

# Agricultural Trade, Agricultural Technological Progress and Urban-Rural Income Gap-- Empirical Analysis Based on 31 Provincial-Level Panel Data

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## Abstract

Based on the analysis of the relevant data of 31 provinces (autonomous regions and municipalities directly under the Central government) from 2013 to 2023, this paper uses the two-way fixed effect model to explore the impact of agricultural trade on the urban-rural income gap, and uses the intermediary effect model to analyze the role of agricultural technology progress in the above impact. The empirical results show that the trade of agricultural products has an impact on the urban-rural income gap. In the whole country, the influence of export and import of agricultural products on the urban-rural income gap is negative, and the influence of export of agricultural products is more significant; In the influence of agricultural product export trade on urban-rural income gap, agricultural technology progress played an intermediary role, but in agricultural product import trade, agricultural technology progress did not play an intermediary role; For provinces with different geographical locations, the mediating effect of agricultural technology progress on urban-rural income gap shows obvious heterogeneity, especially the eastern, central and western regions have obvious differences. Based on the above research conclusions, this paper further proposes to increase the investment and promotion of agricultural technology, strengthen the technical exchange and cooperation between different regions, improve agricultural production efficiency, optimize the allocation of human resources, so as to narrow the urban-rural income gap.

## Keywords

**Agricultural Product Trade; Agricultural Technology Progress; Urban-rural Income Gap; Mediating Effect.**

## 1. Introduction

The report to the 20th National Congress of the CPC pointed out that Chinese-style modernization means the modernization of common prosperity for all the people, and achieving common prosperity is the essential requirement of socialism with Chinese characteristics. The most arduous and onerous task in comprehensively building a modern socialist country still lies in the rural areas. Since the beginning of reform and opening up, China's rural economy has achieved rapid development, and the income level of farmers has increased significantly. Statistics show that the disposable income of rural residents in China will reach 21,691 yuan in 2023, a 161-fold increase from 134 yuan in 1978. Due to the "stumbling block" of unbalanced and inadequate economic development in China, the large urban-rural income gap has become an important problem restricting China's economic development. Data from the National Bureau of Statistics show that China's rural-urban income ratio in 2023 will be 2.39, which is significantly lower than 2.64 in 2019, but the absolute

difference between urban and rural income is still large. Therefore, narrowing the urban-rural income gap is still an urgent issue to achieve common prosperity.

Agricultural products are the direct result of agricultural production, and the trade of agricultural products affects the structure of agricultural production, technological progress and employment, and has an important impact on farmers' income. Huang Xiaoyan et al pointed out that the import of agricultural products can alleviate the pressure of domestic shortage of agricultural resources, especially the import of raw material agricultural products has a significant effect on promoting China's industrial development and improving farmers' non-agricultural income, and the direct impact and spatial spillover effect of agricultural products export on farmers' income increase is far greater than that of agricultural products import[1] Existing literatures on agricultural trade and urban-rural income gap mainly focus on mechanism analysis, and believe that import and export of agricultural products can affect urban-rural income distribution pattern[2] Zhang Shien further pointed out that agricultural trade affects farmers' income through a multi-level and multi-channel transmission mechanism, which mainly includes price, scale, technology and employment mechanisms[3] Scholars hold different views on the relationship between agricultural technology progress and urban-rural income gap. One view holds that agricultural technological progress has generally exacerbated income inequality, especially among high-income farmers[4] The other view holds that agricultural technological progress has a lagged effect on the urban-rural income gap in the short term, and will further widen[5] However, Lu Wencong found that agricultural technological progress would have a positive impact on farmers' income growth in both the long and short term, thus helping to narrow the urban-rural income gap[6]

To sum up, the existing literature mainly focuses on the research and discussion on the relationship between agricultural product trade, agricultural technology progress and urban-rural income gap, and few literatures include the three into the same framework for research. Then, will agricultural product trade have an impact on urban-rural income gap through agricultural technology progress, and what is the effect? Based on this, the research ideas of this paper are as follows: Firstly, from the perspective of theoretical analysis, the influence path of agricultural product trade on urban-rural income gap is expounded and the hypothesis is given; Secondly, by setting the intermediary effect model, the panel data of 31 provinces were empirically analyzed, and the robustness and heterogeneity of the model were analyzed. Finally, countermeasures and suggestions are given to further narrow China's urban-rural income gap, promote the effective allocation of resources, and provide theoretical support for achieving common prosperity.

## 2. Theoretical Analysis and Research Hypothesis

There are abundant achievements on the influence of agricultural products trade on farmers' income level. Zhang Biyun studied the impact of agricultural trade on farmers' income by systematically analyzing the resource utilization effect, comparative advantage effect, economies of scale effect, competition effect and poverty growth effect[7] Taking Xinjiang as an example, Wang Yongjing used the method of intermediary effect model analysis to discuss the issue[8] The author believes that agricultural product trade mainly affects farmers' income through the following ways, and then affects the level of urban-rural income gap. First, the trade of agricultural products affects farmers' income through the price mechanism. The market price of agricultural products directly affects the income level of farmers, and the supply and demand relationship of agricultural products market directly determines the price of agricultural products. When the import volume of agricultural products increases, the imported agricultural products have an impact on the local products, prompting the price level to fall, farmers' income to decrease, and the income gap between urban and rural areas may further increase; On the

other hand, when the quantity of agricultural products exported increases, the supply and demand for agricultural products in the market increase at the same time, the supply curve and the demand curve move to the right, the price level rises, the income of farmers increases, and the income gap between urban and rural areas may be further narrowed. Secondly, the trade of agricultural products has an impact on farmers' income by affecting employment. On the one hand, the export of agricultural products leads to an increase in the demand for agricultural products in the market, so more labor is needed to improve the efficiency of agricultural production. On the other hand, the development and perfection of agricultural products market can promote the rise of other related industries, thereby increasing employment and increasing farmers' income. In addition, the trade of agricultural products may cause the international flow of labor force, lead to transnational employment, and have an impact on farmers' income. Thirdly, technical factors play an important role in the process of agricultural trade and the increase of farmers' income. For example, in the process of importing agricultural products, people can also have access to advanced agricultural science and technology and production methods of other countries. Through imitation and learning of advanced technologies, the efficiency and quality of domestic agricultural production can be improved, thus increasing the market competitiveness of agricultural products and promoting the increase of farmers' income.

Based on this, this paper puts forward hypothesis 1.

H1: Trade of agricultural products can increase farmers' income and narrow the income gap between urban and rural areas.

In the trade of agricultural products, technology trade is often the easiest to achieve. In the process of importing agricultural products, in addition to the introduction of various types of agricultural products, technology transfer is often accompanied. Firstly, by learning the advanced production technology of other countries and applying it to the production process of our own agricultural products, the production efficiency of our agricultural products can be improved. Secondly, with the increase in the number of agricultural imports, foreign agricultural products gradually occupy a favorable position in the domestic market, which is bound to have a threat and impact on local agricultural products, so that domestic agricultural producers continue to improve production technology and increase investment in technological innovation to ensure their competitiveness in the agricultural product market. In addition, with the development of agricultural product export trade, agricultural producers often improve production technology to improve production efficiency, so as to enhance the competitiveness of agricultural products export. At present, the research on agricultural technology progress and farmers' income is very extensive, and it is generally believed that the effect of technological progress on farmers' income increase is significant[9] Among them, Gan Ruihuan deeply analyzed the internal mechanism[10] Wang Jingchun studied the impact of agricultural technology progress on urban-rural income gap from the perspective of spatial spillover, and concluded that agricultural frontier technology progress is an effective spillover path to restrain urban-rural income gap[11]

Based on the above analysis, hypothesis 2 and hypothesis 3 are proposed in this paper.

H2: Agricultural technological progress plays an intermediary role in the influence of agricultural export trade on urban-rural income gap.

H3: Agricultural technology progress plays an intermediary role in the influence of agricultural product import trade on rural-urban income gap.

### 3. Model Setting and Variable Selection

#### 3.1. Measurement method selection

In this paper, the least square method of econometrics is used to regression the data, respectively using fixed effects model (re) and random effects model (fe). By controlling the fixed effects of individuals and time, unobservable heterogeneity associated with explanatory variables can be effectively eliminated, thus avoiding the bias of missing variables. However, when the time dimension is small or the number of individuals is very large, the fixed effects model may lead to inaccurate estimation due to the loss of freedom, and the random effects model may be better in this case. For the choice of fixed effects model and random effects model, hausman test can be used to reach a conclusion. Based on the Hausman test, this paper draws the conclusion that the fixed effects model is more effective. Therefore, this paper adopts the fixed effects model for regression.

#### 3.2. Model setting

This paper establishes the following intermediary effect model to test the influence path and effect of agricultural product trade on urban-rural income gap through agricultural technology progress. The specific model is set as follows:

$$\text{gap} = \alpha_0 + \alpha_1 \text{trade} + \sum \text{control} + \delta_1 + \varepsilon_{it} + \mu_i \tag{1}$$

$$\text{innov} = \beta_0 + \beta_1 \text{trade} + \sum \text{control} + \delta_1 + \varepsilon_{it} + \mu_i \tag{2}$$

$$\text{gap} = \gamma_0 + \gamma_1 \text{trade} + \gamma_2 \text{innov} + \sum \text{control} + \delta_1 + \varepsilon_{it} + \mu_i \tag{3}$$

Where,  $\alpha_1$  in model 1 represents the coefficient of influence of agricultural trade on urban-rural income gap (gap),  $\beta_1$  in model 2 represents the coefficient of influence of explanatory variable agricultural trade on intermediary variable agricultural technology innovation (innov),  $\gamma_1$  in model 3 reflects the degree of influence of agricultural trade on urban-rural income gap after controlling intermediary variables. And  $\gamma_2$  represents the impact degree of agricultural technology innovation on urban-rural income gap after controlling the independent variable of agricultural product trade. The independent variable of agricultural trade in the model includes agricultural export and agricultural import. The control variables were agricultural labor productivity (labor), financial input (finance), marketization level (market), regional per capita output level (pgdp), urbanization level (urban) and regional planting structure (struc).  $\delta_t$  and  $\mu_i$  represent time and individual fixed effects, respectively, and  $\varepsilon_{it}$  represents random perturbation term.

Drawing on the research of Zhang Hongli[12]. On the mediation effect model [12] the analysis method of the mediation effect model in this paper is as follows: If  $\alpha_1$ ,  $\beta_1$ , and  $\gamma_2$  are all significant in the regression results, and  $\beta_1 \cdot \gamma_2$  and  $\gamma_1$  have the same sign, it indicates the existence of a mediation effect; if  $\alpha_1$ ,  $\beta_1$ , and  $\gamma_2$  are all significant in the regression results, but  $\beta_1 \cdot \gamma_2$  and  $\gamma_1$  have opposite signs, it indicates that the direct effect and indirect effect of agricultural product trade on the urban-rural income gap are opposite, that is, a "masking effect" exists; while if  $\alpha_1$  is significant, but at least one of  $\beta_1$  and  $\gamma_2$  is not significant, the significance of  $\beta_1 \cdot \gamma_2$  needs to be further determined to judge whether to reject the hypothesis that  $\beta_1 \cdot \gamma_2 = 0$ . If the result is not significant, the null hypothesis that  $\beta_1 \cdot \gamma_2 = 0$  is rejected, indicating that the indirect effect is not significant; if the result is significant, it indicates the existence of a mediation effect.

#### 3.3. Data source and variable selection

Table 1. Descriptive statistics

VarName	Obs	Mean	SD	Min	Median	Max
lnexport	341	20.756	1.524	15.987	20.864	23.782

lnimport	341	20.774	2.333	13.343	20.966	24.330
lnpgdp	341	10.970	0.440	10.003	10.918	12.207
lnfinance	341	6.319	0.551	4.703	6.396	7.322
gap	341	2.562	1.255	0.812	2.314	7.053
struc	341	0.654	0.151	0.341	0.650	0.971
labor	341	5.361	2.578	1.895	4.511	15.550
urban	341	0.602	0.126	0.232	0.596	0.942
market	341	8.229	2.214	-0.160	8.447	12.864
innov	341	3.724	1.957	0.742	3.304	11.838

The data in this paper are mainly from the National Bureau of Statistics and provincial statistical almanacs, and some data are from the Ministry of Agriculture and Rural Affairs, PRC. For the data missing in individual years, interpolation method is used to complete. The main variables in this paper and their measurement methods are as follows.

### 3.3.1. Explained variables

The dependent variable of this study is the urban-rural income gap. In existing literature, there are two commonly used indicators to measure the urban-rural income gap: the urban-rural income ratio [13] and the Thales index [14]. Each of these two indicators has its own advantages and disadvantages. Rural-urban income ratio can directly reflect the relative difference between urban and rural residents in the income level, but this index only reflects the static status of urban and rural income in a certain period, ignoring its dynamic change process. Compared with other indicators to measure income gap, Thiel Index has a higher decomposability, and can measure the intra-group gap (income gap between urban and rural areas) and inter-group gap (income gap between urban and rural areas) respectively, thus helping us to understand the source and composition of urban-rural income gap in a more detailed way. However, it also has some defects. For example, the calculation is relatively complicated and can not directly reflect the absolute income gap between urban and rural areas. By comparing these two measurement methods, this paper selects the rural-urban income ratio for benchmark regression.

### 3.3.2. Explain the variables

trade, as the explanatory variable of this paper, is further decomposed into import and export of agricultural products. The import value of agricultural products reflects the amount of agricultural products purchased by a region from other countries in a certain period, while the export value of agricultural products reflects the amount of agricultural products sold by a region to other countries in a certain period, both of which are important indicators affecting the income level of farmers. In order to maintain the stability of the data and reduce the heteroscedasticity, this paper takes logarithms of the import amount and the export amount of agricultural products.

### 3.3.3. Mediating variables

Using agricultural technological progress (innov) as an intermediate variable, this paper studies the effect of innov on narrowing urban-rural income gap in agricultural trade. On the one hand, the improvement of agricultural production technology, especially the improvement of agricultural mechanization level, can significantly improve agricultural production efficiency and increase the output of agricultural products. On the other hand, advances in agricultural technology such as gene editing and breeding have significantly improved the quality of agricultural products, thus meeting society's demand for the quality of agricultural products. In this paper, referring to the research method of scholar Jin Yang, the ratio of agricultural added

value to the number of labor forces in agricultural production is used to represent agricultural technological progress[15]

### 3.3.4. Control variables

(1) Agricultural labor productivity. Agricultural labor productivity is an important factor affecting agricultural output, and there are differences in agricultural labor productivity in different regions. In this paper, the ratio of the total power of agricultural machinery to the number of rural primary industry employees is used to express agricultural labor productivity[16]

(2) Financial input to agriculture. Through the government's financial investment in agriculture, the construction of agricultural infrastructure can be strengthened, agricultural science and technology can be popularized, and the efficiency and quality of agricultural production can be improved.

(3) The level of market. The marketization level reflects the free flow and effective allocation of various market factors such as labor, capital and land under the market mechanism. With the continuous development and improvement of the agricultural product market, the trade level of agricultural products has also been continuously improved, creating favorable conditions for farmers to increase their income. In this paper, the index of marketization is chosen to measure the marketization level[17]

(4) Regional per capita output level (pgdp). There are differences in the level of economic development in different regions, and the per capita output level of a region is one of the important indicators to measure a region's development level, which reflects the average output created per unit population in a certain period of time. Similarly, in order to reduce the heteroscedasticity of the model, logarithmic treatment is also adopted for this variable in this paper.

(5) Urbanization level (urban). The development of urbanization has brought about great changes in population distribution and employment structure. A large number of rural people move to cities. On the one hand, it provides rich labor resources for the development of cities, and on the other hand, it also changes the lifestyle of rural people, thus affecting the level of agricultural output. In this paper, the proportion of urban population in the total population is used to represent the level of urbanization.

As can be seen from the Table 1, among the 31 provinces in China, the difference between the maximum value and the minimum value of agricultural imports after taking the logarithm is 7.795, and the difference between the maximum value and the minimum value of agricultural exports after taking the logarithm is 10.987, indicating that there are great differences in agricultural trade in different regions.

## 4. Empirical analysis

### 4.1. Regression result analysis

Table 2. National regression results 1

	Model (1)	Model (2)	Model (3)
	gap	innov	gap
lnexport	-0.126*** (0.000)	0.234*** (0.008)	-0.102*** (0.002)
lnimport	-0.017 (0.458)	0.089 (0.135)	-0.010 (0.663)
innov			-0.080*** (0.000)

Constant	-0.449 (0.815)	-13.928** (0.015)	-1.404 (0.458)
Other control variables	control	control	control
Timefixed	Y	Y	Y
Provincial fixed	Y	Y	Y
Observations	341	341	341

Table 2 presents the regression results on a national scale. Model 1 does not incorporate the mediating variable of agricultural technological progress. The results show that both agricultural product exports and imports have a negative impact on the urban-rural income gap, indicating that on a national scale, both agricultural product exports and imports can narrow the urban-rural income gap, thus verifying Hypothesis 1. The impact of agricultural product exports on narrowing the urban-rural income gap is significant at the 5% level, while that of agricultural product imports is not significant. When agricultural product exports increase by 1 percentage point, the urban-rural income gap will decrease by 0.126 percentage points, while when agricultural product imports increase by 1 percentage point, the urban-rural income gap will only decrease by 0.017 percentage points. This suggests that the urban-rural income gap can be narrowed by increasing agricultural product exports. Model 2 examines the effect of agricultural product trade on agricultural technological progress. The results show that both agricultural product imports and exports have a positive impact on agricultural technological progress, but the effect of agricultural product exports on agricultural technological innovation is significant at the 5% level, while the effect of agricultural product imports is not significant. The main reason is that agricultural producers often update technologies to increase the market competitiveness of agricultural products in order to export more and gain profits. Agricultural product imports not only include the products themselves but also can introduce advanced agricultural production technologies from other countries to improve the local agricultural production technology level. Model 3 introduces the mediating variable on the basis of Model 1. Compared with Model 1, although agricultural product exports remain significant at the 5% level, the absolute value of the regression coefficient has decreased; agricultural product imports remain insignificant, and the absolute value of the regression coefficient has also decreased. From the regression results in Table 2, it can be seen that  $\alpha_1$ ,  $\beta_1$ , and  $\gamma_2$  of agricultural product exports are all significant, and  $\beta_1 \cdot \gamma_2$  and  $\gamma_1$  have the same sign, indicating that agricultural product exports will affect the urban-rural income gap through the mediating effect of agricultural technological progress. Thus, Hypothesis 2 can be verified, that is, agricultural technological progress plays a mediating role in the impact of agricultural product export trade on the urban-rural income gap. Since the impact of agricultural product imports on the urban-rural income gap is not significant, Hypothesis 3 has not been verified, which means agricultural technological progress has not played a mediating role in the impact of agricultural product imports on the urban-rural income gap.

## 4.2. Robustness analysis

In order to further verify the reliability of the results of the intermediary effect model of agricultural technological progress, this paper adopts two methods of reducing the sample time range and one stage lag of explanatory variables to analyze the robustness of the model.

### 4.2.1. Robustness test of reduced time range

On the basis of the original data from 2013 to 2023, the time span was reduced to 2013-2021 for regression, and the results were shown in Table 3. The significance levels of explanatory variables and intermediary variables were basically consistent with the nationwide results, indicating that the results of the model were stable.

Table 3. Robustness test of the reduced time span

	Model (4)	Model (5)	Model (6)
	gap	innov	gap
lnexport	-0.099*** (0.000)	0.169** (0.034)	-0.084*** (0.001)
lnimport	-0.012 (0.499)	0.078 (0.157)	-0.006 (0.724)
innov			-0.071*** (0.000)
Constant	2.792* (0.083)	-11.508** (0.048)	2.126 (0.175)
Other control variables	control	control	control
Timefixed	Y	Y	Y
Provincial fixed	Y	Y	Y
Observations	279	279	279

#### 4.2.2. Robustness test for explanatory variables lagging by one stage

Due to the influence of various policies and other factors, there is a lag effect in agricultural product trade. Therefore, after lagging the import and export of agricultural products by one period and conducting regression, the regression results are shown in Table 4. The significance levels of agricultural product exports and agricultural technological progress are basically consistent with the results at the national level; while the sign of agricultural product imports has not changed, its significance has changed. In Model (4), the impact of agricultural product imports on the urban-rural income gap is significant at the 5% level, and in Model (5), the impact of agricultural product imports on agricultural technological progress remains insignificant. After adding agricultural technological progress, in Model (6), both agricultural technological progress and agricultural product imports have a significant impact on the urban-rural income gap. Since  $\beta_1 \cdot \gamma_2 = 0.0012$  is not zero, it indicates that the indirect effect is not significant, and agricultural product imports cannot significantly affect the urban-rural income gap through agricultural technological progress, which is consistent with the conclusion in the previous text and further demonstrates the stability of the model results.

Table 4. The robustness test of the variable with a lag of one stage

	Model (4)	Model (5)	Model (6)
	gap	innov	gap
lnexport	-0.128*** (0.000)	0.249*** (0.006)	-0.104*** (0.002)
lnimport	-0.031** (0.044)	0.044 (0.229)	-0.027* (0.068)
innov			-0.075*** (0.001)
Constant	0.581 (0.768)	-15.364** (0.010)	-0.428 (0.826)
Other control variables	control	control	control
Timefixed	Y	Y	Y
Provincial fixed	Y	Y	Y

Observations	341	341	341
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## 5. Conclusions and Suggestions

By collecting and analyzing the panel data of 31 provinces in China from 2013 to 2023, this paper uses the intermediary effect model to analyze the role of agricultural technology progress in the impact of agricultural products trade on the urban-rural income gap. The research finds that: First, the import and export trade of agricultural products can narrow the urban-rural income gap nationwide. The export trade of agricultural products has a more significant effect on narrowing the urban-rural income gap, while the import trade of agricultural products has no significant effect on narrowing the urban-rural income gap. Second, agricultural technology progress played a mediating effect on the effect of agricultural product export on narrowing the urban-rural income gap, that is, agricultural product export narrowed the urban-rural income gap through agricultural technology progress, while agricultural product import did not affect the urban-rural income gap through agricultural technology progress. Third, the effect of agricultural technology progress on urban-rural income gap shows obvious heterogeneity in different geographical locations, especially in the eastern, central and western regions. Except in the export trade of agricultural products in the eastern region and import trade of agricultural products in the central region, the progress of agricultural technology in other regions has not played a significant role in the impact of agricultural products trade on urban-rural income gap. Based on this, the following two suggestions are given:

First, increase investment in agricultural technology and popularize advanced production technology. Government departments can ensure sufficient funds for agricultural technology by increasing financial input for agricultural technology research and development, or support local agricultural technology innovation activities through transfer payments and special subsidies, and encourage different regions to strengthen technological exchanges and cooperation. In addition, it is necessary to strengthen the popularization of advanced technologies so that technological progress can be more effectively translated into agricultural productivity. Specific measures include: establishing agricultural technology demonstration bases and promoting smart agriculture; Organizing technical exchanges and training activities to enhance farmers' ability to apply technology.

Second, we will increase the import and export of agricultural products. We will encourage and support agricultural enterprises to adopt advanced technologies and management models to improve the quality of agricultural products and enhance their international competitiveness. Promote international trade facilitation of agricultural products through cooperation with international economic and trade organizations to create more opportunities for agricultural exports; To build a number of well-known international brands of agricultural products and enhance the international visibility of China's agricultural products. For different regions in eastern, central and western China, different development plans for agricultural import and export trade should be formulated to increase farmers' income and narrow the income gap between urban and rural areas. The eastern and western regions should accelerate the development of agricultural import trade, while the central region should promote the development of agricultural export trade.

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