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A Bayesian Approach to Inequality-Growth Relationship

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A Bayesian Approach to Inequality-Growth Relationship

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Abstract

For almost sixty years, economists debated and continues to debate on how income disparity affects economic growth making this an active area of research. The existing literature in inequality and growth relationship highlights that income inequality may be either positively or negatively associated to economic growth. In addition, several studies have also yielded inconclusive findings. In this study, using relevant inequality data for 56 countries for the time period 1999-2020 we explore the role of inequality on growth. First, we document important stylized facts between inequality and growth and then employ Bayesian Moving Average (BMA) method to investigate whether inequality matters in presence of all growth determinants. Our results indicate inequality *does* matter in the process of growth. Specifically, we find that inequality has an adverse impact on growth. The posterior inclusion probability of inequality equal to one across all models reaffirms the negative impact of inequality on growth. According to our estimation, one basis point increase in inequality has the potential to reduce growth by nearly four basis points.

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Our results withstand the robustness checks and also remain unchanged when we use an alternative dependent variable.

Keywords: Inequality, Economic Growth, Bayesian Moving Average

JEL Classification: 040, C5, 047, C6.

1 Introduction

Global economic inequality around the world today is primarily a consequence of the unequal progress of countries over the last two centuries. It is clear that certain countries achieved strong growth while others lagged, resulting in an increase in per capita income disparities over time.In the 1950s and 1960s, economists such as Nicholas Kaldor and Simon Kuznets contended that there is a trade-off between eliminating inequality and encouraging growth. During the postwar period, many East Asian economies had relatively low levels of inequality (for countries with comparable income levels) and grew at unprecedented rates. In stark contrast to this experience, many Latin American countries enjoyed substantially better levels of equality and expanded at a fraction of the typical East Asian rate. These patterns sparked renewed attention in the relationship between inequality and growth, particularly a rethinking of how a country's degree of income disparity predicts its future rate of economic growth. [1] The distribution of income varied greatly across countries, as did living conditions. This is due to changes in the income distribution among different groups (or classes) in society. The factorial distribution of income within an economy is a multifaceted notion that is well addressed in the existing literature.[2] Thus, understanding the effect of income inequality on economic growth still attracts attention as the there is no clear concensus on it making this an active area of research.

In this paper, we make an attempt to clarify the relationship between income inequality and economic growth from 1999 to 2020 for a set of 56 countries using Bayesian Model Averaging (BMA) method . We incorporate all relevant growth determinants available in this nexus to obtain the intended results. For this purpose, we will be using Bayesian Model Averaging (BMA) technique with Gini coefficient

[1]Pritchett (1997) presented the fact that growth rates for developed economies show convergence, but the growth rates between developed and developing economies show considerable divergence. Similarly, Chen and Ravallion (2010) found less evidence of poverty reduction across the globe and argued that there are important regional differences in the extent of world progress.

[2]See Lewis (1954), Kaldor (1957), Cline (1975), Knight (1976) and Bigsten (1983).

and GDP per capita (at constant 2015 US$) as variables of interest.[3] We used World Bank Database for countries for which the Gini index is available from 1999 to 2020 and the corresponding GDP per capita (constant 2015 US$).

The contributions of this paper include the fact that we are taking a global perspective by examining the relationship between income inequality and economic growth for a diverse set of 56 countries from 1999 to 2020. We are not restricting the analysis to a specific geographic region or any particular income group. Secondly, this paper incorporates a comprehensive range of potential determinants that could affect the relationship between income inequality and economic growth. We investigate how different growth-promoting factors influence the inequality-growth nexus, in contrast to previous studies that often focused on a limited set of growth. We also address the heterogeneity in the existing literature regarding the inclusion of different sets of explanatory variables in growth inequality relationship by employing appropriate method. Specifically we use the Bayesian Model Averaging (BMA) technique that allows for the consideration of model uncertainty and provides a more reliable identification of the key determinants affecting the relationship between income inequality and economic growth. This methodological approach and the exclusive data set contribute significant insights to the ongoing debate in the economic literature regarding the interplay between growth and inequality.

The impact of income inequality on economic growth have been the subject of interest and debate among economists for more than 60 years. The main question for this debate is does income inequality tend to improve, worsen or have no necessary effect on economic growth? This started with Kuznets (1954) inverted U-hypothesis, in which he argued that inequality tends to rise in a country's early stages of economic development and observed that it then appears to stabilize and decline as developed nations' economies continue to grow and mature giving rise

[3]We are using Gini coefficient in our study as it is a well tested and proved measure of income inequality, widely used in the exiting literature.The method is described in the estimation strategy section.

to what is now known as the Kuznets curve. However, this hypothesis was challenged in the existing literature for sample selection bias.[4] Later, based on different country groups and growth determinants, a number of studies reported that income inequality might be either positively or negatively related to economic growth. In addition, several studies have yielded inconclusive findings, with most reporting that the relationship is positive in high-income and negative in low-income countries. A few studies have also reported no significant relationship between inequality and growth.

Given such theoretical ambiguity, it is not surprising that empirical findings on the relationship between income disparity and economic growth continue to be contested. It is commonly believed that income inequality reduces economic growth across countries as it fuels social dissatisfaction and raises the threat of social political, and economic unrest in the country. This negative relationship has been confirmed by numerous empirical findings.[5] Evidence of a negative relationship has however been challenged by studies which reported positive results on the inequality-growth nexus. These results are operational in the light of various transmission mechanisms (or channels) linking income inequality to economic growth. These include, technological advancements, savings rate, institutions, fertility rate, imperfection of credit markets and investment climate (e.g., trade, FDI etc.).[6]

The existing literature explaining the positive relationship explains the channels through which distribution of income might affect the economic growth. For e.g, income inequality exerts a positive influence on economic growth through saving rate. As total income increases in the economy, so the savings of the people. In the

[4]Saith (1983), Ahluwalia (1976) and Fields (1991) argued that Kuznets (1955) did not hypothesize about the income of low developed countries (LDC), as a result the inverted U hypothesis does not work for LDCs. They showed that the relationship between income inequality and economic growth seem to be associated with the "patterns of growth" i.e., specific characteristics of a country such as social structure, political system, and natural resources. Hence, countries with similar characteristics exhibits a common inequality-growth relationship.

[5]See Alesina and Rodrik (1994), Persson and Tabellini (1994), Perotti (1996) and Panniza (2002).

[6]See Partridge (1997), Li and Zou (1998), Forbes (2000), Rangel et al. (2002) and Westhuizen (2008).

presence of high income inequality, rich people earn high incomes which help them to save more, thereby enhancing aggregate savings and economic growth in the long run.[7] However, the results of some channels can run in either direction i.e., positive or negative depending upon the country circumstances. For e.g., early stages of technological advancements favors technical skilled labors rather than unskilled labors. High income inequality will get soared due to creation of wage differential gap between skilled and unskilled workers in the economy, thereby increasing unemployment in the country.[8] On the other hand, as economy moves to the more mature stages of technological development, income inequality decreases, the reason being that as more labor shifts to the sector using new technology, the incomes of those who remained in the sector with old technology also increase due to the low supply in labor in that sector. Therefore, the wage differential gap between them declines, leading to a decrease in income inequality.[9]

The present literature also includes studies that seek to explain both the positive and negative relationships between inequality and growth. Halter et al. (2014) found that higher inequality helps economic performance in the short term but reduces economic growth in the long run. The growth-promoting effects arise in short run from purely economic mechanisms (convex saving functions, capital market imperfections, innovation and incentives). The growth-reducing effects in long run, involve the political process, the change of institutions, the rise of socio-political movements, or they operate through changes in the educational attainment of the population. Similarly, Voitchovsky (2005) found that inequality at the top end of the distribution is positively associated with growth, while inequality lower down the distribution is negatively related to subsequent growth. Although, there exists vibrant literature available explaining the link beyween inequality and growth yet there is no unanimity on the much debated issue. This creates a puzzle in our minds

[7]See Corneo and Jeanne (2001) and Peng (2008).
[8]See Krueger (1993) and Aghion et al. (1999).
[9]See Galor and Tsiddon (1997) and Helpman (1997).

related to the direction and magnitude of this relationship across countries.

The rest of the paper is organized as follows. Section II presents a full literature analysis covering all of the channels in this linkage. Section III describes our data and descriptive findings of the study. Section IV is covering the estimation technique used in the study. Section V presents our empirical results and inferences drawn. Section VI will be the conclusion and policy implications.

2 Literature Overview

This section explores five major types of mechanisms (or channels) through which income inequality can potentially affect economic growth of the country as documented in the existing literature. Namely the channels are saving rate, investment climate, technological development, institutions and fertility rate. We briefly discuss each of these channels below.

Saving Rate: The interpretation of gini coefficient in line with the theory of relative deprivation was first provided by Yitzhaki (1979). If relative deprivation exists in the society then the impact of deprivation resulting from not having X when others have it is an increasing function of the number of persons in the reference group who have X. This will increase saving rate in the economy. Corneo & Jeanne (2001) extended the basic endogenous growth model by assuming that individuals care about social status (their rank in the distribution of wealth) and their consumption. They argued that income inequality enhances economic growth because it makes it easier for everyone to ascend the wealth hierarchy and thereby improve one's social status. Similarly, Peng (2008) showed that when individuals are concerned with relative deprivation, they are willing to save extra amounts in order to lessen the extent of relative deprivation. This fuels up savings in the growth process.

Investment Climate: Trade liberalization and foreign investments are likely to have conflicting effects on the distribution of earnings in less developed countries. Due to the insufficient human capital foundation prevalent in nations, external operations distort the labor market structure and creates wage differential gap between educated and uneducated workers. Income inequality is inversely associated with economic growth through imperfect credit markets as it restricts poor from accessing credit thereby reducing investing opportunities in the economy.[10] Lundberg and Squire (2003) reveal that increasing the Sachs-Warner index, particularly the test for trade openness to promote growth, would lead to greater inequality. Similarly, Rehme (2007) showed that in the presence of high income inequality, there are differences in human capital (or education levels) across countries that hinder growth process. Evans and Timberlake (1980) argue that high levels of income disparity in less developed countries have been ascribed to the penetration of their economies by investments from multinational corporations based in advanced economies. They find a positive relationship between investment dependence and inequality in poor countries. To the contrary, Edwards (1997) states that for developing countries, there is no clear evidence linking openness or trade liberalization to the increase in inequality.

Technological Development: Aghion et al. (1999) noted that technical change is a key component in explaining the increase in wage inequality in the economy. They contended that technological development has a nonlinear impact on earnings inequality. In the event of disembodied technical change, the introduction of a new 'General Purpose Technology' (GPT) raises the skill premium. Similarly, in the case of embodied technological development, the introduction of a GPT would initially increase knowledge transferability (due to the generality of current cutting-edge technology). Krueger (1993) also showed how technical advancements can be detrimental to growth due to concerns about increasing inequality and unemployment as the wage gap between skilled and unskilled workers widens. On the other hand,

[10] Aghion et al. (1999) argued that inequality has a direct negative effect on growth as it reduces investment opportunities, worsens borrower's incentives and generates macroeconomic volatility.

Helpman (1997) and Galor and Tsiddon (1997) suggested that income inequality will decline at later stages of technological development, as both wage and skill gaps will get reduced after the phase of learning externalities gets over.[11]

Institutions: High economic disparity provides a fertile environment for bad or exploitative institutions. Political decisions are often biassed towards enriching the already wealthy minority at the expense of the poor. This leads to ineffective policies, a waste of state resources, social dissatisfaction, and political instability. It exacerbates inequality and slows growth in the long run.[12] Countries with institution-driven growth and re-distributive policies, on the other hand, may have lower income disparities.[13] Persson and Tabellini (1994) found that income inequality is harmful for growth, because it leads to policies that do not protect property rights and do not allow full private appropriation of returns from investment. Similarly, Zagha (2013) argued that inequality could be significantly reduced through institutional reforms that reduce the cost of the transfer system, increase the role of markets in resource allocation, expand infrastructure investments, and improve the delivery of education and health care to marginalised populations.

Fertility Rate: The low-income demographic has more children than the high-income group. They also make fewer educational investments for their children due to a lack of funds. Thus, significant income inequality produces disparities in human capital across the economy, impeding the growth process. Gottschalk (1997) shows that the relative wages of better-educated and experienced workers grew significantly across countries. The relative price of expertise climbed dramatically, as did the relative skill intensity. The rise in the price of skill is caused by both an increase in the real wages paid to more skilled workers and a steep drop in the absolute real

[11]Learning externalities restrict an economy to adopt exponential technologies and grow further because it requires learning of human capital to operate these technologies. In the initial phases of growth, it is better to adopt existing technologies instead of large investments in innovative technologies.

[12]See Acemoglu et al. (2002) colonialism of Europeans based on mortality and setting up of extractive institutions.

[13]See Rodrik (2005) on importance of good quality institutions for sustaining economic growth in the long run.

earnings paid to less competent workers. Changes in employment markets resulted in changes in family income distribution. The changes in family income distribution had a direct impact on poverty rates. Fishman and Simhon (2002) suggested that in extremely unequal societies, there is a vicious cycle of poverty caused by a lack of specialisation, low productivity, and low wages.

The next section briefly explains the data-set, variables and source of data.

3 Data

The World Development Indicators (WDI) database provided information on the Gini coefficient for 56 countries for the time period 1999 - 2020. Data on GDP (constant 2015 US$), GDP per capita (constant 2015 US$), and growth determinants (or control variables) have also been compiled.[14] Using GDP per capita series, the average annual growth rate from 1999 to 2020 is computed.

In Table 1 and 2, we look at the income share of countries in 1999 and compare it with 2020. We find that share of the bottom 10 countries has not increased largely from 1999 to 2020 i.e., from 1.58% to 2.44%. Over the years, the share has not even climbed to 5% of the total income of countries in our sample. The share of income of top 10 countries also remained more or less constant i.e., 50.8% in 1999 and 48.4% in 2020. In the list of the top 10 countries UK is replaced by Finland in 2020. On the other hand, El Salvador and Ecuador joins the bottom 10 countries list in 2020 in place of China and Belarus in 1999.[15]

<Tables 1 & 2 here>

Tables 3 and 4 divide our GDP per capita data for 1999 and 2020 into ten equal portions (deciles), comparing the highest and lowest deciles. Between 1999 and 2020, the lowest decile's share increased by just 0.59% to 0.88%. Over time, the

[14] A list of all other variables used in the study is provided in the appendix section.

[15] The appendix section provides the income share of all country groups in 1999 and 2020 (based on the categorization of ten countries in each group).

income share of the lowest decile has not increased to even 1% of the total income of countries in our sample. Additionally, the highest decile's income share stayed relatively same, i.e., 35.5% in 1999 and 34% in 2020. In place of Iceland in 1999, Ireland enters in highest income decile in 2020. Georgia and Armenia, on the other hand, move up from the lowest income decile in 1999 to the second lowest in 2020. This suggests that roughly every decile's income share stayed largely unchanged when we compare between 1999 and 2020.[16]

<Tables 3 & 4 here>

Tables 5 and 6 compare the top ten countries with the highest Gini coefficients between 1999 and 2020. We notice that every country remains the same in both years for the decile, except for 2020, when Costa Rica replaced El Salvador. In contrast, there are variations noted in the top ten nations with the lowest Gini coefficient. A number of European nations, including Finland, Norway, Sweden, the Netherlands, and Austria, were unable to maintain their positions in the lowest group with respect to Gini coefficients in 2020 as compared to 1999. In 2020, Belarus, Belgium, Ukraine, and Armenia joined the group. These tables indicate that between 1999 and 2020, both income shares and the Gini coefficient stayed roughly constant across countries, showing that inequality did not significantly diminish across economies.

< Tables 5 & 6 here>

Figure 1 shows that countries with initial low income registers higher growth while high initial income leads to growth of countries at a slower rate. This confirms with the Neoclassical Solow model finding that countries with lower initial income are expected to grow at a faster rate. Figure 2 plots the average GDP per capita growth rate for the group of countries against the initial Gini coefficient of 1999-2000. Apparently it seems that inequality does not have any relationship with the

[16]The appendix section provides the income share of all country groups in 1999 and 2020 (based on the deciles).

average GDP per capita growth rate. Finally, figure 3 checks that if there is any significant change in terms of inequality between 1999-00 and 2000-20. One would expect that countries which experienced a drop in Gini coefficient would lie below 45-degree line in a space where 1999 and 2020 Gini coefficients are plotted in in x-axis and y-axis respectively. In our case we notice that the opposite has happened in most of the countries in our data-set. A large group of countries are actually located above the 45-degree line, including advanced economies, indicating an increase in degree of inequality over time. Thus, it becomes more interesting to investigate the role of inequality in the process of economic growth in the recent past.

4 Estimation Strategy

In econometric analysis, regression coefficients 'β' reflect inferences or predictions about true population parameters 'ϑ'. Bayes rule describes how the observed data update the prior beliefs for ϑ i.e., p(ϑ) to posterior beliefs i.e., p(ϑ|data). There can exist multiple hypotheses or models H_i that can describe a relationship between ϑ and the data. So, we first compute posterior model probability (PMP) i.e., p(H_i|data) which describes the plausibility of H_i after the data are observed. Thus, PMP chooses the best plausible model given the data (model selection). It is more appealing to select a specific model which dominates the distribution of PMP and reflects the best approximation of the actual situation. However, there is remaining uncertainty not only about parameters but also about the underlying true model. In this case, a Bayesian analysis allows one to take into account not only uncertainty about the parameters given a particular model but also uncertainty across all models combined. This is done via Bayesian Moving Average (BMA), in which one takes the combined distribution of a parameter, weighted by the respective PMPs of all candidate models.

From a Bayesian perspective, no model ever totally disappears, and thus no model completely dominates the relationship, just as no model is ever without a doubt the “true” model. Each model represents its own inferences and predictions for the outcome variable. However, if the probability of a single model is much larger than others then the average prediction is dominated by this model. But in PMP there always remains uncertainty about other small models. In this situation, the optimal prediction is obtained by averaging over the models rather than selecting only to the arbitrarily the largest model.

BMA takes into account all conceivable scenarios with probability that influence the outcome, and the estimate is obtained through the following equation:

$$p(t) = \sum_i p(t|H_i)p(H_i) \tag{1}$$

The BMA estimate is adjusted as new data becomes available, this information can be referred to collectively as “data”, and the BMA estimate becomes:

$$p(t|data) = \sum_i p(t|H_i, data)p(H_i|data) \tag{2}$$

The essence of the BMA approach is the ability to swiftly choose models, or more specifically sets of explanatory variables, which possess a high likelihood of affecting our outcome variable. By averaging across a large set of models one can determine those variables which are relevant to the data-generating process for a given set of priors used in the analysis. Each model (a set of variables) receives a weight and the final estimates are constructed as a weighted average of the parameter estimates from each of the models. BMA includes all of the variables within the analysis, but shrinks the impact of certain variables towards zero through the model weights. These weights are the key feature for estimation via BMA and will depend upon a number of key features of the averaging exercise including the choice of prior specified. The implementation of BMA, which was first proposed by Leamer (1978), for linear regression models. Consider a linear regression model with a constant term, β_0, and k potential explanatory variables $x_1, x_2, ...x_k$

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + \varepsilon \tag{3}$$

Given the number of regressors, we will have 2^k different combinations of right-hand side variables indexed by H_i for $i = 1, 2, 3, ...k^k$. Once the model space has been constructed, the posterior distribution for any coefficient of interest, say β_h, given the data is:

$$p(\beta_h|data) = \sum_i p(\beta_h|H_i, data)p(H_i|data) \tag{4}$$

BMA uses each model's posterior probability, $p(H_i|data)$ as weights. The posterior model probability of H_i is the ratio of its marginal likelihood to the sum of marginal likelihoods over the entire model space and is given by:

$$p(H_i|data) = p(data|H_i)p(H_i)/\sum_i p(data|H_i)p(H_i) \tag{5}$$

where,

$p(data|H_i) = \int p(data|\beta_i, H_i)p(\beta_i|H_i)d\beta$ and β_i is the vector of parameters from model $H_i, P(\beta_i|H_i)$ is a prior probability distribution assigned to the parameters of model H_i, and $P(H_i)$ is the prior probability that H_i is the true model. The estimated posterior means and standard deviations of $\hat{\beta} = (\hat{\beta}_0, \hat{\beta}_1, \ldots, \hat{\beta}_k)$ are then constructed as:

$$E[\beta|\widehat{data]} = \sum_i p(H_i|data) \tag{6}$$

$$Var[(\hat{\beta})|data] \hat{=} \sum_i (var[\hat{\beta}|data, H_i] + \hat{\beta^2})(H_i|data) - E[\beta|\hat{data}]^2 \tag{7}$$

BMA is particularly useful when the goal is prediction or parameter estimation in the light of multiple competing models. BMA is less useful when a single model dominates all others, or when the goal is to quantify evidence for a set of candidate models. It provides information about estimated coefficients and their standard errors (mean and standard deviation of the posterior distribution), t-ratios, posterior inclusion probabilities (the posterior probability that a variable is included in the model), and one-standard error bands. Estimation results for the focus and the auxiliary parameters are displayed in the upper and the lower panels of the results produced by STATA package. An auxiliary regressor is considered to be robustly correlated with the outcome if the t ratio on its coefficient is greater than one in absolute value or, equivalently, the corresponding one-standard error band does not include zero. Alternatively, robustness of the auxiliary regressors can be judged on the basis of their posterior inclusion probabilities. Posterior inclusion probability of 0.5 corresponds approximately to a t ratio of one in absolute value (Raftery, 1995 and Masanjala and Papageorgiou, 2008).[17]

[17]BMA can support only a limited number of auxiliary regressors. Suppose k_1 is the set of focus regressors and k_2 are auxiliary regressors. When k_2 is large, the most binding constraint is expected to be computing time. The time needed for fitting the model with $k_2 = 30$ was 157 hours (6 days and 13 hours) (dataset analyzed by Sala i-Martin, Doppelhofer, and Miller (2004), Ley and Steel (2007), and Magnus, Powell, and Prufer (2010), which includes 67 determinants of the average GDP growth rate per capita of 88 countries from 1960–1996). But in our study, we are working

5 Results

In this section, we discuss the results of BMA regressions which are reported in tables 7 and 8. These tables provide the estimated coefficients (β) and posterior inclusion probabilities (pip) for 14 different regression models covering the period from 1999 to 2020 across 57 countries. The figures highlighted in bold indicate that the corresponding variables are included in the main regression. Otherwise, they have been part of the auxiliary regression. For instance, in Model 1, only the constant is included in the main regression while all other variables are part of auxiliary regression. Similarly, in Model 2, the constant and unemployment variable (unemp) are included in the main regression, while the others are in auxiliary part. Finally in the last model i.e., Model 14, gini coefficient (gini) is the only variable left in the auxiliary part and rest all control variables are included in the main regression. This exercise was performed to assess how income inequality affects economic growth throughout different combinations of control variables included in the main regression. In other words, the probability of including of gini variable into the main regression is examined across all 14 regression models. In Tables 7 and 8, we are investigating the impact of income inequality (measured by the Gini coefficient) on two dependent variables: annual GDP per capita growth rate (agdppcgr) and annual GDP growth rate (agdpgr), respectively. Additionally, we conducted robustness checks by comparing the results of Bayesian Model Averaging (BMA) regressions with simple Ordinary Least Squares (OLS) regressions. We report the results in Appendix A.3. Sensitivity analyses is also conducted by replacing one of our explanatory variable i.e., government expenditure on education as a percentage of GDP (geegdp), with government expenditure on education as a percentage of total expenditure (geetge), as presented in Appendices A.4 and A.5. Our primary results remain unchanged.

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with 15 growth determinants (or control variables), as a result computational time is relatively less. We are utilizing this econometric technique to solve the puzzle of the inequality-growth nexus which involves various channels affecting this relationship.

<Tables 7 & 8 here>

Table 7 demonstrates that the relationship between income inequality (Gini coefficient) and the annual GDP per capita growth rate (agdppcgr) using 1231 observations and employing the Bayesian Moving Average (BMA) technique. Our primary results indicate that inequality is consistently turning out to be negative across all regression models. The posterior inclusion probabilities (pip values) associated with these coefficients exceed 0.5 (approximately equivalent to a t ratio of one in absolute value), indicating that the Gini coefficient significantly influences per capita economic growth. The negative sign of Gini coefficient along with statistical significance clearly indicates that inquality is detrimental for growth. The pip values for the Gini coefficient range from 0.72 to 0.92 across all 14 models, indicating a high degree of inclusion of the Gini coefficient in the main regression model. The range of estimated coefficients of Gini lies between -0.061 to -0.041. These results imply that (for e.g., in model 1) as the value of Gini coefficient increases by 1 basis point the per capita growth rate of an economy can get reduced by 6 basis points. In Table 8, a similar pattern emerges where the Gini coefficient exhibits a negative and statistically significant impact on the annual GDP growth rate. The range of pip values falls between 0.77 and 0.72 in regression models. Similarly, the estimated coefficients of Gini in table 7 ranges from -0.041 to -0.061. These results imply that (for e.g., in model 1) as the value of Gini coefficient increases by 0.01 the growth rate of an economy is reduced by 0.041.

Variables such as government's share of final consumption, inflation, number of mobile phones and unemployment turn out to be highly significant and negative in more than half of the models (Column 6 - Column 13).Thus these variables affect the annual GDP growth and per capita GDP growth rate adversely. Apart from number of mobile phones rest of the other variables are of expected sign. For instance in model 13 of Table 7, the estimated coefficient of these variables are -0.202, -0.014, -0.007 and -0.079 respectively. On the other hand, variable such as number of hospital beds, internet penetration, life expectancy, mineral rent, natural gas rent, oil rent, population, and trade have a positive and statistically significant impact on annual GDP growth and per capita GDP growth (Column 6 - Column 13). Again in model 13 of Table 7, the estimated coefficient of these variables are 0.272, 0.027, 0.004, 0.051, 0.174, 0.024, 0.117 and 0.008 respectively. These results are consistent with Evans and Timberlake (1980) and Lundberg and Squire (2003). Finally, in column (14) inequality is included in the regression. Our results indicate that inequality enters the regression with posterior inclusion probability of 1. It confirms the fact that inequality cannot be ignored in the growth regressions and the negative direction of the inequality variable implies that higher inequality is significantly associated with lower growth. coefficients of all variables including that of inequality are all seemingly consistent. The sign of the coefficients are also equally stable. Comparing these findings to those of Ordinary Least Squares (OLS) regressions (please refer to Table A.3 in Appendix), we observe that the Gini coefficient maintains its negative and significant effect on both outcome variables. For example in model 1 of Table A.3, if the value of Gini coefficient increases by 1 basis point the per capita growth rate of an economy is reduced by 5 basis points. The results are on similar lines. However in BMA we left the model selection to the estimation procedure itself . It did all possible permutations and combinations to conclude that inequality is an important and significant determinant of growth and the relation ship between inequality and growth is inversely related.

In Table 8 we conduct the same exercise but we replace our dependent variable per capita GDP growth by GDP growth rate. In all occasions our measure of inequality has negative sign and posterior inclusion probability (pip) with greater than 0.5. Specifically the value of pip for inequality varies from 0.71 to 0.81. Like previous the negative sign of the inequality retains the inverse relationship with GDP growth. The absolute value of the coefficient of the inequality ranges from 0.035 to 0.042. The magnitude of the coefficient drops but the essence of our results hold true. For all the possible cases the pip value greater than 0.5 implies that inequality is an important and significant variable which needs to be included for analysis. The negative sign and the magnitude of the coefficient hints one basis point increase in the inequality has the potential to reduce the GDP growth by nearly 4 basis points. The BMA method kept on adding one variable at a time in the main regression while keeping others in the auxiliary equation. Our measure of health infrastructure of the country (number of hospital beds per thousand) has positive coefficient with pip value one at the end. This signifies the importance of health infrastructure in enhancing growth of an economy. The digital infrastructure captured by the internet connection has the predicted value with pip vale of one in all occasions. Needless to mention that that digital infrastructure has become an integral part of the economic growth. The oil rent and natural gas variables remain positive and ends up with pip value of 1 in table 8. The coefficient of natural gas and oil rent is 0.163 and 0.085 respectively in the last column of table 8. This clearly indicates that despite all other relevant variables present in the model natural resource continues to influence economic growth significantly. The population and trade variables have positive coefficient and pip value of fourth and third column respectively. This signifies the importance of both of these variables in the context of growth. The coefficient of trade variable ranges from 0.010 (with pip value of 1) in column 3 to 0.012 (with pip value of 1) in column 14. Similarly the coefficient of the population 0.087 (with pip value of 1) in column 4 of table 8 to 0.092 (with pip value of 1) in column 14. The results resembles the findings of the table 7.

On the other hand it turns out that government's share of final consumption remains consistently negative with pip value of one in table 8. It is echoing the similar result we obtained for the government's share of final consumption in table 7. The magnitude of the coefficient marginally drops but the negative value of the coefficient with pip vale of one signifies a negative impact of government's share of final consumption on growth. The inflation rate retains its negative sign through out the table and gains the pip value of one from column 10 onward.This is a similar picture for inflation as in table 7. In table 8 the inflation rate finally ends up with a coefficient of -0.008 and pip value of one. In table 7 it ended up with coefficient of -0.014 and pip value of one. These results of inflation rate reconfirms the fact that higher inflation rate reduces the economic growth. Finally the unemployment rate reflects expected negative sign in both tables. In both tables and in all cases the pip value is one. This reaffirms that the unemployment rate is one of the most important and significant variables in explaining growth of an economy. The negative sign of the coefficient confirms the fact that high unemployment rate is associated with lower growth or in other words unemployment and rate of economic growth shares an inverse relationship between each other. In terms of the magnitude of the coefficient - in table 7 it has a value of -0.079 and -0.141 in table 8. It is noted that the coefficient is almost doubled when we use GDP growth rate as dependent variable in our analysis.

Consequently, based on these results, we can infer that the primary finding of our analysis that income inequality exerts a negative and significant influence on a country's economic growth. Our inference is drawn after incorporating all relevant control variables that could influence this relationship in the regression models. Our findings are consistent with Panizza (2002), Peng (2008), and Persson and Tabellini (1994). The following section concludes.

6 Conclusion

The primary purpose of this research is to reassess the nature and relevance of the relationship between the inequality and growth. Since Kuznet's (1954) inverted U shaped relationship between inequality and growth came into existence, there has been interest in the dynamics of inequality and growth. The Kuznet curve worked well till 1980 for developed and developing economies but after 1980 the overall picture changed. The existing literature does not agree unanimously to the view that inequality affects the growth in an adverse way or has some advantageous effect in the process of growth. Or Does it matter at all? Thus, we still exactly do not know about the role of inequality on growth or the exact relationship between these to important macroeconomic variables. This gave us the scope to conduct this study in a more profound way by employing an econometric method that suits the purpose.

This study uses an advanced estimation technique not just to reduce measurement error, but also to control for time-invariant omitted variables through panel data set. Specifically, we use Bayesian Moving Average (BMA) method to decipher the much debated nexus between inequality and economic growth for a set of 56 countries for the time period 1999-2020. We acknowledge that although the data on inequality have improved significantly, measurement error may still be an issue, and while panel estimate accounts for time-invariant omitted variables, it does not account for omitted factors that change over time. We included the most commonly used variables which are used in the growth regressions. After including all the relevant variables to mitigate the problem of omitted variable bias we investigated the relevance of inequality. In other words, does inequality matter in terms of growth in the presence of the most relevant variables? Our Bayesian estimation results indicate a strong and negative impact of inequality on growth. We find that if the value of Gini coefficient increases by 1 basis point the per capita growth rate of an economy has the potential to reduce by 5 basis points.Our primary result is in alignment with studies conducted before which found the negative relationship between inequality and growth (please refer to literature review section). However, we claim that our results are more robust than previous studies as we estimated the effect using the BMA method in presence of other relevant variables. In all occasions the posterior inclusion probability of inequality is equal to 1. It implies that inequality is an important and significant variable that needs to be included in growth regressions.

It also signifies that inequality is a major variable that explains growth to certain extent. Our results are robust to sensitivity analysis (by using alternate dependent variables) and inclusion of other variables.

7 Figures and Tables

Figure 1 GDP per capita 1999 and average GDP per capita growth rate, 1999-2020

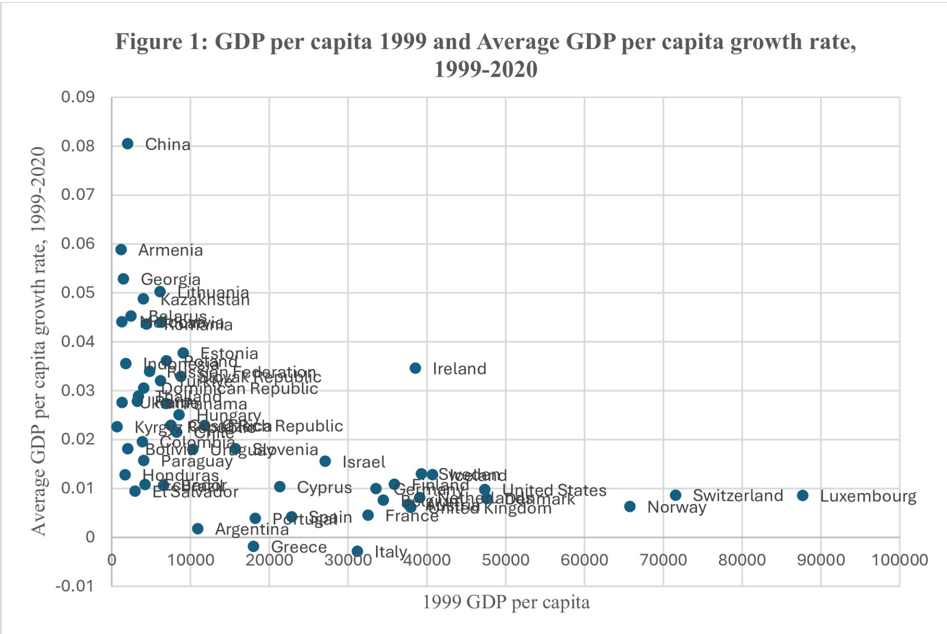

Figure 2 Gini coefficient 1999 and average GDP per capita growth rate, 1999-2020

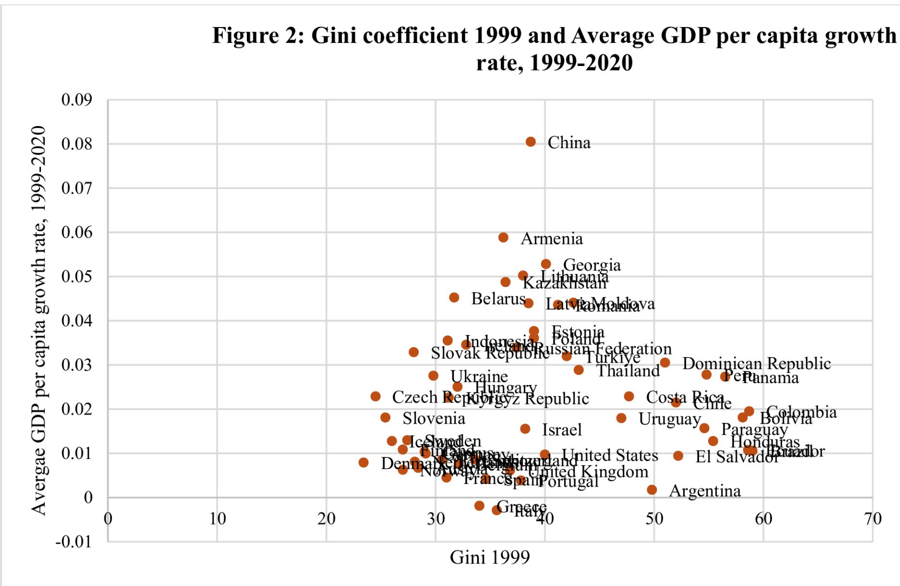

Figure 3 Gini coefficient 1999 and 2020

Figure 3: Gini 2020 vs Gini 1999

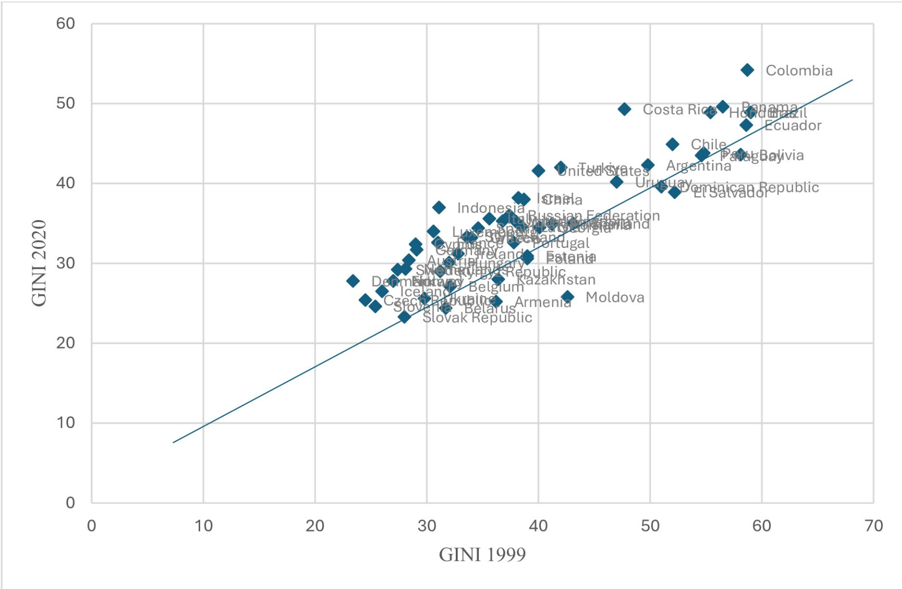

Table 1 Income share of top and bottom ten country groups in 1999

Countries	1999_GDP_pc	% Share_1999	Group
Luxembourg	87695.34	50.85%	Top 10 Countries
Switzerland	71583.69		
Norway	65768.99		
Denmark	47622.44		
United States	47360.54		
Iceland	40725.89		
Sweden	39309.60		
Netherlands	39106.39		
Ireland	38557.45		
United Kingdom	37975.10		
Belarus	2461.83	1.58%	Bottom 10 Countries
Bolivia	2048.03		
China	2038.20		
Indonesia	1804.71		
Honduras	1714.96		
Georgia	1508.66		
Ukraine	1327.57		
Moldova	1307.98		
Armenia	1210.36		
Kyrgyz Republic	689.42		

Table 2 Income share of top and bottom ten country groups in 2020

Countries	2020_GDP_pc	% Share_2020	Group
Luxembourg	104879.26	48.45%	Top 10 Countries
Switzerland	85685.29		
Ireland	78732.55		
Norway	75017.16		
United States	58060.31		
Denmark	56202.17		
Iceland	53188.04		
Sweden	51541.66		
Netherlands	46345.35		
Finland	45009.62		
Ecuador	5315.52	2.44%	Bottom 10 Countries
Georgia	4447.66		
Armenia	4021.05		
Indonesia	3757.12		
El Salvador	3632.45		
Moldova	3235.95		
Bolivia	2986.02		
Ukraine	2350.40		
Honduras	2239.01		
Kyrgyz Republic	1102.66		

Table 3 Income share of countries in highest and lowest deciles in 1999

Countries	1999_GDP_pc	% Share_1999	Group
Kyrgyz Republic	689.42	0.59	Lowest Decile
Armenia	1210.36		
Moldova	1307.98		
Ukraine	1327.57		
Georgia	1508.66		
Iceland	40725.89	35.57	Highest Decile
United States	47360.54		
Denmark	47622.44		
Norway	65768.99		
Switzerland	71583.69		
Luxembourg	87695.34		

Table 4 Income share of countries in highest and lowest deciles in 2020

Countries	2020_GDP_pc	% Share_2020	Group
Kyrgyz Republic	1102.66	0.88	Lowest Decile
Honduras	2239.01		
Ukraine	2350.40		
Bolivia	2986.02		
Moldova	3235.95		
Denmark	56202.17	33.93	Highest Decile
United States	58060.31		
Norway	75017.16		
Ireland	78732.55		
Switzerland	85685.29		
Luxembourg	104879.26		

Table 5 Countries with highest Gini coefficient in 1999 and 2020

Top 10 Countries	Gini coefficient (highest)	Year
Brazil	59	1999
Colombia	58.7	
Ecuador	58.6	
Bolivia	58.1	
Panama	56.5	
Honduras	55.4	
Peru	54.8	
Paraguay	54.6	
El Salvador	52.2	
Chile	52	
Colombia	54.2	2020
Panama	49.6	
Costa Rica	49.3	
Brazil	48.9	
Honduras	48.9	
Ecuador	47.3	
Chile	44.9	
Peru	43.8	
Bolivia	43.6	
Paraguay	43.5	

Table 6 Countries with lowest Gini coefficient in 1999 and 2020

Top 10 Countries	Gini coefficient (lowest)	Year
Denmark	23.4	1999
Czech Republic	24.5	
Slovenia	25.4	
Iceland	26	
Finland	27	
Norway	27	
Sweden	27.4	
Slovak Republic	28	
Netherlands	28.1	
Austria	28.4	
Slovak Republic	23.3	2020
Belarus	24.4	
Slovenia	24.6	
Armenia	25.2	
Czech Republic	25.4	
Ukraine	25.6	
Moldova	25.8	
Iceland	26.5	
Belgium	27.1	
Denmark	27.8	

Table 7 BMA results: relationship between Gini coefficient and per capita GDP growth rate, 1999-2020

Variables	Model (1)	Model (2)	Model (3)	Model (4)
gini	-0.061 (0.92)	-0.061 (0.92)	-0.054 (0.87)	-0.055 (0.89)
gfcgdp	-0.228 (1.00)	-0.226 (1.00)	-0.221 (1.00)	0.219 (1.00)
geegdp	-0.000 (0.08)	-0.000 (0.09)	-0.000 (0.08)	-0.000 (0.10)
hbed	0.248 (0.99)	0.255 (1.00)	0.252 (1.00)	0.242 (0.99)
intern	-0.038 (1.00)	-0.038 (1.00)	-0.038 (1.00)	-0.039 (1.00)
inf	-0.000 (0.06)	-0.000 (0.06)	-0.000 (0.06)	-0.000 (0.06)
lexp	-0.002 (0.05)	-0.001 (0.05)	-0.001 (0.05)	-0.001 (0.05)
mrent	0.001 (0.04)	0.001 (0.04)	0.002 (0.04)	0.001 (0.04)
mphone	-0.000 (0.08)	-0.000 (0.09)	-0.000 (0.09)	-0.000 (0.09)
ngrent	-0.000 (0.03)	-0.001 (0.03)	-0.000 (0.03)	-0.000 (0.03)
oilrent	0.000 (0.04)	0.000 (0.03)	0.000 (0.05)	0.000 (0.03)
log_pop	0.003 (0.05)	0.002 (0.04)	0.000 (0.05)	**0.089 (1.00)**
trade	0.004 (0.66)	0.004 (0.59)	**0.006 (1.00)**	**0.008 (1.00)**
unemp	-0.057 (0.72)	**-0.080 (1.00)**	**-0.076 (1.00)**	**-0.073 (1.00)**
constant	**9.404 (1.00)**	**9.591 (1.00)**	**8.956 (1.00)**	**7.500 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	16384	8192	4096	2048

Variables	Model (5)	Model (6)	Model (7)	Model (8)
gini	-0.057 (0.89)	-0.056 (0.89)	-0.056 (0.88)	-0.054 (0.87)
gfcgdp	-0.216 (1.00)	-0.214 (1.00)	-0.219 (1.00)	-0.214 (1.00)
geegdp	-0.000 (0.09)	-0.000 (0.10)	-0.000 (0.14)	-0.000 (0.13)
hbed	0.234 (0.99)	0.239 (0.99)	0.239 (0.99)	0.244 (0.99)
intern	-0.039 (1.00)	-0.039 (1.00)	-0.033 (1.00)	-0.032 (1.00)
inf	-0.000 (0.06)	-0.000 (0.06)	-0.000 (0.07)	-0.000 (0.07)
lexp	-0.001 (0.04)	-0.002 (0.05)	-0.002 (0.05)	-0.002 (0.05)
mrent	0.001 (0.04)	0.001 (0.04)	0.002 (0.04)	**0.060 (1.00)**
mphone	-0.000 (0.09)	-0.000 (0.09)	**-0.005 (1.00)**	**-0.006 (1.00)**
ngrent	-0.003 (0.03)	**-0.098 (1.00)**	**-0.088 (1.00)**	**-0.097 (1.00)**
oilrent	**0.021 (1.00)**	**0.032 (1.00)**	**0.030 (1.00)**	**0.029 (1.00)**
log_pop	**0.087 (1.00)**	**0.092 (1.00)**	**0.097 (1.00)**	**0.095 (1.00)**
trade	**0.008 (1.00)**	**0.008 (1.00)**	**0.008 (1.00)**	**0.008 (1.00)**
unemp	**-0.071 (1.00)**	**-0.073 (1.00)**	**-0.074 (1.00)**	**-0.075 (1.00)**
constant	**7.479 (1.00)**	**7.401 (1.00)**	**7.607 (1.00)**	**7.446 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	1024	512	256	128

Variables	Model (9)	Model (10)	Model (11)	Model (12)
gini	-0.058 (0.89)	-0.053 (0.85)	-0.053 (0.86)	-0.052 (0.86)
gfcgdp	-0.206 (1.00)	-0.207 (1.00)	-0.207 (1.00)	-0.207 (1.00)
geegdp	-0.000 (0.12)	-0.000 (0.13)	0.000 (0.13)	-0.000 (0.13)
hbed	0.222 (0.96)	0.250 (0.98)	0.249 (0.98)	**0.254 (1.00)**
intern	-0.028 (0.99)	-0.028 (0.99)	**-0.028 (1.00)**	**-0.028 (1.00)**
inf	-0.001 (0.08)	**-0.013 (1.00)**	**-0.013 (1.00)**	**-0.013 (1.00)**
lexp	**-0.044 (1.00)**	**-0.051 (1.00)**	**-0.049 (1.00)**	**-0.049 (1.00)**
mrent	**0.054 (1.00)**	**0.055 (1.00)**	**0.055 (1.00)**	**0.056 (1.00)**
mphone	**-0.006 (1.00)**	**-0.006 (1.00)**	**-0.006 (1.00)**	**-0.006 (1.00)**
ngrent	**-0.151 (1.00)**	**-0.161 (1.00)**	**-0.160 (1.00)**	**-0.161 (1.00)**
oilrent	**0.027 (1.00)**	**0.028 (1.00)**	**0.028 (1.00)**	**0.028 (1.00)**
log_pop	**0.098 (1.00)**	**0.099 (1.00)**	**0.099 (1.00)**	**0.099 (1.00)**
trade	**0.008 (1.00)**	**0.008 (1.00)**	**0.008 (1.00)**	**0.008 (1.00)**
unemp	**-0.074 (1.00)**	**-0.074 (1.00)**	**-0.074 (1.00)**	**-0.074 (1.00)**
constant	**10.52 (1.00)**	**10.82 (1.00)**	**10.76 (1.00)**	**10.69 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	-	-	-	-

Variables	Model (13)	Model (14)
gini	-0.041 (0.72)	-0.041 (0.72)
gfcgdp	-0.202 (1.00)	**-0.202 (1.00)**
geegdp	**-0.000 (1.00)**	**-0.000 (1.00)**
hbed	**0.272 (1.00)**	**0.273 (1.00)**
intern	**-0.027 (1.00)**	**-0.027 (1.00)**
inf	**-0.014 (1.00)**	**-0.014 (1.00)**
lexp	**-0.044 (1.00)**	**-0.044 (1.00)**
mrent	**0.051 (1.00)**	**0.051 (1.00)**
mphone	**-0.007 (1.00)**	**-0.007 (1.00)**
ngrent	**0.174 (1.00)**	**0.174 (1.00)**
oilrent	**0.024 (1.00)**	**0.023 (1.00)**
log_pop	**0.117 (1.00)**	**0.117 (1.00)**
trade	**0.008 (1.00)**	**0.008 (1.00)**
unemp	**-0.079 (1.00)**	**-0.079 (1.00)**
constant	**9.547 (1.00)**	**9.543 (1.00)**
No. of obs.	1231	1231
Model Space	-	-

Table 8 BMA results: relationship between Gini coefficient and GDP growth rate, 1999-2020

Variables	Model (1)	Model (2)	Model (3)	Model (4)
gini	-0.041 (0.77)	-0.041 (0.77)	-0.040 (0.77)	-0.042 (0.80)
gfcgdp	-0.201 (1.00)	-0.201 (1.00)	-0.201 (1.00)	-0.200 (1.00)
geegdp	-0.000 (0.04)	-0.000 (0.04)	-0.000 (0.04)	-0.000 (0.04)
hbed	0.030 (0.23)	0.030 (0.24)	0.030 (0.24)	0.023 (0.19)
intern	-0.040 (1.00)	-0.040 (1.00)	-0.040 (1.00)	-0.040 (1.00)
inf	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)
lexp	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)
mrent	0.007 (0.08)	0.007 (0.08)	0.007 (0.08)	0.007 (0.08)
mphone	-0.000 (0.12)	-0.000 (0.12)	-0.000 (0.12)	-0.000 (0.13)
ngrent	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)
oilrent	0.018 (0.23)	0.018 (0.23)	0.018 (0.24)	0.015 (0.21)
log_pop	0.004 (0.05)	0.004 (0.05)	0.004 (0.05)	**0.087 (1.00)**
trade	0.010 (0.99)	0.010 (0.99)	**0.010 (1.00)**	**0.011 (1.00)**
unemp	-0.136 (1.00)	**-0.136 (1.00)**	**-0.136 (1.00)**	**-0.133 (1.00)**
constant	**9.786 (1.00)**	**9.786 (1.00)**	**9.768 (1.00)**	**8.330 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	16384	8192	4096	2048

Variables	Model (5)	Model (6)	Model (7)	Model (8)
gini	-0.041 (0.81)	-0.042 (0.81)	-0.042 (0.81)	-0.041 (0.79)
gfcgdp	-0.191 (1.00)	-0.189 (1.00)	-0.194 (1.00)	-0.186 (1.00)
geegdp	-0.000 (0.04)	-0.000 (0.04)	-0.000 (0.05)	-0.000 (0.04)
hbed	0.012 (0.12)	0.016 (0.15)	0.016 (0.14)	0.020 (0.17)
intern	-0.039 (1.00)	-0.040 (1.00)	-0.033 (1.00)	-0.033 (1.00)
inf	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.04)	-0.000 (0.04)
lexp	-0.001 (0.04)	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)
mrent	0.005 (0.06)	0.006 (0.07)	0.008 (0.08)	**0.101 (1.00)**
mphone	-0.000 (0.13)	-0.000 (0.13)	**-0.006 (1.00)**	**-0.007 (1.00)**
ngrent	-0.006 (0.04)	**-0.161 (1.00)**	**-0.149 (1.00)**	**-0.163 (1.00)**
oilrent	**0.075 (1.00)**	**0.094 (1.00)**	**0.093 (1.00)**	**0.091 (1.00)**
log_pop	**0.079 (1.00)**	**0.089 (1.00)**	**0.093 (1.00)**	**0.091 (1.00)**
trade	**0.012 (1.00)**	**0.012 (1.00)**	**0.012 (1.00)**	**0.012 (1.00)**
unemp	**-0.127 (1.00)**	**-0.131 (1.00)**	**-0.131 (1.00)**	**-0.132 (1.00)**
constant	**8.099 (1.00)**	**7.988 (1.00)**	**8.241 (1.00)**	**8.029 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	1024	512	256	128

Variables	Model (9)	Model (10)	Model (11)	Model (12)
gini	-0.039 (0.76)	-0.037 (0.72)	-0.037 (0.72)	-0.008 (0.21)
gfcgdp	-0.191 (1.00)	-0.191 (1.00)	-0.191 (1.00)	-0.192 (1.00)
geegdp	-0.000 (0.05)	-0.000 (0.05)	-0.000 (0.05)	-0.000 (0.06)
hbed	0.029 (0.22)	0.041 (0.28)	0.041 (0.28)	**0.145 (1.00)**
intern	-0.035 (1.00)	-0.034 (1.00)	**-0.034 (1.00)**	**-0.033 (1.00)**
inf	-0.000 (0.03)	**-0.005 (1.00)**	**-0.005 (1.00)**	**-0.008 (1.00)**
lexp	**0.024 (1.00)**	**0.021 (1.00)**	**0.021 (1.00)**	**0.033 (1.00)**
mrent	**0.104 (1.00)**	**0.105 (1.00)**	**0.105 (1.00)**	**0.114 (1.00)**
mphone	**-0.007 (1.00)**	**-0.007 (1.00)**	**-0.007 (1.00)**	**-0.007 (1.00)**
ngrent	**-0.131 (1.00)**	**-0.135 (1.00)**	**-0.135 (1.00)**	**-0.154 (1.00)**
oilrent	**0.092 (1.00)**	**0.093 (1.00)**	**0.093 (1.00)**	**0.088 (1.00)**
log_pop	**0.089 (1.00)**	**0.089 (1.00)**	**0.089 (1.00)**	**0.078 (1.00)**
trade	**0.012 (1.00)**	**0.012 (1.00)**	**0.012 (1.00)**	**0.012 (1.00)**
unemp	**-0.132 (1.00)**	**-0.132 (1.00)**	**-0.132 (1.00)**	**-0.132 (1.00)**
constant	**6.351 (1.00)**	**6.480 (1.00)**	**6.470 (1.00)**	**4.237 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	-	-	-	-

Variables	Model (13)	Model (14)
gini	-0.005 (0.16)	-0.005 (0.16)
gfcgdp	-0.191 (1.00)	**-0.191 (1.00)**
geegdp	**-0.000 (1.00)**	**-0.000 (1.00)**
hbed	**0.148 (1.00)**	**0.148 (1.00)**
intern	**-0.032 (1.00)**	**-0.032 (1.00)**
inf	**-0.008 (1.00)**	**-0.008 (1.00)**
lexp	**0.035 (1.00)**	**0.036 (1.00)**
mrent	**0.110 (1.00)**	**0.110 (1.00)**
mphone	**-0.007 (1.00)**	**-0.007 (1.00)**
ngrent	**-0.163 (1.00)**	**-0.163 (1.00)**
oilrent	**0.085 (1.00)**	**0.085 (1.00)**
log_pop	**0.092 (1.00)**	**0.092 (1.00)**
trade	**0.012 (1.00)**	**0.012 (1.00)**
unemp	**-0.141 (1.00)**	**-0.141 (1.00)**
constant	**3.773 (1.00)**	**3.771 (1.00)**
No. of obs.	1231	1231
Model Space	-	-

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Appendix

Table A.1 Income share of deciles in 1999 and 2020

Deciles	1999_GDP_pc (% share)	2020_GDP_pc (% share)
1	0.60	0.88
2	1.29	1.99
3	1.84	2.35
4	2.95	4.55
5	4.20	5.79
6	4.70	6.10
7	10.65	9.83
8	15.67	13.65
9	22.53	20.92
10	35.57	33.94

Table A.2 Income share of country groups in 1999 and 2020

Country Groups	1999_GDP_pc (% share)	2020_GDP_pc (% share)
1	50.85	48.45
2	29.08	25.55
3	10.75	12.59
4	5.59	8.19
5	2.96	4.07
6	0.77	1.15

Table A.3 OLS regression results

Variables	Model 1 (agdppcgr)	Model 2 (agdpgr)
gini	-0.057 (0.028)*	-0.033 (0.018)*
gfcgdp	-0.365 (0.047)***	-0.350 (0.046)***
geegdp	-0.000 (0.000)	-0.000 (0.000)
hbed	0.305 (0.093)**	0.181 (0.091)*
intern	-0.050 (0.008)***	-0.055 (0.008)***
inf	-0.008 (0.008)	-0.006 (0.008)
lexp	0.110 (0.061)*	0.168 (0.060)**
mrent	0.054 (0.087)	0.087 (0.085)
mphone	-0.000 (0.004)	-0.000 (0.004)
ngrent	-0.030 (0.253)	-0.036 (0.248)
oilrent	0.113 (0.062)*	0.153 (0.061)*
log_pop	0.149 (0.121)	0.118 (0.118)
trade	0.019 (0.004)***	0.021 (0.004)***
unemp	-0.144 (0.033)***	-0.206 (0.032)***
constant	0.365 (5.297)	-3.101 (0.032)
No. of obs.	1231	1231
R^2	0.16	0.18

Note: In Model 1, the dependent variable is the annual GDP per capita growth rate, while in Model 2, it is the annual GDP growth rate.

Table A.4 BMA results: relationship between Gini coefficient and per capita GDP growth rate, 1999-2020

Variables	Model (1)	Model (2)	Model (3)	Model (4)
gini	-0.061 (0.92)	-0.062 (0.93)	-0.055 (0.88)	-0.056 (0.90)
gfcgdp	-0.228 (1.00)	-0.226 (1.00)	-0.221 (1.00)	0.220 (1.00)
geetge	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)
hbed	0.248 (0.99)	0.255 (1.00)	0.252 (1.00)	0.242 (0.99)
intern	-0.038 (1.00)	-0.038 (1.00)	-0.039 (1.00)	-0.039 (1.00)
inf	-0.000 (0.06)	-0.000 (0.06)	-0.000 (0.06)	-0.000 (0.06)
lexp	-0.002 (0.05)	-0.001 (0.05)	-0.001 (0.05)	-0.001 (0.05)
mrent	0.001 (0.04)	0.001 (0.04)	0.002 (0.04)	0.001 (0.04)
mphone	-0.000 (0.08)	-0.000 (0.09)	-0.000 (0.08)	-0.000 (0.09)
ngrent	-0.000 (0.03)	-0.001 (0.03)	-0.000 (0.03)	-0.000 (0.03)
oilrent	0.000 (0.04)	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)
log_pop	0.003 (0.05)	0.002 (0.04)	0.004 (0.05)	**0.087 (1.00)**
trade	0.004 (0.66)	0.004 (0.59)	**0.006 (1.00)**	**0.008 (1.00)**
unemp	-0.056 (0.71)	**0.079 (1.00)**	**-0.075 (1.00)**	**-0.073 (1.00)**
constant	**9.435 (1.00)**	**9.629 (1.00)**	**9.002 (1.00)**	**7.580 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	16384	8192	4096	2048

Variables	Model (5)	Model (6)	Model (7)	Model (8)
gini	-0.058 (0.90)	-0.057 (0.90)	-0.057 (0.90)	-0.056 (0.89)
gfcgdp	-0.216 (1.00)	-0.214 (1.00)	-0.220 (1.00)	-0.215 (1.00)
geetge	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.04)	-0.000 (0.04)
hbed	0.233 (0.98)	0.238 (0.99)	0.237 (0.99)	0.242 (0.99)
intern	-0.039 (1.00)	-0.033 (1.00)	-0.033 (1.00)	-0.032 (1.00)
inf	-0.000 (0.06)	-0.000 (0.07)	-0.000 (0.07)	-0.000 (0.07)
lexp	-0.001 (0.04)	-0.002 (0.05)	-0.002 (0.05)	-0.002 (0.05)
mrent	0.001 (0.04)	0.001 (0.04)	0.002 (0.04)	**0.060 (1.00)**
mphone	-0.000 (0.09)	-0.000 (0.09)	**-0.005 (1.00)**	**-0.006 (1.00)**
ngrent	-0.003 (0.03)	**-0.096 (1.00)**	**-0.085 (1.00)**	**-0.094 (1.00)**
oilrent	**0.021 (1.00)**	**0.032 (1.00)**	**0.031 (1.00)**	**0.030 (1.00)**
log_pop	**0.085 (1.00)**	**0.091 (1.00)**	**0.095 (1.00)**	**0.093 (1.00)**
trade	**0.008 (1.00)**	**0.008 (1.00)**	**0.008 (1.00)**	**0.008 (1.00)**
unemp	**-0.070 (1.00)**	**-0.073 (1.00)**	**-0.073 (1.00)**	**-0.074 (1.00)**
constant	**7.549 (1.00)**	**7.481 (1.00)**	**7.731 (1.00)**	**7.558 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	1024	512	256	128

Variables	Model (9)	Model (10)	Model (11)	Model (12)
gini	-0.059 (0.91)	-0.055 (0.87)	-0.055 (0.88)	-0.054 (0.88)
gfcgdp	-0.206 (1.00)	-0.208 (1.00)	-0.208 (1.00)	-0.208 (1.00)
geetge	-0.000 (0.04)	-0.000 (0.04)	0.000 (0.04)	-0.000 (0.04)
hbed	0.220 (0.96)	0.247 (0.98)	0.247 (0.98)	**0.251 (1.00)**
intern	-0.029 (0.99)	-0.028 (0.99)	**-0.029 (1.00)**	**-0.029 (1.00)**
inf	-0.001 (0.08)	**-0.013 (1.00)**	**-0.013 (1.00)**	**-0.013 (1.00)**
lexp	**-0.044 (1.00)**	**-0.051 (1.00)**	**-0.050 (1.00)**	**-0.049 (1.00)**
mrent	**0.054 (1.00)**	**0.056 (1.00)**	**0.056 (1.00)**	**0.056 (1.00)**
mphone	**-0.006 (1.00)**	**-0.006 (1.00)**	**-0.006 (1.00)**	**-0.006 (1.00)**
ngrent	**-0.149 (1.00)**	**-0.159 (1.00)**	**-0.158 (1.00)**	**-0.160 (1.00)**
oilrent	**0.028 (1.00)**	**0.029 (1.00)**	**0.029 (1.00)**	**0.029 (1.00)**
log_pop	**0.096 (1.00)**	**0.097 (1.00)**	**0.097 (1.00)**	**0.096 (1.00)**
trade	**0.008 (1.00)**	**0.008 (1.00)**	**0.008 (1.00)**	**0.008 (1.00)**
unemp	**-0.073 (1.00)**	**-0.073 (1.00)**	**-0.074 (1.00)**	**-0.074 (1.00)**
constant	**10.65 (1.00)**	**10.97 (1.00)**	**10.92 (1.00)**	**10.85 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	-	-	-	-

Variables	Model (13)	Model (14)
gini	-0.052 (0.86)	-0.052 (0.86)
gfcgdp	-0.208 (1.00)	**-0.208 (1.00)**
geetge	**-0.000 (1.00)**	**-0.000 (1.00)**
hbed	**0.260 (1.00)**	**0.260 (1.00)**
intern	**-0.028 (1.00)**	**-0.028 (1.00)**
inf	**-0.013 (1.00)**	**-0.013 (1.00)**
lexp	**-0.046 (1.00)**	**-0.046 (1.00)**
mrent	**0.055 (1.00)**	**0.055 (1.00)**
mphone	**-0.006 (1.00)**	**-0.006 (1.00)**
ngrent	**0.167 (1.00)**	**0.166 (1.00)**
oilrent	**0.027 (1.00)**	**0.027 (1.00)**
log_pop	**0.111 (1.00)**	**0.111 (1.00)**
trade	**0.008 (1.00)**	**0.008 (1.00)**
unemp	**-0.075 (1.00)**	**-0.075 (1.00)**
constant	**10.34 (1.00)**	**10.34 (1.00)**
No. of obs.	1231	1231
Model Space	-	-

Table A.5 BMA results: relationship between Gini coefficient and GDP growth rate, 1999-2020

Variables	Model (1)	Model (2)	Model (3)	Model (4)
gini	-0.041 (0.77)	-0.041 (0.77)	-0.041 (0.77)	-0.042 (0.80)
gfcgdp	-0.202 (1.00)	-0.202 (1.00)	-0.201 (1.00)	-0.200 (1.00)
geetge	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)
hbed	0.030 (0.23)	0.030 (0.23)	0.030 (0.23)	0.023 (0.19)
intern	-0.040 (1.00)	-0.040 (1.00)	-0.040 (1.00)	-0.040 (1.00)
inf	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)
lexp	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)
mrent	0.007 (0.08)	0.007 (0.08)	0.007 (0.08)	0.007 (0.08)
mphone	-0.000 (0.12)	-0.000 (0.12)	-0.000 (0.12)	-0.000 (0.13)
ngrent	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)
oilrent	0.018 (0.24)	0.018 (0.24)	0.018 (0.24)	0.016 (0.21)
log_pop	0.004 (0.05)	0.004 (0.05)	0.004 (0.05)	**0.087 (1.00)**
trade	0.010 (0.99)	0.010 (0.99)	**0.010 (1.00)**	**0.011 (1.00)**
unemp	-0.135 (1.00)	**-0.136 (1.00)**	**-0.136 (1.00)**	**-0.133 (1.00)**
constant	**9.795 (1.00)**	**9.795 (1.00)**	**9.778 (1.00)**	**8.350 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	16384	8192	4096	2048

Variables	Model (5)	Model (6)	Model (7)	Model (8)
gini	-0.041 (0.82)	-0.042 (0.81)	-0.042 (0.82)	-0.041 (0.80)
gfcgdp	-0.191 (1.00)	-0.189 (1.00)	-0.194 (1.00)	-0.186 (1.00)
geetge	-0.000 (0.04)	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)

hbed	0.012 (0.32)	0.016 (0.14)	0.016 (0.14)	0.020 (0.17)
intern	-0.039 (1.00)	-0.040 (1.00)	-0.033 (1.00)	-0.033 (1.00)
inf	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.04)	-0.000 (0.04)
lexp	-0.001 (0.04)	0.000 (0.03)	0.000 (0.03)	0.000 (0.03)
mrent	0.005 (0.06)	0.006 (0.07)	0.008 (0.08)	**0.101 (1.00)**
mphone	-0.000 (0.13)	-0.000 (0.12)	**-0.006 (1.00)**	**-0.007 (1.00)**
ngrent	-0.006 (0.04)	**-0.161 (1.00)**	**-0.149 (1.00)**	**-0.162 (1.00)**
oilrent	**0.075 (1.00)**	**0.094 (1.00)**	**0.093 (1.00)**	**0.091 (1.00)**
log_pop	**0.079 (1.00)**	**0.089 (1.00)**	**0.093 (1.00)**	**0.090 (1.00)**
trade	**0.012 (1.00)**	**0.012 (1.00)**	**0.012 (1.00)**	**0.012 (1.00)**
unemp	**-0.127 (1.00)**	**-0.131 (1.00)**	**-0.132 (1.00)**	**-0.132 (1.00)**
constant	**8.115 (1.00)**	**8.004 (1.00)**	**8.263 (1.00)**	**8.049 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	1024	512	256	128

Variables	Model (9)	Model (10)	Model (11)	Model (12)
gini	-0.040 (0.77)	-0.038 (0.72)	-0.038 (0.72)	-0.008 (0.21)
gfcgdp	-0.191 (1.00)	-0.191 (1.00)	-0.191 (1.00)	-0.193 (1.00)
geetge	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)	-0.000 (0.03)
hbed	0.029 (0.22)	0.040 (0.28)	0.040 (0.28)	**0.145 (1.00)**
intern	-0.035 (1.00)	-0.034 (1.00)	**-0.035 (1.00)**	**-0.033 (1.00)**
inf	-0.000 (0.03)	**-0.005 (1.00)**	**-0.005 (1.00)**	**-0.008 (1.00)**
lexp	**0.024 (1.00)**	**0.021 (1.00)**	**0.021 (1.00)**	**0.033 (1.00)**
mrent	**0.104 (1.00)**	**0.105 (1.00)**	**0.105 (1.00)**	**0.114 (1.00)**
mphone	**-0.007 (1.00)**	**-0.007 (1.00)**	**-0.007 (1.00)**	**-0.007 (1.00)**

ngrent	**-0.131 (1.00)**	**-0.135 (1.00)**	**-0.135 (1.00)**	**-0.154 (1.00)**
oilrent	**0.092 (1.00)**	**0.093 (1.00)**	**0.093 (1.00)**	**0.088 (1.00)**
log_pop	**0.089 (1.00)**	**0.089 (1.00)**	**0.089 (1.00)**	**0.077 (1.00)**
trade	**0.012 (1.00)**	**0.012 (1.00)**	**0.012 (1.00)**	**0.012 (1.00)**
unemp	**-0.132 (1.00)**	**-0.132 (1.00)**	**-0.132 (1.00)**	**-0.1328 (1.00)**
constant	**6.379 (1.00)**	**6.510 (1.00)**	**6.501 (1.00)**	**4.260 (1.00)**
No. of obs.	1231	1231	1231	1231
Model Space	-	-	-	-

Variables	Model (13)	Model (14)
gini	-0.007 (0.21)	-0.007 (0.20)
gfcgdp	-0.1913 (1.00)	**-0.193 (1.00)**
geetge	**-0.000 (1.00)**	**-0.000 (1.00)**
hbed	**0.148 (1.00)**	**0.148 (1.00)**
intern	**-0.033 (1.00)**	**-0.033 (1.00)**
inf	**-0.008 (1.00)**	**-0.008 (1.00)**
lexp	**0.034 (1.00)**	**0.034 (1.00)**
mrent	**0.114 (1.00)**	**0.114 (1.00)**
mphone	**-0.007 (1.00)**	**-0.007 (1.00)**
ngrent	**-0.157 (1.00)**	**-0.157 (1.00)**
oilrent	**0.087 (1.00)**	**0.087 (1.00)**
log_pop	**0.085 (1.00)**	**0.085 (1.00)**
trade	**0.012 (1.00)**	**0.012 (1.00)**
unemp	**-0.139 (1.00)**	**-0.139 (1.00)**
constant	**4.045 (1.00)**	**4.042 (1.00)**

No. of obs.	1231	1231
Model Space	-	-

List of Variables	**Abbreviations**
GDP growth (annual %)	agdpgr
GDP per capita (constant 2015 US$)	agdppc
GDP per capita growth (annual %)	agdppcgr
General government final consumption expenditure (% of GDP)	gfcgdp
Government expenditure on education, total (% of GDP)	geegdp
Government expenditure on education, total (% of government expenditure)	geetge
Gross fixed capital formation (% of GDP)	gfcf
Hospital beds (per 1,000 people)	hbed
Individuals using the Internet (% of population)	intern
Inflation, GDP deflator (annual %)	inf
Life expectancy at birth, total (years)	lexp
Mineral rents (% of GDP)	mrent
Mobile cellular subscriptions (per 100 people)	mphone
Natural gas rents (% of GDP)	ngrent
Oil rents (% of GDP)	oilrent
Population growth (annual %)	popgr
Total Population	totpop
Trade (% of GDP)	trade
Unemployment, total (% of total labor force) (modeled ILO estimate)	unemp