On the dynamic relationship between Inequality and Economic growth

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Abstract: This study re-examines the nonlinear relationship between inequality and economic growth in the dynamic context and addresses what the nonlinear function looks like and the nature of nonlinearity. To this end, we employ the methodology of the nonlinear flexible inference for the unknown functional relation. The estimation results based on the panel data set of 77 countries for the period 1982 ~ 2011 confirm earlier findings for the nonlinear relationship between inequality and growth. In particular, we find that there exists a threshold value in the Gini Coefficient and when the level of inequality is greater than the threshold value, the reduction in inequality seems to enhance economic growth whereas while the level is less than the threshold value, the reduction in inequality appears to retard economic growth. The inclusion of the threshold specification appears to characterize the nonlinear relationship adequately and thus seems to capture the nature of nonlinearity.

Key words: Economic growth; Income inequality; Nonlinearity; Threshold value; Flexible inference

JEL classification: C11; C23; O11; O15

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1 Introduction

How income inequality is related to long-run economic growth is an important topic and given the recent increases in the level of inequality, understanding the causes and consequences of income inequality and investigating its effect on economic growth deserve valuable and deep research agenda. In fact, there have been many studies on the relationship between inequality and economic growth but the relationship has not been addressed clearly yet. On the one hand, inequality has a positive effect on growth through incentives, saving rates, or investment indivisibilities mechanism (Li & Zhou 1998, Forbes 2000, Lundberg & Squire 2003, etc). On the other hand, , there is a negative association of inequality with growth from the fiscal redistribution and distortion, sociopolitical instability, imperfect credit markets, and/or fertility differentials channels based on endogenous growth model (Alesina & Rodrik 1994, Persson & Tabellini 1994, Wan, Lu & Chen 2006, Sukiassyan 2007, etc).

Several literature has tried to reconcile the conflicting evidence on the inequality-growth linkage in the context of nonlinearity. Galor (2000), and Galor & Moav (2004) show that the relationship between inequality and growth is nonlinear according to economic development. Bandyopadhyay & Basu (2005) state that the long-run inequality-growth correlation depends crucially on the extent of barriers to knowledge spillovers, the skill intensity in technology, and the degree of income redistribution. From this point of view, a positive association between inequality and growth is expected in the industrial countries while a negative correlation emerges for the non-industrial countries. Barro (2000) shows that inequality appears to encourage growth in rich economies and to slow it down in poor ones. Banerjee and Duflo (2003) document an inverted-U relationship between inequality & growth in that higher inequality enhances growth in more equal societies but reduces growth in less equal ones. Lin et al. (2009) try to 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 find a threshold effect of inequality on economic growth.

Although the literature has provided evidence in favor of nonlinear relationship on the inequality-growth linkage, all the empirical studies to date assume specific parametric models. In reality, however, we do not directly observe the relationship in the economy, so that there exists an unbounded universe of possible alternative nonlinear specifications. We realize that it is valuable to investigate the nature of any nonlinearities in the inequality-growth linkage while avoiding specific parametric assumptions.

The purpose of this paper is to revisit and examine the nonlinear relationship between inequality and economic growth and if the nonlinear relation exists, we try to address what the nonlinear function looks like and what the nature of nonlinearity is. To this end, we employ the methodology of the flexible inference for the unknown functional relation which has been 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 model, the nonlinear functional relation is common across countries and over time and 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 third being an idiosyncratic shock. The estimation results confirm the claim that the relationship between income inequality and economic growth is nonlinear: at the higher level of inequality, the improvement in inequality appears not to have significant effect on the growth whereas at the lower level of inequality, further reduction in income inequality is clearly harmful for economic growth. The alternative specifications with nonlinear flexible inference confirm the threshold level of inequality.

The structure of this paper is as follows. In section 2, we review the literature on the relationship between income inequality and economic growth in terms of theoretical and empirical analysis. 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 presented in Section 4. Concluding remarks are offered in Section 5.

2 Literature Review

In terms of existing literature, the relationship between income inequality and growth can be summarized as three cases. First of all, 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 human and physical capital. Alesina and Rodrik (1994), Persson and Tabellini (1994), and Benabou (1996) argue that inequality creates political pressure to redistribute resources from the rich to the poor, resulting in discouraging investment and work effort. Alesina and Perotti (1996) describe that that inequality induces the poor to engage in crime and antisocial activities and thus the participation of the poor in crime and disruptive activities divert resources away from productive activities. Easterly (2007) shows that inequality has an adverse effect on economic growth and development by using agricultural endowments—in particular, the abundance of land suitable for growing wheat relative to that suitable for growing sugarcane—as an instrument for inequality. Galor, Moav, and Vollrath (2009) find using state-level data from the U.S.A. that inequality has a negative impact on human capital formation, resulting in an adverse effect on economic growth.

Secondly, there is a positive relationship between inequality and growth. Kaldor (1955) and Kalecki (1971) state that inequality is conductive to saving and capital accumulation. Bhattacharya (1998) argues that bequests of capitalists could mitigate credit market frictions and thereby promoting financial market efficiency and capital accumulation while it increases inequality. In the political economy model of Saint-Paul and Verdier (1993), inequality is beneficial for economic growth 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 they engage in innovation and risk-taking, resulting in higher economic growth. Alesina and Rodrik (1994) show ,by employing fixed-effects and random-effect estimators, that their model based on the division of public expenditure into productive and consumptive services and the incorporation of them 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 period 1966–1995 that higher income inequality in a country results in subsequent economic growth in the short and medium term.

Thirdly, another existing literature emphasizes nonlinear relationship between inequality and growth. In this line of literature, inequality affects growth differently in various stages of economic development. Bandyopadhyay and Basu (2005) show in a general equilibrium growth model that a positive inequality-growth correlation arises in economies with low barriers to knowledge spillover, high skill intensity in the technology, and high degree of redistribution whereas economies with the opposite characteristics should display a negative inequality-growth relationship. Barro (2000) finds that inequality and growth have a nonlinear relationship in which inequality appears to promote growth in rich countries but retard growth at 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) show that while the effect of inequality on growth is significantly negative at lower levels of developments, this effect diminishes along the growth process and then 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 and show that greater income inequality in low-income countries boosters transitional growth, whereas inequality has a significant negative effect on transitional growth in high-income countries. Hailemariam and Dzhumashev (2019) point out that modern theories that explain the effect of inequality on growth can be directly linked to the differences across countries in terms of political structure and economic policies. They show that after accounting for heterogeneity, the nonlinear growth effect of income inequality remains statistically and economically significant and find a threshold effect of inequality on economic growth.

In terms of existing literature, we consider that the contrasts in empirical findings may be related to the linear and nonlinear specifications and if nonlinear specification would be desirable, it is important to address what nonlinear function looks like and what the nature of nonlinearity is. In addition, since generally it takes time for inequality to affect growth, a consideration of time is important for investigating the relationship between inequality and growth. From this point of view, a dynamic model might be more desirable than a contemporaneous analysis. To incorporate the dynamic relationship, we consider five years average as a period in the dynamic panel model.

3 Nonlinear flexible model

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

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

where y_{it} is a scalar-dependent variable at time t for country i,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 $\mathbf{x}_{i\tau}$ for $i = 1, 2, ..., N$ and $\tau = t, t-1, ..., 1$. This specification considers the nonlinear relation over the group as well as 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, $\mu_i(x_{it})$, is written as

$$\mu_i(\mathbf{x}_{it}) = \alpha_0 + \alpha'_{i1}\mathbf{x}_{it} + \lambda_i m(\mathbf{g}_i \odot \mathbf{x}_{it}), i = 1, 2, ..., N, \tag{2}$$

where $m(\cdot)$ denotes the realization of a scalar-Valued Gaussian random field with mean zero and unit variance, $\alpha_0, \alpha'_{i1}, \lambda_i$, and $\mathbf{g}_i$ are population parameters to be estimated. $\mathbf{g}_i = (g_{i1}, g_{i2}, ..., g_{ik})'$ and $\odot$ indicates element-by-element multiplication. λ_i^2 governs the overall importance of the nonlinear component, and $\mathbf{g}_i$ governs the variability of the nonlinear component with respect to each explanatory variable. Following Kim (2012) for the examination of the nonlinear relationship between oil price change and business cycle 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:

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

where, ω_i is an individual specific variable, a_t a time-specific variable and v_{it} is the remainder. $\omega_i' s, a_t' s$, and $v_{it}' s$ are random, have zero means, have variance $\sigma_\omega^2, \sigma_a^2$, and σ_v^2 and are independent of each other. That is, it is assumed that $E\omega_i = Ea_t = Ev_{it} = 0$, $E\omega_i\omega_j = 0$ for $i \neq j$, $Ea_t a_s = 0$ for $t \neq s$, $Ev_{it}v_{js} = \sigma_v^2$ for $i = j, t = s$, and zero otherwise, $E\omega_i a_t = E\omega_i v_{it} = Ea_t v_{it} = 0$. In addition $\mathbf{x}_{i\tau}$ is independent of ω_i, a_t, and v_{it} for all i and $\tau \leq t$, assuming that the regressor x_{it} is strictly exogenous and x_{it} and ε_{it} are independent of the realization of the random field $m(\cdot)$ in equation (3.2).

For simplicity, we further assume that the slopes in the linear component in equation (2) are homogenous among diferent individuals, and λ_i and $\mathbf{g}_i$ are not specific to cross-section units. In general, allowing nonlinear parameters to be country-specific (heterogenous nonlinear components), may be useful for considering the panel heterogeneity issue in the application of our method to various economic application. However, the homogenous assumption for nonlinear parameters over different countires would make one 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 equation (2) in the panel can be rewritten

$$y_{it} = \alpha_0 + \alpha_1' x_{it} + \lambda m(\mathbf{g} \odot \mathbf{x}_{it}) + \varepsilon_{it}, \tag{4}$$

$$\varepsilon_{it} = \omega_i + a_t + v_{it}, \tag{5}$$

$$\mu(\mathbf{x}_{it}) = \alpha_0 + \alpha_1' \mathbf{x}_{it} + \lambda m(\mathbf{g}_i \odot \mathbf{x}_{it}), i = 1, 2, ..., N, t = 1, ..., T. \tag{6}$$

The basic idea of the flexible nonlinear inference is that nonlinearity implies the value for

$\mu(\mathbf{x}_{is})$ and $\mu(\mathbf{x}_{jt}), i, j = 1, ..., N,\ t, s = 1, ..., T$, will be positively correlated for countrys i and j, and periods t and s whenever the vectors $\mathbf{x}_{is}$ and $\mathbf{x}_{jt}$ are close to each other. The key is then parameterizing this correlation based on the distance measure $h_{is,jt} = (1/2)\{[\mathbf{g} \odot (\mathbf{x}_{is} - \mathbf{x}_{jt})]'[g \odot (\mathbf{x}_{is} - \mathbf{x}_{jt})]\}^{1/2},\ i, j = 1, ..., N,\ t, s = 1, ..., T$. Hamilton (2001) proposes that $\mu(\mathbf{x}_{is})$ should be uncorrelated with $\mu(\mathbf{x}_{jt})$ if $\mathbf{x}_{is}$is sufficiently far away from $\mathbf{x}_{jt}$. Kim (2012) develops the Lagrange multiplier test of the null hypothesis that $\lambda = 0$ conditional on $\sigma^2 = (\sigma^2_\omega, \sigma^2_a, \sigma^2_v)'$, 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. In our application, y_{it} is an economic growth at the time t in the country i and $\mathbf{x}_{it} = (x_{it-1}, x_{it-2}, ..., x_{it-p})'$ are the lagged log value of Gini coefficients for $t-1, t-2, ..., t-p$ in the country i.

4 Empirical results

4.1 Data

As pointed out in Atkinson and Brandolini (215) and Hailemariam and Dzhumashev (2019), the data availability on income inequality is a serious issue due to sparse coverage, measurement errors and limited comparability, etc. Nevertheless, many studies use the Luxembourg Income Study (LIS) data base or the World Income Inequality Database (WIID). Solt (2016) develops a new and improved dataset which is the Standardized World Income Inequality Database (SWIID) that combines the strengths of the LIS and WIID datasets. Hailemariam and Dzhumashev (2019) state that The SWIID dataset utilizes all the available data with full geographic and population coverage, and 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. The data on real GDP and population is from Penn World Table (PWT 8.0). We construct a panel data set of 77 countries from the period 1982 –2011 based on the data availability and the number of observation is 2156.

Economic growth (y_{it}) is the log difference of the real GDP per capita for each country and the income inequality (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 use 5-year average data. The 5-year average for economic growth may filter out business cycle fluctuations. In addition, Since 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 noisy effect.

4.2 Linear error component model

We begin with the cross-sectional analysis where we calculate the mean of the each coutnry for inequality and growth over 30 years. Figure 1 plots the relationship between Gini coefficient and economic growth. The linear fitted line is negative, implying that the relationship between inequality and growth is negative and thus lower inequality may be related to higher economic growth.

When $\lambda = 0$, the model of equations (4), (5) and (6) is a two-way error component model as follows:

$$y_{it} = \alpha_0 + \alpha_1' x_{it} + \varepsilon_{it}, \tag{7}$$

$$\varepsilon_{it} = \omega_i + a_t + v_{it}, i = 1, 2, ..., N, t = 1, 2, ..., T. \tag{8}$$

The estimation result for equations (7) and (8) is follow as:

$$y_{it} = \underset{(0.031)}{-0.069} + \underset{(0.009)}{0.022} x_{it-1} + \underset{(0.041)}{0.367} y_{it-1}. \tag{9}$$

The coefficient on Gini coefficient (x_{it-1}) is positive and statistically significant at the 1% 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 21.19 ($p-vaule$: 0.000004) which for a $\chi^2(1)$ variable implies overwhelming rejection of the null hypothesis that the relation is linear in the panel.

4.3 Nonlinear flexible model

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

$$y_{it} = \underset{(0.086)}{-0.075} + \underset{(0.024)}{0.023} x_{it-1} + \underset{(0.041)}{0.349} y_{it-1} + \underset{(0.095)}{4.564} [\underset{(0.249)}{0.403} m(\underset{(3.873)}{3.236} x_{it-1}) + \widetilde{\omega}_i + \widetilde{a}_t + \widetilde{v}_{it}], \tag{10}$$

$$\widehat{\sigma}^2_\omega = 0.290, \widehat{\sigma}^2_a = 4.331, \widehat{\sigma}^2_v = 20.833,$$

where $\widetilde{\omega}_i \sim N(0,1)$,$\widetilde{a}_t \sim N(0,1)$, $\widetilde{v}_{it} \sim N(0,1)$ 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 equation (4) can be written as σ_v times ζ which is the ratio of the standard deviation of the nonlinear component $\lambda m(\mathbf{x})$ to that of the residual v and the estimate of ζ is 0.403. The estimated coefficient on $x_{it-1}$is positive but not statistically significant in the linear component. This indicates that as one considers nonlinear component into the relationship between inequality and growth, the positive relation appears to be weak. Although one would accept a hypothesis of linearity for the lag of inequality individually, collectively the nonlinear component makes a contribution (as evidenced by 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 x_{it-1} and evaluated the Bayesian posterior expectation of the optimal inference of the value of the unobserved function $\mu(x_{it})$.Figure 2 plots flexible inference on the effect of inequality in previous period on current period GDP growth along with 95% probability region. The region of dashed lines indicates the degree of confidence about 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 3.48. When the log of Gini coefficient is higher than this value,decreases in inequality for previous five years have almost no consequences for current five years GDP growth, whereas 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 as in Hailemariam and Dzhumashev (2019). Even though there is not simply a mechanical relation between inequality and output, we view the incentive and captial accumulation effect of inequality as an explanation of nonlinear inequality-growth relation. When inequality is sufficiently low, further decreases in inequality may be detrimental for economic incentive such as savings and capital accmulation, resulting in lower economic growth.

In order to confirm that the threshold specification in the relationship between inequality and growth is entire nature of nonlinearity, we consider and estimate following specification:

$$y_{it} = \alpha_0 + \alpha_1 \delta_I + \beta_1 x_{it-1} + \beta_2 \delta_I x_{it-1} + \gamma y_{it-1} + u_{it}, \tag{11}$$

$$\delta_I = \{ \begin{matrix} 1, & if x_{it-1} > 3.48 \\ 0, if x_{it-1} \leq 3.48 \end{matrix} \tag{12}$$

where δ_I is an indicator function for the threshold value. The estimated result of the threshold model for equations (11) and (12) is as follows:

$$y_{it} = \underset{(0.094)}{-0.273} + \underset{(0.117)}{0.315} \delta_I + \underset{(0.029)}{0.085} x_{it-1} - \underset{(0.034)}{0.092} \delta_I x_{it-1} + \underset{(0.041)}{0.353} y_{it-1}. \tag{13}$$

All estimated coefficients are statistically significant. The estimated coefficient on Gini Coefficient for relatively low inequality countries ($\delta_I \leq 3.48$) is 0.085 but that of Gini Coefficient for relatively high inequality countries ($\delta_I > 3.48$) is negative ($-0.007 = 0.085 - 0.092$). This result implies that there is an asymmetric relation between inequality and growth and decreases in inequality for relatively high inequality countries help promote economic growth whereas decreases in inequality for relatively low inequality countries are detrimental for economic growth. This result confirms the inverted U-shaped relationship between income inequality and growth as in Chen (2003) and Banerjee and Duflo (2003).

In order to examine the validity of the threshold model in equations (11) and (12), we perform the nonlinearity test and the test statistic is 0.445 and $p - value$ is 0.504, 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 for conflicting relationship between inequality and growth.

5 Concluding remarks

Existing studies on the inequality-growth nexus show conflicting results in which inequality is benefical for economic growth whereas inequality is detrimental for growth. Furthermore, several studies point out that the relation is nonlinear. Thus theoretical and empirical studies have been inconclusive about the effect of inequality on growth. This study re-examines the relationship between inequality and growth in the empirical aspect. For this end, we do not assume any parametric specification and try to infer functional relation from the data and evaluate the inference.

we find from the panel study of 77 countries for the period of 1982-2011 that income inequality has a nonlinear relationship with economic growth. There appears to be a threshold point in the log of Gini Coefficient whose estimated value is 3.48. Our nonlinear flexible inference suggests that in the countries with higher inequality than the value, decreases in inequality tend not to promote economic growth whereas in the countries with lower inequality than the value, decreases in inequality retard 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 are detrimental for economic growth. Thus, our estimation results provide an explanation for conflicting existing studies for the inequality-growth nexus. Unfortunately, we do not address why there is a threshold value in the inequality-growth nexus and how we explain the channel through which inequality has a non-monotonic effect on growth. We leave this structural question as a future research.

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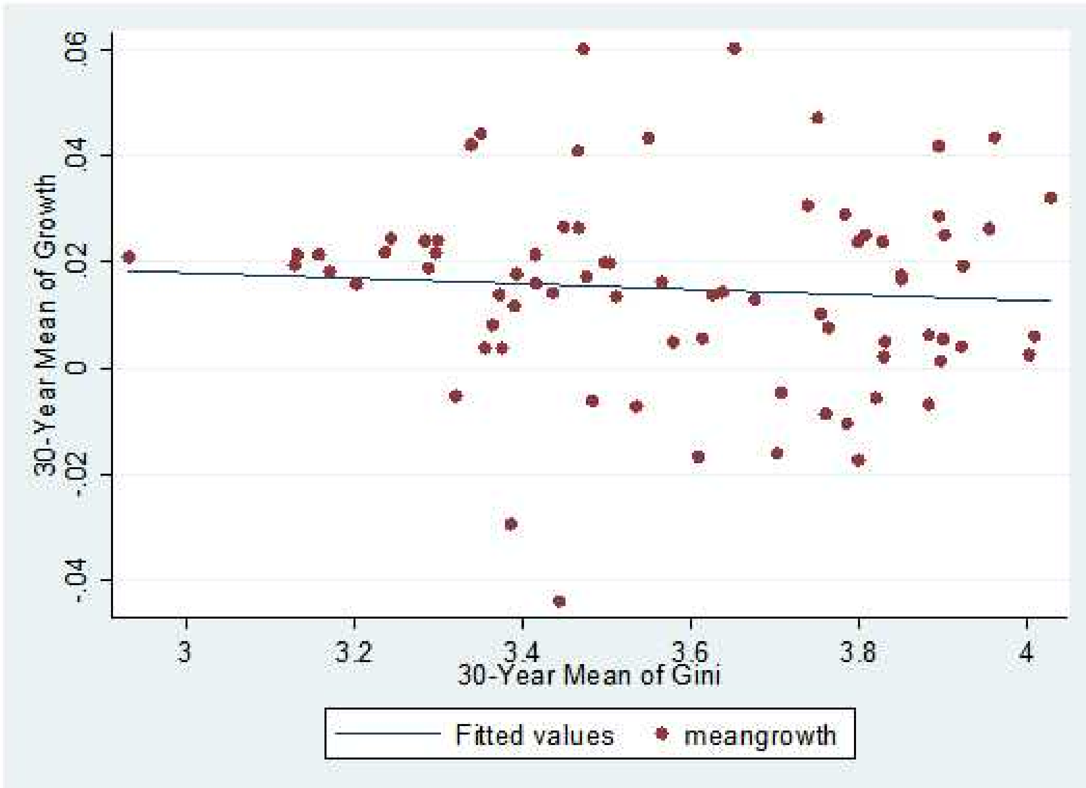
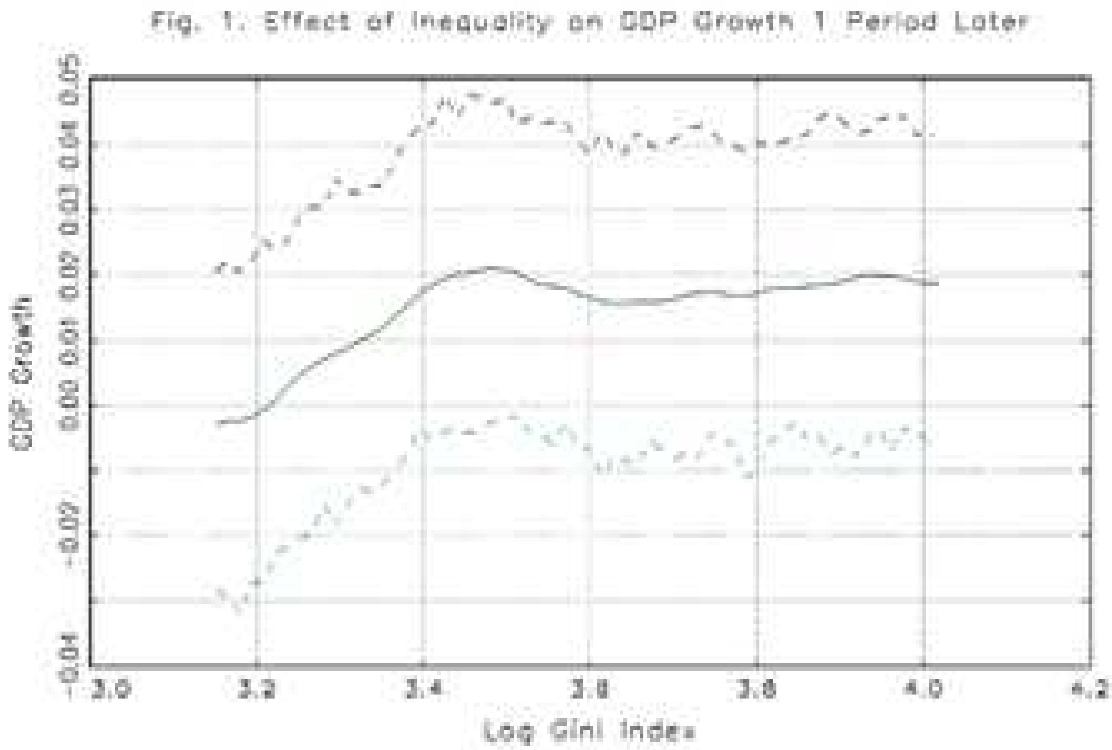


<Figure 1> The relationship between Income Inequality and economic growth: 30-years mean and cross-section data

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 - 2011. Solid line plots the regression estimate.



<Figure 2> Effect of income inequality on GDP growth 1 period later

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