

**DOES INCOME INEQUALITY HAMPER OR FOSTER
ECONOMIC GROWTH IN SUB-SAHARAN AFRICA?**

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EXECUTIVE SUMMARY

POLICY QUESTION

“What is the relationship between inequality and economic growth? Specifically, does income inequality hamper or foster economic growth in developing countries?”

BACKGROUND

As the global economy experienced rapid economic growth after World War II, an intense debate arose as to whether such growth benefited poor people and reduced income inequality or vice versa. In the 1950s, Kuznets explained that there is a trade-off between income inequality and economic growth. He proposed that income inequality initially rises but then declines as per capita income increases. If this hypothesis is true, the income inequality that developing nations are experiencing is not something that they should be concerned about, as it would eventually decline over the course of their economic growth. Many scholars have attempted to confirm as well as rebut this relationship; however, it remains ambiguous.

In contrast, studies of this relationship for sub-Saharan African countries have not been conducted thoroughly. African regions were struggling with extreme poverty and, as a result, dealing with poverty issues was the main concern of the governments and researchers. And sub-Saharan Africa countries had desperate health issues to deal with, such as high HIV prevalence rates. Finally, and most importantly, sufficient data for sub-Saharan African countries were lacking.

Recently, academic research on income inequality in sub-Saharan African countries became available as several countries started household surveys, which allowed the collection of more empirical data in this region. The increasing attention of international organizations further accelerated the research. Thus, the purpose of this master’s project is to examine the relationship between income inequality and economic growth in sub-Saharan African countries using these newly-available data.

METHODS AND MEASUREMENTS

The measure of income inequality used in the current study is the Gini coefficient. The main data source for income inequality is PovcalNet, an online poverty analysis tool provided by World Bank. The constructed data set is an unbalanced panel with data from 40 sub-Saharan African countries from 1980 to 2009. This paper examines the relationship between income inequality and economic growth with country-fixed effects to exclude time-invariant omitted variable bias.

RESULTS AND INTERPRETATION

This paper finds that income inequality is positively correlated to annual changes in economic growth, controlling for changes in other explanatory variables. As a non-linear relationship was tested, this paper expects that the positive correlation will not continue for long for sub-Saharan African countries and that income inequality will eventually slow and decrease economic growth. This does not support other previous research in which only linear relationships were tested.

DISCUSSION AND CONCLUSION

The results of this paper cannot guarantee that income inequality will eventually be detrimental to economic growth in the longer term. The measurement error and the possibility of reverse-causality remain as limitations. This paper, however, does address the fact that income equality is related to economic growth, suggesting that policy-makers in both the sub-Saharan African countries and international organizations should be more concerned about income inequality. Finally, this paper suggests that future researches consider the importance of instrumental variables to delineate the causal relationship between income inequality and economic growth.

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POLICY QUESTION

What is the relationship between inequality and economic growth? Specifically, does income inequality hamper or foster economic growth in developing countries?

INTRODUCTION

As the global economy experienced rapid economic growth after World War II, an intense debate arose as to whether such growth benefited poor people and reduced income inequality or vice versa. Many researchers have grappled with this relationship, but there has not been yet a clear answer to the pattern and sources of the effect that income inequality has on economic growth, and income inequality remains persistent around the world. Moreover, few studies have attempted to empirically investigate the effects of income inequality on economic growth in sub-Saharan Africa. Previous studies have focused on either Asia, which experienced rapid economic growth in the 1970s and 1980s, or Latin America, which had severe income inequality in the late 20th century.

The primary objective of this paper is to examine the relationship between income inequality and economic growth in sub-Saharan Africa. Sub-Saharan Africa has experienced the least economic growth around the world while other parts of the earth have undergone rapid growth. Unlike other nations that were once colonized and gained independence in the early 20th century, sub-Saharan Africa remains the poorest and least-developed region in the world after the European colonial era. This trend holds even for resource-rich countries such as the Democratic Republic of Congo and Nigeria.

This paper targets only sub-Saharan Africa for a number of reasons. First, with a few exceptions, countries in sub-Saharan Africa are in their initial stages of economic growth compared to elsewhere, yet

sub-Saharan Africa has relatively high income inequality. Focusing on African countries allows us to re-examine the previously proven relationship between income inequality and economic growth. Second, sub-Saharan Africa has great potential for economic growth with an increasing population and abundant natural resources, which other developing nations often lack. At the same time, however, the region is suffering from extreme poverty and health issues, such as a high HIV prevalence rate. This unique environment is the second reason that focusing on sub-Saharan Africa is of interest. Finally, studies on income inequality in sub-Saharan Africa have not been conducted until recently either in the policy domain or in academic research (Nel 2003). Both domestic and international institutions' focus was on poverty reduction and the high HIV prevalence rates, so sufficient data regarding income inequality in sub-Saharan African countries have been lacking.

From a policy point of view, it is a reasonable approach to deal with poverty and health issues in the first place, but it is also important to delineate the relationship between income inequality and economic growth. First, policy-makers would be able to learn whether and when to adopt redistributive policies. With such processes, government can evaluate whether current policies are effective, understand the given situation, and define the factors to change the situation (Deininger and Squire 1997; Okojie and Shimeles 2006). Moreover, income inequality will hinder efficient resource allocation, ruin productive potential, and impede institutional development (Anyanwu 2011). Poverty reduction cannot be the only means of dealing with income inequality, and persistent income inequality will delay progress toward poverty reduction generally, and, eventually, economic growth as well (Anyanwu 2011).

With these insights, academic research on income inequality in sub-Saharan African countries has become available as several countries have started household surveys, which allows the collection of more empirical data in those regions (Okojie and Shimeles 2006). The Poverty Reduction Strategy Papers (PRSP) approach, initiated by the International Monetary Fund (IMF) and the World Bank in 1999, and

the United Nations' MDGs accelerate the research as well.

Thus, this paper aims to examine the influence of income inequality on economic growth for sub-Saharan Africa countries using the available data. The rest of the paper is organized as follows: The next section reviews both the theoretical and empirical literatures. After the data and empirical framework are explained, this paper provides empirical analysis of the relationship. And finally, the last part offers policy implications and a conclusion.

BACKGROUND

Theoretical Framework

The relationship between income inequality and economic growth has been thoroughly studied both theoretically and empirically in recent decades. Most theoretical arguments posit that income inequality affects economic growth negatively. The first main argument is the credit market imperfection theory (Aghion and Bolton 1997; Galor and Zeira 1993; Piketty 1997; Banerjee and Newman 1993). This theory argues that an imperfect credit market distorts individuals' investment in human and physical capital. In other words, individuals' investment in human and physical capital is decided by their income levels. As a result, low-income individuals would have limited access to investment, while those who have more could invest and exploit the high rate of return. Increasing income inequality, therefore, would result in distorted investment and restrict economic growth.

Another argument is the political economy model developed by Alesina and Rodrik (1994) and Persson and Tabellini (1991). This theory stresses that the more unequal a society is, the more distorted redistributive policies will be introduced. Such distorted redistributive policies would reduce investment

and, eventually, hinder economic growth. The researchers argue that even if no redistributive policies have been implemented, any lobbying activities against the policies are enough to cause inefficiency and corruption, which generally slows economic growth (Alesina and Rodrik 1994; Persson and Tabellini 1991).

Gupta (1990) and Alesina and Perotti (1993) also offered a new explanation for the relationship between income inequality and economic growth. According to them, increasing income inequality has the potential to cause political or social instability, as the poor or the least benefited population may engage in protests or revolutions. And these instability eventually will discourage investment and strong establishment of property rights, which will lead to lower economic growth (Gupta 1990; Alesina and Perotti 1993).

Income Inequality and Economic Growth

Most of the economics literature on the relationship between income inequality and economic growth has its origin in Kuznets (1955), who proposed that income inequality initially rises and then declines as per capita income increases further. If this hypothesis is true, the income inequality that developing nations are experiencing is not something that they should be concerned about, as inequality will eventually decline over the course of economic growth.

Many scholars have attempted to confirm this relationship. Earlier studies show a consistent relationship between income inequality and economic growth, as Benabou (1996) concluded that these studies demonstrated negative effects of initial income inequality on long-run economic growth after reviewing 23 previous studies.

The empirical studies on this relationship are divided into two distinct phases, before and after the development of the worldwide data set, Deininger and Squire's (1996) World Bank Inequality Database. Even before the Deininger and Squire's data set has become available, the quality of inequality data sets, which were compiled prior to the release of the Deininger and Squire (1996) data set, were questioned as the coverage and the sources have not been consistent among the data sets, although studies such as Perotti (1996), Alesina and Rodrik (1994), Persson and Tabellini (1994), and Clarke (1995) showed that income inequality is detrimental to economic growth.¹

Deininger and Squire's (1996) data set not only covers 138 countries around the world but also labels the acceptability of the data according to their quality.² The data set provides the Gini coefficients, the major variable used to measure income inequality, for the listed countries and sufficient sources regarding whether the Gini coefficients are calculated by income or expenditures. The release of this data set, therefore, has allowed researchers to estimate the relationship using the same data set, which obviously lessened the debate over the quality of data. With this data set, researcher have attempted to use a different estimation method compared to the previous research, where cross-sectional analysis was the most popular. And this deviation has challenged the already-discussed negative effects of income inequality on economic growth. For example, Li and Zou (1998) re-ran Alesina and Rodrik's (1994) and Persson and Tabellini's (1994) work with panel data and found that the previously found negative relationship becomes positive. Forbes (2000) re-ran Perotti's (1996) study with this data set and rebuked Perotti's argument that increasing income inequality retarded economic growth. Forbes used panel data analysis with fixed effects and emphasized the efficiency of analysis in explaining how income inequality influences economic growth in a country, in which cross-country analyses had failed. She used country

1. For example, Perotti (1996) used Jain's (1975) and Lecaillon et al.'s (1984) data compilation, and Persson and Tabellini (1994) used income distribution data compiled by Paukert (1973).

2. The "acceptable" data are: (i) based on household surveys; (ii) represent the entire population in a country; and (iii) have comprehensive income measures.

dummies and time dummies with the same controlling variables as Perotti's, income, male education, female education, and market distortion.

To measure income inequality, most of these research studies used the Gini coefficient. Clarke (1995) differentiated his research from the previous works by using four different measures of income inequality, such as Theil's index³ and the ratio of total income earned by the poorest 40% of the population to that earned by the richest the 20%. Even with different measures, his results remained consistent regarding the negative effect of income inequality on economic growth.

Recently, a new data set has become available, the United Nations University – World Institute for Development Economics Research (UNU-WIDER) World Income Inequality Database (WIID). Knowles (2001) used this data set, arguing that the data and the findings of previous research were neither appropriate nor robust. With this data set, he also found a negative correlation between income inequality and expenditures and economic growth for developing countries.

Sub-Saharan Africa

Earlier studies on this region aligned with Kuznets' inverted-U curve. Sandbrook and Barker (1985) indicated that inequality in Africa is not an economic crisis but an inevitable outcome generated in the course of economic growth in the early and middle stages. However, a question remains as the sub-Saharan Africa remains the poorest region in the world, and sufficient empirical work has not been conducted in this area.

³ Theil's index is another measure of inequality, originally introduced by Theil, who presented the concept based on information theory. Unlike the Gini coefficients, Theil's index does not require prior household surveys to calculate the coefficient and can measure inequality within and between subgroups. More information is available from the University of Texas Inequality Project. (Conceicao and Galbraith 2000)

As previously noted, only a handful of studies have tested the relationship between income inequality and economic growth (Fielding 2001; Odedokun and Round 2004; Nel 2003; Nafziger 1988; Tsikata 2001). Nafziger's study does not have sufficient country coverage in sub-Saharan African countries. Although Odedokun and Round found some significant and negative relationships between income inequality and economic growth, their inequality measure lacks in explanation, so it is still hard to draw conclusive evidence for the relationship. Nel tries to confirm the influence of income inequality on economic growth using the recent high-quality inequality data, but his focus is only on the period 1986-1997, and the statistical results are not significant.

Recently, Okojie and Shimeles (2006) reviewed the empirical literature on both income and non-income inequality in sub-Saharan Africa conducted by institutions and individuals in Africa. They confirmed that sub-Saharan Africa countries are experiencing great inequality and that research on income inequality became available thanks to new data sources. They also addressed the importance of future research on this issue, considering the fact that even African research institutions have not been seriously engaged in demonstrating this relationship.

For sub-Saharan Africa, income inequality was addressed more as a part of a broader relationship between poverty and economic development (Fielding 2001; Tsikata 2001; Ali and Thorbecke 2000; Fosu 2011). Moreover, although poverty reduction and economic growth are systematically correlated, the initial level of inequality is crucial for economic growth to actually lower poverty (World Bank 2000). Thus, profound research that can actually corroborate or disprove the relationship between income inequality and economic growth is necessary.

METHODS AND MEASUREMENTS

Data

The measure of income inequality used in this study is the Gini coefficient as calculated from the Lorenz curve, which plots cumulated population on the x-axis and cumulated income shares of the population on the y-axis. The Gini coefficient ranges from 0 to 1—twice the area between the 45-degree line and the Lorenz curve—where 0 indicates a perfect egalitarian society and 1 indicates a perfect unequal society. This paper uses the Gini coefficient in percentage scale, and, therefore, it ranges from 0 to 100.

The Gini coefficient can be calculated based on two welfare indicators, income and expenditure. The coefficient calculated by income may be not as accurate as the coefficient calculated by expenditure because; individuals who report income are inclined to report less or more amount; and income can be measured by various sources, not only salary but property or pension income (Son 2010). In turn, expenditure can pinpoint hidden income sources, and, therefore, this paper will use the Gini coefficient based on expenditure.

The main data source for income inequality is PovcalNet, an online poverty analysis tool provided by World Bank. PovcalNet provides the developing world's poverty estimates, including the Gini coefficient, from 1981 to 2009. Deininger and Squire's (1996) data set—one of the mostly widely used data sets for cross-country income inequality studies—is not used because it does not contain sufficient data for sub-Saharan African countries.

The major concern with the Gini coefficient is the lack of coverage. This is the main problem with inequality data, as many other researchers have pointed out, and is serious for sub-Saharan African regions. (Barro 2000; Okojie and Shimeles 2006; Forbes 2000) To expand the sample size, Barro (2000)

added a number of observations from other sources even at the expense of some measurement errors. This paper conducts the same method, and adds a number of observations provided by the United Nations University-World Institute for Development Economics Research (UNU-WIDER) World Income Inequality Database (WIID). To reduce inconsistency between the measures, 6.6%p was deducted from the Gini coefficient if it was based on income, as Deininger and Squire (1996) stated.

The dependent variable is real GDP per capita. For estimation, the logarithm of real GDP per capita was used. The controlling variables are education, openness and market distortion. To incorporate sub-Saharan Africa countries' characteristics, infant mortality rate, and life expectancy at birth are used. Openness and market distortion is from the Penn World Tables version 7.0, and all the other data are collected from the World Bank's African Development Indicator (ADI). Table 1 shows the descriptive statistics of the variables.

Empirical Framework

Using the data described in the previous section, this paper tests the influence of initial income inequality on economic growth. This paper does not use cross-sectional analysis as most previous studies did. Cross-sectional analysis has limitation in explaining how a change in a country's level of income inequality is related to changes in country's growth performance. Moreover, cross-sectional analysis is effective to explain the long-term relationship between income inequality and economic growth. For sub-Saharan African countries, however, short-term and medium-term growth is as important as long-term growth, to make the region actually get out of the extreme poverty.

So, this paper uses panel data analysis to estimate the relationship between income inequality and economic growth. As Forbes (2000) stated, panel data analysis is more effective than cross-sectional analyses to limit the unobserved time-invariant heterogeneity, and to clearly delineate how the changes of

income inequality influences economic growth within a country. This paper would incorporate country dummies.

The collected data are unbalanced panel data with 40 sub-Saharan African countries from 1981 to 2009. Because of data availability, Barro (2000) and Forbes (2000) averaged the data in ten-year and five-year period correspondingly. Averaging the data not only lessens the short-term vulnerability but avoids serial correlation from business cycles. (Forbes 2000) This paper, therefore, would estimate the relationship between income inequality and economic growth in two ways; using yearly, and five-year averaged data. By transforming the original data set into five-year period, the data set now has six periods of growth. The Gini coefficients were replaced to the closest value to the base year in given time period. (i.e. for 1981-1985, the base year is 1981.) All the other controlling variables are simply averaged for five-year period. Table 2 gives the list of countries in the sample, and the Gini coefficients in ten-year period.

For the empirical analysis, this paper first assumes the relationship between income inequality and economic growth is

$$(1) \quad \ln(Y_{i,t}) = c + \beta_1 X_{1,i,t} + \beta_2 X_{1,i,t}^2 + \beta_3 X_{2,i,t} + \beta_4 X_{3,i,t} + \beta_5 X_{4,i,t} + \beta_6 X_{5,i,t} \\ + \beta_7 X_{6,i,t} + \alpha_i + e_t$$

Y: GDP per capita

X₁: Gini coefficient

X₄: Life expectancy at birth

X₂: Primary education

X₅: Market distortion

X₃: Infant mortality rate

X₆: Openness

where c is a constant, α_i is country dummies, and e_t is the error term when i represents country and t represents each time period. The dependent variable is annual per capita growth. The inclusion of the squared term of the Gini coefficient allows for non-linearity in the income inequality and economic growth relation. In the next estimation, equation (2), all the explanatory variables are converted into annual changes except the Gini coefficients. Due to lack of data, the Gini coefficients could not be converted into annual or five-year averaged changes. And in the last equation, the dependent variable is also converted into annual changes.

$$(2) \quad \ln(Y_{i,t}) = c + \beta_1 X_{1,i,t} + \beta_2 X_{1,i,t}^2 + \beta_3 \Delta X_{2,i,t} + \beta_4 \Delta X_{3,i,t} + \beta_5 \Delta X_{4,i,t} + \beta_6 \Delta X_{5,i,t} \\ + \beta_7 \Delta X_{6,i,t} + \alpha_i + e_t$$

$$(3) \quad \Delta \ln(Y_{i,t}) = c + \beta_1 X_{1,i,t} + \beta_2 X_{1,i,t}^2 + \beta_3 \Delta X_{2,i,t} + \beta_4 \Delta X_{3,i,t} + \beta_5 \Delta X_{4,i,t} \\ + \beta_6 \Delta X_{5,i,t} + \beta_7 \Delta X_{6,i,t} + \alpha_i + e_t$$

Table1. Summary Statistics

		Mean	Std.	Min	Max	
Inequality	Gini coefficient		44.53	8.96	28.6	74.33
		1985	40.7	10.0	28.6	54.2
		1990	44.5	10.8	33.2	63.7
		1995	48.8	11.2	30.4	74.3
		2000	44.8	8.3	30.0	60.0
		2005	44.6	7.7	29.8	67.4
		2009	42.2	9.3	33.3	65.8
Education	Average years of primary education		6.14	0.60	4.00	8.00
		1985	6.1	0.7	4	7
		1990	6.1	0.6	4	7
		1995	6.1	0.6	4	7
		2000	6.2	0.6	4	7
		2005	6.2	0.6	4	7
		2009	6.2	0.5	5	7
Life expectancy	The number of years a new born infant would live (male and female)		52.20	7.40	26.41	73.69
		1985	51.3	7.3	39.9	69.0
		1990	52.3	7.9	39.6	70.0
		1995	52.6	8.8	27.8	70.9
		2000	52.6	7.7	37.9	71.9
		2005	52.9	7.3	42.0	72.2
		2009	54.3	7.3	44.9	73.1
Market Distortion	Price level of investment PPP over investment divided by the exchange rate times 100		66.45	55.89	3.18	684.69
		1985	90.0	86.6	22.7	521.0
		1990	66.9	35.6	25.6	203.4
		1995	59.5	21.5	23.8	123.0
		2000	57.0	31.2	27.8	184.1
		2005	54.3	34.9	25.2	253.0
		2009	56.5	24.2	28.8	177.0
Openness	Total trade as a percentage of GDP		69.59	38.28	13.81	364.18
		1985	66.2	34.2	17.1	156.0
		1990	66.0	35.3	18.5	161.8
		1995	64.4	33.2	16.7	171.9
		2000	71.0	39.8	20.1	172.8
		2005	72.7	37.0	27.0	179.5
		2009	78.6	42.1	29.5	212.7
Mortality rate	Infant Mortality rate (per 1,000 live births)		85.40	36.66	11.10	184.70
		1985	103.2	37.8	16.0	174.9
		1990	99.8	37.9	13.3	166.1
		1995	96.6	36.3	12.7	169.3
		2000	89.7	31.1	12.1	150.2
		2005	80.5	29.4	11.5	134.2
		2009	75.9	29.0	11.3	127.0

Note: The Gini coefficient is taken from the closest year to the base year in a five-year period.

Source: The Gini-coefficient is from PovcalNet, World Bank, and the United Nations University-World Institute for Development Economics Research (UNU-WIDER) World Income Inequality Database (WIID); Market distortion and openness is from PWT 7.0. Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 7.0, Center for International Comparisons, University of Pennsylvania; Other data are from World Development Indicator(WDI).

Table 2. List of Countries and the Trend of the Gini coefficients

Country	1980s	1990s	2000s
Angola		58.64	
Burundi		33.33	33.27
Benin			38.62
Burkina Faso		50.71	39.60
Botswana	54.21	60.96	
Central African Republic		61.33	43.57
Cote d'Ivoire	41.21	36.91	48.39
Cameroon	49.00	46.82	44.56
Congo, Rep.			47.32
Comoros			64.30
Cape Verde			50.52
Ethiopia	32.42	39.96	29.76
Gabon		37.50	41.45
Ghana	35.35	38.13	42.76
Guinea		46.84	43.34
Gambia		47.50	47.28
Guinea-Bissau		55.70	35.52
Kenya		57.46	47.68
Liberia			38.16
Lesotho	56.02	57.94	52.50
Madagascar		46.12	47.47
Mali	36.51	50.56	40.01
Mozambique		44.49	47.11
Mauritius	33.20	30.40	30.50
Malawi	50.70	62.00	39.02
Namibia		74.33	
Niger		36.10	43.89
Nigeria	28.60	44.95	42.93
Rwanda	28.90	46.68	53.08
Senegal		54.14	41.25
Sierra Leone	63.70		42.52
Swaziland		60.65	50.40
Seychelles		42.73	65.77
Chad			39.78
Togo			34.41
Tanzania		33.83	36.70
Uganda	44.36	42.62	45.77
South Africa	40.40	59.33	67.40
Congo, Dem. Rep.			44.43
Zambia		48.40	42.08
Mean	42.47	48.61	44.41
Standard Deviation	10.89	10.45	8.54

Note: The Gini coefficient is taken from the oldest available date within the given period.

RESULTS & INTERPRETATION

Table 3 reports the effects of income inequality on economic growth using fixed effects when the dependent variable is a logarithm of real GDP per capita. Columns (i) and (ii) use yearly-unbalanced data, and columns (iii) and (iv) use five-year averaged data. Columns (ii) and (iv) include squared Gini coefficients to estimate the non-linear relationship between income inequality and economic growth. For all four estimations, the coefficients of income inequality are not significant. The coefficients of the squared Gini coefficients are extremely small for both column (ii) and (iv), but the signs are different; the coefficient is negative in column (ii), yearly data, but positive in column (iv), five-year averaged data, so the estimation results in Table 3 are not consistent in the short-term and medium-term. Explanatory variables are insignificant as well, except for education for columns (i) and (ii), where the increase in years of primary education is positively related to economic growth.

In Table 4, all the explanatory variables are converted into annual or five-year averaged changes, while the dependent variable remains the same as in the previous table. Still, the coefficients of inequality are not significant, as are the explanatory variables. The coefficients of education are no longer significant. The coefficients for the squared Gini coefficient are not significant and extremely small, but at least they have the same signs for yearly and five-year averaged data.

The last table, Table 5, is different from the first two sets of estimation results. First, the dependent variable is changes in real GDP per capita such as the explanatory variables. In this way, the influence of income inequality on relative changes in economic growth can be measured, as the other explanatory variables deviate from the previous year. As sub-Saharan African countries are experiencing high volatility in economic conditions, this method may be more appropriate for them. The estimation also

used random effects to test the relationship as the fixed effects estimation became significant. Random effects can be more efficient as differences across countries are incorporated, while fixed effects refer only to the differences within countries. The random effects, however, assume that the country-specific effect is not correlated to the explanatory variables, and Hausman's test examines this assumption. This assumption, however, is unlikely to be met for the non-experimental data set as this paper has.

In column (i) in Table 5, the coefficient of income inequality is positive and significant. This may imply that, as a country becomes more unequal, economic performance gets better compared to the previous year. In column (ii), the coefficients of both inequality and squared Gini coefficients are significant. The coefficient of income inequality is positive, but because the squared term is negative, this may be interpreted as indicating that changes in income inequality has an inverted-U shaped relationship to changes in real GDP per capita. This implies that economic performance may improve as income distribution become more unequal, but after a certain point, unequal distribution may harm economic growth. Because the magnitude of the coefficient for the squared term is really small, the inverted-U shape would have flatter slope. This result does not deviate much even if random effects estimation was used, as column (iii). In column (iii), the coefficients for both income inequality and the squared inequality are significant. Hausman's test, however, does reject the assumption for random effects. This is different from what previous research such as Forbes (2000) or Son (2010) have found. This can be interpreted as indicating that, for sub-Saharan African countries, differences within countries are more critical than differences across countries. This may be due to the relative short history of nations in that region and similar public health conditions. The coefficient of income inequality is neither significant nor positive for five-year period data, as in column (iv). The other explanatory variables, education, life expectancy, market distortion, and openness, do not have statistical significance. In particular, the changes in market distortion have a negligible and statistically insignificant effect on income inequality.

Table 3. Regression Results: dependent variable = ln (real GDP per capita)

	Yearly <i>Fixed-effects</i>	Yearly <i>Fixed-effects</i>	Five-year <i>Fixed-effects</i>	Five-year <i>Fixed-effects</i>
	(i)	(ii)	(iii)	(iv)
Inequality	-0.001 (0.002)	0.001 (0.017)	0.0002 (0.003)	-0.002 (0.021)
Inequality Squared		-0.0000 (0.0002)		0.0000 (0.0002)
Education	0.188** (0.084)	0.189** (0.085)	0.165 (0.114)	0.165 (0.115)
Life expectancy	0.008 (0.005)	0.008 (0.005)	0.002 (0.007)	0.002 (0.007)
Market distortion	0.0002 (0.0005)	0.0003 (0.0006)	0.0003 (0.0007)	0.0003 (0.0008)
Infant mortality rate			-0.003 (0.002)	-0.003 (0.002)
Openness	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)
R squared	0.0856	0.0857	0.1415	0.1416
Countries	40	40	40	40
Observations	153	153	111	111

Note: **, * represent significance level of 5% and 10% respectively; Standard errors in parenthesis; All forty countries in sub-Saharan African are included; Infant mortality rate is excluded in column (i) and (ii) due to lack of data; dependent variable is average annual per capita growth; R squared is the within-R squared.

Table 4. Regression Results: dependent variable = ln (real GDP per capita)

	Yearly <i>Fixed-effects</i>	Five-year <i>Fixed-effects</i>
	(i)	(ii)
Inequality	0.000 (0.015)	-0.014 (0.026)
Inequality Squared	-0.000 (0.000)	-0.000 (0.000)
Δ in Education	0.030 (0.075)	0.022 (0.089)
Δ in Life expectancy	-0.037 (0.027)	-0.004 (0.005)
Δ in Market distortion	-0.000 (0.001)	-0.000 (0.001)
Δ in Openness	0.028 (0.044)	-0.094 (0.075)
R squared	0.0261	0.0478
Countries	40	37
Observations	149	90

Note: **, * represent significance level of 5% and 10% respectively; Standard errors in parenthesis; Three countries, Republic of Congo, Benin, and Namibia are excluded in five-year period analysis due to lack of data; Infant mortality rate is excluded in yearly data.

Table 5. Regression Results: dependent variable = Δ in \ln (real GDP per capita)

	Yearly <i>Fixed-effects</i>	Yearly <i>Fixed-effects</i>	Yearly <i>Random-effects</i>	Five-year <i>Fixed-effects</i>
	(i)	(ii)	(iii)	(iv)
Inequality	0.002** (0.000)	0.009** (0.004)	0.007** (0.003)	-0.005 (0.041)
Inequality Squared		-0.0001** (0.000)	-0.0001** (0.000)	0.000 (0.000)
Δ in Education	0.013 (0.021)	0.010 (0.020)	-0.011 (0.020)	0.103 (0.143)
Δ in Life expectancy	0.012* (0.007)	0.010 (0.007)	0.009 (0.006)	0.001 (0.008)
Δ in Market distortion	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.001)
Δ in Openness	0.005 (0.012)	0.006 (0.012)	0.006 (0.011)	-0.079 (0.121)
Hausman's Test (p-value)			0.021	
R squared	0.099	0.134	0.0824	0.024
Countries	40	40	40	37
Observations	148	148	148	89

Note: **, * represent significance level of 5% and 10% respectively; Standard errors in parenthesis; All forty countries in sub-Saharan African are included except for column (iv), where Republic of Congo, Benin, and Namibia are excluded; Infant mortality rate is excluded in yearly data due to lack of data.

This result is hardly comparable to previous research such as Forbes (2000), which found that an increase in income inequality enhances economic growth significantly in the short to medium term. This result does not align with the earlier empirical studies, either, which indicated that there is a negative relationship between income inequality and economic growth. There can be a couple of reasons for this. First, the previous research did not include sub-Saharan African countries due to lack of data, and their empirical analyses were based on the data constructed up to the early 1990s. Sub-Saharan African countries have relatively severe income inequality, and inequality continues to rise even in the 2000s. Second, the previous research did not consider the squared Gini coefficient, so they could not explain the non-linear relationship of income inequality on economic growth. However, in fact, for countries like those in sub-Saharan Africa, estimating the non-linear relationship would further explain the relationship, as the countries have extremely high inequality. Thus, although sub-Saharan African countries may experience a positive influence of income inequality on economic growth, as column (i) in Table 5 shows, this relationship would not continue for long and, eventually, harm the economy, as column (ii) in table 5 describes. These results were hardly anticipated in previous research studies in which only linear relationship analysis was conducted.

DISCUSSION & CONCLUSION

This paper has studied the influence of income inequality on economic growth in the sub-Saharan Africa. With the most up-to-date available data, this paper finds that income inequality is indeed positively correlated to annual changes in economic growth, controlling for changes in other explanatory variables. As a non-linear relationship was tested, this paper expects that the positive correlation will not continue for long for sub-Saharan African countries and that income inequality will eventually slow and decrease

economic growth. This does not support other previous research in which only linear relationships were tested.

This paper's result, however, still does not guarantee that income inequality will eventually be detrimental to economic growth in the longer term. First, there is a possibility that the non-linear relationship of income inequality with economic growth is not as simple as the squared term. Second, endogeneity remains a problem. Although a panel data analysis was effective in estimating the difference in data across time within each country, it also has limitations. Barro (2000) once explained that the Gini coefficient is more volatile across countries, so country fixed effects may exaggerate the results. Third, this paper does not address the indirect effect of income inequality on economic growth. To alleviate this problem, a case study in the sub-Saharan region would be helpful, which can give some insight into the different channels. In fact, sub-Saharan African countries have a unique history and unusual public health conditions compared to other developing nations, so developing a picture of economic growth in that region may shed more light on the relationship. Finally, the estimation in this paper cannot disprove the possibility of reverse-causality between income inequality and economic growth. Instrumental variables (IV) estimation can be an alternative for this. The instrumental variable method can derive a reliable estimate of the causal relationship of income inequality on economic growth, without reverse causality.

Among these limitations, endogeneity is inevitable for non-experimental data. Endogeneity in this paper would be due to mostly measurement error, as time-constant unobserved heterogeneity can be disregarded with the panel data analysis. Measurement error is unavoidable for cross-country analysis. In this paper, the possibility of carrying more measurement error is higher due to the lack of consistency in the Gini coefficients. Although we now have more access to higher-quality data on the sub-Saharan Africa region, more yearly data would be helpful in clarifying the complicated relationship between income inequality and economic growth.

The last concern is that the result addresses only short-term and medium-term estimation. Thus, for a longer-term analysis, there is a possibility that the signs of the coefficients may be reversed. Because the panel data analysis used in this paper is not suitable for longer-term analysis, a new estimation technique is required.

Thus, the results of this paper cannot be interpreted as suggesting a strong relationship between income equality and economic growth. However, this paper does address the fact that income equality is related to economic growth, suggesting that policy-makers in both the sub-Saharan Africa and international organization should be more concerned about income inequality. In fact, the Gini coefficients in this region have not changed significantly since the 1980s, as the data show. Moreover, identifying the effects of income inequality on poverty is necessary considering the persistent poverty in this region and the existing policy tools for poverty reduction. If income inequality reduction and poverty reduction can share policy instruments, which seems to be a reasonable guess, policy-makers and sub-Saharan African countries would benefit from further economic growth. Thus, this paper suggests that further research be conducted not only to identify the relationship but, eventually, to lessen inequality and promote economic growth.

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