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Original Article

Measuring the Redistributive Effects of China's Personal Income Tax

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Abstract

Personal income tax is a commonly used redistributive instrument to deal with inequality. Whether it achieves that efficacy requires an appropriate measurement. This paper aims to examine the redistributive effects of personal income tax (PIT) based on the generalized entropy indexes. Compared with the commonly used approach based on the Gini coefficient, the generalized entropy indexes are more sensitive to the structural features of the redistributive effects and can lead to more reliable evaluation about the redistributive policy adjustments. Based on this new approach, we assess the redistributive effects of the 2011 PIT adjustment in China by using the urban household survey data. Different from previous studies, our results show that the 2011 PIT adjustment has effectively reduced the inequality within high income group, and if hidden income is taken into consideration, the overall inequality reduction resulted from the tax adjustment turns out to be positive. This finding highlights the importance of judging the redistributive effects of PIT on the basis of right household income data and that China should pay more attention to the hidden income in designing the redistributive tax rules.

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1. Introduction

The rising inequality in the early 21st century has put personal income tax, a widely used redistributive instrument, on the reform agenda of many major countries (see, e.g. OECD 2011). To reform this tax to achieve greater inequality reduction, policy-makers need good measurement for its redistributive effect. Because the redistributive effect of personal income tax (PIT) is essentially the extent to which the income inequality is reduced by the PIT, the results of its assessment might be greatly influenced by the underlying inequality measure adopted.

Following the seminal work of Musgrave and Thin (1948), scholars have conducted evaluation of the redistributive effect of PIT on the basis of the Gini coefficient (Kakwani 1977 1984; Lambert 1993; Pfähler 1990). In our opinion, this traditional approach is attractive partly because of the popularity of Gini coefficient as a summary inequality measure, and partly because its results can be decomposed easily to illustrate the roles of rate structures, tax deductions, allowances and credits in determining the overall progressivity of net income

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tax liabilities. However, more credible definition of inequality reduction shall be based on the concept of Lorenz dominance (Atkinson 1985; Lambert 2001; Sen & Foster 1973), or we can say that distribution x is more equal than distribution y only if the Lorenz curve of x lies everywhere on or above the Lorenz curve of y . As Sen and Foster (1973) have noticed, the Gini coefficient is more sensitive to changes at the lower tail of the income distribution, so the fact that the Gini coefficient of distribution x is lower than the Gini coefficient of distribution y does not necessarily mean that x Lorenz dominates y . Thus, the results of comparing the redistributive effects of different tax rules based on the Gini coefficient might be misleading.

In contrast, Cowell (1977, 2011) has described a class of inequality measures developed from the information theory which, known as the GE indexes, can be sensitive to changes in the bottom, middle or top part of the income distribution when the sensitivity parameter θ is given different values (Hao & Naiman 2010). Therefore, by assessing the redistributive effect of PIT based on the generalized entropy (GE) indexes, we can expect to achieve richer and more reliable results.¹

As a part of the efforts to combat the rising inequality in household income distribution, the Personal Income Tax Law (PITL) was revised in China in 2011. The main purpose of this tax adjustment is to 'lower the tax burden on medium and low-income groups and strengthen the adjustment of excessively high income'.² Most notably, as of September 2011, the standard deduction for payroll income was increased from CNY2000 per month to CNY3500 per month (see Section 3 for more

details about the tax adjustment). However, until now, most of the domestic studies have concluded that the 2011 PIT adjustment just dampened the overall effect of China's PIT system on the household income redistribution (Li & Sicular 2014; Xu et al. 2013; Yue et al. 2012).

We notice that those studies are mainly conducted by comparing the redistributive effects of PIT before and after the tax adjustment on the basis of the Gini coefficient. As the tax adjustment barely changed the tax burden of low income taxpayers, and the Gini coefficient mainly responded to changes in the bottom of the income distribution, it is quite likely that the redistributive effect of the 2011 PIT adjustment has been underestimated.

To properly examine the redistributive effect of the 2011 PIT adjustment in China, we develop a new approach of measuring the redistributive effect of PIT based on the GE indexes. This approach is similar to Zandvakili (1995), but instead of emphasizing the decomposability property of the GE indexes, we address more about the implications of different values of the sensitivity parameter θ and carefully select the values for it. We find that the case in China can well illustrate the utility of our new approach, as our findings do differ from the previous ones based on the Gini coefficient. We also find that the results are quite sensitive to the pre-tax household income structure, which again indicates the importance of adopting right inequality measures to capture the structural features of the income distribution and redistribution.

The rest of our paper is organized as follows: Section 2 introduces the approach based on the GE indexes. Section 3 describes China's PIT system and its adjustment in 2011. Section 4 discusses the data and the major features of China's urban household income distribution. Section 5 presents the results, and Section 6 concludes.

2. Measuring Redistributive Effect of PIT on the Basis of the GE Indexes

Because the redistributive effect of PIT shall represent the extent to which a given tax rule

1. The GE indexes also possess other desirable properties for good inequality measures, such as scale independence, population invariance, decomposability and compatibility with both the weak and strong principles of transfer (Cowell 1977, 2011).

2. Source: Press conference of the responsible officials from the Ministry of Finance and State Administration of Taxation (China) on issues about Amendment to the Personal Income Tax Law (Draft), available at http://www.mof.gov.cn/zhengwuxinxi/zhengcejiedu/2011zhengcejiedu/201104/t20110420_539060.html.

leads to a shift in the distribution of income toward equality, in order to formulate a measure for this effect, we shall first choose an inequality measure and, second, specify a way to compute the gap between the values of this inequality measure for pre-tax and post-tax income distribution.

As mentioned in the preceding texts, following the classic work of Musgrave and Thin (1948), many redistributive effect indexes have been developed based on the Gini coefficient, among which we have

$$RE^g = \frac{1 - G_a}{1 - G_b}, \quad (1a)$$

$$RE^g = \frac{G_b - G_a}{G_b}, \text{ or} \quad (1b)$$

$$RE^g = G_b - G_a, \quad (1c)$$

where RE^g denotes the redistributive effect index based on the Gini coefficient and G_b and G_a denote the Gini coefficients for pre-tax and post-tax income distributions.³ As lower value of the Gini coefficient means more equal income distribution, higher value of RE^g represents greater redistributive effect of PIT.

According to Sen and Foster (1973), the Gini coefficient G for the income distribution of n persons can be expressed as

$$G = 1 + (1/n) - (2/n^2\bar{y}) \cdot [y_1 + 2y_2 + \dots + ny_n], \quad y_1 \geq y_2 \geq \dots \geq y_n, \quad (2)$$

where \bar{y} denotes the average income, and y_i denotes the income of person i , $i = 1, \dots, n$.

It is clear that the higher the incomes of the poorer persons in comparison with the average income, the lower the value of Gini coefficient, which just indicates the reduced inequality. Moreover, because higher weights are given to the incomes of lower level, the Gini coefficient is more sensitive to the changes at the lower tail of the income distribution. Even though it seems ethically acceptable to attach more value

3. See Kiefer (1984) for a detailed review about these indexes.

to the well-being of the poor in evaluating the overall income distribution, when it comes to the assessment of a redistributive policy measure, we should account for not only its impact on the poor but also that on the rich. Actually, as argued by Piketty (2014), in recent decades, it is just at the upper tail of the income distribution that dramatic dispersion has occurred in many major countries around the world. Therefore, failure to get full structural information might be a major drawback of basing the redistributive effect measure on the Gini coefficient.

On the other hand, the GE indexes put forward by Cowell (1977, 2011) can be expressed as

$$GE_\theta = \frac{1}{\theta^2 - \theta} \left[\frac{1}{n} \sum_{i=1}^n \left(\frac{y_i}{\bar{y}} \right)^\theta - 1 \right] \quad (\theta \neq 0, 1), \quad (3a)$$

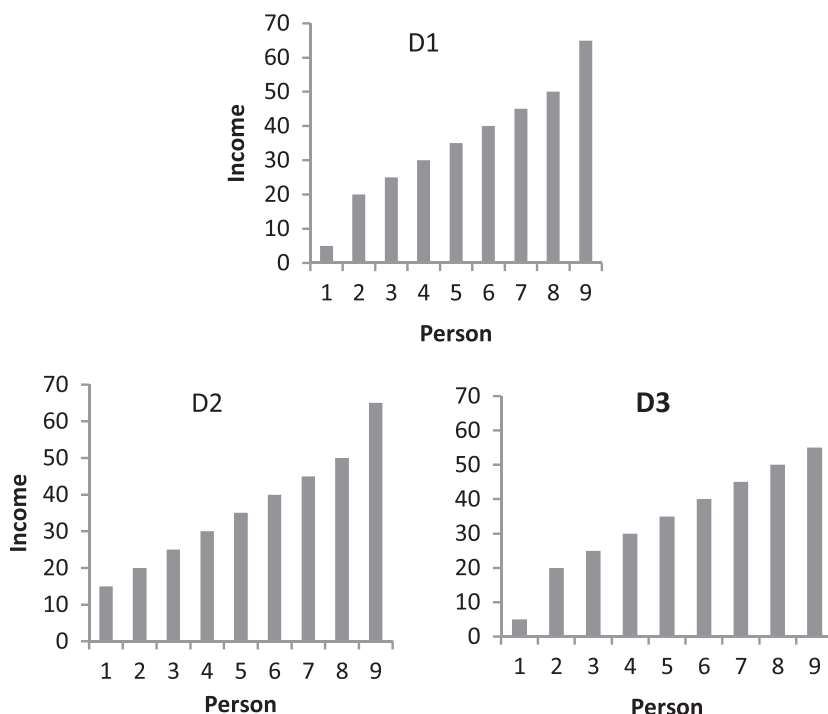
$$GE_\theta = \frac{1}{n} \sum_{i=1}^n \frac{y_i}{\bar{y}} \ln \left(\frac{y_i}{\bar{y}} \right) \quad (\theta = 1), \text{ or} \quad (3b)$$

$$GE_\theta = \frac{1}{n} \sum_{i=1}^n \ln \left(\frac{\bar{y}}{y_i} \right) \quad (\theta = 0), \quad (3c)$$

where GE_θ denotes the GE index with a sensitivity parameter θ whose value can be any real number. When $\theta = 1$, we obtain the famous Theil index. It is also noticeable that GE_0 is known as the mean logarithmic deviation and GE_2 is a multiple of the squared coefficient of variation.

GE_θ also signals more unequal income distribution with larger value, but it can take any value outside the (0,1) range. In particular, it can be proven that GE_θ is more sensitive to the income differences in higher part of the income distribution when $\theta > 2$, more sensitive to the income differences in lower part of the income distribution when $\theta < 2$ and is scale invariant when $\theta = 2$. In addition, the sensitivity of GE_θ mentioned in the preceding texts increases with θ when $\theta > 2$ and decreases with θ when $\theta < 0$ (see Appendix 1 for the proof). This means we can make use of GE_θ to capture more structural features of the income distribution inequality.

Figure 1 Three Hypothetical Income Distributions



The differences in the Gini coefficient and the GE indexes with several typical values of θ can be illustrated by a hypothetical example with three possible income distributions of nine persons shown in Figure 1.

The nine persons can be divided into three groups: low income group, middle income group and high income group. Assume distribution D1 is the original distribution, and distribution D2 and D3 are results of

redistribution. As can be seen in Figure 1, the income gap between the rich and the poor is relatively high in distribution D1, income of the poorest person is higher in distribution D2 than in distribution D1 by 10 units, and income of the richest person is lower in distribution D3 than in distribution D1 by 10 units.

Table 1 illustrates the inequality of these distributions measured by the Gini coefficient and

Table 1 The inequality of three hypothetical income distributions under different measures

Inequality Measures	Distributions			Inequality ranking	Inequality gap (D2 vs. D3)
	D1	D2	D3		
(1)	(2)	(3)	(4)	(5)	(6)=(3)/(4)
Gini	0.268	0.232	0.248	D1>D3>D2	0.94
GE ₂₀	70.056	37.495	5.489	D1>D2>D3	6.83
GE ₂	0.113	0.085	0.096	D1>D3>D2	0.88
GE ₁	0.129	0.085	0.115	D1>D3>D2	0.74
GE ₀	0.182	0.091	0.168	D1>D3>D2	0.54
GE ₋₁	0.345	0.104	0.323	D1>D3>D2	0.32
GE ₋₂	0.917	0.129	0.852	D1>D3>D2	0.15
GE ₋₂₀	2.1E+13	1.1E+04	1.1E+13	D1> D3>D2	0.00

Source: The authors' calculations using Stata 12.0 and the DASP package (see Araar and Duclos (2007) for more information about this package).

the GE indexes with θ being equal to $-20, -2, -1, 0, 1, 2$ and 20 .

From Table 1, we can have the following findings. First, the Gini coefficient is more sensitive to the redistribution made in the lower part of the income distribution, as on basis of Gini coefficient, the inequality in D2 is lower than in D3. Second, the ranking of inequality for the three distributions differs under different measures. On basis of GE_{20} , the inequality of distribution D2 is higher than D3, but under other measures, the inequality of distribution D3 is higher than D2. Since D2 and D3 are essentially redistribution made in upper tail and lower tail of the income distribution respectively, in evaluating the inequality of different distributions, it makes more sense to reveal their structural features instead of focusing only on ranking.⁴ Third, the inequality measured by the GE indexes does depend on the value of θ . As can be seen in column (6) of Table 1, the gap of inequality between D2 and D3 decreases with θ , indicating that GE indexes with θ of lower value put less weight on the inequality in the upper tail of the income distribution. Therefore, by constructing the redistributive effect measures on the basis of the GE indexes with proper values of θ , we can capture more structural features of the income distribution so as to evaluate the redistributive effect of PIT more fully and precisely.

Zandvakili (1995) made the first attempt to measure the income tax progressivity based on the GE indexes. In his study, the specific form of the progressivity index is

$$I_{\theta} = GE_{\theta}^b - GE_{\theta}^a, \quad (4)$$

where GE_{θ}^b denotes the GE index for pre-tax income and GE_{θ}^a for post-tax income. By definition, the progressivity here is equivalent to the redistributive effect. However, Zandvakili mainly accounted for the decomposability property of the GE indexes. With regard to θ , he just adopted three values, being $-0.5, 0$ and -1 , but gave no reasons for that.

The form of our measure is nearly the same as that of Zandvakili (1995). But as discussed

4. Sen and Foster (1973) have discussed the difficulties in ordering inequality more formally.

in the preceding texts, the key point lies in the value of θ . In particular, five values for θ can be specified, namely, $-1, 0, 1, 2$ and 4 , so that we can account for the GE index more sensitive to the income change at the upper tail (GE_4), the GE index more sensitive to the income change at the lower tail (GE_{-1}), the GE index equally sensitive to the income change everywhere (GE_2) and two special GE indexes (GE_1 and GE_0). Then, we have

$$RE_{\theta}^{ge} = GE_{\theta}^b - GE_{\theta}^a, \theta = -1, 0, 1, 2, 4 \quad (5)$$

Larger value of RE_{θ}^{ge} again indicates greater redistributive effect, which is similar to RE^g , but with different values of θ , this measure may provide specific information about the changes of inequality at different parts of the income distribution.

As the GE indexes are decomposable such that the measured total inequality can be expressed as the sum of the between-group inequality and the weighted average of the within-group inequalities, or

$$(GE_{\theta}^y)^T = (GE_{\theta}^y)^B + \sum_{i=1}^n ((GE_{\theta}^y)^w \cdot w_i), \quad (6)$$

where $(GE_{\theta}^y)^T$, $(GE_{\theta}^y)^B$, $(GE_{\theta}^y)^w$ and w_i denote the total GE index, the between-group GE index, the within-group GE indexes and the weight, respectively⁵; we can decompose the redistributive effect measure RE_{θ}^{ge} accordingly to obtain further structural information.

3. China's PIT System and Its Adjustment in 2011

China's PIT is essentially scheduler. According to the PITL, which was promulgated in 1993 and took effect in 1994, and its subsequent amendments, the gross taxable incomes are divided into 11 categories and subject to different tax treatments.

As illustrated in Table 2, different incomes are taxed on a monthly, annual or per payment basis. Some categories of income are taxed at progressive rates, while others are taxed at flat

5. If \bar{y} and \bar{y}_i denote for the total average income and the average income of group i , and the proportion of the number of people in group i in total is m_i , then $w_i = m_i(\bar{y}_i/\bar{y})^{\theta}$.

Table 2 The Categories of Gross Taxable Income for PIT in China (Before the 2011 Tax Adjustment)

Category of income	Basis	Rate	Deduction or allowance	% of total PIT revenue ^{¶¶}
Payroll income	Monthly	5%–45%	CNY2000 [†] + SSCs [‡]	65.3
Business income I [§]	Annual	3–35%	CNY2000 × 12 + SSCs [‡] + expenses	12.6
Business income II [¶]	Annual	3–35%	CNY2000 × 12 + SSCs [‡] + expenses	1.3
Personal service income	Per payment	20%–40%	CNY800/20% of gross income ^{††}	2.2
Royalties	Per payment	20%	CNY800/20% of gross income ^{††}	0.0
Property lease income	Monthly	20% ^{‡‡}	CNY800/20% ^{‡‡} + expenses + taxes	0.3
Property transfer income	Per payment	20%	CNY800/20% ^{‡‡} + expenses + taxes	5.3
Interest/dividends	Per payment	20% ^{§§}	0	11.1
Manuscript remuneration	Per payment	14%	CNY800 / 20% of gross income	0.1
Contingent income	Per payment	20%	0	1.1
Other income	Per payment	20%	0	0.7

Source: State Administration of Taxation, China.

[†]The deduction standard is changed to CNY4800 for expatriates.

[‡]SSC refers to social security contribution.

[§]'Business income I' refers to business income of industrial or commercial households with the taxpayers being the household heads.

[¶]'Business income II' refers to business income from contracting or leasing operations of enterprises or institutions derived by individuals.

^{††}The deduction is CNY800 for a single payment less than CNY4000 and is 20% of gross income for a single payment exceeding CNY4000.

^{‡‡}The rate is reduced to 10% for income from lease of individually-owned houses.

^{§§}The rate is reduced to 0 for interest from government bonds and deposit savings and reduced to 10% for dividends received from listed companies.

^{¶¶}The data are for 2010.

rates. Moreover, the deduction or allowance rules vary across the income categories. Because no aggregation of different categories is required for determining the final tax liability, it is hard to predict the redistributive effect of PIT from the rate schedules.

The last column of Table 2 indicates that the bulk of PIT revenue in China is derived from labour incomes and business incomes. In 2010, the payroll income and personal service income accounted for 65.3 and 2.2 per cent of the total PIT revenue, respectively, and two categories of business income accounted for 12.6 and 1.3 per cent of the total PIT revenue respectively.

In fact, China has set labour income and business income as the main targets for the purpose of income redistribution through PIT. But even though the four categories of labour income and business income are all subject to progressive rates with the top marginal rate being as high as 45 per cent, when measured on the basis of the Gini coefficient, the PIT system in China had hardly any effect on reducing the inequality of household income distribution until mid-2000s (Brys et al. 2013).

In recent years, in order to pursue sustainable and equitable growth, China has promised to enhance its efforts in inequality reduction. As a result, the PITL was revised for the fifth time in 2011. This revision mainly adjusted the deduction standard and rate schedules for payroll income and two categories of business income. As of 1 September 2011, the deduction standard for these incomes was lifted from CNY2000 per month to CNY3500 per month⁶ and the applicable rates were increased for the top income workers and decreased for others (see Table 3).

The changes brought about by the 2011 PIT adjustment seem consistent to its alleged purposes of 'lowering the tax burden on medium and low-income groups, strengthening the adjustment of excessively high income and intensifying the redistributive effect of taxation'.⁷

6. This deduction standard remains CNY 4800 for expatriates.

7. Source: Press conference of the responsible officials from the Ministry of Finance and State Administration of Taxation (China) on issues about Amendment to the Personal Income Tax Law (Draft), available at http://www.mof.gov.cn/zhengwuxinxi/zhengcejiedu/2011zhengcejiedu/201104/t20110420_539060.html.

Table 3 The PIT Rate Schedules for Payroll Income and Business Incomes in China

<i>A. The rate schedule applicable to payroll income</i>			
<i>Before the tax adjustment</i>		<i>After the tax adjustment</i>	
<i>Monthly taxable income (CNY)</i>	<i>Applicable tax rate (%)</i>	<i>Monthly taxable income (CNY)</i>	<i>Applicable tax rate (%)</i>
Up to 500	5	Up to 1,500	3
501–2,000	10	1,501–4,500	10
2,001–5,000	15	4,501–9,000	20
5,001–20,000	20	9,001–35,000	25
20,001–40,000	25	35,001–55,000	30
40,001–60,000	30	55,001–80,000	35
60,001–80,000	35	Over 80,000	45
80,001–10,000	40		
Over 10,000	45		

<i>B. The rate schedule applicable to business incomes</i>			
<i>Before the tax adjustment</i>		<i>After the tax adjustment</i>	
<i>Annual taxable income (CNY)</i>	<i>Applicable tax rate (%)</i>	<i>Annual taxable income (CNY)</i>	<i>Applicable tax rate (%)</i>
Up to 5,000	5	Up to 15,000	5
5,001–10,000	10	15,001–30,000	10
10,001–30,000	20	30,001–60,000	20
30,001–50,000	30	60,001–100,000	30
Over 50,000	35	Over 100,000	35

Source: State Administration of Taxation, China.

However, some scholars argued that this tax adjustment just weakened the overall redistributive effect of China's PIT system (Li & Sicular 2014; Xu et al. 2013; Yue et al. 2012). They put the blame for this negative effect on the fact that higher tax threshold (deduction standard) would lead to less revenue of PIT and therefore less transfer of income from richer to poorer households.

Even though failure to raise desirable amount of tax revenue does constitute a major drawback of China's PIT system and tends to weaken its redistributive effect, it is noteworthy that those studies were mostly simulation analysis based on the Gini coefficient (and data before 2011). Because the Gini coefficient is more sensitive to the changes at the lower tail of the income distribution, and the post-tax incomes of those taxpayers earning wages or salaries of less than CNY2000 per month would not be affected by the tax adjustment at all, it is quite likely that the redistributive effect of the 2011 PIT adjustment has been underestimated. Therefore, in this paper, we will try to re-examine the redistributive effect of the tax adjustment based on the GE indexes.

4. Data and the Features of China's Urban Household Income Distribution

In China, PIT is solely levied in urban area, so this paper will mainly examine the effect of PIT on urban household income redistribution. Our study will be based on the urban household survey data obtained from the National Statistics Bureau of China (NSBC). The sample includes 11,271 households (with 44,068 family members) in Liaoning, Sichuan, Guangdong provinces and Shanghai municipality. Although only four provincial level regions are covered, because the Gini coefficient of pre-tax annual per capita income of the sample households is quite close to the officially published urban household Gini coefficient derived from the whole urban household survey data,⁸

8. The Gini coefficient for the pre-tax per capita annual income of our sample households in 2012 was 0.33, and as indicated in the *Annual Report for Household Income Distribution in China* (Zhang 2011), the urban household Gini coefficient derived from the whole urban household survey data in 2010 was 0.34. The 2012 and 2013 versions of this report (Zhang 2013) did not publish the urban household Gini coefficient but mentioned that the indicator has not changed much.

Table 4 Ratios of Imputed Income to Statistics Income by Household Groups (2008)

Group	Bottom	Low	Mid-low	Middle	Mid-high	High	Top	Total
Ratio	1.125	1.009	1.174	1.280	1.431	2.091	3.187	1.904

Source: Wang (2012); both of the statistics income and the imputed income are gross annual per capita household income without deducting any expenses, taxes or social security contributions.

the representativeness of this sample is acceptable. This paper uses the data for 2012, which is just a year after the 2011 PIT adjustment. Compared with previous simulation analysis based on earlier data (Xu et al. 2013; Yue et al. 2012), the results derived from this more updated data shall be more close to the real effect of the tax adjustment.

The NSBC urban household survey data are the most authoritative microdata which provide detailed information about the incomes of urban households in China and are available to researchers only upon restriction. However, a principal disadvantage of these data lies in the fact that the surveyed families, especially those at the top of the income distribution, tend to underreport their incomes. According to a widely reported study of Wang (2012), almost 10 trillion Yuan, or 30% of the country's gross domestic product, is hidden from the urban household survey conducted by the NBSC. Furthermore, Wang's study showed that, from 2005 to 2008, the hidden income increased by 91%. This growth rate is almost 20% higher than that of the gross domestic product.

Because the amount of the hidden income is too large to be ignored, our paper will try to base the analysis on the household income data including the hidden income. Following Wang, we take annual per capita income as the measure of household income and let 'imputed income' and 'statistics income' denote the household income with and without the hidden income, respectively. Then, we divide the sample households into seven groups and derive the imputed income according to the ratios of imputed income to statistics income estimated by Wang. As shown by Table 4, the share of hidden income progressively rises with the overall income level.

It is discussed in the preceding texts that different incomes are subject to different tax treatments under China's scheduler PIT

system, and in 2011, only the tax treatments for payroll income and business incomes were adjusted. Therefore, it is necessary to make a brief structural analysis for the income distribution of the sample households before we fully discuss the redistributive effect of the tax adjustment.

In the 2012 NSBC urban household survey data, the household incomes are classified into four types: labour income, net operating income (which is equivalent to business income by definition), property income and transfer income. Figure 2 shows the total shares of income received by various groups along the income distribution and their composition in terms of the statistics income and the imputed income.⁹ The horizontal axis indicates 10 decile groups with income from low to high, and the vertical axis indicates the share of each type of income earned by each group in the total income in a stacked way. The sum of the shares of four types of income for a specific group reflects the total share enjoyed by that group in the total income of all the groups.

As illustrated in Figure 2, higher income groups enjoy larger share in the total income, and there is a steep increase in the share of income going to the 10 per cent households of top income level. In terms of the imputed income, the share of the top decile even reaches 42.8%. More notably, different from the common perception that top incomes are primarily composed of business income and property income, it is labour income that represents the major component of the total income at the top. In terms of the statistics income, 17.7% of total payroll income goes to the top 10 per

9. Because the labour income is highly regulated, people usually intend not to underreport such income, so we allocate the hidden income of each household only to the other three types of income.

Figure 2 Income Share and Composition for the Sample Households (2012)

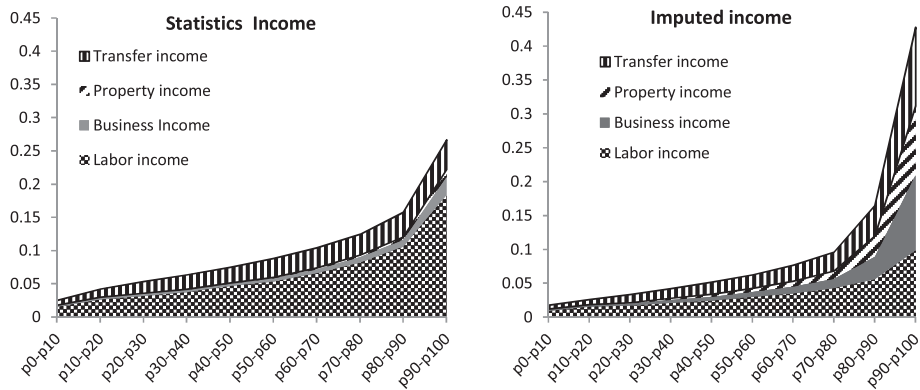


Table 5 Inequality of Each Type of Income and Its Contribution to the Overall Income Inequality

Income type	For statistics income			For imputed income		
	% of total income	Gini coefficient	Contribution to total inequality (%)	% of total income	Gini coefficient	Contribution to total inequality (%)
Labour	62.87	0.51	69.13	34.94	0.51	24.66
Business	8.50	0.93	10.42	19.53	0.74	25.16
Property	3.08	0.92	5.28	16.52	0.75	23.32
Transfer	25.55	0.67	15.18	29.01	0.61	26.85

cent rich households, the share is much higher than 10.1%, or the share of the next less rich group. Regarding the imputed income, it is still the top income group that holds the highest proportion of labour income.

Table 5 shows the level of inequality of each type of income and its contribution to the overall income inequality.¹⁰ In terms of the statistics income, due to its overwhelming share in the total income, labour income makes the largest contribution to the overall inequality even with the lowest Gini coefficient. However, in terms of the imputed income, because other incomes account for more in the total income and have higher inequality level *per se*, their contribution to the overall inequality increases and reaches to similar level of that of labour income.

The structural features mentioned in the preceding texts have at least two implications:

10. Due to limited space, here we only present the results calculated based on the Gini coefficient. Those based on the GE indexes are similar.

First, the tax adjustments targeted to the labour income will cause influences on the tax burden of households of various income levels similar to those directly targeted to the total income. Second, the redistributive effect of the 2011 PIT adjustment in terms of the statistics income may differ from that in terms of the imputed income.

5. Redistributive Effect of the 2011 PIT Adjustment in China

As the focus of our paper is to illustrate the implications of choosing GE indexes as the underlying inequality measures for assessing the redistributive effect of PIT, we define the redistributive effect of the 2011 PIT adjustment in China as the gap between the redistributive effects of PIT under the tax rules before and after the PITL revision. This means that we consider only the direct short-run effect of the tax adjustment and ignore the impacts of the long-run economic growth, the behavioural responses (e.g. tax planning

or labour supply reduction) of the taxpayers and the possible inefficient tax collection. For this purpose, the PIT payable will be calculated for each household according to the ‘statutory’ tax rules and then subtracted from the pre-tax income to derive the post-tax income.

In the NBSC urban household survey data, ‘labour income’ is further divided into ‘salary and subsidy income’ and ‘other earned income’. According to their definitions, we apply the old rule and new rule for ‘payroll income’ to ‘salary and subsidy income’ and the rules for ‘personal service income’ to ‘other earned income’. The rules for ‘business income’ are applied to ‘net operating income’ in the survey data. As for ‘property income’ and ‘transfer income’, because there are no direct applicable tax rules, the amount of ‘PIT paid’ indicated in the NBSC urban household survey data will be taken as the PIT payable. This inconsistency will not affect the basic conclusion of this paper, because ‘property income’ and ‘transfer income’ are not involved in the 2011 PIT adjustment. The basic tax units are individuals, and some types of taxable incomes are subject to monthly taxation under China’s

schedular PIT system, so we can first calculate the tax payable for each tax unit in each taxable period, and then derive the annual per capita tax payable for each household. Moreover, because the hidden income could not be taxed, for each household, we set the tax payable for each type of imputed income identical to the tax payable for statistics income of the same type.

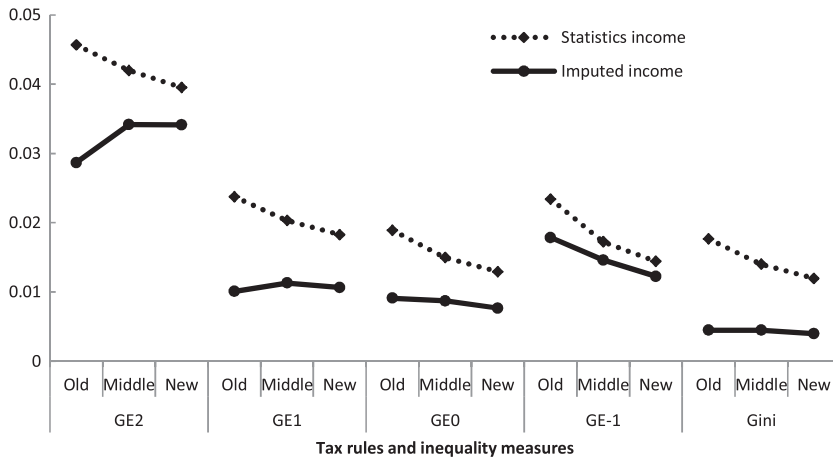
After the data treatment mentioned in the preceding texts, the redistributive effects of PIT under the two tax rules are measured by using both the statistics data and the imputed income data, and based on both the GE indexes (according to Equation 5) and the Gini coefficient (according to Equation 1c). The results are illustrated in Table 6 and Figure 3.

The important fact standing out here is that the results vary with the inequality measures and the income data. RE^g under the new tax rule is lower than that under the old one when the statistics income data are adopted, which is consistent to the findings of the aforementioned previous studies in Section 1. However, with larger value of θ , RE_{θ}^{ge} under the new tax rule turns out to be ‘relatively’ higher. This trend is even more obvious when the imputed income data are adopted. As a result, for the

Table 6 Redistributive Effects of PIT Under Different Tax Rules and for Different Income Data

A. The results based on the GE indexes							
Inequality measure	Tax rule	For statistics income			For imputed income		
		GE_{θ}^b	GE_{θ}^a	RE_{θ}	GE_{θ}^b	GE_{θ}^a	RE_{θ}
GE ₄	Old	0.2632	0.2176	0.6439	0.9098	0.8811	1.6719
	New	0.2632	0.2237	0.6351	0.9098	0.8756	1.9900
GE ₂	Old	0.1971	0.1733	0.0457	0.5226	0.5125	0.0287
	New	0.1971	0.1788	0.0395	0.5226	0.5120	0.0341
GE ₁	Old	0.1926	0.1737	0.0237	0.4681	0.4590	0.0101
	New	0.1926	0.1796	0.0183	0.4681	0.4604	0.0106
GE ₀	Old	0.2567	0.2333	0.0189	0.6581	0.6402	0.0091
	New	0.1926	0.1796	0.0129	0.4681	0.4604	0.0077
GE ₋₁	Old	0.2567	0.2333	0.0234	0.6581	0.6402	0.0178
	New	0.2567	0.2423	0.0144	0.6581	0.6458	0.0123
B. The results based on the Gini coefficient							
Inequality measure	Tax rule	For statistics income			For imputed income		
		G _b	G _a	RE^g	G _b	G _a	RE^g
Gini	Old	0.3349	0.3173	0.0177	0.5217	0.5172	0.0045
	New	0.3349	0.3230	0.0120	0.5217	0.5177	0.0040

Figure 3 Redistributive Effects of PIT Under Different Tax Rules and for Different Income Data



imputed income data, RE_{θ}^{ge} under the new tax rule finally exceeds that under the old tax rule when θ equals 1, 2 and 4.¹¹

Because the imputed income data are closer to the real-world urban household income distribution in China, we shall pay more attention to the findings obtained for the imputed income data. The contradictory results mentioned in the preceding texts given by different underlying inequality measures imply that the post-tax income distribution under the new tax rule does not Lorenz dominate that under the old tax rule, and vice versa. Consequently, we cannot decide whether the overall redistributive effect of the 2011 tax adjustment is positive or negative.

However, making use of the good decomposability property of the GE indexes, we can break down RE_{θ}^{ge} into within-group and between-group components according to Equation 6 and get more structural information. Table 7 presents the results with regard to GE_4 , GE_2 and GE_{-1} , where G1 to G5 stand

for five groups with household income from low to high.

From Table 7, we can have the following major findings: First, the overall redistributive effect of the 2011 PIT adjustment mainly comes from the between-group effect and the top income (G5) within-group effect. Second, the inequality reduction for the top income group under the new tax rule outperforms that under the old one for each value of θ and each income data. Third, the between-group inequality reduction under the new tax rule underperforms that under the old one for each value of θ and each income data. Fourth, the between-group inequality reduction for the imputed income data under the new tax rule is to a lesser extent lower than that under the old tax rule, and higher weight is given to the inequality reduction for the top income group when θ is larger; thus, for the imputed income data, RE_2^{ge} and RE_4^{ge} under the new tax rule finally exceed that under the old tax rule.

The results in the preceding texts are closely related to the structural features of the urban household income distribution in China. It can be derived from Table 3 that, roughly speaking, the 2011 PIT adjustment has increased the tax burden for those taxpayers who earn monthly wages or salaries of over CNY21100 and decreased the tax burden for others. Because the income level of

11. Figure 3 also shows the redistributive effect of a 'middle' PIT regime, under which the tax threshold (monthly deduction standard) is raised from CNY2000 to CNY3500 while the rate schedule remains unchanged, to present the effects of lifting tax threshold and altering rate schedule separately. The change in tax threshold turns out to be the main cause for the redistributive effect of the tax adjustment, while the change in rate schedule has almost no impact.

Table 7 Breakdown of RE_{θ}^{ge} Under Different Tax Rules and for Different Income Data

Group (1)	For statistics income					For imputed income				
	Pre-tax indicators			RE_{θ}^{ge}		Pre-tax indicators			RE_{θ}^{ge}	
	GE_{θ}^b (2)	Weight (3)	Contribution (%) (4)	Old rule (5)	New Rule (6)	GE_{θ}^b (7)	Weight (8)	Contribution (%) (9)	Old rule (10)	New rule (11)
GE₄										
G1	0.035	0.004	0	0	0	0.029	0.000	0	0	0
G2	0.004	0.028	0	0	0	0.009	0.004	0	0	0
G3	0.004	0.094	0	0	0	0.006	0.021	0	0	0
G4	0.005	0.325	0.1	0	0	0.009	0.112	0	0	0
G5	0.359	3.590	83.5	0.136	0.147	0.883	15.418	91.8	0.088	0.108
Between	0.254	.	16.4	0.040	0.029	1.213	.	8.2	0.03	0.031
Total	1.546	.	100	0.644	0.635	14.837	.	100	1.672	1.990
GE₂										
G1	0.040	0.028	0.4	0	0	0.036	0.010	0	0	0
G2	0.004	0.075	0.1	0	0	0.009	0.029	0	0	0
G3	0.004	0.137	0.2	0	0	0.006	0.065	0	0	0
G4	0.005	0.255	0.5	0	0	0.008	0.150	0.1	0	0
G5	0.105	0.847	33.8	0.024	0.026	0.229	1.756	44.2	0.009	0.012
Between	0.171	.	65.0	0.020	0.014	0.505	.	55.5	0.0088	0.0087
Total	0.263	.	100	0.046	0.040	0.910	.	100	0.029	0.034
GE₋₁										
G1	0.107	0.538	22.5	0	0	0.104	0.912	14.4	0	0
G2	0.004	0.327	0.6	0	0	0.009	0.527	0.7	0	0
G3	0.004	0.242	0.3	0	0	0.006	0.350	0.3	0	0
G4	0.005	0.177	0.3	0	0	0.008	0.231	0.3	0	0
G5	0.057	0.097	2.2	0.009	0.010	0.160	0.067	1.6	0.002	0.004
Between	0.190	.	74.1	0.020	0.012	0.544	.	82.6	0.015	0.011
Total	0.257	.	100	0.023	0.014	0.658	.	100	0.018	0.012

Note: Due to limited space, the post-tax indicators are omitted here. But GE_{θ}^g can be derived from GE_{θ}^b and RE_{θ}^{ge} according to Equation 5 and the post-tax ‘weight’ and ‘contribution’ are quite similar to the pre-tax ones.

CNY21100 is at around 99.85 quantile in the distribution of monthly ‘salary and subsidy income’ in the 2012 NSBC urban household survey data, and as mentioned in Section 4 (see Figure 2), those who earn the most labour income generally also earn the most total income. Therefore, the majority of the high-income households (G4 and G5) actually has benefited from the tax reform. As can be seen in Table 8, the drop in average PIT burden

(equal to the ratio of PIT payable to total income) for the top 20% richest households (G5) is close to 7 times that of the bottom 20% poorest households (G1). Hence, the 2011 PIT adjustment reduced the income differences within the top income group but at the same time enlarged the income gap among different income groups.

Nevertheless, with regard to the imputed income, although higher income group still

Table 8 Average PIT Burden of Five Income Groups Before and After the 2011 PIT Adjustment

Group	PIT burden for statistics income (%)			PIT burden for imputed income (%)		
	Old rule	New rule	Tax cut	Old rule	New rule	Tax cut
G1	0.73	0.24	0.49	0.68	0.22	0.46
G2	1.16	0.22	0.94	1.04	0.2	0.84
G3	2.14	0.46	1.68	1.72	0.37	1.35
G4	3.63	1.10	2.53	2.63	0.79	1.83
G5	7.42	3.98	3.44	3.03	1.55	1.48

enjoys larger absolute value of tax reduction, when it comes to the ratio of tax reduction to total income, it is the mid-high income group (G4) that benefits the most. This is due to the fact that the hidden income, which cannot be taxed either before or after the tax adjustment, accounts for a larger part in the total income of the top income households. As the hidden income drives up the total income but not the tax reduction, the tax reduction as a percentage of the total income for the top income households will be relatively lower. This explains the relatively higher between-group redistributive effect for the imputed income data.

6. Conclusions

This paper has presented a new approach of measuring the redistributive effect of PIT on the basis of the GE indexes. This approach is similar to the traditional method based on the Gini coefficient in that it also makes use of the scalar summary inequality measures to facilitate comparative analysis across different time points. However, as it is sensitive to the inequality reduction at more parts of the income distribution, and can be decomposed more easily into within-group effect and between-group effects, compared with the traditional method, this new approach can provide richer summary and structural information about the redistributive effect of PIT.

The advantage of measuring the redistributive effect of PIT on the basis of the GE indexes is closely related to the sensitivity parameter θ . We carefully discussed the implications of setting different values for θ and decided to choose five values, namely, -1 , 0 , 1 , 2 and 4 , to ensure that our measurement can capture the redistributive effect of PIT at lower, middle and upper part of the income distribution.

This new approach is then used to analyse the redistributive effect of the 2011 PIT adjustment in China. It seems that the case in China can well illustrate the differences between our new approach and the commonly used approach based on the Gini coefficient. As China barely grants any credit to tax payers, and low income households typically cannot get any transfer

through the PIT system, the redistributive effect of PIT in China mainly happens at the top tail of the income distribution. Therefore, even though China adjusted the PIT rule in 2011 aiming to strengthen the redistributive effect of this tax, as the Gini coefficient gives higher weight to the incomes of lower level, the measurement based on the traditional approach has reported no positive change at all. On the contrary, using the new approach, it is revealed that the 2011 PIT adjustment has effectively reduced the inequality within high income group, although such adjustment widened the between-group inequality as well. If we include the hidden income in household income data and adopt the GE index, which is scale invariant (GE_2) or puts more weight on the inequality within high income group (GE_4), the overall redistributive effect of this tax adjustment turns out to be positive.

Of course, because the hidden income is just estimated, our results may not reflect the exact reality, but our analysis does illustrate that the GE indexes are better basic inequality measures for evaluating the redistributive effect of PIT at least in the countries like China, where PIT mainly brings changes to the upper tail of the income distribution. Our paper also highlights the importance of judging the redistributive effect of PIT on the basis of right household income data. China should pay more attention to the hidden income in designing the redistributive tax rules.

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Appendix 1.

In order to analyse the sensitivity of GE indexes to the changes in income at different parts of the distribution, we can construct the following function based on the general form of the GE index (Equation 3a),¹²

$$F(y) = \frac{1}{n(\theta^2 - \theta)} \left(\frac{y}{\bar{y}} \right)^\theta \quad (A1)$$

For a specific value of θ , when a small amount c ($c > 0$) is transferred from income y , the change in GE can be expressed as

$$\Delta GE(y) = F'(y) - F'(y - c) \quad (A2)$$

By differentiating $F(y)$ with respect to y , we have

$$\Delta GE(y) = \frac{1}{n(\theta - 1)\bar{y}^\theta} \left[y^{\theta-1} - (y - c)^{\theta-1} \right] \quad (A3)$$

Then by differentiating $\Delta GE(y)$ with respect to y , we have

12. In the two special cases of $\theta = 1$ and $\theta = 0$, we can follow similar steps and achieve the same conclusion.

$$\frac{\partial(\Delta GE)}{\partial y} = \frac{1}{n\bar{y}^\theta} \left[y^{\theta-2} - (y-c)^{\theta-2} \right] \quad (\text{A4})$$

It can be derived from Equation A4 that when $\theta > 2$, $\frac{\partial(\Delta GE)}{\partial y} > 0$; when $\theta < 2$, $\frac{\partial(\Delta GE)}{\partial y} < 0$ and when $\theta = 2$, $\frac{\partial(\Delta GE)}{\partial y} = 0$. This means that the GE index is more sensitive to the change at the upper part of the income distribution when $\theta > 2$, more sensitive to the change at the lower part of the income distribution when $\theta < 2$, and equally sensitive to the change in each part of the income distribution when $\theta = 2$.

We can further discuss how $\frac{\partial(\Delta GE)}{\partial y}$ changes with θ . It is clear that $\frac{1}{n\bar{y}^\theta}$ increases with θ when $\theta > 0$ and decreases with θ when $\theta < 0$, and $[y^{\theta-2} - (y-c)^{\theta-2}]$ increases with θ when $\theta > 2$ and decreases with θ when $\theta < 2$. Therefore, in case that $\theta > 2$, larger θ will cause even more sensitivity of GE indexes to higher value of income, while in case that $\theta < 0$, smaller θ will cause even more sensitivity of GE indexes to lower value of income. If θ is between 0 and 2, the influence of change in the value of θ cannot be decided.