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Impacts of rural dual economic transformation on the inverted-U curve of rural income inequality: An empirical study of Tianjin and Shandong provinces in the People's Republic of China

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IMPACTS OF RURAL DUAL ECONOMIC TRANSFORMATION ON THE INVERTED-U CURVE OF RURAL INCOME INEQUALITY: AN EMPIRICAL STUDY OF TIANJIN AND SHANDONG PROVINCES IN THE PEOPLE'S REPUBLIC OF CHINA

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Abstract

Using a case study about rural Tianjin and Shandong provinces, we try to explain what mechanism affects income inequality in rural areas, especially how rural dual structural transformation leads to the income inequality "inverted-U" Curve in some developed areas in the People's Republic of China (PRC). We choose Tianjin to represent developed provinces, which depend on nonagricultural and urban agricultural development modes, and take Shandong Province to represent areas dominated by traditional agriculture.

We can clearly observe that the changes in rural income inequality are roughly consistent with the changes in dual economic transformation in different regions. A marginal decomposition analysis on the Gini coefficient changes of income inequality shows that the distribution effect always accounts for the dominant position and determines the inequality change direction, both in Tianjin and Shandong. By comparison, we find that the dual transformation is sure to affect and change the sectoral labor participation rate directly, and then affect and change the within-sector income inequality, and further to make total income inequality go up or down. Through this empirical and comparative study, we suggest some policies to both grow rural income and reduce income inequality in rural PRC, which means accelerating growth in order to go beyond the "inverted-U curve" turning point.

Keywords: Inverted-U curve, income inequality, Gini coefficient, dual economic transformation

JEL Classification: O15, D31

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1. INTRODUCTION

By means of the case analysis on rural Tianjin (TJ) and other provinces, we attempt to explain the mechanism on how rural dual structural transformation leads to the income inequality "inverted-U" curve,[1] and how to affect the income inequality in rural areas, especially how to influence the "inverted-U" transition in some developed areas in the People's Republic of China (PRC). We choose TJ as a representative of developed provinces because rural TJ depends more on the urban economy and benefits a lot from complete infrastructure, urban technology, and human resources. In addition, the degree of rural labor transfer and agricultural specialization, modernization, and economic intensity in TJ is higher.[2] As a result, the rural income inequality has surpassed the turning point of the income inequality "inverted-U" curve. Comparatively, with higher proportion of the rural population and significant dual economic structure, Shandong (SD) can represent the general situation of agricultural provinces dominated by the traditional agriculture mode, and thus rural income inequality increases constantly, just like the situation in most rural areas of the PRC to some extent. In brief, through this empirical and comparative study, we can make some policy suggestions to both grow rural income and reduce income inequality in rural PRC, which means to accelerate to pass the "inverted-U curve" turning point.

The data of our researches are mainly from *TJ rural social and economic survey data in 1994–2008*, the quintile grouped data of disposable income of *TJ Rural residents in 2003–2014,* and *SD rural economic and social economy survey data in 2007–2009*. Among them, indicators in the rural economic and social survey data are comprehensive, and these data have high accuracy and comparability in comparison with the corresponding packet data. In addition, the national statistics used in this paper are mainly from the *China Statistical Yearbook 1994–2014*. With reference to Sharrock and Wan (2004), we decompose the income grouped data of national rural residents in 1994–2013 and TJ rural residents in 2003–2014 into the data of personal income. From this point of view, we calculate the Gini coefficient of per capita income in rural TJ and rural PRC, respectively.[3] In comparison with the Gini coefficient of income inequality in rural TJ calculated from different data and different methods, we find that there are very small differences between these results, therefore the calculations have high reliability.

[1] As to the general principle of dual economic transformation's impact on income inequality, we have stated in "income inequality inverted-U curve in public ownership economy." See Chen (1991), p. 164.

[2] The term "urban agriculture" was first seen in "Agricultural Economic Geography" from Japanese scholar Shiro Aoshika. Urban agriculture is the agriculture scattered within the business district and residential areas in the city, or scattered around urban peripheral area in a special form.

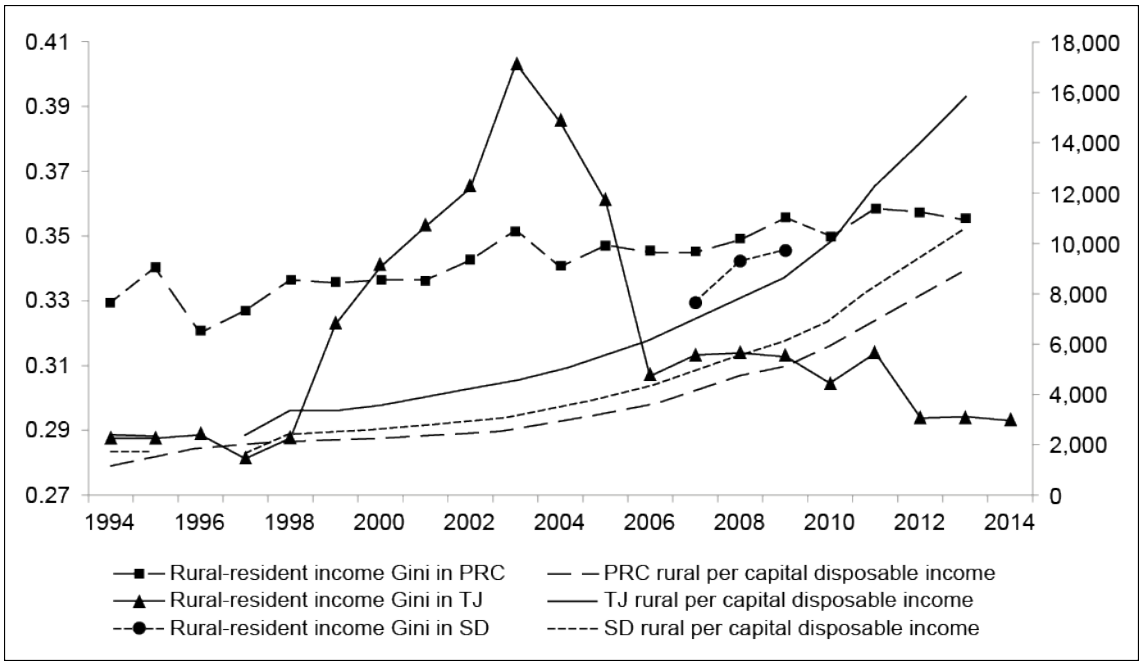
[3] For SD, depending on the available data, we can only calculate several years Gini by *Shandong rural socio-economic survey in 2007–2009*.

2. THE EVOLUTION PATHS OF DUAL ECONOMIC TRANSFORMATION AND INCOME INEQUALITY IN RURAL AREAS

2.1 Changes in Income Inequality in Rural Tianjin and the People's Republic of China

Through the analysis of related data (as shown in Figure 1), we can find, from 2003 to 2013, the rural-resident income Gini in TJ reduced from 0.4036 to 0.2974, with an average decrease of 2.92% per year, while from 1994 to 2013, the rural-resident income Gini in the PRC increased from 0.33 to 0.36, an increase of 7.99%. It looks that the change tendency of the Gini in TJ before 2003 is consistent with that in the PRC, and rural-resident income Gini also expanded rapidly with the rapid economic growth and improvement of household income (Figure 1). However, after crossing the vertex in 2003, the rural-resident income Gini in TJ turned into the decline phase, showing an "inverted-U curve," which is much different from the situation in SD and the whole of PRC. If the change of TJ is sustainable, we believe, it must contain some important variables and information which may be applied for prompting the turning changes in income inequality in other provinces of the PRC.

Figure 1: Changes in Rural Income Inequality Gini and per Capita Income, 1994–2014



PRC = People's Republic of China, TJ = Tianjin, SD = Shandong.

Sources: Authors' calculations based on data from *PRC Statistical Yearbook 1995–2014*, *Shandong Statistical Yearbook 1995–2014,* the quintile grouped data of *Tianjin Rural residents household income survey 2003–2014,* and *Tianjin rural social and economic survey 1994–2008.*

To make a more intuitive analysis, except Gini coefficient, we also calculate the income share that constitutes Gini and the average income within each income group. Further, we list out the changes in the income share by quintiles of rural household income in TJ and the PRC, as well as the average income within each income group from 2003 to 2013 (Table 1). In this way, we may observe whether or not the changes in income share in each group are abrupt or smooth, thus determine whether the changes are sustainable or not.

Table 1: The Income Share (%) and Average Income (CNY) of Rural Households by Quintile

Income Quintile Groups		Bottom		Lower		Middle	
Categories		Average	Share	Average	Share	Average	Share
2003	TJ	1,092.7	4.58	2,697.2	11.30	3,884.1	16.27
	PRC	865.9	6.06	1,606.5	11.23	2,273.1	15.90
2004	TJ	1,351.8	5.19	3,121.0	11.98	4,340.1	16.65
	PRC	1,006.9	6.31	1,842.0	11.54	2,578.5	16.15
2005	TJ	1,531.3	5.14	3,371.5	11.32	4,976.1	16.70
	PRC	1,067.2	6.03	2,018.3	11.41	2,851.0	16.12
2006	TJ	2,416.8	7.33	4,225.2	12.81	5,608.3	17.00
	PRC	1,182.5	6.07	2,222.0	11.41	3,148.5	16.17
2007	TJ	2,694.1	7.38	4,837.4	13.24	6,287.9	17.22
	PRC	1,346.9	5.98	2,581.8	11.47	3,658.8	16.26
2008	TJ	3,227.1	7.78	5,521.1	13.30	7,017.9	16.91
	PRC	1,499.8	5.8	2,935.0	11.35	4,203.1	16.26
2009	TJ	3,365.7	7.29	6,107.5	13.23	8,031.4	17.39
	PRC	1,549.3	5.54	3,110.1	11.13	4,,02.1	16.11
2010	TJ	3,947.1	7.44	6,993.5	13.19	9,540.7	17.99
	PRC	1,869.8	5.81	3,621.2	11.24	5,221.7	16.21
2011	TJ	4,285.6	6.97	8,306.9	13.51	10,843.0	17.64
	PRC	2,000.5	5.25	4,255.7	11.16	6,207.7	16.28
2012	TJ	5,811.1	8.25	9,462.6	13.43	12,394.0	17.59
	PRC	2,316.2	5.35	4,807.5	11.10	7,041.0	16.26
2013	TJ	5,961.7	7.54	10,977.9	13.88	14,274.0	18.05
	PRC	2,583.2	5.31	5,516.4	11.33	7,942.1	16.31
Change rate (2013/2003)	TJ	445.59%	64.63%	307.01%	22.83%	267.50%	10.94%
	PRC	198.33%	12.38%	243.38%	0.89%	249.40%	2.58%

continued on next page

Table 1 *continued*

Income Quintile Groups		Higher		Top		Income Ratio (Top/Bottom)
Categories		Average	Share	Average	Share	
2003	TJ	5,374.7	22.52	108,201	45.33	9.90
	PRC	3,206.8	22.43	6,346.9	44.39	7.33
2004	TJ	5,918.1	22.71	11,330	43.48	8.38
	PRC	3,607.7	22.6	6,930.7	43.41	6.88
2005	TJ	7,160.1	24.03	12,757	42.81	8.33
	PRC	4,003.3	22.63	7,747.4	43.8	7.26
2006	TJ	7,714.1	23.39	13,020	39.47	5.39
	PRC	4,446.6	22.83	8,474.8	43.52	7.17
2007	TJ	8,198.2	22.44	14,508	39.72	5.39
	PRC	5,129.8	22.79	9,790.7	43.5	7.27
2008	TJ	9,207.9	22.19	16,527	39.82	5.12
	PRC	5,928.6	22.93	11,290	43.66	7.53
2009	TJ	10,628.	23.02	18,038	39.07	5.36
	PRC	6,467.6	23.14	12,319	44.08	7.95
2010	TJ	12,321	23.23	20,230	38.15	5.13
	PRC	7,440.6	23.11	14,050	43.63	7.51
2011	TJ	13,971	22.72	24,078	39.16	5.62
	PRC	8,893.6	23.32	16,783	44.00	8.39
2012	TJ	15,990	22.69	26,812	38.05	4.61
	PRC	10,142	23.41	19,009	43.88	8.21
2013	TJ	18,264	23.09	29,607	37.44	4.97
	PRC	11,373	23.36	21,273	43.69	8.24
Change rate (2013/2003)	TJ	239.81%	2.53%	–72.64%	–17.41%	–49.80%
	PRC	254.65%	4.15%	235.17%	–1.58%	12.41%

PRC = People's Republic of China, TJ = Tianjin.

Note: The income ratio of the last column in the table is the ratio between the average income in highest income group and that in the lowest income group.

Sources: Authors' calculations based on data from *China Statistical Yearbook 1995–2014*, *Shandong Statistical Yearbook 1995–2014,* the quintile grouped data of *Tianjin Rural residents household income survey 2003–2014,* and *Tianjin rural social and economic survey 1994-2008.*

Table 1 shows that (i) Overall, the rural-resident income inequality both in TJ and the PRC is still relatively higher: 20% of top-income households occupy about 40% of the income, while the bottom 20% of households occupy only less than 8% of the income; (ii) Specifically, the declining trend of income share in the highest income group in TJ is more significant in most years, and, comparatively, it decreased by 17.41 % from 2003 to 2013. At the same time, the income shares of the lowest income group and lower-middle income group increased year by year, and totally increased by 65% for the lowest group, namely the relative poverty of the 20% lowest-income family eased to a certain extent. In contrast, despite the income share of the highest income group in the whole PRC slightly decreases, the income share of the lowest income group and middle-income group exhibits a significant decline, indicating that the relative poverty degree of low-income people is getting higher and higher; and (iii) From the view of the ratio of the average household income between the top and bottom groups (income ratio), rural-resident income inequality in TJ appears to decrease significantly

after 2003. The income ratio decreased by 49.80% until 2013, indicating that the relative income inequality between TJ high-income and low-income households is shrinking. While the rural-resident income inequality in the PRC generally increased, the income ratio rose by 12.41% from 2003 to 2013, which is broadly consistent with the change tendency of income inequality demonstrated by the Gini coefficient.

The above grouping decomposition analysis indicates that rural-resident income inequality in TJ experienced a process from expansion to reduction, while rural resident income inequality in the PRC continued to expand gradually. Both of these two processes occurred smoothly without any abrupt change, which means the processes are both general trend and characteristics correspondingly, and thus may be sustainable.

2.2 The Evolution Path of Rural Dual Economy in the People's Republic of China and Tianjin

Why does rural income inequality in TJ and the PRC show us the above trends? We think mainly they can be attributed to the changes in rural dual economic transformation in recent 20 years. It is that the changes in the deep relationship between the urban sector and the rural sector led to the changes in rural inequality. For instance, the development of urban agriculture and the growing number peasants migrating to urban areas have resulted in increasing rural income inequality. As a consequence, the rural dual economic transformation can be treated as a very important part of the structural change between rural and urban sectors, which is also an important driving force of overall income inequality.

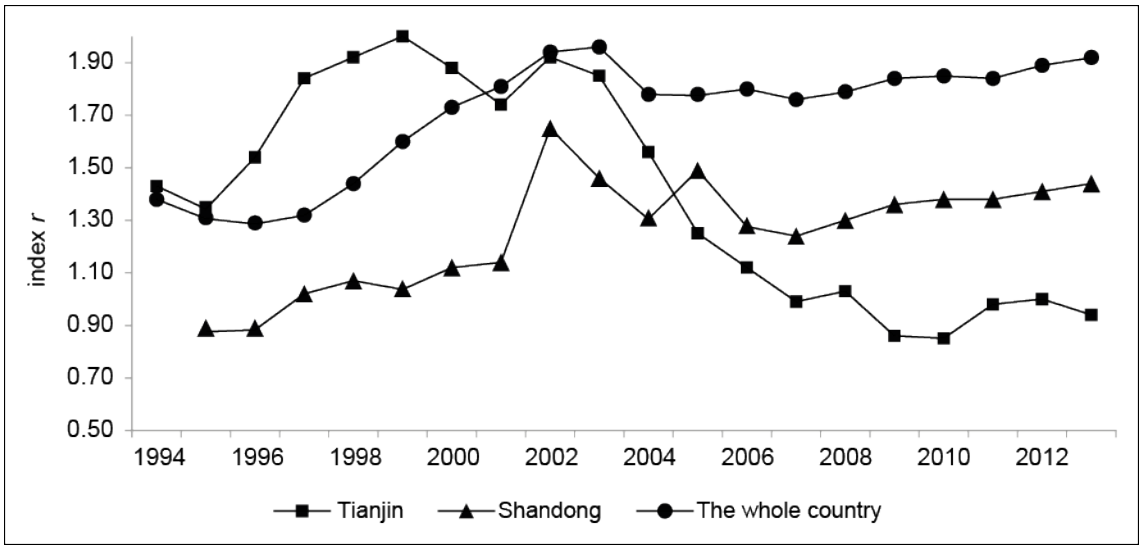
The rural dual economic transformation reflects the reallocation of output and labor force among several sectors. Correspondingly, it would contribute to a decrease in the proportion of output and employment in the traditional sector, but to an increase in the two proportions in the modern sector. Some scholars constructed a comprehensive dual index, which can make up the shortcomings of the existing indicators in the field of measuring the dual structure, such as comparative labor productivity, dual contrast coefficient, or dual contrast index, etc. All of these indexes may only measure the difference among labor productivities without overcoming their shortages. But the comprehensive dual index can better measure the economic growth performance in dual economic transformation (Gao 2007). Hence, we adopt its exponential form to estimate the extents of dual economy in rural areas as follows:

$$r = [(E_m / E_{rt}) \times (W_{rt} / W_m)]^{1/2}. \quad (1)$$

Where E_{rm} refers to the labor productivity of the nonagricultural sector, and E_{rt} to the labor productivity of the traditional agriculture sector in the rural economy. E_{rm} is the rural-resident per capita nonagricultural income, including employment wage income from rural enterprise, nonagricultural business income, and property income. E_{rt} is the rural-resident per capita agricultural income and mainly refers to the household income of agricultural management. The ratio between E_{rm} and E_{rt} reflects the comparison of labor productivity between the two sectors. W_{rt} refers to the proportion of the labor force in the traditional agriculture sector, and W_{rm} to the proportion of the labor force in the nonagricultural sector in the rural economy. W_{rt} is the number of rural residents engaging in primary agriculture, and W_{rm} is the number of rural residents engaging in nonagricultural industry. The ratio between W_{rt} and W_{rm} reflects the sectoral structure of labor force, and there is also a positive correlation between this ratio and the structural intensity of rural dual economy. In addition, we adopt the form of square root

to stabilize the excessive influence which may be caused by multiplication of these two factors. Typically, the smaller the $\text{index } r$, the lower the extent of dual economy may be.

Figure 2: Changes in Comprehensive Dual Index in Tianjin, Shandong, and the People Republic of China, 1994–2013



Sources: *Statistical Yearbook of PRC 1995–2014*, *Tianjin Statistical Yearbook 1995–2014*, *Statistical Yearbook of Shandong 1995–2014*.

In Figure 2 and Table 2, we can find, after 1994, the evolution path of dual economy in TJ exhibited obvious characteristic different from rural PRC. The dual economy in rural PRC was intensified and still maintains overall stability, while the transformation of dual economy in TJ can be totally divided into two stages.

The first stage is from 1994 to 2002. In this period, the dual economy is almost the same as the rural PRC. The comprehensive dual indexes in TJ, SD, and the PRC showed a growth trend, and rural dual economic structure was intensified constantly. Unemployed rural laborers mostly choose to work in the nonagricultural sector as part of "the tide of migrant workers." However, due to the constraints of the household registration system, peasants can only be migrant workers and the remittances from migrant workers are included in the nonagricultural income, which exacerbates the rural income inequality to a greater extent. In addition, the difference of labor productivity between the nonagricultural and agricultural sectors expands continuously in the rural economy, for the migrant workers first transferring to the nonagricultural sector must be skilled labor with high productivity. Therefore, the transfer of labor force also increases the productivity differences between the traditional agriculture sector and the nonagricultural sector in the rural economy, resulting in a significant expansion in income inequality within rural areas.[4] At this stage, the intensity of dual economy in rural TJ is significantly higher than SD and the PRC, and was closely related to the relatively high level of nonagricultural in TJ.

[4] This is consistent with the conclusions of our past study. See Chen and Zhou 2000.

The second stage is from 2002 to 2013. The evolution of the dual economic structure within rural areas began to vary with the regions. Located along the coast and relatively lacking in land, TJ rural labor force began to move from traditional agriculture to modern industry and urban agriculture in 2000, which lead to a slowdown or even stagnation in rural surplus labor. Due to higher degree of specialization and modernization, and more intensive level of capital, technology, equipment, and other elements, the labor productivity in industry and urban agriculture is relatively higher. As a result, it contributes to the steady decline in difference of labor productivity between the agricultural sector and the nonagricultural sector. The comprehensive dual index in TJ dropped rapidly; it was lower than that in rural PRC after 2002, as well as lower than that in SD province after 2004. From 2002, the comprehensive dual index in Shandong and PRC has stopped rising and slightly decreased. However, as a traditional agricultural province, SD has more land resources and larger arable land per capita, so most of the rural residents are still stuck in the traditional agriculture sector. On the other hand, the development of nonagricultural sector is much slower than that in TJ, so the proportion of nonagricultural income and employment in SD is relatively lower (Table 2). Taking into consideration the income share of the two sectors and the sectoral structure of labor force, the intensity of dual economy in SD is still bigger than in TJ in 2004, and its change path is roughly the same as rural PRC. One of the specific reasons is the *hukou* system, which seriously hindered a large number of surplus labors to transfer. Furthermore, the difference of labor productivity in rural economy inevitably becomes much wider. Correspondingly, the change in the rural income inequality must show the same tendency.

Table 2: The Nonagricultural Income Share and Employment Share of Rural Residents

	The Proportion of Nonagricultural Income			The Proportion of Nonagricultural Employment		
Years	**TJ**	**SD**	**Rural PRC**	**TJ**	**SD**	**Rural PRC**
1994	60.70	—	61.15	46.54	—	24.95
1995	55.95	25.03	60.62	45.46	29.84	27.53
1996	62.66	26.12	59.57	45.63	30.91	28.98
1997	70.67	31.52	58.38	45.83	30.65	28.95
1998	72.30	34.05	55.15	45.72	31.08	28.24
1999	74.65	37.11	51.53	46.24	35.28	26.98
2000	69.78	41.76	48.40	44.70	36.44	26.34
2001	64.00	41.48	47.61	43.36	35.13	25.22
2002	68.65	44.16	45.85	43.47	22.60	23.86
2003	68.23	43.57	45.60	44.24	26.53	23.79
2004	64.85	41.31	47.61	46.48	29.14	25.85
2005	72.60	53.57	45.15	56.53	34.05	27.71
2006	73.74	46.11	42.41	59.90	34.14	29.57
2007	68.90	45.91	42.15	60.03	35.65	30.74
2008	75.40	46.68	40.88	62.98	34.04	31.15
2009	71.90	48.93	38.58	64.97	34.19	32.03
2010	69.74	50.31	37.69	74.89	34.58	32.56
2011	74.25	51.93	36.12	76.03	36.29	34.35
2012	78.79	54.38	34.39	77.36	37.52	34.92
2013	74.72	57.85	33.02	78.34	39.88	35.52

PRC = People's Republic of China, SD = Shandong, TJ = Tianjin.

Sources: *Statistical Yearbook of China 1995–2014*, *Tianjin Statistical Yearbook 1995–2014*, *Statistical Yearbook of Shandong 1995–2014*.

2.3 The Relationship between Rural Dual Transformation and Income Inequality

Based on the above analysis, we can make the summary in Table 3: the comprehensive dual index is an earlier or prior index which would lead to the change in the rural income inequality. Concretely, the Gini coefficient of rural income inequality in TJ began to decline in 2003, but the comprehensive dual index decreased in 2002. Further, the proportion of nonagricultural income of rural residents exceeded the proportion of agricultural income before 1994, but the proportion of nonagricultural employment exceeded agricultural in 2005. However, in SD and rural PRC, both proportions of nonagricultural income and employment are below 50%. Their comprehensive dual indexes also fluctuated within a narrow range in 2002 but did not pass the turning point, and there was no obvious sign to lead the Gini coefficient to decline.

Table 3: The Relationship between Rural Dual Transformation and Income Inequality

	TJ	SD	Country
Gini coefficient turning point	2003	No	No
dual index turning point	2002	No	No
Nonagricultural income share over 50%	Before 1994	No	No
Nonagricultural employment share over 50%	2005	No	No

SD = Shandong, TJ = Tianjin.

Sources: *Statistical Yearbook of China 1995–2014*, *Tianjin Statistical Yearbook 1995–2014*, *Statistical Yearbook of Shandong 1995–2014*.

Here, we further conduct a basic regression analysis, simply revealing the relationship between the income inequality, income growth, and dual economic transformation in rural TJ and the PRC. The outcome is shown in Table 4.

Table 4: Regression Estimation Results

Variable	Ln Income	Ln Income2	Ln Income L1	Ln Index	_cons	R^2
Ln Gini (TJ)	3.082*** (0.947)	–0.201*** (0.054)	0.539*** (0.211)	0.283*** (0.083)	–17.375*** (4.132)	0.7370
Ln Gini (PRC)	0.031*** (.008)	–	–	0.087*** (0.034)	–1.363*** (0.059)	0.7850

PRC = People's Republic of China, TJ = Tianjin.

Sources: *Statistical Yearbook of PRC 1995–2014*, *Tianjin Statistical Yearbook 1995–2014*, *Statistical Yearbook of Shandong 1995–2014*.

In this regression model, Gini coefficient (Gini) is related with the independent variables such as rural per capital income (income) and comprehensive dual index (index). The rural per capital income represents the level of rural economic development, and the comprehensive dual index is to measure the extent of rural dual economic transformation. The study sample contains two parts: TJ and the PRC, and the time span is from1994 to 2013. Gini and income are the same as the resource of Figure 1, and index is calculated in section 2.2. Taking into account that the sample data is small, we only make a basic regression estimation, and the outcome (shown in Table 4) is basically consistent with theoretical predictions.

As for TJ, the coefficient of linear term is positive, and the coefficient of quadratic term of per capital income is negative, and also the coefficient of dual index is positive, which means a positive effect on the income inequality according to the change path of dual index itself, which first goes up and then goes down. All of estimations indicate that TJ rural income inequality exhibits an inverted-U curve change tendency. As for the general situation for the whole rural PRC, the linear term is positive, and the dual indexes are positive too, which means that income inequality in rural PRC still enlarges with a linear feature.

Both in TJ and the PRC, the dual economic transformation totally has a positive effect on the income inequality, which corresponded to the evolution path of rural income inequality. Thus, we still need to conduct a more detailed analysis, to calculate the sectoral effects of income inequality, as well as the "structure effect" and "distribution effect" of rural dual economic transformation on the rural income.

3. IMPACT EXTENT OF RURAL DUAL ECONOMIC TRANSFORMATION ON THE RURAL INCOME INEQUALITY

Through the analysis of the previous section, we observe directly that, after 2003, the evolution path of internal dual economy in rural areas began to vary in TJ, SD, and all rural PRC, which corresponded to the evolution path of rural income inequality. However, the analysis did not answer the question: how and to what extent the dual economy transformation leads to the regional differences of income inequality in rural PRC.

To answer the question, we conduct a decomposition analysis about the contribution rate of income inequality between and within sectors to total income inequality according to the Fei–Ranis decomposition method. The rural income inequality can be divided into two parts: one is income inequality between the rural modern nonagricultural and traditional agricultural sectors, and the other one is the income inequality within each sector. Calculation is as follows: first, according to the sorting of total income per capita of rural households, we calculate the sectoral Gini coefficient of each sector's income,[5] and then combine the sectoral Gini coefficient by the proportion of each sector's income, to calculate total income inequality. The formula is

$$G = \sum G_i \times Y_i . \tag{2}$$

Here G is the total rural income inequality, $G_i$is the income inequality of sector i, and Y_i is the proportion of total income. G_i is calculated according to the sorting of net income of rural residents, and is the sectoral Gini coefficient mainly reflecting the relationship between the sectoral income inequality and total income inequality: (i) if sectoral Gini coefficient is positive and greater than Gini coefficient of total income, it indicates that the sectoral income inequality is the determinant to expand total income inequality; (ii) if sectoral Gini coefficient is positive but less than Gini coefficient of total income, it

[5] The sectoral Gini, namely Pseudo Gini coefficient, is the Gini coefficient calculated from income inequality within each sector, according to the order and sorting of household income per capita. The reason why we adopt it to analyze is based on its good property of decomposability. On the other hand, it allows a better observation and comparison of the influence of each sector's income inequality to total income inequality, based on the sorting of household income per capita, rather than sectoral income sorted by the sectors.

indicates that sectoral income inequality is the determinant relatively to reduce the total income inequality; (iii) if sectoral Gini coefficient is negative, it indicates that the sectoral income inequality is absolutely the determinant to reduce the total income inequality (Chen 1991).

Second, based on the analysis, we study the contribution rate of the traditional agricultural and modern nonagricultural sectors' income inequality to the total inequality. The formula is

$$\Phi_j = G_i \times Y_j / G. \quad (3)$$

$$\sum \Phi_i = 1. \quad (4)$$

Here Φ_i is the contribution rate of the sectoral income inequality to the total income inequality.

It should be noted that the application of the Fei–Ranis decomposition method has a high requirement of the data. In particular, it is necessary to distinguish agricultural income from the nonagricultural income. Therefore, we only adopt the fully available data in *Tianjin (TJ) Rural Socio-economic Survey* in 1994–2008. We know that the income inequality in rural TJ reached the "inverted U-curve" turning point in 2003. Therefore, even without the data after 2009, the reliability of this study should not be affected. The results are shown in Table 5.

Table 5: The Decomposition of Total Gini Coefficient by Sectoral Inequality in Tianjin and Shandong

	TJ			
Year	**Agricultural Gini**	**Nonagricultural Gini**	**Transfer Gini**	**Total Gini**
1994	0.3492 (58.74)	0.2318 (40.07)	0.1852 (1.18)	0.2878 (100)
1995	0.3583 (68.83)	0.2040 (30.37)	0.1275 (0.82)	0.2879 (100)
1996	0.3920 (69.53)	0.1813 (29.34)	0.1671 (1.11)	0.2891 (100)
1997	0.4158 (65.98)	0.1766 (33.51)	0.0813 (0.54)	0.2817 (100)
1998	0.3887 (58.22)	0.2138 (40.80)	0.1503 (0.98)	0.2881 (100)
1999	0.4530 (57.06)	0.2389 (42.48)	0.0817 (0.45)	0.3233 (100)
2000	0.4160 (54.89)	0.2788 (42.46)	0.3108 (2.64)	0.3416 (100)
2001	–	–	–	–
2002	0.4069 (35.47)	0.3318 (60.22)	0.4564 (4.31)	0.3596 (100)
1994–2002 Average	0.3975 (58.59)	0.1977 (39.91)	0.2200 (1.50)	0.3074 (100)

continued on next page

Table 5 *continued*

Year	TJ			
	Agricultural Gini	**Nonagricultural Gini**	**Transfer Gini**	**Total Gini**
2003	0.4604 (36.8)	0.3735 (61.57)	0.2833 (1.63)	0.3981 (100)
2004	0.3768 (35.06)	0.3562 (61.48)	0.4695 (3.46)	0.3778 (100)
2005	0.4001 (31.57)	0.3640 (68.16)	0.0707 (0.27)	0.3801 (100)
2006	0.3494 (29.76)	0.3073 (68.83)	0.1921 (1.42)	0.3187 (100)
2007	0.3911 (36.98)	0.2691 (61.06)	0.4258 (1.96)	0.3149 (100)
2008	0.33409 (36.68)	0.3724 (60.88)	0.2107 (2.43)	0.3113 (100)
2009	–	–	–	–
Average	0.3854 (34.66)	0.3224 (63.35)	0.2754 (1.99)	0.3501 (100)

Year	SD			
	Agricultural Gini	**Nonagricultural Gini**	**Transfer Gini**	**Total Gini**
1994				
1995				
1996				
1997				
1998				
1999		`		
2000				
2001				
2002				
1994–2002 Average	–	–	–	–
2003	–	–		–
2004	–	–		–
2005	–	–		–
2006	–	–		–
2007	0.3144 (43.25)	0.3254 (54.72)	0.3491 (2.03)	0.3252 (100)
2008	0.3503 (45.49)	0.3568 (51.84)	0.3561 (2.87)	0.3526 (100)
2009	0.3333 (41.05)	0.3480 (57.01)	0.3461 (1.94)	0.3393 (100)
Average	0.3327 (43.26)	0.3434 (54.52)	0.3504 (2.28)	0.3390 (100)

SD = Shandong, TJ = Tianjin.

Note: The number in the bracket is the contribution rate of each sector's income inequality to total income inequality.

Source: Authors' calculations based on data from *Tianjin Rural Socio-economic Survey in 1994–2008* and *Shandong Rural Socio-economic Survey in 2007–2009.*

3.1 Income Inequality in the Traditional Agriculture Sector

It was shown that the sectoral Gini coefficient of traditional agricultural income in TJ is greater than the total Gini, which implies that the development of urban agriculture leads more residents to enter the higher-income class, thus to expand the total inequality. It is much different from SD and rural PRC, where the distribution of agricultural income is generally more equal than total income. Some literature concerning rural income inequality shows that the inequality of agricultural income plays an important role in reducing total income inequality. The reason why TJ is different is that the characteristics of urban agricultural development in TJ, including input element, output function, and mode of operation, are much different from general agriculture in SD and other traditional agricultural provinces.

From the perspective of input factors, the development of urban agriculture, less dependent on labor force in agriculture and land resources, mainly relies on factor inputs of capital and technology, which determines that the richer family has easier access and gets high income from urban agriculture, and thus increasing the rural income inequality. However, SD and other traditional agricultural provinces, more dependent on rural unskilled labor and land resources, have relatively lower labor productivity in rural areas. Thus, income inequality in agricultural labor is relatively small.

From the perspective of the output function, urban agriculture not only provides fresh, non-staple food commodities and some other tangible products for the city, but also provides green environment, beautiful scenery, and other intangible products. Therefore, urban agriculture has production function, ecological function, and cultural function. However, the endowment difference of intangible products is large; thus, it will exacerbate the total income inequality in rural areas.

In terms of location of production and business mode, since the rural area in TJ is just around the big city, peasants have more opportunities to come into cities and engage in selling flowers or vegetables as well as other nontraditional agricultural business. Through rental market, professional contractor, family-farm, and some other channels, agricultural land and other productive resources gradually concentrate in large-scale growing and breeding farmers, as well as some other nonagricultural professional producers. Some peasants stand out from the ordinary peasants, and their production mode gradually get rid of the past small-scale family-farms economy. By means of the development of large-scale operation of grain, export agriculture, characteristic agriculture, and animal husbandry, or a combination of production and sales, they gradually transform into large-scale mechanization and modernization. As a result, they become wealthy in rural areas in various ways, which widen the income gap between them and ordinary agricultural households.

3.2 Income Inequality in the Rural Nonagricultural Sector

The sectoral Gini coefficient of nonagricultural income in TJ is lower than the total Gini, indicating nonagricultural economy driven by the development of urban agriculture is an important determinant to decrease income inequality. In contrast, in SD and most parts of rural PRC, the nonagricultural sector not only contributes to improving the level of total income but also exacerbates the rural income inequality, no matter how peasants choose to work in the rural township enterprises or to be migrant workers.

In TJ, the development of urban agriculture brings about diverse forms of nonagricultural economy, such as facility horticulture, planting base, agricultural products logistics, and agricultural leisure tourism, which can absorb surplus labors widely. According to the TJ survey, t 80% of rural households participated in nonagricultural activity in 2007 and 90% in 2008. It is due to the universality of this distribution that nonagricultural income relatively becomes a major factor in reducing income inequality. But in SD and most parts of rural PRC, peasants mostly rely on being engaged in township enterprises, working as migrant or some other traditional forms of nonagricultural work, so the less developed nonagricultural may exacerbate income inequality in rural areas. The main reason is that large enterprises in cities substantially reduce the township enterprises' capability to absorb rural labor, and to decline in the participation rate of rural residents. On the other hand, without urban agriculture
in most areas, the highly educated and capable peasants usually choose to serve as migrant workers to get higher income, which leads to the expansion of rural income inequality.

3.3 Transfer Income Inequality

The Gini coefficient of transfer income distribution mainly reflects the effects of the implementation of some redistributive policies, and usually should be negative and absolutely reduce total inequality. Most Gini coefficients of transfer income are lower than total Gini coefficient in TJ, indicating that transfer income contributes to relatively reducing the total income inequality. It is surprising, however, to find the transfer income Gini in SD as slightly higher than the total Gini coefficient, implying that the redistribution policy expands rural income inequality to some extent. It is difficult to explain this phenomenon because transfer income is usually the subsidy for the poorest families. One possibility is that some special subsidies were distributed to richer people to encourage them to invest in enterprises or some special industry, or the living subsidy for poorer people is so small and dispersed that the distribution of transfer income itself is much unequal than the total income inequality. In short, we need to further collect data and conduct a deeper research, and distinguish the productive subsidies from living subsidies which should be guaranteed to go to the poorer strata.

3.4 Contribution Rate of Sectoral Income Inequality: Sectoral Effects

The influence of TJ agricultural income inequality on the total income inequality suffers a significant decline. The average contribution rate from 2003 to 2008 is only 34.66%, but is close to 60% in the first stage from 1994 to 2002. Particularly, in 2002, namely the initial stage of TJ urban agricultural development, the contribution rate of nonagricultural income inequality exceeds that of agricultural, reaching more than 50%, which reflects the rapid development of TJ modern nonagricultural sector, and then its sectoral income inequality replaced the traditional agriculture sector to become the main determinant of total inequality in rural TJ. As for SD, the average contribution rate of the modern nonagricultural sector to total is slightly higher (54.52%), but the contribution rate of agricultural inequality still accounts for nearly half the share. In addition, both in rural TJ and SD, the contribution rates of transfer inequality are so small that they may be negligible.

In short, we can clearly observe that dual economic transformation exerts constraint on the change of rural income inequality, and the process of dual economic transformation is consistent with the process of income inequality change in different regions. The turning moment of the income inequality "inverted-U curve" in rural TJ occurred roughly and consistently with the dual economic transformation, in which nonagricultural income inequality accounts for most of total inequality instead of agricultural inequality. However, the income inequality in SD and rural PRC did not exhibit an "inverted-U curve" transition, which is also consistent with their dual economic transformations, in which agricultural income inequality still holds the dominant position in total inequality.

4. THE STRUCTURAL EFFECTS AND DISTRIBUTION EFFECTS OF DUAL ECONOMIC TRANSFORMATION ON RURAL INCOME INEQUALITY

We need to do further research and to know, in the process of rural dual economic transformation, which one is the main determinant to lead to total income inequality change (either increase or decrease): the change in the proportion of sectoral income caused by the dual economic transformation or the change of sectoral income inequality; and further to what extent these determinants lead to. To answer these questions, we need more detailed marginal decomposition analysis on total Gini coefficient of income inequality. Thus, the formula (2), (4) can be expanded as follow:

$$G = Y_1G_1 + Y_2G_2 + Y_3G_3 \tag{5}$$

$$1 = Y_1G_1/G + Y_2G_2/G + Y_3G_3/G \tag{6}$$

Here, formula (5), (6) show that total income inequality is a weighted sum of the sectoral income inequality, and the weight is the proportion of sectoral income in total. In other words, the contribution rate of sectoral income inequality to total inequality is the combined result of the changes of sectoral income shares in total and sectoral income inequality. Based on this, we get derivative with respect to t in the above formula, to obtain marginal decomposition formula as follows:

$$dG/dt = \alpha + \beta \tag{7}$$

$$\alpha = dY_1/dtG_1 + dY_2/dtG_2 + dY_3/dtG_3 \text{ (Structural Effect)} \tag{8}$$

$$\beta = dG_1/dtY_1 + dG_2/dtY_2 + dG_3/dtY_3 \text{ (Distribution Effect)} \tag{9}$$

In the perspective of dual economic transformation, we divide the change in total income inequality into two parts: (i) Structural Effect, which is the change in total Gini coefficient caused by the proportion changes in agricultural, nonagricultural income (and transfer income)[6]; (ii) Distribution Effect, which is the change in the total Gini coefficient caused by the changes in sectoral Gini coefficients. If both effects are positive (negative), the increment of total Gini coefficient must be positive (negative); on the contrary, if the signs of the two effects are just opposite to each

[6] Here structural effect is different from sectoral effect. Sectoral effect is the contribution rate of sectoral income Gini to total Gini in the stationary condition, while structural effect is the effect of changing sectoral income proportion in the dynamic condition, namely the change of total Gini coefficient caused by changes in proportion of sectoral incomes along with the process of time.

other, the direction of the marginal Gini coefficient change depends on a comparison between them.

We adopt data in *Tianjin Rural Socio-economic Survey* in 1994–2008 and *Shandong Rural Socio-economic Survey* in 2007–2009 to study the influence of rural dual economic transformation on the change in rural income inequality in 1994–2002 (rising stage of inverted-U curve) and 2003–2008 (decline stage of inverted-U curve) respectively, depending on the evolution path of income inequality "invert-U curve" in rural TJ. The results are shown in Table 6.

Table 6: Structural Effects and Distribution Effects of Dual Economic Transformation on Changes in Rural Income Inequality (Tianjin 1994–2002, 2003–2008; Shandong 2007–2009)

Provinces (Time)/Sectors		Structural Effect = α		Distribution Effect = β		Total	
		Gini Change	Share (%)	Gini Change	Share (%)	Gini Change	Share (%)
TJ (1994–2002)	Agriculture	–0.0596	–96.27	0.0280	45.16	–0.032	–51.11
	Nonagricultural	0.0360	58.06	0.0498	80.36	0.0857	138.42
	Transfer	0.0029	4.68	0.0050	8.01	0.0079	12.70
	Total	–0.0208	–33.53	0.0827	133.53	0.0619	100
TJ (2003–2008)	Agriculture	–0.0332	30.82	–0.040	37.29	–0.073	68.11
	Nonagricultural	0.0221	–20.48	–0.072	67.01	–0.050	46.53
	Transfer	0.0037	–3.43	0.0121	–11.21	0.0158	–14.64
	Total	–0.0074	6.91	–0.100	93.09	–0.108	100
SD (2007–2009)	Agriculture	–0.0091	–62.07	0.0079	53.73	–0.001	–8.33
	Nonagricultural	0.0064	43.69	0.0059	40.35	0.0123	84.05
	Transfer	0.0037	25.04	–0.000	–0.75	0.0036	24.29
	Total	0.0010	6.67	0.0137	93.33	0.0146	100

SD = Shandong, TJ = Tianjin.

Source: Authors' calculations based on data from *Tianjin Rural Socio-economic Survey in 1994–2008* and *Shandong Rural Socio-economic Survey in 2007–2009.*

4.1 The Distribution Effects of Income Inequality Changes can Better Explain Total Inequality Changes in Both SD and TJ, compared with the Structural Effects of Dual Economic Transformation[7]

Our previous researches on the rural income inequality in TJ in the 1980s and 1990s also show that the distribution effect accounts for 88.4% of rural income inequality in TJ from 1984 to 1988 (Chen 1991, 2000), while here the distribution effect is as high as

[7] It is that because reduces of agricultural income proportion ($\mathrm{d}\Phi_{rt} < 0$) offsets the rises of nonagricultural income proportion ($\mathrm{d}\Phi_{rt}$>0), the structure effects, which is the sum of them, would be relatively smaller. Despite that, there is no mathematical logic problem in formula (8), (9), in the assumptions that changes of transfer income ($\mathrm{d}\Phi_T$) is exogenous, there is a trade-off between proportions of agricultural income and nonagricultural income. In other words, under the condition that Pseudo Gini coefficient is greater than 0, the signs of $\mathrm{d}\Phi_{rt}/\mathrm{d}tG_{rt}$ and $\mathrm{d}\Phi_{rm}/\mathrm{d}tG_{rm}$ are inevitably just opposite to each other. It is general that $\mathrm{d}\Phi_{rt}/\mathrm{d}tG_{rt} < 0$ and $\mathrm{d}\Phi_{rm}/\mathrm{d}tG_{rm}$>0, which determines that the structural effect may be small after they are summed. Due to the technical limitations, when we analyze the structure effect on the contribution rate of rural income inequality, we should only focus on the absolute value of each factor's contribution rate, rather than the structure effect.

108.25% from 1984 to 1988. Hence, though the distribution effect varies in different periods of time, it always occupies the dominant position and is the fundamental factor in determining the change in the rural income inequality. It implies that dual economic transformation always changes the sectoral structure of labor to further change the total income inequality. In other words, dual economic transformation can affect the income inequality of residents directly by changing the labor force participation and, further, affect the total income inequality. Without changing the labor participation rate to change the sectoral inequality, but simply adjust the income proportion between two sectors, it would have little effect on the total income inequality.

By comparing the expansion stage (1994–2002) and reduction stage (2003–2008) of the rural income inequality in TJ, the distribution effect is always the most important factor influencing income inequality, and the expansion and reduction of income inequality depend critically on the changes in sectoral income inequality. Meanwhile, the structural effect is relatively small, it always contributes to reducing the internal rural income inequality. By comparing the different stages of dual economic transformation in the same area, we can see that the essential ingredient to reverse the direction of change in rural income is to reduce the nonagricultural income inequality (described in detail below). Of course, it is necessary to adjust the income proportion between two sectors to reduce income inequality. Especially when the income inequality is expanding, the absolute value of contribution rate of agricultural income's structural effect on income inequality is as high as 96.27%.

By further comparison with the situation in TJ (2003–2008) and SD (2007–2009), we can find that no matter if the rural income inequality is rising or reducing, the distribution effect still dominates. It implies that dual economic transition must change the sectoral structure of labors and then result in the changes in sectoral income inequality, and further to change total income inequality in different stages of dual economic transformation in different regions. In other words, the dual economic transformation must affect sectoral income inequality through changing labor participation rate directly, and further to change the total income inequality in different stages. Which further explain that only when the labor participation rate reaches a certain level, total income inequality would enter into the process of decrease after rising initially in the period of inverted-U curve transition. For instance, when the labor participation rate in the nonagricultural sector reaches at least 50% (just like in TJ, and at that time its proportion of income even was higher than 70%, see Table 2), the inverted-U transition automatically occurs. Again, without changing the labor participation in two sectors and their sectoral inequality, but simply to adjust the income proportion of two sectors, the overall impact on total income inequality is very small.

4.2 The Decline of the Modern Nonagricultural Income Inequality in Tianjin is the Most Important Factor in Reducing the Total Income Inequality (The Contribution Rate is 67.01%)

First, dual economic transformation promotes almost all peasants to participate in the nonagricultural economy. In 2008, for example, more than 90% of peasants were involved in nonagricultural production derived from urban agriculture. Among them, 75.83% chose to engage in nonagricultural production activities in the township, while only 0.8% chose to be migrant workers. Second, the contribution rate of the reduction of agricultural income inequality is 37.29% in 2003–2008. Regardless of less significant than nonagricultural income, it still plays an important role in reducing total income inequality. Third, the change in proportion of agricultural income reduces total income

inequality by 30.82%, but the change in proportion of nonagricultural income expands income inequality by 20.48%. As a result, the total income inequality decreases by 7% totally. Thus, when the development of dual economy enters into a certain stage, for instance, when nonagricultural income in TJ occupies the dominant position (about 70% in 2003, while the share of employment was 50% [see Table 2]), both structural effect and distribution effect are conducive to reducing income inequality in rural areas, in fact, which is just the beginning of the inverted-U transition of rural income inequality. It has a significant reference for rural PRC that the rapid development of dual economy in the rural areas around big city would accelerate rural income inequality to pass over the turning point, then to enter into the process of reduction. (Here, the transfer income inequality exhibits an evolution path of expansion. But because of its relatively smaller proportion, it is not discussed.)

4.3 The Expansion of Rural Income Inequality in SD is Firstly Attributed to the Expansion of Income Inequality in the Traditional Agriculture Sector; Its Contribution Rate is 53.73%

Second, the contribution rate of nonagricultural income to the expansion of total inequality is 43.69%. For instance, in 2009, 31.32% of rural residents in SD choose to go out to work. Third, the expansion of nonagricultural income inequality itself is the reason to increase total inequality, and its contribution rate is 40.35%. Fourth, the proportion change of agricultural income is the factor to reduce income inequality, and its contribution rate is 62.07%, which is smaller than other factors' greater influence, so total income inequality in SD is continuously expanding (transfer income ignored). In other words, for rural areas in SD and rural PRC, the rural surplus labor transferring from the agriculture sector to the nonagricultural sector is still to expand rural income inequality in current stage of dual economic transformation, which implies that there is still a far and long journey to go to reach the inverted-U turning point. Even to achieve the target like TJ in 2003, the nonagricultural income of rural residents of SD still needs to increase by about 30%, and nonagricultural employment needs to increase by 25%, namely to be doubled. According to the current speed of labor transfer and nonagricultural income growth in SD, we forecast,[8] that nonagricultural labor participation rate can reach 50% and nonagricultural income proportion may grow by 70% until 2020 at least, and then probably to achieve turning point of inverted-U transition.

5. CONCLUSIONS AND SUGGESTIONS

From this paper's empirical study, we can draw the following conclusions:

First, after 1980s, the PRC's dual economic transformation exhibited different evolution characteristics, and the evolution path of dual economy in rural areas has begun to vary with the regions. TJ rural dual economic transformation entered a higher stage in which the proportions of nonagricultural employment and income hold the dominant position, and the rural duality declines gradually. The rural dual economy in SD and rural PRC are still at the stage in which agriculture holds a predominant role. Correspondingly, changes in rural income inequality constrained by dual transformation

[8] We adopt exponential smoothing method to forecast it according to the time series of nonagricultural employment and the proportion of nonagricultural income in Shandong during 1995–2013.

also exhibit regional differentiation. Rural income inequality in SD and most of rural PRC is still rising but this rise has slowed down, so it may indicate that they are in the latter part of rising stage in "inverted-U curve." In areas similar to TJ, where the urban agriculture and nonagricultural sector develop rapidly, income inequality exhibited an obvious "public economic income inequality inverted-U curve" process; therefore, it is important to study the variable factors so that we may predict and promote the evolution of income inequality in rural PRC.

Second, the development of the modern nonagricultural sector in rural TJ, unlike SD or other parts of the PRC, prompted reduction of rural income inequality and became the major determinant to reduce the income inequality in rural TJ. The development of urban agriculture is an important factor in reducing the income inequality. In contrast, in most rural areas of the PRC and SD, despite the rural residents choice to work in the rural township enterprises or to be migrant workers, their nonagricultural income not only contributes to improving the level of total income, but also exacerbates the rural income inequality, becoming the main factor in expanding income inequality. While the distribution of agricultural incomes is more equal relative to the total income, its overall influence is to reduce total inequality.

Third, there are some differences between TJ and SD provinces in terms of stages of dual economic transformation, and the directions of influence exerted by determinants of income inequality. As for TJ, with the development of the modern nonagricultural sector entering a higher stage, its sectoral income inequality exhibited an evolution path of decrease and lead total inequality in rural areas to a narrowing trend. Whether from the perspective of distribution effect or structural effect, urban agricultural income is also conducive to reducing the rural income inequality. Correspondingly, in SD and other parts of the PRC, such dual economy is still in the transition stage in which the transfer of rural surplus labor from the agriculture sector to the nonagricultural sector is still the most important determinant of expanding rural income inequality. Besides, the rising proportion of nonagricultural income, as well as the expansion of the nonagricultural inequality itself, causes rural income inequality to increase, notwithstanding the decrease in magnitude (Figure 1).

In summary, by the comparative analysis of TJ and SD provinces, as well as the whole of rural PRC, we study the relationship between rural dual economic transformation and rural income inequality changes. In order to prompt total income inequality of rural PRC to pass the turning point of "public-ownership economic inequality inverted-U curve" as soon as possible, we may make the following three suggestions: (i) In suburbs around small and medium-sized cities, government should encourage suburban rural peasants to join the development of the nonagricultural sector. At the same time, some policy should be made to induce urban enterprises to accelerate urban-agricultural investment and attract more labor transfer. (ii) In the large agricultural provinces, especially the central and western provinces of the PRC, urbanization should be accelerated to develop the nonagricultural sector sustainably. Agricultural provinces around big cities with good conditions should develop urban agriculture, and encourage foreign and domestic investment and agricultural enterprise from eastern regions to get into western regions, to establish modern rural nonagricultural economic sector closely related with agricultural production with relatively high maturity and various forms. (iii) The western region should attract their rural migrant workers back to their hometowns and guide the transfer of surplus labor into the local nonagricultural economy, so that they can get incomes from local industries. A continued implementation of such basic strategic initiatives must accelerate growth so that rural economies can progress from total inequality towards the reduction stage of "public-ownership economic inequality inverted-U curve."

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