



Machinery investment decision and off-farm employment in rural China[☆]

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ABSTRACT

This paper investigates the endogenous linkages between farmers' machinery investment decision and off-farm employment in China. Both the theoretical model and the empirical results based on a survey of 453 households in Anhui Province indicate that agricultural labor input and small-sized machinery investment are gross complements rather than substitutes when machinery services are available in the market. Consequently, farmers with small-sized machinery are more likely to reduce their off-farm employment time. On the other hand, an increase in off-farm employment is more likely to reduce the possibility of possessing small-sized machineries mainly due to substitution effects of market machinery services.

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1. Introduction

Off-farm employment plays a critical role in many developing and transition economies. Studies find that 20–70% of the household income is from off-farm sources (Adams, 2001; Benjamin, 1992; De Brauw et al., 2002; De Brauw & Rozelle, 2008; Wang, Herzfeld, & Glauben, 2007; Yu & Zhao, 2009). However, the role of capital investment is also critical for rural development and economic transition. Some studies claim that capital constraints are a major determinant of the adoption rate of new technologies (Larson et al., 2000; Mundlak, 1993), and others believe that capital accumulation is essential for the development of rural communities (De Brauw & Rozelle, 2008; Liu & Wang, 2005; Stark, 1991).

Furthermore, the current literature has pointed out that the linkages between off-farm labor markets and farms' capital investments have important policy implications. Labor market policy tends to spill over to the farm sector via farmers' decisions regarding labor and capital inputs, while agricultural policy affects both rural and urban labor markets (Ahituv & Kimhi, 2002; Rosenzweig, 1980). Ahituv and Kimhi (2002) find that off-farm labor supply and farm capital are negatively correlated in Israel and indicate that farmers' capital investments enhanced by heavily subsidized credit prevent them from seeking off-farm employment opportunities. Similarly, Lagerkvist, Larsen, and Olson (2002) find that farmers' capital accumulation has a negative impact on the off-farm income share in Southwestern Minnesota.

The current literature mainly sheds light on the effect of off-farm work on farmers' (farm or nonfarm) capital accumulation decisions (De Brauw et al., 2002; De Brauw & Rozelle, 2008; Shi, Heerink, & Qu, 2007). It is important to note that the capital markets are less complete in developing economies and off-farm income can finance capital accumulation when the agriculture household is subject to borrowing constraints (De Brauw et al., 2002; De Brauw & Rozelle, 2008; Reardon, 1997).

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A less concerned but perhaps more important issue is the impact of off-farm work on the demand for farm capital. Some studies suggest that labor and capital are complements in farm production, so that off-farm work opportunities (or the wage level) would reduce farm capital demand. Wang et al. (2007) indicate that the accumulation of productive assets and the development of livestock production have reducing effects on the off-farm labor supply of households in rural China. Foltz and Aldana (2006) find that wages driven by local economic conditions indeed reduce investments in cows of Wisconsin dairy farmers. However, other researchers presume that farm labor and farm capital are substitutes, which would make the relationship complicated: The substitution effect of inputs in farm production results in a positive correlation between off-farm employment and capital accumulation, while the expansion effect, which denotes that a decrease in agricultural output due to less labor input leads to less demand for capital, could cause a negative correlation. The aggregate effect depends on the relative sizes and signs of the two individual effects. Kada (1992) finds that the substitution effect plays a major role in the case of Japanese rice farms as farm labor and capital are negatively associated. Interestingly, even though Ahituv and Kimhi (2002) and Liu, Zhang, and Fan (2002) similarly find that off-farm employment and farm capital are negatively correlated, they explain it by the expansion effect.

In farm production, certain types of capital (e.g. dairy cows) are complements to labor, while others (e.g. tractors) are substitutes for labor. Therefore, in the analysis attention should be paid to the differences in the relationships between different types of capital and off-farm employment.

This study will specifically shed light on the relationship between machinery and off-farm employment. There are three reasons for this: first, machinery investment is the largest part of farm investment in Chinese crop production and it is important for technical progress in agricultural production (Liu & Wang, 2005); second, machinery and labor are obvious substitutes in farm production, and the relationship between off-farm employment and machinery investment is hence ambiguous as aforementioned and thus it needs an empirical analysis for clarification; third, the Chinese government started to subsidize agricultural machinery in 2004 and has increased the subsidy to 13.0 billion yuan in 2009, so that this study focusing on farmers' joint decision of off-farm employment and machinery investment can help to calibrate the effect of machinery subsidies on the labor market.

Even though a few studies have analyzed the impact of off-farm employment on machinery investment, the other side of the picture, that is to say the feedback of machinery on off-farm employment, has not been well studied. Possibly, the decisions regarding off-farm employment and machinery investment are even made simultaneously, thus causing endogeneity. For instance, Zhao (2002) divided laborers into non-migrants, migrants and returnees, and found that in rural China the numbers of non-migrants and returnees have a significant marginal effect on machinery investment, while the number of migrants has no significant influence. Even though these results imply that off-farm employment could reduce farm machinery investment, the applied model did not control for other important variables and the endogeneity problem has not been dealt with.

A common shortcoming of agricultural household investment models in the current literature is that the capital services market is neglected and that the investment behavior is regarded to be the same as the production input behavior. However, we cannot deny the fact that the capital services market does exist, especially for agricultural machinery. Indeed, most rural households in China buy some or all of their machinery services from the market. Similar situations can be found in other countries where the average scale of farms is small.

When market services are available, the relationship between off-farm employment and machinery investment becomes even more complicated. On the one hand, off-farm employment influences machinery investment through three channels. First, off-farm employment influences the demand for machinery service in agricultural production. Usually, the more services are used in production, the more likely the agriculture household is to invest in small self-used machinery. Second, off-farm employment opportunities increase the opportunity costs of laborers operating farm machinery, which makes households more likely to purchase market services. Third, off-farm income relaxes the budget constraints and helps the household to purchase machinery. On the other hand, machinery also impacts off-farm employment decisions. When an agricultural household maintains agricultural machinery, this implies that its shadow costs of machinery services should be lower than the market price, which would influence both farm and off-farm labor supplies. In addition, when more laborers operate tractors, it would also reduce off-farm labor supply.

The primary goal of our paper is to examine the simultaneous decision regarding off-farm employment and agricultural machinery investments in the presence of a machinery services market available to agricultural households in China. To meet this goal, we have three specific objectives. First, we introduce the development of the agricultural machinery services market in China and the farmers' choice between purchasing machinery and purchasing market services. Second, we develop a theoretical model that illustrates farmers' endogenous linkages between off-farm employment and machinery investments. Third, we empirically test the above-mentioned relationship using a structural econometric model to identify the endogeneity issues. The data used for our study come from a face-to-face farmer survey in China's Anhui province.

2. Background and data description

2.1. The development of the agricultural machinery services market in China

Prior to 1980, China was characterized by a centrally planned economic system and the investment decisions regarding agricultural machinery were controlled by the governments. Specifically, the agricultural machinery stations owned by the state or the collectives monopolistically provided machinery services for agricultural production at a planned price. A large production collective was more likely to have large-size machinery. In fact, it was an incorrect perception that large-size machinery cannot be divided and there was a scale economy in agricultural production induced by the adoption of the collective economy, namely the people's communes in China. For instance, agricultural mechanization had been used as one of the slogans for the collective

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