Analysis on the establishment of natural reserves and the transfer of agricultural labor forces taking Jiangxi Province as an example*

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Abstract

Purpose – The purpose of this study was to conduct a comprehensive analysis of the impact and its mechanism on the transfer of agricultural labor forces in the surrounding areas resulting from the establishment of a natural reserve, which holds great significance. The significance of this analysis is on the ecological protection of the natural reserve and the coordinated development of local social economy.

Design/methodology/approach – This study first performs an analysis on the impact and its mechanism on the establishment of the natural reserve on the transfer of agricultural labor forces from two aspects, which are push and pull factors. Then, based on county panel data in Jiangxi Province from 1995 to 2012, this study builds a generalized difference-in-difference model and performs an empirical study on the impact, heterogeneity and its mechanism on the establishment of the natural reserve on the transfer of agricultural labor forces.

Findings – The empirical analysis reveals that the establishment of natural reserves would significantly promote the transfer of agricultural labor forces to non-agricultural sectors. The robust test and placebo test with changed estimation methods verify the robust of the result. The result passes the parallel trend test and shows that the impact is most significant within one year after the implementation of the policy. From the mechanism analysis, the impact mainly comes from the "push" effect brought by the restricted development of agricultural production and primary industry on agricultural labor forces, and the "pull" effect brought by the development of local tertiary industry.

Originality/value – The conclusion of this study enriches the understanding of the internal mechanism between the establishment of natural reserves and the transfer of agricultural labor forces from the push and pull factors, and can provide reference for formulating policies to promote the coordinated development of natural reserve construction and regional social economy.

Keywords Natural reserves, Agricultural labor, Transfer, Difference-in-difference model, Mechanism analysis

Paper type Research paper

1. Introduction

The construction of natural reserves is an important measure to promote ecological civilization and an important guarantee to maintain ecological security (Wang *et al.*, 2013). Since the establishment of the first natural reserve in 1956, China has basically formed a natural reserve system with relatively complete types, reasonable layout and relatively complete functions. The 19th National Congress of the Communist Party of China proposed to "establish a natural reserve system with national parks as the main body". As an important part of natural reserves, the protection and development of natural reserves is still an important part of creating "green water and green mountains". By 2018, a total of 2,750

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natural reserves of various types and levels have been established nationwide, with a total area of 1.4717mn square kilometers. The land area of the natural reserve is 1.427mn square kilometers, accounting for 14.86% of the land area. There are 463 national natural reserves with a total area of about 974500 square kilometers (according to Bulletin of Marine Ecology and Environment Status of China in 2018). The establishment of natural reserves plays an important role in storing biological species, protecting biological diversity and species viability, conducting scientific research experiments and driving the development of tourism in surrounding areas (Heckman *et al.*, 1997); However, the establishment of natural reserves will limit the use of resources and change the traditional lifestyle of surrounding residents (Chen *et al.*, 2018). For example, Regulations of the People's Republic of China on natural reserves stipulates that "activities such as logging, grazing, hunting, fishing, mining, reclamation, burning, mining, quarrying, and sand digging are prohibited in the natural reserves." The restriction of resource utilization and the forced change of production and lifestyle will also promote the transfer of agricultural labor around the natural reserve to non-agricultural sectors. The existing research is mostly based on the survey data of farmers around the natural reserve to empirically analyze the impact of the establishment of the natural reserve on rural labor transfer (Wu *et al.*, 2022; Zhang *et al.*, 2020, 2021; Yang, 2017; Zhou and Qi, 2020; Bi *et al.*, 2020; Li *et al.*, 2013), and also find that the establishment of the natural reserve has promoted the non-agricultural transfer of labor in the surrounding areas (Yang, 2017; Zhang *et al.*, 2021). However, the transfer of agricultural labor force is not only related to "push," but also to "pull," and the establishment of natural reserves will affect the transfer of agricultural labor force by affecting the "push" end and "pull" end. Therefore, it is necessary to further analyze the comprehensive impact of the establishment of natural reserves on the non-agricultural transfer of labor force and reveal its mechanism from these two aspects, which is of great significance to further understand the impact and formulate policies to promote the coordinated development of ecological protection and regional farmers' income.

2. Literature review and theoretical hypotheses

2.1 Literature review

As for the impact of the establishment of natural reserves on the transfer of agricultural labor, the academic community has explored a lot. Existing research focuses on the impact of natural reserve construction on the livelihood capital and livelihood strategies of surrounding farmers, as well as the impact on promoting the transformation of surrounding farmers from purely agricultural to non-agricultural. For example, some scholars found that, based on the survey data, since the establishment of natural reserves limits the use of natural resources in the surrounding areas, natural capital accounted for the lowest proportion of livelihood capital, and human capital and physical capital accounted for a higher proportion than natural capital, financial capital and social capital (Wu *et al.*, 2022; Zhang *et al.*, 2020). The lack of natural capital increased the number of migrant workers, and part-time farmers and non-agricultural employment became a common livelihood strategy choice in the surrounding areas of the natural reserve (Yang, 2017; Zhang *et al.*, 2021). With a large number of agricultural labor force going out to work, the agricultural population declined and the income increased significantly (Zhang *et al.*, 2020). The proportion of non-agricultural income of residents in the surrounding areas of the natural reserve increased significantly, and their non-agricultural income mainly came from migrant workers and tourism development (Wu *et al.*, 2022; Zhang *et al.*, 2020).

Foreign scholars have focused on the impact of the urban–rural income gap when studying the factors affecting the transfer of rural surplus labor in China. De Brauw (2002) studied the rural labor market in China and concluded that the human capital level of rural

labor has a significant positive impact on the transfer of rural surplus labor, and has a significant impact on the treatment of rural surplus labor transferred to the non-agricultural sector. George (1987) proposes the self-selection model, which suggests that rural labor migration depends on three main factors: the observable or unobservable "transferability" of individual capabilities of potential migrants, the degree of relative income inequality, and the comparison of average income levels between the origin and destination. Sandeep (2007), professors at the University of California, conducted an empirical analysis of labor migration in China. Through the analysis based on Probit model, they found that the development of individual enterprises in rural areas has an impact on the migration of rural labor: the development of individual enterprises in rural areas is conducive to the development of the rural economy, increasing labor productivity in the primary sector and raising the per capita income of farmers.

To sum up, the existing literature mostly explored the impact of the establishment of natural reserves on the livelihood strategies of farmers in the surrounding communities based on the micro data of the survey of farmers in and around the natural reserves. However, the establishment of natural reserves will not only affect the livelihood capital of surrounding farmers and their choice of livelihood strategies, that is, the "push" side of labor transfer, but also affect the outward migration of agricultural labor of surrounding farmers, that is, the "pull" side of labor transfer, by affecting the development of the secondary and tertiary industries in the region. Moreover, the existing research based on micro survey data is difficult to sample people who have moved out of rural areas due to the limitations of sampling, so it will underestimate its impact. Therefore, this study first constructs the mechanism of the establishment of natural reserves for the transfer of labor force from the two aspects of push and pull, and then, based on the long-term panel data at the county level in Jiangxi Province from 1996 to 2012, constructs a generalized difference-in-differences (DID) model to empirically analyze the impact of the establishment of natural reserves on the transfer of agricultural labor force and the extent of its impact, and further discusses its mechanism of action, as well as the heterogeneity in different regions.

The innovation points in this paper are as follows. First, in terms of the mechanism, the previous microresearch obtained the impact of the establishment of natural reserves on the transfer of agricultural labor through questionnaires, and only focused on the push level and could not discuss the mechanism. This study conducted a theoretical analysis of its impact from the two aspects of push and pull. Second, in terms of empirical content, the existing research mainly analyzes the impact of the establishment of a natural reserve on the livelihood of surrounding farmers based on the microsurvey data. It is difficult to survey the farmers who have moved out, but there is a certain deviation. This paper uses county level statistical data to avoid this problem. Third, in terms of research methods, unlike other relevant studies, which are based on cross-sectional data, this study constructs county-level panel data for the natural reserves established in Jiangxi Province from 1996 to 2012, which can control the impact of some unobservable variables.

2.2 Theoretical hypotheses

The practice and research on the transfer of rural labor have started early abroad, and the research has a high theoretical and practical depth. At present, the more influential ones include the Lewis Dual Economy Theory, the Rani-Fei Model, the Todaro Model, the Schultz's Human Capital Investigation Model and the Stark Hypothesis of Relative Economic Status Change. He proposed in "Political Arithmetic" that comparative income interests motivated the transfer of rural labor to the non-agricultural sector. Lewis (1954), Gustav and Fei (1961) proposed a "Dual Economy Model" of labor migration in developing countries. They believed

that in a dual economy, the pull of higher wages in the industrial sector and the push of lower wages in the agricultural sector would drive a continuous flow of rural labor to the industrial sector. Todaro (1969), on the other hand, argued that the flow of agricultural labor to urban areas depends on the push and pull of the expected income gap between urban and rural areas. Based on the Dual Economy Model of labor migration, researchers further used the push–pull theory to explain the transfer of agricultural labor. In 1938, Herbert integrated economic, demographic, sociological and other factors and pointed out that migration is caused by a series of forces, including the "push" that forces a person to leave one place and the "pull" that attracts the person to another place, which is the earliest proposed push–pull theoretical model. Later, based on Herbert's push–pull theory, Donald Berger proposed a systematic "push-pull" theory of population transfer in "Domestic Migration," which conducted in-depth research on the causes of population migration between regions. See Figure 1.

The "push" effect of the establishment of natural reserves on the transfer of agricultural labor force is mainly reflected in restricting the use of natural resources and infrastructure construction. First of all, the direct impact of the establishment of natural reserves is to change the original way of resource utilization (Wang *et al.*, 2013), and reduce the area of cultivated land and means of production. The government's restrictions on logging and other activities have restrained the original production and operation activities, leading to the shift of labor originally engaged in agriculture, forestry, animal husbandry and fishery to urban areas. Second, the establishment of natural reserves will inhibit the construction of infrastructure (Gao and Wen, 2004; Fu, 2005). As the construction of roads will damage the natural environment, the construction of roads will bypass the natural reserves. Considering that the transportation cost will be increased due to the inconvenience of transportation, and the preservation of agricultural products will be more difficult during the transportation process, the rural families who make a living by these products will reduce the planting of crops, especially cash crops, and the surplus labor will shift to urban areas to make a living. Therefore, the limited development of the primary industry will lead to the reduction of the corresponding labor demand, prompting some agricultural labor to transfer to the non-agricultural sector.

The "pull" effect of the establishment of natural reserves on the transfer of agricultural labor force is mainly reflected in tourism development, industrial development and

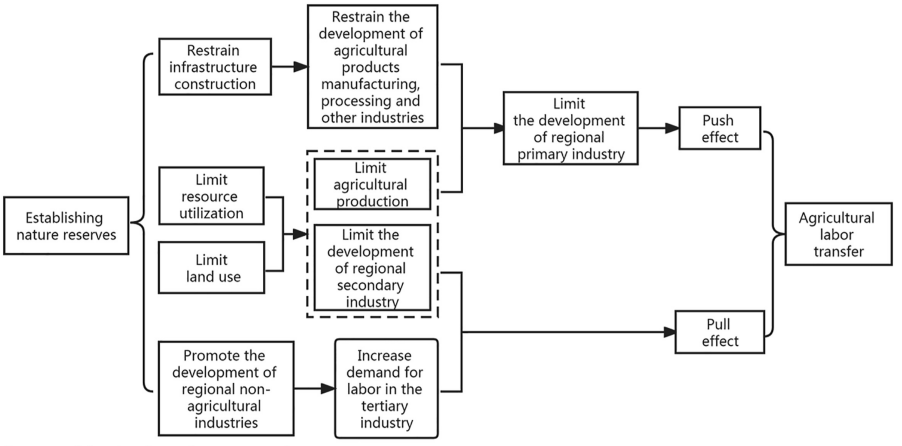

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Figure 1.
Theoretical mechanism

other aspects. First of all, the establishment of natural reserves will promote the development of tertiary industries such as ecotourism and service industry in the surrounding areas (Wang *et al.*, 2011), which will increase the demand for non-agricultural labor and transfer a large number of rural labor to non-agricultural sectors. Second, the establishment of natural reserves will restrict the mining, sand mining and other activities of surrounding industrial enterprises, thereby limiting the development of local industries. The development of the secondary industry in the region is limited, and the demand for labor force decreases, which to some extent inhibits the outward transfer of agricultural labor force. However, the impact of the establishment of natural reserves on industrial development is mainly limited to specific areas, while the location of industrial development is relatively flexible, and the inhibition of the establishment of natural reserves is relatively small, so the negative pull-on labor transfer is relatively small.

Based on the above analysis, this paper proposes the following theoretical hypotheses:

H1. The establishment of natural reserves will promote the migration of agricultural labor force.

H2. The establishment of natural reserves will restrict the use of resources and inhibit the development of the primary industry, thus promoting the outward transfer of agricultural labor.

H3. The establishment of natural reserves will promote the development of non-agricultural industries, and then pull the agricultural labor force outward.

3. Model setting, variable description and data source

3.1 Model setting

3.1.1 Benchmark regression model setting. Due to the different time and date of establishing natural reserves in different regions, this paper will use DID model with Multiple Time Periods Time and Date to investigate the impact of the establishment of natural reserves on the transfer of agricultural labor. The benchmark regression model in this paper is set as follows:

$$Y_{it} = \alpha_0 + \alpha_1 Consev_{it} + \alpha_2 year\_dummy_t + \alpha_3 imecofuc_{it}\_dummy_t + \delta_i + \lambda_t + \varepsilon_{it} \quad (1)$$

The subscript i represents county, t represents time and Y_{it} refers to the explanatory variable of county i in year t, expressed by the number of people engaged in agriculture, forestry, animal husbandry and fishery. $Consev_{it}$ indicates the establishment of natural reserves. If county i establishes a natural reserve in year t, then $Consev_{it} = 1$;If not, then $Consev_{it} = 0$. This study focuses on coefficients α_1, if α_1 is significantly negative, indicating that the establishment of protected areas will promote the migration of agricultural labor. $year\_dummy_t$ is a control variable, and it is represented by the interaction term between the *ex-ante* characteristic variable and the year dummy variable to eliminate the potential impact of *ex-ante* economic characteristics on the estimation results. To mitigate the result error caused by other policy impacts, the interaction item of whether it is a national key ecological functional area and the year dummy variable is included in regression 1 and is expressed as $imecofuc_{it}\_dummy_t$ [1]. δ_i is the individual fixed effect of the county. λ_t is the fixed effect of the year. ε_{it} is a stochastic disturbance term.

3.1.2 Parallel trend test model setting. The premise of building the DID model is that the treatment group and the control group meet the parallel trend assumption before the event, that is, whether the number of agricultural labor in the first two groups of establishing the natural reserve has the same change trend. Therefore, a dynamic DID model is constructed for parallel trend test. The specific model is as follows:

$$Y_{it} = \beta_0 + \sum_{k=2}^{K} \beta_k Consev_{i,\ t-k} + \sum_{l=0}^{L} \gamma_l Consev_{i,\ t+l} + \gamma_2 year\_dummy_t + \gamma_3 imecofuc_{it}\_dummy_t + \delta_i + \lambda_t + \varepsilon_{it} \quad (2)$$

Among them, $Consev_{i,\ t-k}$ represents the pre-item of the k phase in establishing the natural reserve, in which the previous phase of establishing the natural reserve is taken as the benchmark. β_k is the core coefficient concerned. It focuses on whether the treatment group and control group before establishing the natural reserve have the same time trend. If β_k is not significant, it means that there is no significant systematic difference between the two groups before establishing the natural reserve, and the parallel trend test is passed. $Consev_{i,\ t+l}$ represents the lag item of the l phase and is used for observing the sustainable impact of establishing natural reserves on the transfer of agricultural labor force.

3.2 Variable selection

The explanatory variable selected in this paper is the proportion of the number of people engaged in agriculture, forestry, animal husbandry and fishery (the number of people engaged in agriculture, forestry, animal husbandry and fishery/the total population at the end of the year). The time range of the variables to be explained in this study is from 1996 to 2012. Apart from the availability of data, there are compelling reasons for choosing the 1996–2012 time frame. First, the year 1996 marked the promulgation and implementation of the Regulations of the People's Republic of China on Natural Reserves, signifying the start of a new phase of legalization and standardization in nature reserve construction in China. Second, substantial progress was made in the construction of nature reserves in Jiangxi Province during the above period, culminating in the establishment of a natural ecological protection network with Wuyi Mountains, Nanling Mountains, Luoxiao Mountains, Jiuling Mountains and Poyang Lake Wetland as key areas. Third, the transfer of agricultural labor force in Jiangxi Province showed a remarkable growth trend. Altogether, selecting the 1996–2012 period allows us to discern the policy effects and social changes in the areas of ecological environment protection and agricultural structure adjustment in Jiangxi Province during this period.

The core explanatory variable selected in this paper is the establishment of natural reserves. Based on the information on the establishment of natural reserves published by the Ministry of Ecology and Environment of the People's Republic of China [2], the establishment information of natural reserves in Jiangxi Province from 1996 to 2012 is sorted out. Jiangxi Natural Reserve was founded in 1972. As of 2017, 200 natural reserves have been established in Jiangxi, with a total area of 1.0988 million hectares, accounting for 6.58% of the national territory. Among them, there are 16 national natural reserves. The information of newly constructed natural reserves in Jiangxi Province over the years is shown in Figure 2. It can be seen that after the reform and opening up, the establishment of natural reserves in Jiangxi Province has entered a stage of steady growth. Since 1999, with the launch of a series of major ecological projects such as natural forest protection in China, the cause of natural reserves in Jiangxi Province has developed rapidly, and then entered a stage of stable development.

The control variables selected in this study are the per capita GDP of counties in Jiangxi Province in 1995 (GDP/total population at the end of the year), the proportion of added value of the secondary industry (added value of the secondary industry/GDP), the proportion of added value of the tertiary industry (added value of the tertiary industry/gross regional product), the county population density (total population at the end of the year/land area of the administrative region), savings deposit balance of urban and rural residents per capita (savings deposit balance of urban and rural residents/total population at the end of the year)

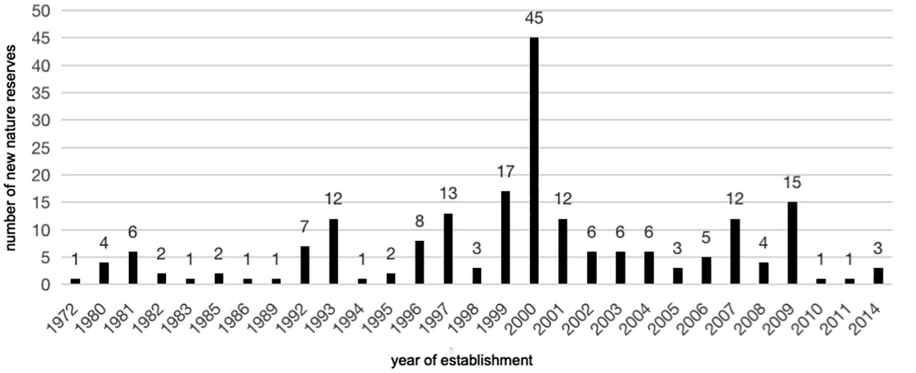


Figure 2.
Establishment of natural reserves in Jiangxi Province

Source(s): National Nature Reserve List, 2017, Ministry of Ecology and Environment of the People's republic of China

and urbanization rate (non-agricultural population/total population at the end of the year). These variables reflect the overall situation of social and economic development, such as the level of economic development, industrial structure, population status, regional capital status, and urbanization level before the establishment of natural reserves.

In the mechanism analysis, the output of the primary, secondary and tertiary industries is measured by the proportion of gross output value of agriculture, forestry, animal husbandry and fishery (gross output value of agriculture, forestry, animal husbandry and fishery/gross regional product), the proportion of added value of the secondary industry (added value of the secondary industry/gross regional product) and the proportion of added value of the tertiary industry (added value of the tertiary industry/gross regional product). The utilization of natural resources is measured by the proportion of crop sown area (crop sown area/land area of administrative region), per capita grain output (total grain output/total population at the end of the year) and per capita fruit output (fruit output/total population at the end of the year). In addition, the impact of the establishment of natural reserves on rural non-agricultural employees (the number of rural employees minus the number of agricultural, forestry, animal husbandry and fishery employees divided by the total population at the end of the year) is also analyzed.

All the dependent variables, independent variables and control variables in this study are from Jiangxi Statistical Yearbook, China County Statistical Yearbook and Jiangxi Provincial Department of Environmental Protection. Since the control variable used in this article is an *ex-ante* characteristic variable in 1995, to make the results more accurate, this article deletes the samples of nature reserves established in Jiangxi Province before 1995. Descriptive statistics of each main variable are shown in Table 1.

4. Empirical results and robustness discussion

4.1 Basic regression results

The benchmark regression results are shown in Table 2. In column (1), only individual fixed effects and time fixed effects are controlled. The results show that the establishment of natural reserves will result in a significant decrease of 3.06% points in the proportion of the number of people engaged in agriculture, forestry, animal husbandry and fishery in the region. In column (2), after adding the *ex-ante* characteristic variables of per capita GDP, the proportion of added value of the secondary and tertiary industries, county population density and urbanization rate in 1995, the results show that the impact is still significant.

Variable name	Unit	Sample size	Mean value	Standard deviation	Maximum value	Minimum value	Sample interval
Number of people engaged in agriculture, forestry, animal husbandry and fishery	People	1292	108645.9	62082.35	377,000	10,178	1996–2012
Total output value of agriculture, forestry, animal husbandry and fishery	10,000 yuan	988	96714.92	58434.76	433,922	18,168	1998–2010
Added value of secondary industry	10,000 yuan	1,064	128393.1	183814.3	2,045,978	7,881	1997–2010
Added value of the tertiary industry	10,000 yuan	1,064	85989.32	86205.89	701,678	8415	1997–2010
Total sown area of crops	Hectare	1,064	63543.65	40933.43	253,825	9780.7	1997–2010
Total grain output	10,000 ton	1,064	212,435	156564.8	1,010,986	30,289	1997–2010
Fruit yield	Ton	1,064	17264.01	54726.21	807,911	50	1997–2010
Total population at the end of the year (1995)	10,000 people	76	41.54	22.27	117.4	10.03	1995
Gao (1995)	10,000 yuan	76	93000.44	55686.25	355,985	29,127	1995
Value added of the secondary industry (1995)	10,000 yuan	76	29113.83	21239.89	100,173	5,285	1995
Added value of the tertiary industry (1995)	10,000 yuan	76	21511.55	15425.41	95,702	5,294	1995
Savings deposit balance of urban and rural residents (1995)	10,000 yuan	76	43326.71	24186.43	152,567	14,316	1995
Non-agricultural population (1995)	10,000 people	76	5.99	3.21	20.76	2.24	1995

Note(s): ① Considering the availability of data, the sample interval of the dependent variables used in the mechanism analysis is 1997–2010. ② The sample interval of the total output value of agriculture, forestry, animal husbandry and fishery in the mechanism analysis is 1998–2010

Source(s): ①Jiangxi Statistical Yearbook, 1995–2012, National Bureau of Statistics of China; ②China County Statistical Yearbook, 1995–2012, National Bureau of Statistics of China

Table 1. Descriptive statistics of variables

In column (3), further add other policy variables, and the results show that the establishment of natural reserves still significantly reduces the proportion of agricultural, forestry, animal husbandry and fishery practitioners by 0.724% points. The results obtained in this study are consistent with those obtained by previous researchers using micro survey data, that is, the establishment of natural reserves will promote the migration of agricultural labor force, and pure farmers will become non-farmers or part-time farmers [6–7].

Dependent variable	Proportion of employees in agriculture, forestry, animal husbandry and fishery (1)	(2)	(3)
$Consev_{it}$	−0.0306*** (0.00369)	−0.00654** (0.00311)	−0.00724** (0.00311
Constant term	0.283*** (0.00303)	0.412*** (0.0106)	0.410*** (0.0106)
Fixed effect at county level	√	√	√
Year fixed effect	√	√	√
ex-ante characteristic variable		√	√
Other policy variables			√
Adjusted R^2	0.048	0.525	0.4841
Observations	1,292	1,292	1,292

Note(s): ① ***, ** and * represent the significance level of 1%, 5 and 10%, respectively; ② Robust standard error is shown in brackets; ③ The *ex-ante* characteristic variables are the per capita GDP, the proportion of the added value of the secondary industry, the proportion of the added value of the tertiary industry, the county population density, the per capita balance of urban and rural residents' savings deposits and the urbanization rate in 1995; Other policy variables are whether it is a national key ecological functional area
Source(s): Authors' own work

Table 2.
Benchmark regression of the impact of establishing natural reserves on the transfer of agricultural labor force

4.2 Robust test

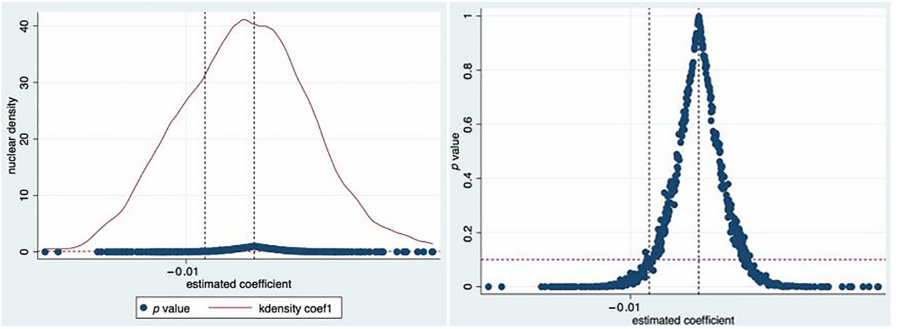
4.2.1 Replacing model to PSM-DID. In reality, the establishment of natural reserves is a quasi-natural experiment, so there will be some self-selection bias when using the generalized DID model to assess the impact. The PSM (Propensity Score Matching) method can match each experimental group sample to a specific control group sample, making the quasi-natural experiment approximate to a random experiment. The trend matching methods used in this study are Markov distance matching, nearest neighbor matching and kernel matching. The regression results are shown in Table 3. The results show that, after the samples are re-selected and regressed using three different propensity score matching methods, the establishment of natural reserves still has a significant positive impact on agricultural labor migration, which is consistent with the generalized DID model mentioned before.

4.2.2 Placebo test. The previous article has controlled the errors caused by the *ex-ante* characteristics of each region and other policies, but it is also necessary to determine whether the impact is interfered by other unobservable factors, and a placebo test is required. Figure 3

Dependent variable	Proportion of employees engaged in agriculture, forestry, animal husbandry and fishery Markov distance matching	Nearest neighbor matching	Kernel matching
$Consev_{it}$	−0.00746** (0.00310)	−0.00901*** (0.00326)	−0.00798** (0.00340)
Constant term	0.411*** (0.0106)	0.415*** (0.0127)	0.404*** (0.0149)
Fixed effect at county level	√	√	√
Year fixed effect	√	√	√
ex-ante characteristic variable	√	√	√
Other policy variables	√	√	√
Adjusted R^2	0.4842	0.4715	0.4691
Observations	1,292	1,184	1,084

Note(s): ① ***, ** and * represent the significance level of 1%, 5 and 10% respectively; ② Robust standard error is shown in brackets; ③ The control variables are the same as before
Source(s): Authors' own work

Table 3.
Robust test of the impact of establishing natural reserves on the transfer of agricultural labor force



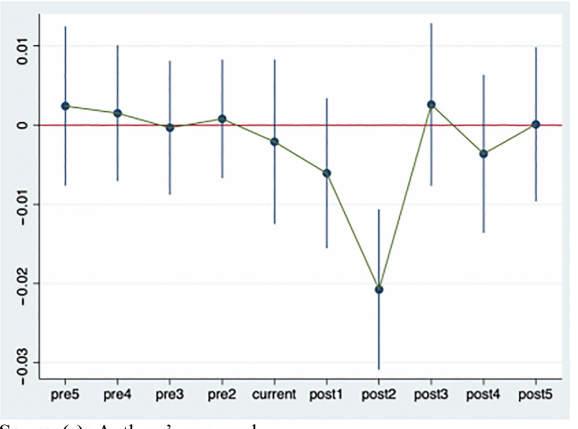
Source(s): Authors' own work

Figure 3.
Placebo test results

shows the distribution of simulated estimation coefficients after 500 repeated regressions. The results show that the mean value of the simulated estimation coefficient is close to zero and presents a normal distribution, and the real coefficient deviates from the distribution of the regression coefficient under the "virtual" policy. The placebo test is passed, indicating that the benchmark regression results are relatively robust.

4.3 Parallel trend test

The regression results of the dynamic DID model are shown in Figure 4. It can be seen that before establishing the natural reserve, the establishment of the natural reserve in each year has no significant impact on the transfer of agricultural labor force and the coefficient has a flat change trend, which indicates that the number of agricultural labor force transferred between the experimental group and the control group does not show significant differences, and the assumption of parallel trend is met between the two groups before the establishment of the natural reserve. In addition, in the second year after the establishment of the natural reserve, the estimated coefficient decreases significantly and is significantly negative, indicating that the second year after the establishment of the natural reserve plays a significant role in promoting agricultural labor migration.



Source(s): Authors' own work

Figure 4.
Parallel trend test and continuity test of the impact of establishing the natural reserve on the transfer of agricultural labor force

5. Heterogeneity analysis

The impact of establishing natural reserves on the transfer of agricultural labor force is related to the level of economic development in each region. Therefore, this study re-divides the regions based on different characteristics to further investigate the differences of impacts.

5.1 Heterogeneity on the economic development level

Generally speaking, the development of the secondary and tertiary industries in areas with better economic level is relatively good. After the establishment of natural reserves, the non-agricultural sector can provide more jobs for the rural surplus labor force, thus promoting the transfer of agricultural labor force to the non-agricultural sector to a greater extent. Therefore, according to the average value of GDP per capita in 1996, all county samples are divided into samples with good economic development and samples with poor economic development [3], and regression is conducted based on equation (1). The results are shown in Table 4 (1) and (2). The results show that in areas with good economic development level, the establishment of natural reserves significantly promotes the migration of agricultural labor force, and the coefficient is larger than the full sample estimation coefficient. In areas with poor economic development, the establishment of natural reserves has no significant impact on the transfer of agricultural labor. It can be seen that in areas with better economic development, the "pull" effect of non-agricultural industry development on agricultural labor transfer is more obvious.

5.2 Heterogeneity in the proportion of the primary industry

The agricultural labor force amount in the areas where the primary industry accounts for a substantial proportion is relatively large. After the establishment of the natural reserve, the impact on this region is more significant, and the transfer amount of agricultural labor force from the county to non-agricultural sectors is also larger. According to the ratio of the total output value of agriculture, forestry, animal husbandry and fishery to the GDP of each county in 1996 from the Jiangxi Statistical Yearbook 1997, and the proportion of the added value of the primary industry to the GDP, the samples are divided into the samples with the largest proportion of the primary industry and the samples with smaller proportion, and the regression results are shown in columns (3) to (6) of Table 4. The results show that the establishment of natural reserves in areas with large primary industry share plays a significant role in promoting agricultural labor migration, while there is no significant impact in areas with small primary industry share.

6. Mechanism analysis

The impact mechanism of establishing natural reserves on the transfer of agricultural labor to non-agricultural sectors is mainly analyzed from the "push" and "pull" aspects. Based on county-level data and regression (1), the above mechanism is tested.

In the mechanism analysis of the push effect, the direct impact is first tested, that is, the establishment of natural reserves will limit the use of natural resources by residents in surrounding communities, and then have an impact on the planting area and crop yield. The results of Table 5 (1) and (2) show that the establishment of natural reserves significantly reduces the proportion of crop sown area by 1.41% points but has no significant impact on per capita grain crop output. Further test whether the development of the primary industry will be affected. The results in Table 5 (3) and (4) show that the establishment of the natural reserve significantly reduces the per capita fruit output by 40.5 tons per 10,000 people, and the establishment of the natural reserve significantly reduces the proportion of the total output value of agriculture, forestry, animal husbandry and fishery by 2.93% points,

Table 4.
Heterogeneity analysis

Dependent variable	Good economic development (1)	Poor economic development (2)	Proportion of employees engaged in agriculture, forestry, animal husbandry and fishery: Agriculture, forestry, animal husbandry and fishery accounts for a larger proportion (3)	Agriculture, forestry, animal husbandry and fishery accounts for a smaller proportion (4)	The primary industry accounts for a larger proportion (5)	The primary industry accounts for a smaller proportion (6)
$Consev_{it}$	−0.0173*** (0.00498)	−0.00303 (0.00386)	−0.0157** (0.00426)	0.00212 (0.00473)	−0.0164*** (0.00432)	0.00104 (0.00509)
Constant term	0.415*** (0.0187)	0.407*** (0.0151)	0.414*** (0.0153)	0.449*** (0.0219)	0.385*** (0.0197)	0.403*** (0.0183)
Fixed effect at county level	√	√	√	√	√	√
Year fixed effect	√	√	√	√	√	√
ex-ante characteristic variable	√	√	√	√	√	√
Other policy variables	√	√	√	√	√	√
Adjusted R^2	0.3479	0.5731	0.5188	0.3922	0.4587	0.4024
Observations	612	680	682	610	665	627

Note(s): ① * * *, * * and * represent the significance level of 1%, 5 and 10% respectively; ② The cluster-robust standard error is shown in brackets; ③ The control variables are the same as before
Source(s): Authors' own work

Table 5.
Mechanism analysis of the impact of establishing natural reserves on labor transfer

	Push				Pull		
Dependent variable	Proportion of planting area of crops (1)	Per capita grain output (2)	Per capita fruit output (3)	Proportion of total output value of agriculture, forestry, animal husbandry and fishery (4)	Proportion of added value of secondary industry (5)	Proportion of added value of the tertiary industry (6)	Number of rural non-agricultural employees (7)
$Consev_{it}$	−0.0141*** (0.00408)	0.00670 (0.0122)	−0.405*** (0.0147)	−0.0293* (0.0171)	0.0797** (0.0354)	0.0922*** (0.0339)	0.0333 (0.0377)
Constant term	√	√	√	√	√	√	√
Fixed effect at county level	√	√	√	√	√	√	√
Year fixed effect	√	√	√	√	√	√	√
ex-ante characteristic variable	√	√	√	√	√	√	√
Other policy variables	0.9775	0.2293	0.1894	0.8910	0.7640	0.6904	0.9065
Adjusted R^2	1064	1064	1064	988	1064	1064	1045

Note(s): ① * * *, * * and * represent the significance level of 1%, 5 and 10%, respectively; ② The cluster-robust standard error is shown in brackets; ③ The control variables are the same as before
Source(s): Authors' own work

which confirms the previous hypothesis, indicating that the establishment of the natural reserve will inhibit the construction of infrastructure, increase the transportation cost of agricultural products and reduce the economic crop planting of farmers.

In the mechanism analysis of pull effect, the results reported in column (5) of Table 5 show that the establishment of natural reserves significantly promotes the development of the secondary industry, which is inconsistent with the theoretical assumptions. It is speculated that the established natural reserves involve a relatively small area of county territory, and most of them are located in mountain areas, which has relatively little impact on industrial development. Moreover, the establishment of natural reserves transfers the surplus agricultural labor force to urban areas, which may accelerate the development of the secondary industry in this area. The results in Table 5 (6) show that the establishment of natural reserves significantly promotes the development of local tertiary industry, which is consistent with the earlier assumptions. In addition, the results in Table 5 (7) show that the establishment of natural reserves has no significant impact on the number of non-agricultural employees in rural areas. This shows that the pull effect of non-agricultural industries on agricultural labor comes from non-agricultural industries in urban areas rather than rural areas.

7. Conclusion and policy implications

As for the establishment of natural reserves and the transfer of agricultural labor force, based on the theoretical analysis and the county-level panel data of Jiangxi Province from 1996 to 2012, this study builds a generalized DID model to test the impact of the establishment of natural reserves on the transfer of agricultural labor force, and further reveals the heterogeneity and mechanism of the impact. Conclusion: First, the establishment of natural reserves significantly promotes the transfer of agricultural labor to non-agricultural sectors, and the results pass the robust test such as parallel trend test, placebo test and replacement of other models. Second, in areas with high economic development level and substantial proportion of primary industry, the establishment of natural reserves plays a significant role in promoting agricultural labor migration. Finally, the mechanism analysis shows that the establishment of natural reserves can promote the transfer of agricultural labor to non-agricultural sectors by inhibiting the development of the primary industry, limiting the push effect of farmers' agricultural production and promoting the pull effect of the development of the tertiary industry.

Based on the above conclusions, this study has the following policy implications. First, the establishment of natural reserves has greatly promoted the transfer of agricultural labor to non-agricultural sectors, indicating that the establishment of natural reserves is conducive to adjusting the rural industrial structure, increasing farmers' income and improving the ecological environment. The government should increase investment and support for natural reserves, improve the compensation system for ecological protection, and encourage all parties to participate in ecological protection. Second, the transfer of agricultural labor to the non-agricultural sector requires the improvement of farmers' cultural quality and skills to meet market demand and the requirements of urban–rural integration. The government should strengthen education and training for farmers, provide employment guidance and services, and at the same time improve the social security system for farmers so that they no longer worry. Third, the government should guide farmers to use land resources rationally to achieve moderate scale and diversified land operations. At the same time, they should cultivate new economic growth points and develop tertiary industries such as characteristic planting and breeding, agricultural product processing and rural tourism.

However, due to the limitations of subjective conditions such as the author's ability, as well as objective conditions such as time constraints, there are still many areas that can be

improved in the paper: As data on the explanatory variables for other years are not available, the study based on panel data from 1995 to 2012 in this study may affect the validity and usefulness of the findings. In addition, this article only examines the impact of the establishment of natural reserves on labor transfer in Jiangxi Province. If the sample size is too small, it will affect the universality of the study. In the future, the national county panel data can be used to investigate the impact of the establishment of natural reserves on labor transfer, and further analyze the differences in their impact between different regions.

Notes

1. Since other policies affecting the transfer of agricultural labor force are also being implemented when establishing natural reserves. Thus, these policies should be considered. To optimize the development and protection of land space, in 2010, the State Council issued the National Main Functional Area Plan, which divided the land space into urbanization areas, main agricultural product production areas and national key ecological functional areas according to the development content. There are 9 counties in Jiangxi Province designated as national key ecological functional areas, which will also have an impact on the transfer of agricultural labor.
2. https://www.mee.gov.cn
3. According to the Jiangxi Statistical Yearbook 1997, the GDP of each county in Jiangxi Province in 1996 is obtained and its average value is calculated. County-level cities with GDP higher than the provincial average are listed as samples with good economic development, and county-level cities with GDP lower than the provincial average are listed as samples with poor economic development.

References

Bi, X., Zhang, L., Su, H.J. and Zhang, M.M. (2020), "Research on Farmers'Sustainable livelihoods impacted by ecotourism in natural reserves", *Issues of Forestry Economics*, Vol. 40 No. 5, pp. 464-472, (in Chinese), doi: 10.16832/j.cnki.1005-9709.20190360.

Chen, C.M., Hou, Y.F. and Wu, L.Y. (2018), "The influence of establishing the natural reserve on residents livelihood——based on investigations of 272 residents in Wuyishan national natural reserve of Fujian Province", *Chinese Journal of Agricultural Resources and Regional Planning*, Vol. 39 No. 1, pp. 219-224, (in Chinese).

De Brauw, A. (2002), "The evolution of China's rural labor markets during the reforms", *Department of Agricultural and Resource Economics, UC Davis Working Paper*, Vol. 30 No. 2, pp. 329-353.

Fu, X.L. (2005), "Research on community economic development of natural reserves in west China", *Future and Development*, No. 5, pp. 51-53+50, (in Chinese).

Gao, G.L. (1995), "Regional economic development and labor migration", *Nankai Economic Studies*, No. 2, pp. 27-32, (in Chinese).

Gao, P. and Wen, Y.L. (2004), "Characters, cause of poverty and its countermeasures in peripheral communities of China's natural reserves", *Research of Agricultural Modernization*, No. 4, pp. 255-257, (in Chinese).

George, J.B. (1987), "Self-Selection and the Earnings of Immigrants", *The American Economic Review*, Vol. 77 No. 4, pp. 531-553.

Gustav, R. and Fei, J.C.H. (1961), "A Theory of Economic Development", *The American Economic Review*, Vol. 51 No. 4, pp. 533-565.

Heckman, J.J., Ichimura, H. and Todd, P.E. (1997), "Matching as an econometric evaluation estimator: evidence from evaluating a job training programme", *Review of Economic Studies*, Vol. 64 No. 4, pp. 605-654.

Lewis, W.A. (1954), "Economic development with unlimited supplies of labor[J]", *Manchester School of Economic and Social Studies*, Vol. 22 No. 2, pp. 139-191.

Li, Q., Wen, Y.L., Ma, N., Wu, W.G. and Wu, C.L. (2013), "Analysis of non-agricultural employment behavior of rural labor force around the nature reserve//green development and management innovation", *Proceedings of the 7th China Forestry Technology and Economic Theory and Practice Forum*, 2013, pp. 141-148, (in Chinese).

Sandeep, M. (2007), "The rise of self -employment in rural China: development orDistress?", *World Development*, Vol. 35.

Todaro, M.P. (1969), "A model of labour migration and urban unemployment in less developed countries", *American Economics Review*, No. 1, pp. 138-148.

Wang, C.H., Wen, Y.L., Shi, J., Hu, C.D. and SiK, C. (2011), "Analysis on introspection of the relationship between natural reserves in qinling and adjacent community from the perspective of symbiosis theory", *Journal of Northwest Forestry University*, Vol. 26 No. 4, pp. 236-240, (in Chinese).

Wang, C.H., Wen, Y.L., Duan, W. and Han, F. (2013), "Coupling relationship analysis on households' production behaviors and their influencing factors in natural reserves: a structural equation model", *Chinese Geographical Science*, Vol. 23 No. 4, pp. 506-518.

Wu, Y.R., Yang, H., Li, J. and Ma, Y.W. (2022), "Study on sustainable livelihoods of farmers in heizhugou natural reserve", *Journal of Southwest Forestry University(Social Sciences)*, Vol. 6 No. 1, pp. 47-53, (in Chinese).

Yang, B.R. (2017), "Livelihood capital and livelihood strategies of residents in natural reserve", *Bulletin of Soil and Water Conservation*, Vol. 37 No. 3, pp. 113-118+124, (in Chinese), doi: 10.13961/j.cnki.stbctb.2017.03.020.

Zhang, Y.X., Liu, X., Zhang, B. and Xie, Y. (2020), "Will the establishment of natural reserves inevitably lead to low household income——an empirical study on household income within and nearby the fujian wuyishan national natural reserve", *National Natural Reserve*, Vol. 56 No. 6, pp. 165-178, (in Chinese).

Zhang, C.H., Liao, N.Y., Liu, J., Tang, Y.J., Su, H.X., Chen, M.Y. and Yang, C.M. (2021), "Analysis of farmers' sustainable livelihood in the communities of natural reserves in ethnic minority areas——a case study of guangxi fangcheng golden camellias national natural reserve", *Forestry Economics*, Vol. 43 No. 10, pp. 37-51, (in Chinese).

Zhou, P. and Qi, D.M. (2020), "Livelihood capital and the transformation of farmers' livelihood strategies:Based on the survey of Zhejiang Kaihua National Park", *Hubei Agricultural Sciences*, Vol. 59 No. 10, pp. 163-168, (in Chinese), doi: 10.14088/j.cnki.issn0439-8114.2020.10.038.

Further reading

Banerjee, B. (1991), "The determinants of migrating with a pre-arranged job and of the initial duration of urban unemployment: an analysis based on Indian data on rural-to-urban migrants", *Journal of Development Economics*, No. 36, pp. 337-351.

Chang, B.D., Xu, C., Qin, G.Y. and Xiong, L.C. (2021), "The impact of ecological public welfare forest construction in collective forest area on labor migration–taking zhejiang province as an example", *Journal of Agrotechnical Economics*, No. 2, pp. 40-49, (in Chinese).

Hansen, G.D. and Prescott, E.C. (1998), "Malthus to Solow", *American Economic Review*, Vol. 92 No. 4, pp. 1205-1217.

Huang, G.H. (2010), "Impact factors analysis about rural labor migration:empirical data from 29 provinces and cities", *Population and Development*, Vol. 16 No. 1, pp. 2-10, (in Chinese).

Lee, E.S. (1966), "A theory of migration", *Demography*, Vol. 3 No. 1, pp. 47-57.

Li, T.T.G.F. (2013), "Influence factors of rural labor transfer: empirical analysis based on data of anhui province from 1990 to 2010", *Economic Research Guide*, No. 15, pp. 66-68, (in Chinese).

Li, B., Wu, S.S. and Zhu, Y. (2015), "Agricultural technology Process, New-urbanization and transference of redundant rural labor force——empirical research based on the 'push-pull theory' and inter-provincial dynamic panel data", *Collected Essays on Finance and Economics*, No. 10, pp. 3-10, (in Chinese), doi: 10.13762/j.cnki.cjlc.2015.10.001.

Qin, H. and Xia, H.X. (2009), "An empirical analysis of the factors affecting the transfer of rural labor force in China", *Economic Theory and Business Management*, Vol. 12, pp. 47-52, (in Chinese).

Su, F. (2016), "The influencing factors in the process of rural labor transfer under the background of new urbanization: a case of gansu province", *Journal of Arid Land Resources and Environment*, Vol. 30 No. 11, pp. 58-63, (in Chinese), doi: 10.13448/j.cnki.jalre.2016.349.

Xiang, Q.F. and Shi, L. (2012), "Influence factors analysis of rural labor migration in western minority areas—a study based on a multilevel logistic models", *Journal of Applied Statistics and Management*, Vol. 31 No. 6, pp. 965-975, (in Chinese).

Yang, L. and Ren, Y. (2020), "Has China's new round of collective forestland tenure reform caused an increase in rural labor transfer?", *Journal of Land*, Vol. 9 No. 9, (in Chinese).

Zhang, K. (2014), "Driving factors and the suggestion of rural population mobility in China : based on the 'push and pull theory' in amended todar migration model", *Science and Information Forum*, Vol. 29 No. 7, pp. 22-28, (in Chinese).

Zhou, X.K., Feng, Q. and Liao, R. (2010), "Empirical research on influencing factors of rural surplus labor transfer", *Statistics and Decision*, No. 16, pp. 74-77, (in Chinese), doi: 10.13546/j.cnki.tjyjc.2010.16.026.

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