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The Impact of Agricultural Mechanization on Urban-Rural Income Gap in China: An Empirical Analysis based on Comprehensive FGLS Estimation

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Abstract: Based on the analysis of mathematical economic models and using panel data from Chinese 31 provinces (excluding Hong Kong, Macao and Taiwan) from1978 to 2019, empirically analyzing the influence of agricultural mechanization on Chinese urban-rural income gap by using the comprehensive FGLS (Feasible Generalized Least Square) estimation. Finally found that, in China, agricultural mechanization can significantly narrow urban-rural income gap, and Suggestions are put forward to improve the level of Chinese agricultural mechanization and narrow Chinese urban-rural income gap.

Keywords: Agricultural mechanization; Urban-rural income gap; Comprehensive FGLS estimation

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1. Introduction

The urban-rural income gap is one of the important problems that need to be solved in the field of income distribution in China, because excessive urban-rural income gap will not only adversely affect consumption, investment and economic operation efficiency, but also may affect social harmony and stability [1]. *The Fourteenth Five-Year Plan and the Outline of 2035 Long-Range Goals* clearly points out that China should "promote common prosperity", which, to a certain extent, puts forward a new requirement for narrowing the urban-rural income gap. As for the factors affecting the urban-rural income gap, scholars have studied them from the perspectives of fiscal policy [2], tax policy [3], urbanization [4], financial development [5], infrastructure construction [6], agricultural technological progress [7], labor transfer [8], household registration system [9], etc.

However, few scholars have studied them from the perspective of agricultural mechanization. *The Strategic Plan for Rural Revitalization (2018-2022)* clearly points out the need to "accelerate the whole-process mechanization of main crop production and improve the intelligent level of agricultural machinery and equipment", because the agricultural mechanization production can improve the efficiency of agricultural production, promote the transfer of rural labor force and increase the total income of farmers [10]. Since the agricultural mechanization has an impact on the income of rural residents, it will have an impact on the urban-rural income gap. Therefore, in the context of Chinese government promotes common prosperity and accelerates the whole mechanization of main crop production and improving the intelligent level of agricultural machinery and equipment, it is of great practical significance to study the impact of Chinese agricultural mechanization on the Chinese urban-rural income gap.

At present, there are relatively few studies on the impact of agricultural mechanization on urban-rural income gap in China. Hence, this paper analyzes firstly the relationship between agricultural mechanization and urban-rural income gap in China using theoretical models, and then carries out empirical verification.

2. Theoretically analyzing

Supposing that, there are two productive sectors in the economy, agricultural production sector 1 and non-agricultural production sector 2. The number of labors in these two sectors is L_1 and L_2, and the capital input is K_1 and K_2. The production function of agricultural production sector is: $Y_1=K_1^{\alpha}L_1^{1-\alpha}$, α ($0<\alpha<1$) represents the capital-output elasticity of the agricultural production sector. Non-agricultural production function of the production department is: $Y_2=K_2^{\beta}L_2^{1-\beta}$, β ($0<\beta<1$) represents the capital-output elasticity of the non-agricultural production sector. Then the conditions of the agricultural production sector and non-agricultural production sector to achieve the maximum output are as follows:

$$w_1=(1-\alpha)K_1^{\alpha}L_1^{-\alpha} \tag{1}$$

$$w_2=(1-\beta)K_2^{\beta}L_2^{-\beta} \tag{2}$$

There, w_1 and w_2 represent respectively the wage level of the agricultural production sector and the non-agricultural production sector respectively. The urban-rural income gap will be defined as g, it is:

$$g=\frac{w_2}{w_1}=\frac{(1-\beta)K_2^{\beta}L_2^{-\beta}}{(1-\alpha)K_1^{\alpha}L_1^{-\alpha}} \tag{3}$$

It can be deduced from equation (3) that:

$$\frac{\partial g}{\partial K_1}=\frac{\partial\left(\frac{(1-\beta)K_2^{\beta}L_2^{-\beta}}{(1-\alpha)K_1^{\alpha}L_1^{-\alpha}}\right)}{\partial K_1}=-K_1^{-\alpha-1}\frac{\alpha(1-\beta)K_2^{\beta}L_2^{-\beta}}{(1-\alpha)L_1^{-\alpha}}<0 \tag{4}$$

According to equation (4), with the increase of capital input K_1 in the agricultural production sector, the urban-rural income gap (g) will be narrowed. With the improvement of the level of agricultural mechanization, the capital input of the agricultural production sector is also gradually increasing, so the urban-rural income gap will be narrowed. Through a simple mathematical model analysis, we can see that the agricultural mechanization can narrow the urban-rural income gap.

3. Empirically analyzing

3.1. Econometric model setting and variable description

According to the above theoretical analysis, Chinese agricultural mechanization can narrow Chinese urban-rural income gap. In order to verify the relationship between the agricultural mechanization and the urban-rural income gap, empirical analysis is carried out, and the following econometric model is set, it is:

$$gap_{it}=c_0+c_1 am_{it}+c_2 \boldsymbol{X}_{it}+e_{it} \tag{5}$$

There, *gap* represents the urban-rural income gap, *am* represents the agricultural mechanization, $\boldsymbol{X}$ represents the control variables, and *e* represents the residual term, *i* represents the individual and *t* represents the year.

The variables required for the empirical analysis are as follows. The explained variable is the urban-rural income gap (*gap*). Referred to the method of Ma Hongqi et al. [11], the urban-rural income gap is measured by the ratio of the per capita disposable income of urban residents and the per capita net income

of rural residents. The core explanatory variable is the agricultural mechanization (*am*) measured by the average total power of agricultural machinery per hectare according to the measurement method of Zhou Xiaoshi [12].

The control variables are as follows: economic development level (*edl*), expressed by per capita GDP; Industrial structure (*is*), expressed by the proportion of the sum of the GDP of the secondary and tertiary industries in the total GDP. Degree of openness (*od*), expressed by the proportion of total foreign imports and exports in the total GDP. Among them, the total value of foreign imports and exports is converted into RMB according to the US dollar exchange rate during the same period. Government participation (*gi*), expressed by the proportion of general public budget expenditure in the total GDP; Agricultural disaster situation (*ad*), expressed by the proportion of the agricultural disaster area in the total sown area; Urban unemployment rate (*uur*). The above variables are Chinese provincial panel data of 31 provinces, municipalities and autonomous regions (excluding Hong Kong, Macao and Taiwan) from 1978 to 2019.

Table 1. Descriptive statistical analysis results

Variable	Number of samples	Mean	Standard deviation	Max	Min
gap	1302	2.537	0.685	0.976	5.605
am	1302	3.92	3.276	0.289	26.98
edl	1302	17739	24855	175	164220
is	1302	0.796	0.126	0.394	0.997
od	1302	0.255	0.453	0.005	4.065
gi	1302	629.2	916.5	0.049	4655
ad	1302	0.274	0.163	0	0.964
uur	1302	0.0331	0.014	0	0.133

The data of above variables come from the database of China National Bureau of Statistics, *China Statistical Yearbook*, the Statistical Yearbook of all provinces (municipalities and autonomous regions), the Statistical Database of China Economic Network, and *Compilation of Statistical Data for 60 Years of the People's Republic of China*. A few missing data of some provinces before 1990 were estimated by moving average method. The results of descriptive statistical analysis of the above variables are shown in **Table 1**.

3.2. Empirical analysis based on comprehensive FGLS estimates

In the estimation strategy, since using the long panel data of 31 provinces in China from 1978 to 2019, considering that the samples may have inter-group heteroscedasticity, intra-group autocorrelation and inter-group synchronous correlation, and the comprehensive FGLS estimation can effectively solve these problems [13], so the comprehensive FGLS estimation is used. According to the above econometric model, control variables were successively added to conduct comprehensive FGLS estimation, and the results were shown in **Table 2**.

According to model 7, the agricultural mechanization (*am*) can significantly narrow the urban-rural income gap (*gap*). For every 1 unit increase in agricultural mechanization level, the urban-rural income gap decreases by 0.018. In addition, the improvement of economic development level (*edl*) can significantly reduce the urban-rural income gap; For the industrial structure (*is*), the higher the proportion of the output value of the secondary and tertiary industries in the total output value, the greater the urban-rural income gap. This is because urban residents are mainly employed in the secondary and tertiary industries. The more developed the secondary and tertiary industries are, the higher the income of urban residents will be. Improve degree of openness (*od*) can narrow the urban-rural income gap; The more government

involvement (*gi*) in economic activities, the less conducive to narrowing the urban-rural income gap. Because the government's excessive participation in economic activities will lead to the lack of efficiency of the market economy, which is not conducive to narrowing the urban-rural income gap. If agricultural disaster situation (*ad*) is serious, the urban-rural income gap will widen; The increase of urban unemployment rate (*uur*) will lead to the widening of the urban-rural income gap. An increase in the urban unemployment rate means a sluggish economy, which will reduce rural residents' income from migrant work and lead to a widening of the urban-rural income gap.

Table 2. Comprehensive FGLS estimation results

	model 1	**model 2**	**model 3**	**model 4**	**model 5**	**model 6**	**model 7**
variable	*gap*	*gap*	*gap*	*gap*	*gap*	*gap*	*gap*
am	-0.001	0.004	-0.019***	-0.023***	-0.023***	-0.02***	-0.018***
	(0.0027)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
edl		-0.000001	-0.000004***	-0.000004***	-0.000005***	-0.000004***	-0.000004***
		(0.0000004)	(0.000001)	(0.000001)	(0.00000)	(0.000001)	(0.000001)
is			2.739***	2.609***	2.609***	2.444***	2.386***
			(0.079)	(0.082)	(0.087)	(0.087)	(0.079)
od				-0.275***	-0.085***	-0.113***	-0.076***
				(0.02)	(0.022)	(0.022)	(0.022)
gi					0.581***	0.686***	0.739***
					(0.103)	(0.101)	(0.096)
ad						0.09***	0.101***
						(0.009)	(0.008)
uur							2.743***
							(0.19)
constant	2.509***	2.524***	0.6***	0.742***	0.647***	0.714***	0.601***
	(0.036)	(0.041)	(0.069)	(0.069)	(0.078)	(0.071)	(0.063)
number of samples	1302	1302	1302	1302	1302	1302	1302
***p* value of Wald test**	0.000	0.000	0.000	0.000	0.000	0.000	0.000
***p* value of LM test**	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Noting: * means $p < 0.1$, ** means $p < 0.05$, *** means $p < 0.01$.

3.3. Robustness test

The control variables were successively added to the comprehensive FGLS estimation for robustness test. From model 1 to model 7, the coefficient and significance of the regression results of the variables are basically consistent, indicating that the regression results are robust.

4. Conclusions

The study found that, in China, the agricultural mechanization can significantly narrow the urban-rural income gap. The study conclusions have the following policy implications for narrowing Chinese urban-rural income gap. Firstly, Chinese government should add the subsidies of purchasing the agricultural machinery to promote the agricultural mechanization. Secondly, Chinese government should increase fiscal expenditure on agriculture, forestry and water conservancy to provide better conditions for mechanized agricultural production. Thirdly, Chinese government should implement preferential policies for relevant agricultural machinery production enterprises to promote the invention and innovation of agricultural production machinery.

Disclosure statement

The author declares no conflict of interest.

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