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Granger Causality Test of Urban-rural Income Gap and Employment of Rural Labor Forces——A Case Study of Shouguang City

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Abstract Taking Shouguang City in Shandong Province as an example, this article researches the mutual relationship between urban-rural income and employment of rural labor forces, and conducting cointegration test and Granger causality test on the variable sequences using statistical data. The results show that the average annual income of rural labor forces influences the income per capita of rural residents, and there is a Granger causality relationship between the income per capita of rural residents and urban employees' average wage. Engaging in production concerning agriculture, forestry, animal husbandry and fishery makes the total income per capita in rural areas of Shouguang City higher than the average wage of urban residents in Shouguang City, even in Weifang City. The comparative advantage in terms of income causes the city to loose attraction to rural residents in Shouguang City. The comparative advantage drives more rural labor forces in Shouguang City to engage in primary industry, thereby greatly reducing the pressure of employment and transfer of rural labor forces. Finally important following measures are put forward to promote employment and on-the-spot transfer of rural labor forces: vigorously propel agricultural industrialization; increase rural residents' income; improve the living conditions for rural residents.

Key words Urban-rural income gap, Rural labor forces, Granger causality test, Shouguang City

The transfer of rural surplus labor forces is the stage that developed countries or regions inevitably experience in the process of industrialization. China is a developing agricultural country, and there are significant differences in the natural, geographical, resource conditions and even industrial structure in all regions of China, therefore, tailoring measures that suit local circumstances so as to choose the path and model of transferring rural surplus labor forces is of practical significance. Shouguang City in Shandong Province is the famous production and circulation base of vegetables in China. In 2009, the structure of the primary industry, secondary industry and tertiary industry changed from 55:30:15 three decades ago to 15:49:36. Although the proportion of agriculture declines, the output value of the primary industry increases from 2.34 billion yuan in 1996 to 5.278 billion yuan in 2009, and the net income per capita of farmers increases at about average annual growth rate of 16%, exceeding the growth rate of the average wage of employees (11.8%) during this period. Taking Shouguang City as an example, I inquire into the relationship between urban-rural residents' income gap and employment of rural labor forces, draw research conclusions through conducting quantitative analysis of relevant time series data concerning Shouguang City, and finally put forward related proposals.

1 Research overview

The practice and research of transfer of rural labor forces overseas start early, with wide field and diverse perspectives of study, forming systematic theoretical system. Given that this

study focuses on the analysis of urban-rural residents' income gap and employment of rural labor forces, I only straighten out the relevant literatures concerning urban-rural comparative advantage.

In early 17th century, William Petty advanced the viewpoint of comparative advantage stemming from income promoting rural labor forces to flow into non-agricultural sectors. This view was accepted by Hicks, etc., and later the Petty Clark theorem was produced. In the mid-1950s, the same view was reflected in the dual theory model of economic development constructed by Lewis, and this model held that whether the labor forces transfer from rural areas to urban areas solely hinges on differences in urban-rural income, but it only emphasized the expansion of modern industrial sector, and did not attach importance to the development of traditional agricultural sector^[1]. Todaro model assumed that the motive of agricultural workers moving into the city is mainly determined by the expected urban-rural income gap, and it well explained the decision-making mechanism of transfer of rural labor forces in developing countries in the case of urban unemployment. The model held that it should pay attention to the development of agriculture and rural areas, strive to narrow the income gap between urban and rural areas, and ease the flow of population from rural areas to urban areas^[2].

The researches on transfer of rural surplus labor forces began in the mid-1980s, lagging behind the transfer practice of rural surplus labor forces. The research on transfer ways, model, and experience of rural labor forces overseas holds that in the process of transfer of rural surplus labor forces after World War II, the western developed countries achieve the common development of urbanization, industrialization and agriculture^[3-5]. Some studies have conducted analysis and evalua-

tion of foreign theoretical research model, and explained the corresponding policy implications^[6-8]. Guan Hailing *etc.* hold that there is clear linear correlation between the transfer of rural labor forces and farmers' income, and we should vigorously implement the construction of rural urbanization, promote the transfer of rural labor forces^[9]. Xia Liyan *etc.* hold that only by the transfer of rural labor forces arising from employment conversion do we fail to reduce urban-rural income gap, thus we should adopt various measures to narrow the income gap between urban and rural areas^[10].

The expected urban-rural income gap is considered as the major or sole motive of agricultural workers moving into the city, but the difference between dual structure model of Lewis and F-R model as well as Todaro model is that the latter two models emphasize the development of rural areas and agriculture, more in line with the current reality of China. The common ground lies in the research on incentive or motive of transfer of rural labor forces into cities, but it does not take into account other possible ways to transfer rural labor forces such as transfer into non-urban areas and non-agricultural industries, and strengthen employment in the field of agriculture. The domestic literatures pay attention to the development of agriculture, and hold that narrowing the income gap between urban and rural areas can help reduce the pressure of transferring rural surplus labor forces into cities, which is consistent with the view held by this study. But in terms of urban-rural income gap, the perspective of domestic researches is inconsistent with this research, and the study conclusions are also different from the expected conclusions of this research.

2 Granger causality test of urban-rural income gap and employment of rural labor forces in Shouguang City

2.1 Indicator selection and data source As the reference variables of decision-making in employment of rural labor forces, the average wage of employees and total annual income per capita of rural labor forces have better comparative value. Considering availability of data, rural residents' total annual income per capita and the average wage of employees are used as the comparative variables of interests. There are different indicators for measuring the transfer of rural surplus labor forces, and this research uses the quantity of labor forces directly engaging in agriculture, forestry, animal husbandry and fishery to indirectly reflect the transfer, more in line with the requirements of researching the appeal of agricultural industry. Thus the following indicators are selected:

X_1 = Total income per capita of rural residents in Shouguang City; X_2 = The labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery; X_3 = The net income per capita of rural residents in Shouguang City; X_4 = The average wage of employees in Shouguang City; X_5 = The average wage of employees in Weifang City.

To ensure comparability of data, all data are from *Weifang City Statistical Yearbook* and *Shouguang City Memorabilia* in the period 1997 – 1999, 2003 – 2010.

2.2 Research method The data collected constitute time series, therefore I mainly use time series analysis method to study the cointegration relationship between variables, establish the related regression equation, and conduct Granger causality analysis of the relevant variables.

2.3 Result and analysis

2.3.1 Stationarity test of sequence. Dynamic time series analysis is based on stationary sequence. Given that the data may be non-stationary time series data, I first conduct test on stationarity of time series. Then I conduct ADF test on stationarity of related time series of data concerning the income of residents and labor forces in Shouguang City. The result can be seen in Table 1.

Table 1 Stationarity test results of time sequence of indicator data selected

Variable	ADF test statistic t	1% critical value	5% critical value	10% critical value
X_1	-4.406 677	-4.886 426	-3.828 975	-3.362 984
X_2	-4.818 845	-4.886 426	-3.828 975	-3.362 984
$\Delta \ln X_3$	-2.820 696	-4.121 990	-3.144 920	-2.713 751
$\Delta \ln X_4$	-5.830 084	-4.992 279	-3.876 302	-3.388 330
$\Delta \ln X_5$	-7.649 786	-4.992 279	-3.875 302	-3.388 330

Table 1 shows that the ADF test result of time sequence of the total income per capita of rural residents (X_1) in Shouguang City is at 5% and 10% significance level and t -value is less than the corresponding critical value, so it rejects the null hypothesis. The original sequence of the total income per capita of rural residents (X_1) in Shouguang City is stationary sequence.

The time sequence of the labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery (X_2) is at 5% and 10% significance level, and t -test value is less than the critical value, so it rejects the null hypothesis. The original sequence of labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery is stationary time sequence.

In three cases (Having intercept and time trend terms, only having intercept term, and no intercept term and time trend term), the sequence is non-stationary time series. I take the logarithm of the sequence to eliminate heteroscedasticity, and conduct ADF test of the first-order difference sequence. The results show that ADF test value of the first-order difference sequence containing constant term is -2.820 696, rejecting the null hypothesis at 10% significance level. The sequence of rural residents' income per capita is integrated of one sequence.

I conduct first-order difference ADF test on the sequence of the average wage of employees in Shouguang City (X_4), and t -value is less than the critical value at three kinds of significance level, so the first-order difference sequence of the original sequence is stationary time series.

The sequence of the average wage of employees in Weifang City (X_5) is at three kinds of significance level, and the first-order difference sequence is stationary sequence.

2.3.2 Cointegration test. As the three sequences of the net

income per capita of rural residents in Shouguang City (X_3), the average wage of employees in Shouguang City (X_4) and the average wage of employees in Weifang City (X_5) are non-stationary series, so before conducting Granger causality test, we should conduct cointegration test, to prove that there is a long-term equilibrium relationship in variable series. Thereby I conduct cointegration test on the net income per capita of rural residents in Shouguang City (X_3) and the average wage of employees in Shouguang City (X_4), conduct ADF test on the residual sequence E_1 . The results can be seen in Table 2. ADF test value is $-3.340\ 056$, even smaller than the critical value of $-2.771\ 926$ at the lowest 1% significance level, so it rejects the null hypothesis, there is a significant cointegration relationship between the net income per capita of rural residents in Shouguang City (X_3) and the average wage of employees in Shouguang City (X_4), namely there is a long-term equilibrium relationship between the net income per capita of rural residents in Shouguang City (X_3) and the average wage of employees in Shouguang City (X_4).

Table 2 Cointegration test results of non-stationary time sequence

Variable	T-statistic	1% critical value	5% critical value	10% critical value
Residual E_1 of sequence X_3 and sequence X_4	$-3.340\ 056$	$-2.771\ 926$	$-1.974\ 028$	$-1.602\ 922$
Residual E_2 of sequence X_5 and sequence X_4	$-2.555\ 236$	$-2.764\ 993$	$-1.970\ 978$	$-1.603\ 693$

Similarly, I conduct cointegration test on the sequence of the average wage of employees in Weifang City (X_5) and the average wage of employees in Shouguang City (X_4) (Table 2). The ADF test value of residual E_2 is $-2.552\ 36$, close to critical value of $-2.754\ 993$ at 1% significance level, so we can approximately hold that there is a cointegration relationship between the two sequences at 1% significance level; t -value is smaller than the critical value at 5% and 10% significance level, so it rejects the null hypothesis, and there is a cointegration relationship between the two. Approximately, I judge that there is a long-run equilibrium relationship between the average wage of employees in Weifang City (X_5) and the average wage of employees in Shouguang City (X_4).

2.3.3 Granger causality test. The premise of Granger test is that the time sequence is stationary sequence. As the original sequences of total income per capita of rural residents in Shouguang City (X_1) and the labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery (X_2) are stationary sequences, therefore, we do not need to conduct cointegration test, and can directly conduct Granger test. The results can be shown in Table 3.

Table 3 shows that in lag period 1 and lag period 2, the probability of two tenable assumptions is small, far less than the 5% significance level, and the test of Granger causal rela-

tionship in fact rejects two assumptions, therefore, there is a Granger causal relationship between total income per capita of rural residents in Shouguang City (X_1) and the labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery (X_2). When in lag period 3, the labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery (X_2) does not Granger cause increase in total income per capita of rural residents in Shouguang City (X_1), but total income per capita of rural residents in Shouguang City (X_1) does Granger cause increase in the labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery (X_2). When in lag period 4, it accepts the null hypothesis, and there is no Granger causal relationship between the labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery (X_2) and total income per capita of rural residents in Shouguang City (X_1). Further testing Granger causal relationship between total income per capita of rural residents in Shouguang City (X_1) and the average wage of employees in Shouguang City (X_4) and conducting comparative benefit analysis are of great significance, but since the two are not the integrated of the same order sequence, thus we cannot conduct statistic test. It is mentioned earlier that we can use the variable of rural residents' income per capita to indirectly explain the relationship between it and the average wage of employees, thus to be analysis variable of decision-making in employment of rural labor forces. But as the labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery (X_2) and the net income per capita of rural residents in Shouguang City (X_3) are not the integrated of the same order sequence, thus we cannot conduct cointegration test and Granger test. I conduct Granger causality test on the net income per capita of rural residents in Shouguang City (X_3) and the average wage of employees in Shouguang City (X_4). The results can be seen in Table 4.

Table 3 Granger test results of rural residents' total income per capita (X_1) and labor forces in agriculture, forestry, animal husbandry and fishery (X_2)

Lag period	Null hypothesis	F-test value	Significance level	Test results
1	X_2 doesn't Granger cause X_1	48.563 2	3.9E -05	Reject
	X_1 doesn't Granger cause X_2	18.766 9	0.001 48	Reject
2	X_2 doesn't Granger cause X_1	20.297 9	0.001 22	Reject
	X_1 doesn't Granger cause X_2	11.057 5	0.006 81	Reject
3	X_2 doesn't Granger cause X_1	1.038 19	0.466 08	Accept
	X_1 doesn't Granger cause X_2	6.999 63	0.045 36	Reject
4	X_2 doesn't Granger cause X_1	2.165 05	0.465 96	Accept
	X_1 doesn't Granger cause X_2	26.554 7	0.144 41	Accept

The results show that in lag period 1 – 3, the significance

levels are all higher than 5%, accepting two assumptions, namely, there is no Granger causal relationship between the average wage of employees in Shouguang City (X_4) and the net income per capita of rural residents in Shouguang City (X_3).

Table 4 Granger test results of rural residents' income per capita and the average wage of employees in Shouguang City

Lag period	Null hypothesis		F-test value	Significance level	Test results
1	$\Delta \ln X_4$ doesn't cause $\Delta \ln X_3$	Granger	3.657 88	0.088 10	Accept
	$\Delta \ln X_3$ doesn't cause $\Delta \ln X_4$	Granger	1.366 26	0.272 48	Accept
2	$\Delta \ln X_4$ doesn't cause $\Delta \ln X_3$	Granger	1.927 65	0.225 65	Accept
	$\Delta \ln X_3$ doesn't cause $\Delta \ln X_4$	Granger	0.511 47	0.623 59	Accept
3	$\Delta \ln X_4$ doesn't cause $\Delta \ln X_3$	Granger	0.697 89	0.616 28	Accept
	$\Delta \ln X_3$ doesn't cause $\Delta \ln X_4$	Granger	0.587 10	0.663 73	Accept

We can conduct Granger test on the average wage of employees in Weifang City (X_5) and the average wage of employees in Shouguang City (X_4), but considering high explanatory power of regression equation, I do not conduct test. The regression equation established through cointegration test is as follows:

$$X_4 = 1\,555.458 + 0.972\,543\,8X_5 \\ (2.016\,705) \quad (18.023\,74)$$

In the regression equation, $R^2=0.964\,376$, $DW=1.422\,613$, indicating that the model has good explanatory power.

2.3.4 Analysis of results. The main conclusions drawn from the above analysis are as follows: engaging in production of agriculture, forestry, animal husbandry and fishery makes the total income per capita in rural areas of Shouguang City higher than urban residents' average wage in Shouguang City, even Weifang City. The comparative advantage from the perspective of income makes city lose attraction to rural residents in Shouguang City. There is Granger causal relationship between total income per capita of rural residents in Shouguang City and the labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery within 1 – 2 years of lag period. According to the choice of reference variable concerning the employment decision-making of rural labor forces, it can be interpreted that there is a factual causal relationship between the two. The employment decision-making is influenced by rural residents' total income per capita. In accordance with the calculation data, the average annual income of rural labor forces in Shouguang City has long been higher than the average employees' wage. In 1997, the ratio of the average annual income of rural labor forces in Shouguang City and the average employees' wage was 1.64:1; in 2007, the ratio of the average annual income of rural labor forces in Shouguang City and the average employees' wage was 1.14:1. High total annual income of rural labor forces generates gravity for rural labor forces to engage in agriculture production. In turn, engaging in agriculture production increases total annual income of rural labor forces, and further increases rural residents' total income per capita. When the lag period is 3 years, the rural residents'

total income per capita does Granger cause increase in the labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery, indicating that in a long period of time, high comparative advantage has promoted rural labor forces' enthusiasm of engaging in agriculture production. The number of labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery has long accounted for more than 50% of the total number of rural labor forces on the average. In 1996, the number of labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery accounted for 49.95% of the total number of rural labor forces; in 2008, the number of labor forces in Shouguang City engaging in agriculture, forestry, animal husbandry and fishery accounted for 64.05% of the total number of rural labor forces, 13 percentage points higher than the average level of Weifang City. The absolute number increased from 196 900 in 1996 to 307 300 in 2008, while the amount of rural labor forces over the same period only increased from 394 200 to 479 800. More rural labor forces enter into the primary industry, and the modern agriculture becomes more and more attractive.

The urban residents' wage is not attractive to rural residents in Shouguang City. In 2008, the average wage of employees in Weifang City was 23 722 yuan, close to 23 918 yuan of average annual income of rural labor forces in Shouguang City in 2007. Purely in terms of income, settling in the city or working in the city has been not attractive to rural labor forces in Shouguang City, even without considering the high cost of urban living. From a practical point of view, Shouguang City should vigorously strengthen the building of towns and villages, and strive to achieve urban and rural integration. In 2009, the urbanization rate of Shouguang City reached 55%. "Have everything one needs" becomes farmers' simple understanding of equivalence of urban and rural areas, and "the air in rural areas is better than that in urban areas", having a strong appeal to rural residents.

There is a long-term equilibrium relationship between the average wage of employees and rural residents' income per capita, but there is no Granger causal relationship, so we cannot use statistical test to indirectly reflect the expectancy of comparative advantage. But this explanation is still meaningful: if rural residents' total income per capita increases, the net income per capita will increase, forming interests comparison with the level of the average wage of employees, influencing decision-making in employment of rural labor forces.

3 Conclusions

Based on the above analysis, we can hold that Shouguang City is the forerunner of China's agricultural industrialization, and after years of careful exploration, it has formed commercialized, specialized, socialized, and technology-based modern agriculture pattern. With the rapid development of urbanization and new countryside construction, the living standard of rural residents has been close to or exceeded that of urban residents in some regions. Developed agriculture and high comparative advantage make the rural labor forces more engage in production of agriculture, forestry, animal husbandry and fishery, which has greatly reduced the pressure of employment and

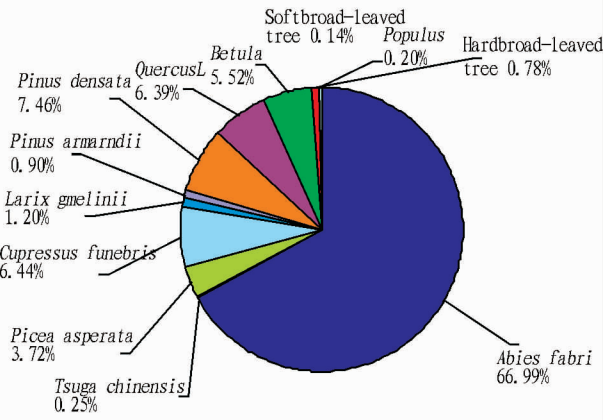


Fig.2 Composition of amount of water regulated of forest in Gongbo Nature Reserve of Tibet

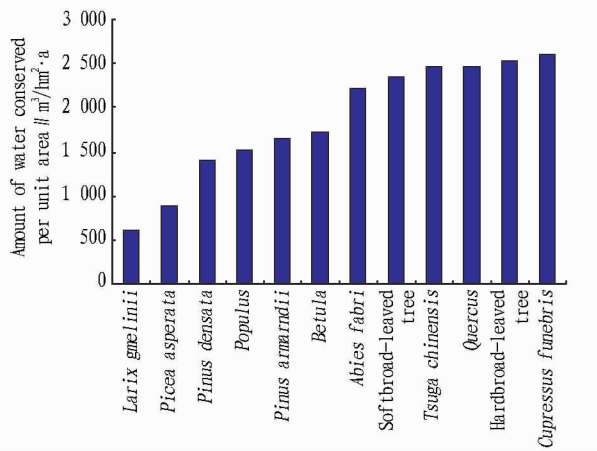


Fig.3 Amount of water regulated per unit area of various dominant tree species in Gongbo Nature Reserve of Tibet

4 Conclusion

Through calculation and research in this paper, the total value of annual water conservation in Gongbo Nature Reserve

(From page 39)

transfer of rural labor forces, and better achieved on-the-spot transfer. The policy implication of Shouguang Model is as follows: taking actions that suit local circumstances, increasing inputs to countryside and agriculture, increasing rural residents' income, and improving rural residents' living standards, is an important way to promote employment of rural labor forces and on-the-spot transfer of surplus labor forces.

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is 8.485 billion yuan. However, the function of water conservation is a small fraction of ecological service function, indicating that there is great ecological value in service function of forest ecosystem in Gongbo Nature Reserve, that is, Gongbo Nature Reserve has vital ecological value. Therefore, in the process of decision-making, we need to strengthen the protection of ecosystem, and especially pay attention to the restoration of damaged ecosystem.

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