Research on Measurement and Early Warning of Redistribution Equity

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Abstract: This paper defines the connotation of redistribution equity, designs the evaluation indicators of redistribution equity, puts forward the measurement of redistribution equity, and constructs the early warning mechanism of redistribution equity. We carry out the measurement and early warning analysis of China's redistribution equity based on the panel data of 31 provinces from 1985 to 2017. The research results show that: (1) the redistribution equity in China is fair on the whole, showing an upward trend, among which our social security is relatively fair, tax burden is fair, and transfer payment is extremely fair. The redistribution equity in the eastern, central and western regions is generally in a fair and extremely fair state. (2) At the present stage and in the next few years, the redistribution equity (as well as the fairness of tax burden, social security and transfer payment) in China and the three major regions is generally in a state of no warning. These findings provide important policy implications.

1. Introduction

Since the reform and opening up, China’s economy has continued to grow, resident income has increased significantly, and our economic and social development has made remarkable achievements. However, the social inequality has also become increasingly prominent, and the income distribution inequality has become more and more serious[1][2], which has affected the harmonious development of economy and society. According to the statistics of the National Bureau of Statistics, the Gini coefficient of national residents’ income was 0.479 in 2003, reached the maximum value (0.491) in 2008, then continued to decline, falling to 0.462 in 2015, and riséd again in the last two years (the Gini coefficient was 0.465 and 0.467 in 2016 and 2017 respectively). The level of income inequality in China has exceeded the warning line, and how to reform the income distribution system and reduce the income inequality has become a significant practical issue for our policy makers and theory circle. The 18th National Congress of the Communist Party of China once again stressed that “both primary distribution and redistribution should give consideration to efficiency and fairness, and redistribution should pay more attention to fairness”. At present, the problem of income distribution in China does not lie in the primary distribution inequality, but lies in the redistribution inequality to some extent. There are few researches on the fairness of tax burden, social security and transfer payment. Therefore, under the background of entering into high-quality development and building a moderately prosperous society in all aspects, this paper explores the redistribution equity evaluation indicators, measurement and early warning mechanism, which is of great significance for us to expand the income distribution theory, comprehensively evaluate our current redistribution equity, and which is also of great significance for government to make scientific and rational regulation policy, promote the fairness of tax burden, social security and transfer payments, maintain social harmony and stability.

2. Literature Review

After several hundred years of development, the theory of distributive justice has put forward many shining thoughts on the connotation, basic principles and ways of realizing distributive justice. However, these theories rarely involve redistribution equity, and rarely involve the related issues...
such as the evaluation indicators, measurement and early warning mechanism of redistribution equity.

2.1. The connotation of redistribution equity

Income redistribution as the main policy to reduce income inequality has been a hot topic in academic circles for many years. Redistribution is a process in which the government readjusts factor income, and it is also an important means for countries to realize income distribution justice. As for the connotation of distributive justice, Tinbergen (1991) summarized it as follows: in terms of primary distribution, distributive justice means that the income obtained by an individual is equal to his contribution to the gross national product. In terms of redistribution, distributive justice equalizes everyone’s welfare. Redistribution equity refers to that the government guarantees the basic living conditions of vulnerable groups, ensures the fairness of tax burden, transfer payment and social security of each social member and moderate income gap between social members through taxation, transfer payment, social security and other redistribution means. Tax burden equity is a fair state that coordinates tax revenue with taxpayers’ economic conditions and ensures balanced tax burden among different taxpayers. The equity of tax burden mainly includes horizontal equity and vertical equity. The former refers to that the taxpayers with the same tax ability should bear the same tax burden. The latter refers to that the taxpayers with different tax ability should bear different tax burden. The important goal of tax burden fairness is to realize income distribution justice. As another dimension of tax equity, exchange equity means the exchange relationship between the government and taxpayers. The taxpayers should be able to enjoy corresponding products and services after paying taxes. Social security means that through legislation the country adopts necessary administrative means to redistribute national income accordingly, and provides necessary, basic and economic security system and relevant measures for those who temporarily or permanently lose the ability to work or those who face living difficulties or survival risks due to various other reasons. As an income redistribution mechanism, the social security system mainly includes social insurance, social assistance, social welfare and social special care and et al. Transfer payment refers to the expenses paid by the government or enterprises to individuals or the lower level governments without compensation to increase their income and purchasing power. Transfer payment reflects the government’s non-market redistribution activities and plays an important role in promoting the coordinated development of regions and realizing the equalization of public services. Caminada et al. (2012) found that the government transfer payment played an obvious role in reducing income inequality in most countries through the analysis of the macro data of 20 countries. Vandyck and Regemorter (2014) found that when the fiscal revenue was used to increase families’ welfare transfer payment, the reform was beneficial to low-income groups.

2.2. Evaluation system of redistribution equity

Most scholars at home and abroad usually use the evaluation indicators of income inequality to express the evaluation indicators of distributive equity, such as the Gini coefficient and Theil index. Since the early Gini coefficient is given in the form of continuous function, people always adopt the Gini coefficient calculation method proposed by Sen (1997) in practice. Theil (1967) introduced the index of inequality, namely Theil index, and established the relationship between the Generalized entropy index and Theil index. Shorrocks (1980) demonstrated a class of additively decomposable inequality measures—Generalized entropy index GE. Due to some defects in Gini coefficient and Entropy index, Sen (2004) proposed the Capability index, and Almas et al. (2011) proposed to use the Generalized Gini coefficient to measure income distribution inequality. Otto (2014) used the random process to simulate the income function to get the variance of income, and used the variance to measure the income distribution inequality. Amarante (2014) comprehensively reflected the income distribution justice by using such indicators as income share of production factors, income inequality of individual families, personal income and property tax and et al. The existing researches seldom involve the evaluation indicators and measurement of redistribution equity. Most of the methods commonly used to measure the income distribution...
justice and the progressive taxation are related to Lorenz curve and the Gini coefficient derived from it. It is generally believed that progressive tax structure can improve the degree of income distribution inequality, and whether the tax system is more progressive and whether tax policies make income distribution more equitable can be measured by calculating the progressive tax index\(^\text{[17]}\). By setting corresponding index, Suits (1977) calculated the Lorenz distribution of income and tax burden or the Gini coefficient which represents distribution inequality\(^\text{[18]}\). Sun and Zhao (2017) constructed an evaluation index system of distributive justice from primary distributive equity and redistribution equity, and proposed the measurement of income distributive justice based on the Gini coefficient\(^\text{[4]}\)\(^\text{[20]-[21]}\).

2.3. Early warning of redistribution equity

The theoretical circle rarely involves the early warning of income distribution. Kaminsky et al. (1998) proposed an early warning system to monitor currency crisis (namely KLR signal approach)\(^\text{[19]}\). Yang et al. (2001) constructed a loan risk warning model and proposed financial risk warning management countermeasures\(^\text{[20]}\). Koyuncugil et al. (2012) constructed a financial risk warning model based on data mining\(^\text{[21]}\). There are rare researches that applying the economic early warning method to the early warning of income distribution. Lu and Tian (2007) constructed an early warning system of income gap\(^\text{[22]}\). Gu and Wang (2009) conducted the analysis of warning degree and warning condition and dynamic monitoring of the income gap between urban and rural residents in China\(^\text{[23]}\). Sun and Gu (2010) constructed an early warning system of the industrial income gap by clarifying the warning situation, finding the warning source, analyzing the warning signs, determining the warning boundary and forecasting the warning degree, then carried out the early warning analysis of the industrial income gap of Zhejiang Province\(^\text{[24]}\). Yang and Cao (2012) constructed China’s residents’ income monitoring system from three aspects: early warning system, warning division and warning response\(^\text{[25]}\). Mu (2014) proposed the idea of “constructing the risk early-warning mechanism of non-equal income poverty index\(^\text{[26]}\). Sun (2014) constructed an early warning mechanism for the appropriateness of income gap from the single index early warning and comprehensive index early warning, and conducted early warning analysis on the appropriateness of income gap in China\(^\text{[27]}\)\(^\text{[38]-[47]}\). Wang and Liu (2017) put forward an early warning system and control mechanism for residents’ income gap in Jiangsu Province\(^\text{[28]}\).

The literatures above provide beneficial reference for us to further discuss the connotation, evaluation indicators, measurement and early warning of the redistribution equity. However, there still some issues should be further discussed. For example, the connotation of distributive justice is often limited to outcome justice, and rarely involves the fairness of tax burden, social security and transfer payment. The evaluation indicators and measurement of distributive equity are mainly aimed at the outcome inequality and seldom involve the evaluation indicators and measurement of redistribution equity. The early warning researches of income distribution justice also focus on the early warning of result inequality (such as the Gini coefficient early warning), and do not involve the early warning mechanism of redistribution equity.

Compared with the existing researches, the main contributions of this paper are as follows: First, this paper defines the connotation of redistribution equity based on the existing research achievements, and constructs an evaluation indicator system of redistribution equity from the fairness of burden tax, social security and transfer payment. Second, on the basis of the Gini coefficient, this paper puts forward the measurement of redistribution equity by using comprehensive evaluation method, and carries out measurement of redistribution equity (as well as the fairness of tax burden, social security and transfer payment) in the whole country and the three major regions in the east, central and west. The evaluation indicators and measurement are put forward according to the measurement of distribution inequality and modern statistical method, which is helpful for us to comprehensively evaluate China's redistribution equity. It is scientific and operable. Third, this paper constructs the early warning mechanism of the redistribution equity by clarifying the warning situation, finding the warning source, analyzing the warning signs, determining the warning limit, forecasting warning degrees and eliminating warning, then carries out the early warning of our
country’s redistribution equity, which provides an empirical evidence for government to formulate scientific and reasonable control measures. The above mentioned issues are not involved in the existing related research.

3. Evaluation Indicators, Measurement and Early Warning Mechanism of Redistribution Equity

Redistribution equity in this paper means that using the policy tools such as tax, social security, transfer payment through the redistribution of national income to satisfy the basic living needs of the social members, maintain moderate income gap between social members, and realize the fairness of tax burden, social security and transfer payment between social members.

3.1. Evaluation indicators of redistribution equity

This paper constructs three second-class evaluation indicators, namely tax burden fairness, social security fairness and transfer payment fairness as the evaluation indicator system of redistribution equity.

Tax equity includes horizontal equity, vertical equity and exchange equity. Horizontal equity means that taxpayers with the same tax capacity or economic conditions should pay the same share of tax. This paper sets the proportion of individual income tax, the proportion of investment income tax, personal income tax elasticity, investment income tax elasticity as proxy indicators of horizontal equity. Vertical equity means that taxpayers with different tax capacity or economic conditions should pay different shares of tax. According to tax capacity or economic conditions, taxpayers are divided into three basic levels, namely, high-income class, medium-income class and low-income class. According to the principle of diminishing marginal utility, the utility loss caused by the same amount of tax is much smaller for high-income people than for low-income people. Conversely, subsidies of the same amount have a much greater positive effect on the poor than on the rich. Therefore, vertical equity can be reflected by the matching degree between income difference and tax burden of different class. This paper sets tax burden differences between high income and middle income, high income and low income, and middle income and low income as proxy indicators of vertical equity. Exchange equity reflects the transaction relationship between taxpayers and the government. For taxpayers, their input is the tax paid, while their output is the return they get from the government. Therefore, the ratio of public services, public infrastructure, and social welfare to tax revenue can be used as proxy indicators of exchange fairness. In addition, this paper also sets the ratio of government revenue to GDP as the proxy indicator of macro tax burden.

As an important part of redistribution policy, social security has the function of ensuring the right to life of those who live in poverty. Social security system is a good policy tool for the country to realize distribution justice. China’s social security system mainly includes social insurance, social assistance, social welfare and social special care and et al. Social security fairness evaluation indicators mainly compose of social insurance fairness indicators (consists of endowment insurance coverage, unemployment insurance coverage, medical insurance coverage, injury insurance coverage, birth insurance coverage), social assistance and social welfare fairness indicators (consists of number of social welfare institutions per 10,000 population, the ratio of social security expenditure to GDP, social security expenditure per capita, the ratio of pensions to retired employees per capita to average wage of worker, the ratio of population under the security line for minimum subsistence, the relative ratio of urban and rural low-income workers).

Transfer payment is a form of income redistribution, mainly including government transfer payments (such as the government’s transfer payment to individuals and agricultural product price subsidies), enterprise transfer payments (such as grants or donations of enterprises to non-profit organization), intergovernmental transfer (such as subsidies from governments at higher levels to governments at lower levels). Transfer payment evaluation indicators consist of transfer payment per capita under the security line for minimum subsistence, the proportion of government transfer payment (subsidy) to enterprises, the proportion of government transfer payment to individuals, the
proportion of enterprise transfer payment, the ratio of financial transfer payments and special transfer payments to local fiscal revenue, and the proportion of agricultural price subsidy. The evaluation indicator system of redistribution equity is shown in Table 1.

Table 1. The evaluation indicator system of redistribution equity

<table>
<thead>
<tr>
<th>Second-class indicators</th>
<th>Third-class indicators meaning and calculation formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation indicators of tax burden fairness</td>
<td>Macro tax burden (the ratio of government revenue to GDP), personal income tax elasticity (the ratio of the growth rate of individual income tax to the growth rate of resident income), enterprises income tax elasticity (the ratio of the growth rate of enterprise income tax to the growth rate of enterprise income), the proportion of individual income tax (the ratio of individual income tax to total tax revenues), the proportion of enterprise income tax (the ratio of enterprise income tax to total tax revenues), tax burden differences between high income and middle income (the ratio of the tax burden of high-income to middle-income groups), tax burden differences between high income and low income (the ratio of the tax burden of high-income to low-income groups), tax burden differences between middle income and low income (the ratio of the tax burden of middle-income to low-income groups), the proportion of public services to tax (the ratio of expenditure on public services to total tax revenues)*</td>
</tr>
<tr>
<td>Evaluation indicators of social security</td>
<td>Social insurance fairness (benefit distribution index, the number of public transfers to total transfers), medical insurance coverage (number of people covered by medical insurance/total population), unemployment insurance coverage (number of people insured by unemployment insurance/total number of employees, the same below), injury insurance coverage, birth insurance coverage, social assistance and social welfare fairness (the ratio of social security expenditure to GDP (replaced by the ratio of social security expenditure to fiscal expenditure due to the availability of the data), social security expenditure per capita, the ratio of pensions to retired employees per capita to average wage of worker, the ratio of population under the security line for minimum subsistence (number of population under the security line for minimum subsistence/total population), number of social welfare institutions per 10,000 population*, the relative ratio of urban and rural low-income workers (the proportion of urban residents entitled to basic living allowances/the proportion of rural residents entitled to basic living allowances j)*</td>
</tr>
<tr>
<td>Evaluation indicators of transfer payment</td>
<td>Transfer payment per capita under the security line for minimum subsistence, the proportion of government transfer payment (subsidy) to enterprises (total amount of government transfer payments to individuals/total amount of transfer payments), the proportion of government transfer payment to individuals (total amount of government transfer payments to individuals/total amount of transfer payments), the proportion of enterprise transfer payment (total amount of enterprise grants or donations to non-profit organizations/total transfer payments)<em>, the ratio of financial transfer payments and special transfer payments to local fiscal revenue</em>, the proportion of agricultural price subsidy (total agricultural price subsidy/total transfer payments)*</td>
</tr>
</tbody>
</table>

Note: Missing data with "*".

In the evaluation indicators of redistribution equity, some indicators, such as the positive indicators, we hope it to be much bigger. However some indicators, such as the negative indicators, we hope it to be much smaller. When dealing with the relationship between these indicators, it is necessary to handle them positively according to their properties.

3.2. Measurement of redistribution equity

The most common method to measure the distributive justice is the Gini coefficient, which is also one of the most widely used indicators by scholars at home and abroad. In this paper, we use the calculation method proposed by Sen (1977) to obtain the fairness degree of each indicator by calculating the Gini coefficient. The specific calculation formula is as follows:

\[
G_{ijt} = \frac{2}{q \mu} \sum_{k=1}^{p} (1 - \frac{q + 1}{2}) a_{ijkt} 
\]

(1)

\[
REDF_{ijt} = 1 - G_{ijt} 
\]

(2)

where \(a_{ijkt}\) is the observed value of of the jth third class indicator of the ith second class indicator of province k in year t (ranked from low to high), \(i=1,2,\ldots,n; j=1,2,\ldots,n; k=1,2,\ldots,p; t=1,2,\ldots,T; \mu = \frac{1}{p} \sum_{k=1}^{p} a_{ijkt}\) as the mean value; \(G_{ijt}\) is the Gini coefficient of the jth third class indicator of the ith second class indicator in year t, \(REDF_{ijt}\) is the fairness degree of the corresponding third class indicator. The fairness degree of second class indicator can be determined by linear weighted evaluation function\(^{29,30}\):

\[
REDF_{it} = \sum_{j=1}^{n} w_{ij} REDF_{ijt} 
\]

(3)
where \( w_{ij} = \frac{\sigma_{ij}}{\sum_{j=1}^{n} \sigma_{ij}} \) is the contribution rate of standard deviation \( \sigma_{ij} \) of redistribution

\[
REDF_{ij}^{\mu}, \sigma_{ij} = \frac{1}{T-1} \sum_{t=1}^{T} \left( REDF_{ij} - \overline{REDF}_{ij} \right)^2, \quad \overline{REDF}_{ij} = \frac{1}{T} \sum_{t=1}^{T} REDF_{ij}.
\]

The fairness degree of redistribution (first-class indicator) can be determined by the geometric weighted evaluation function:

\[
REDF_i = \prod_{i=1}^{m} REDF_{i,j}^{w_i}
\]  

Where \( w_i \) is the contribution rate of standard deviation \( \sigma_{ij} \) of \( REDF_i \) \((t=1,2,\ldots,T)\), the calculation method is similar to \( w_{ij} \). The fairness degree of redistribution equity \( REDF_i \) \( \in [0,1] \), which is closer to 1 means the higher fairness of redistribution, while is closer to zero means the lower fairness of redistribution. Referring to the income inequality classification by Gini coefficient, we make the following classification according to the redistributive fairness degree: when \( 0 < REDF_i \leq 0.5 \), redistribution is extremely unfair; when \( 0.5 < REDF_i \leq 0.6 \), redistribution is relatively unfair; when \( 0.6 < REDF_i \leq 0.7 \), redistribution is relatively fair; when \( 0.7 < REDF_i \leq 0.8 \), redistribution is fair; when \( 0.8 < REDF_i \leq 1 \), redistribution is extremely fair \(^{[4][21]}\).

3.3. Early warning mechanism of redistribution equity

Early warning mechanism is a full set of early warning and forecasting mechanism for warning objects, which mainly includes design and quantization of early warning indicators, collection and analysis of economic early warning information (warning source, warning situation, warning signs), setting warning area (warning limit), analysis and judgment of type of warning level (warning degree), transmission and submission of early warning information, setting and implementation of pre-arranged planning \(^{[30][39]}\). Early warning of redistribution equity refers to the monitoring and evaluation of the future evolution trend of redistribution equity system, and the early warning of possible problems in the future operation of redistribution equity system, so as to provide decision basis for preventing or resolving the risks of redistribution equity system in advance. The basic process is as follows:

First, we should clarify the warning situation. Warning situation is the object of monitoring and warning, the content of monitoring and forecasting, and the abnormal situation in the process of system development. It is the first step to construct the early warning mechanism, and it is necessary to find appropriate indicators to measure the warning situation. For the single indicator of redistribution fairness warning, we first select \( REDF_i \) \((i=1,2,3,\ldots,m)\), representing tax burden fairness, social security fairness, and transfer payment fairness respectively) as the indicator to reflect the warning situation. Then, we construct ARIMA \((p, d, q)\) model to judge the future development trend of redistribution equity \(^{[31][28][30][294]}\).

\[
\Delta REDF_i = \varphi_0 \Delta REDF_{i-1} + \varphi_1 \Delta REDF_{i-2} + \cdots + \varphi_p \Delta REDF_{i-p} + u_i + \theta_q u_{i-1} + \theta_{q-1} u_{i-2} + \cdots + \theta_q u_{i-q}
\]  

where \( p \) and \( q \) are orders of autoregression model and moving average model, and \( d \) is single integral order of \( REDF_i \). ARIMA model was used for prediction. The prediction period was \( r \), and the predicted value was \( \hat{REDF}_i \) \((t=t+1, t+2,\ldots, T+r)\), using geometric weighted average method to obtain the predicted value of redistribution equity (warning indicator).

Secondly, we should find the warning source, and analyze the warning signs (mainly for comprehensive indicator warning). The warning source is the source of warning. Finding warning sources is the start of the warning process. Warning sources can be generally divided into exogenous and endogenous sources. Warning sign refers to the sign before the outbreak of warning
caused by abnormal changes in warning indicators. Warning indicator, also known as leading indicator, is a kind of warning indicator that can directly provide warning signal. The warning indicator is the result of the warning source indicator and constitutes the main body of the warning indicator system.

Thirdly, we should divide the warning limit. Dividing warning limit is the key link in early warning process. Warning area and warning point are called warning limit. The warning area is the range of warning signs. Warning point is the cut-off point of early warning, which is the critical point of quantitative change to qualitative change. It is a warning boundary between safety and danger. Since redistribution equity is non-negative, the theoretical minimum value is set at 0, and the closer it is to 1, the higher the fairness. According to the warning limit classification method of $3\sigma^{[32]}_{37-40}$, the redistribution equity warning area is divided into five interval. By subdividing the warning area, we divide the warning area to no warning area, light warning area, medium warning area, heavy warning area and huge warning area, and then use different colors, namely blue, green, yellow, orange, red, which represent no warning, light warning, medium warning, heavy warning, huge warning respectively. The division of redistribution equity warning area is shown in table 2.

<table>
<thead>
<tr>
<th>Early warning situation</th>
<th>Huge warning area</th>
<th>Heavy warning area</th>
<th>Medium warning area</th>
<th>Light warning area</th>
<th>No warning area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early warning area</td>
<td>$[0, \mu-3\sigma]$</td>
<td>$[\mu-3\sigma, \mu-2\sigma]$</td>
<td>$[\mu-2\sigma, \mu-\sigma]$</td>
<td>$[\mu-\sigma, \mu]$</td>
<td>$[\mu, 1]$</td>
</tr>
<tr>
<td>Redistribution equity</td>
<td>Extremely unfair</td>
<td>Relatively unfair</td>
<td>Relatively fair</td>
<td>Fair</td>
<td>Extremely fair</td>
</tr>
<tr>
<td>Warning sign</td>
<td>Red</td>
<td>Orange</td>
<td>Yellow</td>
<td>Green</td>
<td>Blue</td>
</tr>
</tbody>
</table>

Note: $\mu$ and $\sigma$ represent the mean and standard deviation of redistribution equity.

Fourth, we should forecast warning degree and eliminate warning. Warning degree is the severity of warning, which is a description of the harm extent of warning results. With reference to the warning limit, using qualitative and quantitative methods, we forecast the severity of the actual warning. Warning degree can be divided into five levels: no warning degree, light warning degree, medium warning degree, heavy warning degree and huge warning degree. The warning graph can be represented by blue light area, green light area, yellow light area, orange light area and red light area respectively. The corresponding warning levels are shown as high safety, safety, worthy of attention, danger and high danger. According to the size of warning degree, formulate countermeasures to eliminate the warning.

4. Measurement and Early Warning of Redistribution Equity in China

The data in this paper is from China Statistical Yearbook, Compilation of Statistical Data of 60 Years of New China, and Statistical Yearbooks of all provinces over the years. In view of the missing annual data of some indicators, this paper uses linear extrapolation to fit the missing year data.

4.1. Measurement of redistribution equity in China

Table 3 shows the calculation results of redistribution equity of the whole country and the three major regions from 1985 to 2017. As can be seen from table 3, the average value of redistribution equity is 0.7274, indicating that China’s redistribution equity is in a relatively fair state on the whole. The degree of redistribution equity increased from 0.533 in 1985 to 0.8131 in 2017, that is to say, our redistribution equity increased from a relatively unfair state to an extremely fair state, showing an upward trend. However, it shows different characteristics in different periods: from 1985 to 1988, our redistribution equity was in a relatively unfair state (the reason was that the fairness of social security was in an extremely unfair state in these years), and from 1989 to 1995, it was in a relatively fair state (the fairness of social security was in a relatively unfair state in these years). From 1996 to 2005, it was in a fair state, and it was in an extremely fair state from 2006 to 2017.
(slightly down from 2009 to now).

Table 3. Calculation results of redistribution equity

| Year | Redistri-
|---|---|
| 1985 | Redistri-
| 1996 | Redistri-
| 2001 | Redistri-
| 2005 | Redistri-
| 2010 | Redistri-
| 2015 | Redistri-
| 2020 | Redistri-
| 2025 | Redistri-
| 2030 | Redistri-
| 2035 | Redistri-
| 2040 | Redistri-
| 2045 | Redistri-
| 2050 | Redistri-
| 2055 | Redistri-
| 2060 | Redistri-
| 2065 | Redistri-
| 2070 | Redistri-
| 2075 | Redistri-
| 2080 | Redistri-
| 2085 | Redistri-
| 2090 | Redistri-
| 2095 | Redistri-
| 2010 | Redistri-
| 2015 | Redistri-
| 2020 | Redistri-
| 2025 | Redistri-
| 2030 | Redistri-
| 2035 | Redistri-
| 2040 | Redistri-
| 2045 | Redistri-
| 2050 | Redistri-
| 2055 | Redistri-
| 2060 | Redistri-
| 2065 | Redistri-
| 2070 | Redistri-
| 2075 | Redistri-
| 2080 | Redistri-
| 2085 | Redistri-
| 2090 | Redistri-
| 2095 | Redistri-
| 2010 | Redistri-
| 2015 | Redistri-
| 2020 | Redistri-
| 2025 | Redistri-
| 2030 | Redistri-
| 2035 | Redistri-
| 2040 | Redistri-
| 2045 | Redistri-
| 2050 | Redistri-
| 2055 | Redistri-
| 2060 | Redistri-
| 2065 | Redistri-
| 2070 | Redistri-
| 2075 | Redistri-
| 2080 | Redistri-
| 2085 | Redistri-
| 2090 | Redistri-
| 2095 | Redistri-
| 2010 | Redistri-
| 2015 | Redistri-
| 2020 | Redistri-
| 2025 | Redistri-
| 2030 | Redistri-
| 2035 | Redistri-
| 2040 | Redistri-
| 2045 | Redistri-
| 2050 | Redistri-
| 2055 | Redistri-
| 2060 | Redistri-
| 2065 | Redistri-
| 2070 | Redistri-
| 2075 | Redistri-
| 2080 | Redistri-
| 2085 | Redistri-
| 2090 | Redistri-
| 2095 | Redistri-
| 2010 | Redistri-
| 2015 | Redistri-
| 2020 | Redistri-
| 2025 | Redistri-
| 2030 | Redistri-
| 2035 | Redistri-
| 2040 | Redistri-
| 2045 | Redistri-
| 2050 | Redistri-
| 2055 | Redistri-
| 2060 | Redistri-
| 2065 | Redistri-
| 2070 | Redistri-
| 2075 | Redistri-
| 2080 | Redistri-
| 2085 | Redistri-
| 2090 | Redistri-
| 2095 | Redistri-

From the three-third class indicators of redistribution equity, the average value of our tax burden fairness, social security fairness and transfer payment from 1985-2017 is 0.7662, 0.6413 and 0.8109 respectively, which indicates that China’s tax burden fairness, social security fairness and transfer payment fairness are in a relatively fair, fair and extremely fair state in general, and the transfer payment fairness is the highest, the tax burden fairness is much higher (except for 1985, 2001-2004, 2007), and the social security fairness is low (the reason is that the ratio of population under the social security line for minimum subsistence, medical insurance coverage, injury insurance coverage and birth insurance coverage rate are low). The tax burden fairness increased from 0.8669 in 1985 to 0.8164 in 2017, that is, the tax burden fairness increased from a relatively unfair state to an extremely fair state, showing an upward trend. From 1985 to 1986, our tax burden was relatively unfair, and from 1987 to 1992, it was relatively fair. The reason was that the fair degree of the proportion of individual income tax in these years was relatively low. The years from 1993 to 2000 and 2013 were fair, while the other years were extremely fair. Since 2007, our tax burden fairness decreased from 0.8744 to 0.8164, showing a downward trend (which was related to the decline of the fair degree of individual income tax in these years).

The social security fairness increased from 0.4587 in 1985 to 0.7652 in 2017, that is, from very unfair to fair, and the overall trend was on the rise. From 1985 to 1987, the social security was in an extremely unfair state, from 1988 to 1996 it was relatively unfair (the reason was that the social security expenditure per capita, the ratio of population under the social security line for minimum subsistence, medical insurance coverage, injury insurance coverage, birth insurance coverage were in a relatively unfair and extremely unfair state), from 1997 to 2004 it was relatively fair, and from 2005 to 2017 it was fair.

The transfer payment fairness increased from 0.5823 in 1985 to 0.8756 in 2017, that is, from relatively unfair to extremely fair, and the overall trend was on the rise. The transfer payment fairness was relatively unfair in 1985, relatively fair in 1986-1988 (the reason was that the proportion of government transfer payment to individuals was relatively low in these years), fair in
1989 to 1992, 2000 to 2002 and 2004, and extremely fair in other years. The trend of redistribution equity is shown in figure 1.

Figure 1. Trend chart of redistribution equity

In terms of the three major regions, the average value of redistribution equity in the eastern, central and western regions of China is 0.7209, 0.8323 and 0.7616 from 1985 to 2017, indicating that the redistribution equity in the eastern, central and western regions is generally in a relatively fair, extremely fair and fair state respectively, and shows an upward trend. The redistribution equity is relatively high in the central region, followed by the western region and relatively low in the eastern region. Among them, the redistribution equity in the eastern region was relatively unfair from 1985 to 1988, relatively fair from 1989 to 1996, fair from 1997 to 2006, and extremely fair from 2007 to 2017 (a slight decline in recent years). The redistribution equity in the central region was relatively fair in 1985, fair from 1986 to 1993 and 1995 to 1996, and extremely fair in 1994 and from 1997 to 2017. The redistribution equity in the western region was relatively unfair from 1985 to 1987, relatively fair from 1988 to 1994, fair from 1995 to 2000, and extremely fair from 2001-2017. The details are shown in figure 2.

Figure 2. Comparison of redistribution equity in eastern, central and western regions

4.2. Early warning of redistribution equity in China

According to the warning process of redistribution equity, we first establish ARIMA (p, d, q) model for the time series REDF_i (i=1, 2, 3, on behalf of the tax burden fairness, social security fairness, transfer payment fairness respectively) to obtain the predicted value of REDF_i, then use geometrical weighted average method to get the predicted value, mean value, and standard deviation of redistribution equity REDF_i. The predicted results of redistribution equity are shown in table 4.

<table>
<thead>
<tr>
<th>Year</th>
<th>Redistribution equity</th>
<th>Redistribuition equity</th>
<th>Redistribuition equity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tax burden fairness</td>
<td>Social security fairness</td>
<td>Transfer payment fairness</td>
</tr>
<tr>
<td>2018</td>
<td>0.8162</td>
<td>0.8210</td>
<td>0.7712</td>
</tr>
<tr>
<td>2019</td>
<td>0.8202</td>
<td>0.8223</td>
<td>0.7799</td>
</tr>
<tr>
<td>2020</td>
<td>0.8221</td>
<td>0.8254</td>
<td>0.7828</td>
</tr>
<tr>
<td>2021</td>
<td>0.8246</td>
<td>0.8275</td>
<td>0.7880</td>
</tr>
<tr>
<td>2022</td>
<td>0.8241</td>
<td>0.8210</td>
<td>0.7926</td>
</tr>
<tr>
<td>μ</td>
<td>0.7397</td>
<td>0.7738</td>
<td>0.6599</td>
</tr>
<tr>
<td>σ</td>
<td>0.0885</td>
<td>0.0833</td>
<td>0.1069</td>
</tr>
</tbody>
</table>

Note: The mean value μ and standard deviation σ refer to the mean and standard deviation of redistribution equity and its second class indicators from 1985 to 2022.
According to the predicted results of the redistribution equity and its second class indicators, in the next few years, the redistribution equity and social security will steadily increase, the tax burden fairness will first increase and then decrease, but the change range is small, while the fairness of transfer payment will drop slightly. In the next few years, the redistribution equity in the western region will rise steadily, the eastern region will rise slightly, and the central region will fall slightly, as shown in table 4.

According to the calculation and predicted results of redistribution equity shown in table 3 and table 4, based on the principles of majority no warning, using the method of 3σ, we get redistribution equity REDF (and tax burden fairness REDF₁, social security fairness REDF₂, transfers payment fairness REDF₃) single indicator warning area, and warning signals can be shown by red, orange, yellow, green, and blue. The details are shown in table 5.

Table 5. Warning area of the redistribution equity and its second-class indicators

<table>
<thead>
<tr>
<th>Warning situation</th>
<th>Huge warning area</th>
<th>Heavy warning area</th>
<th>Medium warning area</th>
<th>Light warning area</th>
<th>No warning area</th>
</tr>
</thead>
<tbody>
<tr>
<td>REDF in the whole country</td>
<td>[0, 0.4792)</td>
<td>[0.4792, 0.5665)</td>
<td>[0.5665, 0.6538)</td>
<td>[0.6538, 0.7412)</td>
<td>[0.7412, 1]</td>
</tr>
<tr>
<td>REDF₁</td>
<td>[0, 0.5240)</td>
<td>[0.5240, 0.6073)</td>
<td>[0.6073, 0.6905)</td>
<td>[0.6905, 0.7738)</td>
<td>[0.7738, 1]</td>
</tr>
<tr>
<td>REDF₂</td>
<td>[0, 0.3393)</td>
<td>[0.3393, 0.4462)</td>
<td>[0.4462, 0.5530)</td>
<td>[0.5530, 0.6599)</td>
<td>[0.6599, 1]</td>
</tr>
<tr>
<td>REDF₃</td>
<td>[0, 0.5890)</td>
<td>[0.5890, 0.6657)</td>
<td>[0.6657, 0.7424)</td>
<td>[0.7424, 0.8190)</td>
<td>[0.8190, 1]</td>
</tr>
<tr>
<td>East REDF</td>
<td>[0, 0.4641)</td>
<td>[0.4641, 0.5542)</td>
<td>[0.5542, 0.6443)</td>
<td>[0.6443, 0.7344)</td>
<td>[0.7344, 1]</td>
</tr>
<tr>
<td>Central REDF</td>
<td>[0, 0.6380)</td>
<td>[0.6380, 0.7053)</td>
<td>[0.7053, 0.7726)</td>
<td>[0.7726, 0.8399)</td>
<td>[0.8399, 1]</td>
</tr>
<tr>
<td>West REDF</td>
<td>[0, 0.4623)</td>
<td>[0.4623, 0.5668)</td>
<td>[0.5668, 0.6713)</td>
<td>[0.6713, 0.7758)</td>
<td>[0.7758, 1]</td>
</tr>
<tr>
<td>Warning signal</td>
<td>Red</td>
<td>Orange</td>
<td>Yellow</td>
<td>Green</td>
<td>Blue</td>
</tr>
</tbody>
</table>

According to the calculation and predicted results of the redistribution equity in table 3 and table 4, combined with the single indicator warning area of the redistribution equity in table 5, we obtain the forecast results of the warning degree of China’s redistribution equity from 1985 to 2022. The details are shown in table 6.

Table 6. Warning degree forecast of redistribution equity and its second-class indicators in China from 1985 to 2022

<table>
<thead>
<tr>
<th>Year</th>
<th>Redistribut ion equity</th>
<th>Tax burden fairness</th>
<th>Social security fairness</th>
<th>Transfer payment fairness</th>
<th>East</th>
<th>Central</th>
<th>West</th>
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</thead>
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<tr>
<td>1985</td>
<td>Heavy warning</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Huge</td>
<td>Heavy</td>
<td>Heavy</td>
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<tr>
<td>1986</td>
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<td>Medium</td>
<td>Heavy</td>
<td>Medium</td>
<td>Heavy</td>
<td>Heavy</td>
</tr>
<tr>
<td>1987</td>
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<td>Heavy</td>
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<td>1990</td>
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<td>1991</td>
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</tr>
</tbody>
</table>

According to the forecast results of warning degree in table 6, we can get the following conclusion:

First, the mean value of redistribution equity in China from 1985 to 2022 is 0.7397, which is generally in a state of no warning. To be specific, the redistribution equity was in a state of heavy warning from 1985 to 1986, medium warning from 1987 to 1991, and redistribution equity in these years was between relatively unfair and relatively fair. From 1992 to 2002, it was in a state of light warning, and from 2003 to 2022, it was in a state of no warning, and the redistribution equity was relatively high in these years, between fair and extremely fair.

Second, from 1985 to 2022, the mean value of the three second-class indicators of redistribution
equity in China, namely, tax burden fairness, social security fairness and transfer payment fairness, is 0.7662, 0.6413 and 0.8109 respectively, which are generally in a state of no warning. To be specific, the tax burden fairness was in a state of heavy warning from 1985 to 1986, and medium warning from 1987 to 1991. In these years, the tax burden fairness was between relatively unfair and relatively fair. From 1992 to 1997, it was in a state of light warning, and no warning from 1998 to 2022. The social security fairness was in a state of heavy warning in 1985 and medium warning from 1986 to 1992. The social security fairness in these years was between extremely unfair and relatively unfair. From 1993 to 2002, it was in a state of slight warning and it was in a state of no warning from 2003 to 2022. The early-warning status of transfer payment fairness fluctuates greatly. In 1985, it was in a state of huge warning, and from 1985 to 1987, it was in a state of heavy warning. The transfer payment fairness in these years was between relatively unfair and relatively fair. From 1988 to 1989, it was in a state of medium warning, and it was in a state of light warning from 1990 to 1992, 1997 to 2004. It was in a state of no warning in other years, and the transfer payment fairness in these years was extremely fair.

Third, from 1985 to 2022, the mean value of redistribution equity in the three regions of east, central and west in China were 0.7209, 0.8323 and 0.7616 respectively, which were generally in a state of no warning. To be specific, the redistribution equity in the eastern region was in a state of heavy warning in 1985, medium warning from 1986 to 1991, light warning from 1992 to 1999, and no warning from 2000 to 2022 (the redistribution fairness in these years was relatively fair and extremely fair). The redistribution equity in the central region was in a state of heavy warning from 1985 to 1986, medium warning from 1987 to 1990, light warning from 1991 to 2002, and no warning from 2003 to 2022 (the redistribution equity in these years was extremely fair). In the western region, the redistribution equity was in a state of heavy warning from 1985 to 1986, medium warning from 1987 to 1992, light warning from 1993 to 2000, and no warning from 2001 to 2022 (the redistribution equity in these years was extremely fair).

From the above warning results we can see that the redistribution equity (as well as the fairness of tax burden, social security and transfer payment) of the whole country and the three major regions is generally in a state of no warning at the present stage and in the next few years, operating within the blue range of no warning.

5. Research Conclusions and Policy Implications

According to the measurement and warning process of redistribution equity, this paper conducts measurement and early warning analysis of redistribution equity in China, and obtains the following research conclusions and policy implications based on the panel data of 31 provinces from 1985 to 2017.

5.1. Research conclusions

Conclusion 1: The redistribution equity in China is in a fair state on the whole, showing an upward trend. Among them, the redistribution equity in the eastern, central and western regions is generally between fair and extremely fair. The research results show that the degree of redistribution equity increased from 0.533 in 1985 to 0.813 in 2017, that is to say, our redistribution equity increased from a relatively unfair state to an extremely fair state, showing an upward trend. Our redistribution equity was in a relatively unfair state (the reason was that the social security fairness was in an extremely unfair state in these years) from 1985 to 1988, and it was in a relatively fair state from 1989 to 1995. From 1996 to 2005, it was in a fair state, and it was in an extremely fair state from 2006 to 2017 (slightly down from 2009 to now, the reason was that our social security fairness decreased in these years). In terms of the three major regions, the average value of redistribution equity in the eastern, central and western regions of China is 0.7209, 0.8323 and 0.7616 from 1985 to 2017, indicating that the redistribution equity in the eastern, central and western regions is generally in a relatively fair, extremely fair and fair state respectively, and shows an upward trend. The redistribution equity is relatively high in the central region, followed by the western region and relatively low in the eastern region.
Conclusion 2: China's social security fairness is generally in a relatively fair state, the tax burden fairness is in a fair state, and the transfer payment fairness is in an extremely fair state, all showing an upward trend. The research results show that the average value of our tax burden fairness, social security fairness and transfer payment from 1985-2017 is 0.7662, 0.6413 and 0.8109 respectively, which indicates that China's transfer payment fairness is higher, in an extremely fair state, followed by tax burden fairness, in a fair state, and social security fairness is low, in a relatively fair state. From 1985 to 1986, our tax burden was relatively unfair, and from 1987 to 1992, it was relatively fair (the reason was that the fair degree of the proportion of individual income tax in these years was relatively low). The years from 1993 to 2000 and 2013 were fair, while the other years were extremely fair. Since 2007, our tax burden fairness showed a downward trend (which was related to the decline of the fair degree of individual income tax in these years). From 1985 to 1987, the social security was in an extremely unfair state, from 1988 to 1996 it was relatively unfair (the reason was that social security expenditure per capita, the ratio of population under the security line for minimum subsistence, medical insurance coverage, injury insurance coverage, birth insurance coverage are in a relatively unfair and extremely unfair state), from 1997 to 2004 it was relatively fair, and from 2005 to 2017 it was fair. The transfer payment fairness was relatively unfair in 1985, relatively fair in 1986-1988 (the reason was that the proportion of government transfer payment to individuals was relatively low in these years), fair in 1989 to 1992, 2000 to 2002 and 2004, and extremely fair in other years.

Conclusion 3: China's redistribution fairness and its second class indicators, tax burden fairness, social security fairness and transfer payment fairness, are generally in the state of no warning, and the three major regions of east, central and west are also in the state of no warning on the whole. The research results show that in the next few years, the redistribution equity and social security will steadily increase, the tax burden fairness will first increase and then decrease, but the change range is small, while the fairness of transfer payment will drop slightly. See table 4. In the next few years, the redistribution equity in the western region will rise steadily, the eastern region will rise slightly, and the central region will fall slightly. From 1985 to 2022, the mean value of our redistribution equity and its three second class indicators in China, namely, tax burden fairness, social security fairness and transfer payment fairness, are 0.7397, 0.7662, 0.6413 and 0.8109 respectively, which are generally in a state of no warning. To be specific, the redistribution equity was in a state of heavy warning from 1985 to 1986, medium warning from 1987 to 1991, light warning from 1992 to 2002, and no warning from 2003 to 2022 (the redistribution equity was relatively high in these years, between fair and extremely fair). The tax burden fairness was in a state of heavy warning from 1985 to 1986, medium warning from 1987 to 1991, slight warning from 1992 to 1997, and no warning from 1998 to 2022. The social security fairness was in a state of heavy warning in 1985, medium warning from 1986 to 1992, slight warning from 1993 to 2002, and no warning from 2003 to 2022. The early-warning status of transfer payment fairness fluctuates greatly. In 1985, it was in a state of huge warning, and from 1985 to 1987, it was in a state of heavy warning. From 1988 to 1989, it was in a state of medium warning, and it was in a state of light warning from 1990 to 1992, 1997 to 2004. It was in a state of no warning in other years (the transfer payment fairness in these years was extremely fair). The warning results show that from 1985 to 2022, the redistribution equity in the three regions of east, central and west in China is generally in a state of no warning. To be specific, the redistribution equity in the eastern region was in a state of heavy warning in 1985, medium warning from 1986 to 1991, light warning from 1992 to 1999, and no warning from 2000 to 2022. The redistribution equity in the central region was in a state of heavy warning from 1985 to 1986, medium warning from 1987 to 1990, light warning from 1991 to 2002, and no warning from 2003 to 2022. In the western region, the redistribution equity was in a state of heavy warning from 1985 to 1986, medium warning from 1987 to 1992, light warning from 1993 to 2000, and no warning from 2001 to 2022 (the redistribution equity in these years was extremely fair). The above research results show that the redistribution equity (as well as the fairness of tax burden, social security and transfer payment) of the whole country and the three major regions is operating within the blue range of no
warning at the present stage and in the next few years.

5.2. Policy implications

Above findings provide important policy implications: in order to achieve the redistribution equity, maintain the redistribution equity to operate within the blue range of no warning, the government should formulate the tax policy to reflect high earners higher taxes, middle-income earners low tax, low-income no taxes or negative tax, in order to reduce income inequality, promote tax burden fairness (horizontal fairness and vertical fairness and exchange fairness). In formulating the social security and transfer payments and other public policies, allocating the social resources, the government must ensure basic living conditions of the vulnerable group, and share the reform development achievement, shorten the social security (include social insurance, social relief, social welfare and social materials) gap between regions, between urban and rural areas, and realize the equal social public resources and public services, promote social security fairness and transfer payments fairness.

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