On the Dynamic Relationship between Inequality and Economic Growth

Jeyoung Moon and Dong Heon Kim

This study reexamines the nonlinear relationship between inequality economic growth in the dynamic context and addresses the nonlinear function and the nature of its nonlinearity. Nonlinear flexible inference was used for the unknown functional relation with estimation results based on the panel data set of 77 countries for the period 1982–2019, confirming earlier findings for the nonlinear relationship between inequality and growth. Particularly, there exists a threshold value in the Gini Coefficient and level of inequality when it is greater than the threshold value, the decrease in inequality seems to enhance economic growth and if the level is less than the threshold value, the reduction in inequality appears to impede economic growth. The inclusion of the threshold specification appears to characterize the nonlinear relationship adequately, thus capturing the nature of nonlinearity.

Keywords: Economic growth; Income inequality; Nonlinearity; Threshold value; Flexible inference

JEL Classification: C11, C23, O11, O15

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I. Introduction

How income inequality's relationship to long-term economic growth is an important topic. Given the recent spike in the level of inequality, understanding the causes and consequences of income inequality and investigating its effect on economic growth deserve deep and sustained scholarly agenda. In fact, there have been many studies on the relationship between inequality and economic growth, but the relationship remains to be clearly addressed. On the one hand, inequality has a positive effect on growth through incentives, saving rates, or investment indivisibilities mechanism (Li and Zou 1998; Forbes 2000; Lundberg and Squire 2003). On the other hand, there is a negative association of inequality between growth from the fiscal redistribution and distortion, sociopolitical instability, imperfect credit markets, and/or fertility differentials channels based on endogenous growth models (Alesina and Rodrik 1994; Persson and Tabellini 1994; Wan, Lu and Chen 2006; Sukiassyan 2007).

Several studies have tried to reconcile the conflicting evidence on the inequality-growth linkage in the context of nonlinearity. Galor (2000), and Galor and Moav (2004) show that the relationship between inequality and growth is nonlinear according to economic development. Bandyopadhyay and Basu (2005) state that the long-run inequality-growth correlation crucially depends on the extent of barriers to knowledge spillovers, the skill intensity in technology, and the degree of income redistribution. Here, a positive association between inequality and growth is expected in the industrial countries, while a negative correlation emerges for non-industrial ones. Barro (2000) shows that inequality appears to encourage growth in rich economies, but slows it down in poor ones. Banerjee and Duflo (2003) document an inverted-U relationship between inequality & growth where higher inequality enhances growth in more equal societies but reduces growth in less equal ones. Lin *et al.* (2009) estimate the inflexion point or threshold given that such a nonlinear relationship exists. Hailemariam and Dzhumashev (2019) show that after accounting for heterogeneity, the nonlinear growth effect of income inequality remains statistically and economically significant and found a threshold effect of inequality on economic growth.

Although existing literature has provided evidence in favor of nonlinear relationship on the inequality-growth linkage, all empirical studies to date assume specific parametric models. However, we do not actually directly observe the relationship in the economy, hence we consider the existence of an unbounded universe of possible alternative nonlinear specifications. It is valuable to investigate the nature of any nonlinearities in the inequality-growth linkage while avoiding specific parametric assumptions.

This study seeks to revisit and examine the nonlinear relationship between inequality and economic growth. Should its existence be verified, we try to address what the nonlinear function looks like and what the nature of nonlinearity is. Flexible inference was used for the unknown functional relation, as developed in Hamilton (2001) in the time-series analysis and extended to the panel framework in Kim (2012). The methodology provides a valid test of the null hypothesis of linearity against a broad range of alternative nonlinear models, consistent estimation of what the nonlinear relation looks like, and formal comparison of alternative nonlinear models.

In our estimated model, the nonlinear functional relation is common across countries and over time while the regression error is assumed to be composed of three independent components: one component associated with the cross-sectional units, another with an aggregate shock, and the last being an idiosyncratic shock. The estimation results confirm the claim that the relationship between income inequality and economic growth is nonlinear — at higher levels of inequality, the improvement in inequality appears not to have any significant effect on growth, whereas for lower inequality levels, further reduction in income inequality evidently hinders economic growth. The alternative specifications with nonlinear flexible inference confirm the threshold level of inequality.

The structure of this paper is as follows: Section 2, reviews the literature on the relationship between income inequality and economic growth from both theoretical and empirical analyses. Section 3 outlines the error components model of the panel data in the context of a parametric approach to flexible nonlinear inference. Estimation results for the analysis of inequality-growth nexus are subsequently presented in Section 4. Section 5 closes the entire study by offering concluding remarks and suggestions for future directions.

II. Literature Review

For existing literature, the relationship between income inequality and growth can be summarized into three cases. Table 1 shows a summary for the existing literature on the relationship between income equality and growth.

First, income inequality hurts economic growth. Galor and Zeira (1993) and Piketty (1997) outline models in which credit market imperfections hamper the possibility for poor households to invest in both human and physical capital. Alesina and Rodrik (1994), Persson and Tabellini (1994), and Benabou (1996) all argue that inequality creates political pressure to redistribute resources from the rich to the poor, discouraging investment and work effort. Alesina and Perotti (1996) describe that that inequality induces the poor to engage in crime and antisocial activities, diverting their resources away from productive activities. Easterly (2007) shows that inequality has an adverse effect on economic growth and development by using agricultural endowments — particularly, the abundance of land for growing wheat relative to land for growing sugarcane — as an instrument for inequality. Galor, Moav, and Vollrath (2009), using state-level data from the U.S.A., found that inequality has a negative impact on human capital formation, negatively affecting on economic growth.

Second, there is a positive relationship between inequality and growth. Kaldor (1955) and Kalecki (1971) state that inequality allows for saving and capital accumulation. Bhattacharya (1998) argues that bequests of capitalists could mitigate credit market frictions, thereby promoting financial market efficiency and capital accumulation while inequality increases. In the political economy model of Saint-Paul and Verdier (1993), economic growth benefits from inequality as it enables better-endowed agents to lobby against the implementation of distorting redistribution policies. Edin and Topel (1997) and Partridge (2006) maintain that inequality functions as a signal, triggering a migration of capital and skilled workers into more unequal regions. Siebert (1998) and Bell and Freeman (2001) contend that inequality enhances incentives for individuals to work harder and engage in innovation and risk-taking, resulting in higher economic growth. Using fixed-effects and random-effect estimators, Li and Zou (1998) show that their model, based on the division of public expenditure into productive and

TABLE 1

BRIEF SUMMARY OF THE EXISTING LITERATURE ON THE RELATIONSHIP BETWEEN INCOME INEQUALITY AND GROWTH

Relationship	Literature	Main reasons
Negative effect	Galor & Zeira (1993), Alesina & Rodrik (1994), Persson & Tabellini (1994), Alesina & Perotti (1996), Benabou (1996), Piketty (1997), Easterly (2007), Galor, Moav & Vollrath (2009)	• Credit market imperfection & destruction for poor households to invest in human & physical capital • Political pressure of redistribution from the rich to the poor & discouraging investment & work effort • Engagement in crime & antisocial activities by the poor• Agricultural endowments creating inequality • Negative impact of inequality on human capital formation
Positive effect	Kaldor (1955), Kalecki (1971), Saint-Paul & Verdier (1993), Edin & Topel (1997), Bhatacharya (1998), Li & Zou (1998), Siebert (1998), Forbes (2000), Bell & Freeman (2001), Partridge (2006)	• Inequality to be conductive to saving & capital accumulation • Bequests of capitalists & mitigation of credit market friction • To enable better-endowed agents to lobby against the implementation of distorting redistribution policies • To function as a signal, triggering a migration of capital & skilled workers into more unequal regions • To enhance incentives for individuals to work harder & to engage in innovation & risk-taking
Nonlinear effect	Barro (2000), Chen (2003), Banerjee & Duflo (2003), Bandyopadhyay & Basu (2005), Lin, Huang & Yeh (2014), Brueckner & Lederman (2018), Hailemariam & Dzhumashev (2019)	• Different effect in various stages of economic growth • Positive correlation in economies with low barriers to knowledge spillover, high skill intensity in the technology, & high degree of redistribution & vice versa • To promote growth in rich countries but retard growth in poor countries • Negative correlation at lower levels of developments but positive at higher levels of development • Positive in low-income countries but negative in high-income countries • Different effect across countries in terms of political structure & economic policies

consumptive services and the incorporation of both into production and utility functions, predicts a positive relationship between inequality and growth. Forbes (2000) finds in the panel study of 45 countries over the periods of 1966–1995 that higher country income inequality leads to economic growth in both the short and medium term.

Third, another stream of literature emphasizes the nonlinear relationship between inequality and growth. Here, inequality affects growth differently in various stages of economic development. Bandyopadhyay and Basu (2005) show through a general equilibrium growth model that a positive inequality-growth correlation arises in economies with low barriers to knowledge spillover, high skill intensity in technology, and high degree of redistribution, whereas economies whose characteristics are otherwise display a negative inequality-growth relationship. Barro (2000) finds that inequality and growth have a nonlinear relationship where inequality appears to promote growth in rich countries but slows it down for poorer countries. Chen (2003) and Banerjee and Duflo (2003) find an inverted U-shaped relationship between income inequality and growth. In the study of the panel data for 48 US states over the period 1945–2004, Lin *et al.* (2014) posit that while the effect of inequality on growth is significantly negative at lower levels of developments, it diminishes along the growth process and subsequently turns significantly positive at higher levels of development. Brueckner and Lederman (2018) point out a decreasing relationship between inequality and growth in the GDP per capita in countries' initial income, arguing that greater income inequality in low-income countries bolsters transitional growth, but has a significant negative effect on transitional growth in high-income ones. Hailemariam and Dzhumashev (2019) point out that modern theories which explain the effect of inequality on growth can be directly linked to the differences across countries in terms of political structure and economic policies—after accounting for heterogeneity, the nonlinear growth effect of income inequality remains statistically and economically significant because of inequality's threshold effect on economic growth.

We consider that the contrasts in current empirical findings may be related to the linear and nonlinear specifications. Should nonlinear specification be desirable, it is important to address what the nonlinear function looks like and what the nature of nonlinearity is. Moreover, since it generally takes time for inequality to affect growth, a consideration of time is important for investigating the relationship between inequality and growth. Following this, a dynamic model might be more effective than a contemporaneous analysis. To incorporate the dynamic relationship, we consider five years average as a period in the dynamic panel model.

III. Nonlinear Flexible model

We consider the general nonlinear regression model in the panel framework as follows:

$$y_{it} = \mu_i(\boldsymbol{x}_{it}) = \varepsilon_{it}, \ (i = 1, 2, \ldots, N, \ t = 1, 2, \ldots T) \tag{1}$$

where y_{it} is a scalar-dependent variable at time t for country i, $\boldsymbol{x}'_{it}$ is a k-dimensional vector of explanatory variables, and ε_{it} is Gaussian with dependence structure with mean zero and independent of both $\mu_i(\cdot)$ *and* $\boldsymbol{x}_{i\tau}$ for i = 1, 2,..., N and τ = t,t−1,...,1. This specification considers the nonlinear relation over and within the group and thus allows the functional relation to be different over cross-country units. Following Hamilton (2001) and Kim (2012), the conditional mean function in the panel data, $\mu_i(\boldsymbol{x}_{it})$, is written as:

$$\mu_i(\boldsymbol{x}_{it}) = \alpha_0 + \alpha'_{i1}\boldsymbol{x}_{it} + \lambda_i m, \ (g_i \odot \boldsymbol{x}_{it}), \ (i = 1, 2, \ldots, N) \tag{2}$$

where $m(\cdot)$ denotes the realization of a scalar-Valued Gaussian random field with mean zero and unit variance, α_0, α'_{i1}, λ_i *and* $\boldsymbol{g}_i$ are population parameters to be estimated. $\boldsymbol{g}_i = (g_{i1}, g_{i2}, \ldots, g_{ik})'$ and $\odot$ indicates element-by-element multiplication. λ_i^2 governs the overall importance of the nonlinear component, and $\boldsymbol{g}_i$ governs the variability of the nonlinear component with respect to each explanatory variable.

Following Kim (2012)'s examination of the nonlinear relationship between oil price change and business cycle in the panel data, we consider the use of an error components model where one component of random error ε_{it} is an unobserved individual effect which is constant through time. Another component is an unobserved time effect which is the same for all individuals at a given time, and the third component is an unobserved remainder. Thus, we assume that the residual, ε_{it} is decomposed into the sum of three components:

$$\varepsilon_{it} = \omega_i + a_t + \upsilon_{it}, \tag{3}$$

where, w_i is an individual specific variable, α_t is a time-specific variable *and* v_{it} is the remainder. $w_i's$, $\alpha_i's$, *and* $v_{it}'s$ are random, have zero means, have variances of σ_w^2, σ_α^2, *and* σ_v^2, and are independent of each other *i.e.*, it is assumed that $E(w_i) = E(\alpha_t) = E(v_{it}) = 0$, $E(w_i w_j) = 0$ for $i \neq j$, $E(\alpha_t \alpha_s) = 0$ *for* $t \neq s$, $E(v_{it} v_{is}) = \sigma_v^2$ for $t \neq s$, and zero otherwise, $E(w_i \alpha_t) = E(w_i v_{it}) = E(\alpha_t v_{it}) = 0$. Moreover, $\boldsymbol{x}_{it}$ is independent of w_i, α_t *and* v_{it} *for all* i *and* $\tau \leq t$ assuming that the regressor $\boldsymbol{x}_{it}$ is strictly exogenous and $\boldsymbol{x}_{it}$ *and* ε_{it} are independent of the realization of the random field m(·) in (2). For simplicity, we further assume that the slopes in the linear component in (2) are homogeneous among different individuals and that λ_i *and* $\boldsymbol{g}_i$ are not specific to cross-section units. Generally, allowing nonlinear parameters to be country-specific (heterogeneous nonlinear components), may be useful for considering the panel heterogeneity issue in the application of our method to various economic applications. However, the homogeneous assumption for nonlinear parameters over different countries puts the focus on common inequality–growth relation across countries.

With these assumptions, our flexible nonlinear specification with random-effect and k−explanatory variables and the conditional mean function of (2) in the panel can be rewritten as:

$$y_{it} = \alpha_0 + \alpha'_1 \boldsymbol{x}_{it} + \lambda m(g \odot \boldsymbol{x}_{it}) + \varepsilon_{i\tau} \tag{4}$$

$$\varepsilon_{i\tau} = w_i + \alpha_t + v_{it}, \tag{5}$$

$$\mu_i(\boldsymbol{x}_{it}) = \alpha_0 + \alpha'_{i1} \boldsymbol{x}_{it} + \lambda_i m, (\boldsymbol{g} \odot \boldsymbol{x}_{it}), (i = 1,2,...,N, t = 1,2,...,T) \tag{6}$$

The basic idea of the flexible nonlinear inference is that nonlinearity implies the value for $\mu_i(\boldsymbol{x}_{is})$ *and* $\mu_i(\boldsymbol{x}_{jt})$, i & $j = 1,2,...,N$, t & $s = 1,2,..., T$ will be positively correlated for countries i and j, and periods t and s whenever the vectors $\boldsymbol{x}_{is}$ *and* $\boldsymbol{x}_{jt}$ are close to each other. Hence, it is important to parameterize this correlation based on the distance measure

$$h_{is,jt} = \frac{1}{2}\{[g \odot (\boldsymbol{x}_{is} - \boldsymbol{x}_{jt})]'[g \odot (\boldsymbol{x}_{is} - \boldsymbol{x}_{jt})]\}^{\frac{1}{2}}, \; i \,\&\, j = 1,2,...,N, t \,\&\, s = 1,2,..., T.$$

Hamilton (2001) proposes that $\mu(\boldsymbol{x}_{is})$ should be uncorrelated with $\mu(\boldsymbol{x}_{jt})$

if $\boldsymbol{x}_{is}$ is sufficiently far away from $\boldsymbol{x}_{jt}$. Kim (2012) develops the Lagrange multiplier test of the null hypothesis that conditional on $\sigma^2 = (\sigma^2_w, \sigma^2_\alpha, \sigma^2_v)'$, outlines the estimation of equations (4) - (6) based on the Bayesian analysis and provides the procedure for the inference about the conditional expectation function in the panel framework. Here, y_{it} is an economic growth at the time t in the country i and $\boldsymbol{x}_{it} = (x_{it-1}, x_{it-2},\ldots,x_{it-p})'$ are the lagged log value of Gini coefficients for $t-1, t-2,\ldots,t-p$ in the country i.

IV. Empirical results

A. Data

As noted in Atkinson and Brandolini (2015) and Hailemariam and Dzhumashev (2019), the data availability on income inequality should be heavily considered due to sparse coverage, measurement errors, and limited comparability, others. Still, many studies use either the Luxembourg Income Study (LIS) data base or the World Income Inequality Database (WIID). Solt (2016) developed a new and improved dataset which is the Standardized World Income Inequality Database (SWIID) that combines the strengths of both LIS and WIID datasets. Hailemariam and Dzhumashev (2019) state that the SWIID dataset utilizes all the available data with full geographic and population coverage, thus provides greater comparability than any other available dataset which is greatly useful in the cross-country studies of the long-run relationship between income inequality and growth. Thus, the data on Gini coefficients is collected from the SWIID (Version 8.3). The data on real GDP and population is from Penn World Table (PWT 9.1). We construct a panel data set of 77 countries from the period 1982–2019 based on the data availability with total number of observations reaching 2,926.[1]

Economic growth (y_{it}) is the log difference of real GDP per capita for each country, while the income inequality ($\boldsymbol{x}_{it}$) is the log Gini index. Following the empirical growth literature and considering the long-run relationship between inequality and growth in which the effect of inequality on growth generally needs to take a long time, we used

[1] The 5-year average of the real GDP and Gini index over 1982–2019 for 77 countries is provided in the [Appendix 1].

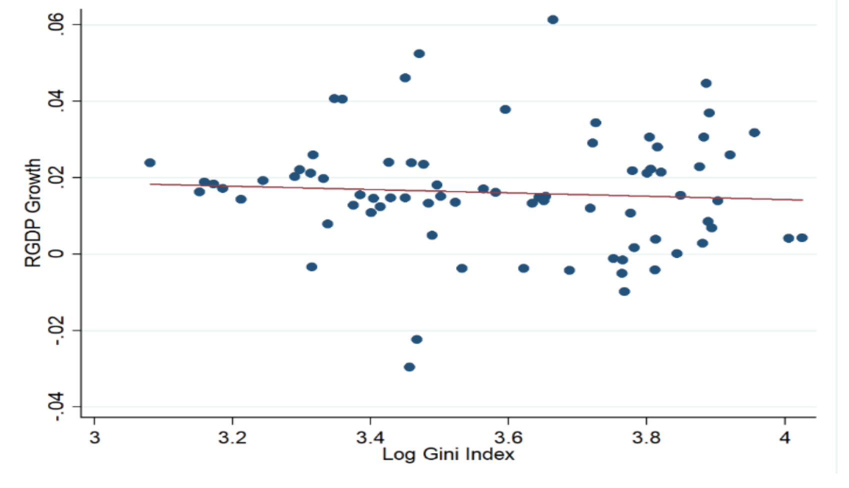
5-year average data. The 5-year average for economic growth filters out business cycle fluctuations and because the annual data of Gini index is usually noisy and is subject to measurement error, 5-years average may be helpful for reducing such an adverse noise effect.

B. Linear error component model

We begin with the cross-sectional analysis where we calculate the mean of each country for inequality and growth over 30 years. The relationship between Gini coefficient and economic growth is plotted in Fig. 1 below:

The linear fitted line is negative, implying that the relationship between inequality and growth is negative. Thus, lower inequality may be related to higher economic growth. When $\lambda = 0$, the model of (4), (5), and (6) is a two-way error component model which is as follows:

$$y_{it} = \alpha_0 + \alpha'_1 \boldsymbol{x}_{it} + \varepsilon_{it}, \tag{7}$$



Note: The dot points are the cross-sectional mean values of the log of Gini coefficient and the growth of GDP per capita for 77 countries over the period of 1982–2019. Solid line plots the regression estimate.

Figure 1

The relationship between Income Inequality and economic growth: 30-years mean and cross-section data

$$\varepsilon_{it} = \omega_i + a_t + \upsilon_{it}, \ (i = 1, 2, \dots, N, \ t = 1, 2, \dots, T) \tag{8}$$

The estimation result for (7) and (8) are as follows:

$$y_{it} = \underset{(0.038)}{-0.059} + \underset{(0.010)}{0.019} x_{it-1} + \underset{(0.035)}{0.357} y_{it-1}, \tag{9}$$

$$\hat{\sigma}^2_\omega = 2.395, \hat{\sigma}^2_a = 3.204, \hat{\sigma}^2_\upsilon = 24.096, \tag{10}$$

Where the value of the parenthesis is the estimated standard error of the coefficient. The coefficient on Gini coefficient ($\boldsymbol{x}_{it-1}$) is positive and statistically significant at the 10% level. This linear relationship between inequality and growth indicates that previously higher inequality is beneficial for economic growth. The test statistic of the null hypothesis has a value of 41.31 ($p \approx 0.000$) which a $\chi^2_{(1)}$ variable implies overwhelming rejection of the null hypothesis of the linearity of the relationship in the panel.

C. Nonlinear flexible model

Due to the test result strongly indicating nonlinear relationship between inequality and growth, Bayesian posterior estimates for (4), (5), and (6) are as follows:

$$\begin{aligned} y_{it} &= \underset{(0.068)}{-0.059} + \underset{(0.019)}{0.019} x_{it-1} + \underset{(0.036)}{0.348} y_{it-1} \\ &\quad + \underset{(0.072)}{4.929}\left[\underset{(0.207)}{0.374} m\left(\underset{(3.309)}{3.472} x_{it-1}\right) + \tilde{\omega}_i + \tilde{a}_t + \tilde{\upsilon}_{it}\right], \\ &\quad \hat{\sigma}^2_\omega = 0.283, \hat{\sigma}^2_a = 2.556, \hat{\sigma}^2_\upsilon = 24.295, \end{aligned} \tag{11}$$

Where $\tilde{\omega}_i \sim N(0,1)$, $\tilde{a}_t \sim N(0,1)$, $\tilde{\upsilon}_{it} \sim N(0,1)$ and $m(\cdot)$ denotes an unobserved realization from a Gaussian random field with mean zero and unit variance. Kim (2012) shows that the parameter λ in (4) can be written as σ_υ times ζ which is the ratio of the standard deviation of the nonlinear component $\lambda m(\boldsymbol{x})$ to that of the residual υ and the estimate of ζ is 0.374. The estimated coefficient of $\boldsymbol{x}_{it-1}$ is positive but not statistically significant in the linear component, indicating that as one considers nonlinear component into the relationship between inequality and growth, the linear positive relation appears to be weak. Although a

Note: Solid line plots the posterior expectation of the function $\alpha_0 + \alpha_1 \boldsymbol{x}_{it\text{-}1} + \gamma y_{t\text{-}1} + \lambda m(x_{it\text{-}1})$ evaluated at $(x_{it\text{-}1}, \bar{y}_{it\text{-}1})$ as a function of $x_{it\text{-}1}$ where $\bar{y}_{it\text{-}1} = (1/\mathrm{T})\Sigma_{t=1}^{T} y_{it\text{-}1}$ and where the expectation is with respect to the posterior distribution of α_0, α_1, γ, λ, and $\mathrm{m}(x_{it\text{-}1})$ conditional on observations of $\{y_{it\text{-}1}, x_{it\text{-}1}\}$ for $t = 1,\ldots,\mathrm{T}$; $i = 1,\ldots,N$, with this posterior distribution estimated by Monte Carlo importance sampling with 100,000 simulations. Dashed lines give 95% probability regions.

FIGURE 2

THE EFFECTS OF INCOME INEQUALITY ON GDP GROWTH 1 PERIOD LATER

hypothesis of linearity for the lag of inequality individually is acceptable, collectively however, the nonlinear component nonetheless contributes (as evidenced by the LM test).

To examine what the nonlinear function $\mu(\cdot)$ looks like, we performed an exercise similar to Kim (2012) and examined the consequence of changing $\boldsymbol{x}_{it\text{-}1}$ and evaluated the Bayesian posterior expectation of the optimal inference of the value of the unobserved function $\mu(\boldsymbol{x}_{it})$. Flexible inference on the effect of inequality in previous period on current period GDP growth along with 95% probability region are plotted in Figure 2.

The region of dashed lines indicates the degree of confidence of the inference based on the Bayesian posterior estimates. The implied relationship between inequality and growth is nonlinear, suggesting that there exists a threshold value whose estimate is at 3.43. When the log of Gini coefficient is higher than this value, decreases in inequality for the previous five years have almost no consequences for the current five years GDP growth. Meanwhile, in the case of the log of Gini Coefficient is lower than the value, inequality decreases significantly reduce expected GDP growth. Furthermore, the confidence interval shows a statistically significant relation. This figure suggests an asymmetric and threshold specification paralleling Hailemariam and Dzhumashev (2019). Despite unavailability of a mechanical relation between inequality and output, we view the incentive and capital accumulation effect of inequality as an explanation of nonlinear inequality-growth relation. When inequality is sufficiently low, further decreases in inequality appear to be detrimental for economic incentives such as savings and capital accumulation, thereby resulting in lower economic growth.

To confirm that the threshold specification in the relationship between inequality and growth is the entire nature of the nonlinearity, we consider and estimate following specification expressed below:

$$y_{it} = \alpha_0 + \alpha_1\delta_I + \beta_1 x_{it-1} + \beta_2\delta_I x_{it-1} + \gamma y_{it-1} + u_{it}, \tag{12}$$

$$\delta_I = \begin{cases} 1, & if\ x_{it-1} > 3.43 \\ 0, & o.w. \end{cases} \tag{13}$$

where δ_I is an indicator function for the threshold value. The estimated result of the threshold model for (12) and (13) is as follows:

$$y_{it} = \underset{(0.090)}{-0.252} + \underset{(0.100)}{0.308}\,\delta_I + \underset{(0.042)}{0.078}\,x_{it-1} - \underset{(0.030)}{0.089}\,\delta_I x_{it-1} + \underset{(0.034)}{0.354}\,y_{it-1}. \tag{14}$$

All estimated coefficients are statistically significant. The estimated coefficient on Gini Coefficient for relatively low inequality countries ($\delta_I \leq 3.43$) is 0.078 but that of Gini Coefficient for relatively high inequality countries ($\delta_I > 3.43$) is negative (−0.011 = 0.078 − 0.089). This implies that there is an asymmetrical relationship between inequality and growth, and a decrease in inequality for relatively high inequality countries helps promote economic growth but a decrease in inequality for relatively low inequality countries are detrimental for economic growth. This also confirms the inverted U-shaped relationship between income inequality and growth in both Chen (2003) and Banerjee and Duflo (2003).

To examine the validity of the threshold model in (12) and (13), we performed the nonlinearity test with the test statistic reaching 2.161 and p value at 0.142, indicating that the null of linearity is not rejected. We understand that the nonlinear relationship between inequality and growth is a threshold specification. Our estimation results appear to provide an explanation for existing literature providing conflicting relationship between inequality and growth.

V. Concluding Remarks

Existing studies on the inequality-growth nexus show conflicting results where inequality is both beneficial and detrimental for economic growth. Furthermore, several studies point out that the relation is nonlinear. Thus, theoretical and empirical studies are inconclusive about the effects of inequality on growth. This study reexamines the relationship between inequality and growth on the empirical aspect. Hence, we do not assume any parametric specification and infer functional relation from the data and evaluate the inference.

We found from the panel study of 77 countries for the period of 1982–2019 that income inequality has a nonlinear relationship with economic growth. There also seems to be a threshold point in the log of Gini Coefficient whose estimated value is at 3.43. Our nonlinear flexible inference suggests that in countries with higher inequality than the value, decreases in inequality have little impact on economic growth. However, in the countries with lower inequality than the value, decreases in inequality hinders growth. We incorporate the nonlinear inference into the parametric specification and confirm that decreases in inequality for relatively high inequality countries enhance growth whereas decreases in inequality for relatively low inequality countries impede economic growth. Thus, our estimation results provide an explanation for conflicting existing studies for the inequality-growth nexus. Unfortunately, some key points remain unexplained by this study, specifically why a threshold value in the inequality-growth nexus exists in the first place, what factors determine the value, and how the channel through which inequality has a non-monotonic effect on growth is explained. We leave these structural questions as suggestions for future research undertakings.

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Appendix 1

The average of real GDP(RGDP) and Gini Index over 1982–2019 for 77 countries

Country Code	Country	RGDP Growth	Log Gini Index
1	Argentina	0.034	3.726
2	Australia	0.015	3.429
3	Austria	0.020	3.290
4	Belgium	0.014	3.213
5	Brazil	0.014	3.904
6	Bulgaria	0.026	3.317
7	Canada	0.011	3.401
8	Chile	0.023	3.877
9	China	0.061	3.664
10	Colombia	0.008	3.889
11	Costa Rica	0.011	3.777
12	Cote d'Ivoire	-0.001	3.752
13	Denmark	0.017	3.186
14	Egypt	0.038	3.596
15	El Salvador	-0.010	3.768
16	Estonia	0.024	3.427
17	Ethiopia	0.017	3.564
18	Fiji	-0.002	3.765
19	Finland	0.016	3.152
20	France	0.013	3.376
21	Georgia	-0.004	3.622
22	Germany	0.021	3.314
23	Greece	0.015	3.502
24	Guatemala	0.007	3.895
25	Hong Kong	0.022	3.779
26	Hungary	0.022	3.297
27	India	0.045	3.887
28	Indonesia	0.028	3.816

Country Code	Country	RGDP Growth	Log Gini Index
29	Iran	0.037	3.891
30	Ireland	0.046	3.450
31	Israel	0.014	3.523
32	Italy	0.013	3.484
33	Japan	0.020	3.332
34	Jordan	0.002	3.782
35	Kazakhstan	0.008	3.339
36	Korea, Republic of	0.052	3.471
37	Kyrgyzstan	-0.030	3.456
38	Latvia	0.015	3.404
39	Lithuania	0.012	3.414
40	Madagascar	-0.005	3.765
41	Malawi	0.003	3.881
42	Malaysia	0.021	3.821
43	Mauritius	0.024	3.081
44	Mexico	0.004	3.813
45	Moldova	0.005	3.490
46	Morocco	0.015	3.654
47	Nepal	0.022	3.806
48	Netherlands	0.019	3.245
49	New Zealand	0.015	3.451
50	Nigeria	-0.004	3.813
51	Norway	0.018	3.173
52	Pakistan	0.015	3.644
53	Panama	0.031	3.883
54	Peru	0.026	3.921
55	Philippines	0.015	3.849
56	Poland	0.041	3.348
57	Portugal	0.024	3.459
58	Russia	-0.004	3.532
59	Sierra Leone	0.000	3.844
60	Singapore	0.029	3.722

Country Code	Country	RGDP Growth	Log Gini Index
61	South Africa	0.004	4.025
62	Spain	0.024	3.477
63	Sri Lanka	0.031	3.804
64	Sweden	0.019	3.159
65	Switzerland	0.016	3.385
66	Taiwan	0.041	3.359
67	Tajikistan	-0.022	3.468
68	Tanzania	0.014	3.652
69	Thailand	0.032	3.956
70	Tunisia	0.013	3.634
71	Turkey	0.021	3.800
72	Ukraine	-0.003	3.315
73	United Kingdom	0.018	3.496
74	United States	0.016	3.581
75	Uruguay	0.012	3.719
76	Venezuela	-0.004	3.688
77	Zambia	0.004	4.006

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