# Research on the Influence Mechanism and Effect of Rural Industrial Convergence on Urban-Rural Income Gap——An Empirical Analysis Based on the Yangtze River Economic Belt

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*Abstract:*

As an important way to promote the prosperity of rural industries and the prosperity of farmers' rural industrial convergence plays an important role in narrowing the income gap between urban and rural areas. This article attempts to entropy weight TOPSIS method to calculate the level of rural industrial convergence in 120 prefecture-level cities in the Yangtze River Economic Belt from 2009 to 2019, examines the mechanism and effect of rural industrial convergence on urban-rural income gap, and studies the regional heterogeneity of rural industrial convergence on urban-rural income gap. The main conclusions as follows: (1) The convergence of rural industries in the Yangtze River Economic Belt as a whole and in various regions is conducive to narrowing the urban-rural income gap, but there is significant regional heterogeneity, which is manifested as "the upper > the middle > the lower reaches". (2) Rural economic growth and urbanization have played a partial mediating effect on rural industrial convergence and narrowing the urban-rural income gap, and rural economic growth is greater than the mediating effect of urbanization. (3) Rural infrastructure has a positive moderating effect on rural industrial convergence and narrowing the urban-rural income gap.

*Keywords*: *Rural industrial convergence, Urban-rural income gap, Yangtze River Economic Belt, Mediating effect, Adjust the effect.*

## I. INTRODUCTION

Since the reform and opening up for more than 40 years, China's economic development has made remarkable achievements, urban and rural residents' income and quality of life have been significantly improved. However, while the income of urban and rural residents in China is growing rapidly, the growing income gap between urban and rural residents is becoming more prominent, thus affecting social stability and residents' living standards. To discuss the reasons for the urban-rural income gap, some scholars have analyzed from the perspective of urban-biased policies. The continuous widening urban-rural

income gap in China is related to the urban-oriented economic policies implemented by local governments [1]. Occupational choice discrimination brought about by urban and rural household registration policies puts farmers at a disadvantage in income [2]. The government's intervention in the market of factors of production and the pattern of resource mobility barriers are also widening the income gap between urban and rural areas. However, since 2004, China has implemented a series of policies to strengthen and enrich peasants. The institutional deficiencies of previous urban tendencies have been significantly improved. The income of farmers has continued to grow, and the urban-rural income ratio has narrowed year by year, but the absolute value of the urban-rural income gap has not narrowed. This indicates that in addition to correcting urban bias policies to narrow the urban-rural income gap, it is necessary to further combine the characteristics of national economic and social development stage, adjustment of urban-rural relations and new technological conditions to return to solving the fundamental problem of low comparative labor productivity in agricultural and non-agricultural industries.

In 2015, the Chinese government first proposed to promote the rural industrial convergence development, and stated that the convergence development of rural industries is an important way to help farmers increase their income. Rural industrial convergence refers to the expansion and intensive allocation of capital, labor and resource elements based on agriculture in a variety of ways, so that the primary, secondary and tertiary industries in rural are closely connected and develop in a coordinated way, and ultimately achieve the reduction of transaction costs, increase of farmers' income and multiplication of economic energy [3, 4]. In the context of new technology and market, industrial convergence is an effective development mode and industrial organization form to improve productivity and competitiveness [5], which should become an important starting point to improve agricultural labor productivity, promote farmers' income and narrow the urban-rural income gap.

As an important inland river economic zone in China, the Yangtze River Economic Belt is also the most important agricultural production area and rural gathering area in China. The absolute income gap between rural areas and cities is widening year by year. At present, the construction of agricultural industrial system in the Yangtze River Economic Belt has made great achievements, but it still faces many problems, such as low added value of agricultural products, low overall agricultural benefits, inadequate expansion of agricultural versatility, and lack of convergence development of agriculture and secondary and tertiary industries in rural areas, especially in the upper reaches of the Yangtze River. Promoting the integrated development of rural industries is conducive to the prosperity of rural industries, helping farmers expand employment and increase their incomes, improving the economic benefits of agriculture, narrowing the urban-rural income gap in the Yangtze River Economic Belt and promoting common prosperity.

## II. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Literature Review
Industrial convergence begins with the technological association between industries [6]. It is the contraction or disappearance of industrial boundaries in order to adapt to industrial growth and the

integration of technology, industry, service and market. The convergence of rural industries was first proposed by Japanese scholar Naraobi Imamura (1994) to develop the concept of "six industrialization" of agriculture, and then scholars continued to evolve and develop on this basis. The existing literature shows that the research on the rural industrial convergence mainly focuses on the following aspects:

The evaluation of rural industry convergence. First, research on the construction of evaluation index system of rural industrial convergence. Scholars' construction of evaluation indicator system of rural industrial convergence is mostly based on the division of multiple rural industry convergence modes. Existing literature includes multiple modes of agricultural industrial chain extension, agricultural multi-function play, factor integration and so on in the construction of evaluation indicator system [7,8], which also covers the evaluation of the economic and social benefits of rural industrial convergence, such as peasants' income increase and employment, and urban-rural integration [9,10]. The comprehensive evaluation results show that the degree of industrial convergence in rural areas keeps deepening over time, and the comprehensive level of industrial convergence increases year by year and presents an obvious trend of periodic changes [11]. Second, as for the use of the measurement method of rural industry convergence, there is no unified understanding in the academic circle. By comparison, entropy method is widely used in evaluation methods of rural industry convergence because it can objectively reflect the weight of each indicator [12], and some scholars also use Analytic Hierarchy Procedure method [9, 13], grey correlation analysis method [14], Hefindahl coefficient method [15] and equalization method [16] are used to evaluate the rural industrial convergence. In addition, when it comes to the evaluation of the convergence level between rural industries, some scholars used the coupling coordination model to measure the coupling coordination degree between industries [17, 18].

The empirical research on the economic effect of rural industrial convergence. The empirical research on the economic effect of rural industrial convergence mainly focuses on the research on rural industrial convergence and the increase of farmers' income. Firstly, the research on the direct effect of rural industrial convergence on increasing farmers' income. Many scholars' empirical studies have found that agricultural industrialization has significantly promoted agricultural production efficiency or farmers' income [19, 20]. Convergence of rural industries through the combination of agriculture and secondary and tertiary industries, the extension of agricultural industry chain, the play of agricultural versatility and the integrated development of agricultural service industry will have a direct impact on the farmers' income increase [21, 22]. Other scholars, based on micro-survey data, found that participation in rural industrial convergence can promote farmers' income growth [23, 24]. Secondly, research on the transmission mechanism of rural industrial convergence affecting farmers' income increase. The level of economic development, urbanization process and supporting conditions are different in different regions of China, these external factors in different regions profoundly affect the change of rural residents' income. Some scholars' empirical test found that in the course of agricultural industrialization, the higher the level of urbanization, the more obvious the increase effect on farmers' income [25]. In provinces and cities with high level of rural economic development, perfect infrastructure construction and in-depth development of agricultural insurance, the impact of integrated development of rural industries on farmers' income is more significant [26]. The level of rural human capital, the level of investment in cultural, sports and entertainment assets

investment, and the level of investment in agriculture, forestry, animal husbandry and fishery fixed assets also play an increasingly important role in the impact path of rural industrial convergence to increase farmers' income [27]. And then, the regional difference analysis of rural industrial convergence affecting farmers' income increase. Due to the great differences in the economic and environmental conditions of different regions in China, there are regional differences in the impact of the rural industrial convergence on farmers' income, and its income effect shows a decreasing trend in the eastern, central and western regions of China [28]. Industrial convergence and coordination of farmers' income fluctuate due to different levels of industrial development in different provinces. Provinces with better coordination of farmers' income usually have fewer constraints and better agricultural development [29]. Therefore, the income effect of convergence development of rural industries has obvious regional heterogeneity due to the difference of external environment and supporting conditions.

The above related research provides a good theoretical basis and ideas for this article. However, there are still the following aspects to be expanded: (1) the analysis of the impact of rural industrial convergence on the urban-rural income gap still needs further research. Related studies mainly concentrated on the evaluation and measurement of rural industrial convergence and farmers' income growth, agricultural industrialization and urban-rural income gap. At present, promoting the rural industrial convergence has become the focus of the Chinese government's agricultural policy. Then the impact of rural industrial convergence on narrowing the urban-rural income gap remains to be tested and analyzed. (2) Existing literature has not paid enough attention to the analysis of the influence mechanism of rural industrial convergence on the urban-rural income gap. Rural industry convergence to reduce the urban-rural income gap in addition to the direct impact, also will be affected by the external environment and supporting conditions of mutual influence, such as rural economic base, the rural human capital level, rural infrastructure, etc., more emphasis on the existing literature from to promote the increment of agricultural industrial chain, the perspective of efficiency of agricultural production and farmers' income to emphasize. However, the influence of external environment and supporting conditions on the transmission mechanism of reducing urban-rural income gap through rural industrial convergence is not paid enough attention. (3) The regional differences of the influence of rural industrial convergence on the urban-rural income gap still need to be enriched and expanded. Due to the great differences in economic and environmental conditions among different regions in China, the impact of rural industrial convergence in different regions of the Yangtze River Economic Belt on the urban-rural income gap will also have obvious regional differences due to the differences in external environment and supporting conditions.

To sum up the relevant research results, this article will carry out research from three aspects. First, it will measure the level of rural industrial convergence in the Yangtze River Economic Belt, discuss the direct impact of rural industrial convergence on the urban-rural income gap, and then consider rural economic growth and urbanization as the mediating variable, taking rural infrastructure as a moderator variable, studies its mediating effect or moderating effect between rural industrial convergence and urban-rural income gap. Finally, analyze the heterogeneity impact of rural industrial convergence on the urban-rural income gap between different regions of the Yangtze River Economic Belt. Based on the research conclusions, put forward policy recommendations to promote rural industrial convergence and

narrow the urban-rural income gap.

### 2.2 Hypothesis Development

The direct impact of rural industrial convergence on urban-rural income gap. From the point of theoretical mechanism and policy making, the rural industrial convergence can narrow the urban-rural income gap by improving the economic benefits of agriculture itself and expanding the channels for increasing peasant's income. Specifically, the goals and expected results can be achieved through the following ways: (1) the integrated convergence within agriculture optimizes the planting and raising structure through the combination of planting and raising, farming and animal husbandry, agriculture and forestry [8], so as to realize the internal ecological, circular, efficient and sustainable development of the agricultural industry, thereby increasing agricultural output and increasing farmers' operating income, and then achieve the effect of narrowing the urban-rural income gap. (2) Through the rural industrial convergence, it promotes the expansion of agriculture to industry and service industry and extends the agricultural industry chain. The extension of agriculture to industry and service industry is reflected in the agricultural products processing industry development brought by the deep processing of agricultural products, and the development of sales, circulation and other related industries driven by the entry of agricultural products into the market. The extension of agricultural industrial chain brings the extension of agricultural supply and demand chain and value chain, changes the disadvantaged position of peasants' at the end of the value chain, increases their right to enjoy dividends, promotes the employment of farmers, and promotes the narrowing of the urban-rural income gap. (3) On the basis of the traditional production function of agricultural products, new forms of agriculture such as leisure agriculture, tourism agriculture, cultural agriculture and creative agriculture have been derived. The ecological function of agriculture should be brought into full play by promoting organic fertilizer and reducing the use of chemical fertilizers and pesticides. The diversification of agriculture can not only improve the quality and efficiency of agriculture, but also drive the concentration of factors and industrial linkage, activate rural land, housing and financial markets, and increase farmers' property income and production and operation income. (4) The convergence of agricultural technology infiltration embodies the important role of agricultural mechanization and informatization in promoting agricultural modernization. Through the convergence of agricultural technology, agricultural production efficiency is improved, agricultural production costs are reduced, large-scale agricultural operation is promoted, rural e-commerce, smart agriculture and other new forms of business development are promoted, agricultural industry upgrading is promoted, farmers' income is greatly increased, and the urban-rural income gap is narrowed. To sum up, this paper proposes the following hypotheses to be tested:

Hypothesis 1 (H1): Rural industrial convergence has a direct narrowing effect on the urban-rural income gap

The indirect influence of rural industrial convergence on urban-rural income gap. In addition to the direct effects discussed in the previous section, the impact of rural industrial convergence on the urban-rural income gap also has indirect effects through some important intermediate variables. Synthesize

the research results of existing relevant literature, this article focuses on the rural economic growth, urbanization and rural infrastructure as several important intermediate variables in the transmission mechanism of rural industrial convergence on urban-rural income gap.

Rural industrial convergence indirectly affects the urban-rural income gap by promoting rural economic growth (as shown in Figure 1). The aggravation of the income imbalance between urban and rural residents is caused by the imbalance of economic growth rate between urban and rural areas. From the perspective of the evolution of the urban-rural income gap, the growth rate elasticity of per capita net income of rural residents is obviously lower than that of urban residents, which leads to the urban-rural income gap has widened [30]. Therefore, the key point of economic growth to narrow the gap between urban and rural income is to increase peasant' income. Rural industrial convergence is an advanced form of China's agricultural and rural economic development. On the one hand, generate new industries and new economic growth poles in rural areas through functional convergence, technological convergence and value integration between different industries, stimulate the vitality of rural economic growth. On the other hand, by fully exploiting and utilizing the advantages of resources, factors and characteristics in rural areas, it will create amiable conditions for the production, living and market environment in rural areas, cultivate new business forms and new driving forces for the rural industrial convergence, and thus lay an industrial foundation for rural economic growth and rural revitalization. On this basis, from the perspective of the " trickle-down effect" theory, the group (or region) that is the first to achieve prosperity can drive other groups to increase their income and become rich through employment, consumption and other ways [31], that is, rural residents share the benefits of rural economic growth brought by the rural industrial convergence, so as to narrow the urban-rural income gap. In summary, this article proposes the following hypotheses to be tested:

Hypothesis 2 (H2): Rural industrial convergence can narrow the urban-rural income gap by promoting rural economic growth
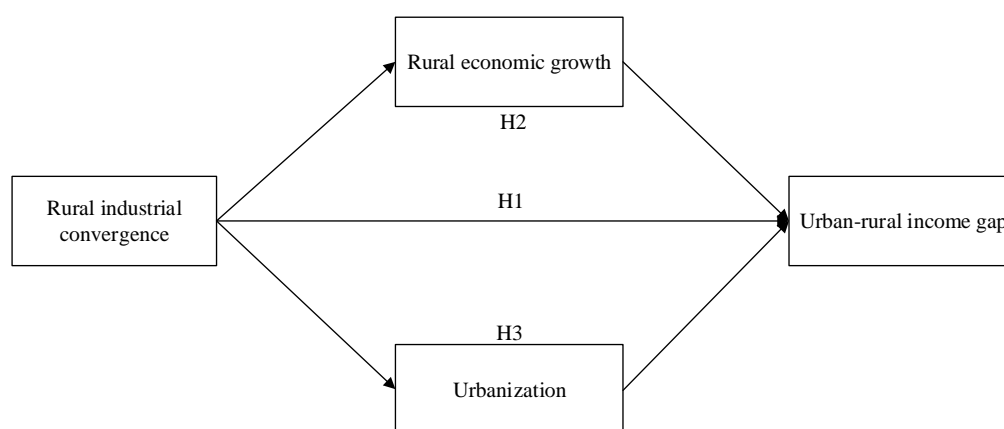


Fig 1: The mechanism of rural industrial convergence, rural economic growth, urbanization and urban-rural income gap

The rural industrial convergence indirectly affects the urban-rural income gap by promoting urbanization (as shown in Figure 1). The coordinated development of rural industrial convergence and new urbanization can narrow the urban-rural income gap effectively [32]. First, the rural industrial convergence can promote urbanization, improve the urban-rural dual structure, and narrow the urban-rural income gap. With the advancement of rural industrial convergence, the dual structure of urban and rural areas will be improved, and the implementation of policies such as the prosperity of rural industries and the equalization of public services will gradually change the push-pull relationship between urban and rural areas. The development of business formats and the return of migrant workers to start businesses will significantly reduce the urban-rural income gap in the region. Secondly, the organic combination of rural industrial convergence and urbanization can effectively promote the transformation and upgrading of agricultural structure, promote agricultural modernization, farmers' employment and farmers' income. The characteristic towns and industrial parks developed by the extension of agriculture to drive urbanization will promote the transformation and upgrading of my country's traditional agriculture. In addition, the coordinated development of rural industrial convergence and urbanization will promote the industrial agglomeration effect between regions, and radiate and drive the employment and income of farmers in the surrounding areas to narrow the urban-rural income gap. Rural industry convergence leading agricultural versatility industry space gathered in the rural areas, rural residents will share to the region's cities and industry coordinated development of all kinds of effects, and further into the regional urbanization and urban economic growth, high quality and with the rural surplus labor force flowing into urban areas step by step, can drive element reward equalization of income gap between urban and rural areas. Therefore, the following research hypotheses are proposed:

Hypothesis 3 (H3): Rural industrial convergence can narrow the urban-rural income gap by improving the level of urbanization

Rural infrastructure is used for agricultural production, which can promote the rural industrial convergence by reducing production costs, improving agricultural productivity, optimizing agricultural industrial structure and accelerating the flow of urban and rural factors, increase farmers' income, and thereby reduce the urban-rural income gap [33], specifically reflected in: (1) The construction of irrigation infrastructure can not only directly contribute to the agricultural production development, but also reduce natural disasters and maintain the stability of agricultural production. The Yangtze River Economic Belt spans a wide geographical area and has diverse meteorological conditions in various regions. The infrastructure unbalanced development, such as irrigation and water conservancy, which is closely related to agricultural production, has a more obvious impact on peasants' income growth. (2) The impact of transportation infrastructure on urban-rural income gap. On the one hand, transportation infrastructure promotes the flow of surplus rural labor to non-agricultural sectors and creates conditions for rural labor to obtain wage income for migrant workers in cities [34]. On the other hand, the rapid flow of factors of production driven by transportation infrastructure can also observably improve the ability of rural residents to obtain income, thus narrowing the urban-rural income gap. (3) The development of energy infrastructure can directly improve the production environment and living conditions in rural areas, improve agricultural production efficiency, and have a positive effect on increasing peasants' income [35]. (4) The construction

of rural information infrastructure can provide peasants with effective information products and services, so that farmers can timely adjust production according to market information, market risk can be reduced, market competitiveness can be further improved, and thus promote peasants to increase their income. To sum up, as shown in Figure 2, rural infrastructure is generally contribute to improving the peasants' income level in the process of rural industrial convergence, thus helping to adjust the expanding of urban-rural income gap. Thus, the research hypothesis is proposed as follows:

Hypothesis 4 (H4): Rural infrastructure has a moderating impact on rural industrial convergence to narrow the urban-rural income gap.
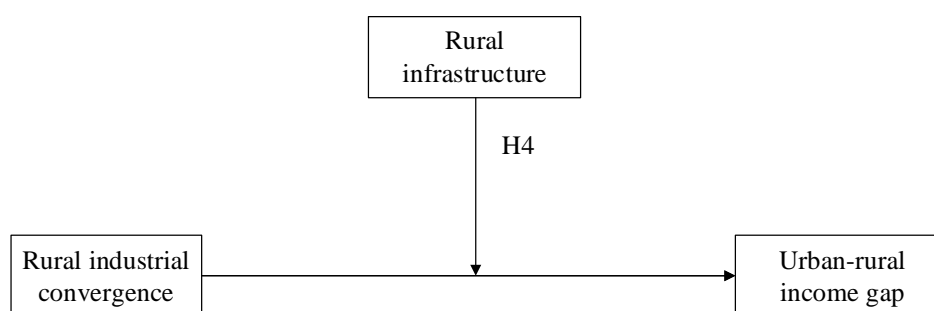


Fig 2: The mechanism of rural industrial convergence, rural infrastructure and urban-rural income gap

Regional heterogeneity analysis of the impact of rural industrial convergence on urban-rural income gap. For quite some time, the rural areas in the middle and lower reaches of the Yangtze River Economic Belt have different location conditions and resource endowments. In some regions, there are relatively rich cultivated land resources and local peasants own a large area of arable land per capita, but other resources are relatively poor. For example, the geographical conditions for the development of new agricultural forms are not enough to support their development. On the contrary, a few regions have excellent geographical conditions and are suitable for developing rural tourism and other new agricultural formats, but their cultivated land resources are less. Few regions have both high quality regional conditions and rich cultivated land resources. This leads to a fusion in rural industry practice, to different parts of the countryside with the integration of resources and reconfigure the process and results of difference, make the industry convergence in influencing the peasants' income structure and alleviate the effect of income gap between urban and rural areas form difference, finally reflected in the difference in the effect of rural industrial convergence on the urban-rural income gap, the differences in the vast rural areas are the embodiment of heterogeneous rural areas. According to the characteristics of regional heterogeneity, this article proposes the following hypotheses about the relationship between rural industrial convergence and urban-rural income gap:

Hypothesis 5 (H5): There is obvious regional heterogeneity in the narrowing effect of rural industrial convergence on urban-rural income gap

### III. RESEARCH DESIGN AND METHOD

3.1 Model and Estimation Methods

3.1.1 Impact of rural industrial convergence on urban-rural income gap

For the sake of empirically test the impact of rural industrial convergence on urban-rural income gap and regional differences, this article draws on the common practices of current academic researches on rural industrial convergence on income distribution [28,36], and based on the affecting factors of urban-rural income gap [37], build a basic econometric model. The benchmark regression model is set as follows:

$$GAP_{it} = \alpha_0 + \alpha_1 CON_{it} + u_i + \varepsilon_{it} \tag{1}$$

In Equation (1), $i$ and $t$ represent city and time respectively. $GAP_{it}$ is dependent variable, represents urban-rural income gap; $CON_{it}$ is the independent variable, representing the level of rural industrial convergence; $u_i$ is unobservable individual heterogeneity, $\varepsilon_{it}$ is random perturbation term; $\alpha_0$ is the intercept, $\alpha_1$ is the regression coefficient of $CON_{it}$.

In addition to the level of rural industrial convergence, the urban-rural income gap is also affected by a series of other factors, such as the level of regional economic development and the level of industrial structure. To this end, Equation (1) is adjusted as follows:

$$\begin{aligned} GAP_{it} = {} & \alpha_0 + \alpha_1 CON_{it} + \alpha_2 \ln GDP_{it} + \alpha_3 IND_{it} + \alpha_4 INV_{it} + \alpha_5 FIN_{it} \\ & + \alpha_6 \ln EDU_{it} + \alpha_7 OPE_{it} + u_i + \varepsilon_{it} \end{aligned} \tag{2}$$

In Equation (2), $GDP_{it}$、$IND_{it}$、$INV_{it}$、$FIN_{it}$、$EDU_{it}$ and $OPE_{it}$ respectively represent regional economic development level, industrial structure level, rural fixed asset investment level, financial support for agriculture, regional education level and regional opening level. $\alpha_2 \sim \alpha_7$ represent the vectors of the parameters to be estimated.

3.1.2 The mediating effect of rural economic growth and urbanization on urban-rural income gap

In the cause of quantitatively identify whether the integrated development of rural industries impacts the urban-rural income gap through rural economic growth and urbanization, this paper uses the mediation effect testing procedure proposed by Wen Zhonglin and Ye Baojuan (2014) [38] to introduce rural economic growth and urbanization into the model as mediating variables respectively. The mediating effect test model is constructed as follows:

$$GAP_{it} = \alpha_0 + \alpha_1 CON_{it} + \lambda Control_{it} + u_i + \varepsilon_{it} \tag{3}$$

$$RGDP_{it} orURB_{it} = \beta_0 + \beta_1 CON_{it} + \theta Control_{it} + v_i + \sigma_{it} \tag{4}$$

$$GAP_{it} = \gamma_0 + \gamma_1 CON_{it} + \gamma_2 RGDP_{it} orURB_{it} + \varphi Control_{it} + \omega_i + \tau_{it} \tag{5}$$

Where, $RGDP_{it}$ is the intermediary variable rural economic growth level; $URB_{it}$ is the urbanization level; $Control_{it}$ is the control variable, including regional economic development level, industrial structure level, rural fixed asset investment level, financial support for agriculture, regional education level and regional opening level. $\alpha$, $\beta$, $\gamma$, $\lambda$, $\theta$ and $\varphi$ are the parameters to be estimated.

Based on the regression results of models (3) ~ (5) above, it can be seen that: ①If Equation (5) of the regression coefficient $\gamma_1$ and $\gamma_2$ were significantly, The regression coefficient $\beta_1$ in Equation (4) is obvious, the regression coefficients $\gamma_1$ in Equation (5) of the regression coefficient of the absolute value of the Equation (3) a downward trend, the partial mediation effect exist in the setting certify that the above relations, that is, the impact of rural industrial convergence on urban-rural income gap partly comes from the transmission of rural economic growth or urbanization; ② If the regression coefficients $\alpha_1$ in Equation (3) is obvious, those $\beta_1$ in Equation (4) is obvious, and the regression coefficient $\gamma_1$ in Equation (5) is not significant and $\gamma_2$ is obvious, the above relationship is considered to have a complete mediating effect. That is, the impact of rural industrial convergence on the urban-rural income gap comes entirely from the transmission of rural economic growth (or urbanization). Therefore, we can accurately identify the transmission mechanism of rural industrial convergence → rural economic growth (or improvement of urbanization level) →reducing the urban-rural income gap.

### 3.1.3 Moderating effect of rural infrastructure on urban-rural income gap

Based on the above mentioned influence mechanism of rural industrial convergence on urban-rural income gap and the moderating effect of rural infrastructure, this article builds a moderating effect model to conduct relevant empirical analysis on the basis of previous research experience [39], so as to further verify the theoretical hypothesis proposed above. It should be noted that both the independent variable and the moderating variable in this paper are continuous variables, so the independent variable and the moderating variable should be centralized first to avoid the multicollinearity of the independent variable, the moderating variable and their interaction terms respectively. To sum up, relevant models are constructed as follows:

$$GAP_{it} = \beta_0 + \beta_1 CON_{it} + \lambda Control_{it} + u_i + \varepsilon_{it} \tag{6}$$

$$GAP_{it} = \beta_0 + \beta_1 CON_{it} + \beta_2 INF_{it} + \beta_3 INF_{it} * CON_{it} + \lambda Control_{it} + u_i + \varepsilon_{it} \tag{7}$$

In the above equation, $GAP_{it}$ is the explained variable urban-rural income gap; $CON_{it}$ is the level of rural industry convergence of the core explanatory variable; $INF_{it}$ is the moderating variable rural infrastructure; $Control_{it}$ is a series of control variables. $u_i$ is the fixed effect that cannot be observed, and $\varepsilon_{it}$ is the random error term.

3.1.4 Estimation method

In order to empirically test the overall affect of the rural industrial convergence level on the urban-rural income gap, this paper adopts OLS, FE and LSDV in static panel data estimation to perform regression estimation on Equation (9). The system GMM method in dynamic panel data estimation is used to perform regression estimation for Equation (9). As for the level of rural industry convergence of the core explanatory variable, the comprehensive index value is obtained by setting up a comprehensive evaluation indication system, using the entropy weight TOPSIS method. The detailed processes are as follows.

The entropy weight TOPSIS method. For $m$ evaluation objects and $n$ evaluation indicators, establish an initial decision matrix $X = (x_{ij})_{m \times n} (i = 1, 2, \cdots m; j = 1, 2, \cdots n)$. Since there are positive indicators and reverse indicators in the indicator system, the evaluation indicators are first treated with the same trend. This paper uses the reciprocal method to treat the reverse indicators with the same trend. The calculation formula is as follows:

$$\begin{cases} \text{Positive indicators: } x_{ij}^* = \dfrac{1}{x_{ij}} \ (i = 1, 2, \cdots, m; j = 1, 2, \cdots, n) \\ \text{Reverse indicators: } x_{ij}^* = x_{ij} \end{cases} \tag{8}$$

On the basis of obtaining the extreme value uniform matrix, the data matrix after the same trending is standardized to obtain the matrix $Z = (z_{ij})_{m \times n} (i = 1, 2, \cdots m; j = 1, 2, \cdots n)$, the calculation formula is as follows:

$$z_{ij} = \dfrac{x_{ij}^*}{\sqrt{\sum\limits_{i=1}^{m} x_{ij}^{*2}}} \ (i = 1, 2, \cdots, m; j = 1, 2, \cdots \cdots, n) \tag{9}$$

The information entropy value $e$ and information utility value $d$ of indicator $j$ are calculated, the formula is:

$$e_j = -k \sum\limits_{i=1}^{m} y_{ij} \ln y_{ij} \ (i = 1, 2, \cdots, m; j = 1, 2, \cdots, n) \tag{10}$$

Among them:

$$y_{ij} = \frac{z_{ij}}{\sum\limits_{i=1}^{m} z_{ij}} \ (0 \le y_{ij} \le 1) \ (i=1,2,\cdots,m; j=1,2,\cdots,n), \quad k=1/\ln m \tag{11}$$

$$d_j = 1 - e_j \ (j=1,2,\cdots,n) \tag{12}$$

Calculate the weight of evaluation indicator *j*:

$$w_j = d_j / \sum_{j=1}^{n} d_j \ (j=1,2,\cdots,n), \quad \text{Among them, } w_j \in [0,1] \ , \text{and} \sum_{j=1}^{n} w_j = 1 \tag{13}$$

Calculate the weighting matrix according to the weight of the evaluation indicator:

$$R = (r_{ij})_{m*n}, \quad \text{Among them, } r_{ij} = w_j^* z_{ij} \ ; (i=1,2,\cdots,m; j=1,2,\cdots,n) \tag{14}$$

Determine the positive ideal solution $s_j^+$ and the negative ideal solution $s_j^-$:

$$s_j^+ = \max(r_{1j}, r_{2j}, \cdots, r_{mj}), \quad s_j^- = \min(r_{1j}, r_{2j}, \cdots, r_{mj}) \tag{15}$$

Calculate the Euclidean distance between the positive ideal solution $s_j^+$ and the negative ideal solution $s_j^-$ of the evaluation object:

$$D_i^+ = \sqrt{\sum_{j=1}^{n}(s_j^+ - r_{ij})^2}, \quad D_i^- = \sqrt{\sum_{j=1}^{n}(s_j^- - r_{ij})^2} \tag{16}$$

Calculate the relative closeness $C_i$ of each evaluation object to the optimal solution:

$$C_i = D_i^- / (D_i^+ + D_i^-), \text{of which} \quad C_i \in [0,1] \ (i=1,2,\cdots,m) \tag{17}$$

The larger the $C_i$ value is, the closer the level of rural industrial convergence is to the ideal solution, and the higher the degree of rural industrial convergence in various cities; otherwise, the lower it is.

3.2 Construction of Evaluation Indicator System of Rural Industrial Convergence

It is helpful to guide the rural industrial convergence development, promote agricultural transformation and upgrading, and achieve the goal of narrowing the urban-rural income gap. Based on the principles of forward-looking guidance, scientific practicability, operability and systematization, and on account of the definition of the connotation of rural industry convergence, this article takes into consideration the characteristics of the Yangtze River Economic Belt and the availability of data. In this article, the evaluation indicator system of rural industry convergence is mainly constructed from four dimensions: agricultural internal regrouping convergence, agricultural industrial chain extension convergence, agricultural function expansion convergence, and high technology infiltration convergence of agriculture (as shown in TABLE I).

**TABLE I. Evaluation indicator system of rural industry convergence in the Yangtze River Economic Belt**

| Aspect | Indicators | Meaning | Attribute |
|---|---|---|---|
| **Agricultural interior convergence type fusion** | Convergence level of planting and animal husbandry and fisher | Gross output value of planting industry | + |
| | | Gross output value of animal husbandry and fishery | + |
| | Level of convergence of animal husbandry, fishery and forestry | Gross output value of animal husbandry and fishery | + |
| | | Gross output value of forestry | + |
| **Extended convergence of agricultural industry chain** | Per capita output value of agricultural processing industry | Annual output value of agricultural products processing enterprises above designated size/Rural population | + |
| | Gross output value of primary industry per capita | Total output value of primary industry/Rural population | + |
| | The level of agricultural service | Gross output value of agriculture, forestry, animal husbandry and fishery services/gross output value of primary industry | + |
| **Agricultural function expansion convergence** | Output of major agricultural products per labor | Agricultural production/Number of employed persons in primary industry | + |
| | Fertilizer application intensity | Fertilizer application/crop area | - |
| | Level of convergence of agriculture and tourism | Gross output value of agriculture, forestry, animal husbandry and fishery | + |
| | | Tourism revenue | + |
| **High-tech osmotic fusion** | Total power of agricultural machinery per capita | Total power of agricultural machinery/number of employed persons in primary industry | + |
| | Convergence level of agriculture and logistics industry | Gross output value of agriculture, forestry, animal husbandry and fishery | + |
| | | Total postal service | + |

3.3 Description of Variables and Data

3.3.1 Variables

(1) Dependent variable. The urban-rural income gap is an important reference indicator that reflects the sharing of economic and social development achievements between cities and rural areas, rural revitalization and the coordinated development of urban and rural areas. The urban-rural income gap is usually measured in three categories: the urban-rural income ratio, the Gini coefficient and the Theil index. This paper draws on the practices of most scholars [40,41], "urban-rural income ratio" is used to measure the urban-rural income gap($GAP$).

(2) Independent variable. The comprehensive evaluation result of rural industry convergence ($CON$) based on entropy weight TOPSIS method is the core explanatory variable. Among them, for the measurement of the integration level of secondary indicators, such as planting and animal husbandry and fishery, animal husbandry and fishery and forestry, agriculture and tourism, and agriculture and logistics, the coupling coordination degree of these secondary indicators is calculated by referring to the method of coupling coordination degree between industries by Cheng Li and Kong Fangxia (2019) [17].

(3) Mediating variables. The growth level of rural economy ($RGDP$) is represented by the actual per capita GDP of rural areas. Rural per capita GDP= rural GDP/ rural population, where rural GDP is measured by the added value of agriculture, forestry, animal husbandry and fishery, and all nominal values are converted into real values according to the GDP deflator with 2009 as the base year. Economic growth is a necessary condition for increasing residents' income. Economic growth can expand the demand for factors of production, improve production capacity, improve employment level and consumption demand capacity, and ultimately improve residents' income level and living standard [42]. Urbanization level($URB$). The level of urbanization is expressed by the urbanization rate, which is usually measured by the proportion of permanent urban residents in the total population of each region.

(4) Moderating variable. The moderating variable in this section is rural infrastructure ($INF$). On the basis of comprehensive literature [43], this article argues that closely related to agricultural production and rural economic development the infrastructure, mainly include transport infrastructure, water infrastructure, energy, infrastructure and information infrastructure four aspects, among them, transportation infrastructure is represented by the number of road miles in the region, water conservancy infrastructure land area is represented by effective irrigation area, energy infrastructure and information infrastructure land area is represented by rural electricity consumption and mobile phone users respectively. Then, the entropy method with strong objectivity of weight assignment is used to calculate the comprehensive index of rural infrastructure from four aspects ($INF$). On this basis, the interaction term $INF*CON$ of rural infrastructure and rural industry convergence is obtained. Among them, the comprehensive index of rural infrastructure is calculated by entropy method [17].

(5) Control variables. According to the existing literature [22], the control variables in this article are selected as follows: regional economic development level ( *GDP* ), and the economic development level of each region is represented by the regional per capita GDP. Industrial structure level ( *IND* ), the ratio of the output value of the secondary and tertiary industries to the output value of the primary industry is used to reflect the industrial structure of a region. The level of rural fixed asset investment ( *INV* ), this article adopts the ratio of fixed asset investment in the primary industry to regional GDP to measure the level of rural fixed asset investment in each city. Financial support for agriculture ( *FIN* ), it is measured by the ratio of fiscal agricultural expenditure to regional GDP. Regional education level ( *EDU* ),this article uses the number of students in ordinary primary and secondary schools per ten thousand people to measure the level of education in the region. Regional opening-up level ( *OPE* ), the ratio of total import and export to regional GDP is used to measure the level of regional opening to the outside world.

### 3.3.2 Data sources

The data of the above indicators come from *EPS database*, the *statistical yearbooks of various cities* over the years and the prefectural and municipal data released by the websites of various municipal statistical bureaus. Considering the availability of data, this article selects panel data of prefecture-level cities in the Yangtze River Economic Belt from 2009 to 2019. In the empirical study, all data related to value forms in the paper are adjusted to the constant value of the base period in 2009 by the corresponding GDP index. For the sake of dispel the dimensional influence, the natural logarithm of rural economic development level, rural fixed asset investment, regional education level and other data is taken.

## IV. RESULT AND DISCUSSION

### 4.1 Descriptive Statistics

As shown in TABLE II, the mean value of the rural industry convergence level is 0.301, and the maximum value and minimum value are 0.580 and 0.099, respectively, indicating that there is considerable regional heterogeneity in the rural industry convergence level. Figure 3 shows that from 2009 to 2019, the level of rural industry convergence showed a steady rise, and the growth trend of rural industry convergence in the lower, middle and upper reaches was highly consistent. During the sample period, in the same period of rural industry convergence, the lower reaches is the highest, which is about 1.17 times of the upper reaches. The middle reaches of the Yangtze River are the second, which is about 1.07 times of the upper reaches. The lowest is in the upper reaches.

**TABLE II. Descriptive statistics of main variables**

| Variables | Abbreviations | Mean | St. dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| Urban-rural income gap | GAP | 2.510 | 0.599 | 1.644 | 5.923 |
| Level of convergence of rural industries | CON | 0.301 | 0.075 | 0.099 | 0.580 |
| Rural economic growth | RGDP | 9354.617 | 4560.911 | 1439.117 | 39646.43 |

| level | | | | | |
|---|---|---|---|---|---|
| Level of urbanization | URB | 0.515 | 0.132 | 0.190 | 0.896 |
| Level of rural infrastructure | INF | 0.156 | 0.101 | 0.006 | 0.708 |
| Regional economic development level | GDP | 45620.970 | 30368.710 | 6279.000 | 180044.000 |
| Level of industrial structure | IND | 13.003 | 22.885 | 1.870 | 366.302 |
| Rural fixed asset investment level | INV | 0.029 | 0.030 | 0.001 | 0.361 |
| Fiscal support for agriculture | FIN | 0.028 | 0.0253 | 0.003 | 0.331 |
| Regional education level | EDU | 1243.277 | 337.795 | 460.000 | 4443.000 |
| Level of regional opening-up | OPE | 0.158 | 0.243 | 0.001 | 2.010 |

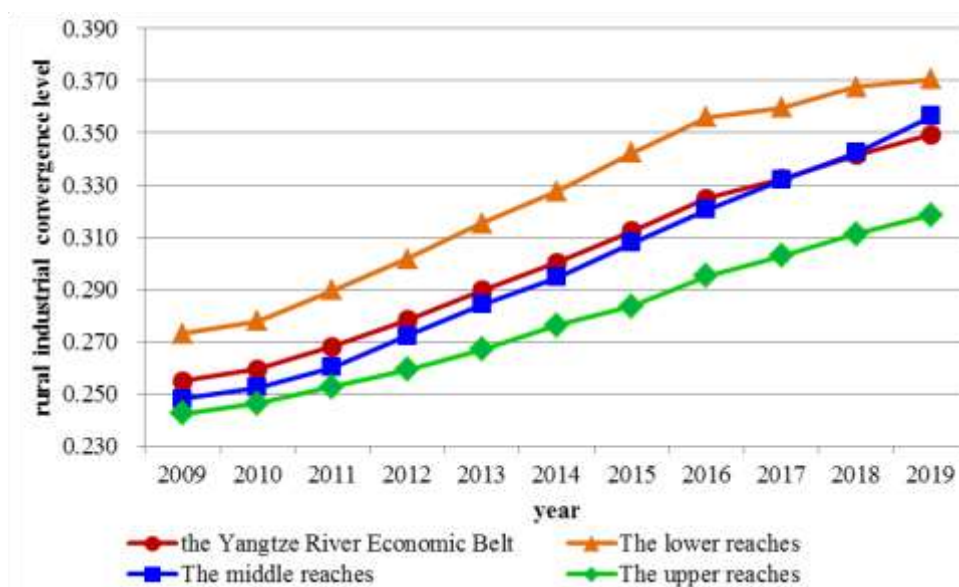Data source: According to stata software calculation results. The same below.



Fig 3: Changes in the level of rural industrial convergence in the Yangtze River Economic Belt and its upper, middle and lower reaches from 2009 to 2019

4.2 Baseline Regression Analysis

On the basis of the mixed OLS regression results in column (1) in TABLE III, it can be seen that the rural industrial convergence has a passive influence on the urban-rural income gap at the 1% significance level, which is in line with expectations. Column (2) further estimates the fixed effect (FE), the results still show that the rural industrial convergence has a passive effect on the urban-rural income gap at a significant level of 1%, and the Hausman test is used to test the model setting. Among them, the Hausman test rejects the null hypothesis at the 1% significance level, indicating that FE is better than OLS. Judging

from the marginal effect results, each unit of increase in the level of rural industrial convergence reduces the urban-rural income gap by about 0.430 units on average. Thus, the research hypothesis H1 has been verified.

4.3 Robustness Test

Based on the robustness test results of LSDV regression in Column (3) of TABLE III, it can be found that the estimated coefficient size and significance of each variable are very similar to FE regression results, and most of the dummy variables of prefecty-level cities are significant, that is, individual effect should be allowed. Of course, the existence form of individual effect may also be random effect, so the robustness is further tested by random effect FGLS estimation in Column (4), and the regression results also verify that rural industrial convergence has a significant narrowing effect on urban-rural income gap.

**TABLE III. Estimation of the impact of rural industrial convergence on the urban-rural income gap**

| Variables | (1) OLS | (2) FE | (3) LSDV | (4) RE-FGLS | (5) SYS-GMM |
|---|---|---|---|---|---|
| CON | -0.744*** | -0.430*** | -0.393** | -0.262* | -0.265** |
| | (-3.89) | (-2.61) | (-2.32) | (-1.70) | (-2.09) |
| LNGDP | -0.419*** | -0.653*** | -0.616*** | -0.513*** | -0.056* |
| | (-15.15) | (-11.83) | (-29.39) | (-8.74) | (-1.75) |
| IND | 0.006*** | 0.002*** | 0.003*** | 0.001* | 0.001*** |
| | (10.65) | (3.88) | (3.89) | (1.67) | (3.59) |
| INV | -0.751* | -0.298 | -0.601** | -0.316 | 0.008 |
| | (-1.90) | (-1.22) | (-2.45) | (-1.52) | (0.03) |
| FIN | 3.560*** | -8.524*** | -8.797** | -4.205*** | 0.559 |
| | (6.57) | (-15.73) | (-16.52) | (-8.21) | (1.07) |
| LNEDU | 0.425*** | -0.030 | 0.019*** | -0.141*** | 0.098** |
| | (8.03) | (-0.56) | (0.36) | (-2.98) | (2.54) |
| OPE | -0.046*** | -0.022* | -0.019 | 0.006 | -0.008 |
| | (-4.77) | (-1.92) | (-1.63) | (0.57) | (-1.20) |
| L.GAP | — | — | — | — | 0.743*** |
| | | | | | (23.27) |
| Constant | 4.601*** | 9.942*** | 9.188*** | 8.803*** | 0.650 |
| | (8.55) | (14.14) | (20.54) | (12.15) | (1.44) |
| $R^2$ | 0.560*** | 0.9266*** | 0.9128 | 0.937*** | — |
| AR(1) p values | — | — | — | — | 0.000 |
| AR(2) p values | — | — | — | — | 0.319 |
| Hansen Statistics | — | — | — | — | 0.772 |
| Observations | 1319 | 1319 | 1319 | 1319 | 1198 |

Note. *, **, and *** indicate significance at the levels of 10%, 5%, and 1% respectively; values within parentheses represent the t statistic.

4.4 Endogeneity Test

Due to many factors affecting the urban-rural income gap, in order to reduce the estimation error that may be caused by omitted variables, and considering the urban-rural income gap may also be affected by previous factors, this article adds the explained variable to the urban-rural income gap on account of Equation (2). The first-order lag term is used as an instrumental variable, and the dynamic GMM estimation method is used to test the endogeneity. The regression results of column (5) show that the *p* value of the AR (2) test is greater than 0.1, indicating that the model has no autocorrelation problem and the endogeneity problem has been overcome; at the same time, the *p* value of the Hansen test is very close to 1, it can be considered that all instrumental variables are exogenous., indicating that the model has no serious misdesignation problem, and the regression results are relatively reliable; in addition, the influence coefficient of *L.GAP* is remarkable positive, indicating that the urban-rural income gap is a long-term continuous process, and the current urban-rural income gap will be affected by the change of the previous urban-rural income gap.

4.5 The Mediating Effect of Rural Economic Growth and Urbanization

First of all, in the view of the influence mechanism of the mediating effect of rural economic growth, the effect of rural economic growth on rural industrial convergence to retard the urban-rural income gap is partly the mediating effect. According to the results in Column (2) of TABLE IV, the estimated coefficient of *CON* to *RGDP* is remarkable positive at the level of 1%. This shows that the rural industry convergence level improvement can improve the level of rural economic development. It can be seen from the results in Column (3) that the estimated coefficient of *RGDP* is significant at the 1% level, which proves that the indirect effect of rural economic growth is obvious in the influence process of rural industrial convergence level on rural economic growth. The estimated coefficient of *CON* is significant at the 5% level, which further proves that rural economic growth does have a mediating effect, which verifies hypothesis of H3. Finally, the product of the estimated coefficient of *CON* in column (1) and the estimated coefficient of *RGDP* in column (2) is the same negative impact as the estimated coefficient of *CON* in column (3). According to the mediation effect testing procedure, the mediation effect of rural economic growth is a partial mediation effect.

**TABLE IV. Analysis of the influence mechanism of rural industrial convergence on the urban-rural income gap**

| Variables | | Rural economic growth intermediary effect | | Mediation effect of urbanization | | The moderating effect of rural infrastructure |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| | **GAP** | **LNRGDP** | **GAP** | **URB** | **GAP** | **GAP** |
| CON | -0.430*** | 0.804 | -0.395** | 0.045** | -0.380** | -0.805*** |
| | (-2.61) | (7.19) | (-2.42) | (2.27) | (-2.25) | (-5.49) |
| LNRGDP | — | — | -0.275*** | — | — | — |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | (-5.64) | | |
| URB | — | — | — | — | -0.594** (-2.39) | — |
| INF | — | — | — | — | — | -0.607*** (-3.97) |
| CON*INF | — | — | — | — | — | 6.432*** (7.32) |
| LNGDP | -0.653*** (-11.83) | 0.314*** (12.26) | -0.471*** (-7.44) | 0.125*** (50.45) | -0.539*** (-14.01) | -0.470*** (-16.72) |
| IND | 0.002*** (3.88) | -0.003*** (-6.23) | 0.002*** (3.15) | 0.00008*** (1.06) | 0.002*** (3.75) | 0.006*** (10.83) |
| INV | -0.298 (-1.22) | 0.555* (1.95) | -0.241 (-0.99) | 0.057* (1.91) | -0.548** (-2.23) | -1.061*** (-2.73) |
| FIN | -8.524*** (-15.73) | -2.010*** (-5.01) | -8.778*** (-16.35) | -0.032*** (-0.52) | -8.712*** (-16.36) | -8.208*** (-14.93) |
| LNEDU | -0.030 (-0.56) | -0.259*** (-6.83) | -0.022 (-0.43) | 0.017*** (2.73) | 0.036 (0.66) | 0.396 (7.63) |
| OPE | -0.022* (-1.92) | -0.008 (-1.42) | -0.022** (-1.95) | 0.003 (2.50) | -0.021* (-1.78) | -0.470*** (-4.56) |
| Constant | 10.138*** (14.63) | 1.941*** (4.77) | 10.673*** (15.45) | -0.966*** (-17.47) | 8.772*** (16.58) | 10.834*** (14.44) |
| Observations | 1319 | 1319 | 1319 | 1319 | 1319 | 1215 |
| $R^2$ | 0.927*** | 0.960*** | 0.929*** | 0.821*** | 0.922*** | 0.928*** |

Note. *, **, and *** indicate significance at the levels of 10%, 5%, and 1% respectively; values within parentheses represent the t statistic.

Then, from the perspective of the influence mechanism of the mediating effect of urbanization, the effect of urbanization on the rural industrial convergence to narrow the urban-rural income gap is a partial mediating effect. Columns (4) and (5) in TABLE IVpresent the estimation results for model (4) and model (5). The coefficient $\beta_1$ of *CON* in column (4) and the coefficient $\gamma_2$ of *URB* in column (5) are significant at the significance level of 1% and 5% respectively, and the absolute value of the regression coefficient $\gamma_1$ of *CON* in column (5) shows a downward trend compared with the absolute value of the regression coefficient $\alpha_1$ of *CON* in column (1). The regression coefficient $\gamma_1$ absolute value shows a downward trend compared with the absolute value of the estimated coefficient CON in column (1), which proves that the effect of urbanization on rural industrial convergence and narrowing the urban-rural income gap is a partial mediating effect. Hypothesis H5 has been verified. Further analysis shows that, on the one hand, the improvement of urbanization level has brought about the increase of urban population and the improvement of residents' consumption demand, and the increase of demand for the quality and quantity of agricultural products, which has led to the increase of rural labor employment and farmers' agricultural production income. On the other hand, urbanization has enhanced the spatial capacity of cities and towns to absorb and accommodate surplus rural labor. At the same time, it is conducive to stimulating and expanding the spillover effect of the transfer of non-agricultural technologies to rural areas, and has promoted the progress of agricultural production technology and agricultural productivity improvement,

which has a favorable impact on increasing farmers' income and narrowing the the urban-rural income gap. Compared with the mediating effect of rural economic growth and urbanization, the mediating effect value of rural economic growth is: $0.804 \times (-0.275) = -0.221$, and the mediating effect value of urbanization is: $0.045 \times (-0.594) = -0.066$, from the absolute value comparison, $0.221 > 0.066$, that is, the mediating effect of rural economic growth is greater than that of urbanization.

4.6 Moderating Effect of Rural Infrastructure

From the point of view the mechanism of the rural infrastructure moderating effect, rural infrastructure plays a moderating role in reducing the urban-rural income gap through rural industrial convergence. As can be seen from the regression results of Column (6) in TABLE IV, when *CON* promotes the narrowing of urban-rural income gap, the interaction term (*CON\*INF*) of rural infrastructure and rural industrial convergence has a positive moderating effect. Thus, hypothesis H7 is verified. Further analysis shows that the level of rural infrastructure in this article is the comprehensive measurement result of transportation infrastructure, energy infrastructure, irrigation infrastructure and information infrastructure, and all aspects of rural infrastructure play a direct or indirect impact on the urban-rural income gap respectively. From the perspective of theoretical analysis, transportation infrastructure can directly increase the income of rural areas by reducing production and transaction costs and improving non-agricultural employment opportunities, or indirectly narrow the urban-rural income gap by improving the education and health status of rural areas, improving employment opportunities, factor production efficiency and stimulating economic growth. Energy infrastructure and irrigation infrastructure can directly improve the production environment and living conditions in rural areas and improve agricultural production efficiency. Therefore, they will play a positive role in promoting the growth of farmers' income. Perfect rural information infrastructure will help to make up for the disadvantages of lagging information in agricultural and rural economic development, actively develop new forms of rural digital economy, expand the space for increasing farmers' incomes and narrow the urban-rural income gap.

From the comprehensive view of the control variables of the three influencing mechanisms, except that industrial structure *( IND )* has a slight positive impact on the widening of the urban-rural income gap to some extent, most of the influencing factors are helpful to narrow the urban-rural income gap. Specifically, regional economic development level (*LNGDP*) can reduce the urban-rural income gap, and regional economic development can create a good development environment and economic foundation for rural industrial convergence. The regression coefficient of rural fixed asset investment *(INV)* on the urban-rural income gap is significantly negative, indicating that the increase in rural fixed asset investment can provide a good material foundation for rural industrial convergence, thereby promoting farmers' income and narrowing the urban-rural income gap. Financial support for agriculture *(FIN)* is negatively correlated with the urban-rural income gap, indicating that the greater the financial support for agriculture, the more beneficial it is to relieve the financial pressure for agricultural production construction, and further promote the farmers' income and narrow the urban-rural income gap. Education level *(LNEDU)* in the mediation effect of urbanization and rural infrastructure adjustment effect on the income gap between urban and rural areas in the influence coefficient is positive, the reason may be that, in the improvement of

education level to bring the ascension of the corresponding labor quality, and the urbanization of labor "siphon effect" and make the loss of high-quality labor force, which has a negative impact on the reduction of the urban-rural income gap. Region opening level *(OPE)* to a certain extent, reflect the region's various aspects including agricultural economic and trade exchanges with foreign countries, such as agricultural trade integration development to create a good international market, promote agricultural and rural economic development to narrow the urban-rural income gap.

4.7 Regional Heterogeneity Research

On the basis of model (1) in the previous section, the Yangtze River Economic Belt is divided into three major economic zones, the upper reaches, the middle reaches and the lower reaches, for sub-regional investigation. It can be found from TABLE V that the integrated development of rural industries in the lower reaches, the middle reaches and the upper reaches of the Yangtze River economic belt has an impact on narrowing the urban-rural income gap, but the impact degrees are different, which verifies hypothesis H5. Specific performance is as follows, according to LSDV regression results with good goodness of fit ($R^2$), if the rural industry convergence level increases by 1% in the lower reaches, the urban-rural income gap will decrease by 0.488%. If the rural industry convergence level increases by 1% in the middle reaches, the urban-rural income gap will decrease by 1.100%. If the of rural industry convergence level increases by 1% in the upper reaches, the urban-rural income gap was narrowed by 2.068%. It can be seen that the upper reaches of rural industry fusion coefficient absolute value is highest, the middle reaches is the second, and the lower reaches is the lowest, suggesting that the upstream area of rural industrial convergence for narrowing the urban-rural income gap of contribution is greater than the middle and lower reaches, the reason may be that for the middle and lower reaches, rural industrial convergence development earlier, rural industry has developed to a higher level. The impact of rural industrial convergence on narrowing urban-rural income gap is in the stage of marginal utility decline. For the upper reaches, the marginal effect of rural industry convergence on narrowing the urban-rural income gap is in the stage of rising marginal utility, with the gradual deepening and penetration of rural industry convergence development in rural, the marginal utility of reducing the urban-rural income gap is still increasing.

**TABLE V. Test results of regional heterogeneity**

|  | The lower reaches | | | The middle reaches | | | The upper reaches | | |
|---|---|---|---|---|---|---|---|---|---|
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Variables | OLS | FE | LSDV | OLS | FE | LSDV | OLS | FE | LSDV |
| CON | -0.519*** (-2.64) | -0.427** (-2.30) | -0.488*** (-2.80) | -0.831*** (-2.69) | -0.781** (-2.51) | -1.100** (-3.12) | -0.844** (-2.03) | -2.178* (-1.66) | -2.068** (-2.48) |
| LNGDP | -0.465*** (-12.96) | -0.377*** (-9.04) | -0.307*** (-4.62) | -0.709*** (-15.36) | -0.665*** (-8.50) | -0.637*** (-8.45) | -0.610*** (-9.73) | -0.855*** (-21.57) | -0.691*** (-3.70) |
| IND | 0.003*** | 0.001 (1.50) | 0.001** (2.05) | 0.037*** | 0.036** | 0.032** | 0.035** (7.15) | 0.027*** (3.99) | 0.028** (2.95) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (6.92) | | | (8.96) | (7.56) | (9.39) | | | |
| INV | -0.276 (-0.33) | -1.968*** (-2.96) | -0.688 (-1.06) | -2.075*** (-3.23) | -1.966*** (-2.95) | -1.893*** (-3.85) | 0.886 (1.49) | 0.377 (1.10) | 0.353 (1.05) |
| FIN | -6.967*** (-5.61) | -11.949*** (-6.83) | -13.426*** (-7.27) | 3.790*** (2.92) | 4.944** (2.73) | 4.801*** (3.58) | 3.353*** (4.71) | -8.156*** (-12.27) | -7.688*** (-3.77) |
| LNEDU | -0.014*** (-0.22) | 0.012 (0.15) | 0.024 (0.29) | 0.138* (1.79) | 0.121 (1.54) | 0.104* (1.84) | 0.780*** (7.65) | -0.329** (-2.20) | -0.551*** (-3.89) |
| OPE | -0.031** (-2.14) | -0.079** (-2.32) | -0.132*** (-3.86) | -0.054*** (-3.20) | -0.050*** (-2.85) | -0.050*** (-7.13) | -0.032** (-1.99) | -0.016 (-1.00) | -0.019 (-1.62) |
| Constant | 8.120*** (11.51) | 7.714*** (10.03) | 8.115*** (8.24) | 9.264*** (11.74) | 8.865*** (8.28) | 8.761*** (7.53) | 3.738*** (3.32) | 15.162*** (11.52) | 15.093** (7.30) |
| Observations | 451 | 451 | 451 | 439 | 439 | 439 | 429 | 429 | 429 |
| $R^2$ | 0.612*** | 0.594*** | 0.894*** | 0.542*** | 0.552*** | 0.567*** | 0.559*** | 0.923*** | 0.930*** |

Note. *, **, and *** indicate significance at the levels of 10%, 5%, and 1% respectively; values within parentheses represent the t statistic.

## V. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This article focuses on the impact of rural industrial convergence in the Yangtze River Economic Belt on the urban-rural income gap and its mechanism, and draws the following conclusions through theoretical analysis and empirical research:

(1) The convergence of rural industries has a prominent narrowing effect on the urban-rural income gap. With the improvement of the development level of rural industry convergence, the urban-rural income gap is gradually narrowing, rural industry convergence and urban-rural income gap shows a passive correlation, that is, rural industry convergence has an important impact on reducing the urban-rural income gap. At the same time, through the sub-regional regression comparison, it is found that there are obvious regional heterogeneity in the effect of rural industrial convergence on reducing the urban-rural income gap, and the impact of rural industrial convergence on narrowing the urban-rural income gap shows the distribution characteristics of the upper reaches > the middle reaches > the lower reaches.

(2) Rural economic development and urbanization level have a mediating effect on rural industrial convergence to narrow the urban-rural income gap. Rural economic growth and urbanization are important ways for rural industrial convergence to influence the urban-rural income gap. The regression results indicate that rural economic growth and urbanization play a partial intermediary impact on rural industrial

convergence to narrow the urban-rural income gap.

(3) The level of rural infrastructure has a moderating effect on rural industrial convergence to narrow the urban-rural income gap. When rural industrial convergence promotes the narrowing of urban-rural income gap, rural infrastructure has a positive moderating effect, that is, rural infrastructure will increase the narrowing effect of rural industrial convergence on urban-rural income gap. Further analysis indicates that the rural infrastructure level in this paper is the comprehensive measurement result of transportation infrastructure, energy infrastructure, irrigation infrastructure and information infrastructure, and all aspects of infrastructure play a direct or indirect impact on reducing the urban-rural income gap respectively. Further improvement of rural infrastructure will help provide physical support for agricultural production, improve agricultural production efficiency, reduce farmers' production and living costs, actively develop new forms of business, expand farmers' income increase space, and narrow the urban-rural income gap.

## 5.2 Recommendations

1. Improve the policy system for rural industrial convergence to provide institutional guarantee for narrowing the urban-rural income gap. To promote the rural industrial convergence, the government needs to play the role of active guidance, planning guidance and policy guarantee. The government's main function is to create good institutional and environmental conditions and provide institutional support and policy guarantee for the integrated development of rural industries through planning guidance, land system reform, fiscal and taxation, finance and insurance, science and technology policies, talent support, market regulation, environmental protection and other policies and measures. The rural industrial convergence requires multiple departments and institutions to do a good job in macro planning and guidance, overall planning and coordination, and provide a good institutional guarantee for its development. For the sake of better improve the rural industrial convergence, it is necessary to further optimize the business environment, establish an integrated market system between urban and rural areas, allow the free flow of production factors between urban and rural areas, provide a good market environment to narrow the urban-rural income gap.

2. Accelerate urbanization and rural infrastructure construction to maximize the income effect of rural industrial convergence. According to the actual development of each region, while promoting the integrated development of rural industries, we should accelerate the promotion of rural economic growth and the construction of new urbanization, and give full play to the intermediary effect of rural economic growth and urbanization on the impact of the integrated development of rural industries on the urban-rural income gap. On the one hand, the region should focus on building the modern industrial system with secondary and tertiary industries have merged, efforts to boost rural industries, strengthen the rural economic development of the new kinetic energy, promote the continuous and rapid growth of the rural economy, trying to close the gap between urban and rural economic development. On the other hand, we will continue to promote a new type of inclusive urbanization. Promote the organic combination of rural industrial convergence and new urbanization, and attract rural secondary and tertiary industries to agglomerate in county towns, key towns and industrial parks, promote the industry equalization and

rationalization development between rural and urban areas, in the meantime, improve the city-industry convergence absorbing rural surplus labor force employment, promote the development of the urban and rural convergence, gradually narrow the gap between the urban and rural residents income.

3. Improve infrastructure construction in rural areas and increase the hardware support for rural industrial convergence. Strengthen the rural transportation construction, water conservancy, energy, communication and other infrastructure, lay the foundation for the improvement of agricultural production efficiency and agricultural modernization, provide hardware support for promoting the circulation and integration of resource elements between urban and rural areas, focus on residents' lives, and improve rural community service functions, rationally arrange the implementation of culture and entertainment in rural areas, and create a living environment suitable for residential and industrial development. In the meantime, for strengthening rural infrastructure construction, attention should be paid to formulating differentiated policies according to their own conditions to provide hardware support for the rural industrial convergence. Specifically, the lower reaches can take advantage of the information infrastructure to strengthen the rural e-commerce construction and distribution networks, increase the e-commerce sales of agricultural products, and increase farmers' income. The upper reaches, especially the mountainous areas of Yunnan and Guizhou provinces, should continue to make up for the shortcomings of transportation and network communication facilities, and create conditions for the investment and market development of agricultural enterprises.

4. Develop the rural industrial convergence model according to local conditions to maximize the effect of increasing farmers' income and narrow the urban-rural income gap. In order to improve the convergence level of agriculture interior, the construction of marine pasture can be strengthened in the lower reaches of the Yangtze River, especially in the prefecture-level cities in the coastal areas of Shanghai, Jiangsu and Zhejiang. As for the natural advantages of higher forest coverage in the upper reaches of the Yangtze River Economic Belt, we can focus on actively developing the under-forest economy and promoting agro-forestry complex management. By extending the industrial chain to improve the agricultural value chain, especially in the upstream areas, agricultural development is at the disadvantage that the sales of primary agricultural products make agricultural production at the bottom of the value chain. It can strengthen the connection between the production of high-quality agricultural products and the agricultural product processing industry, and increase the agricultural products added value. For actively expanding the multiple functions of agriculture, Yunnan and other ethnic minority areas in the upper reaches of the country can excavate characteristic tourism villages such as natural ecological villages, folk customs villages, and orderly develop new rural tourism and leisure products. We will encourage areas where conditions permit, especially the lower reaches of the Yangtze River, to develop smart rural tourism and improve online marketing capabilities, to ensure that the market for agricultural products meets the market for rural consumption and tourism. The penetration of high technology into agriculture is an significant driving force for the rural industrial convergence. For the agricultural areas in the middle and lower reaches of the Yangtze River in the vast plains, the level of agricultural mechanization can be further improved to improve agricultural production efficiency. The penetration of technology, fresh-keeping storage and transportation technology into agriculture has found a broad sales market for agricultural

products. The penetration of high technology into agriculture provides technical support for increasing farmers' income and narrowing the urban-rural income gap.

## ACKNOWLEDGEMENTS

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