Exploring the Two-Way Relationship between Income Inequality and Growth

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***Abstract*—We conduct empirical analyses on the two-way relationship between income inequality and growth in three groups of income levels, i.e. lower middle, upper middle and high income countries. The data is collected for 31 countries, ranging from 1990 to 2011. Besides, four variables are tested as determinants of growth and income inequality. Applying a panel data approach, our results detect only one-way relationship, i.e. growth influences income inequality. There is no significance effect from income inequality on growth across three groups of countries. Our results also reveal that enrollments of primary education, price level of investment and trade openness have no significance impact on income inequality. These factors have impacts on growth but the impacts vary across countries.**

***Index Terms*—economic growth, income inequality, Gini index, panel data, inverted-U Kuznets curve**

I. Introduction

The studies concerning the relationship between income inequality and economic growth had been conducted over the last half century. Economic growth is the increase in the amount of production of goods and services in an economy over a certain period of time. Economic growth can be measured through the real gross domestic product (real GDP) or real per capita gross domestic product (real per capita GDP). Income inequality is measured by Gini index. The higher the value of Gini index means the higher in income inequality or the larger of the gap between the rich and the poor. Both variables are believed to be related since higher income inequality is often found in lower developed countries. Most studies focused in a one-way regression, i.e. either to study the impact of growth on income inequality or the impact of income inequality on growth.

In this paper, we seek to investigate the relationship using two-way approach. The study is focused on three groups of income levels, i.e. lower middle, upper middle and high income groups. Apart from this, we also seek to reveal the factors that determine the relationship of income inequality and growth. Applying a panel data approach, our results only detect one-way relationship, i.e. growth influences income inequality. We fail to detect significance impact from income inequality on growth across 3 groups of countries. Enrollments of primary education, price level of investment and trade openness have no significance impact on income inequality. These factors have impacts on growth but the impacts vary across countries.

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II. Literature Review

A. The Measurement of Income Inequality

Lorenz curve and Gini coefficient are two ways of measurements commonly used to measure income inequality. As in [1] Lorenz curve shows the relationship between percentage of population and the percentage of total income the population received. The horizontal axis represents the percentage of population. The vertical axis shows the percentage of total income that received by the percentage of population considered. Both of the variables on the horizontal axis and vertical axis must be ordered from the lowest to the highest.

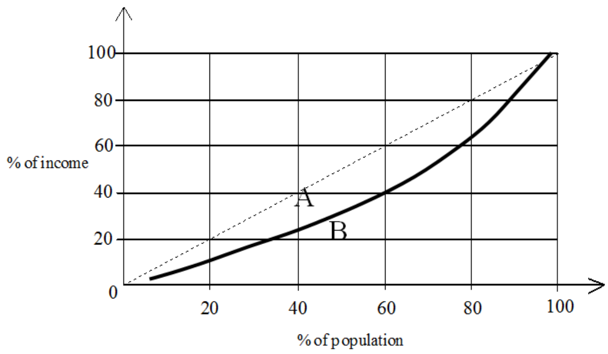

Figure 1. Lorenz curve.

As shown in Fig. 1, the dashed line represents a perfectly equal income distribution in an economy and it implies that every person in the population has the same income. By contrast, the horizontal axes and the vertical axes, which are the lines of perfect inequality, represent a perfectly unequal income distribution in an economy. In this case, only one person has all the income and all others have none. The inequality of the income distribution is shown by the distance of the Lorenz curve from the line of perfect equality. The inequality becomes higher if the Lorenz curve bends further away from the line of perfect equality (45 degree line) as in [2].

Gini coefficient is a measurement of income inequality based on Lorenz curve, which ranges between 0 and 1. Gini coefficient with 0 represents perfect income equality

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and 1 represents perfect income inequality. The larger the Gini coefficient over 0 means the higher the inequality.

B. *Inverted Kuznets Curve*

Kuznets depicts the relationship between the income inequality and growth in an inverted U-shaped curve as shown in Fig. 2. According to Kuznets, development involves the shift of population from the agricultural sector (low wage-rural sector) to industrial sector (high-wage urban sector). In the early stages of development, movements from agriculture to industrial sector would increase the income of the population, but the income for those who stay in agriculture sector would not increase as fast as those in industrial sector and this would increase the income inequality of the population. While at the later stages, the aggregate income of the population would still increase, but the income inequality decrease as the labor force in industrial sector increase and decrease in agriculture sector.

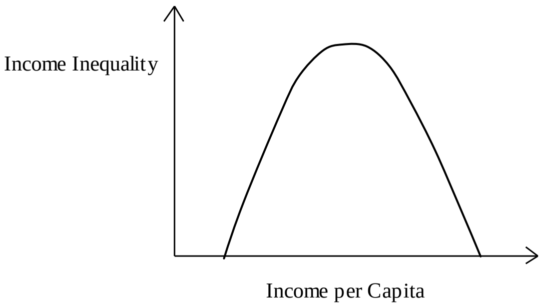

Figure 2. Kuznets inverted U curve.

Source: Mekenbayeva and Karakuş (2011).

C. *Empirical Findings*

Previous studies reported different relationship between income inequality and growth which deviates from the inverted Kuznets U curve. Some authors find a negative relationship between income inequality and economic growth, while some obtain a positive relationship between the both variables. For example, [3] conducted the panel data analysis in 45 countries for the period of 1965-1995. His result showed that income inequality has a positive effect on economic growth in the short and medium terms. On the other hand, [4] focused his studies in 20 developing countries for the period of 1966-1990 and his result also supported for the positive relationship between growth and income inequality. However, [5] found negative relationship between the two variables in his study in 3117 United States counties for the period of 1977-2000. Other than that, some studies consider that both negative and positive relationships are possible depend on the level of development of the countries involved. For instance, [1] found positive relationship between income inequality and economic growth in developed countries while negative relationship in developing countries in their study in 5 developed countries and 4 developing countries for the period of 1980-2009.

Comparing the results that focused on developed versus developing countries, most of the researchers find a negative effect of income inequality on economic growth in developing countries or poorer countries and a positive relationship between the both variables in developed or richer countries. These researchers include [1], [6] and [7] Minority papers show an inverted-U shaped relationship between income inequality and economic growth. These papers include [8] and [9]. Besides that, [10] shows an ordinary U-curve relationship between both variables.

There are a number of determinants that had been found to affect the relationship between inequality and economic growth. For instance, [11] found that more physical and human capital, openness to trade and higher government spending would reduce income inequality and enhance economic growth. On the other hand, [7] found that credit market imperfection, political economy, social unrest and saving rates are among the determinants that affect the relations between inequality and growth while [12] think that measurement error is an important factor that affects the relationship between inequality and growth besides political economy and wealth effect. Besides that, [13] has evidence to show that regional productive structure specifically agricultural sector would change the relation of the both variables from negative to positive for the bottom of the earnings distribution while [14] found that the influence of inequality on growth is affected by urbanization and social cohesion.

III. DATA

Before conducting the analyses, we categorize the countries into three groups according to the World Bank's classification of countries by income group using 2011 data on gross national income (GNI) per capita. In this study, the group of low income is not considered due to the data availability problem. There are 8 countries, 11 countries and 12 countries for the group of lower middle income, upper middle income and high income respectively. The countries that include in this analysis are shown in Table I.

The data used in this analysis are from year 1990 to 2011. Data on growth rate of GDP per capita, percentage of gross enrollment in primary education and fertility rate are taken from the World Bank. Data on price level of investment and trade openness are taken from Penn World Tables. The Gini data are taken from two sources, World Bank and European Union Statistics on Income and Living Conditions (EU-SILC). The following table shows the unit of measurement of each data used.

TABLE I. CLASSIFICATION OF COUNTRIES BASED ON INCOME GROUP

Income group	Countries
Lower middle income	Armenia, Bolivia, El Salvador, Georgia, Honduras, Moldova, Paraguay, Ukraine.
Upper middle income	Argentina, Brazil, Colombia, Costa Rica, Dominican Republic, Kazakhstan, Peru, Romania, Russian Federation, Uruguay, Bulgaria.
High income	Poland, Belgium, Denmark, Estonia, Greece, Spain, France, Luxembourg, Austria, Finland, Sweden, United Kingdom.

TABLE II. UNIT OF MEASUREMENT OF DATA

No.	Data	Unit of measurement
1.	Growth rate of GDP per capita (Growth)	%
2.	Gross enrollment in primary education (Edu)	%
3.	Fertility rate (Fert)	%
4.	Price level of investment (PLI)	%
5.	Trade openness (Open)	%
6.	Income inequality (Gini)	Index

IV. METHODOLOGY

Simultaneous equations model is used in this study as there are two equations involved, i.e. Gini (inequality of income) and growth. These equations are:

$$\begin{aligned} Growth_{i,t} &= \beta_1 + \beta_2 Edu_{i,t} + \beta_3 PLI_{i,t} + \beta_4 Open_{i,t} \\ &+ \beta_5 Fert_{i,t} + \beta_6 Gini_{i,t} \\ &+ \gamma_1 Growth_{i,t-1} + \varepsilon_{i,t} \end{aligned} \quad (1)$$

$$\begin{aligned} Gini_{i,t} &= \beta_7 + \beta_8 Edu_{i,t} + \beta_9 PLI_{i,t} \\ &+ \beta_{10} Open_{i,t} + \beta_{11} Fert_{i,t} + \beta_{12} Growth_{i,t} \\ &+ \gamma_2 Gini_{i,t-1} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where $Growth_{i,t}$ and $Gini_{it}$ are the endogenous variables, $Edu_{i,t}, PLI_{i,t}, Open_{i,t}$ and $Fert_{i,t}$ are the exogenous variables, $Gini_{i,t-1}$ and $Growth_{i,t-1}$ are the lagged endogenous variables and $\varepsilon_{i,t}$ is the unobserved error term.

We estimate the equation (1) and (2) simultaneously using generalized method of moments (GMM).

A. *Generalized Method of Moments (GMM)*

Ordinary Least Squares (OLS) is biased or misleading when endogeneity problem arises. Endogeneity problem occurs when the assumption of $\text{cov}(x_{i,t}, \varepsilon_{i,t}) = 0$ is violated. When this problem arises, one should apply GMM as the instrument variables in GMM help to control the relation between $x_{i,t}$ and $\varepsilon_{i,t}$ so that $\text{cov}(x_{i,t}, \varepsilon_{i,t}) = 0$ as in [15].

Suppose there are n equations to be estimated, the equations can be written in matrix notation as:

$$y_{i,t} = x_{i,t}\beta_i + \varepsilon_{i,t} \quad (3)$$

where $i = 1,...,n$ is the equation number, and $t = 1,...,T$ is the number of observations. $y_{i,t}$ is $n\times 1$ vector of dependent variables, $x_{i,t}$ is a $n \times k$ matrix of independent variables, $\varepsilon_{i,t}$ is unobserved error term and β_i is a $k\times 1$ vector of unknowns parameter.

Now, assume there is a $n\times 1$ dimensional $(n > k)$ function $f(\beta, y_i, x_i, z_i)$ where z_i is a $(n\times 1)$ vector of instrument variables.

The main idea of GMM is to select a set of parameter estimates that match the theoretical relation as close as possible or the estimated parameters are closely equal to the actual parameters. If β_0 is the actual value of β, we seek to achieve the following moment condition:

$$E\left[f(\beta_0, y_i, x_i, z_i)\right] = E\left[f(\beta, y_i, x_i, z_i)\right] = 0 \quad (4)$$

where β_0 is a $(n\times 1)$ vector of unknown parameters.

The theoretical moment is replaced by the sample moment of T observations:

$$\overline{f}(\beta, y_T, x_T, z_T) = \frac{1}{T}\sum_{i=1}^{T} f(\beta, y_i, x_i, z_i) = 0 \quad (5)$$

If the number of moments is equal to the number of unknown parameters $(n = k)$, the GMM estimator $\hat{\beta}$ can be obtained by solving $\overline{f}(\hat{\beta}_T, y_T, x_T, z_T) = 0$. When the equations are over-identified, which means there are more moment than unknown parameters $(n > k)$, there will be no unique solution. The problem is solved by minimizing the weighted distance between the theoretical and actual values by considering k linear combination of the n moment condition:

$$\begin{aligned} &Q(\beta, y_T, x_T, z_T) \\ &= \min_{\beta} \overline{f}\left[(\beta, y_T, x_T, z_T)\right]' W\left[(\beta, y_T, x_T, z_T)\right] \overline{f}\left[(\beta, y_T, x_T, z_T)\right] \end{aligned} \quad (6)$$

where W is taking as the $n\times n$ positive definite weighting matrix. A necessary condition to obtain an efficient estimate of β is to set W as the inverse of the covariance matrix of the sample moments. If the optimal weighting matrix is

$$W = \lim_{T\to\infty} T.E\left\{\left[\overline{m}\left(\beta_0, y_T, x_T, z_T\right)\right]\left[\overline{m}\left(\beta_0, y_T, x_T, z_T\right)\right]'\right\}$$

The following minimization problem for GMM estimates will be obtained:

$$\begin{aligned} &Q(\beta, y_T, x_T, z_T) \\ &= \min_{\beta} \overline{f}\left[(\beta, y_T, x_T, z_T)\right]' W^{-1}\, \overline{f}\left[(\beta, y_T, x_T, z_T)\right] \end{aligned} \quad (7)$$

We expect the law of large numbers holds if z_t is stationary and $m\left(\beta, y_t, x_t, z_t\right)$ is continuous,

where $\bar{m}(\beta, y_T, x_T, z_T) \xrightarrow{p} E\left\{m\left(\beta, y_t, x_t, z_t\right)\right\}$.

In the case where $m\left(\beta, y_t, x_t, z_t\right)$ is not serially correlated, the optimal weighting matrix W can be constantly estimated by:

$$\hat{W}_T = \frac{1}{T}\sum_{i=1}^{T}[f(\beta_T, y_i, x_i, z_i)][f(\beta_T, y_i, x_i, z_i)]' \xrightarrow{p} W \quad (8)$$

where $\hat{\beta}_T$ is the consistent estimate of β_0 as in [16].

B. J Statistic (J-test)

J-test is used to test the validity of over-identifying restrictions. The test is applied to check the orthogonality conditions and correct model specification under over-identification case such that $\mathrm{cov}(\varepsilon_i, z_i) = 0$. In order to get the identified GMM estimator, the number of instrument variables should at least equal or greater than the number of parameters $(n \geq k)$. The J-statistic multiplied by the size of observations (T) is an asymptotically χ^2_{n-k} distribution with $(n-k)$ degrees of freedom.

$$T.\left\{\bar{f}\left[\left(\hat{\beta}, y_T, x_T, z_T\right)\right]' \hat{W}^{-1}\bar{f}\left[\left(\hat{\beta}, y_T, x_T, z_T\right)\right]\right\}_{H_0}^{a} \sim \chi^2_{n-k} \quad (9)$$

The main idea of J-test is to check if the sample moments of $\bar{f}(\hat{\beta}, y_T, x_T, z_T)$ are expected to be zero if the population moments $E\left[f(\beta_0, y_i, x_i, z_i)\right] = 0$. The validity of over-identifying restrictions is satisfied when one cannot reject the null hypothesis of valid over-identification, which means the instrument variables are good as in [16].

V. Result

TABLE III. Summary of Result of Estimation

Parameters	Lower middle income	Upper middle income	High income
Growth equation			
Constant	55.8602***	6.4585	18.6368**
Edu	-0.4323***	0.0633	-0.1662*
PLI	-0.0651	-0.081**	-0.0714***
Open	-0.0501**	-0.0174	0.0085*
Fert	-0.2962	-0.2531	0.8253
Gini	0.0415	-0.1148	0.1588
Growth (-1)	0.3341*	0.3972***	0.0443
R-square	0.2073	0.1887	0.1379
Gini equation			
Constant	-0.9497	4.251	3.4386
Edu	0.0228	-0.0318	-0.0128
PLI	-0.0168	0.003	0.0016
Open	0.0099	0.001	-0.002
Fert	0.3191	-0.7554*	-0.3844
Growth	0.0034	-0.0783	-0.0699**
Gini (-1)	0.9344***	1.0163***	0.9535***
R-square	0.9745	0.8795	0.9154
J-stat	0.623	0.3021	0.4198

Notes:
*** denotes the 1% significant level.
** denotes the 5% significant level.
* denotes the 10% significant level.

The results of estimation are summarized in Table III. The first column is the result for lower middle group and the second and third columns are results for upper middle income and high income groups respectively. The results of growth equation show that income inequality or Gini does not have significance impact on growth movement for all income groups. However, growth is mostly determined by its previous growth as the increase of 1% in Growth (-1) leads to significance increase of 0.33% and 0.40% in current growth in lower middle and upper middle income groups respectively. Previous growth does not have significance impact on current growth in high income group.

The results of Gini equation show that income inequality is highly impacted by previous income inequality. 1% increase in previous income inequality or Gini (-1) will lead to 0.93%, 1.02% and 0.95% increase in current income inequality in lower middle, upper middle and high income groups respectively. Growth only shows significance impact on determining income inequality in high income group but not the other income groups. 1% increase in growth leads to 0.38% decline in Gini or improvement in income inequality in high income group.

Besides, we also investigate if the four variables of Edu, PLI, Open and Fert have significance impact on growth and income inequality. Our results reveal that these four variables do not have significance impact on determining the income inequality in all income groups but may have different effects on growth across income groups. It is surprised that total enrollment rate as % on population (Edu) has negative impact on growth in lower middle income group. Perhaps primary education is not able to produce skills/ knowledge for labour to improve production and growth. On the other hand, trade openness leads to negative impact on growth for lower middle income group but it imposes positive impact on growth in high income group. This phenomenon is due to producers in lower group have lower competitive power and they open trading may deteriorate their business. PLI is measured as purchasing power parity over investment divided by the exchange rate multiplied by 100. PLI has negative impact on growth in all income groups. This may be explained by higher purchasing power leads to higher consumption, hence higher import relative to export and this leads to lower income or growth.

The J-stat shows that all estimations fulfill the over identification requirement. The R-square shows that the income inequality equation can be explained by (above 87%) by the endogenous variables. However, the R-square values are relatively low for growth equation. There may be other important factors that not include in this equation but have significance impact on growth.

VI. Conclusion

This study investigates the two-way relationship between income inequality and economic growth using a panel of 31 countries over the period 1990 to 2011. The countries are classified into three income groups which are lower middle income, upper middle income and high income group according to countries classification from World Bank. GMM estimation approach is applied to provide consistent estimates when there is an endogeneity problem.

Besides that, this study investigates four other variables to estimate their possible impacts on income inequality and economic growth, i.e. enrollment of primary education, fertility rate, price level of investment and trade openness. Including these variables in estimation could influence the relationship between income inequality and growth.

The results of estimation indicate that there is a one-way relationship between income inequality and growth, i.e. income inequality has no significant impact on growth in all income groups but growth has positive significant impact on income inequality in high income group. The movements of income inequality and growth do not impacted by income groups as income groups do not lead to significant differences in their movements.

Enrollments of primary education, price level of investment and trade openness have no significant impact on income inequality. On the other hand, enrollments of primary education, price level of investment and trade openness have significant impact on growth but the impacts vary across income groups.

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