The Impact of Agricultural Mechanization on Urban-rural Income Gap and its Mechanism

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Abstract. The income and living standard of Chinese people are surging. Despite the continuous improvement of material quality of life, the income gap between urban and rural areas is expanding, which gradually becomes one of the prominent contradictions restricting China's economic development. The existing literature generally indicates that the development of agricultural modernization has a positive impact on farmers' income. Due to the broad definition of agricultural modernization and the large regional differences in China, the mechanism of agricultural mechanization to increase farmers' income varies from region to region. This paper uses the relevant data from the National Bureau of Statistics to establish an econometric model to specifically study the impact of agricultural mechanization on the urban-rural income gap and its impact mechanism. At the same time this paper make a regional division between agricultural provinces and non-agricultural provinces studying their heterogeneity, and finally analyze how human capital affects the income gap as a threshold variable. The empirical results show that the development of agricultural mechanization is conducive to narrowing the urban-rural income gap by increasing farmers' income and there is regional heterogeneity. Compared with the central and western regions and non-agricultural provinces, the use of agricultural machinery has a more significant negative effect on the urban-rural income gap in eastern and agricultural provinces. The effect of agricultural mechanization on the urban-rural income gap is nonlinear, and human capital has a threshold effect on it.

Keywords: Agricultural Mechanization; Urban-rural Income GAP; Rural Human Capital; Regional Heterogeneity.

1. Introduction

The income and living standard of Chinese people are improving rapidly. Despite the continuous improvement of material quality of life, the gap between urban and rural incomes(GAP) is expanding, which gradually becomes one of the prominent contradictions restricting China's economic development. The data in the China Statistical Yearbook shows that, China's urban-rural income ratio was as high as 3.23 times in 2010, and has declined since then. But until 2020, the ratio of disposable income between urban and rural residents is still 2.56, which shows that GAP in China is large. GAP makes the consumption desire of rural residents suppressed, the consumption level reduced, and the supply relationship unbalanced, which restricts productivity; the polarization between rich and poor makes the fruits of economic and social development cannot be universally benefited, thus stimulating social instability, which affects the process of common prosperity of Chinese people, how to effectively alleviate GAP has become a key concern in academic circles.

With the increase of industrialization rate in China, the degree of agricultural mechanization (AM) is also deepening. AM refers to the process of improving agricultural production and operation conditions with advanced and applicable agricultural machinery. AM is one of the important symbols that distinguish traditional agriculture from modern agriculture. The use of agricultural machinery can significantly reduce the human cost in the production of agricultural products, improve the efficiency of agricultural production, and also organically combine the primary industry with the secondary and tertiary industries, broaden the marketing of agricultural products and increase the income for rural farmers. While the AM process of agriculture deepens, the human capital of rural areas also has to be improved. The use of machine makes farmers learn to master certain mechanical skills, thus promoting the improvement and development of the education level of the rural population.

Enhancing AM rate and vigorously developing rural human capital is one of the effective ways to bridge the GAP and advance the modernization process of Chinese society. Using relevant data from the National Bureau of Statistics, this paper establishes an econometric model to study the impact of AM on the GAP and analyzes how human capital affects GAP as a mediating variable, which provides a more novel perspective on the impact of AM on the GAP and helps the government to formulate more targeted policies in promoting AM in rural areas and improving the education level of rural population, so as to enhance policy implementation performance, and promote the realization of comprehensive rural revitalization.

2. Literature Review

GAP is one of the major difficulties that China needs to face in its fight against poverty, thus reducing the GAP, is one of the important goals of China's economic and social development at this stage. For example, Hong Yuan et al. found that fiscal investment with a "rural bias" could effectively reduce the GAP.[1]; Zhang Yaojun et al. find that any increase in the level of urbanization is conducive to reducing the GAP in that area [2]; Yu, Y. Z. et al. found that the construction of high-speed rail significantly reduced the GAP [3]; Household registration discrimination has a significant impact on GAP [4] (Wan, Haiyuan, Li, Shi, 2013. However, there are still relatively few existing studies on the influence mechanisms between the GAP and AM.

Studies on AM have been conducted to show that agricultural mechanized production can improve agricultural labor productivity [5] (Puren Bai, 2009), induce the transfer of surplus rural labor [6] (Zhang Lin, Wang Chunxia, 2013), and promote agricultural sustainability [7] (Luo, X. W., Liao, J., Hu, L., et al. 2016), and these advantages of AM have a positive impact on the improvement of farmers' income.In addition, studies on agricultural development patterns in developed countries also show that the degree of AM is positively correlated with farmers' income, and studies in countries with a high degree of AM, such as the United States and Japan, have proved that AM has a catalytic effect on increasing farmers' income.The adoption of large-scale, intensive, modern agricultural production in the United States has significantly increased farmers' incomes [8] (Lagüe C,2020);Japan chose the AM path of chemicalization before AM, refinement, and high-quality agricultural socialization services in order to significantly increase the overall level of farmers' income [9] (Yu Liu, Junbiao Zhang, 2005);Germany, the Netherlands and Israel are also empowering AM through high technology, while developing digital agriculture and precision agriculture to improve farmers' income [10] (Jianhua Li, 2012).From the social development paths of these countries above, the improvement of the degree of AM and the level of agricultural technology has led to the alleviation of GAP generated in the early and middle stages of industrialization. Therefore, we can see that the study of the relationship between AM and agricultural modernization has guiding significance for narrowing GAP in China and alleviating the problem of relative poverty.

However, China's current AM rate is not optimistic, according to the research of Feng Qigao and others, China's AM is facing a series of problems: unreasonable equipment structure, low level of development of agricultural machinery industry; low level of AM operations, production AM scale is small; agricultural machinery services industrialized service system is not yet complete [11]. The development of the degree of AM is closely related to the rural human resources. At present, the lack of rural human resources and the limited education per capita are serious constraints to the popularization of AM and the improvement of rural productivity. Meanwhile, the transfer of rural labor accelerates the development of AM, and Li Xiaoyang and Sun Songlin et al. found that there is an inextricable relationship between the level of AM and agricultural labor transfer, and AM is the result of agricultural labor transfer, and they are interrelated, mutually influencing and constraining each other [12]. By using provincial panel data based on 2001-2020, Deng Yue, Wu Zhongbang et al. found that the negative moderating effect of rural human capital on AM is greater for regions with major grain producing areas and larger per capita arable land, and there is a significant complementarity between agricultural professional and technical personnel and AM [13].

The existing literature generally indicates that the development of agricultural modernization contributes to farmers' income, and the degree of AM has a positive influence on farmers' income. Due to the broad definition of agricultural modernization and the large differences between regions in China, the mechanism of AM to increase farmers' income varies from region to region and from human resource environment to human resource environment. This paper uses the relevant data from the National Bureau of Statistics to establish an econometric model to specifically study the impact of AM on GAP and its impact mechanism, and at the same time to make a regional division between large agricultural provinces and non-agricultural provinces and study their heterogeneity, and finally to analyze how human capital affects GAP as a threshold variable. The innovation of this paper mainly lies in three aspects. Firstly, it provides a more novel perspective for the reduction of GAP by specifically referring agricultural modernization to AM, highlighting the important role of AM in the development path of agricultural modernization, which helps the government to promote AM in rural areas, enhance the performance of policy implementation, and promote the realization of comprehensive rural revitalization. Second, this paper separates the impact of AM on different regions to provide a theoretical basis for more targeted policies. Third, this paper focuses on the role of human capital in the impact of AM in narrowing GAP and promoting the improvement of rural population's education level and other aspects.

3. Theoretical Analysis

With the popularization of agricultural machinery in rural areas, AM has greatly changed the production and living environment of rural residents and promoted the reduction of GAP. To a certain extent, AM can alleviate the low income of farmers caused by the low productivity and unstable production of farmers. At the same time, the popularization of agricultural machinery can improve the education level and innovation ability of farmers, and thus stimulate the endogenous motivation of farmers to increase their income.

From the point of view of product production, first of all, the premise of the use of agricultural machinery is the scale of land, land to a certain scale to use agricultural machinery for effective farming [14], so the use of AM is conducive to the scattered, small-scale pattern into large-scale farming, to achieve economies of scale.Standardized production and intensive processing are conducive to the optimization of the apportion of production factors and other resources, reducing production costs, improving farmers' income and reducing GAP. Secondly, the essence of AM is to develop agriculture from the perspective of industrial development [15], which helps to promote industrial integration and the extension of industrial chain, thus increasing the added value of agricultural products. Because of the low elasticity of demand price of agricultural products, the rise in the price of agricultural products is conducive to the increase in the income of farmers, which in turn reduces GAP. Meanwhile, the use of agricultural machinery in pre-production, production and post-production has greatly improved the production efficiency, which has led to the integration and process of sowing, irrigation, fertilization, harvesting, storage and transportation, which is conducive to the precision of agricultural production, improving the quality of agricultural products, enhancing market competitiveness and further reducing GAP.

From the perspective of labor force, firstly, as the AM of agriculture achieves a significant increase in production efficiency, a considerate amount of rural labor force is released [16], which promotes the transfer of employment of surplus rural labor and realizes higher wage income for the surplus labor force engaged in non-agricultural industries.At the same time, as the remaining labor force is less dependent on the land, it further specializes agricultural production and achieves an increase in farmers' business income [17].Second, the development of AM has forced the rural labor force to continuously improve their skills. Through participating in training and other ways, farmers can cultivate certain scientific management and scientific management quality in production, which is conducive to the promotion of rural human capital. The improvement of rural human capital can further promote the increase of farmers' income [18] and narrow GAP.

Due to the large differences in resource endowment and topographic conditions in different regions of China, there are regional differences in the application of AM. The existing emergence of AM models with Chinese characteristics, such as cross-area operations and agricultural machinery cooperatives, provides a partial solution to the regional heterogeneity of AM. [19]

4. Variable Selection, Data Sources and Model Construction

4.1 Model Construction

Based on the preliminary analysis of the impact of AM on urban and rural incomes, this paper uses a two-way fixed effects model for analysis, which is set as follows:

$$gap_{it} = \beta_0 + \beta_1 lnmachine_{it} + \sum \beta_2 X_{it} + \eta_i + \sigma_t + \varepsilon_{it}$$

where i and t denote province and year respectively, the dependent variable gap_{it} stand for the urban-rural income gap, and the core independent variable $lnmachine_{it}$denotes the degree of AM. $X_{it}$are the control variables for each province and city over time. η_i and σ_t are province fixed effects and time fixed effects respectively, and ε_{it} is random disturbance term.

4.2 Variable Selection

The dependent variable in this paper is the GAP. Referring to the study of Hao-B Zhang et al, this paper uses the ratio of urban residents' disposable income to rural residents' disposable income (net income) in each province to express the GAP. [20] The statistical method of rural residents' income changed in 2014, so this paper selects the ratio of urban residents' disposable income to rural residents' net income in each province to indicate the GAP before 2014, and the ratio of urban residents' disposable income to rural residents' disposable income in each province after 2014 to indicate the GAP.

The core independent variable in this paper is the level of AM. According to the existing literature, the total power of agricultural machinery is usually used to measure the level of agricultural machinery.[21] Since the absolute value of the total power of agricultural machinery is relatively large compared with other variables, under the condition that the data correlation is unchanged, in order to reduce this absolute difference and make the range of values closer for comparative analysis, as well as to weaken the covariance and heteroskedasticity, this paper does logarithmic treatment of the total power of agricultural machinery.

The threshold variable in this paper is rural human capital. Human capital helps to advance AM and promote socioeconomic growth at both theoretical and practical levels [22]. In this paper, we choose the average years of education of the rural labor force to measure rural human capital, and use the education method to calculate. [23] The specific calculation formula is as follows:

$$A = \frac{a \times 6 + b \times 9 + c \times 12 + d \times 16}{r}$$

Where A stands for average years of schooling for rural population. a, b, c and d denote rural elementary school population,rural junior high school population, rural high school population and rural college and above population. r is rural population over 6 years old.

To avoid errors in the model regression due to omitted variables, this paper selects government investment, industrial structure, government intervention, infrastructure, and openness to the outside world as control variables. [24] The general investment in fixed assets, the share of secondary industry, and the area of roads per capita are used to represent government investment, industrial structure, and infrastructure, respectively. Government intervention is measured by calculating the ratio of fiscal expenditure to GDP, and the ratio of the amount of import and export of goods to GDP is calculated as a basis for the degree of openness to the outside world.

The above variables are all from the national panel data of 30 provinces from 2003 to 2020, and the statistics are gained from the China Statistical Yearbook and the China Population and Employment Statistical Yearbook. Descriptive statistics of specific variables are shown in Table 1.

Table 1. Descriptive Statistics of Variables

Variable	obs	Mean	Std. dev.	Min	Max
Invest	540	0.6742616	0.2503572	0.1936599	1.479545
Structure	540	0.4520864	0.0854063	0.158	0.615
Finance	540	0.2172884	0.0978571	0.0791762	0.6430112
Infrastructure	540	13.72343	4.842511	4.04	26.78
Trade	540	0.3048099	0.3694246	0.0075724	1.721482
Machine	540	3012.457	2772.515	93.97	13353.02
GAP	540	2.826004	0.5532847	1.845149	4.758562

5. Results and Analysis

5.1 Analysis of Regression Results of Benchmark Model

Based on relevant data from 30 provinces, municipalities and autonomous regions across China from 2003 to 2020, Stata SE 17 software was used for empirical analysis to construct a two-way fixed-effects model to study the influence of AM on the GAP and its mechanism, and robustness tests were conducted.

Table 2 reports the regression results of the benchmark model in this paper. Only the variable of AM was added to model 1, and the regression results show that the development of AM has a negative effect on the GAP at the 1% significance level, and its marginal effect is -0.339, i.e., for every 1% increase in AM, GAP will decrease by 33.9%. Considering that the omitted variables may have an impact on the accuracy of the model estimation results, this paper adds control variables such as government investment and industrial structure in model 2, model 3 and model 4 in turn. The regression results of models 2~4 show that AM can reduce the GAP, and all of them are significant at the 1% level. For each 1% increase in AM development, the GAP decreases by 18.6%, 19.2% and 12.9%, respectively.

Table 2. Regression Results of the Benchmark Model

	GAP(1)	GAP (2)	GAP (3)	GAP (4)
lnmachine	-0.339*** (-8.83)	-0.186*** (-4.92)	-0.192*** (-4.92)	-0.129*** (-3.42)
Invest		-0.482*** (-8.45)	-0.483*** (-8.01)	-0.392*** (-6.72)
Structure		-0.783*** (-3.96)	-0.821*** (-3.99)	-0.670** (-3.43)
Finance			-0.057 (-0.24)	0.162 (0.71)
Infrastructure			0.003 (0.72)	0.007 (2.12)
Trade				0.498*** (-7.54)
Time Effect	yes	yes	yes	yes
Regional Effect	yes	yes	yes	yes
Constant Term	5.498*** (19.84)	4.970*** (18.50)	5.012*** (18.23)	4.544*** (16.97)
R2	0.063	0.0568	0.0521	0.3256
Obs	540	540	540	540

Note: Coefficients reported in the table are marginal effects; t-values are in parentheses; ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively.

As far as the control variables are concerned, government intervention, industrial structure and foreign trade have a significant negative effect on the GAP at the 1% level. Although government intervention and infrastructure have some effect on the GAP, neither of them is significant. A possible explanation lies in the fact that investment in fixed assets has a certain rural bias, [25] and helps to significantly improve the state of rural poverty and promote farmers' income growth. The adjustment and balance of industrial structure helps extend the industrial chain, expanding human capital enhancement and employment opportunities for farmers, thus narrowing the GAP. The expansion of foreign trade helps expand overseas markets, and provinces with large market size are more likely to achieve inclusive growth, which has a negative effect on GAP. Government fiscal policy intervention and infrastructure construction may lead to distorted demand and ineffective resource allocation due to excessive administrative intervention, which instead exacerbates urban-rural income inequality.

5.2 Analysis of Structural Effect

GAP depends on the rapid growth of rural residents' income or the slowdown of urban residents' income growth rate. The paper further finds that AM development has a significant positive effect on the increase of rural residents' income at the 1% level. For every 1% increase in the level of AM, the income of rural residents increases by 4.9%. On the contrary, the increase in the level of AM has no significant effect on the income of urban residents. Thus, it can be seen that AM reduces the GAP by increasing the income of rural residents.

Table 3. Regression Results of the Structural Effect

	lnURBANINCOME(1)	lnRURALINCOME (2)
lnmachine	0.012 (1.25)	0.049*** (5.23)
Invest	-0.011 (-0.75)	0.111*** (7.57)
Structure	0.123** (2.37)	0.283*** (5.79)
Finance	0.021 (0.34)	-0.099* (-1.72)
Infrastructure	0.005*** (5.70)	0.002*** (2.65)
Trade	0.008 (0.46)	0.173*** (10.51)
Time Effect	yes	yes
Regional Effect	yes	yes
Constant Term	8.798*** (124.46)	7.294*** (108.99)
R2	0.8297	0.7875
Obs	540	540

5.3 Analysis of Heterogeneity

There are large distinction in the level of agricultural development in the east, middle and west regions of China. Because the factors of production in the three major zones are quite different, in terms of natural environment, resource endowment, industrial structure and economic foundation [26], the impact of AM on the GAP in different regions is also somewhat different.

As shown in Table 4, the negative effect of AM development on the GAP is more significant in the eastern region compared to the central and western regions. In the eastern region, for every 1% increase in the level of AM, the GAP is reduced by 16.7%, and it is significant at the 1% level. In the central and western regions, the development of AM also has a negative effect on the GAP, but the effect is not significant. The possible explanation is that the eastern region is flatter, mainly plain, with less undulating terrain, which is suitable for the use of agricultural machinery, thus producing scale effects, lowering production costs, improving production efficiency, raising farmers' income,

and narrowing the GAP. While the central and western regions are steep, some areas due to the rugged terrain and undulating terrain, some areas are inaccessible to agricultural machinery, resulting in low utilization of agricultural machinery.

Table 4. Regression Results of Regional Heterogeneity

	Eastern	Central and Western	Agricultural Province	Non-agricultural Province
lnmachine	-0.167*** (-3.13)	-0.046 (-0.89)	-0.247*** (-4.19)	-0.206*** (-3.79)
Invest	-0.458*** (-5.70)	-0.330*** (-4.25)	-0.742*** (-6.38)	-0.371*** (-5.13)
Structure	0 .637* (1.72)	-0.635*** (-2.66)	-0.392 (-1.54)	-0.574* (-1.79)
Finance	0 .510 (1.08)	-0.072 (-0.26)	0.573 (1.45)	0.408 (1.44)
Infrastructure	0.008** (1.99)	0.001 (0.18)	0.003 (0.44)	0.001 (0.30)
Trade	-0.156** (-2.21)	-1.419*** (-6.00)	-0.706*** (-4.57)	-0.532*** (-7.01)
Time Effect	yes	yes	yes	yes
Regional Effect	yes	yes	yes	yes
Constant Term	3.553*** (9.80)	4.296*** (10.29)	5.456*** (11.42)	5.059*** (15.05)
R2	0.0104	0.3840	0.4059	0.2204
Obs	198	342	270	270

Note: The eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Hainan provinces, the remaining 19 provinces are designated as the central and western regions.

Since there is no definition of large agricultural provinces in China, this paper refers to Wu Hongwei's definition [27] of traditional large agricultural provinces, uses the average of sown area of each province from 2003 to 2020 to indicate the production scale of food crops and agricultural products, and ranks them according to their numerical size, with the top 15 provinces defined as large agricultural provinces and the bottom 15 provinces defined as non-agricultural provinces, and uses the benchmark model for regression analysis respectively.

The results show that an increase in the level of AM has a significant negative effect on the GAP at the 1% level in both large agricultural and non-agricultural provinces. For each 1% increase in AM, the GAP in large agricultural and non-agricultural provinces decreases by 24.7% and 20.6%, respectively. The marginal effect is more significant in large agricultural provinces. This can be explained by the larger planted area and higher production in large agricultural provinces, where mechanized agricultural production significantly frees up labor and thus more nonfarm income. On the contrary, in the large non-agricultural provinces, the number of laborers participated in agricultural production is relatively small, and the use of agricultural machinery releases relatively less labor, so it is not conducive to the rise of farmers' wage income [28], and the effect of AM to reduce the GAP is relatively small.

5.4 Further Analysis

The regression results in Table 5 show that AM helps to reduce the GAP by increasing farmers' income, and the effect is more significant for the eastern provinces and large agricultural provinces. Then, based on the introduction of a one-period lag of GAP, this paper selects human capital as the threshold variable, constructs a dynamic threshold model, and gradually adds control variables to explore whether such an effect is only linear.

The regression results show that the threshold value is 8.117 with or without the inclusion of control variables, indicating that the effect of AM development on the GAP is nonlinear. The coefficient of the negative effect of AM on the GAP is -0.103 at the 5% significance level when rural human capital is below the threshold, and the coefficient of the negative effect of AM on the GAP is

-0.118 at the 5% significance level when rural human capital is above the threshold. The results find that although with the gradual addition of control variables, the effect coefficient changes, the impact coefficient above the threshold is always larger than that below the threshold, indicating that the threshold effect of human capital on the GAP does exist.

Table 5. Regression Results of Rural Human Capital Threshold Effect

	D=HR	D=HR	D=HR
L1.GAP	0.860*** (39.39)	0.781*** (30.43)	0.774*** (28.44)
Below_thres	-0.220*** (-15.40)	-0.064** (-2.10)	-0.103** (-2.05)
Above_thres	-0.238*** (-17.37)	-0.079** (-2.57)	-0.118** (-2.43)
Invest	-0.045** (-2.02)	-0.064 (-1.31)	-0.060 (-1.05)
Structure	-0.234*** (-4.04)	-0.523*** (-3.94)	-0.554*** (-8.87)
Finance		-0.053 (-0.18)	0.144 (0.40)
Infrastructure		-0.021*** (-5.04)	-0.020*** (-5.50)
Trade			0.164 (1.50)
Constant Term	2.184*** (21.17)	1.656*** (7.96)	1.870*** (6.09)
Threshold Value	8.117	8.117	8.117
Obs	510	510	510

The possible reason is that the use of agricultural machinery has higher requirements for human capital. Farmers are motivated by the increase in production efficiency and production cost saving, extending their years of education and improve their working ability, which in turn enables them to master the use of agricultural machinery more quickly and skillfully. The improvement of human capital helps to increase farmers' income [29] and reduce the GAP.

5.5 Robustness Tests

5.5.1 Hysteresis Effect Method

Since AM and human capital have certain lagged effects on the GAP, this paper further conducts robustness tests. The empirical results show that the coefficient of AM remains negative at the 1% significance level. This leads to the conclusion that the development of AM always has a negative effect on the GAP, whether lagged by one period or two periods.

5.5.2 Instrumental Variables Method

There may be a two-way causal relationship between AM and GAP which leads to endogenous problems. On the one hand, AM reduces the GAP by increasing farmers' income and human capital. On the other hand, the GAP affects the use of agricultural machinery. In this paper, we use the instrumental variables approach to deal with the endogeneity problem of the model.

In this paper, the one-period lagged value of AM is used as an instrumental variable for AM. After correcting for endogeneity using instrumental variables, the effect of AM on the GAP remains significantly negative at the 1% significance level, further indicating that AM development has a significant effect of reducing the GAP.

5.5.3 Replacement Sample Method

Considering the better economic development of the four municipalities, and that the data may have extreme values due to economic and geographical environment factors, this paper highlights the

data of the four municipalities and finds that the regression results are still consistent with the benchmark regression model, which illustrates the robustness of the benchmark regression results.

Table 6. Results of Robustness Tests

	One Period Behind	Two Period Behind	Instrumental Variables Method	Replacement Sample Method
lnmachine	-0.110*** (-2.68)	-0.120*** (-2.82)	-0.117*** (-2.82)	-0.115*** (-2.62)
Invest	-0.386*** (-6.49)	-0.390*** (-6.77)	-0.388*** (-6.94)	-0.404*** (-6.67)
Structure	-0.701** (-3.42)	-0.840*** (-3.94)	-0.689*** (-4.07)	0.827*** (-3.97)
Finance	0.240 (1.00)	0.281 (1.15)	0.247 (1.16)	-0.133 (-0.56)
Infrastructure	0.006* (1.69)	0.003 (0.81)	0.006* (1.87)	0.005 (1.10)
Trade	-0.504*** (-7.28)	-0.493*** (-6.98)	-0.508*** (-6.74)	-0.320*** (-3.54)
Time Effect	yes	yes	yes	yes
Regional Effect	yes	yes	yes	yes
Constant Term	4.440*** (15.18)	4.603*** (15.13)	4.057*** (19.71)	4.585*** (13.79)
R2	0.3504	0.3395	0.9405	0.2968
Obs	510	480	510	468

6. Conclusion and Policy Recommendations

Since the reform and opening up, despite the continuous enrichment of people's material life, the GAP has been expanding, gradually becoming one of the prominent contradictions restricting China's economic development. AM, as an important criterion for the division of modern agriculture, helps to improve production efficiency and increase farmers' income. Existing studies, but not yet. This paper selects data from the statistical yearbook and establishes an econometric model for quantitative analysis, and finally obtains several conclusions as follows:

First, the increase in the level of AM is conducive to narrowing the GAP. In this paper, a two-way fixed-effects model is selected as the benchmark regression model. The model regression results demonstrate that the coefficient of AM remains significantly negative after gradually adding control variables, indicating that AM has a significant negative effect on the GAP. In the robustness tests, the explanatory variables were replaced using GAP with one and two lags, respectively, and data from four municipalities were excluded for sample replacement, and all three tests yielded results consistent with the baseline model. In addition, after using the instrumental variables approach to deal with the endogeneity problem, the regression results continue to indicate that AM is effective in reducing the GAP.

Second, AM reduces the GAP by increasing farmers' income. The use of agricultural machinery has a significant effect on raising the income of rural residents, compared with the less significant effect on raising the income of urban residents.

Third, there are regional differences in the negative effect of AM on the GAP. Compared with the central and western regions, the effect of AM on the GAP is more significant in the eastern region because of the more developed economy and relatively flat terrain, and the higher utilization rate of agricultural machinery. Compared with non-agricultural provinces, the use of agricultural machinery releases more labor, promotes the increase of farmers' income, and has a more significant negative effect on the GAP because there are more laborers engaged in agricultural labor in large agricultural provinces.

Fourth, the effect of AM on the GAP is nonlinear, and human capital has a threshold effect on it. The role of AM in reducing the GAP is more significant when human capital is above the threshold.

In this regard, this paper proposes the following policy suggestions:

First, pay attention to the development of AM. Strengthen the publicity work on the use of agricultural machinery, provide certain subsidies for the purchase and use of agricultural machinery, and encourage the use of agricultural machinery for large-scale service operations. Strengthening cooperation between agricultural enterprises helps to promote the popularization of AM and the guarantee of agricultural machinery purchase at a later stage.

Second, reduce the differences in AM between regions. Increase research expenditures to develop more universal agricultural machinery to avoid restrictions due to topography, terrain and other natural environmental factors. Enhance cross-area service operations and make full use of restrictions on agricultural machinery to increase production efficiency.

Third, focus on human capital improvement. Provide relevant training to farmers to improve their overall quality. At the same time, rural medical services should be enhanced to improve the physical quality of farmers and reduce the GAP between rural and urban residents in terms of medical and cultural literacy.

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