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Effect of Human Capital Inequality and Income Inequality, Estimated by Generalized Method of Moment (GMM)

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Abstract

This paper examines the effect of human capital inequality on income inequality in Developed and Developing Countries using Gini coefficient as a consistent measurement for both types of inequality. This paper also adds a few control variables such as Globalization Index, GDP per capita and trade using dynamic panel data two-Step System Generalized Method of Moment (GMM) for 92 countries over the period of 1970-2010. The empirical results show that, human capital inequality has a significance positive effect on income inequality in developing and developed countries. This result is similar with the theoretical framework, where the human capital inequality and income inequality are positively correlated. Second, the average years of education (AYRS) are also significant for all countries at 5 and 10 percent level. However, other control variables such as Global, trade, GDP per capita and GDP squared are insignificant at 5 and 10 percent level**.** Thus, in order to reduce income inequality and to give citizens equal opportunities, governments of developing countries and policymakers need to minimise human capital inequality.

Keywords: Human capital inequality, Income inequality

Introduction

The rising income inequality in most countries has attracted the interest of philosophers, economists and other social scientist throughout the ages. According to Checchi (2001), rising income inequality occurred initially in developing countries, but now it is affecting industrialized countries too (Milanovic, 1999). In addition, Atkinson (1998) commented that, the large increases in income inequality occurred in developed and developing countries during the 1980s and early 1990s and that the trend is still increasing until today in most countries. If income inequality is still increasing it has negative impacts on several issues such as political instability, unhappy society, pressure for higher wealth redistribution, health, education, incidence of crime, and violence.[1] To reduce income inequality and its effect, the role of human capital through average years of education is one of the most important variables especially in 21st century as reported by World Bank (2009). But, as we know the economic performance of a country, should not depend on its average level of human capital alone since the asset of human capital is not freely traded in a market. The equal distribution of human capital in the country is also important in analyzing the country's economic performance as well as reducing income inequality. It is because human capital is one of determinants in influencing income inequality.

Theoretically, the human capital inequality and income inequality are positively correlated (Fields, 1980; Chakraborty and Das, 2005). If human capital inequality is high, income

[1] (Barro, 2000; Deaton, 2001; Persson and Guido, 1994; Thorbecke and Charumilind, 2002; Kelly (2000) and Brush, 2007)

inequality can be expected to be high. However, previous studies have been using different measurements to estimate the effects of inequality in distribution of human capital on income inequality and they showed contradictory or inconclusive results between these two variables. For example, Ram (1990) Park (1996) and Gregorio and Lee (2002) used a standard deviation of education as a measure of human capital inequality and income share for income inequality for cross country data. They found the existence of higher human capital inequality leads to higher income inequality. On contrary, Ram (1984; 1989) and Digdowiseiso (2009) found human capital inequality has no significant effects on income inequality when they used standard deviation for human capital inequality. In another study, Pose and Tselios (2009) found that higher human capital inequality leads to higher income inequality in European Union (EU) regions using Theil Index for these relationships. The studies reviewed above show inconclusive relationship between income inequality and human capital inequality, and hence it is difficult to determine clearly the direction of the relationship. This problem might be attributed to the usage of unsuitable measurement for human capital inequality. Therefore, it is important to examine and use the appropriate measurement to estimate both types of inequalities.

The objective of this paper is to examine the effect of human capital inequality on income inequality in developing and developed countries. This paper applies the concept of Gini Coefficient to measure human capital inequality (human capital Gini) and income inequality (Income Gini) as a consistent measurement for both inequalities. The human capital Gini seems to be an appropriate measure, consistent, robust and a good measure for the distribution of education compared to other measures (Thomas *et al.*2000**,** Castello and Domenech, 2002). There are several studies that have examined these relationships in cross country studies, but there has been no study using Gini coefficient as a consistent measurement in developing countries, and hence this study specifically examines the relationship of both inequalities covering data set for the years 1970 to 2010. The relationship between human capital inequality and income inequality is important for government of developing, developed countries and policy makers. For instance, policy makers are keen to know the effect of human capital inequality on income distribution and how this relationship affects economic growth. Understanding this relationship will allow policy makers to assess whether human capital inequality will reduce income inequality.

The main contribution of this paper over previous empirical literature is in a number of important aspects. First, this paper computed and extended data set of human capital inequality for two periods (2005-2010) using Human capital Gini for developing and developed countries based on the latest dataset from Barro and Lee (updated in 2010). Recently, Castello and Domenech (2002) computed the human capital Gini for the period 1960 to 2000, using Thomas *et al* model (2000) and Barro and Lee dataset (2000). Thus, this paper produces the results of the study from larger sample and longer periods. Second, this paper considers the importance of human capital inequality in reducing income inequality with a clear cut picture on the sign, direction and extent of association between income inequality and human capital inequality for periods 1970 to 2010 in developing and developed countries using a consistent measurement for both of inequality. Finally, this paper employs the Generalized Method of Moments (GMM) using system GMM two-step as proposed by Arrelano and Bond (1991) for broad panel data in developing and developed countries which is different from previous studies that used OLS estimator, SUR Technique and others methods.

The rest of the paper is organized as follows. Section 2 reviews the related literatures. Section 3 explains the empirical model, method estimation and data used in the analysis, while Section 4 reports and discusses the econometric results. The final section concludes and synthesizes the whole study.

A Brief Literature Review

Empirical model for the effect of human capital inequality on income inequality

The theoretical research how human capital influence income distribution originated from Schultz (1963), Becker and Chiswick (1966), Psacharopoulos (1977) and followed by Gregorio and Lee (2002). To estimate the relationship between human capital inequality and income inequality in developed and developing countries, this paper also followed Gregorio and Lee (2002) but we used Gini coefficient of education to measure human capital inequality by reapplying standard deviation of education. The empirical model specification can be shown as follow:

$$lnGiNi_{j,t} = \beta_1 lnGiNi_{j,t-1} + \beta_2 lninitial\_GiNi_{j,t} + \beta_3 lnG^h_{j,t} + \beta_4 lnAYS_{j,t} + \beta_5 lnGDP_{j,t} + \beta_6 lnGDP^2_{j,t}\ \beta_7 ln\ GLOBAL_{j,t} + \beta_8 lntrade_{j,t} + \varepsilon_{j,t} \quad (1)$$

Where GINI is Gini coefficient for income inequality, lninitial_GiNi$_j$ for initial income gini 1965 for each country, G^h is human capital inequality using gini coefficient (human capital Gini), AYS is average years of education for the population of 25 age and over and include a few control variables such as Globalization Index, trade, GDP per capita and GDP2 is percapita squared. Lastly ε is Error term and *j,i* represents index countries and periods.

Methods of Estimation

To estimate the model specification for relationship between income inequality and human capital inequality in 92 countries with T=9, this paper uses dynamic panel data procedure Generalized Method of Moments (GMM). The reason of using GMM is to allow the identification of country-specific effects, control the unobserved effects by first-different data, and control the potential endogeneity of all the explanatory variables and controls for a simultaneity bias caused by the possibility that some of the explanatory variables may be endogenous. Some authors, for example, have found that Human capital Gini (G^H), Human capital (average years of education), Global and trade are assumed to be endogenous. Arellano and Bond (1991) proposed transforming Equation (1) into first differences to eliminate country-specific effects as follows:

$$LnGini_{j,t} - LnGini_{j,t-1} = \beta_1(ln\ Gini_{j,t-1} - lnGini_{j,t-2}) + \beta_2(lnInitial\_Gini_{j,t} - lninitial\_Gini_{j,t-1}) + \beta_3(lnG^h_{j,t} - lnG^h_{j,t-1}) + \beta_4(ln\ AYS_{j,t} - ln\ AYS_{j,t-1}) + \beta_5(lnGDP_{j,t} - ln\ GDP_{j,t-1}) + \beta_6(lnGDP^2_{j,t} - ln\ GDP^2_{j,t-1})\ \beta_7(ln\ GLOBAL_{j,t} - lnGLOBAL_{j,t-1}) + \beta_8(lntrade_{j,t} - lntrade_{j,t-1}) + (\varepsilon_{j,t} + \varepsilon_{j,t-1}) \quad (2)$$

To address the possible simultaneity bias of explanatory variables and the correlation between ($ln\ Gini_{j,t-1} - lnGini_{j,t-2}$) and ($\varepsilon_{j,t} + \varepsilon_{j,t-1}$), Arellano and Bond (1991) proposed the lagged levels of the regressors are used as instruments. It is valid under the assumptions such as the error term is not serially correlated and the lag of the explanatory variables are weakly exogenous. This step is known as difference GMM estimation and the moment conditions can be listed as follow:

$$E[lnGini_{j,t-s}(\varepsilon_{j,t} + \varepsilon_{j,t-1})] = 0 \text{ for } s\geq 2;\ t = 3;\ldots;T \quad (3)$$
$$E[lnG^H_{j,t-s}(\varepsilon_{j,t} + \varepsilon_{j,t-1})] = 0 \text{ for } s\geq 2;\ t = 3;\ldots;T \quad (4)$$
$$E[lnAYS_{j,t-s}(\varepsilon_{j,t} + \varepsilon_{j,t-1})] = 0 \text{ for } s\geq 2;\ t = 3;\ldots;T \quad (5)$$
$$E[lnGDP_{j,t-s}(\varepsilon_{j,t} + \varepsilon_{j,t-1})] = 0 \text{ for } s\geq 2;\ t = 3;\ldots;T \quad (6)$$
$$E[lnGDP^2_{j,t-s}(\varepsilon_{j,t} + \varepsilon_{j,t-1})] = 0 \text{ for } s\geq 2;\ t = 3;\ldots;T \quad (7)$$
$$E[lnGLOBALi_{j,t-s}(\varepsilon_{j,t} + \varepsilon_{j,t-1})] = 0 \text{ for } s\geq 2;\ t = 3;\ldots;T \quad (8)$$

$$E[\ln Trade_{j,t-s}(\varepsilon_{j,t} + \varepsilon_{j,t-1})] = 0 \text{ for } s \geq 2;\ t = 3;\ldots;T \quad (9)$$

As known, the difference estimator is able to control for country-specific effects and simultaneity bias, but the difference estimator leads to biased parameter estimates in small samples and larger variance. This problem occurred when the explanatory variables are persistent and the lagged levels of the variables become weak instruments as reported by Alonso-Borrego and Arellano (1999) and Blundell and Bond (1998). To solve this problem, Arellano and Bover (1995) proposed an alternative system GMM that combines the difference Equation (2) and the level Equation (1) with additional moment conditions for the second part of the system as follows:

$$E[\ln Gini_{j,t-s} - \ln Gini_{j,t-s-1}](\eta i + \varepsilon_{j,t}) = 0 \text{ for } s = 1 \quad (10)$$
$$E[\ln G^{h}_{j,t-s} - \ln G^{h}_{j,t-s-1}](\eta i + \varepsilon_{j,t}) = 0 \text{ for } s = 1 \quad (11)$$
$$E[\ln AYSgini_{j,t-s} - \ln AYS\ gini_{j,t-s-1}](\eta i + \varepsilon_{j,t}) = 0 \text{ for } s = 1 \quad (12)$$
$$E[\ln GDP_{j,t-s} - \ln GDP_{j,t-s-1}](\eta i + \varepsilon_{j,t}) = 0 \text{ for } s = 1 \quad (13)$$
$$E[\ln GDP^{2}_{j,t-s} - \ln GDP^{2}_{j,t-s-1}](\eta i + \varepsilon_{j,t}) = 0 \text{ for } s = 1 \quad (14)$$
$$E[\ln Global_{j,t-s} - \ln Global_{j,t-s-1}](\eta i + \varepsilon_{j,t}) = 0 \text{ for } s = 1 \quad (15)$$
$$E[\ln Trade_{j,t-s} - \ln Trade_{j,t-s-1}](\eta i + \varepsilon_{j,t}) = 0 \text{ for } s = 1 \quad (16)$$

Basically, the system GMM estimators are applied in one and two-step variants (Arellano and Bond, 1991). According to Bowsher (2002) and Windmeijer (2005) found that the two-step GMM estimation with numerous instruments can lead to biased for standard errors, parameter estimates and the numerous instruments may lead to a weakened over identification test. This makes the two step system estimator asymptotically more efficient than the one-step estimator. Thus, this paper uses the moment conditions as presented in equation (3)-(16) and employs the two-step System GMM based on recommendation of Roodman (2009b). To consistency of the GMM estimator, this paper also tests the validity of the moment conditions by using the conventional test of over identifying restrictions proposed by Sargan (1958) and Hansen (1982) and testing the null hypothesis that the error term is not second order serially correlated of the difference in equation (2). Furthermore, we test the validity of the additional moment conditions associated with the level equation with the difference Hansen test. Besides that, AR (1) and AR (2) are tested to evaluate the validity of appropriate instrumentation (Arellano and Bond, 1991; Blundell and Bond, 1998). The purpose to test AR is to determine the error term serial correlation, as far as the assumption of nonexistence serial correlation of $\varepsilon_{j,t}$ .It is important for the consistency for the estimators. If $\varepsilon_{j,t}$ is not serially correlated, there should exist negative series correlation (AR (1)) for the first stage and there is no proof of serial correlation in the second stage (AR (2)).

Data description and sources

This paper used several main variables and control variables as control variables to the problem of omitted variables. This paper used Gini coefficient as a dependent variable. Data for Gini Coefficient index is taken from Deininger and Squire World Income Inequality Dataset (2009) of consumption instead of combining income and consumption indices. To measure human capital inequality, this paper used human capital Gini from two sources. For periods 2005 and 2010, we extended and computed human capital Gini based on average years of education of the population aged 25-64. The average year of education is taken from Barro and Lee data set updated in 2010 and we used model suggested by Thomas *et al.* (2001). However, for periods 1970-2000, we used Castello and Domenech dataset (2002). They were used in the computed human capital Gini used Barro and Lee Dataset (2000) and computed using the same model from Thomas *et al.* (2001). Since the Barro and Lee data set provides information on the average schooling years and attainment levels with four levels of education such as no education, primary, secondary and higher education respectively. The human capital Gini (G^h) can be computed as follows:

$$G^h = \frac{1}{2\overline{H}} \sum_{i=0}^{3} \sum_{j=0}^{3} \left|\hat{x}_i - \hat{x}_j\right| n_i n_j \qquad (17)$$

where H are the average schooling years of the population aged 25 years and over, i and j stand for the different levels of education, n_i and n_j are the shares of population with a given level of education, and x ^x_i and ^x_j are the cumulative average schooling years of each educational level such as follows:

$$\boldsymbol{x_0} = x_0 = 0 \qquad \boldsymbol{x_1} = x_1 \qquad \boldsymbol{x_2} = x_1 + x_2 \qquad \boldsymbol{x_3} = x_1 + x_2 + x_3 \qquad (18)$$

From equation (17) and (18) the human capital Gini coefficient can be rewritten as follows:

$$G^h = n_0 \frac{n_1 x_2 (n_2 + n_3) + n_3 x_3 (n_1 + n_2)}{n_1 x_1 + n_2 (x_1 + x2) + n_3 (x_1 + x_2 + x_3)} \qquad (19)$$

Where $x_0 =$ 0, x_1 is average years of primary schooling in the total population divided by the percentage of the population with at least primary education, x_2 is average years of secondary schooling in the total population divided by the percentage of the population with at least secondary education, x_3 is average years of higher schooling in the total population divided by the percentage of the population with at least higher, n_o is the percentage population with no education, n_1 is the percentage in the population with primary education, n_2 measures the percentage in the population with secondary education, and n_3 the percentage in the population with higher education. This paper also included a few control variables in the econometric estimation. One of the control variables is Globalization Index. Based on empirical evidence the Globalization index has a significant impact on income inequality (Jaumotte, *et al* 2008: Krugman, and Vanables, 1995; Ruffin, 2009). This paper used the globalization index extracted from Dreher (2007). The three main dimensions of globalization namely economics, social and political is considered and used in this paper. Another control variable used in the analysis is Gross Domestic Production per capita. Studies have shown that GDP per capita has positive and significant effect on income inequality and human capital inequality (Gregorio and Lee, 2002; Lin, 2007; Pose and Vassilis Tselios, 2009). The Gross Domestic Production per capita data was obtained from World Development Indicator (2009) and it covers 9 periods starting from 1970 to 2010. The last of control variable used in this paper is the trade. It also has positive and significant effect on income inequality. This data is taken from Barro and Lee data set updated 2010 covering over 9 periods starting years 1970-2010.

Empirical Result

Table 1: The effect of human capital inequality on income inequality in developed and developing countries (1970-2010).

Dependent Variable(Lnincome_gini)	World	Developed	Developing
L.lnincomegini	0.758***	0.819***	0.813***
	(0.0445)	(0.0729)	(0.0502)
initialcondition	0.114**	0.132	0.0443
	(0.0376)	(0.0788)	(0.0365)
lnhcgini	0.188**	0.281*	0.365**

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	(0.0682)	(0.139)	(0.0579)
lnayrs	-0.0323*	-0.0765*	-0.0889*
	(0.0154)	(0.0381)	(0.0135)
lngdpc	0.0404*	0.0200	0.0156
	(0.0168)	(0.162)	(0.0113)
lngdpc2	-0.00298*	-0.00220	-0.000920
	(0.00119)	(0.00876)	(0.000679)
lnglobax_index	0.0148	0.0347	-0.00119
	(0.0171)	(0.0525)	(0.0146)
lntrade	0.0138	-0.0124	0.00339
	(0.00788)	(0.0157)	(0.00492)
year			0.00297
			(0.00184)
_cons	0.124	-0.118	-5.390
	(0.154)	(0.830)	(3.580)
N	724	210	514
No of country	92	26	66
Year	No	No	Yes
AR(1)	0.001	0.018	0.005
AR(2)	0.155	0.127	0.071
Sargan Test	0.000	0.000	0.156
Hansen Test	0.487	0.994	0.915

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

STATA 11.0 software is used to estimate the effect of human capital inequality on income inequality in develop and developing countries for periods 1970-2010 using system Generalized Method of Moment (GMM) with two steps. From the estimation coefficients, the income gini with lagged one year (Incomegini (-1)) is positive and has significant effect on income inequality in world, developing and developed countries at 1 percent level. This implies that, the previous income inequality in each country is very important in influencing the current income inequality. As expected, human capital inequality (G^h) is significant with positive effect on income inequality at 5 percent level in the world and Developing countries. However in a developed human, capital inequality is significant at 10 percent level. This result is parallel with theoretical prediction, where, human capital inequality and income inequality are positively correlated (Fields, 1980; Chakraborty and Das, 2005). This simply means that, reducing human capital inequality can lead to reduction in income inequality in all countries. Secondly, the average years of education (AYRS) also has a significant impact on income inequality with negative sign at 5 percent level in the world, developed and developing countries. This finding is similar with previous studies by Knight and Sabot (1983), Park (1996), Checchi (2001) who found that average years of education have a strong negative effect on income inequality. Besides that, GDP per capita and GDP squared is also influencing income inequality at 5 percent significant level only in the world. This implies that greater economic growth can reduce income inequality and vice versa.

However, the effect of globalization on income inequality as a control variable is not significant at 1 percent, 5 percent and 10 percent level. This finding is also supported by Duncan (2000), he reported that globalization should not be contributing in reducing income inequality for all countries especially for developing and developed countries except occurred external shocks as a result of the greater openness in trade and investment. This simply means, this problem is not to reverse globalisation effect but how to manage the risks introduced by greater openness is very important. As is known, globalisation must lead to greater income equality in developing countries such as increased the wages of the less-skilled and domestic policies. Besides that, the trade also insignificant with income inequality at 5 percent and 10 percent level. Finally, based on the AR (2), the result found that no error term serial correlation in the second stage, while Hansen Test proves that the instrument used in this model is a valid instrument. Both tests AR (2) and Hansen Test do not reject the null hypothesis.

Conclusion

In this paper, we consider the role of human capital inequality and income inequality which has not been precisely discussed altogether in previous research for 66 developing countries and 26 developed countries for periods 1970-2010 using Gini coeffient as consistent measurement for both inequalities. The analysis shows that more equally distributed human capital opportunities can alleviate income inequality. As a conclusion, government of developing, developed countries, policy makers and politicians need to pay attention to investment in human capital and distribution of human capital through increasing the average year of education as it has the potential to reduce income inequality. It is because most of policy decision makers do not consider education as the top priority. Human capital is very important because it is an investment in education is a prerequisite for both personal and national advancement.

Besides that, in many developing countries, the privatization of education has indeed brought about an increase in the share of private financing at the basic level but more commonly at the post basic education level. Nowadays, the number of private schools and private universities has increased. This trend emerged largely as a result of the incapability of the state to satisfy the increasing demand at all level. Thus, to improve income inequality in developing and developed countries, the first of importance is to improve human capital inequality through introducing the private schools among countries. So the policy maker also should pay more attention to distribution of private schools. In other words, the private school much more positive move to imply more resources for the education sector, more efficient use of these resources and more flexibility in education delivery. This is parallel with Millennium Development Goal (MDG) to achieve the target education for all especially primary school and to make distribution in human capital equally for all countries.

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