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EDITED BY  
Zhen Wang,  
Huazhong Agricultural University, China

REVIEWED BY  
Yi Peng,  
Zhejiang University of Finance and  
Economics, China  
Duo Chai,  
Central University of Finance and  
Economics, China

\*CORRESPONDENCE  
Yongmu Jiang,  
jiangyongmu@163.com

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# Assessing the impact of off-farm employment on land efficiency in different patterns: Field evidence from post-reform China

Sudan Zhao<sup>1</sup>, Siyi Pei<sup>2</sup>, Yongmu Jiang<sup>3\*</sup> and Xianqiang Wu<sup>4</sup>

<sup>1</sup>School of Marxism, Sichuan University, Chengdu, China, <sup>2</sup>School of Marxism, South China University of Technology, Guangzhou, China, <sup>3</sup>School of Economics, Sichuan University, Chengdu, China, <sup>4</sup>Financial and Economic Work Committee of the Ningbo People's Congress Standing Committee, Ningbo, Zhejiang, China

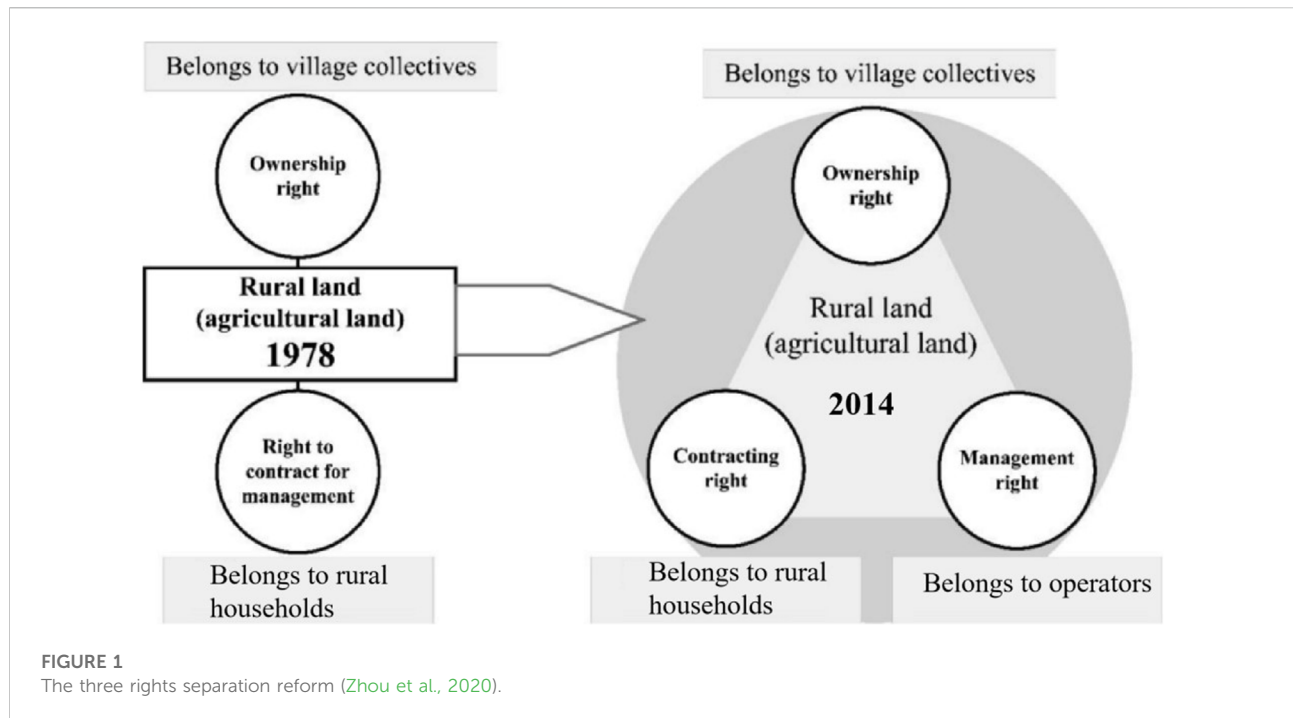
The three rights separation reform (TRSR) has laid a concrete foundation institutionally to guide the well-ordered transfer of farmland and promoting the development of urbanization. With the new economics of labour migration (hereinafter referred to as the NELM) theory as the analytic basis, this empirical research investigates the potential ramifications of off-farm employment on land efficiency with household-based survey data from four provinces in China after TRSR. Unlike existing studies, we delve into how the effects are manifested differently among the types of off-farm employment by adopting an ordinary least squares (OLS) model and a two-stage least squares (2SLS) estimator. It provides evidence that migration positively affect land efficiency significantly, whereas a negative impact of local off-farm employment on land efficiency is observed, which distinct this study from previous findings. From the perspective of policy-making, land administrators should realize that off-farm employment differentiation is an important factor affecting land efficiency, and therefore needs to be fully considered in policy-making. Meanwhile, the establishment of local labor markets and favorable policies that stimulate productive technologies are needed.

## KEYWORDS

local off-farm employment, migration, land reform, land efficiency, China

## 1 Introduction

Accelerated urbanization and industrialization in countries around the world have triggered substantial changes in rural economy and structure (Rigg et al., 2016). Large numbers of rural laborers seek higher-return jobs and engage in off-farm employment while either transfer their farmland to others or simply abandon it, creating potential hazard to food security in China (Wang and Zhang, 2017). As such, the CPC Central Committee (the Communist Party of China) launched TRSR, the Three Rights Separation Reform, (separation of ownership, contracting and management right of agricultural land) in 2014. This policy divides the contracting rights of farmland into management rights and contracting rights, which profoundly changes the landscape of land transfer.



Although whether off-farm employment can result in land efficiency increase has been a hot topic for decades, TRSR has significantly changed the situation. Before TRSR, the “contracting rights” and “management rights” of farmland were considered as one and the same i.e., “contracting management rights”, which was not “transferable”. After TRSR, the contracting rights are endowed with the rights of possession, disposal, inheritance, and withdrawing, which allow farmers to keep the contract right over the allocated land and only pass on the management right should the land be leased to other household, pledged to financial institutions or invested in rural cooperatives in exchange of shares (Wang and Zhang, 2017) (Figure 1) and in a way, create favorable conditions for the rural labor to take part in off-farm employment (Deininger et al., 2014). Based on the framework of New Institutional Economics, TRSR is expected to bring change to the categorization of off-farm employment, promote urbanization and boost the outflow of rural labor (He and Luo, 2015). It is also observed that the strengthened management rights reduce transaction cost, stimulate the migration of rural labor to urban regions and the land transfer from households of low to high productivity (Kang, 2014). Short-term off-farm engagement and withdrawal from agricultural production are distinctive processes that cater to different institutional settings. Yet, surveys on the correlation between different types of off-farm engagement and land efficiency under the background of TRSR are scarce.

Among the handful of literature that investigates how off-farm employment affects agricultural productivity, some observed a negative correlation between the two. Damon

(2010) found that off-farm employment negatively affects labor and land productivity in El Salvador. A study carried out in Hubei province, China, by Li and Fan (2010) also confirmed that off-farm employment significantly lessens land efficiency. By adopting a computable general equilibrium model that considers faultiness of the market and the survey data from a distant village in the Chinese province of Jiangxi, Shi et al. (2007) found that the (small) positive income effect is much weaker than the negative lost-labor effect of off-farm employment on agricultural income. Zhong et al. (2016) found that the negative marginal effect of off-farm employment on cash crops seems to be stronger compared with that of grain production, whereas cash crops are more dependent on labor input.

On the contrary, some studies argue otherwise that off-farm employment is conducive to improving agricultural productivity. Taylor et al. (2003) estimated a simultaneous-equation model with the data from 787 rural families from 31 villages of Liaoning and Hebei provinces and found that the positive income effect resulted from migrant remittances almost evens out the obstructive lost-labor effect caused by migration on crop yield. Taylor and Feldman (2010) analyzed the agricultural production of Mexican immigrant households and found that labor migration contributes to land efficiency. When rural labor moves out of agriculture, agricultural yield is expected to rise and the labor required per unit of land to fall because of the advances in fertilizers, machinery, and production techniques (Chiodi, Jaimovich, & Montes-Rojas, 2012), which further promote land efficiency (Chang, 2012). Following a three

stage least squares (3-SLS) method, Kapri and Ghimire concluded that remittances offset the negative impact of migration (Kul Kapri, Shankar Ghimire, 2020).

There are also several studies stating that off-farm employment has a complicated impact on the efficiency of agricultural production. Wang et al. (2014) observed that labor migration exerts a frail influence on agricultural productivity in China and Gambia. By adopting the Driscoll and Kraay standard errors fixed effects model, Zhao et al. (2021) found a U-shaped relationship between off-farm employment and the change in agricultural land use efficiency in China. On the contrary, based on a panel data of 1961 counties in China, Yang et al. (2020) found an inverted-U correlation between off-farm employment and grain production.

Although existing studies attach more importance to the underlying mechanisms with a handful of valuable results, findings on how off-farm employment affects agricultural production remain inconsistent. This is possibly because that the different kinds of off-farm employment are overlooked in their estimation. This paper thus adds up to the current research field in the following respects. First, it investigates the correlation between land efficiency and off-farm employment under the background of the Three Rights Separation Reform, given that TRSR substantially affects the types of off-farm employment, the agricultural operating system and tenure security, all of which impact land efficiency (Wang, 2019). However, econometric research testifying the effects brought along by TRSR has received little attention. Based on data collected from four provinces during the year 2016–2018, this paper investigates the linkages between land efficiency and off-farm employment by analyzing the effect of tenure security brought about by TRSR. Second, by analyzing the heterogeneous effects incurred due to different types of off-farm employment, this study confirms that off-farm employment has a differential influence on land efficiency among households with migrant workers and local workers, which differs from existing literature which overlooked the diverse roles and mechanisms of different kinds of off-farm employment. Third, this paper probes deeper into the prospective influence of rural migration on land efficiency, supported by proof collected from an hands-on research in China, a developing country going through major shift with its slew of off-farm workers. The rigorous and meticulous examination on the correlation between land efficiency and off-farm employment lends lucid reference for the policy-makers concerned in China and the rest of the developing world.

The following sections of the paper is rendered in the manner below. Section 2 sets out the theoretical framework and introduces the hypotheses for analysis. Section 3 presents the data collected and the empirical strategies adopted in the empirical analysis. In Section 4, we present the research results of the study, discuss and compare the empirical observations, and Section 5 provides the conclusions of this paper.

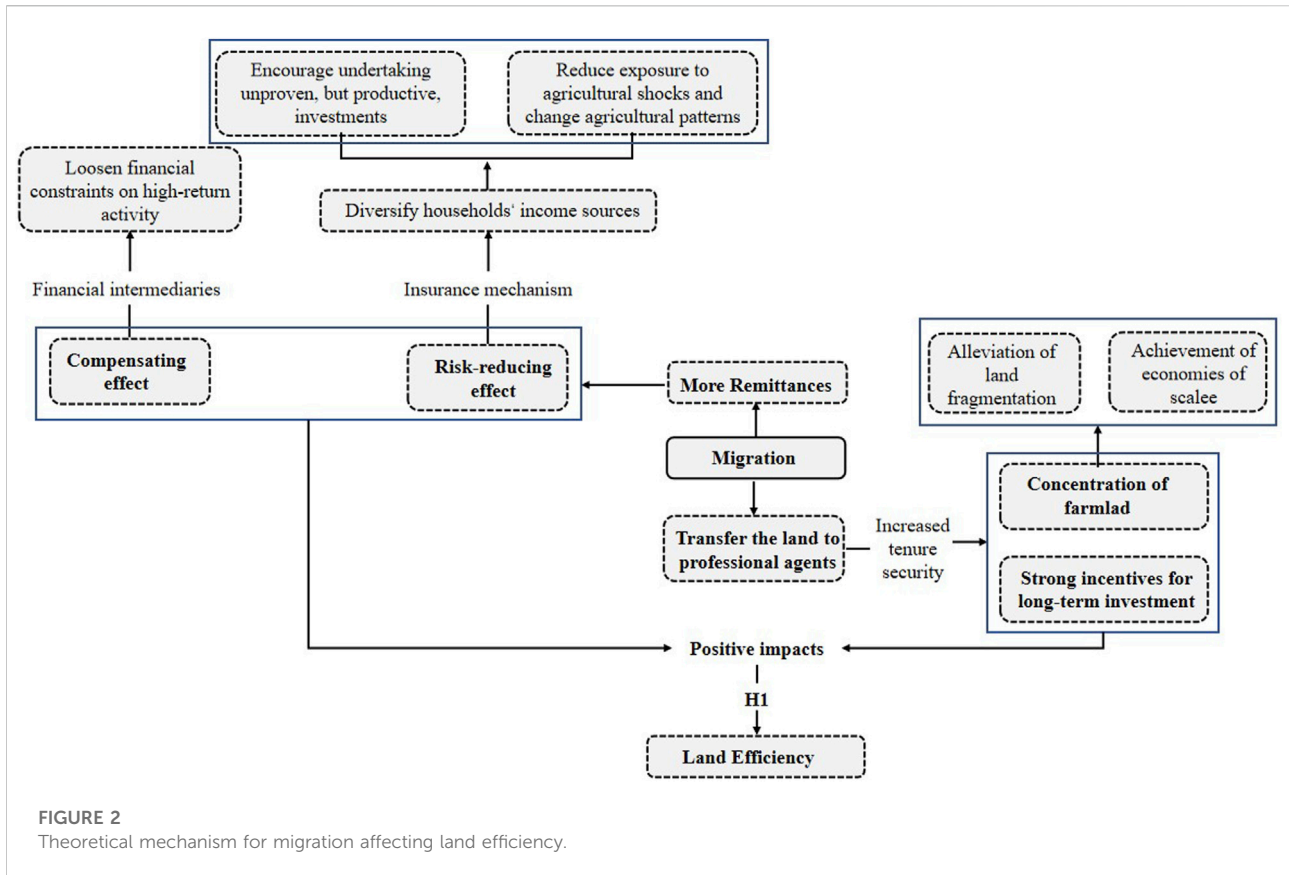
## 2 Theoretical framework

The New Economics of Labor Migration (NELM) opens up new perspectives in terms of the envisage and modeling on the connection between agricultural activity and off-farm employment. The first formal model of the NELM was presented by Stark and Bloom (1985) and Stark (1991b). By highlighting the convolution of migration as an economic fact and offers a more subtle research angle, the NELM assess the negative effects of family labour loss and the positive influences of remittances on family production (Taylor et al., 2003). In specific, the negative effect is generated by the lost-labor effect, which is regarded as the reduction of human resources. Normally, migrants have been viewed as capable and significant agricultural laborers (Sharma et al., 2016). Their leaving may result in neglecting production and affecting labor quality (changing from grown male members to female, underaged and senior members). Whereas the positive influences come from the income-effect of the remittances. Remittances sent back by migrants recompense for labor input decline and pool funds for enhancement in production, farmland reclamation and the hiring of agricultural laborer (De Haas, 2006; McCarthy et al., 2006; Hull, 2007). In general, both positive and negative impacts can be generated from off-farm employment, but the logic of the correlation differs across the types of off-farm employment. With the help of the NELM theory, this study presents an econometric approach testifying two hypotheses:

### 2.1 H1. Migration exerts a positive impact on land efficiency.

Based on how the rural labor force participate in non-agricultural industries, we divide the kinds of off-farm employment into two categories: migration and local off-farm employment. The rural family members who left their homes in the rural area to work in urban areas for more than 6 months a year are defined as migration, while local off-farm employment denotes rural family members who have not left the rural area but do work locally for over a half of a year.

Migration is speculated to affect land efficiency positively in two aspects (Figure 2). On the one hand, rural-urban migration becomes a major incentive to create new agricultural operating systems. Families that send out migrants have to find a way to transfer their farmland to others and retain the contracting rights at the same time. They found a way that could provide a solution: rural families transfer their land to other operators (e.g., family farms, large and specialized family entities, and agribusinesses and farmers' professional cooperatives), turn their contracting rights into stock rights and receive dividends based on their shares. For the agricultural operators, they have stronger tenure security in this operating system, and usually hire agents or managers to engage in agricultural activities on large-scale



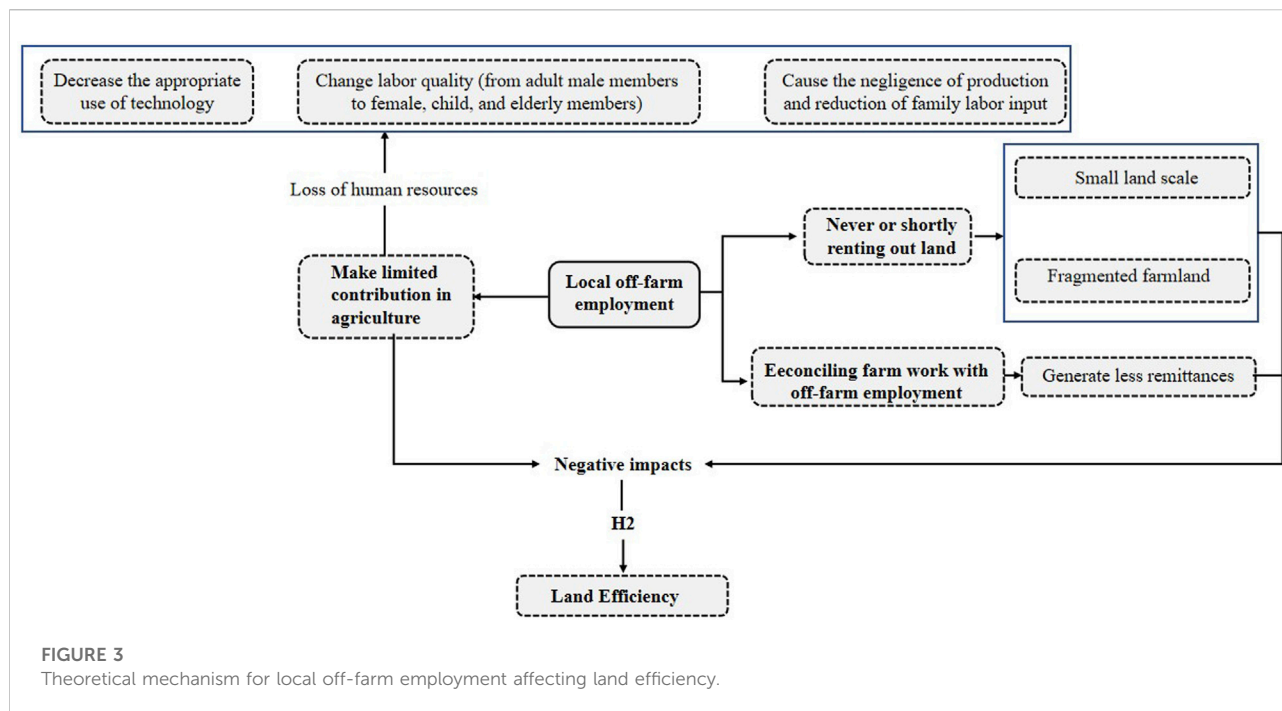
farmland. This approach positively affects land efficiency in three ways. First, the “lost-labor” effect can be replaced by the hired managers and laborers (Taylor et al., 2003). By adopting the new agricultural operating system, the migrants leave their farmland to the professional operators instead of their left-behind family members. The labor loss can be recompensed for by recruited agribusinesses, managers and workers, as well as the utilization of technologies for higher-productivity (Li et al., 2013). Consequently, a rise in productivity can be achieved (Harris and Todaro, 1970). Second, land transfer by migrants attenuates the negative effect of land fragmentation. The determination of land fragmentation is primarily based on the land area and the quantity of plots (King and Burton, 1982), can be pernicious in agriculture (Hartvigsen, 2014). Before land transfer, only minimum quantity of land is allotted to each family, leading to decentralization and fragmentation into small farms (Dong, 1996; Chien, 2015; Lu and Xie, 2018). But after the concentration of land toward the operators, the likelihood of large-scale agricultural management increases, which reduces agricultural productive costs and subsequently improves productivity (Li et al., 2021). Third, the stronger tenure security achieved by stock right facilitates timely returns on agricultural investment, including afforestation, conservation of water and soil and the utilization of organic fertilizers

(Abdulai et al., 2011; Muraoka et al., 2018), which is conducive to land efficiency.

On the other hand, migration improves land efficiency by raising household income and overcoming capital constraints (Gartaula et al., 2012). The NELM holds that migration and remittances generated therefrom contributes to the betterment of rural livelihoods since they tackle the restraints that used to bind agricultural production, facilitate income source diversification, and pool financial fund for prospective investment (Stark, 1991a). Migrants do not go back to their rural homes on a regularly and frequent basis, they tend to be engaged in more stable careers and receive higher wages, thus migration families receive relatively more remittances, which generates a compensating effect and a risk-reducing effect that are more substantial to even out the negative impact.

## 2.2 H2. Local off-farm employment negatively affects land efficiency.

Local off-farm employment affects land efficiency negatively (Figure 3). Three possible explanations are, first, there is a low probability that the “lost-labor” effect is to be offset by the seasonal labor contribution. The “lost-labor” effect leads to



the reduction of labor available for farm work and undermines the incentives for investment (Zimmerer 1993; Miluka et al., 2009; Gilles et al., 2013; Amare and Shiferaw, 2017). Though local off-farm employees stay at their rural homes and are plausible to engage in farm work, they could only manage the farm work when they are spared from their off-farm jobs, which can be in conflict with the production periods. Besides, some of them choose to be local off-farm employees instead of migrants for the convenience of nurturing children or teenagers, the seasonal contributions to farm work can be meager. As a consequence, local off-farm employment causes shift in the characteristics of human capital among the left-behind. The “ageing” and “feminization” phenomena resulted from labor outpouring contribute to the land efficiency (Li and Zhao, 2009; Mu and Van de Walle, 2011) since the elderly and women are less strong in terms of physical strength, less skilled, and less likely to utilize new technologies (Hunt, 2004; Yue and Sonoda, 2012). Unlike households with migrants, households with local off-farm employees do their farm work mostly by family members instead of by operators and agents, which makes it less likely for them to replace the family’s off-farm members by hired laborers. As such, the negative effect of human capital change on land efficiency is not likely to be offset.

Second, families with local off-farm workers usually choose not to withdraw entirely from the land by retaining some labor supply for farming. They are rarely engaged in land transfer with new agricultural operators. Consequently, the attenuation of land fragmentation and achievements of scale economies or stronger tenure security are more unlikely to be observed. Third, local

off-farm workers stay in rural homes, their families receive less stable and less sufficient remittances, which produces smaller compensating and risk-reducing effects to even out the lost-labor effect.

### 3 Data and empirical form

#### 3.1 Data

China is going through an unprecedented large labor migration, with a yearly growth of 1 percentage point over the past 4 decades. Based on the data quoted from China National Bureau of Statistics, the urbanization rate has jumped from 17.9 to 64.7 percent from 1978 to 2021 in this country. This further confirms that labor out-flow has been shaping rural China in a profound way, which constitutes a chance to measure the influence of off-farm employment on land efficiency.

Stratified random sampling is used to decide the sample area as well as the interviewees for representational effectiveness and research validity. Firstly, based on the generally accepted zoning of the east, central and west China and the criterion of rural population, Sichuan province, Henan province, Shandong province and Zhejiang province are selected. Next, in the four provinces, five villages (a total of 20) are selected randomly on the basis of the distance from the capital of the given province. Last, 30 rural families are selected randomly from each village to be the interviewees of the questionnaire.

The questionnaire survey is carried out in the manner of face-to-face interview. The questionnaire consists of the demographic background of the household head, that of the family (including the number and construction of family members, income formation and economic status) and the basic facts in their agricultural production. The survey was carried out from the year 2016–2018, with a total of 600 questionnaires gathered. Questionnaires in which the data provided are incomplete or should there be any missing information are eliminated. As such, a total of 543 valid questionnaires are retained (Table 1), with a questionnaire effective rate of 90.5%.

### 3.2 Empirical model

We establish the following model by referring the methodologies of Feng et al. (2010):

$$Y = \alpha_1 + \alpha_2 \text{Emp} + \sum \delta_i Z_i + \epsilon \quad (1)$$

Where Y represents household land efficiency (profit RMB yuan/mu of land) in 2017. Land efficiency is the crucial criterion for agricultural capacity. As such, in China, it bears much relevance to the critical issue of food self-sufficiency (Qian and Hong, 2016). However, its correlation with off-farm employment has not received its deserved attention for the time being. Hence, land efficiency is set as the key variable in calculating agricultural productivity. Land efficiency is represented by the yearly output/profit (per mu of land). The output is the difference where the aggregate market value of agricultural products (by crop type, excluding the household's food expenditure) minus the expenses for culture (cost of rent, laborers, seeds, fertilizers and machine, etc.).

Emp represents the number of migrant and local off-farm workers in every family, respectively. It is measured by the number of migrants or local off-farm workers in every family (Taylor et al., 2003; Atamanov and Van den Berg, 2012; Ma et al., 2022). Migrants refer to the members who move to urban areas and engage in non-agricultural undertakings for more than 6 months a year and do not go back their rural homes regularly (less than 2 times a year), whereas local off-farm employees denote the ones who remain in their rural homes and participate in off-farm work for over a half of a year.

Zi controls for the features at the individual, household, and village level to explain land efficiency. It consists of agricultural production measures, such as agricultural labor input, land size, land transfer, and machinery. The agricultural labor input is a key factor that affects land efficiency (Baležentisa et al., 2021). The total land size is conducive to enhancing machine-based management of production and realizing the outcomes of scale economies (Li et al., 2021), which is measured by the size of the land put in production. With the progress of TRSR, we have witnessed accelerated land transfer, with significantly enlarged

TABLE 1 The distribution of survey samples.

Province	City	Number of villages	Number of valid samples
Zhejiang	Yuyao	3	80
	Ningbo	2	50
Shandong	Weihai	5	138
Henan	Puyang	2	54
	Luohe	3	83
Sichuan	Guangan	2	56
	Chengdu	3	82
<b>Subtotal</b>	<b>7</b>	<b>20</b>	<b>543</b>

scale (Ji et al., 2018). Land transfer refers to the households who are engaged in transferring in or out their farmland *via* rental, exchanging for shares, or any other ways of passing on the management right. It affects agricultural productivity through mediating variables such as farm size in cultivation, family farm labor input, and capital services input (Zhang et al., 2020). We evaluate the impact of land transfer by including two land transfer dummy variables. Machinery boosts agricultural intensification and provides supports for labor-efficient and energy-efficient technologies (Takeshima et al., 2013; Benin, 2015). It is measured by the annual rental fee or the depreciation expense of agricultural machines.

Human capital characteristics are also incorporated in the equation. It is vital to discern the productivity of the left-behind when examining the lost-labor effect on agricultural production resulted from human capital change. The gender, age and education information of the household head and the agricultural training received are expected to play a part. It is expected that male-headed families have a higher tendency to embrace new techniques, which is probably due to the fact that men usually are exposed to higher availability of key inputs including land and labor, they also have more access to supplementary endowments including credit and additional information on extended services (Babu and Gajanan, 2022). Furthermore, an array of literature present evidence that confirms gains from receiving education and other human capital affect migration and crop production positively (Jamison and Lau, 1982; Taylor and Martin, 2001). Household heads who are more educated and receive more training are speculated to master better skills in farming and thus be more high-yielding (Feng et al., 2010).

Village characteristics are also found to be related to agricultural productivity (Qian and Hong, 2016). Therefore, the variable of village economy is included in the equation and is represented as the average income of village members. In addition, there are other factors at the village level that affect land efficiency but have not been controlled by variables listed above. A vector of dummy variables is also employed to control

TABLE 2 Descriptive statistics (N = 543).

Variable	Definition	Mean	Std.Dev
Land efficiency (Y)	Annual output/profit (per mu of land in 2017) (log value)	3.335	0.332
Emp for migration families	Number of migrants in every family	0.634	0.547
Emp for local off-farm employment families	Number of local off-farm workers in every family	0.982	1.108
Transferring in land	Land transfer dummy variable (1 = household rents in land)	0.320	0.4671
Transferring out land	Land transfer dummy variable (1 = household rents out land)	0.271	0.445
Agricultural labor input	labor force input in agriculture	0.287	0.281
Total land size	Size of the land in agricultural production (measured by contracted land + rented land- leased - deserted land, mu)	11.005	28.309
Machinery	Annual cost of agricultural machinery (log value)	2.408	1.460
Gender of household head	Gender of the household head (1 = male)	0.862	0.345
Age of household head		53.436	9.874
Educational level of the household head	Schooling years of the household head	8.765	2.033
Training of household head	Agricultural training dummy variable (1 = yes)	0.387	0.487
Economy of the village	Average income of the village members (log value)	4.076	0.215

for fixed effects at the village level. Table 2 gives a summary of statistics on the primary variables in this study.

### 3.3 Endogeneity

The empirical approach raises concerns over endogeneity in its methodology in terms of sample selection bias and reverse causality. To be more specific, households with off-farm workers tend to be more productive than the ones without while the most productive rural laborers have a higher tendency to occupy themselves with off-farm work for a better life. As such, a bias might arise in the coefficient of off-farm employment where land efficiency is examined with an ordinary least squares (OLS) regression. Nevertheless, the contrary bias may also come into being since it is possible that households with off-farm workers are not as productive. This may exactly be the case, for example, when a family is actually “forced” to have some of its members taken part in off-farm employment for reasons such as inadequate land efficiency. In this sense, the lost labor effects might trace back to the fact that households with inadequate productivity are actually forced to have an off-farm laborer, which may lead to the concern that the number of off-farm laborers are endogenous explanatory variables in the land efficiency equation. These problems are tackled by introducing instrumental variables (IVs) to achieve consistent estimations.

$I_0$  is the vector of IV. Portion of secondary and tertiary industry in local GDP (PST) is one of the most widely applied instruments for off-farm employment given their contributions to rise in chance and to costs cut of off-farm employment (Zhang and Hu, 2006; Yu, 2009). It is expected that a higher PST contributes to a greater likelihood of participating in

TABLE 3 Variance inflation factors (VIF) of the empirical model.

Variable	VIF	1/VIF
Emp	1.11	0.898
Transferring in land	2.53	0.395
Transferring out land	1.33	0.754
Agricultural labor input	1.67	0.598
Total land size	2.16	0.462
Machinery	1.34	0.749
Gender of household head	1.25	0.799
Age of household head	1.21	0.824
Educational level of the household head	1.17	0.857
Training of household head	1.11	0.903
Economy of the village	1.99	0.503
Mean VIF	1.53	

non-agricultural sectors for rural population, because the well-developed non-agricultural industries provide more jobs for the rural laborers. The less-developed regions provide limited opportunities and the potential workers have to stay in counties and villages. This argument is reinforced by Hu et al. (2009), who suggested that farmers who live close to highly industrialized and urbanized regions have a higher tendency to take part in off-farm work. It is also concluded that 45%–75% change in off-farm employment is attributed to non-agricultural industry development (Fan and Tian, 2003; Han and Liu, 2007). The proxy of PST is the ratio of added value of the secondary and tertiary industry to the city’s GDP in 2017. Following the prediction of Zhang and Hu (2006), the PST elaborates household-level off-farm employment stock in 2017, but it is

TABLE 4 Estimates from reduced-form equation, IV, and OLS estimators.

Types of off-farm employment	Reduced form		2SLS (IV)		OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
	Migration	Local off-farm employment	Migration	Local off-farm employment	Migration	Local off-farm employment
A)	First stage					
	Land efficiency		Off-farm employment			
PST	5.065 (4.178)	0.285 (0.299)	0.828*** (0.238)	0.706*** (0.142)		
F-stat of instruments			15.47	14.56		
B)	Second Stage		Land efficiency			
Off-farm employment			0.339** (0.167)	-1.203*** (0.264)	0.090*** (0.032)	-0.085*** (0.030)
TI			0.092 (0.133)	0.023 (0.170)	0.071 (0.109)	0.298*** (0.066)
TO			0.169*** (0.048)	-0.149 (0.103)	0.135*** (0.044)	0.182*** (0.053)
Labor			-0.812*** (0.075)	-0.333 (0.224)	-0.755*** (0.082)	-0.017 (0.123)
Land			1.394*** (0.069)	0.635*** (0.131)	1.340*** (0.062)	0.610*** (0.072)
Observations	207	336	207	336	207	336
R-squared					0.918	0.769
Hausman test			3.970		90.620	
p-value for Hausman test			0.046		0.000	
F-stat of Cragg-Donald Wald			12.13		19.67	

Note: Off-farm employment is instrumented. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ ; estimators of some control variables are not presented.

exogenous to land efficiency and is not directly relevant to features that are not observed at the level of households.

We also deal with the possibility of multicollinearity by testing the Variance Inflation Factor (VIF). Table 3 shows that the values of VIF and each VIF of all variables are less than 10, indicating that multicollinearity is insignificant in this paper.

## 4 Results and discussions

Table 4 presents the estimation results of the effect of off-farm employment on land efficiency with the help of 2SLS and OLS. Across the alternative regressions, the coefficients do not show marked variation, indicating ours to be robust results. The instrument variable is significant statistically at the 1 percent confidence level. Among all regressions, the F-statistic of Cragg-Donald Wald are 12.13 and 19.67 and it passes the tests for weak instruments (Table 4).

As was shown in models three and five (Table 4, panel B), with each additional member engaged in migration, land efficiency increases significantly by 0.339 and 0.09. This result indicates that the land efficiency of families with more migrants tend to be higher. This conclusion differs from that of Shi et al. (2011)—which is one of only a handful of research that clarifies the differential effects of three kinds of off-farm employment. In the research of Shi et al. (2011), it was found that the lost-labor effect for local off-farm employment is not as strong as that for migration. The reason for the inconsistency between the two findings is that the effect of labor loss caused by migration is compensated for in the context of TRSR, which may not have been observed during their research period in 2011. In general, migration usually results in neglecting agricultural production and affect family labor input negatively (Maharjan et al., 2012). To be more specific, migration leads to the decrease of the number of more productive and skilled members that may remain in their rural households (Uprety, 2019). As a result, the entire household is speculated to have lower productivity.



However, under the background of TRSR, the effect of migration on land efficiency can be positive *via* three mechanisms. First, households that send migrants to urban regions do not return to rural homes regularly and have to leave their land to the professional operators instead of their left-behind family members. The labor loss can be offset by hired agribusinesses, managers and workers, as well as the utilization of technologies for higher-productivity (Li et al., 2013). Thus, a rise in productivity can be observed (Snarr et al., 2011). Second, TRSR separates the contracting rights and management rights, enables farmers to keep the contract right of the allocated land and pass on the management right by investing the land in a rural cooperative for shares (Wang and Zhang, 2017). Therefore, farmers' contracting rights are stabilized while management rights liberalized, which promotes the concentration of land toward cooperatives and develops larger scale operation of agricultural production (Liu et al., 2017). Large-scale operation of agriculture attenuates the negative effect of land fragmentation and reduces costs of agricultural production and consequently improves productivity (Li et al., 2021). In addition, arrangements of TRSR help to avoid the frequent land reallocation (Ito et al., 2016), the strengthened tenure security and potential long-lasting contracts are well-placed to make the ones involved to take on enduring investments including improving farming skills in order to manage larger lands with higher efficiency (Rao et al., 2016). Third, given the fact that migrants do not return rural homes on a regular and frequent basis, households of migrants in turn receive more remittances comparatively, which leads to more marked offsetting and risk-reducing effects that even out the lost-labor effect (Zhao and Jiang, 2022).

With regard to the impact of local off-farm employment, on average, it contributes negatively to higher land efficiency. More specifically, if the member of local off-farm employment increases by one person, land efficiency decreases by about 1.203 and 0.085, respectively. There are three possible reasons for the results. Firstly, lost-labor and ageing effects of local off-farm employment impair land efficiency. Given that local off-farm workers usually choose not to exit from agriculture and maintain some labor supply to farming but inevitably with insufficient time or participation, the labor loss in farm work is considerable. In our survey, some local off-farm workers are found to be not engaged in agricultural production during their stay in their rural homes. This is typically the case under the following two conditions. One is when the local off-farm workers could not find long-term employment and thus have to return to their rural homes. In this case, they are in fact "compelled" to return to the villages or counties. In this scenario, they are very likely to occupy themselves with non-agricultural jobs instead of agricultural activities given that local off-farm employment contributes more to the family income. The other is that some local off-farm workers decide to go home to better nurture their underaged children or teenagers. As such, the actual labor input

in agricultural activities is still inadequate. In addition, the lost-labor effect cannot be compensated for by hired workers due to the incomplete labor markets and capital constraints (Atamanov and Van den Berg, 2012). As a result, most of the farm work is managed by left-behind residents (mostly the senior and the female) (Aratame, 2006). These residents are less educated and skilled than the young and male members, thus a negative impact on productivity is exerted (Peterman et al., 2011; Xu et al., 2019). Secondly, tenure insecurity undermines the incentives for productive investments and land expansion (Befikadu et al., 2018). Farmland is viewed as a sort of fixed asset with a comparatively long payback period as investment, which indicates that tenure security could impose a significant impact on the security of residual claimant rights for the farmers who rented land from others (Feng, 2008; Nie, 2017). Local off-farm workers rent out land temporarily to take up off-farm employment instead of entire withdrawal from agriculture, they usually choose to possess the management rights by their own due to the risk of losing their off-farm jobs. The ideal choice for households is to work in agricultural and non-agricultural sectors and to keep the management rights of land for risk prevention. These families usually lease their land to the agents shortly during their departure, thus the land transfer is conducted *via* contracts rather than by stock rights. As a result, agricultural operators have concerns over the tenure security and that the land might be redistributed at some point in the future (Deininger et al., 2014). Therefore, the incentives for investment in technologies for higher-productivity are undermined (Muraoka et al., 2018). In addition, the decreased production cost brought about by larger farm size and economies of scale, as well as the increased longer-term investments achieved by reduction of fragmentation, is unable to be observed under this situation (Latruffe and Piet, 2014). Thirdly, the compensating effects of remittances from local off-farm workers are meager. Given that local off-farm workers stay in rural home, their families receive relatively less remittances, which produces smaller compensating and risk-reducing effects to even out the lost-labor effect.

For other variables, from Table 4 it is observed that families with more farmland showcase higher land efficiency, and the elasticity of which is about 1.3 and 0.6. This may be due to the fact that land is a crucial production factor (Yang et al., 2016). Larger land size (while keeping other measures unchanged) could lead to rise in land efficiency given larger farm size denotes lower level of land fragmentation and improved machine-based operation in production, improving agricultural output (Wu et al., 2005; De Janvry et al., 2015). The findings are consistent with the results reached by De Janvry et al. (2015) and Deininger and Ayalew Ali (2007). A positive correlation was found between transferring out land and land efficiency in the majority of regressions, because the land certificates brought along by the TRSR encourage farmers to transfer land to the ones who could enable highly-proficient use of the farmland (Deininger et al., 2014). When

farmers transfer their land to the full-time agents, the increased professionalism in agricultural work leads to a drop in the aggregate cost of production.

## 5 Conclusion

The important role that rural-urban labor migration plays in rural China is self-evident. The important role that rural-urban labor migration plays in rural China is self-evident. Unlike existing studies that mainly focus on one village or province, this study collects proof from a hands-on research in four provinces of China, which provides an expansive and thorough perspective to testify the NELM theory. Meanwhile, it investigates the correlation between land efficiency and off-farm employment under the background of the Three Rights Separation Reform, which has received little attention in established econometric research. In addition, with the NELM theory as the research framework, we further estimate how the effects of off-farm employment differ across the types of migration and local off-farm employment. That is, migration has a significant positive impact on land efficiency because of the offset lost-labor effect achieved by hired agents, the scale economies obtained by strengthened tenure security and the stronger compensating effect brought about by sufficient remittances, whereas the negative impact of local off-farm employment on land efficiency is observed, making it stand out from previous findings. The robustness test results also support the above conclusion.

The Three Rights Separation Reform aims at meeting the dual challenge of inexpensive labor supply for fields that arise and resolving the food self-sufficiency issues faced by policy makers. By clarifying land rights through issuing formal certificates, the TRSR encourages off-farm employment, with different kinds of off-farm employment playing important but distinct roles in determining land efficiency. The research findings in this study are well placed to offer policy makers new perspectives in tackling the above-mentioned problems.

First, a negative effect of local off-farm employment on land efficiency has been found, suggesting that rural-urban migration may lead to lower land efficiency if proper countermeasures have not been taken. The lost-labor effect is more evident in families with local off-farm workers where agricultural production relies on labor of the household and where there are short of labor. As such, appropriate measures shall be taken such as the establishment of a local labor market. With such a market, local off-farm employment households could make up for the household's absent members by recruited labor to even out the negative effect of labor inadequacy on land efficiency. Second, the findings indicate that migration affect the enhancement of land efficiency positively and can lessen the lost-labor effect through the offsetting effect brought out by the remittances. As it is often the case that rural families have their own minds in terms of how

to make the most of the remittances to better their living conditions, the authorities shall, by all means, introduce more favorable policies to invite more farmers to spend more of the remittances in advanced technologies that boost productivity such as new seeding techniques, better fertilizer arrangements with high efficiency and machine-based operation if we aim to improve rural land efficiency. Third, the heterogeneous effect of migration and local off-farm employment on land efficiency calls for differentiated measures. For regions where local off-farm employment dominates, the outflow of labor resources results in the decline in land efficiency because of the lost-labor effect and ageing-issue effect. Measures should be taken in overcoming the effect of labor loss, such as encouraging investment in mechanization, providing technical services, establishing financial institutions to alleviate capital constraints and improving the human capital of left-behind workers through education or skill training. For regions where migration dominates, the outflow of labor force improves land efficiency because of the strengthened tenure security and land concentration. The strengthened tenure security is based on the strong trust in management rights and expectation of stable possession of land brought about by the TRSR. As a result, further deepening the Three Rights Separation Reform is urgently needed, in that the released rural labor force, more capital investment and new agricultural operators nurtured contribute to more reasonable allocation of factors including land, capital, technology and labor. Policies should also focus more on encouraging the transfer of farmland, establishing proper distribution of interests between agents and rural households, as well as the protection of agents' management rights and rural populations' contract rights.

As new research perspectives and insights on the heterogeneous impacts of migration and local off-farm employment on land efficiency could be drawn from our study, the current paper still needs to be improved on several fronts. Firstly, migrants are employed will not continue to consume food at their rural homes if they are employed elsewhere. This could well be one key motivation to migrate especially for economically-deprived households (Van der Geest, 2010). It has a direct impact on the household's agricultural production (Burger, 1994; Shi et al., 2011) and the current study has not covered this aspect in its analysis of the theoretical basis. Due to the absence of food consumption data of individual households, this factor was not separately examined. Furthermore, data collected from four Chinese provinces are analyzed and the conclusion draw are based on these data. However, factors such as different resource and environmental constraints faced by farmers might generate different effects of off-farm employment on land use, we can only control for the environmental factors by including the variable of village economy and a vector of dummy variables at the village level. If more detailed data from more provinces or regions in China could be collected, this study will shed more light on the research

domain. In addition, we explain the impacts of the Three Rights Separation Reform (TRSR) on land efficiency *via* the mechanism of the land tenure security. Efforts should be made to analyze the influencing factors and future research is needed to examine if the proposed causes are valid.

## Data availability statement

The datasets presented in this article are not readily available because the dataset is not allowed to be public without the permission of the Ministry of Education of the People's Republic of China. Requests to access the datasets should be directed to [xmsb@sinoss.net](mailto:xmsb@sinoss.net).

## Ethics statement

Ethics review and approval/written informed consent was not required as per local legislation and institutional requirements.

## Author contributions

SZ: Conceptualization, investigation, methodology, project administration, supervision, writing—review and editing. SP:

Methodology, formal analysis. YJ: Conceptualization, resources, writing—review and editing. XW: Investigation, data curation.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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