

Road Expansion and Off-Farm Work in Rural China*

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Abstract

This study estimates the impact of road expansion on off-farm activities in rural China. To achieve this goal, econometric models that capture the impact of road expansion on migration and local off-farm works are developed and estimated using individual data. Estimation results show that road expansion encourages farmers to participate in local off-farm work rather than migrate. In addition, road expansion also has a significant impact on the working time and income of local off-farm work.

Keywords: road; migration; local off-farm work; rural China

Investment in roads has always played an important role in development. The theoretical literature argues that road expansion should stimulate development by promoting trade, reducing transaction costs and improving the flow of information.¹ There also is an empirical literature on roads, economic growth and rural incomes.² Several papers measure the linkages between the improvement of road access and economic growth.³ In many of these papers, economic growth is shown to be linked to better opportunities for farmers to sell their goods at higher prices, which leads to income growth.⁴

More recently researchers have tried to identify more nuanced ways that roads affect income. In particular, there are papers that show that roads can help rural

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1 Gannon and Liu 1997; Olsson 2009.

2 For example, Binswanger, Khandker and Rosenzweig 1993; Gibson and Rozelle 2003; van de Walle and Mu 2007; Calderon and Serven 2008.

3 For example, Binswanger, Khandker and Rosenzweig 1993.

4 For example, Gibson and Rozelle 2003; Escobal and Ponce 2002; Jacoby 2000.

individuals gain access to off-farm employment activities.⁵ For example, a case study in Brazil shows that access to roads raises the returns to off-farm activities – even more than they raise the returns to on-farm activities.⁶ Studies in other countries, such as Vietnam⁷ and Mexico,⁸ also demonstrate the effect of roads on rural employment and have found a significant relationship between road expansion and off-farm job opportunities.

Mirroring the international literature, linkages between road expansion and its impact in China are also empirically estimated. Some studies show that improvements to transportation infrastructure have contributed to national economic growth,⁹ farm income and poverty alleviation.¹⁰ Other studies analyse the relationship between road expansion and off-farm activities. Using provincial-level data from the 1980s and 1990s, Shenggen Fan and Connie Chan-Kang demonstrate that road expansion has a positive and significant impact on off-farm GDP.¹¹ Likewise, Fan, Zhang and Zhang find that road density has positively affected the participation of farmers in off-farm employment activities.¹²

While this new thread in the literature is interesting to both researchers and policymakers, a disaggregated analysis would be even more helpful since some types of off-farm work may be affected by road expansion differently. Off-farm work in the migrant sector is mostly located in large cities which are typically far from the migrants' homes. On the other hand, local off-farm job opportunities, which largely depend on the nature of local economic growth, allow farmers to live in their own homes while working off the farm. Owing to these inherent differences and because of the way road expansion reduces transaction costs for different types of off-farm employment, road expansion may be expected to have different impacts on local off-farm work and migration.¹³

To our knowledge (with a couple of exceptions), there is little disaggregated empirical analysis on the impact of road expansion on off-farm employment in China. Using household-level data from the mid-1990s collected in Sichuan province, Yaohui Zhao finds that the presence of paved roads between villages and the areas outside of the village has a negative impact on migration,¹⁴ and has an insignificant impact on local off-farm employment. Unfortunately, there is no way to judge the validity of the findings, since the author does not explain her modelling approach. Other studies on transportation do spend time discussing their empirical modelling approaches.¹⁵ However, these papers are largely

5 Gachassin, Najman and Raballand 2010.

6 Escobal 2001.

7 Mu and van de Walle 2007.

8 de Janvry and Sadoulet 2001.

9 Xu, Li and Yang 2007; Zhang, Xueliang 2007; Yao, Guan and Fang 2001.

10 Démurger 2001; Felloni et al. 2001; Jalan and Ravallion 2002; Fan, Zhang and Zhang 2002; Lin 2003.

11 Fan and Chan-Kang 2005.

12 Fan, Zhang and Zhang 2004.

13 Mundlak 1979.

14 Zhao 1999a, 1999b.

15 For example, Shi, Heerink and Qu 2007; Démurger, Fournier and Yang 2010.

focused on the ability of households to access markets (in general) and do not focus directly on the impact of road expansion on off-farm employment. To date, we believe that no empirical work examines the impact of road expansion on total working time or the off-farm income of rural individuals.

The overall goal of this article is to understand the impact of road expansion on the off-farm work activities of farmers in rural China. In particular, we seek to track empirically how road expansion affects different types of off-farm employment opportunities (i.e. local off-farm and migrant employment opportunities) in terms of participation, total working time and off-farm earnings.¹⁶ To meet this overall goal, we have three specific objectives. First, using survey data we provide a profile of China's rural road expansion, document the rise of off-farm employment and descriptively chart the way that roads and off-farm employment appear to move together. Second, we seek to understand if road expansion, all other things being equal, is associated with the level of participation in migrant and local off-farm labour markets. Finally, we empirically identify the different sources of the effects of road expansion on off-farm employment: is there an impact on total working time or income, or both?

The rest of this article is organized as follows. In the next section, we discuss the data collection. We then present a brief discussion of road expansion in China and the correlation between road expansion and off-farm employment. The econometric approach is presented, and the empirical results are discussed, in the fourth section. The last section concludes.

Data

The data used in this article are from a nearly nationally representative survey in rural China conducted by the Center for Chinese Agricultural Policy, Chinese Academy of Sciences, in 2005 and 2008. In this survey, 100 villages were randomly selected from 50 townships in 25 counties located in 5 provinces. The sample villages were selected as follows. First, five provinces were each randomly selected to represent five of China's major agro-ecological zones: Jiangsu represents the eastern coastal areas (Jiangsu, Shandong, Shanghai, Zhejiang, Fujian and Guangdong); Sichuan represents the south-western provinces (Sichuan, Guizhou and Yunnan) plus Guangxi; Shaanxi represents the provinces on the Loess Plateau (Shaanxi and Shanxi), Inner Mongolia and the rest of the provinces in the north-west (Gansu, Ningxia, Qinghai and Xinjiang); Hebei represents the north and central provinces (Hebei, Henan, Anhui, Hubei, Jiangxi

16 Although we understand that corruption in land procurement may harm the interests of rural residents by offsetting possible positive impacts on employment and the like (especially in cities or densely populated suburbs), we believe that in the context of most rural areas this is not too great a problem (that is, in areas in which roads are needed and land is relatively plentiful). There is undoubtedly corruption, but it is mostly between the builder of the road (the construction company) and the financier of the road (i.e. the county and/or township government agencies and/or the village leadership). This article focuses on measuring the effect of roads on off-farm employment, and so a complete discussion of the corruption that surrounds road building is beyond its scope.

and Hunan); and Jilin represents the north-eastern provinces (Jilin, Liaoning and Heilongjiang).

After the provinces were selected, the second step of the sample selection involved choosing the counties, townships and villages. 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 because Rozelle shows that it is one of the best predictors of standard of living and development potential and is often more reliable than net rural per capita income.¹⁷ Within each county, the survey team chose two townships, one from each half of a list of townships also arranged in descending order of per capita GVIO. Finally, within each township, two villages were chosen following the same procedure as the township selection.

We then chose the sample households. In each village eight households were randomly selected in 2005. After excluding the households in which no individual was in the labour market (e.g. a household of two elderly people who did not work on-farm or off-farm), 773 households were included in this study. In 2008, we were able to re-interview 625 households (again, those households with at least one person in the labour market). In this manner, we were able to revisit 81 per cent of the households. All of the selected households answered similar questionnaires in both years.

It is possible to show that attrition between the 2005 and 2008 surveys has not compromised the nature of the sample. According to our data (from 2005), when we compare the households that were lost from the sample during the period between the two survey waves to those households that remained in the sample, there is no significant impact on the nature of our sample. The comparison was made in terms of a number of different characteristics of the household head (such as gender), the household (such as the number of elderly dependents and the household's per capita land holdings), and the township in which each sample household lived (such as per capita GDP at the township level). Likewise, and perhaps more importantly, households' access to roads did not differ between those that remained in the sample and those that dropped out of the sample. Hence, we do not consider that attrition between the first and second wave of the survey is a serious problem in the subsequent analysis.¹⁸

The dataset collected for this study includes basic information about townships, villages and households in the study areas for both 2004 (collected in 2005) and 2007 (collected in 2008). Enumerators interviewed village leaders using a survey form designed to collect basic socio-economic information, such as total population and the number of individuals in the labour force. For highways outside the village and paved roads within the village, detailed questions (about information such as location and the type of road) were asked and recorded. In order to have a better understanding of road expansion over time,

17 Rozelle 1996.

18 The results of the attrition analysis are available upon request from the authors.

information on the nature of the road system in 1997 was also collected from records and from the recollection of respondents. Finally, basic social-economic indicators such as per capita GDP, per capita income and township-level GVIO were also collected.

At the same time, the team collected a great deal of information about each sample household during both waves of the survey. In addition to survey blocks enumerating the basic characteristics of households (for example, each household's land and labour endowments, production assets and housing), there were two sections that collected information that forms the core of this article's analysis. First, there is a section on the demographic information of each individual in the household, detailing facts such as gender, age, education and marital status. Second, the survey has a long section that records the working experience of each household member who was part of the labour force. Enumerators asked questions about whether each member of the household's labour force had an off-farm job, and if so, what type of off-farm job, how much time was spent on that job and how much income was earned from it, both monetary and non-monetary.

Road Expansion and Off-Farm Employment in Rural China

Prior to the economic reforms, rural-to-urban migration was highly restricted in China. This urban–rural segregation was instituted following the devastating famine that occurred between 1959 and 1961.¹⁹ Consequently, the income of rural households became tied to the participation of household members in on-farm work. In cases where rural individuals were able to move to cities to work, they faced high costs of living since they did not have access to necessities such as housing and food, and were unable to access many jobs which were reserved for urbanites. Such restrictions succeeded in controlling the size of the urban population for decades. As a result, the proportion of the population that lived in urban areas was less than 20 per cent by the late 1970s.²⁰

There are at least three reasons why the government loosened restrictions and began to allow farmers to move from rural areas to China's cities after the beginning of the economic reforms in the 1980s. First, following the decollectivization of farmland, many were eager to move out of farming since the plots allocated to farmers were small, which led to a surplus of labour in many families. Second, as economic growth led to a reduction in the shortages of food and other goods, markets emerged and the cost of moving to the city fell. Rural individuals were able to find rudimentary housing and affordable food and clothing in the city. Finally, rapid economic growth in the cities and adjacent industrial zones resulted in a huge demand for low-paid labour. With little opportunity to increase on-farm income and with the availability of off-farm employment, tens of millions of farmers left their hometowns and migrated to the cities in the late

19 Zhao 1999b.

20 NBSC 2010.

1980s and 1990s. Rural–urban migration not only increased the income of rural households, it also became an important force driving China’s economic growth during the 1980s and 1990s.²¹

The volume of labour that migrated from rural to urban areas in China during this period was unprecedented. Even though there was almost no rural–urban migration before the reforms began in the late 1970s, according to China’s own statistical sources, the number of migrants was around 90 million in 2001.²² This number increased to more than 130 million in 2006, which is about a quarter of the total labour force in rural China.²³ The number continues to increase rapidly.²⁴

There was also considerable movement of labour off farm to nearby factories and to local towns. According to the National Bureau of Statistics of China (NBSC), the average number of rural individuals with local off-farm employment was about 90 million during the late 2000s.²⁵ The survey data collected by NBSC, which included information on all provinces in China (with the exception of Tibet), showed that rural households in eastern coastal regions were most likely to work in local off-farm jobs (when compared to those in western and central regions).

Our survey data are consistent with national statistics. In our sample, as in the national-level statistics, members of rural households have two off-farm employment options. First, there is off-farm work in or near their hometowns where the individuals live in their own houses in their villages and commute to work. Hereafter, we call this type of work local off-farm employment. Alternatively, individuals can work off the farm outside of their hometowns. In these cases, the individuals do not live in their own homes, but instead they live in rented accommodation in the destination city or in a dormitory on the job site. This is what we term as “migration,” and those that engage in migration are called “migrants.”

According to our data, there are substantial levels of local off-farm employment and migration among the sample households. The share of individuals in the labour force in our sample that has found local off-farm employment is 28 per cent (see [Table 1](#)). At the same time, 24 per cent of the individuals in our sample are migrants. The share of the sample individuals who only farm (that is, they have no local off-farm employment and are not engaged in migration) is less than 50 per cent.

[Table 1](#) also shows the characteristics of those working off the farm. Specifically, our data show that migrants are younger, more educated and less likely to be married than individuals with local off-farm employment. [Table 1](#) also shows that the per capita GVIO of the towns which have higher shares of

21 Young 2003.

22 NBSC 2002.

23 NBSC 2006.

24 NBSC 2012a.

25 Ibid.

Table 1: **Characteristics of Labourers with and without Off-Farm Work^a**

	Individuals with off-farm work					
	Migrants	Local off-farm workers	p-value (1) vs (2)	Individuals who only farm	p-value (1) vs (4)	p-value (2) vs (4)
	(1)	(2)	(3)	(4)	(5)	(6)
Share of individuals (%)	24	28		49		
Share of individuals married (%)	58	91	0.00	89	0	0.10
Share of male (%)	68	65	0.18	34	0	0.00
Age (years)	30.85	40.19	0.00	43.30	0.00	0.00
Education (years)	8.86	8.36	0.00	7.29	0.00	0.00
Number of children in the household aged 0–7	0.42	0.36	0.07	0.38	0.11	0.58
Number of elderly in the household aged 65 and over	0.26	0.22	0.12	0.21	0.01	0.49
Per capita land (<i>mu</i>)	1.55	1.39	0.08	1.96	0.00	0.00
Per capita GVIO (1,000 yuan)	5.87	7.91	0.00	6.02	0.76	0.00
Total working time (1,000 hours)	2.48	2.19	0.00			
Off-farm income ^b (1,000 yuan)	10.34	7.30	0.00			

Notes:

^aSamples include those aged 16–60 years old and who are not in school. ^bTotal off-farm income, including non-cash income, and 2007 income is adjusted using CPI.

Source:

Authors' survey.

individuals who work in local off-farm employment is more than the per capita GVIO of towns which have higher shares of migrants. Presumably, individuals in China's poorer regions are more likely to be migrants since there are fewer local off-farm job opportunities. In contrast, individuals in non-poor regions have relatively more opportunities to work locally. Our data also show that the average working time of migrants is longer than those working in local off-farm employment; the income from migration is also higher.

In contrast, individuals who only farm are more likely to be female, older and less educated than individuals with either type of off-farm employment. As shown in row 8, per capita land holdings of individuals who only farm are higher than those of individuals with off-farm work (1.96 *mu* versus 1.55 *mu*/1.39 *mu*).²⁶ Table 1 also shows that individuals who only farm are more likely to be in poor regions than those with local off-farm employment.

26 1 *mu* is equal to 1/15th of a hectare.

Interestingly (and importantly for reasons of external validity), these figures are consistent with those from national statistical sources and other case studies.²⁷ This consistency not only reinforces the idea that there are different types of workers in different types of jobs in rural China, but also suggests that our sample is fairly representative of households in rural China.

Road expansion in China

China was poorly endowed with transportation infrastructure when the economic reforms began in 1978. Under the centrally planned system, the government was the sole investor in all sectors of the economy, and priority was given to heavy industry. Road building fell far below what it should have been, given China's ambitions and growth targets. As a result, with the exception of an emerging transportation network in the north and north-eastern regions of China – where the nation's heavy industry was located – there was little development of roads in other regions until the late 1970s and early 1980s.²⁸ The total length of the highway network was only 883,000 km in 1978; the road density was less than 100 km per thousand square km, a level that indeed put China among the world's poorest nations.²⁹

Recognizing that the nation's infrastructure was not keeping pace with the needs of its developing economy, the government began to focus on road development in the mid-1980s. Between 1990 and 2010, road expansion was one of the highest priority items in the annual “Report on the work of the government” document.³⁰ The government also expended a great deal of effort on advertising its road expansion policy in order to gain support for the huge fiscal expenditures that were being invested. In the 1990s, one of the most common slogans in China's countryside was: “Want to get rich? Build a road first!”³¹

China's leadership has backed up its plans and propaganda campaigns with serious investment commitments. Particularly since the early 1990s, China's government has invested heavily in all dimensions of the nation's road network,³² including towards the expansion of the road network in counties and towns,³³ improving the quality of roads,³⁴ and increasing the number and length of expressways in both eastern coastal regions and western inland regions.³⁵ The total length of China's highway system increased from less than 1 million km in 1978 to more than 4 million km at the end of 2010.³⁶ By the end of 2010,

27 For example, NBSC 2006; Mu and van de Walle 2009; de La Rupelle et al. 2010.

28 World Bank 1999.

29 NBSC 2009.

30 State Council various years.

31 Nyiri and Breidenbach 2008, 128.

32 Nyiri and Breidenbach 2008.

33 Ministry of Communications 2005; 2006.

34 Liu, Chengfang, et al. 2009.

35 State Council 2001.

36 NBSC 2009; 2011.

the total length of the nation's network of expressways was 74,100 km, making China second only to the United States in overall expressway density.³⁷

Researchers have now begun to document and analyse the unfolding road-building frenzy in China. Previous studies have shown that highway expansion leads to the rapid development of the local economy along the new roads.³⁸ Using provincial and county-level data, Fan and Zhang also show that road expansion contributes to local economic development.³⁹ Road expansion also has had a significant positive impact on farmer income and poverty alleviation – especially in poor areas.⁴⁰

Despite the progress in road building during the 1980s and 1990s, it was widely acknowledged in the early 2000s that more road networks were needed – especially in rural areas. Living conditions in rural areas were still poor after two decades of reform.⁴¹ Studies show that rural infrastructure was also still poor and was partially to blame for the wide and widening gap between rural and urban areas. For these reasons, in the early 2000s, the government launched the “building a new socialist countryside” campaign.⁴² As part of its commitment to improve livelihoods in rural areas, the government dramatically increased its investment in rural areas in order to improve rural infrastructure, and road expansion was at the top of the list of priorities.⁴³ Between 2006 and 2010, the government invested 197.8 billion yuan in the construction of rural roads, leading to an annual growth rate of 30 per cent for the rural road network.⁴⁴ By 2011, the length of the rural highway network had reached 3.5 million km,⁴⁵ accounting for 87 per cent of China's total road network.⁴⁶ During this time, the quality of rural roads was also improved.⁴⁷

The extent of road expansion from our survey data is consistent with these macro-statistics that come from government reports. In [Figure 1](#), we use two variables to measure road expansion: a) the distance to the nearest highway from a village;⁴⁸ and b) the length of paved road within a village's boundaries. As shown in Panel A, the average distance from a village to the nearest highway was 3.35 km in 1997; it decreased to 1.66 km by 2007, a reduction of about 50 per cent. The rise of paved roads within the boundaries of villages is also

37 NBSC 2011.

38 You and Han 2000; Liu, Nan 2002.

39 Fan and Zhang 2003.

40 Zhou and Ruan 2010; Luo et al. 2007.

41 Luo et al. 2007.

42 Wen 2007; Cho 2001.

43 Luo et al. 2007.

44 ResearchInChina. 2011. “China road construction industry report 2010,” <http://www.reportbuyer.com/go/RIC00635>. Accessed 18 May 2011.

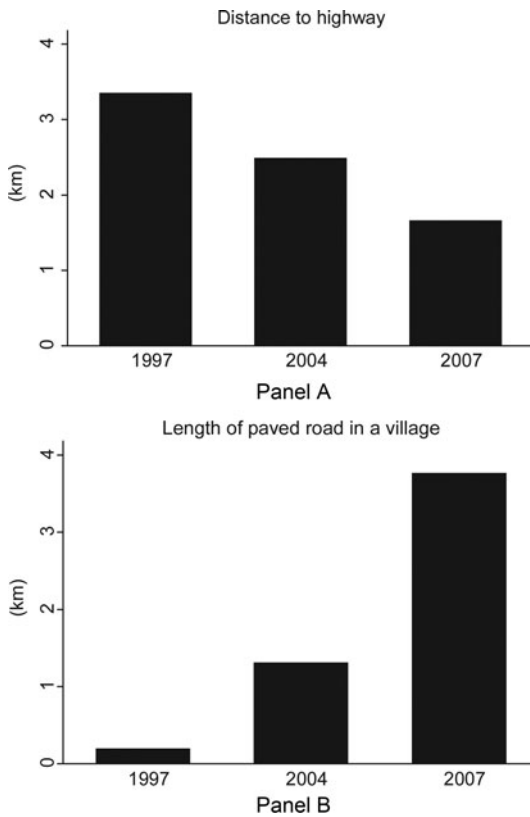
45 NBSC 2012b.

46 Ministry of Communications. 2012. “Investment in rural road increased by 16 times over 10 years,” <http://www.chinanews.com/gn/2012/03-31/3788711.shtml>. Accessed 6 June 2011.

47 Liu, Chengfang et al. 2009.

48 “Distance to the nearest highway from the village” is the distance from the village office to the nearest highway.

Figure 1: Road Development, 1997–2007



significant. Our data show that between 1997 and 2007, the total length of paved road within our sample villages increased from 0.22 km to 3.84 km (Panel B).

Road expansion and off-farm employment

To study the correlation between road expansion and the changes in off-farm employment, we need to create a set of variables to measure the nature of roads and the nature of off-farm employment. Since road quality and type may have different impacts on the off-farm activities of rural individuals,⁴⁹ we use two road variables in this study: the distance to the nearest highway from a village; and the per capita length of paved road within a village's boundaries.⁵⁰ We then divide farmers into different groups according to their access to roads. We first divide the sample into three subgroups according to the distance to the nearest highway from a village: a “near” group is defined as such if the distance

49 Fan and Chan-Kang 2005.

50 Per capita length of paved road within a village is used to control for the size of the village in the analysis.

to the nearest highway from a village is less than 0.50 km; a “middle” group if the distance is less than 3 km but greater than 0.5 km; and a “far away” group if the distance is greater than 3 km.⁵¹

Using these cut-off definitions, we can see a correlation between the type of road and the nature of off-farm employment. As shown in [Table 2](#), 41 per cent of the individuals in our sample belong to the near group, with the average distance to the nearest highway being 0.08 km. In addition, 39 per cent of the sample individuals belong to the middle group. The average distance of the middle group to the nearest highway is 1.66 km. Finally, 21 per cent of the sample individuals belong to the far away group, with an average distance to the nearest highway of 9.80 km.

We also use our other road variables, paved roads within the village, to create analytical groupings. Since about two thirds of the sample villages contain no paved roads inside their boundaries, we divide the sample into two parts. Specifically, as seen from [Table 2](#), 68 per cent of individuals live in villages without paved roads (henceforth the “no paved roads” group). In contrast, 32 per cent of individuals live in villages with paved roads (henceforth the “yes paved roads” group).

[Table 2](#) shows that the expansion of roads appears to have a positive impact on the off-farm employment of our sample individuals. According to our data, in the case of villages that are far away from the highway, the share of migrants is 60 per cent, which is higher than in middle or near villages (49 per cent and 38 per cent, respectively). The opposite is true in the case of local off-farm employment. As shown in column 4 of [Table 2](#), in near villages, more than 60 per cent of the sample individuals have local off-farm employment, but only 40 per cent of those in far away villages work in local off-farm employment.

[Table 2](#) also shows that road expansion is correlated with total working hours and income. This is especially true for those working in local off-farm employment. As shown in column 6, the total working time of sample individuals in near villages is 1,444 hours. In contrast, the totals of working hours of sample individuals in middle and far away villages are lower, ranging between 771 and 1,046 hours. Similarly, the off-farm income of sample individuals in near villages is 8,000 yuan, which is about 50 per cent higher than that of individuals in far away villages. Hence, according to our data, in villages with access to roads, local off-farm workers work longer hours and their off-farm income is higher. The story is slightly different with migrants. Even though migrants from far away villages work longer hours than migrants from near and middle villages, their income is not significantly higher.

A similar pattern of correlations appears if we examine the relationship between the presence of paved roads within the boundaries of the village and

51 The distances, 0.5 km and 3 km, were chosen since individuals in our sample (as discovered during field surveys) usually considered they were “near” a highway if the distance to the nearest highway was less than 0.5 km; they almost always believed they were “far away” if the distance to the nearest highway was more than 3 km. We also tried a number of different cut-off points (e.g. 1 km and 5 km) and arrived at similar results.

Table 2: Road Expansion and Off-Farm Work

	Group	Road Expansion		Off-Farm Work Participation (%)		Total Working Time (hours)		Off-Farm Income (yuan)	
		Distance (km) (1)	Share of observation (%) (2)	Migrants (3)	Local off-farm workers (4)	Migrants (5)	Local off-farm workers (6)	Migrants (7)	Local off-farm workers (8)
Distance to the nearest highway ^a	Near ^c	0.08	41	38	62	1,015	1,444	11,636	8,000
	Middle ^c	1.66	39	49	51	1,175	1,046	9,178	6,996
	Far away ^c	9.80	21	60	40	1,420	771	10,020	5,374
Paved road within village ^b	No ^d	0.00	68	49	51	1,164	1,046	8,254	5,973
	Yes ^d	2.56	32	41	59	1,125	1,399	14,602	9,006

Notes:

^aDistance (km) to the nearest highway from a village. ^bPaved road within the boundaries of a sample village. ^cWe defined a “near” group as such if the distance to the nearest highway from a village was less than 0.5 km; a “middle” group if the distance was less than 3 km but greater than 0.5 km, and a “far away” group if the distance was greater than 3 km. ^dA “yes paved roads” group was defined as such if there was paved road within the boundaries of a sample village, and a “no paved roads” group if there was no paved road within the boundaries of a sample village.

Source:

Authors’ survey.

different types of off-farm employment (Table 2). According to the data, 49 per cent of sample individuals work as migrants if they are from the no paved road villages. In contrast, only 41 per cent of those from paved road villages work as migrants. At the same time, for local off-farm workers, the presence of paved roads within the village has positive correlations with total working hours and off-farm income. Sample individuals in villages with paved roads work longer hours (1,399 versus 1,046) and earn more off-farm income (9,006 yuan versus 5,973 yuan) than those in villages with no paved roads.

Multivariate Approach and Empirical Findings

In this section, we seek to isolate the impact of road expansion on off-farm employment by estimating a series of econometric models. We do so because it is possible that the descriptive results in the previous section are misleading since the impact of other factors which affect off-farm employment outcomes are not excluded. In order to isolate the effect of road expansion on off-farm employment, we define an econometric model and describe the findings below.

Econometric model

The econometric model we use can be specified as:

$$\begin{aligned} \text{Off-farm}_{i,t} = & a_0 + a_1^* \text{Road}_{i,t-1} + a_2^* \text{Individual}_{i,t} + a_3^* \text{Household}_{i,t} \\ & + a_4^* \text{Social-economics}_{i,t} + a_5^* \text{Year}_{i,t} + e_{i,t} \end{aligned}$$

Equation (1)

where *off-farm* is a binary variable, which is equal to 1 if individual *i* has an off-farm job, and is equal to 0 otherwise. The variable, *Road*, is specified in one of two ways (and is used in separate models): 1) the distance to the nearest highway from a village; or 2) per capita length of paved road within a village's boundaries. In this model, we use lagged measures of road (that is, the measure of road length from the previous time period of our data). It is possible that the impact of road expansion may be overestimated if there is any degree of reverse causality (i.e. if off-farm participation might be associated with road expansion) and this source of endogeneity is ignored. For this reason, lagged road expansion is used in the analysis as is common practice in other similar studies.⁵² The second reason for using lagged road expansion is that it might take some time for the impact of road expansion to appear.

The model in the above equation (1) also controls for other factors. Specifically, *Individual* is a vector of the characteristics of the individuals in our sample. We include several variables to measure the characteristics which may account for some of the heterogeneity in off-farm employment across

52 For example, Kao and Chiang 2001.

individuals. For example, years of *education* are included as a measure of human capital; and *age* and *age-squared* are included to control for the life-cycle effects that may influence the decision to participate in migrant and local off-farm labour markets. In addition, as in other studies,⁵³ *married* (a dummy variable which is equal to 1 if the individual is married, and is equal to 0 otherwise) and *gender* (a dummy variable which is equal to 1 if the individual is male, and is equal to 0 if female) are also included.

The *Household* variable is a vector of household characteristics. *Per capita Land* is used to control for factors affecting farming income at the household level and, by implication, differences in the potential of individuals to increase income from working off-farm.⁵⁴ We also include the *number of children* (aged 0–7) and the *number of elderly* (aged 65 and over) in the household to measure the impact of the number of dependents on off-farm work participation, as do other studies.⁵⁵

Finally, we include two variables to measure the impact of the *socio-economic* factors of our individual's town/villages. The first variable is *ratio of migration in the village's total labour force* during the previous time period. This variable, among other things, is used to measure the impact of social networks on an individual's migration decision, which is common in previous studies.⁵⁶ The second variable is the *per capita GVIO* of the township. This variable, as discussed above, is included to control for the nature of the local economy. A year dummy (*Year*) is added to control the impact of time. The symbol *e* is the error term.

Since off-farm work participation is a discrete variable, OLS may produce biased and inconsistent parameter estimates.⁵⁷ Therefore, Logit models are used in this study. Because an individual's off-farm employment decision may be affected by the off-farm employment status of other individuals in the family (for example, if one household member is farming, the other may be more likely to work off-farm), all of the models correct for clustering at the household level.

Estimation results

The results of the econometric estimation of equation (1) are shown in Table 3, columns 1–6. In general, most of the regression results are consistent with the descriptive analysis above. Most coefficients on the control variables are as expected and statistically significant. For example, the results show that educated male labourers are more likely to engage in off-farm work; land endowment on the other hand is negatively related to off-farm work participation. These findings are consistent with most previous studies.⁵⁸ We also find that social networks

53 For instance, Zhao 1999a; 1999b.

54 Shi, Heerink and Qu 2007; Zhao 1999a.

55 For example, Shi, Heerink and Qu 2007.

56 For example, Zhao 2003; Zhang and Li 2003; Chen, Huffman and Rozelle 2004.

57 Maddala 1983.

58 For example, Zhao 1999a; 1999b; de Brauw and Rozelle 2008.

Table 3: Logistic Models of Off-Farm Work Determination

	Pooled Logit Models						Fixed Effect Logit Models					
	Off-farm work (1)	Migration (2)	Local off-farm work (3)	Off-farm work (4)	Migration (5)	Local off-farm work (6)	Off-farm work (7)	Migration (8)	Local off-farm work (9)	Off-farm work (10)	Migration (11)	Local off-farm work (12)
Distance to nearest highway from village	-0.0165 (-2.20)**	0.0412 (4.71)***	-0.0687 (-5.33)***				0.0433 (1.34)	0.0864 (2.37)**	-0.0532 (-1.66)*			
Per capita length of paved road within village				0.1918 (3.93)***	0.0153 (0.27)	0.1780 (3.53)***				0.0520 (0.61)	-0.0571 (-0.61)	0.1315* (1.59)
Married (yes = 1)	0.0937 (0.50)	-0.4552 (-2.48)**	0.8233 (4.17)***	0.0940 (0.50)	-0.4721 (-2.58)***	0.8398 (4.26)***	-0.5147 (-0.80)	-0.7891 (-1.39)	0.8667 (1.21)	-0.5053 (-0.78)	-0.7216 (-1.27)	0.7510 (1.04)
Gender (male = 1)	1.4963 (17.65)***	1.0845 (10.88)***	0.9126 (10.99)***	1.4989 (17.58)***	1.0856 (11.01)***	0.8930 (10.77)***						
Age (years)	0.0600 (1.59)	-0.0695 (-1.70)*	0.2310 (5.64)***	0.0598 (1.59)	-0.0615 (-1.52)	0.2253 (5.55)***						
Age-squared	-0.0015 (-3.28)***	-0.0002 (-0.38)	-0.0029 (-5.90)***	-0.0015 (-3.31)***	-0.0003 (-0.55)	-0.0029 (-5.81)***						
Education (years)	0.1065 (5.82)***	0.0882 (3.58)***	0.0586 (2.98)***	0.1109 (6.10)***	0.0757 (3.06)***	0.0713 (3.64)***						
Number of children in household aged 0–7	-0.1019 (-0.98)	0.0610 (0.51)	-0.1470 (-0.92)	-0.0838 (-0.81)	0.0348 (0.29)	-0.1081 (-0.67)	-0.0227 (-0.11)	-0.2943 (-1.28)	0.2593 (1.21)	0.0022 (0.01)	-0.2947 (-1.28)	0.2967 (1.37)

Continued

Table 3: Continued

	Pooled Logit Models						Fixed Effect Logit Models					
	Off-farm work (1)	Migration (2)	Local off-farm work (3)	Off-farm work (4)	Migration (5)	Local off-farm work (6)	Off-farm work (7)	Migration (8)	Local off-farm work (9)	Off-farm work (10)	Migration (11)	Local off-farm work (12)
Number of elderly in household 65 and above	0.0385 (0.37)	0.1625 (1.39)	-0.0753 (-0.62)	0.0347 (0.33)	0.1570 (1.32)	-0.0960 (-0.79)	-0.4485 (-1.18)	-0.2610 (-0.72)	-0.0737 (-0.23)	-0.4365 (-1.15)	-0.2871 (-0.80)	-0.0078 (-0.02)
Per capita land (<i>mu</i>)	-0.1274 (-4.50)***	-0.0324 (-1.09)	-0.1355 (-3.64)***	-0.1290 (-4.47)***	-0.0319 (-1.09)	-0.1412 (-3.76)***	0.0179 (0.35)	0.0787 (1.19)	-0.0243 (-0.43)	0.0074 (0.15)	0.0492 (0.78)	-0.0238 (-0.42)
Ratio of migration in village's total labour force	0.0135 (0.04)	2.7066 (5.50)***	-2.3747 (-5.39)***	0.0689 (0.18)	2.7006 (5.46)***	-2.4323 (-5.52)***	-0.2377 (-0.32)	-0.8147 (-0.96)	0.3464 (0.39)	-0.2354 (-0.32)	-0.8399 (-0.99)	0.4516 (0.51)
Per capita GVIO at township level	0.0719 (1.51)	-0.0194 (-0.34)	0.0829 (1.75)*	0.0705 (1.51)	-0.0312 (-0.54)	0.0886 (1.91)*	0.0636 (0.41)	-0.3752 (-2.26)**	0.4602 (2.90)***	0.0439 (0.27)	-0.3338 (-2.00)**	0.3884 (2.48)**
2007 year dummy	0.0981 (1.12)	0.0577 (0.51)	0.0683 (0.75)	-0.0447 (-0.47)	0.0135 (0.11)	-0.0396 (-0.40)	-0.0027 (-0.02)	0.4641 (2.71)***	-0.4572 (-2.83)***	-0.0613 (-0.41)	0.4287 (2.34)**	-0.5261 (-3.01)***
Constant	-1.2670 (-1.94)*	0.0026 (0.00)	-6.0976 (-8.04)***	-1.3718 (-2.11)**	0.1141 (0.16)	-6.3084 (-8.31)***						
Pseudo R ²	.18	.23	.11	.19	.23	.11	.01	.05	.03	.01	.03	.03
Observation	3,422	3,422	3,422	3,422	3,422	3,422	868	664	760	868	664	760

Note: z-statistics are in parentheses. *, **, *** statistically significant at the 10%, 5%, 1% levels, respectively.

Source: Authors' survey.

have a positive and significant impact on participation in the migrant labour force.⁵⁹

Table 3 also provides results that show that road expansion does have a positive and significant impact on off-farm employment. As shown in the first column, the estimated coefficient on the variable measuring distance to the nearest highway from a village is negative and statistically significant in the total (or migration + local) off-farm work participation equation. In other words, the results show that the smaller the distance is, or the better the transportation infrastructure is, the more likely it is that rural individuals will have off-farm employment. The positive impact of road expansion on off-farm work is consistent with the descriptive findings above and the findings of previous studies.⁶⁰

Our results, however, go beyond the impact of road expansion on off-farm employment in general. According to our findings, road expansion has different effects on different types of off-farm employment (that is, migration and local off-farm employment). As shown in the first row of Table 3, the estimated coefficient on the distance to the nearest highway from a village variable is positive and significant in the migration equation (column 2) and is negative and significant in the local off-farm employment equation (column 3). In other words, the estimation results show that road expansion encourages local off-farm employment, but, all other things being equal, discourages migration.

A similar story is found in our econometric analysis when we examine the impact of the alternative measure of road expansion, per capita paved roads in our sample villages, on different types of off-farm employment. The estimated coefficient on the per capita length of paved roads within a village variable is positive and statistically significant in the local off-farm employment equation (column 6). In other words, the estimation results show that when paved road per capita is higher, rural households send more of their members to work in local off-farm employment. In contrast, the estimated coefficient on the paved road per capita variable is insignificant in the case of migration (column 5).

To control the impact of all time-invariant factors that may be affecting the estimated relationship between road expansion and off-farm employment (and the endogeneity problems that such unobserved heterogeneity can create), we take advantage of the panel nature of our data and estimate a fixed effect (FE) model (controlling for household fixed effects). We follow the lead of Warr.⁶¹ Specifically, the FE model that we estimate is:

$$\begin{aligned} \Delta \text{Off-farm}_i = & \beta_0 + \beta_1^* \Delta \text{Road}_i + \beta_2^* \Delta \text{Married}_i + \beta_3^* \Delta \text{Household}_i \\ & + \beta_4^* \Delta \text{Social-economics}_i + \varepsilon_i \end{aligned}$$

Equation (2)

59 For example, Zhang, Xiaobo, and Li 2003; Zhao 2003.

60 For instance, Fan and Chan-Kang 2005.

61 Warr 2010.

Here, $\Delta\text{Off-farm}$, ΔRoad , $\Delta\text{Household}$ and $\Delta\text{Social-economics}$ are changes between time periods 1 and 2 of the variables defined above (and used in the estimation of equation (1)). However, in this version of the equation, we only include a subset of the variables (that is, only those variables that vary over time – since all others are differenced away). In fact, except for *marriage*, all the other individual variables, such as *age*, *gender* and *education*, are excluded since they do not vary over time.

The results of the FE Logit models are similar to those of the pooled Logit models (from equation (1), Table 3, columns 1–6). As shown in Table 3, the estimated coefficients of interest (that is, those on the variable measuring the distance to the nearest highway from a village) are positive and significant in the migration equation, and negative and significant in the local off-farm employment equation. In other words, the results from both the pooled and fixed effect Logit models are consistent and robust. The expansion of roads has an impact on whether the rural households decide to migrate or find employment in the local off-farm labour market. However, the effect is different: it is negative or neutral in the case of migration and positive in the case of local off-farm employment.⁶²

Because of the nature of the labour allocation problem in rural China today, it might be argued that accounting for the three different options (farming, out migration and local employment) at the same time is a more appropriate way to approach the empirical estimation of the link between roads and off-farm employment. Therefore, we also define a multinomial Logit model and simultaneously model the labour allocation problem (i.e. whether an individual works on the farm, in the local off-farm employment market or in the migrant labour market). Using this approach, we find that the results are almost identical (Table 4). Road expansion is associated with rising interest in local off-farm employment and less (or relatively less) interest in migration.

While it is beyond the scope of this article to identify definitively what lies behind the empirical results at which we arrive, it is possible to speculate. Specifically, the different impacts of road expansion on local off-farm employment and migration may be down to at least two reasons. First, it could be that transaction costs fall when the road infrastructure is improved. For individuals with options for local off-farm employment, road expansion may reduce the cost of getting to/finding work. Since these rural workers have to commute on a daily basis, even a small reduction in travel time (for example) could lead to significant gains in welfare on an annual level. In contrast, in the case of migrants, who live and work far from home, the impact of the expansion of roads inside a village may be small (since they often only come home – and use the roads – once a year). Hence, such a dynamic may be seen as making local off-farm employment more attractive than migration, all else being equal.

62 As is the case in the pooled Logit model, the coefficient of the variable, per capita paved roads in a sample village, is positive and significant in the local off-farm employment equation. The measured impact on migration is statistically insignificant.

Table 4: Multinomial Logit Models of Employment Choice

	Work on the farm	Migration	Local off-farm work	Work on the farm	Migration	Local off-farm work
Distance to the nearest highway from village	0.0071 (2.82)***	0.0065 (4.99)***	-0.0136 (-5.10)***			
Per capita length of paved road within the boundaries of sample village				-0.0482 (-3.96)***	0.0076 (0.91)	0.0406 (3.82)***
Married (yes = 1)	-0.0728 (-1.62)	-0.0524 (-1.64)	0.1252 (3.88)***	-0.0716 (-1.58)	-0.0556 (-1.72)*	0.1272 (3.92)***
Gender (male = 1)	-0.3589 (-19.28)***	0.1667 (10.79)***	0.1921 (11.88)***	-0.3599 (-19.27)***	0.1688 (10.97)***	0.1911 (11.82)***
Age (years)	-0.0264 (-2.71)***	-0.0106 (-1.72)*	0.0371 (4.44)***	-0.0268 (-2.77)***	-0.0096 (-1.56)	0.0365 (4.39)***
Age-squared	0.0005 (4.35)***	-0.0000 (-0.39)	-0.0005 (-4.76)***	0.0005 (4.43)***	-0.0000 (-0.55)	-0.0005 (-4.73)***
Education (years)	-0.0271 (-5.90)***	0.0142 (3.85)***	0.0130 (3.22)***	-0.0282 (-6.18)***	0.0125 (3.35)***	0.0157 (3.88)***
Number of children in the household aged 0–7	0.0203 (0.74)	0.0066 (0.38)	-0.0269 (-0.85)	0.0157 (0.58)	0.0033 (0.19)	-0.0190 (-0.59)
Number of elderly in the household aged 65 and over	-0.0092 (-0.34)	0.0231 (1.35)	-0.0139 (-0.55)	-0.0055 (-0.20)	0.0234 (1.33)	-0.0180 (-0.71)
Per capita land (<i>mu</i>)	0.0330 (4.44)***	-0.0048 (-1.01)	-0.0282 (-3.71)***	0.0344 (4.54)***	-0.0045 (-0.94)	-0.0299 (-3.83)***
Ratio of migration in the village's total labour force	0.0486 (0.49)	0.3835 (5.15)***	-0.4321 (-4.84)***	0.0540 (0.56)	0.3917 (5.17)***	-0.4458 (-4.98)***
Per capita GVIO at the township level	-0.0173 (-1.49)	-0.0007 (-0.08)	0.0180 (1.84)*	-0.0169 (-1.47)	-0.0024 (-0.28)	0.0192 (2.00)**
2007 Year dummy	-0.0271 (-1.24)	0.0124 (0.73)	0.0147 (0.79)	0.0074 (0.31)	0.0027 (0.15)	-0.0102 (-0.50)
Observations	3,422	3,422	3,422	3,422	3,422	3,422

Notes:

Marginal effects are reported; z-statistics are in parentheses. *, **, *** statistically significant at the 10%, 5%, 1% levels, respectively.

Source:

Authors' survey.

Table 5: Determinant of the Working Time and Income of Local Off-Farm Work

	Off-farm income (yuan)		Working time (hours)	
Distance to the nearest highway from village	-697.38 (-2.55)**		-28.77 (-1.63)	
Per capita length of paved road within the boundaries of sample village		2,018.80 (4.06)***		84.91 (2.18)**
Married (yes = 1)	6,141.87 (1.28)	1,372.27 (0.29)	456.95 (1.67)*	373.58 (1.35)
Number of children in the household aged 0–7	-210.42 (-0.14)	284.15 (0.19)	-35.18 (-0.32)	-27.28 (-0.25)
Number of elderly in the household aged 65 and over	-1,135.29 (-0.50)	128.19 (0.06)	-0.34 (-0.00)	14.99 (0.08)
Per capita land (<i>mu</i>)	-393.47 (-0.47)	-589.67 (-0.73)	-48.71 (-1.11)	-33.53 (-0.79)
Ratio of migration in the village's total labour force	2,398.11 (2.25)**	830.28 (0.76)		
Per capita GVIO at the township level	1,957.75 (0.44)	4,716.17 (1.08)	983.53 (4.21)***	897.76 (4.04)***
R ²	.12	.18	.01	.01
Observations	520	520	1,720	1,720

Notes:

t-statistics are in parentheses. *, **, *** statistically significant at the 10%, 5%, 1% levels, respectively.

Source:

Authors' survey.

A second reason is that road expansion may facilitate the expansion of the local economy, which in turn may raise the prospects of local off-farm employment over migration. As shown in previous studies, road expansion can have a positive and significant impact on the development of the local economy.⁶³ As a result, both job opportunities and the level of income from local off-farm work might be expected to increase. This is consistent with the findings in the regression analysis in this study. As shown in Tables 3 and 4, the development of the local economy (as measured by per capita GVIO) is associated with a rise in the probability that a rural individual will find off-farm work employment, especially at the local level.

Our results can also show that the effects of road expansion go beyond access to employment; road expansion can affect total working time and the earnings of those engaged in local off-farm employment. As shown in Table 5, if the distance to the nearest highway from a village is reduced by 1 km, local off-farm income will increase by 697 yuan (or 9.55 per cent of total local off-farm income). We find similar results when using the alternative variable (per capita paved roads). Table 5 also shows that an increase in local off-farm income is associated with an increase in the total number of hours that a rural individual can work

63 For example, Fan, Zhang and Zhang 2004.

off-farm owing to the improvement of the road network. In other words, this study seems to show that as roads expand, rural individuals working in local off-farm employment can work more since they spend less time commuting. The same result is found in the case of road expansion and a rise in off-farm earnings.

Conclusion

Infrastructure has been, and will continue to be, one of the most important parts of the public investment portfolio in rural China. Previous studies show that road expansion has had a positive impact on economic growth and rural income. In this study, we go beyond this aggregated result. The findings of the empirical analysis suggest that road expansion has different impacts on different types of off-farm employment. Specifically, road expansion leads to more local off-farm employment and relatively less migration.⁶⁴ As a result, with the improvement of local transportation, some migrant labourers might turn instead to off-farm work. We also show that road improvement increases both the total working time and income of local off-farm workers.

This study has important policy implications. First, although China has made great progress in building up its rural infrastructure since the 1980s, public services are still severely underfunded in most communities, especially in poor regions.⁶⁵ Previous studies show that road expansion has a positive impact on local economic development.⁶⁶ This study shows that road expansion plays an important role in increasing the participation of rural individuals in off-farm work (especially in the case of local off-farm employment) and well-being. In other words, it can be argued that increasing the level of investment in rural roads will contribute to both rising rural incomes and a reduction of the urban–rural inequality that plagues China today. On the other hand, the previous studies by Fan, Zhang and Zhang, and Fan and Chan-Kang show that the return to road investments in richer regions (for example, in China’s coastal regions) is higher than that of poor regions (for example, in China’s western regions).⁶⁷ Hence, all else being equal, private companies may have less of an incentive to invest in poor regions if roads are built in both places (and if the results from the 1990s are still true). In other words, if the objective is to stimulate local economic development, raise rural incomes and reduce inequality, it may be that even more public investment in roads is needed in poor rural regions.

Second, the results show that the impact of rural road expansion is contributing to the success of another set of development policies. China’s central government is pursuing a strategy that seeks to channel rural people into small cities and

64 One possible bias is that we did not include the impact of railway expansion, which might have a positive impact on a farmer’s migration decision. In this sense, the impact of highway expansion on migration is under-estimated.

65 Luo et al. 2007; Unger 2003; West 1997.

66 Fan, Zhang and Zhang 2004; Bai and Qian 2010.

67 Fan, Zhang and Zhang, 2004; Fan and Chan-Kang 2005.

towns rather than big cities.⁶⁸ In this study, we show that an improved road network encourages rural individuals to join the local off-farm workforce rather than migrate to large and more distant urban districts. Our findings would urge the government, assuming that they are really interested in developing inland cities, to continue to support road expansion in rural areas.

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