Print ISSN: 1738-3110 / Online ISSN 2093-7717
http://dx.doi.org/10.15722/jds.17.01.201901.21

A Study on the Determinants of Income Distribution: Evidence from Macroeconomics

Yugang He*, Wang Feng**

Received: November 15, 2018. Revised: November 26, 2018. Accepted: January 05, 2019.

Abstract

Purpose – As the market economy deepens, the issue of social equity caused by income distribution becomes more and more significant. Therefore, this paper attempts to exploit the determinants of income distribution in terms of macroeconomics.

Research design, data, and methodology - The data set from 1990 to 2017 will be used to conduct an empirical analysis under a menu of econometric approaches such as vector autoregressive model and impulse response function. The income distribution and other macroeconomic variables such as foreign direct investment and employment will be used to conduct an empirical analysis to explore the determinants of income distribution in terms of macroeconomics.

Results - The findings indicate that the income distribution is related with macroeconomics. More specifically, the export, import, GDP and foreign direct investment play a role in deteriorating the income distribution. Conversely, the industrialization, inflation and employment can improve the income distribution. Unfortunately, the inflation and employment do not get through under 5% significant test.

Conclusions – Due to that a good income distribution can be beneficial for both a country and an individual, this paper provides a new scope for China's government to improve its income distribution in terms of macroeconomics.

Keywords: Income Distribution, Macroeconomics, Econometric Approaches.

JEL Classification: E21, F49, I39, O11.

1. Introduction

Income distribution is the division of total income by the provider of corporate capital. It is mainly based on the pre-tax profit of the enterprise such as interest, income tax and net profit for the division among various stakeholders. The composition of income distribution has two parts. One is the distribution of corporate income in the broad sense. Another is the distribution of after-tax profits in the narrow sense. Currently, the income distribution is considered to be one of the most important indicators of social development. The quality of income distribution can reflect the level of economic development of a country. In reality, there are many factors that affect income distribution, such as economic development level, social and cultural traditions, political and economic systems, etc. In this paper, we create a new scope to explore the determinants of income distribution in terms of macroeconomics.

At present, the Gini coefficient is recognized by the world as an indicator to measure the quality of income distribution. According to the standard of United Nations Development Programme, the Gini coefficient can be classified into five ranks. The specific information rank of Gini coefficient gives in <Table 1>.

Table 1: Classification of Gini Coefficient

Rank	Value	Definition
1	<0.2	Income distribution is excessive average
2	>0.2 and <0.29	Income distribution is relative average
3	>0.3 and <0.39	Income distribution is relative reasonable
4	>0.4 and <0.59	income distribution gap is too large
5	>0.6	income distribution is highly uneven

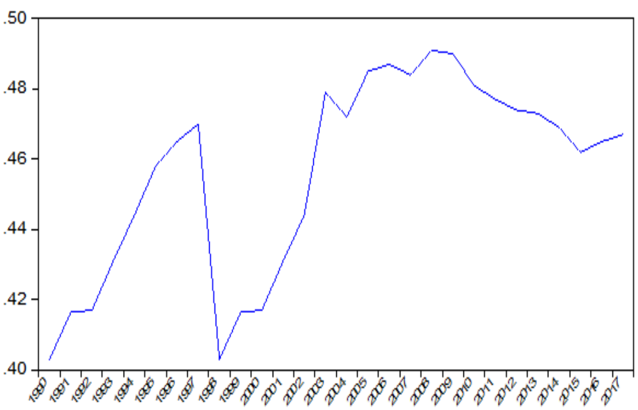
Note: The source is from the United Nations Development Programme; Internationally, 0.4 is used as a warning line for the income gap between rich and poor.

China is the largest developing country in Asia. Meanwhile, China is also the second largest economic entity

* First Author, Graduate Student, Department of International Trade, Chonbuk National University, South Korea.
E-mail: 1293647581@jbnu.ac.kr.

** Corresponding author, School of Basic Medicine, Taishan Medical University, China. E-mail: 1138746380@qq.com

in the world. However, China's internal economic development is very uneven. The overall trend of China's economic development is that the eastern coastal regions' economy develops fastest; the central regions' economy develops moderately; the western region's economy develops very slowly. Due to this reason, the gap of income in China always keeps large since the reform and opening up. Based on that China is equipped with these special features, this paper sets China as an example to study the determinants of income distribution in terms of macroeconomics. Meanwhile, the quality of income distribution will be denoted by the Gini coefficient. China's Gini coefficient from 1990 to 2017 will be exhibited in <Figure 1>.



Note: The source is from the National Bureau of Statistics of China.

Figure 1: Gini Coefficient in China from 1990 to 2017

<Figure 1> indicates the changes of Gini coefficient. During the period of 1990 to 2017, China's Gini coefficient has experienced five periods. From 1990 (0.403) to 1997 (0.470) , theGinicoefficientgoesup.ItmeansthatChina's income distribution experiences a deterioration. From 1997 (0.470) to 1998 (0.403), the Gini coefficient goes down sharply. It means that China's income distribution experiences an improvement. From 1998 (0.403) to 2008 (0.491), the Gini coefficient goes up. It means that China's income distribution experiences a deterioration. From 2008 (0.491) to 2015 (0.462), the Gini coefficient goes down relatively slowly. It means that China's income distribution experiences an improvement. From 2015 (0.462) to 2017 (0.467), the Gini coefficient goes up slowly. It means that China's income distribution experiences a deterioration. When taking [Figure 1] as a whole, it can be found that the Gini coefficient always keeps above 0.4. Said differently, the income distribution in China is not reasonable. Namely, the income distribution gap in China exists since 1990.

This paper takes China as the research object to explores the determinants of income distribution from the perspective of macroeconomics. Because the macroeconomics involves a wide range, this paper selects some representative macroeconomic variables such as import, industrialization, inflation, GDP, foreign direct investment, export and employment to represent the macroeconomics. And the Gini coefficient will be selected to measure the income distribution. Meanwhile, a quantity of econometric approaches such as vector autoregressive model and impulse response function will be employed to perform an empirical analysis. The empirical results indicate that the income distribution is related with macroeconomics. Specifically speaking, the export, the import, the GDP and the foreign direct investment play a role in deteriorating the income distribution. Conversely, the industrialization, the inflation and the employment can improve the income distribution. Unfortunately, the inflation and the employment do not get through under 5% significant test.

The rest of this paper is structured as follows. Section two describes the previous researches. Section three discusses the methodology that we use for the empirical analysis. Section four proceeds the process of empirical analysis and results. Section five describes the conclusions and corresponding suggestions.

2. Literature Review

The issue of income distribution is a historic one because it is always accompanied along with the evolution of human beings. Especially in recent years, even though the government has taken many measures to improve the deterioration of income distribution, the deterioration of income distribution is still expanding. Due to this background, a lot of scholars have analyzed this issue in terms of different aspects. Their achievements will be shown as the following demonstrated.

Qi and He (2007) use the Kuznets' inverted U-shaped hypothesis to study the impact of urbanization on income distribution. They find that the change of China's income distribution obeys the Kuznets' inverted U-shaped change. Ceteris paribus, the proportion of urban residents is 0.457. Said differently, China's income distribution gap is very serious. Du (2007) studies the income distribution in terms of marketization. He finds that the strengthening marketization is fair to income distribution and the weakening marketization has a negative impact on the fairness of income distribution. Shen and Pan (2008) employs the annual data from 1987 to 2003 to exploit the impact of foreign direct investment on regional income gap. Via the Granger causality test, his results show that the foreign direct investment is an important cause of income disparity in the region. Wen and Sun (2008) attempt to explore the impact of international trade on income distribution in terms of an empirical analysis based on Gini coefficient. Their results indicate that the expansion of trade has generally improved the income inequality in China; Exports improve income distribution more effectively than that of imports; The increase in the proportion of exports of manufactured goods has a significant improvement effect on income distribution; Declining share of imports of manufactured goods may worsen income distribution. Ran and Pan (2009) analyze the relationship between government public expenditure and the income gap of the national residents, residents in urban and rural areas, residents in eastern and western regions based on the vector autoregressive model. Their results show that the public expenditure has a negative effect on the income distribution of China’s residents.

Ding (2010) conduct an investigation on the impact of public education expenditure on income distribution. His results indicate that China's education expenditure will lead to the growth of per capita disposable income, but at the same time it will also narrow the gap between urban and rural per capita disposable income. Guan (2012) takes use of the annual data from 1990 to 2009 to analyze the relationship between total fiscal expenditure, central fiscal expenditure, local fiscal expenditure, various fiscal expenditures and income distribution gap. His results show that the total fiscal expenditure widens the income distribution gap, the central fiscal expenditure narrows the income distribution gap, and the local fiscal expenditure expands the income distribution gap. In summary, the impact of different fiscal expenditure items on the income distribution gap is different. Gao (2011) performs an research on the impact of finance on the structure of national income distribution. He finds that the irrational distribution of national income is the consequence of a combining factors, and the finance plays a role that cannot be ignored. The rational distribution of national income and the inclusive growth of economy can be achieved through the differential interest rates, the establishment of a policy financial institution, the establishment of a credit system, the reform of the financial industry and the improvement of the economic analysis capabilities of the financial sector. Li (2011) tries to find the effect of international product trade on income distribution in view of an empirical analysis based on industrialized Data. He uses the panel data from 35 industrial sectors in China to examine the effect of intra-industry trade on the distribution of skilled and unskilled labor within the industry. He finds that at current stage, compared with the technological progress, the international intra-product trade is not an important factor that influences the widening income gap in China. Meanwhile, due to the relative lack of skilled labor factor endowments in China, the intensity of industry factors in international product trade is different, and the impact on income distribution is different. The income gap between workers of different natures in labor-intensive and capital-intensive industries will shrink, while the income gap between industries with technology- intensive and capital-intensive and technology-intensive industries will widen. Guo and Tian (2012) use the vector autoregressive model to explore the impact of economic growth on income distribution. Their results show that the economic growth can lead to an deterioration in the income distribution to a certain extent. However, the deterioration of the income distribution can affect the economic growth. Through the co-integration analysis, they find that there is a stable long-term equilibrium relationship between economic growth and income distribution. Hu and Yan (2012) use the vector autoregressive model to analyze the interactive relationship between China’s industrial structure and income distribution structure based on the data from1990 to2007. Their result shows In the short term, upgrading of industrial structure has an increasingly weakening inhibitory effect on residents’ income levels. The variation of income distribution structure results in a small contribution to variation of industrial structure, while variation of industrial structure results in a great contribution to variation of income distribution structure.

Ding and Xu (2013) put the social security level in to the Kuznets measurement model to analyze the interaction among social security, income distribution and economic growth with an annual sample from 1978 to 2010 by employing the Granger causality test, vector error correction model and impulse response function in vector autoregressive model. Their findings show that there is a long-term equilibrium relationship among the social security, income distribution and economic growth in China. Their findings show that the current social security system does not play a regulatory role in the income distribution field, and even exists a certain degree of regressive adjustment effect, named “lose insufficient and fill superabundant”; China has entered the inflection point stage of the “inverted U” curve, which is golden era to adjust income distribution gap and improve the social security system. Tan and Yuan (2013) try to examine the relationship among social security expenditure, national economic development and income distribution during the period from 1991-2010 based on the vector autoregressive model. Their results show that the social security expenditure can not adjust the income distribution. Lu (2014) also use the vector autoregressive model to study the determinants of income distribution in China. His results indicate that the financialization can improve income distribution, and the monopoly can deteriorate the income distribution.

Adams and Klobodu (2017) employ the annual data from 1984 to 2013 over twenty one sub-Saharan African countries to analyze the differential impacts of capital flows on income distribution. They find that the foreign direct investment has a weak positive impact on income inequality, which indicates that the foreign direct investment increases income inequality. However, remittances and external debt as well as aid flows do not have strong impact on income inequality. Moreover, their findings indicate unidirectional causality from foreign direct investment to income inequality in the short run when we take up the heterogeneity. Finally, their results show that capital flows have mixed impact on inequality in sub-Saharan African. Tomkiewicz (2018) analyzes the relationship between labour market and income distribution in terms of post-socialist economies. His finding shows that an increase in the unemployment will deteriorate the income inequalities. Kunieda, Nishimura, and Shibata (2018) use a three-country dynamic general equilibrium model to examine how financial frictions impact the income distributions across and within country.Their results indicate that the income inequality in each country studied in their paper will be different due to the financial constraints. Baiardi and Morana, (2018) set the euro area countries as an example to study the income distribution. They find strong evidence in favor of an euro area-wide steady-state financial Kuznets curve and of ongoing convergence across euro area members toward a common per capita income turning point level. They also point to worsening conditions of economic growth and income inequality for all the euro area countries, only partially ensued from "austerity" policies. Therefore, a good financial system and its well-functioning development seem to be instrumental not only to economic growth, but also to a more egalitarian income distribution.

Those papers analyzed above have excavated this proposition in terms of different concrete respects such as foreign direct investment, international trade, capital flow and so on. In this paper, the vector autoregressive model will be employed to explore the determinants of income distribution in terms of macroeconomics. Said differently, this is also a greatest innovation in this paper.

3. Theoretical Framework

3.1. Model Setting

With the deepening of reform and opening up, the domestic economy has witnessed more obvious development than that of the past, but the income gap of residents is also widening. The problem of excessive income disparity has affected the consumption propensity of residents. In recent years, the continued decline in the consumption rate of residents has affected the stability of the domestic economy. The factors that cause uneven income distribution are macroeconomic factors as well as micro economic factors. In this paper, the macroeconomic factors (inflation, GDP, industrialization, import, export, employment and foreign direct investment) will be focused on to explore their impact on income distribution.

The model used in this paper gives:

$$\log gini_t = a + a_1 \log \infty_t + a_2 \log gdp_t + a_3 \log \in d_t + a_4 \log im_t + a_5 \log ex_t + a_6 \log emp_t + a_7 \log fdi_t + \varepsilon_t \tag{1}$$

Where $gini$ denotes the Gini coefficient; denotes the inflation; gdp denotes the gross domestic products; $i.nd$ denotes the industrialization the (ratio of manufacturing industry output to gross domestic products). Im denotes the import; ex denotes the export; emp denotes the employment population; fdi denotes the real use of foreign direct investment from the world; ε denoted the white noise; a denotes the constant; $a_1, a_2, a_3, a_4, a_5, a_6, a_7$ are the coefficients. Moreover, the values of these coefficients indicate how these variables affect the Gini coefficient, namely, income distribution.

3.2. Assumption Analysis

In theory, the macroeconomic variables applied in this paper may have a relation with the income distribution. However, in reality, the relation between income distribution and macroeconomic variables can not be confirmed. Due to this reason, the assumption between income distribution and each macroeconomic variable used in this paper will be made. These assumptions will be exhibited as follows.

Assumption one (relation between income distribution and inflation):

Inflation can increase the asset prices and consumer prices, which makes people with more assets relatively wealthy, while those without assets are relatively poor. As a result, the income gap will be widened. Generally speaking, those with more assets are those with higher economic status in the society. Therefore, it may cause the rich to get richer and the poor to get poorer. So, we can assume that the inflation is negatively related with income distribution.

Assumption two (relation between income distribution and GDP):

Kuznets (1955) sets the United States of America, United Kingdom, German and so forth as an example to study the long-run changes of income distribution in his article "Economic growth and income inequality". He comes into a conclusion that In the early stage of economic growth, the inequality of permanent income structure will continue to expand. When a society changes from the former industrial civilization to the industrial civilization, the unequal expansion is more rapid, then there is a stable period, in the latter stage income inequality will gradually narrow. Said differently, In the process of long-term economic growth, the unequal changes of individual income distribution follow an inverted U-trajectory, which is the Kuznets "inverted U hypothesis" in the theory of economic growth and income distribution. According to Kuznets' estimate, the inverted U curve goes from rising to falling, that is, the income distribution is from expansion to shrinking. Therefore, we can assume that the relation between income distribution and GDP is ambiguous.

Assumption three (relation between income distribution and industrialization):

Murphy, Shleifer, and Vishny (1989) propose the theory that the income distribution affects industrialization through market size. That is, due to the different demand structure, the equalization of income distribution affects the market scale of industrialization, which in turn affects the development level of industrialization. In addition, the industrialization theories proposed by Murphy, Shleifer, and Vishny from the perspective of the demand for industrialized products not only make up for the shortcomings of traditional industrialization theory, but also form a certain scale and foundation for the development of industrialization. The continuation of industrialization and structural upgrading have important theoretical and practical significance. They also propose that “the middle-income class is a natural consumer of industrialized products”. Thence, we can assume that the industrialization is positively related with income distribution.

Assumption four (relation between income distribution and import):

Based on the import trade data of China and 64 countries from 1992 to 2008, Zhang and zhang (2011) employ the feasible generalized least squares method to estimate the impact of the income distribution gap on the structure of China's imported goods. They find that an increase in the income distribution gap in China will lead to an increase in the import of luxury goods, which will increase the proportion of luxury goods and necessities. And the more developed the economy of the country of origin, the greater the influence of income distribution gap on luxury goods import. As a result, we can assume that the import is positively related with income distribution.

Assumption five (relation between income distribution and export):

Wen (2011) uses the non-parametric kernel density estimation to measure the overlap of income distribution between China and 45 major export destination countries (regions), which is treated as the overlap of demand structure. The empirical test by feasible generalized least squares method shows that the higher the income distribution overlap between China and the country of destination (region) is, the more the export will be. Consequently, we can assume that the export is positively related with income distribution.

Assumption six (relation between income distribution and employment):

Generally speaking, the change of income distribution does not necessarily lead to the direct or fixed direction of employment. Similarly, the expansion or contraction of the income gap does not necessarily mean that the unemployment rate rises or falls simultaneously. The relation between income distribution and employment is linked by the impact of other economic variables. Accordingly, we can assume that the relation between income distribution and employment is ambiguous.

Assumption seven (relation between income distribution and foreign direct investment):

Using data from bilateral investor direct investment in 16 OECD countries and 57 host countries during the period 1982-1997, Choi (2004) uses parallel data regression to examine the role of international direct investment in the convergence of income levels and income growth between countries. He finds that when bilateral international direct investment increases, the gap between the income level and income growth of the investor country and the host country will be reduced. Consequently, we can assume that the foreign direct investment is positively related with income distribution.

4. Empirical Analysis

4.1. Variable Description

Said and Dickey (1984) purpose an approach, called the Augmented Dickey Fuller Test, which is used to test the stationarity of a time series data. In this paper, the Augmented Dickey Fuller Test will be employed to test the stationarity of these variables used. The result of Augmented Dickey Fuller Test will be reported in <Table 2>

Table 2: Results of Augmented Dickey Fuller Test

Variable	Authentication type (C, T, L)	T-statistic	5% Test Critical Value	Prob.*	Result
$\log gini$	(C, T, 0)	-2.226	-3.588	0.458	Non-rejected
$\log emp$	(C, T, 0)	-0.278	-3.588	0.997	Non-rejected
$\log ex$	(C, T, 0)	-0.290	-3.588	0.987	Non-rejected
$\log fdi$	(0, T, 0)	-0.722	-1.954	0.865	Non-rejected
$\log gdp$	(C, 0, 1)	-0.713	-2.981	0.826	Non-rejected
$\log im$	(C, T, 0)	-0.462	-3.588	0.979	Non-rejected
$\log gind$	(C, T, 1)	-3.114	-3.595	0.124	Non-rejected
$\log ginf$	(C, 0, 3)	-2.965	-2.992	0.053	Non-rejected
$\triangle \log gini$	(C, T, 0)	-5.285	-3.595	0.001	Rejected
$\triangle \log emp$	(0, 0, 0)	-1.993	-1.954	0.048	Rejected
$\triangle \log ex$	(C, T, 0)	-4.300	-3.595	0.011	Rejected
$\triangle \log fdi$	(C, 0, 0)	-2.250	-1.954	0.026	Rejected
$\triangle \log gdp$	(C, T, 0)	-4.659	-2.981	0.001	Rejected
$\triangle \log im$	(C, T, 0)	-3.729	-3.595	0.038	Rejected
$\triangle \log gind$	(C, 0, 0)	-3.078	-1.954	0.004	Rejected
$\triangle \log ginf$	(C, 0, 2)	-3.147	-2.992	0.036	Rejected

Note: * indicates the MacKinnon (1996) one-sided p-values; △ indicates the difference operator; C indicates the constant; L indicates the lag length; T indicates the trend.

Table 3: Johansen System Cointegration Test

Trace Test			Maximum Eigenvalue Test		
Hypothesized No. Of CE(s)	Trace Statistic	0.05 Critical Value	Hypothesized No. Of CE(s)	Max-Eigen Statistic	0.05 Critical Value
$r=0$*	506.883	159.530	$r=0$*	132.421	52.363
$r\leq 1$*	374.463	125.615	$r=1$*	111.851	46.231
$r\leq 2$*	262.612	95.754	$r=2$*	89.554	40.078
$r\leq 3$*	173.058	69.819	$r=3$*	73.401	33.877
$r\leq 4$*	99.657	47.856	$r=4$*	40.488	27.584
$r\leq 5$*	59.169	29.797	$r=5$*	32.172	21.132
$r\leq 6$*	26.997	15.485	$r=6$*	18.260	14.265
$r\leq 7$*	8.736	3.841	$r=7$*	8.736	3.841

Note: * denotes rejection of the hypothesis at the 0.05 level.

<Table 2> indicates the results of Augmented Dickey Fuller Test. According to the p-value, it can be found that all these macroeconomic variables are not stationary since the p-values tested are greater than 5%. However, via conducting the first difference,it can be found that all these macroeconomic variables are stationary since the p-values tested are less than 5%. in summary, it can be concluded that these macroeconomic variables are integrated of order, namely $I(1)$.

4.2. Long-run Effect

In econometrics, there are quantities of approaches to study the long-run relationship between variables. In this paper, Johansen system cointegration test will be employed to test the long-run relationship among these variables. The advantage, unlike the Engle-Granger method, is that the Johansen system cointegration test is a kind of test for cointegration which allows for more than one cointegrating relationship. However, this kind of test is subject to the asymptotic properties. The results of Johansen system cointegration test show in <Table 3>.

<Table 3> demonstrates the results of Johansen system cointegration test. As the values of trace statistic and Max-Eigen statistic, All these values are greater than the 0.05 critical values. Said differently, the long-run relationship among these variables exist. The normalized cointegrating equation with a regressand (gini) and seven regressors (import, industrialization, inflation, GDP, foreign direct investment, export and employment) gives.

$$\begin{aligned}\log gini_t = {} & \underset{(0.021)}{0.087}\log im_t - \underset{(0.005)}{0.025}\log i.nd_t - \underset{(0.160)}{0.076}\log\infty_t + \underset{(0.034)}{0.188}\log gdp_t \\ & + \underset{(0.022)}{0.083}\log fdi_t + \underset{(0.033)}{0.144}lohex_t - \underset{(0.027)}{0.007}lohemp_t\end{aligned} \tag{2}$$

Where value in the parentheses is the standard error.

Equation (2) reveals the long-run relationship among these variables. The import, the GDP, the export and the foreign direct investment have a positive effect on income distribution. It means that these variables can deteriorate the income distribution. Conversely, the industrialization, the employment and the inflation have a negative effect on income distribution. It means that both of them can improve the income distribution. General speaking, in the long run, when the import increases by 1%, the income distribution will be deteriorated by 0.087%; when the export increases by 1%, the income distribution will be deteriorated by 0.144%; when the foreign direct investment increases by 1%, the income distribution will be deteriorated by 0.083%; when the GDP increases by 1%, the income distribution will be deteriorated by 0.188%. Conversely, when the industrialization increases by 1%, the income distribution will be improved by 0.025%; when the employment increases by 1%, the income distribution will be improved by 0.007% (But, not significant); when the inflation increases by 1%, the income distribution will be improved by 0.076% (But, not significant). In reality, as the economic growth, the income gap continues to expand. The results of Johansen system cointegration test are in line with China's real situation. Meanwhile, these results also match the assumptions.

4.3. Vector Autoregressive Model

Sims (1980) proposes a vector autoregressive model. This model takes the form of multiple equations, which is not based on economic theory. In each equation of the model, the endogenous variables regress the lag terms of all endogenous variables of the model to estimate the dynamic relationship among all endogenous variables.

The vector autoregressive model with two variables ($y_{1,t}$ and $y_{2,t}$) and one lag gives:

$$y_{1,t} = c_1 + \pi_{11,1}y_{1,t-1} + \pi_{12,1}y_{2,t-1} + \varepsilon_{1t} \tag{3}$$

$$y_{2,t} = c_1 + \pi_{21,1}y_{2,t-1} + \pi_{22,1}y_{2,t-1} + \varepsilon_{2t} \tag{4}$$

Where c is the constant; π is the coefficient; ε is the white noise. On equation (3) and equation (4), and ε_{1t} are

ε_{2t} independently identically distributions ($\varepsilon_{1t}, \varepsilon_{2t} \sim iid(0, \sigma^2)$). The correlation between ε_{1t} and ε_{2t} is zero ($Cov(\varepsilon_{1t}, \varepsilon_{2t}) = 0$).

The matrix form gives:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} \pi_{11.1} & \pi_{12.1} \\ \pi_{21.1} & \pi_{22.1} \end{bmatrix} \times \begin{bmatrix} y_{1,t-1} \\ y_{2,t-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \tag{5}$$

Assume $Y = \begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix}$, $C = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix}$, $\Pi_1 = \begin{bmatrix} \pi_{11.1} & \pi_{12.1} \\ \pi_{21.1} & \pi_{22.1} \end{bmatrix}$, $\varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$,

Therefore, we can obtain that $Y_t = C + \Pi_1 Y_{t-1} + \varepsilon_t$.

Based equation (3) and equation (4), the vector autoregressive model with variables and lag k periods give:

$$Y_t + C + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \ldots + \Pi_k Y_{t-k} + \varepsilon_t \tag{6}$$

Where $\varepsilon_t \sim iid(0, \Omega)$, $Y_t = (y_{1,t}, y_{2,t} \cdots y_{N,t})'$, $C = (c_1, c_2 \cdots c_N)'$,

$$\Pi_j = \begin{bmatrix} \pi_{11,j}, & \pi_{12,j} \cdots \pi_{1N,j} \\ \pi_{21,j}, & \pi_{22,j} \cdots \pi_{2N,j} \\ \cdot & \cdot \quad\quad \cdot \\ \cdot & \cdot \quad\quad \cdot \\ \cdot & \cdot \quad\quad \cdot \\ \pi_{N1,j}, & \pi_{N2,j} \cdots \pi_{NN,j} \end{bmatrix}, \; j = 1, 2, \ldots k, \; \varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \ldots \varepsilon_{Nt})'.$$

However, there may be a correlation between random error terms corresponding to different equations.

Since the right side of each equation in the vector autoregressive model contains only the lag term of the endogenous variable, they are asymptotically uncorrelated with ε_t. So each equation can be estimated sequentially by the ordinary least squares method, and the obtained parameter estimators are consistent.

Before establishing the vector autoregressive model, we should select the optimal lag. The vector autoregressive lag order selection criteria will be used to confirm the optimal lag. The results show in <Table 4>.

Table 4: VAR Lag order Selection Criteria

Lag	Akaike information criterion*	Schwarz information criterion**
0	-35.664	-33.277
1	-49.174	-45.690
2	-58.609*	-52.028*

note * Akaike information criterion= $T \times \ln(\sum of\ squared residuals) + 2n$;

** Schwarz information criterion= $T \times \ln(\sum of\ squared\ residuals) + n \times \ln(T)$

Where: n=number of parameters estimated (p+q+possible constant term); T=number of usable observations.

According to the results of vector autoregressive lag order selection criteria, the optimal lag is two based the Akaike information criterion and the Schwarz information criterion. the vector autoregressive model with eight variables and lag 2 periods give in <Table 5>.

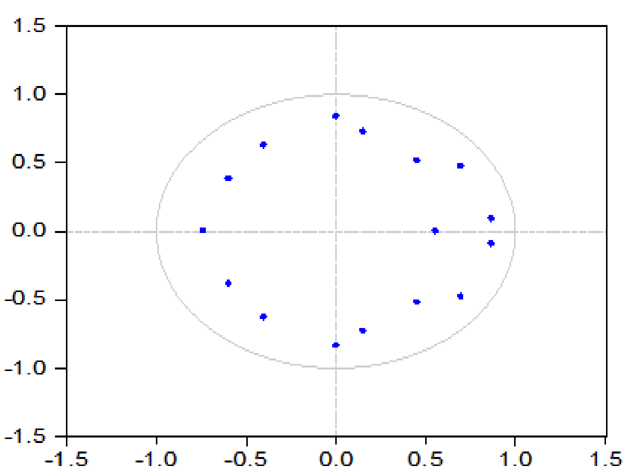
Table 5: Vector Autoregression Estimates

Model	Model(1)	Model(2)	Model(2)	Model(4)	Model(5)	Model(6)	Model(7)	Model(8)
Variable	$\triangle \log gini_t$	$\triangle \log gdp_t$	$\triangle \log fdi_t$	$\triangle \log ex_t$	$\triangle \log emp_t$	$\triangle \log gim_t$	$\triangle \log gind_t$	$\triangle \log ginf_t$
$\triangle \log gini_{t-1}$	0.057 (0.011) [-5.182]	0.230 (0.054) [4.259]	0.693 (0.182) [2.027]	1.213 (0.731) [1.660]	0.0003 (0.008) [0.043]	0.800 (0.949) [0.843]	0.138 (0.184) [0.746]	0.0475 (0.196) [0.242]
$\triangle \log gini_{t-2}$	-0.983 (0.121) [-8.124]	-0.511 (0.123) [-4.154]	-1.294 (0.981) [-1.319]	-0.291 (0.730) [-0.399]	0.003 (0.008) [0.347]	-0.919 (0.948) [-0.969]	-0.0009 (0.184) [-0.005]	-0.231 (0.196) [-1.179]
$\triangle \log gdp_{t-1}$	0.362 (0.092) [3.935]	-0.712 (0.201) [-3.542]	-2.023 (0.751) [-2.694]	-1.085 (0.159) [-6.824]	0.005 (0.006) [0.886]	-1.764 (0.726) [-2.430]	-0.382 (0.141) [-2.707]	-0.322 (0.150) [-1.179]
$\triangle \log gdp_{t-2}$	0.157 (0.017) [9.235]	0.507 (0.110) [4.609]	0.293 (0.768) [0.382]	-0.787 (0.172) [-4.576]	-0.005 (0.006) [-0.858]	-0.546 (0.743) [-0.736]	0.111 (0.144) [0.771]	-0.270 (0.154) [-1.756]
$\triangle \log fdi_{t-1}$	0.101 (0.026) [3.885]	0.223 (0.059) [3.780]	1.244 (0.298) [4.176]	-0.092 (0.022) [-4.182]	-0.001 (0.002) [-0.310]	0.313 (0.288) [1.088]	0.113 (0.056) [2.023]	0.108 (0.060) [1.809]
$\triangle \log fdi_{t-2}$	0.061 (0.019) [-3.211]	-0.424 (0.127) [-3.339]	-1.013 (0.427) [-2.374]	0.229 (0.037) [6.189]	0.004 (0.003) [1.039]	-0.083 (0.412) [-0.201]	-0.100 (0.080) [-1.246]	-0.026 (0.85) [-0.305]
$\triangle \log ex_{t-1}$	0.269 (0.044) [-6.114]	0.159 (0.059) [2.695]	0.079 (0.016) [4.938]	-1.127 (0.418) [-2.697]	-0.0002 (0.004) [-0.051]	-1.135 (0.543) [-2.092]	-0.105 (0.105) [-0.996]	-0.290 (0.112) [-2.585]
$\triangle \log ex_{t-2}$	0.293 (0.058) [5.052]	0.248 (0.033) [0.753]	0.226 (0.061) [3.705]	0.392 (0.046) [8.522]	-0.002 (0.005) [-0.407]	0.572 (0.598) [0.957]	0.196 (0.116) [1.691.0]	0.024 (0.124) [0.196]
$\triangle \log emp_{t-1}$	-0.429 (0.944) [-0.454]	-0.994 (0.897) [-1.108]	0.123 (0.312) [0.394]	-0.180 (0.371) [-0.485]	0.778 (0.153) [5.085]	-0.891 (0.668) [-1.334]	-0.861 (0.626) [-1.375]	-0.031 (0.860) [-0.036]

$\triangle \log emp_{t-2}$	0.088 (0.971) [0.091]	0.923 (0.927) [0.996]	-0.203 (0.510) [-0.398]	0.051 (0.542) [0.094]	0.073 (0.123) [0.593]	0.680 (0.993) [0.685]	0.119 (0.913) [0.130]	0.433 (0.301) [1.439]
$\triangle \log gim_{t-1}$	0.544 (0.122) [4.459]	0.548 (0.127) [4.315]	0.451 (0.790) [0.570]	1.792 (0.588) [3.046]	0.007 (0.006) [1.045]	2.286 (0.764) [2.993]	0.250 (0.148) [1.686]	0.274 (0.158) [1.733]
$\triangle \log gim_{t-2}$	0.350 (0.096) [3.684]	-0.868 (0.407) [-2.133]	-0.932 (0.264) [-3.530]	-0.073 (0.568) [-0.129]	-0.004 (0.006) [-0.729]	-0.692 (0.738) [-0.938]	-0.322 (0.143) [-2.248]	0.056 (0.153) [0.370]
$\triangle \log gind_{t-1}$	-1.089 (0.361) [-3.017]	-0.481 (0.099) [-4.859]	2.010 (3.750) [0.536]	-1.688 (2.790) [-0.605]	-0.006 (0.030) [-0.201]	-2.691 (3.625) [-0.742]	0.112 (0.704) [0.159]	0.312 (0.749) [0.416]
$\triangle \log gind_{t-2}$	-0.525 (0.089) [-5.899]	5.199 (1.853) [2.805]	5.889 (3.476) [1.694]	6.118 (2.587) [2.365]	0.017 (0.028) [0.610]	7.141 (3.360) [2.206]	0.777 (0.653) [1.190]	1.223 (0.695) [1.760]
$\triangle \log ginf_{t-1}$	-0.005 (0.063) [-0.079]	-1.582 (0.373) [-4.241]	-2.992 (2.200) [-1.360]	-2.328 (1.637) [-1.422]	-0.030 (0.017) [-1.735]	-3.746 (2.130) [-1.761]	-0.404 (0.413) [-0.977]	-0.358 (0.440) [-0.814]
$\triangle \log ginf_{t-2}$	-0.007 (0.058) [0.121]	1.653 (0.479) [3.451]	2.933 (2.024) [1.449]	-2.484 (1.506) [-1.649]	0.007 (0.016) [0.439]	-0.798 (1.956) [-0.408]	0.504 (0.380) [1.326]	-0.730 (0.405) [-1.804]
C	-0.004 (0.022) [-0.165]	0.112 (0.045) [2.478]	0.216 (0.084) [2.558]	0.180 (0.063) [2.863]	0.0001 (0.001) [0.155]	0.207 (0.082) [2.539]	0.019 (0.016) [1.167]	0.061 (0.017) [3.595]
R^2	0.724	0.734	0.895	0.775	0.969	0.665	0.692	0.830

Note: ( ) indicates the standard errors; [ ] indicates the t-statistics.

Based on the values of, it can be concluded that these models above have a good explanation. Even so, we should keep these models steady. Then, the inverse roots of AR characteristic polynomial should be tested. The results give in <Figure 2>:



<Figure 2> Inverse Roots of AR Characteristic Polynomial

<Figure 2> shows the results of inverse roots of AR characteristic polynomial. We can find that all points are located inside the unit circle. Said differently, these estimated models mentioned above are efficient.

4.4. Impulse Response Function

In practical applications, since the vector autoregressive model is a non-theoretical model, when analyzing the vector autoregressive model, it is often not analyzed how the change of one variable affects the other variable, but rather when an error term changes, or the dynamic impact on the system when the model is subjected to some kind of impulse. This approach used to analyze the dynamic relationship among variables is called the impulse response function. The impulse response function of income distribution gives in <Figure 3>.

<Figure 3> shows the results of impulse response function of income distribution. In regard to the response of income distribution to the one standard innovation of income distribution, the income distribution will decrease from period one (0.015) to period two (-0.003) (improvement). From period two (-0.003) to period three (0.003), the income distribution will increase (deterioration). From period three (0.003) to period four (-0.007), the income distribution will decrease (improvement). From period four (-0.007) to period seven (0.002), the income distribution will increase (deterioration). From period seven (0.002) to period eight (-0.003), the income distribution will decrease (improvement). From period eight (-0.003) to period ten (0.000), the income distribution will increase (deterioration). After period ten, the response of income distribution to the one standard innovation of income distribution will be disappeared.

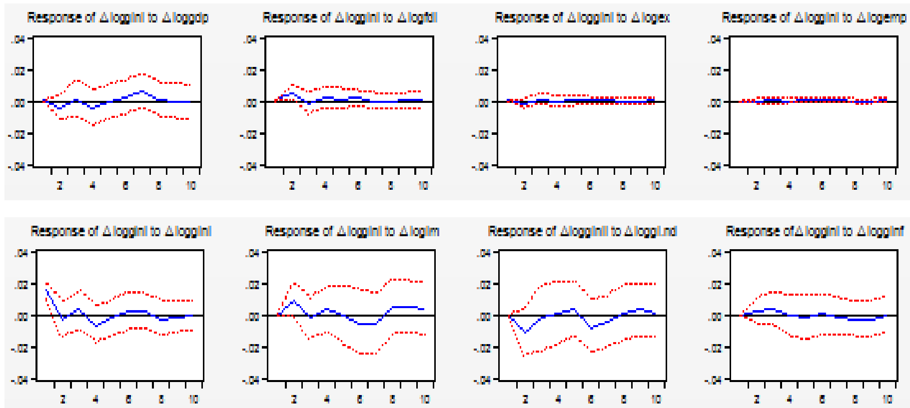


Figure 3: Response of Income Distribution to Cholesky One S. D. Innovations

With respect to the response of income distribution to the one standard innovation of GDP, the income distribution will increase from period one (0.000) to period two (0.001) (deterioration). From period two (0.001) to period four (-0.002), the income distribution will decrease (improvement). From period four (-0.002) to period five (0.000), the income distribution will increase (deterioration). From period five (0.000) to period six (-0.002), the income distribution will decrease (improvement). From period six (-0.002) to period eight (0.005), the income distribution will increase (deterioration). Then, the income distribution will decrease (improvement).

In relation to the response of income distribution to the one standard innovation of foreign direct investment, the income distribution will increase from period one (0.000) to period two (0.009) (deterioration). From period two (0.009) to period five (-0.003), the income distribution will decrease (improvement). From period five (-0.003) to period six (0.005), the income distribution will increase (deterioration). From period six (0.005) to period nine (-0.003), the income distribution will decrease (improvement). From period nine (-0.003) to period ten (-0.001), the income distribution will increase (deterioration).

As to the response of income distribution to the one standard innovation of export, the income distribution will increase from period one (0.000) to period two (0.004) (deterioration). From period two (0.004) to period three (0.000), the income distribution will decrease (improvement). From period three (0.000) to period four (0.003), the income distribution will increase (deterioration). From period four (0.003) to period seven (-0.007), the income distribution will decrease (improvement). From period seven (-0.007) to period ten (0.003), the income distribution will increase (deterioration).

Concerning the response of income distribution to the one standard innovation of employment, the income distribution will increase from period one (0.000) to period two (0.001) (deterioration). From period two (0.001) to period three (-0.001), the income distribution will decrease (improvement). From period three (-0.001) to period five (0.001), the income distribution will increase (deterioration). From period five (0.001) to period seven (-0.002), the income distribution will decrease (improvement). From period seven (-0.002) to period nine (0.001), the income distribution will increase (deterioration). After that, the response of income distribution to the one standard innovation of income distribution will be at 0.001.

As for the response of income distribution to the one standard innovation of import, the income distribution will increase from period one (0.000) to period two (0.011) (deterioration). From period two (0.011) to period three (-0.004), the income distribution will decrease (improvement). From period three (-0.004) to period four (0.006), the income distribution will increase (deterioration). From period four (0.006) to period (-0.004), the income distribution will decrease (improvement). From period (-0.004) to period nine (0.003), the income distribution will increase (deterioration). From period nine (0.003) to period ten (0.002), the income distribution will decrease (improvement).

About the response of income distribution to the one standard innovation of industrialization, the income distribution will decrease from period one (0.000) to period two (-0.006) (improvement). From period two (-0.006) to period five (0.002), the income distribution will increase (deterioration). From period five (0.002) to period six (-0.005), the income distribution will decrease (improvement). From period six (-0.005) to period nine (0.002), the income distribution will increase (deterioration). From period nine (0.002) to period ten (0.001), the income distribution will decrease (improvement).

Taking the response of income distribution to the one standard innovation of inflation into consideration, the income distribution has no change. It means that the inflation can not affect the income distribution.

Table 6: Variance Decomposition of Income Distribution

Period	S. E	$\triangle \log gini$	$\triangle \log gdp$	$\triangle \log fdi$	$\triangle \log ex$	$\triangle \log emp$	$\triangle \log im$	$\triangle \log gind$	$\triangle \log i.nf$
1	0.015	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.022	46.345	0.174	17.069	3.182	0.058	25.569	7.577	0.016
3	0.023	44.738	0.547	17.917	2.960	0.417	26.014	7.359	0.048
4	0.025	45.458	0.831	15.604	3.678	0.627	27.400	6.317	0.085
5	0.025	44.619	0.801	16.750	3.686	0.820	26.394	6.820	0.111
6	0.027	38.856	0.991	18.000	8.520	0.878	23.058	9.602	0.095
7	0.029	35.082	1.035	16.307	13.441	1.139	22.792	10.105	0.099
8	0.030	34.206	3.320	16.258	12.940	1.094	22.436	9.637	0.109
9	0.031	32.851	4.487	16.643	12.921	1.221	22.304	9.450	0.122
10	0.031	32.428	4.544	16.452	13.413	1.285	22.359	9.398	0.122

4.5. Variance Decomposition

The application of the vector autoregressive model can also use the variance decomposition method to study the dynamic characteristics of the model. The impulse response function describes the impact of the impulse of each endogenous variable in the vector autoregressive model on itself and other endogenous variables, or the impulse response function is the response of each variable in the observed model to the impulse over time. The variance decomposition is to further evaluate the contribution of each endogenous variable to the prediction variance. In 1980, Sims proposes a variance decomposition method to measure the influence relationship between variables quantitatively but coarsely. The variance decomposition is the analysis of the proportion of the standard deviation of the predicted residuals that are affected by the impulse of different innovations, that is, the proportion of the contribution of the endogenous variables to the standard deviation. The results of variance decomposition of income distribution show in <Table 6>.

<Table 6> indicates the variance decomposition of income distribution. At tenth period, the contribution of income distribution to itself 32.428%. The contribution of GDP to income distribution is 4.544%. The contribution of foreign direct investment to income distribution is 16.452%. The contribution of export to income distribution is 13.413%. The contribution of employment to income distribution is 1.285%. The contribution of import to income distribution is 22.359%. The contribution of industrialization to income distribution is 9.398%. The contribution of inflation to income distribution is 0.122%.

5. Conclusion

Along with the rapid economic growth, the unprecedented shock of each macroeconomic variable on income distribution has become more and more significant. However, how the unprecedented shocks of these macroeconomic variables affect the income distribution is still an urgent proposition needed to be solved. In reality, since the excessive gap between rich and poor will affect the social stability, the entire economic system will suffer from a great negative shock. Simultaneously, because the income distribution is over-average, the economic growth will be lack of motivation. As a result of this background, this paper sets China an example to seek for the determinants of income distribution in terms of macroeconomics. In this paper, the annual data from 1990 to 2017 will be used to conduct an empirical analysis under a menu of econometric approaches such as vector autoregressive model and impulse response function. The findings indicate that the income distribution is related with macroeconomics. Specifically speaking, the export, the import, the GDP and the foreign direct investment play a role in deteriorating the income distribution. Conversely, the industrialization, the inflation and the employment can improve the income distribution. Unfortunately, the inflation and the employment do not get through under 5% significant test. Even through the inflation and the employment do not get through under 5% significant test, both of them also meet the real situation. As for the inflation, due to that it affects both the poor and the rich at the same time, the gap of income between both of them does not change. Said differently, the inflation can not improve the income distribution. And it also can not deteriorate the income distribution. As for the employment, the rich (employer) will pay for the poor (employee). meanwhile, the rich will also gain from productions which are produced by the poor. If the difference between the pay for poor and the gain for the rich is greater than zero, the employment will improve the income distribution. If the difference between the pay for poor and the gain for the rich is less than zero, the employment will deteriorate the income distribution. If the difference between the pay for poor and the gain for the rich is equal to zero, the situation of employment is the same as the inflation. Seen from the empirical result of this paper, the difference between the pay for poor and the gain for the rich is ambiguous.

According to the empirical results in this paper, some corresponding suggestions will be put forward to improve the income distribution in terms of macroeconomics. In aspect of deteriorating income distribution, China's government can improve the income distribution through some related macroeconomic policies such as tariff policy to balance the international trade, industrial policy to rearrange the industrial structure so to make each industry develop in a relative equilibrium and domestic tax policy to control the cost of foreign direct investment. In view of improving the income distribution, China's government can improve the income distribution through enlarging the scale of industrialization. Even through the inflation and the employment can improve the income distribution, they do not get through under 5% significant test. Said differently, China's government should establish a better monetary policy and employment policy, which can make them play their due role in improving the income distribution.

References

Adams, S., & Klobodu, E. K. M. (2017). Capital flows and the distribution of income in sub-Saharan Africa. *Economic Analysis and Policy, 55*, 169-178.

Baiardi, D., & Morana, C. (2018). Financial development and income distribution inequality in the euro area. *Economic Modelling, 70,* 40-55.

Choi, C. (2004). Foreign direct investment and income convergence. *Applied Economics, 36*(10), 1045-1049.

Ding, F. (2010). Impact of public education expenditure on income distribution. *Manager' Journal, 24*(14), 6-6.

Ding, S. Q., & Xu, Z. T. (2013). A Study on the Relationship of Social Security, Income Distribution and Economic Growth--An Empirical Analysis Based on VAR model. *Economic Issues In China, 6*(6), 3-12.

Du, X. Y. (2007). The positive and negative influences about marketability to the division of income fair. *Journal of the Chinese People's Armed Police Force Academy, 23*(1), 41-44.

Gao, X. M. (2011). Impact of finance on the structure of national income distribution. *Journal of Yibin University, 12*(7), 72-74.

Guan, L. (2012). Impact of fiscal expenditure on income distribution gap. *Modern Business Trade Industry, 24*(1), 18-20.

Guo, G. F., & Tian, Y. Q. (2012). Research on the Relationship between Economic Growth and Income Distribution Based on VAR Model. *Journal of Anyang Normal University, 6*(4), 38-45.

Hu, R. C., & Yan, H. (2012). Interactive Relationship between Chinese Industrial Structure and Income Distribution Structure— An Empirical Analysis Based on VAR. *Journal of Wuling, 6*(2), 47-52.

Kunieda, T., Nishimura, K., & Shibata, A. (2018). Specializations, financial constraints, and income distribution. *International Review of Economics & Finance, 56*, 3-14.

Kuznets, S. (1955). Economic growth and income inequality. *The American economic review, 45*(1), 1-28.

Li, R. Q. (2011). Effect of international product trade on income distribution—An empirical analysis based on industrialized Data. *Finance and Trade Research, 6*(6), 63-69.

Lu, C. Y. (2014). An Analysis of the Relationship between Financialization, Monopoly and Income Distribution in China. *Economic Survey, 6*(1), 142-148.

Murphy, K. M., Shleifer, A., & Vishny, R. (1989). Income distribution, market size, and industrialization. The Quarterly *Journal of Economics, 104*(3), 537-564.

Qi, W. D., & He, L. (2007). Impact of urbanization on income distribution. *Economic Forum, 12*(1), 33-34.

Ran, G. H., & Pan, H. (2009). Study on Income Distribution Effect of Government Public Expenditure: Based on VAR Model. *Journal of Chongqing University (Social Science Edition), 15*(2), 19-23.

Said, S. E., & Dickey, D. A. (1984). Testing for unit roots in autoregressive-moving average models of unknown order. *Biometrika, 71*(3), 599-607.

Shen, Y. J., & Pan, S. B. (2008). An empirical analysis of the impact of foreign direct investment on regional income gap. *Journal of International Trade, 12*(2), 100-104.

Sims, C. A. (1980). Macroeconomics and reality. *Econometrica: Journal of the Econometric Society, 48,* 1-48.

Tan, Y., & Yuan, Y. (2013). Empirical Study on Social Security Expenditure, Economic Growth and Income Distribution in China—An Empirical Analysis Based on VAR Model. *Journal of Insurance Professional College, 6*(1), 15-21.

Tomkiewicz, J. (2018). The labour market and income distribution in post-socialist economies–Non-obvious regularities. *Communist and Post-Communist Studies, 51*(4), 315-324.

Wen, J., & Sun, C. R. (2008). Impact of international trade on income distribution—An empirical analysis based on Gini coefficient. *Journal of International Trade, 12*(11), 15-23.

Wen, Y. (2011). The Impact of Income Distribution on China's Export Trade: An Analysis based on the Overlapping Demand Structure calculated by Nonparametric Kernel Density Estimation. *World Economy Study, 12*(10), 33-39.

Zhang, Y., & Zhang, Z. H. (2011). Influence of Income Inequality to Import Trade of China. *Journal of International Trade, 12*(11), 43-52.