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The Road to Specialization in Agricultural Production: Evidence from Rural China

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Summary. — Many rural poor in developing countries live in areas far away from markets and isolation is a key limiting factor to their livelihood. In this paper, we use four waves of a primary panel household survey conducted in 17 remote natural villages in China to study how road access shapes farmers' production patterns, input use, and rural poverty. We adopt a difference-in-difference approach by comparing the outcomes of the households in villages with and without road access, before and after the introduction of each road. Our results show that access to roads facilitates specialization in agricultural production. In natural villages with better road access, farmers plant fewer numbers of crops, purchase more fertilizer, and hire more labor. Consequently, road connections improve household agricultural income and reduce poverty. In addition, road access significantly increases local nonfarm income for the relatively poor households, but not the rich. Overall, our research provides empirical justification on the importance of rural road on agricultural specialization and poverty reduction, especially in isolated and impoverished regions.

Key words — road, agricultural specialization, input use, income, rural China

To get rich, build road first

[An old Chinese proverb]

1. INTRODUCTION

In developing countries, many rural poor live in isolated areas. Because they reside far from markets, the poor are more likely to rely on self-sufficient, subsistence farming to survive. Spatial poverty traps are a silent feature of the rural landscape (Jalan & Ravallion, 2002). Scholars have argued that rural roads are a key instrument in overcoming spatial poverty traps in developing countries (Calderón, 2009; Escobal D'Angelo & Ponce, 2002; Fan & Hazell, 2001; Jacoby & Minten, 2009). However, rural roads may be costly to build, therefore rigorous impact assessments of the effects of rural roads in lagging areas are necessary before policy interventions.

A limited number of studies have evaluated the returns to investing in rural roads in developing countries, but many of them are conducted at the aggregate level (Fan & Hazell, 2001; Fan & Zhang, 2004; Zhang & Fan, 2004). Those studies have been criticized for failing to uncover the mechanisms by which road connections shape household production and consumption behavior (Jacoby, 2000). Studies at the household level, on the other hand, often rely on cross-sectional data due to difficulties in obtaining long-term time series data in poor areas. It is well-known that cross-sectional data cannot address the problem of endogenous road placement—that is, roads are more likely to be built in high-potential areas. To overcome the problem of endogeneity, Jacoby (2000) develops an innovative approach to evaluate the impact of road access on agricultural land value, computed based on the discounted stream of maximal profits from cultivation. Yet the approach is inadequate for evaluating impact on the welfare of landless laborers, who are common in developing countries. In the context of China, the method is also inapplicable because farmers do not own the land but only hold the right to cultivate it. In the absence of fully-functioning agricultural land markets, uncovering true farmland value proves difficult.

In this paper, we use a primary panel household dataset collected in a remote and poor area of China to investigate the impact of road connections on rural welfare by focusing on agricultural specialization and input use. Road connections can potentially reshape the production choice set of isolated farmers and affect agricultural production—the major livelihood of the poor—in at least two ways.

First, with lower transportation costs due to road connections, farmers may shift their agricultural production from autarkic, subsistence farming to more market-oriented, specialized activities (Limao & Venables, 2001; Renkow, Hallstrom, & Karanja, 2004). Yang and Ng (1993) develop a theoretical model showing that producers will choose to specialize in one activity according to their comparative advantage and simply purchase other goods and services from the market, provided that transaction costs are sufficiently small. In contrast, when transaction costs are too high, it makes more economic sense for producers to remain autarkic. Roumasset, Setboonsarng, Wickramasinghe, Estudillo, and Evenson (1995) build up a theory of labor market evolution and conclude that infrastructure investment, as a way to reduce transaction cost, would lead to labor market specialization in the agricultural market. De Janvry, Fafchamps, and

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Sadoulet (1991) and De Janvry and Sadoulet (2006) provide a household decision model and explain that higher trade costs (such as transportation cost) may lead to subsistence farming. Using a simulation approach, Omamo (1998) finds that as distance to the market shortens, small-scale farmers tend to shift away from diversified cropping patterns in favor of cultivating only one crop.

However, the empirical findings on transport cost and agricultural specialization are mixed. For example, Stifel, Minten, and Dorosh (2003) show that in Madagascar, the concentration level of agricultural production in the least remote areas is around 1.5 times that of the most remote areas, suggesting that improved road access facilitates specialization in agricultural production. Gibson and Rozelle (2003) provide a counter example: they find that in Papua New Guinea, each extra hour it takes to reach the nearest road induces a 2.6% reduction in the number of activities, in contrast to the theoretical prediction. Strictly speaking, the variable "number of activities" does not necessarily reflect the intensity of each activity, such as the time spent, income earned, or area cropped. Therefore, the result in Gibson and Rozelle (2003) may not directly contradict with the estimation by Stifel *et al.* (2003) which focus on the dimension of specialization.

Second, as improved road access reduces transportation costs, the prices of modern inputs such as fertilizer are more likely to drop (Khandker, Bakht, & Koolwal, 2009). Consequently, farmers may apply more modern inputs to improve agricultural productivity. In addition, farmers may hire more labor to take care of specialized agricultural production as road access improves. Gollin and Rogerson (2010) develop a theoretical model and calibrate it with Ugandan data, showing that as transportation cost declines, farmers will use more intermediate inputs, which in turn contribute to agricultural output growth. The empirical findings on the impact of rural roads on modern input use, however, are inconclusive. Benziger (1996) finds that better road access leads to increasing fertilizer use in villages in Hebei, China. Stifel *et al.* (2003) show that farmers in more isolated regions of Madagascar use less fertilizer than those in places with better road access. However, Dorosh, Wang, You, and Schmidt (2010) tell a more complicated story: input use depends on not only distance to roads but also the density of road networks. In East Africa, for example, reducing travel time significantly increases adoption of high-input/high-yield technology, whereas roads have an insignificant impact in West Africa, where road network density is relatively higher at the beginning of the sampling period.

One challenge to an empirical evaluation of the impact of road access on agricultural production is data limitation. Most empirical studies rely on cross-sectional data, making it hard to control for unobserved factors, such as the placement effect mentioned earlier. In this paper, we use a primary household panel dataset collected in 17 natural villages over four waves in Guizhou Province, China, to investigate how road access shapes farmers' cropping decisions and their livelihoods. [1]

Our dataset possesses two advantages when studying the impact of access to road networks in isolated villages. First, given that it relies on non-recall panel data, our study provides relatively accurate and credible information with respect to household agricultural production. Second, the four waves of data allow us to conduct a difference-in-differences analysis, which helps mitigate estimation biases as a result of omitting variables and reverse causality commonly seen in regressions based on cross-sectional datasets. To the best of our knowledge, this is the first paper to empirically document the impact of road access on agricultural specialization and input use in China.

We find that access to roads fosters household agricultural specialization. The impact is economically significant and is about one-fifth of the standard deviation of the Herfindahl–Hirschman specialization index (HHI). In addition, better road connectivity induces farmers to apply more fertilizer and spend more money hiring labor. Thanks to those two channels, road access is shown to boost farmers' agricultural income. However, the impacts of road on households' nonfarm income vary by income groups. Road access significantly increases local nonfarm income for the relatively poor households and reduces their poverty incidence. However, the impact on the local nonfarm income of the richer group is more muted.

The findings may have some policy implications for China. In the past decade, the Chinese government has massively invested in building a nationwide highway system and high-speed rail network (Shi & Huang, 2014). These investments are largely urban biased, possibly enlarging the already enormous urban–rural gap (Roberts, Deichmann, Fingleton, & Shi, 2012; Faber, 2014; Qin, 2015). Fan and Chan-Kang (2005) argue that it makes more economic sense to gear more investment toward rural roads. But rural roads carry less traffic, and are harder to maintain, and more costly to build in remote areas. Therefore, it is important to gather more empirical evidence as to how rural roads affect agricultural patterns and rural livelihoods in lagging regions.

One should be cautious in explaining the findings. Our sample focuses only on the mountainous rural areas in southwestern China, where smallholder farming is the dominant mode of agricultural production. As China is a large and spatially diverse country, the findings drawn from this sample may not apply to China as a whole. Our study is more relevant for understanding as to how road connections might affect farming practices and rural livelihoods in isolated and impoverished regions.

2. DESCRIPTION OF DATA

As Fig. 1 shows, Guizhou is located in southwestern China. Guizhou is one of China's poorest provinces and has the shortest road length due in part to its mountainous terrain. [2] Fig. 2 depicts the road system in Guizhou as of 2004. Highway networks are sparse in Guizhou, with only four stretching from the provincial capital (Guiyang Shi) to major cities in the province. Although national and provincial roads are numerous, the density is much lower than the national average. In remote mountainous villages, some households still practice subsistence farming, whereas households in relatively flat areas sell most of their agricultural products to the market. The large variation in road access in our sample thus provides us with a valuable opportunity to study the impact of road access on agricultural production in isolated regions.

The survey site, Puding County, comprises 11 townships and 317 administrative villages, and as of the end of 2008 had a total population of 448,000 people. [3] A highway and a national road bypass the county border, and one provincial road cuts through the county. In 2008 the average household income in Puding County was around 5,800 yuan, slightly above the provincial median but below the provincial mean. As Fig. 3 depicts, in terms of *per capita* rural income, Puding is in the middle tercile, suggesting that Puding is a rather representative county in Guizhou Province.

Three administrative villages representing different levels of economic development of Puding were chosen for the survey. The three administrative villages (henceforth referred to as