Research on the Characteristics of Urban Household Income Polarization in China

Based on the Empirical Analysis of CFPS Data

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Abstract—This article analyzed the characteristics of urban household income polarization in China based on the 2010-2016 China Family Panel Studies (CFPS). The empirical results show that: first, there is a certain income polarization in China's urban household income, but the polarization has shown a slowing trend. Second, the widening income gap among urban households in China may be a major factor in income polarization, but mobility and internal differentiation among different income groups have improved. Third, the results of the dynamic polarization of income polarization further indicate that the increase in urban household income in China has increased the level of income polarization to some extent, but at the same time income growth has made the distribution structure of household income more reasonable and slowed down the extent of polarization.

Keywords: income polarization, Shapley decomposition, DER index

I. INTRODUCTION

With the rapid development of China's economy and the steady progress of urbanization, the income gap between urban residents has sharply expanded, and there are many related research results. Many scholars use different sources of data to measure through different indicators of income inequality, and analyze the income gap and inequality of Chinese urban residents in more detail. First, the income distribution of Chinese urban residents has a tendency to worsen, manifested by an increasing change in the income inequality index (Qu Jing and Yao Xianguo, 2011; Liu Changgeng and Liu Na, 2018). Second, the income gap between urban residents is growing and there is polarization, that is, the shrinking of middle income groups (Luo Chuliang, 2010; Long Ying and Xie Jingwen, 2016). Some scholars have concluded that the income of Chinese urban residents has polarization effect (Wang Chen et al., 2015)

Income polarization refers to the aggregation of different income groups near a pole. If the aggregation points are located on both sides of the income distribution, it is called polarization; if there are multiple aggregation points, it is called income multi-polarization. When income polarization occurs, it may cause much harm to the society. Generally, income polarization indicates a decrease in income mobility, which is not conducive to the formation of an olive-type income structure (Esteban JM and Ray D., 1994). In addition, income polarization can easily cause confrontation among different income groups, which is not conducive to economic growth and social stability. So, what is the degree and trend of income polarization of Chinese urban residents? Where does the main source of income polarization for urban residents come from? The study of these issues needs to be explored in depth. Therefore, this paper intends to use the CFPS survey data system to analyze the degree and dynamic trend of urban household income polarization, and to use Shapley value decomposition method to decompose income polarization dynamically, and to explore the main factors of dynamic changes in income polarization of urban residents.

II. RESEARCH DESIGN

A. The measurement of income polarization

At present, the most commonly used measurement of income polarization is the DER polarization index, which was first developed by Esteban and Ray (1994) based on the idea of potential conflicts and divergent interests which as well constructed a multi-polar ER index. They believe that polarization is actually the process by which individuals identify or alienate different groups. Different individuals within the same group have similar attributes and different groups have significantly different attributes. The ER index can be used to measure not only the polarization problem but also the multi-polarization problem. The core of the ER index is to properly group the entire sample. However, due to the subjective nature of grouping, the relevant conclusions of its measurement can easily be questioned. Therefore, Duclos et al. (2004) proposed an optimal group partition based on the distribution density function, so that the number of groups depends on the aggregation characteristics of the sample distribution itself.

$$DER = P_\alpha(f) = \iint f(x)^{1+\alpha} f(y)|x - y| dxdy \qquad (1)$$

$\alpha \in [0.25,1]$ is the parameter of the degree of polarization avoidance and $f(x)$ represents the density function of income x.

$P_\alpha(f)$ can be further expressed as a relationship of product according to the feeling of recognition, alienation, and their correlation. The feeling of recognition of y is defined as $\iota(\alpha)=f(y)^\alpha$, the average social recognition is $\bar{\iota}(\alpha)=\int f(y)^{1+\alpha}dy$, the feeling of alienation from x to y is $|x-y|$, thus, the feeling of alienation to y is $a(y)=\int f(x)|x-y|dx$, and the average social alienation is $\bar{a}=\iint f(x)|x-y|dxdy$. The correlation coefficient between feeling of alienation and feeling of recognition is $\rho=\text{cov}(\iota(\alpha),a(y))/\bar{\iota}(\alpha)\bar{a}(y)$, that is, $DER=\bar{\iota}(\alpha)*\bar{a}*(1+\rho)$.

Therefore, the increment of the DER polarization index can be expressed as the sum of the increase in social average recognition, the increase in social average alienation, and the correlation coefficient between recognition and alienation. In addition, the Gini coefficient is actually a special case of the DER index, because when $\alpha=0$, the EDR index degenerates to the Gini coefficient.

B. Dynamic decomposition of income polarization

Further, the DER index uses the Shapley value method to decompose the DER index dynamically to analyze the change of polarization dynamic factors. This decomposition method decomposes the income polarization index change effect into growth effect and redistribution effect by constructing a counterfactual income distribution, and the decomposition result is not affected by the decomposition path. Using the results of the dynamic decomposition of the income polarization index, it can be more clearly understood that the polarization changes is caused by income growth factors or the change of income distribution structure.

Specifically, assuming that μ_x, L_x are the expectation of income x and the Lorentz curve respectively, the change in income polarization P (x) from t to t + 1 can be expressed as:

$$\Delta P(x) = P(x_{t+1}) - P(x_t) = P(\mu_{x_{t+1}}, L_{x_{t+1}}) - P(\mu_{x_t}, L_{x_t})$$

$$= \frac{1}{2}P(\mu_{x_{t+1}}, L_{x_{t+1}}) + \frac{1}{2}P(\mu_{x_{t+1}}, L_{x_{t+1}}) - \frac{1}{2}P(\mu_{x_t}, L_{x_t}) - \frac{1}{2}P(\mu_{x_t}, L_{x_t})$$

$$+ \frac{1}{2}P(\mu_{x_{t+1}}, L_{x_t}) - \frac{1}{2}P(\mu_{x_t}, L_{x_t}) + \frac{1}{2}P(\mu_{x_t}, L_{x_{t+1}}) - \frac{1}{2}P(\mu_{x_t}, L_{x_{t+1}})$$

$$= \frac{1}{2}\left(\left[P(\mu_{x_{t+1}}, L_{x_t}) - P(\mu_{x_t}, L_{x_t})\right] + \frac{1}{2}\left[P(\mu_{x_{t+1}}, L_{x_{t+1}}) - P(\mu_{x_t}, L_{x_{t+1}})\right]\right)$$

$$+ \frac{1}{2}\left(\left[P(\mu_{x_t}, L_{x_{t+1}}) - P(\mu_{x_t}, L_{x_t})\right] + \frac{1}{2}\left[P(\mu_{x_{t+1}}, L_{x_{t+1}}) - P(\mu_{x_{t+1}}, L_{x_t})\right]\right) \quad (2)$$

Among them, $\frac{1}{2}\left(\left[P(\mu_{x_{t+1}}, L_{x_t}) - P(\mu_{x_t}, L_{x_t})\right] + \frac{1}{2}\left[P(\mu_{x_{t+1}}, L_{x_{t+1}}) - P(\mu_{x_t}, L_{x_{t+1}})\right]\right)$ shows the growth effect, $\frac{1}{2}\left(\left[P(\mu_{x_t}, L_{x_{t+1}}) - P(\mu_{x_t}, L_{x_t})\right] + \frac{1}{2}\left[P(\mu_{x_{t+1}}, L_{x_{t+1}}) - P(\mu_{x_{t+1}}, L_{x_t})\right]\right)$ shows the re-distribution effect, and those are the polarized dynamic Shapley decomposition equation.

However, in reality, the researchers only have access to obtain information of $P(\mu_{x_{t+1}}, L_{x_{t+1}})$, $P(\mu_{x_t}, L_{x_t})$. It is not possible to have income data for different periods of mean income and income distribution. Therefore, how to estimate the $P(\mu_{x_t}, L_{x_{t+1}})$, $P(\mu_{x_{t+1}}, L_{x_t})$ income data in a suitable way is the key to dynamically decompose Shapley polarization.

To solve this problem, the method of constructing the income distribution counter-factually is generally used to handle the two counterfactual income distributions of mathematical formulas $P(\mu_{x_t}, L_{x_{t+1}})$, $P(\mu_{x_{t+1}}, L_{x_t})$ in different periods using the data of existing mathematical formulas in the reporting period and the base period $P(\mu_{x_{t+1}}, L_{x_{t+1}})$, $P(\mu_{x_t}, L_{x_t})$:

$$F_x(\mu_{x_{t+1}}, L_{x_t}) = F_x\left(\mu_{x_t} \times \frac{\mu_{x_{t+1}}}{\mu_{x_t}}, L_{x_t}\right) \quad (3)$$

$$F_x(\mu_{x_t}, L_{x_{t+1}}) = F_x\left(\mu_{x_{t+1}} \times \frac{\mu_{x_t}}{\mu_{x_{t+1}}}, L_{x_{t+1}}\right) \quad (4)$$

C. Sources of data and selection of variables

The data is selected from the urban household income and household characteristics in the $2010-2016$ CFPS household tracking China family panel studies. The urban household income in the database consists of five types of income sources: wage income, operating income, property income, transfer income and other income. In the data screening, the missing of income and expenditure data information are excluded, then the number of valid samples of urban households in 2010, 2012, 2014 and 2016 were 5,978, 5,295, 5,747 and 6,464 respectively.

The research variable selects the real income per capita of urban households. The real income per capita of urban households refers to the ratio of total household income to the size of the total population. It is deflated by the 2008 CPI index.

TABLE I. THE BASIC CHARACTERISTIC OF PER CAPITA INCOME OF URBAN HOUSEHOLDS IN CHINA FOR THE YEAR 2010–2016

Year	Mean value	Median	Standard deviation	Skewness	Kurtosis	Sample size
2010	15112.45	9802.696	23889.44	15.39898	499.6576	5978
2012	14081.68	9617.412	27616.12	28.02489	1273.431	5295
2014	16816.73	12207.42	22910.04	16.54264	510.3561	5747
2016	20643.77	14944.02	31364.76	23.14617	1009.613	6464

From "Table I" above, we can know that for the urban households in China from 2010 to 2016, the average and median real income of the family continued to increase, reflecting the steady growth of family income. The growth is especially obvious after 2015. At the same time, it can be seen from the standard deviation that the income gap between urban households is still growing, and income differentiation is still serious. In addition, judging from the skewness and kurtosis coefficient, it reflects the characteristics of urban household income distribution with sharp peaks and fat tails and right skewness.

TABLE II. THE STRUCTURE OF MAJOR INCOME SOURCES OF CHINESE URBAN HOUSEHOLDS IN THE YEAR OF 2010—2016

Year	Wage income	Property income	Operating income	Transfer income	Other income	Total
2010	67.73%	1.68%	8.68%	16.62%	5.29%	100.00%
2012	56.41%	5.05%	7.88%	25.08%	5.59%	100.00%
2014	62.72%	3.30%	4.91%	25.21%	3.86%	100.00%
2016	62.67%	3.50%	5.31%	23.49%	5.04%	100.00%

As can be seen from "Table II", the main sources of income for urban households in China are wage income, transfer income, operating income, other income, and property income. Over time, the proportion of wage income has declined, stabilizing at about 63% in 2016, and operating income has also declined, while property income has a clear upward trend, accounting for about 3.5% in 2016. In addition, transfer income has increased significantly, accounting for 23.5% in 2016, which shows that wages are the main source of income for urban households, and the proportion of retirees in a family is increasing, reflecting the aging trend to a certain extent.

III. THE POLARIZED CHARACTERISTIC OF CHINA URBAN HOUSEHOLDS INCOME AND THE DYNAMIC DECOMPOSITION

A. The polarized characteristic of China urban households income

For comparison, this article measures the Gini coefficient, FW index, ER index of $\alpha=1$, and the $\alpha=1$ of polarization aversion parameters, and the EGR index of the $\beta=0.5$ of identity sensitivity parameters and the polarization aversion parameter are measured separately. The DER index of the $\alpha=0.5$ and $\alpha=1$ is shown in "Table III".

TABLE III. THE LEVEL OF CHINA URBAN HOUSEHOLDS INCOME POLARIZATION

Year	GINI	FW	EGR(g=3)	ER(g=3)	DER(α=1)	DER(α=0.5)
2010	0.4997	0.4686	0.2572	0.2888	0.2237	0.2835
2012	0.4936	0.4456	0.2471	0.2805	0.2067	0.2767
2014	0.4770	0.4519	0.2427	0.2744	0.2035	0.2732
2016	0.4820	0.4483	0.2451	0.2768	0.2055	0.2735

"Table III" shows that for urban households, the per capita income polarization index of urban households in China declined slightly during the period of 2010-2016. The family income gap has similar conclusions. In fact, from the perspective of changes in income polarization, the average growth rate of the Gini coefficient is -1.2%, the FW index is -1.5%, and the DER index is -2.7%, which indicates that there is a multi-level differentiation in the income of Chinese urban residents. However, the trend of worsening income distribution has been improved.

TABLE IV.   THE RECOGNITION-ALIENATION DECOMPOSITION OF CHINA URBAN HOUSEHOLDS INCOME IN THE YEAR OF 2010－2016

Year	DER(α=1)			DER(α=0.5)		
	Feeling of alienation	*Feeling of recognition*	*Correlation coefficient*	*Feeling of alienation*	*Feeling of recognition*	*Correlation coefficient*
2010	0.499725	0.551389	-0.201022	0.499725	0.682168	-0.17346
2012	0.493621	0.497357	-0.170721	0.493621	0.656601	-0.15316
2014	0.477002	0.479823	-0.129575	0.477002	0.637718	-0.11062
2016	0.482	0.47798	-0.125616	0.482	0.635538	-0.11501

"Table IV" further gives the polarization breakdown results obtained from the recognition-alienation analysis framework. The results show that the polarization identification index of per capita income of urban households in China has declined slightly, and the index of alienation has also tended to decrease. Generally speaking, the sense of identity within a group measures the strength of the local clustering phenomenon of income groups, and its decline indicates that the local clustering phenomenon in the income distribution is weakened, that is, the degree of polarization within different groups is reduced. The sense of alienation between groups measures the local distance between different income groups, which is equivalent to the Gini coefficient to a certain extent, and its decline indicates that the polarization between different income groups tends to be alleviated. As a result, the measurement of income polarization index and the recognition-alienation decomposition results show that the widening of the income gap of urban households in China could be the main factor of income polarization, but the mobility and internal differentiation among different income groups have slowed down.

B. The dynamic decomposition of China urban households income

Static analysis and comparison of household income polarization is not comprehensive enough, and the time factor occupies an important status in many comparative analyses. Therefore, according to the Shapley value decomposition idea, this paper dynamically decomposed the income multi-polarization DER (α = 0.5) index to decompose the polarization effects of urban household income in China into growth effects and redistribution effects.

TABLE V.   THE DYNAMIC DECOMPOSITION OF CHINA URBAN HOUSEHOLDS INCOME IN THE YEAR OF 2010－2016

Period	2010－2012			2012－2014		
Dynamic decomposition factor	*Growth effect*	*Re-distribution effect*	*Polarization change effect*	*Growth effect*	*Re-distribution effect*	*Polarization change effect*
	-0.003	-0.004	-0.007	-0.013	0.010	-0.003
Period	**2014－2016**			**2010－2016**		
Dynamic decomposition factor	*Growth effect*	*Re-distribution effect*	*Polarization change effect*	*Growth effect*	*Re-distribution effect*	*Polarization change effect*
	0.015	-0.015	0.000	0.012	-0.022	-0.010

The results in "Table V" show that during the period of 2010-2012, the polarization of urban household income in China declined, and both the growth effect and the redistribution effect decreased. The reason is that the narrowing of the gap in urban household income growth also comes from the expansion of middle-income groups which has made the distribution of urban household income more reasonable. During the period of 2012－2014, the polarization of urban household income in China still declined, but the reasons for the slowdown of polarization have changed. The increase in urban household income has reduced the degree of polarization of households, but the change in income distribution has increased the extent of polarization. From 2014 to 2016, the polarized growth effect of China's urban household income was obvious, while the redistribution effect had little impact.

To sum up, during the period of 2010－2016, the level of polarization of urban household income in China declined slightly. The dynamic decomposition results show that the increase in household income over time has strengthened the level of income polarization to a certain extent, but at the same time, income growth has made the structure of household income distribution more reasonably reduced the level of polarization.

IV.   CONCLUSION

Based on the 2010－2016 Chinese Family Tracking Survey data, the paper analyzed the characteristics of Chinese urban household income polarization, established a multi-polar DER index in the recognition-alienation analysis framework, and empirically measured the degree and change trend of urban household income polarization in China. The Shapley value is used to dynamically decompose the urban household income polarization index. The empirical research shows that, at first, there is a certain degree of income polarization in China's urban household income, but the

polarization has slowed down. Second, the widening income gap among urban households in China may be a major factor in income polarization, but mobility and internal differentiation among different income groups have improved. Third, the results of the dynamic decomposition of the Shapley value further show that the increase in urban household income in China over time has strengthened the level of income polarization to a certain extent, but at the same time income growth has made the distribution structure of household income more reasonable and slowed down the degree of polarization.

As a rapidly transforming developing country, preventing the polarization of personal income distribution is an inherent requirement for building a harmonious society, and it is also an inherent necessity for people to pursue a better life. Although the empirical evidence shows that the polarization and trend of income distribution of urban households in China have alleviated, it is an indisputable fact that the income gap between urban residents in China continues to widen, and the contradictions between different income groups are becoming more acute as economic growth slows down. Therefore, how to prevent the increasing polarization of income through effective means of income monitoring is another important issue that the authorities must pay attention to while increasing the income level of residents. Of course, in terms of policy implications, the rapid development of the economic level is not the only determinant of the current widening income gap among Chinese urban residents. We need to find out the real main reason, and then apply the right medicine on the income distribution policy to further improve the market and then improve the income distribution system in the course of the economic system. At the same time, we must be alert to the policy guarantee for the basic income of low- and middle-income people in the process of continuous urbanization.

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