The Application of Non-parametric Pointwise Regression Model in Skilled Wage Premium

Jinghui Duan[1]; Qianhui Zhuang[2], Xueru Guo[3], Lu Liu[4]

{Corresponding author:duanjinghui@shcc.edu.cn[1];
0310220225@m.shcc.edu.cn[2] ;guoxueru@shcc.edu.cn[3]; liulu@shcc.edu.cn[4]}

Shanghai Customs College, Shanghai, China

Abstract. This study examines the moderating impact of individual income tax on skilled wage premiums in China from 2003 to 2017 using a non-parametric pointwise regression model. The findings indicate that: Individual income tax has an inverted U-shaped moderating effect on the wage premium between high-skilled and low-skilled workers; it can reduce the skilled wage premium of low-skilled individuals but not the skilled pay premium within the group of high-skilled workers.

Keywords: Non-parametric pointwise regression; Skilled Wage Premium; Individual income tax.

1 Introduction

After China has completed constructing an all-around fairly prosperous society, solid progress in promoting common prosperity for all people has become the core issue in the new stage of development. The realization of common prosperity needs to construct the system of coordinating primary distribution, redistribution, and third distribution, and play the regulating function. Being a crucial policy instrument for the government to modify the distribution of income, individual income tax can play an important role in adjusting income distribution and promoting common prosperity.

Many scholars have studied whether individual income tax can adjust income distribution. There are currently three main views:(1) Individual income tax has the function of regulating income disparity and improving the disparity between wealth and poverty. According to the theory of optimal income tax, the Government can set different marginal tax rates for taxpayers with different incomes, and appropriately raise the middle- and high-income earners' marginal tax rate, to achieve the purpose of regulating income distribution and realize the policy objective of maximizing social welfare (Mirrlees,1971)[1]. Milanovic (1999)[2]measured the Gini coefficients before and after taxes in 79 countries in different periods, and the study's findings demonstrated that the after-tax Gini coefficients of developed countries were significantly smaller than those of developing countries, which led to the conclusion that personal taxes have a positive regulatory effect on income redistribution that is more obvious in developed countries. Richard & Eric's (2005)[3] study on developing countries, the results shows that the share of personal income tax in fiscal revenues is found to have a significant impact on exerting redistributive effects. One instrument used by policymakers to limit inequality in income growth and minimize distortion is the progressive rate of personal income tax (Piketty & Qian, 2009)[4]. According to

MSIEID 2023, December 08-10, Guangzhou, People's Republic of China

DOI 10.4108/eai.8-12-2023.2344743

Mathews (2014)'s[5] analysis, the personal income tax in the United States has a positive impact on household income structure and can successfully close the income distribution gap. (2) Although personal income tax can regulate income distribution to some extent, its regulation is very limited. While personal taxes can regulate observable income inequality, they cannot regulate true income inequality (Duncan & Peter, 2016)[6]. Through research on developing nations, Bird & Zolt (2005) [7]discovered that the personal income tax had relatively little effect on the redistribution of income. Ma (2014) [8]uses individual microdata from China from 1997 to 2011 to analyze the redistributive effects of personal income tax. She finds that while China's income tax is more progressive, the average tax rate is low, meaning that the middle-class population bears the majority of the tax revenue.(3)The distribution of income is not governed by individual income taxes. The income adjustment effect of personal income tax was tested by Wenjun Hu (2017) [9]using the PVAR model for the years 2001 to 2012. The findings indicated that with regard to total income, personal income tax would increase the income gap between urban and rural areas, the intra-urban income gap, and the total income gap; additionally, the income from wage and salary personal tax would increase the income gap between urban and rural areas, the intra-urban income gap, and the intra-rural income gap; and finally, the income from business personal tax would widen the intra-urban income gap.

The progressive tax rate of personal income tax serves as a means of "automatic stabilization" of taxation, thereby regulating the distribution of income and narrowing the wealth gap. However, the negative impact of a low average effective tax rate on income redistribution may be mitigated (Zhang Xuan, etc. 2020)[10]. Furthermore, regarding the direction of the research: Mirrlees (1971)[1], Piketty & Qian (2009) [4], Duncan & Peter (2016)[6], Bird & Zolt (2005)[7], Ma (2014)[8], etc. provided some relevant results. Nevertheless, the majority of these studies simply examined the relationships between them using linear approaches. Thus, the goal of this paper is to investigate how China's individual income tax adjusts income distribution using a non-parametric pointwise regression model.

The contribution of this paper is threefold:(1)The study of the intrinsic mechanism of the personal income tax's regulation of the skill wage difference and its linkage to the personal income tax proves that the personal income tax regulates the wage income of different skilled laborers differently. This, in turn, contributes to the understanding of the personal income tax's limited ability to regulate the income of heterogeneous laborers. By considering the various factors affecting the income regulation of individual income tax in the collection and management practice, as well as the features of the income structure and income distribution of workers with different skills in China, we analyze the internal mechanism and effect of individual income tax in regulating the income disparity of workers with different skills. (2)By using the decomposition of the Gini coefficients by Yonghong Cheng (2006)[11] to investigate the causes of income disparity, the micro-survey data were used to measure the Gini coefficients among low-skilled workers, high-skilled workers, and high-skilled-low-skilled workers in a comprehensive manner. This approach somewhat broadens the perspective of measuring income disparity in terms of content. (3)A non-parametric point-by-point regression method was used to construct the model, which not only avoids the errors generated by parametric regression, but two can reflect the dynamic change process of the factors affecting the income gap.

2 Methodology

All of the variables discussed in this section are transferred as natural logarithms in order to remove heteroscedasticity. The non-parametric panel model has the following form:

$$y_{ijt} = \beta_i + f(x_{\mathrm{ijt}}) + \mu_{it} \quad (1)$$

$$y_{ijt}=ln(Gini),$$

$$x_{\mathrm{ijt}} = (\ln(tb_{ijt}), \ln(ti_{ijt}), \ln(open_{ijt}), \ln(rd_{ijt}), \ln(ior_{ijt}), \ln(fip_{ijt}), \ln(ur_{ijt})) \quad (2)$$

Here y_{ijt} indicates the income gap， tb is the average personal income tax rate; ti is a degree of technological innovation; open is openness to trade; rd is R&D investment intensity; ior is fixed assets input-output ratio; fip is foreign investment proportion; ur is urbanization rate. β_{i} is individual effects, μ_{ijt} is a separate, equally normal distribution with variance $\sigma^2$and mean of 0, meet $\mathrm{E}(\mu_{\mathrm{ijt}}|x_{\mathrm{ijt}}) = 0, \mathrm{E}(\mu_{\mathrm{ijt}}^2|x_{\mathrm{ijt}}) = \sigma^2$.$(\cdot)$is unknown smoothing function. The unknown function f (x) cannot be identified, but its derivative f(x) can be identified. Ullah and Roy's (1998)[12] local linear estimation technique is employed for estimating in this work. Taylor expansion at model X is performed as follows:

$$f(x) \approx f(x_0) + f'(x)(x - x_0) + \frac{f''(x_0)}{2!}(x - x_0)^2 + \ldots + \frac{f^{(p)}(x_0)}{p!}(x - x_0)^p \quad (3)$$

The above equation can also be written as:

$$f(x) = \beta_0 + \beta_1(x - x_0) + \ldots + \beta_p(x - x_0)^p \quad (4)$$

$\beta_j = \frac{f^j(x_0)}{j!}, j = 0,1,\ldots,p$， the problem of local polynomial fitting is transformed into the optimization problem of weighted least squares regression as follows:

$$argmin \sum_{i=1}^{n}\{Y_i - \sum_{j=0}^{p}\beta_j(x_0 - X_i)^j\}^2 K_h(x_0 - X_i) \quad (5)$$

Where, H represents the width of the form (that is, the smoothing parameter), P is the order of the polynomial, and K is the kernel function. Defining the design matrix:

$$X = \begin{pmatrix} 1 & (x_0 - X_1) & \ldots & (x_0 - X_1)^p \\ \ldots & \ldots & \ldots & \ldots \\ 1 & (x_0 - X_n) & \ldots & (x_0 - X_n)^p \end{pmatrix} \quad (6)$$

$\beta = (\beta_0, \beta_1, \ldots, \beta_p)^{\mathrm{T}}$ the least squares estimate of is：$\hat{\beta} = (X^T W X)^{-1} X^T W y$.

According to (4):

$$\hat{f}(x) = \rho^T \hat{\beta} = \rho^T (X^T W X)^{-1} X^T W y \quad (7)$$

3 Empirical Analysis

Data sources. With the exception of Tibet, Hong Kong, and Macao, the information in this report was gathered between 1998 and 2008 from the "China General Social Survey", "China Statistical Yearbook", "China Tax Yearbook", National Statistics Network, and Global Trade Monitoring.

Indicator design and calculation methodology. The Gini coefficient is the explanatory variable, representing the wage gap. Personal income tax is the core explanatory variable. Meanwhile, the degree of technological innovation, trade openness, R&D input ratio, fixed asset input-output ratio, proportion of foreign investment and urbanization rate are selected as control variables. The indicators selected in this paper are all relative indicators, and the calculation method of the indicators is shown in Table 1:

Table 1. Indicator description and calculation methodology.

variable name	Description of indicators	calculation method
tb	Average individual income tax rate	Regional personal income tax/regional GDP
ti	Technological innovativeness	Total Regional Patent Transactions/Regional GDP
open	Trade openness	Total regional imports and exports/regional GDP
rd	R&D investment intensity	Total investment in science and technology/regional GDP
ior	Fixed asset input-output ratio	Total investment in fixed assets/regional GDP
fip	proportion of foreign capital	Foreign fixed asset investment/total social fixed asset investment
ur	urbanization rate	Urban population/total population
$Gini_n$	Overall Gini coefficient by province	Measured from CGSS data
$Gini_1$	Gini coefficient within the high-skill group by province	Measured from CGSS data
$Gini_2$	Gini coefficients within low-skill groups by province	Measured from CGSS data
$Gini_3$	Gini coefficient between high and low skills by province	Measured from CGSS data

Parameter estimation results. Ullah & Roy's (1998)[12]research states that the optimal window width is $h = an^{(-1/13)}$.In this paper$a = 4.2$, the corresponding window is obtained $h = 2.6000$.Table 2 displays the model parameter estimation findings.

Table 2. The estimation results of Non-parametric pointwise regression models.

Variables	low-skilled workers	high-skilled workers	high-and low-skilled workers
tb	-0.0124	0.1282	-0.1066
ti	-0.0288	-0.0371	-0.1427
open	-0.0481	-0.0478	0.0932
rd	-0.0198	-0.0114	-0.1123
ior	-0.0665	-0.0619	0.053
fip	-0.0097	-0.0675	0.1339
ur	-0.2463	-0.0682	-0.8969

We discover the following empirical findings by looking at the estimates of regression coefficients in the nonparametric panel data models:(1) All models had negative coefficients for ti, rd, and ur, suggesting that these factors may be able to reduce the income disparity. Personal income tax can reduce the income gap between low-skilled and high-skilled workers, but not the income gap between high-skilled workers. This is because the coefficients of tb to low-skilled workers and high-and low-skilled workers are negative, while other coefficients of tb are positive.

Estimate of pointwise regression. We split into 29 ranges, each with 30 terminal points, to obtain the estimate of elasticity for each element at various times. Therefore, it is possible to determine the relationship between the personal income tax and economic development based on the non-parametric pointwise regression estimate function $(x_{1i}, \bar{x}_2, \bar{x}_3, \bar{x}_4, \bar{x}_5, \bar{x}_6, \bar{x}_7)$ at the point $\hat{\beta}_j(x_{1i}, \bar{x}_2, \bar{x}_3, \bar{x}_4, \bar{x}_5, \bar{x}_6, \bar{x}_7)$.

The following is a summary of the regression results based on Figures 1 through 3:

(1) Figure 1 shows that the Gini coefficient decreases when the personal income tax rate rises. That means personal income tax can narrow the income gap of low-skilled workers gradually.

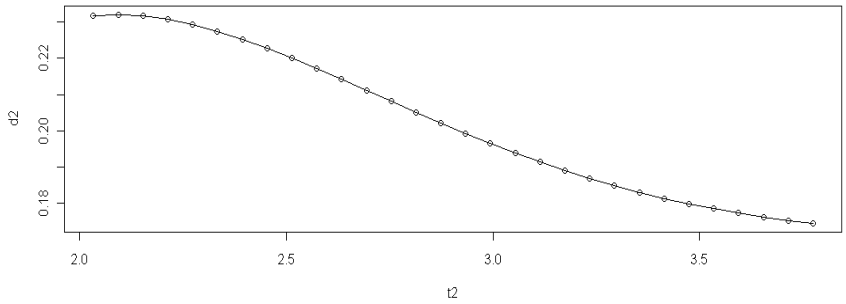

Fig.1. Personal income tax on the wage gap for low-skilled workers.

(2) According to Figure 2， We can know that as personal income taxes rise, the Gini coefficient keeps rising. Income inequality among high-skilled workers will increase. This indicates that personal income tax will increase income inequality among high-skilled workers.

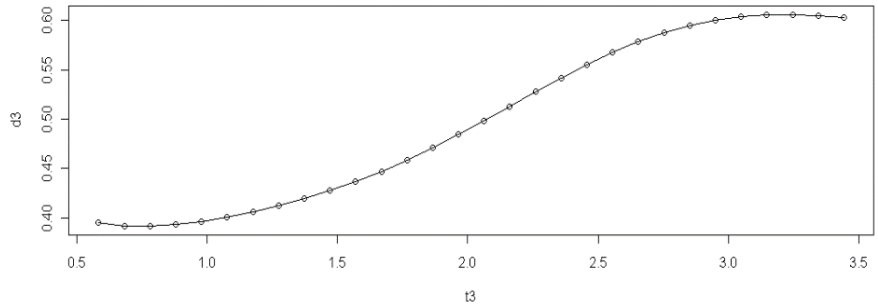

Fig.2. Personal income tax on the wage gap for high-skilled workers.

(3)According to Figure 3, we are able to determine that the Gini coefficient and individual income tax have a turning point. The Gini coefficient has a U shape when individual income tax rates rise.

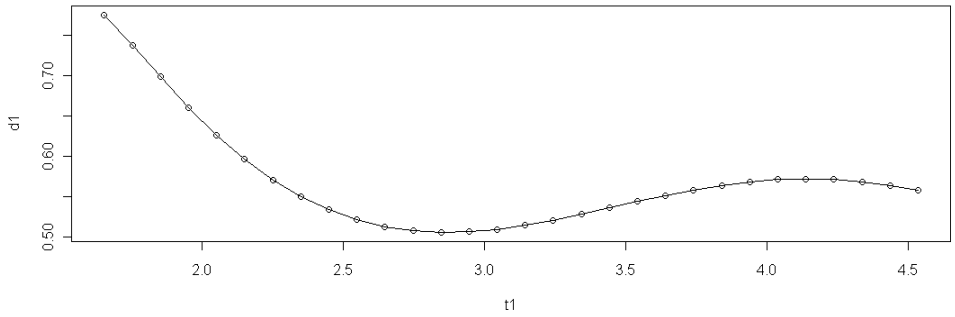

Fig.3. Personal income tax on the wage gap for high-and low-skilled workers.

4 Conclusion

This study creates non-parametric pointwise regression models using data spanning from 2003 to 2017 and comes to the following conclusions:

(1) Individual income taxes have the greatest potential to close the income gap between residents and low-skilled workers, with the latter group benefiting most from these taxes. In China, the wage income of low-skilled laborers is relatively low, and the number of low-skilled laborers is large and weighted. According to the existing experience, taxing less or no tax for low-income people can play a role in adjusting the income gap.

(2) Individual income tax has widened the income gap for highly skilled workers, who are usually senior professionals in various fields, scientific and technological talents, and managerial talents with very high professional knowledge and skills, and whose incomes are

mainly in the form of wages and salaries, and who earn relatively high incomes. High-income earners have a wide range of sources of income and are more capable of or motivated to hide their income, and it is of little use to regulate their income gap through personal income tax. Moreover, the number of highly educated people among the respondents is small, so the number of workers who are subject to high tax rates is even smaller. For the study in this paper, the impact of this paper's measurement results is limited in terms of the volume of high-skilled laborers.

(3) When the average personal income tax rate is raised, the income gap between highly skilled and lowly skilled workers gradually narrows. However, there is an optimal value of the average tax rate between the average personal income tax rate and the income gap, and when it is exceeded, the income gap between highly skilled and lowly skilled workers will widen instead of narrowing. This means that the regulation of personal income tax on the wage-income gap between the skills of high and low workers is not a simple linear relationship.

References

[1] Mirrlees, J. A.: An Exploration in theory of optimum income taxation. Review of Economic Studies. 38(114):175-208 (1971)

[2] Milanovic, B.: Explaining the increase in inequality during transition. Economics of transition. 7(2), 299-341 (1999)

[3] Richard, M. B., & Eric. M. Z.: Redistribution via taxation: The limited role of the personal income tax in developing countries. ITP Working Paper. (2005)

[4] Piketty, T., & Qian, N.: Income inequality and progressive income taxation in China and India, 1986-2015. American Economic Journal: Applied Economics. 1(2): 53-63 (2009)

[5] Mathews, T.: Historical trends in the degree of federal income tax progressivity in the United States. The Social Science Journal. 51(1), 90-99 (2014)

[6] Duncan, D., & Sabirianova Peter, K.: Unequal inequalities: Do progressive taxes reduce income inequality?. International Tax and Public Finance. 23, 762-783 (2016)

[7] Bird, R. M., & Zolt, E. M.: The limited role of the personal income tax in development countries. Journal of Asian Economics. 16(6), 928-946 (2005)

[8] Ma, G., & Xu, J.: The Income redistribution effect of China's personal income tax: What the micro-data say. Contemporary Economic Policy. 33(3):488-498 (2014)

[9] Hu, W. J..: Personal income tax, non-monetary income differences and income distribution. Statistical research. 34(08):80-91 (2017)

[10] Zhang X., Yue X., & Shao G. International comparison of the redistributive effects of individual income tax revenue. International Taxation. (07):18-24 (2020)

[11] Cheng YH.: Calculation and decomposition of the mixed urban-rural Gini coefficient in a dual economy. Economic Research. (01):109-120 (2006)

[12] Ullah, A., & Roy, N.: Nonparametric and semiparametric econometrics of panel data: Econometrics of Victoria, Victoria, British Columbia. In Handbook of Applied Economic Statistics. pp. 599-601, CRC Press (1998)