Impact of changes in labor resources and transfers of land use rights on agricultural non-point source pollution in Jiangsu Province, China

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A B S T R A C T
This study systematically explores the likely mechanisms driving the effect of the transfer of agricultural land use rights (ALURs) on agricultural non-point source pollution (ANSP) in the context of changing agricultural labor resources. It quantitatively estimates the direction and degree of this influence from a microeconomic perspective using data from rural households. The results reveal that economies of scale caused by ALUR transfers contribute to reducing both the ANSP and marginal costs of inputs. Changes in agricultural labor resources lead to reductions in agricultural labor supply and negatively impact on ANSP. Encouraging farmers to participate in ALUR transfers, therefore, helps to reduce ANSP. The government and related departments should implement policies that support farmers who decide to rent an entire village’s land or the adjacent land to achieve economies of scale. Accelerating the development of small farm machinery that is suitable for smaller farm plots and the elderly can serve to reduce the use of chemical fertilizer and promote green production and sustainable agricultural development.

1. Introduction

Since the 1980s, the shifting of workers from agricultural to non-agricultural sectors has caused a shortage of agricultural labor in China. At the same time, the implementation of the new “Labor Contract Law” and the demonstrated effects of the continuous growth of the minimum wage in cities have led to a rigid upward trend in the cost of agricultural labor. Gai et al. (2014) argued that China has already passed the Lewis turning point and that agricultural labor is now in short supply. The Report on China’s Migrant Population Development (2015) pointed out that, by 2020, the migrant population in China will gradually grow to 291 million, of which 220 million will be migrants from rural to urban areas. However, this trend has also caused the aging1 and feminization2 of agricultural labor to deepen as well as a general reduction in the actual labor supply. Some adverse effects of these changes in agricultural labor resources on the agricultural environment have gradually emerged.

Agricultural land policies lie at the core of production relationships in agriculture. The implementation and development of agricultural land-use rights (ALURs) transfer policies have profoundly affected farmers’ management behavior. With the continuous advancement of rural reforms, the function of agricultural land as an asset continues to strengthen, and the market for agricultural land circulation is developing quickly. By the end of June 2016, contracted land covered an area of over 0.087 billion ha, and land with transferred usage rights covered an area of 30.67 million ha, accounting for approximately one-third of total contracted land. ALURs transfers have become increasingly active, and agricultural households have begun to differentiate themselves. Farmers’ factor inputs and management behavior also tend to differ. These differences may eventually cause varying degrees of impact on the agricultural environment. However, the majority of studies have focused on the impact of ALURs transfers on agricultural production and farmers’ incomes (Deininger and Jin, 2005; Jin and Jayne, 2013; Nyberg and Rozelle, 1999), and little attention has been
paid to their impact on the agricultural environment.

Agricultural land policies and the agricultural environment are closely associated (Wei et al., 2012). As the external environmental changes, agricultural land policies are likely to affect agricultural production methods, thereby indirectly influencing the agricultural environment. Wei et al. (2012) claimed that the defects and shortcomings of the current property rights system for agricultural land are the major institutional causes of agricultural non-point source pollution (ANSP) in China. Long and Ren (2016) argued that, compared to farmers that have their own land, farmers of transferred land tend to be better educated, to be more likely to apply advanced production technologies, and to demonstrate better control over ANSP. However, they did not verify their hypothesis from an empirical perspective with quantitative data. Generally, when the property rights of agricultural land3 are not clearly defined, agricultural production externalities are less likely to be avoided. The instability of agricultural land usage rights increases the difficulty of guiding farmers’ attention to the agricultural environment and may even lead to negative environmental consequences. Gao et al. (2011) investigated how the transfer of ALURs may affect farmers’ investments and discovered certain differences in farmers’ behavior. Compared to land with contracted usage rights (i.e., their own land), farmers were less likely to apply organic fertilizer to land with transferred usage rights (i.e., transferred land), and if organic fertilizer was applied to land with transferred usage rights, the volume of fertilizer was, on average, much less than what would otherwise be used.

From the perspective of agricultural households, factors such as limited resource endowments affect farmers’ agricultural management behavior. Some studies suggest that the shifting of labor from agricultural to non-agricultural sectors has reduced the supply of labor for agricultural production (Lu and Hu, 2017; Xie and Lu, 2017). Farmers have growing expectations about improving the marginal productivity of agricultural labor and reducing labor intensity. Driven by time constraints and economic interests, farmers no longer abide by the traditional, intensive, and meticulous farming methods. Instead, they have developed an over-reliance on modern techniques, such as chemical fertilizer, to increase output, leading to rising fertilizer consumption (Chang and Mishra, 2012; Ebenstein et al., 2011; Williamson, 2011). Moreover, an increasing volume of land has been transferred to the production of higher-yield, industrial crops that require more fertilizer (Xin et al., 2012). The increase in non-agricultural income further diminishes financial constraints, allowing farmers to purchase more agricultural inputs, leading to more fertilization (Ebenstein, 2012; Huang et al., 2008). Farmers also tend to reduce the frequency of application and increase the amount of fertilizer applied each time to save labor costs, avoid the loss of output, and reduce risks (Abdoulaye and Sanders, 2005; Calhoun, 1989; Horowitz and Lichtenberg, 1993; Hu and Yang, 2015; Jepson, 2005). Mishra et al. (2005) conclude that among winter wheat farmers, those who purchase revenue insurance tend to spend less on fertilizer. Since a large fraction of young and middle-aged workers has shifted to non-agricultural sectors, the leaders of agricultural production are those with relatively less knowledge of scientific fertilization and less awareness of rural ecological and environmental protections, further leading to more extensive fertilization and more severe ANSP (Zhang, 2008).

The First National Census on Pollution Sources revealed that the load of ANSP on China’s water environment is more than half of the total water pollution, leading to lower drinking water quality and high metal content in the soil. The census report also pointed out that the excessive use of chemical fertilizer has become a major cause of ANSP in China. Qiu et al. (2014) demonstrated that the amount of chemical fertilizer applied per unit of arable land in China has far exceeded both the global average level and the optimal limit, and the current application rate of fertilizer is 1.6 times the world average. According to the National Agricultural Modernization Plan (2016–2020), the chemical fertilizer rate of major crops was 35.2% in 2015, and this figure may increase to 40% by 2020, indicating prominent issues of inefficient and excessive application of chemical fertilizer.

Presently, ANSP is prominent, and tougher measures have been proposed to control it. The internal and external environmental conditions of agricultural development are undergoing significant changes in China. Changes in agricultural land markets and labor markets have affected farmers’ behavior, and, due to the impact of externalities in agricultural production, ANSP has begun to develop. However, few studies have further analyzed the impact of ALURs transfers on ANSP or have systematically analyzed the probable mechanisms of this impact from a theoretical perspective, and studies that utilize a qualitative approach to examine the direction and degree of this impact are even fewer. In the context of promoting green production and the sustainable agriculture development, both further investigation and validity testing with micro-level data are therefore necessary and meaningful.

The purpose of this study is to provide a reference and motivation for the establishment of an agro-ecological movement and the implementation of related policies. This study attempts to construct a theoretical framework to illustrate the mechanism of the impact of ALURs transfers on ANSP in the context of changing agricultural labor resources. Furthermore, utilizing econometric methods, this study develops a quantitative estimate based on the established model. The rest of this paper is structured as follows. First, the econometric model is constructed based on a theoretical analysis of the probable mechanisms between ALURs transfers and ANSP. Next, the data sources and descriptive statistics are presented. Finally, the results of the model are discussed, and the conclusions and implications of this study are presented.

2. Mechanism analysis and model construction

2.1. Mechanism analysis

During the process of agricultural production, land, labor, and capital are substitutable to a certain degree. Driven by the goal of profit maximization, farmers are inclined to reallocate agricultural inputs based on changes in costs. With changes in population structure, the opportunity cost of working in the agricultural sector continues to increase. These changes in agricultural labor resources, in essence, have altered the factor endowment for agricultural households and the land per capita in rural areas. As a result, the structure of the agricultural resources invested by farmers will be affected. The negative externalities in agriculture eventually lead to ANSP.

2.1.1. Mechanism 1: the mechanisms behind the impact of changes in agricultural labor resources on ANSP

Changes in agricultural labor resources are likely to cause
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