes the attributes.

Evaluation aspects	Attributes/questions	Point allocation scheme	Road projects 1 2 3	Weight (%)
I. Quality of road alignment and cross-section (20 points)				
Horizontal curvature	01. Number of bends per 100 m	≤one = 100; two = 60; ≥three = 40.		4
Vertical curvature	02. Number of slopes per 100 m (this question does not apply if the surface is originally flat)	≤one = 100; two = 60; ≥three = 40.		4
Cross section conditions	03. Road width	2.5 m = 60; 3.0 m = 70; 3.5 m = 80; ≥4.0 m = 100.		8.4
	04. Any road shoulder?	Yes = 100; No = 0.		1.2
	05. Any passing zone?	Yes = 100; No = 0.		1.2
	06. Is cross-slope drainage possible on road surface?	Yes = 100; No = 0.		1.2
II. Quality of road bed (20 points)				
Road bed	07. Material of road bed	Clay = 60; Sandy soil = 80; Sand and gravel soil = 100.		16
Side ditch	08. Side ditch condition	Drain well = 100; Do not drain well = 60; No side ditch = 0.		4
III. Quality of road surface (50 points)				
Base course (not applicable to gravel roads)	9. Base course material	Rock pieces = 60; Lime + coal + dirt = 70; Lime + coal + gravel = 80; Lime + coal + rubble = 90; Cement + rubble = 100; Base of old dirt road = 40; Base of other old road = 100.		6.25
	10. Base course thickness	≤10 cm = 0; 10–15 cm = 60; ≥15 cm = 100.		6.25
Surface	11. Surface type	1 = asphalt mixture; 2 = concrete, skip to question 17; 3 = sand + gravel, dirt + gravel, etc., skip to question 23.		–
	Attributes 12–16: applicable to asphalt roads only			
	12. Surface material and thickness	Asphalt penetration: ≥5 cm = 100; 3–5 cm = 60; ≤3 cm = 40. Asphalt coating: ≥5 cm = 100; 3–5 cm = 60; ≤3 cm = 40. Asphalt gravel: ≥5 cm = 100; 3–5 cm = 60; ≤3 cm = 40.		22.5
	13. Surface condition	Smooth but not straight = 60; Straight but not smooth = 60; Smooth and straight = 100.		3.75
	14. Size of most pits	Deeper than 10 cm = 40; <10 cm in depth = 70; No pits at all = 100.		1.875
	15. Pit density Note: for pits with diameter > 10 cm only.	Number of pits per 10 square meter ≥10 = 0;		1.875

Appendix A (*continued*)

Evaluation aspects	Attributes/questions	Point allocation scheme	Road projects 1 2 3	Weight (%)
	16. Asphalt laying process	5–10 = 60; ≤5 = 80; No pit at all = 100. Rolled over by medium road roller ≤3 times = 40; 3 times = 80; ≥3 times = 100. Rolled over by small road roller ≤4 times = 40; 4 times = 80; ≥4 times = 100.		7.5
	Attributes 17–22: applicable to concrete roads only			
	17. Surface thickness	≤10 cm = 40; 10–15 cm = 60; ≥15 cm = 100.		22.5
	18. Distribution of expansion and contraction joints	Interval between joints ≤5 m = 100; 5–7 m = 60; ≥7 m = 40.		3.75
	19. Pits on road surface	With pits = 40; Without pits = 100.		1.875
	20. Structure inside road surface	With honeycomb-like web = 40; Without web = 100.		3.75
	21. Is surface grinded?	Yes = 100; No = 0.		1.875
	22. Number of cracks per plate	No = 100; One = 70; ≥two = 40.		3.75
	Attributes 23–30: Applicable to gravel roads only			
	23. Surface material	Natural sand and gravel = 60; Crushed rubble = 80; Dirt and crushed rubble = 100.		11
	24. Surface thickness	≤20 cm = 60; ≥20 cm = 100.		16
	25. Size of most pits	Deeper than 10 cm = 40; <10 cm in depth = 70; No pit at all = 100.		3
	26. Pit density Note: for pits with diameter >10 cm only.	Number of pits per 10 square meter ≥10 = 0; 5–10 = 60; ≤5 = 80; No pit at all = 100.		3
	27. Are road base rock pieces observable from the surface?	Count of rock pieces per 10 square meter ≥10 = 0; 5–10 = 60; ≤5 = 80; No rock pieces = 100.		3
	28. Is there wet mud or sludge on the surface?	Yes = 0; No = 100.		3
	29. Is the road accessible in rainy days?	Yes = 100; No = 0.		5.5
	30. Tire print on lanes	No print = 100; Light prints = 70; Heavy prints = 40.		5.5
IV. Quality of the attributes for road safety (10 points)				
	31. Do plants along the road affect visibility?	Yes = 0; No = 100.		2
	32. Do irrigation channels affect the road?	Yes = 0; No = 100.		1
	33. Is there landslide or slope erosion along the road?	Yes = 0; No = 100.		2
	34. Is it common that road surface is lower than road shoulder?	Very common = 0; Slight = 50; None = 100.		2
	35. Is it comfortable to drive on this road?	Comfortable = 100; Average = 60; Uncomfortable = 0.		1
	36. Is it common that a car cannot pass by another?	Yes = 0; No = 100.		2
V. Comprehensive road quality scores (100 points)				

Appendix B. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jpubeco.2017.06.006.

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