A COMMENT ON THE RELATIONSHIP BETWEEN INEQUALITY AND GROWTH

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Abstract

Recent empirical research on the relationship between income inequality and economic growth has provided controversial results. Some studies predict a negative, and some a positive effect of inequality on growth. Answers to the controversy have usually been sought from problems in the estimation technique, the measure of inequality, or from some form of non-linearity between inequality and growth. This study shows that the controversy can be attributed to all three aforementioned causes. In conclusion, this study finds that the effect of inequality to growth depends on the level of economic development – as Kuznets originally argued.

Keywords: Developed and developing economies, Kuznets relation, generalized method of moments, panel estimation.

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1 Introduction

In classical economic theory, inequality of incomes was thought to influence economic growth rates through savings and consumption. According to Adam Smith (1811), an increased division of labor raises productivity, but savings govern capital accumulation, which enables production growth. It was a common belief in the 18th century that only rich people saved. Therefore, economic growth was possible only when there were enough rich people in society. Adam Smith also argued that production growth would not be possible without sufficient demand. He stated that every man should be able to provide for himself and his family. This would constitute the threshold of sustainable inequality and would assure a sufficient level of demand.

According to John Maynard Keynes (1936), inequality of incomes leads to slower economic growth. Keynes argued that marginal consumption rates are fairly equal among all income brackets. As a result, aggregate consumption depends on changes in aggregate income. According to Keynes, demand is the basis of investments, and because inequality lowers aggregate consumption, inequality of incomes will diminish economic growth.

Inequality of incomes may also affect economic growth rates more indirectly. In sociology, inequality of incomes has been found to cause social disorganization, which is commonly associated with increased crime rates and lower social capital (Shaw & McKay 1969, Sampson & Groves 1989, Sampson & Raudenbush 1999). Inequality can also increase corruption and illegal rent-seeking (Jong-Sun & Khagram 2005, Merton 1938). Property crimes, vandalism, theft and corruption in particular can harm economic growth by discouraging investments and lowering productivity by inflicting additional costs on companies (Hall & Jones 1999, Murphy etc. 1993). Social capital is also considered to consist of such societal features as trust, norms and social networks, which can be considered to be important factors behind economic growth (Putnam 1993, Whiteley 2000). Other factors through which inequality has been linked to growth include human capital, division of labor, and taxation (Barro 2000, Fishman & Simhon 2002, Forbes 2000).

The effects of income inequality on economic development may also be non-linear. Developing economies need assets in order to raise their economy to a higher growth path. Inequality of incomes may enable greater investments through greater aggregate savings. A greater amount of capital in developed economies may require a higher level of consumption. Equality of incomes will raise aggregate consumption if marginal consumption rates are fairly equal among income brackets, or if the poor have greater marginal consumption rates than the rich. Given credit-market imperfections inequality may discourage schooling in rich economies, and encourage it in poor economies (Fishman & Simhon 2002). Inequality can also increase social disorganization more easily in rich than in poor economies (Merton 1938, Shaw & McKay 1969).

The macroeconomic effects of inequality have been under investigation for several decades, but no clear consensus on the direction of the effect has emerged. Empirical research on the subject truly commenced in 1955 when Simon Kuznets released his study. According to Kuznet's relation, inequality of incomes will first increase and then decrease in the course of economic development. Inequality will increase in the beginning of industrialization due to a growing wage disparity between agricultural and factory pay. Lower mortality rates, greater fertility rates, and investments in new technology will also increase the inequality of incomes during the first phases of industrialization. Growth of inequality is necessary because an egalitarian agrarian economy cannot accumulate enough savings so that capital creation would be sufficient for production growth. Later on, as the economy industrializes, the distribution of incomes will even out as a larger portion of people move to higher industry pay. Kuznet's data, composed of data from three countries, the United States, Germany and Great Britain, did give some proof for the existence of such a relation, but subsequent research has produced mixed results.[1]

Recent studies have encountered problems concerning the measure of income distribution and model estimation. Many previous studies have, for example, relied on a simple cross-country estimation. This has an obvious drawback, e.g., the omitted-variables bias. If region-, country-, or some group-specific factors affect growth rates, explanatory variables can capture the effects of these factors, and parameter estimates will not represent the true effect of the explanatory variables *per se*.[2] Studies using panel estimation to control for the omitted-variable bias have commonly used Klaus Deininger and Lyn Squire's (1996) Gini index as an estimate of income distribution.[3] Anthony Atkinson and Andrea Brandolini (2001) and James Galbraith and Hyunsub Kum (2004) have raised concerns about the consistency of Deininger and Squire's dataset. Kristin Forbes (2000, p. 882-4) has also conducted a sensitivity analysis according to which the growth elasticity of inequality does not vary between different income groups within countries. Forbes uses fixed effects to estimate an equation that includes a lagged dependent variable, which leads to inconsistent parameter estimates. Forbes uses fixed effects because she estimates the elasticity of growth with respect to inequality separately in different income groups, which in turn leads to a very small number of observations in certain groups.[4] This is an obvious problem facing the study of non-linear relations with endogenous explanatory variables in a panel setting. That is, there are usually not enough observations in different groups for feasible group- or country-specific instrumental estimation.[5] The problem can be approached with non-linear estimators that enable the use of full data coverage in a country- or group-specific estimation.

This study uses an improved measure of income distribution and a non-linear estimator to tackle the problems presented above. The results imply that inequality has no statistically significant linear effect on growth, but the elasticity of growth with respect to inequality changes with the level of economic development. More

[1] For example, Barro (2000) and Lundberg and Squire (2003) versus Forbes (2000) and Deininger and Squire (1998).

[2] There are, for example, clear indications of this in Deininger and Squire's (1998, p. 270) study, where country dummies affected the growth elasticity of inequality. More detailed analysis of problems relating to the omitted-variable bias in growth regressions with inequality as an explanatory variable can be found in Forbes (2000).

[3] For example Barro (2000), Forbes (2000) and Banerjee and Duflo (2003).

[4] Forbes (2000, 883) estimates the elasticity of growth with respect to inequality in countries below $1000, above $1000, below $3000, above $3000, below $6000 and above $6000. Elasticity of growth with respect to inequality is positive in all groups.

[5] For example, Forbes's (2000, p. 883) smallest groups have only 48 and 54 observations.

specifically income inequality accelerates growth in poor economies and decelerates growth in rich economies.

2 Theoretical effects of inequality on growth

2.1 Credit-market imperfections

Credit-market imperfections refer to the situation in which people's access to credit is restricted. These restrictions can originate from the regulations of legislative institutions' or credit rationing imposed by central banks. Further, credit-market imperfections are present when acquiring credit in return for expected future profits is gravely limited.

If credit-market imperfections are present, the income distribution can affect the economy through changes in human capital or in the division of labor and employment. Given credit-market imperfections, inequality of incomes will restrict households' opportunities for education.[6] If an economy's aggregate capital is small, unevenly distributed incomes urge capital owners to invest in specialization (Fishman & Simhon 2002). In this case, inequality results in a higher level of human capital, a higher division of labor and faster economic growth (Fishman & Simhon 2002). When an economy's aggregate capital is large, the more equal distribution of income encourages households to invest in specialization and entrepreneurship (Fishman & Simhon 2002). Equality of incomes will create a more risk-free environment and a wide-based demand for goods. This will lead to higher employment, a greater division of labor, and faster economic growth.

2.2 Political economy

In a society in which the mean income exceeds the median income, the idea may occur to even out the distribution of income through the political process (Barro 2000). In such cases, taxation and transfer payments are commonly used to redistribute income, regardless of their unclear overall effect on economic activity and income distribution. Tightened income taxation affects consumption rates by lowering the disposable incomes of the rich, but income transfers to lower income brackets increase their disposable incomes. How this affects the aggregate consumption depends on the effectiveness of the tools used to redistribute incomes, and on the marginal consumption rates in different income groups. Capital taxation lowers the motivation to invest. A decline in investments lowers the GDP growth rate and job creation, thus affecting the distribution of incomes. Wage taxation has a two-fold effect on the supply of labor. At higher wage levels, the supply of labor is usually assumed to be backward bending because the marginal benefit of working more becomes smaller than the marginal cost of losing more leisure. Wage taxation shifts the point of juncture upwards in the labor supply curve, increasing the supply of labor and/or the work effort. At the lowest wage levels, income transfers may lower the supply of labor and/or the work effort if the difference in after-tax incomes between employment and unemployment is not great enough.

[6] To be more precise, when access to credit is limited, households' investment opportunities depend on their assets and incomes. Thus, given credit-market imperfections, poor households usually forego investments in human capital (Barro 2000).

The redistribution of income through a political process is only possible when political power is distributed evenly, e.g., every consenting adult has only one vote (Barro 2000). If this is not the case, the distribution of votes defines the distribution of power and income. When incomes are distributed unevenly, the wealthier portion of the population may try to influence politicians not to increase taxes and income transfers, which can lead to a corrupt government (Barro 2000). In a country with a great inequality of incomes, the poor are also usually more dependent on social services. The poor may then be forced to use corruption to ensure those much needed social services (Jong-sung & Khagram 2005). If corruption spreads through the public administration, it can lead to inefficiencies in the distribution of licences, social benefits etc. The demand for licenses is usually high and inflexible, so a rise in license prices lowers the profits of producers and investors (Murphy et al. 1993). Inefficiencies in the distribution of social benefits, basic health care etc. may lower the disposable incomes of both the rich and the poor, therefore lowering the rates of aggregate consumption.

2.3 Unrest related to social policy

A rising inequality of incomes may motivate individuals to perpetrate crimes, illegal rent-seeking activities or other acts that disturb the stability of society (Barro 2000, Merton 1938, Shaw & McKay 1969). Disorderly conduct may grow if people do not feel reasonably equal in the satisfaction of their basic needs (Merton 1938). Basic health care, education and some form of social security can be seen as basic needs. Inequality can also increase social disorganization, when social networks are disrupted in residential areas (Shaw & McKay 1969). Social disorganization may lower social capital and increase crime and delinquency rates (Shaw & McKay 1969, Sampson & Groves 1989). Crime and illegal rent-seeking activities may inflict additional costs on producers and investors (Hall & Jones 1999, Murphy et al. 1993). Lower social capital can also increase the bargaining and enforcement costs of contracts as the parties have less trust in each other (Ostrom 1990). Low social capital also usually means a more risk-averse society.

Notably, growing inequality can also increase social disorganization and crime more easily in rich than in poor countries (Merton 1938, Shaw & McKay 1969). The culture in poor countries is usually community and family oriented, while the culture in rich countries tends to be more money- and individual-oriented (Merton 1938, Shaw & McKay 1969). In cultures where money and individualism are highlighted, individuals usually react more easily to inequality of incomes with disorderly conduct (Merton 1938, Shaw & McKay 1969).

2.4 Saving rates

In neo-classical growth theory, aggregate saving is central to production growth (Mankiw et al. 1992, Solow 1956). In Solow’s (1956) growth model, an economy’s production level is determined by

$$Y = F(K, AL)\,, \qquad (2.1)$$

where Y is output, K is physical capital, A is technical development, and L is labor. Savings govern capital accumulation, and capital stock evolves through time according to

$$\dot{k} = sf(k) - (n + d + g)k \,, \tag{2.2}$$

where k is capital per laborer, $\dot{k}$ is a change of capital relative to labor and technical development, d is the depreciation of capital relative to labor, s is savings relative to labor, n is the growth rate of labor, and g is the growth of productivity relative to labor (appendix 1). The economy's steady-state growth rate is

$$y = \left(\frac{s}{n + d + g} \right)^{\frac{\alpha}{1-\alpha}} A \tag{2.3}$$

(appendix 1). If technical development (A) is constant, the economy grows if $s > (g + n + d)$ and declines if $s < (g + n + d)$.

High saving rates are thought to be especially important for developing economies, because raising an economy to a higher growth path requires substantial investments (Sachs et al. 2004, Stiglitz 2002). Funds for investments come from aggregate savings and/or loans from abroad. Domestic investments can also be replaced by direct foreign investments. These options are not equal in risk. Large scale lending can lead to a balance of payments deficit and to a debt circle if the higher growth path remains unattained. Direct foreign investments do create jobs and raise incomes in the region, but they also supersede the domestic supply. A major portion of the profits of foreign firms are also usually repatriated to a foreign country. This affects the balance of payments and hinders the exercise of an independent monetary policy. Foreign investments are also usually highly sensitive to economic fluctuations and speculation, which may cause uncontrollable shifts in the balance of capital. Thus, increasing the domestic saving rate is usually the safest way for a developing country to finance its structural investments.

Consequently, inequality of incomes can accelerate economic growth in developing economies by raising aggregate savings, but production growth is still not possible without sufficient demand. If the incomes of a major portion of the population do not grow sufficiently in the course of economic development, the higher growth path may remain unattained.

3 Model and data

The basis for estimation is a commonly used extended version of the neo-classical growth model:

$$\begin{aligned} \log(growth_{it}) &= \alpha + \beta_1 \log(GDP_{i,t-1}) + \beta_2 \log(investments_{i,t-1}) \\ &+ \beta_3 \log(education_{i,t-1}) + \beta_4 \log(Gini_{i,t-1}) + \kappa_{it} \end{aligned} \,, \tag{3.1}$$

where κ_{it} is the residual, which includes both the possible country-specific effect (u_i) and the error term (ε_{it}).

The data consists of the following variables: real GDP per capita, change of real GDP per capita, gross domestic investments as a portion of the GDP, gross enrollment in secondary school as a portion of the population of the age group that officially corresponds to that education level, and the Gini index. The data covers the years 1970 - 95, and it is mostly compiled from the Global Development Network's Growth Database (Easterly & Sewadeh 2002). The only exception is the Gini index, which is acquired from the University of Texas Inequality Project (UTIP) (Galbraith & Kum 2004). Descriptive statistics are presented in table 1 and the country list in appendix 3.

Table 1. Descriptive statistics

variable	mean	std. deviation	min.	max.
GDP	5353.09	5202.27	341.00	38562.43
GDP growth rate (%)	2.4783	3.9595	-14.4909	20.9099
domestic investments (%)	22.1770	7.2295	4.5308	46.3420
Gini index	37.6475	4.7251	26.6300	48.5000
sec. school enrol. (%)	70.5245	27.6981	7.0000	142.0000

Gross domestic product is stated in real terms with the base year 1985. The GDP growth rate is measured as a ratio between the real GDP growth rate and the population growth rate. Secondary school enrollment constitutes the education that completes the basic education and aims toward lifelong learning and human development. (Easterly & Sewadeh 2002)

Income distribution is estimated with the University of Texas Inequality Project's EHII2.1 Gini index. EHII2.1 combines Deininger and Squire's (1996) Gini index with a set of measures of the dispersion of pay across industrial categories in the manufacturing sector and the manufacturing share of the population . Although pay inequality and income inequality are technically different economic concepts, they are closely related. In most countries the manufacturing pay is a major portion of all pay, and pay is usually the single largest portion of income everywhere. The manufacturing sector is also a foundational part of the economy, and the low-wage workers in the manufacturing sector are substitutes for the low-wage workers in the service and agriculture sectors. (Galbraith & Kum 2004, p. 9-17)

EHII2.1 Gini index is obtained by regressing Deininger and Squire's Gini coefficients on the values of explanatory variables, which include the different income measures of Deininger and Squire's data set, the set of measures of the dispersion of pay in the manufacturing sector, and the manufacturing share of the population. All estimates are adjusted to household gross-income. Unexplained variations in Deininger and Squire's income measures are treated as inexplicable, and they are disregarded in the calculations of EHII2.1 Gini coefficients. (Galbraith & Kum 2004, 17)

The EHII2.1 Gini index is distributed more evenly than Deininger and Squire´s (1996) Gini index. The steep declines and elevations in the values of Gini, which are common in Deininger and Squire's dataset, are not present in EHII2.1.[7] The main reason behind the variation is the different income measures (net-gross, household-per capita, expenditure-income) of Deininger and Squire's dataset, which are not always compatible. This is clearly seen from the great differences in Gini values depending on the measure used (Galbraith & Kum 2004, p. 4-9).[8] Deininger and Squire suggest adding 6.6 Gini points to the expenditure data to make their dataset more compatible. It is quite unlikely, however, that this simple mathematical procedure would erase the heterogeneity of the data, especially as there are great differences in the values of other measures of Gini (Atkinson & Brandolini 2001, Galbraith & Kum 2004, Knowles 2005).[9] Values of EHII2.1 also correspond to the estimates of income distributions of other research institutes, such as VATT and the OECD,[10] better than those of Deininger and Squire's Gini index (Föster & Pearson 2002, Galbraith & Kum 2004).

Figure 1 depicts the correlation pattern between the logarithmic EHII2.1 Gini index and the logarithmic growth rate of real GDP. The variance is quite stable and not much can be deduced from it. However, the scattergram does not tell anything about the relationship between the Gini index and GDP growth in a single country or a group of countries.

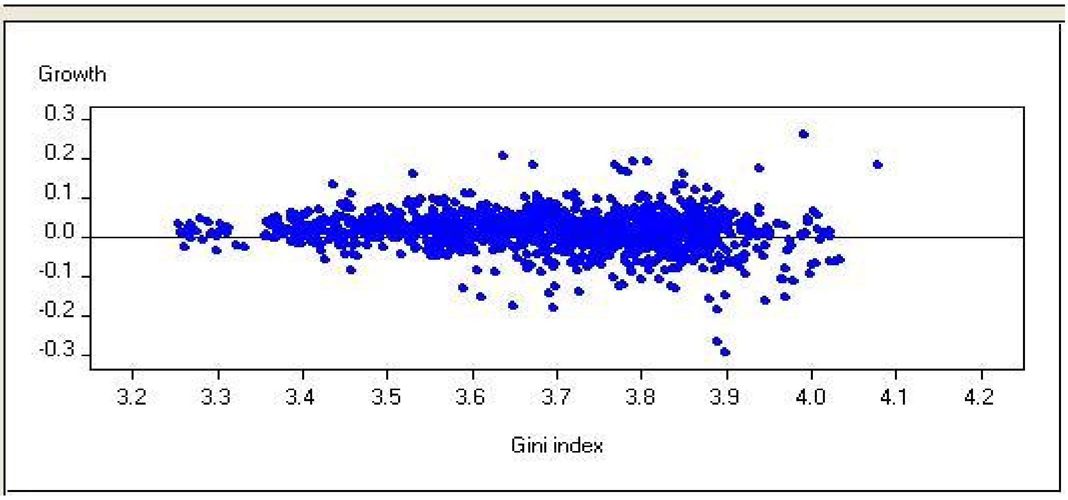

Figure 1. EHII2.1 Gini index and GDP growth rate

[7] In Deininger and Squire's (1996) dataset, for example, Brazil's Gini index is saw edged, fluctuating constantly between values of about 55 and about 60 in the period 1970-90. Columbia experiences a drop of about 7 points in values of Gini in 1973-74 and an elevation of about 8 points in 1974-77.

[8] The lowest mean Gini value of sub-Saharan Africa, for example, is 43.86 (per capita net expenditure), and the highest 57.82 (household net income) (Galbraith & Kum 2004, p. 5).

[9] For example, the mean Gini value of South Asia is 39.73 according to household gross income, 31.55 according to household net expenditure, 30.06 according to per capita net income, and 32.44 according to per capita net expenditure (Galbraith & Kum 2004, p. 5).

[10] VATT (Government Institute for Economic Research) is a research centre in Finland.

4 Estimation

Error terms in equation (3.1) are assumed to be independent and identically distributed ($\varepsilon_{it} \sim i.i.d.(o,\sigma^2)$). Growth is measured in five-year averages to control for short-run economic fluctuations. The average growth rate during each five-year period is regressed on the values of the explanatory variables in the year immediately preceding each period.[11] The use of five-year intervals means that there are only five observations available from each country. The instrumentation of endogenous variables will drop the number of observations in the estimation to three for each country. So, in practice, the estimation covers the years 1980 to 1995.

As shown by Forbes (2000, p. 876), the estimation of equation (3.1) is complicated by the endogeneity of the GDP, which can be demonstrated by writing GDP growth as a difference in levels of income and adding $income_{i,t-1}$ to both sides:

$$\begin{aligned} &\log(income_{it}) = \gamma \log(income_{i,t-1}) + \beta_2 \log(investment_{i,t-1}) \\ &+ \beta_3 \log(Gini_{i,t-1}) + \beta_4 \log(education_{i,t-1}) + \kappa_{it} \end{aligned}, \qquad (4.1)$$

where $\gamma = \beta_1 + 1$. Clearly $E(\kappa_{it} income_{i,t-1}) \neq 0$. In panel data all explanatory variables can correlate with the (possible) country-specific effect, and the endogeneity of every explanatory variable must be tested. This is done using Hausman's (1978) specification test (appendix 2).

Because the model (3.1) is dynamic by nature, the estimation is done with the generalized method of moments estimator (GMM). The benefits of GMM include that heteroskedasticity does not affect it, and it can easily be equipped to withstand autocorrelation. The first and second lags of the differences of each explanatory variable are used as instruments for the explanatory variable presumed to be endogenous.[12] In Hausman's (1978) specification test, the GDP is treated as endogenous in the reference estimator, and in the estimator presumed to be consistent under misspecification, the GDP and the explanatory variable to be tested are treated as endogenous.

EHII2.1 Gini's and investments' endogenous estimators have smaller error variances than their exogenous counterparts. Consequently, it is clear that both Gini and domestic investment are endogenous. Hausman's test statistic for secondary school enrollment is negative. Because the test statistic should follow χ^2-distribution with three degrees of freedom, nothing can be deduced from a negative test statistic. However, it is obvious that the endogeneity of Gini and domestic investments causes the reference estimator to be inconsistent under H_0 (appendix 2). Consistency is achieved when domestic investments and Gini are also treated as endogenous in the reference estimator. Despite the correction, the test statistic of secondary schooling remains negative.

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[11] For example, the averaged growth rate in 1986 to 1990 is regressed on the values of the explanatory variables in 1985.
[12] The correlation between difference and level commonly diminishes rapidly after the second lag. Thus, only the first two lags of differences are usually relevant for the identification.

In technical terms the only reason for the negative test statistic is that the difference between covariance matrices of the reference estimator and the estimator presumed to be consistent under misspecification is indefinite (appendix 2). There are four parameters included in the estimation (excluding intercept) and only 121 observations available. Because GMM is efficient only asymptotically, the number of observations may be too small for this to be attained. Hausman's (1978, p. 1252) specification test presupposes that the efficient estimator attains the asymptotic Cramer-Rao bound. In small or in mid-sized samples with badly behaving distributions, the GMM estimator does not necessarily attain that limit (Altonji & Segal 1996, Carrasco & Florens 2004). If the reference estimator is not asymptotically fully efficient, the rationale behind Hausman's specification test is no longer valid and the test statistic may be biased (appendix 2). Moreover, the assumptions behind Hausman's specification test are highly asymptotic, and the definiteness of the estimated covariance matrix of the difference between the two estimators can never be guaranteed with finite datasets (Rahiala 2006).

Returning to the issue at hand, when secondary schooling is treated as endogenous, there are significant changes in the parameter estimates of all the explanatory variables. Thus, secondary schooling seems very likely to be endogenous.

The results of the nonlinear GMM estimation of equation (3.1) are presented in table 2. A Newey-West estimator with lag one is used as the GMM estimator's weight matrix to account for autocorrelation in the variables appearing in the orthogonality conditions. Hansen's test is used to evaluate the validity of extra instruments. According to the test, the orthogonality conditions seem quite realistic for the chosen set of instruments.

According to the results, the elasticity of growth with respect to domestic investments was approximately 0.04. The standard deviation of the estimator was about 0.017. The parameter estimates of the GDP, Gini and secondary schooling were not statistically significant.

Table 2. Results of the nonlinear GMM estimation of growth

growth5y	
intercept	-0.08105
	(0.0806)
GDP $_{t-1}$	0.00239
	(0.0021)
investments $_{t-1}$	0.03592
	(0.0167)*
Gini $_{t-1}$	0.01494
	(0.0173)
education $_{t-1}$	0.00268
	(0.0058)
Hansen	3.87 (8)
countries	53
observations	121

* =p<0.05, ** =p<0.01. The parameter estimate's standard error is presented in parentheses. The first and second lags of differences are used as instruments for variables presumed to be endogenous.

In order to study the elasticities of economic growth with respect to domestic investments, to the GDP level, and to the Gini index separately in countries with different levels of economic development, equation (3.1) is transformed to:

$$\begin{aligned}\log(growth) &= \beta_1 dr_i + \beta_2 dmi_i + \beta_3 dp_i \\ &+ (\beta_4 dr_i + \beta_5 dmi_i + \beta_6 dp_i) * \log(GDP_{i,t-1}) \\ &+ (\beta_7 dr_i + \beta_8 dmi_i + \beta_9 dp_i) * \log(investments_{i,t-1}), \\ &+ (\beta_{10} dr_i + \beta_{11} dmi_i + \beta_{12} dp_i) * \log(gini_{i,t-1}) + \kappa_{it}\end{aligned} \quad (4.2)$$

where dr_i is a dummy variable for rich economies, dmi_i is a dummy variable for middle-income economies, dp_i is a dummy variable for poor economies, and κ_{it} is the residual, which includes both the possible country-specific effect (u_i) and the error term (ε_{it}), $(\varepsilon_{it} \sim i.i.d.(o,\sigma^2))$. Education is discarded from the equation (4.2), because it had no statistically significant linear effect on growth, and as it was assumed to have only a linear relationship on growth.[13] A country is denoted as poor if its GDP per capita was under \$2000 in the year 1970, and rich if its GDP per capita was over \$7000 in 1970. Countries between these thresholds are denoted as middle

[13] Leaving secondary school enrollment aside releases more degrees of freedom, and increases the number of observations on poor countries. Leaving it aside from the estimation of equation (3.1) also changes the parameter estimates of remaining variables only marginally.

income.[14] Descriptive statistics assorted by income groups are presented in appendix 4.

The results of the non-linear Newey-West GMM estimation of equation (4.2) are presented in table 3. As before, Newey-West uses one lag. All the explanatory variables are assumed to be endogenous. The first and second lags of the differences are used as their instruments. According to the Hansen's test, orthogonality conditions seem fairly realistic for the chosen set of instruments.

Table 3. Growth elasticities of selected explanatory variables in different income groups

growth 5y	
dummy-poor (dp)	-0.10693*
	(0.0413)
dummy-middle-income (dmi)	0.02518
	(0.0660)
dummy-rich (dr)	0.20178*
	(0.0783)
dp*GDP $_{t-1}$	-0.00164
	(0.0017)
dmi*GDP $_{t-1}$	0.00034
	(0.0023)
dr*GDP $_{t-1}$	-0.00412
	(0.0024)
dp*investment $_{t-1}$	0.04168***
	(0.0112)
dmi*investment $_{t-1}$	0.0137
	(0.0127)
dr*investment $_{t-1}$	-0.05479
	(0.0302)
dp*Gini $_{t-1}$	0.03016**
	(0.0104)
dmi*Gini $_{t-1}$	-0.00805
	(0.0129)
dr*Gini $_{t-1}$	-0.04323
	(0.0163)**
Hansen	8.69 (18)
countries	53
observations	131

* =p<0.05, ** =p<0.01, *** =p<0.001. The parameter estimates' standard error is presented in parentheses. The first and second lags of differences are used as instruments for variables presumed to be endogenous.

[14] There are 24 poor, 12 rich and 17 middle-income countries in the dataset.

According to the results, the elasticity of growth in terms of rich economies was approximately 0.20. The standard deviation of the estimator was about 0.73. The elasticity of growth in terms of poor economies was approximately -0.11. The standard deviation of the estimator was about 0.04. Dummy of the middle-income economies was not statistically significant. Thus, income group-specific factors had a clear effect on the growth rates. This implies that a normal cross-country analysis could suffer from omitted-variables bias.

According to the results, coefficients of the GDP level were not statistically significant. The elasticity of growth with respect to domestic investments was approximately 0.04 in poor economies. The standard deviation of the estimator was approximately 0.011. In rich and middle-income economies the coefficient of domestic investments was not statistically significant.

The elasticity of growth with respect to Gini was approximately 0.03 in poor economies. The standard deviation of the estimator was about 0.01. The elasticity of growth with respect to Gini was approximately -0.04 in rich economies. The standard deviation of the estimator was about 0.016. In middle-income economies, the coefficient of the Gini was negative, but not statistically significant.

Accordingly, inequality had a clear positive effect on growth in developing economies. If Keynes's (1936) assumption about the steady marginal consumption rates between income groups is sound, increasing inequality will increase savings and lessening inequality will increase consumption. Dynan et al. (2004) have also reported higher saving rates among the rich than the poor. In this case, the growth in inequality of incomes would increase savings proportionally more than the amount of concentration of incomes and *vice versa*. In poor economies, the elasticity of growth with respect to domestic investments and Gini were very close in magnitude. Therefore growth in aggregate savings was most likely one important factor affecting the growth rate in poor economies.

Domestic investments had no effect on the growth rate in middle-income and rich economies. This implies that when countries get richer they receive relatively more foreign investments, whose influence on economic growth increases. In this case, economic growth is less dependent on domestic investments and domestic savings. Developed economies´ higher level of capital also requires higher consumption levels. A large part of the GDP of developed economies comes from the service sector, and because exporting services is still highly restricted, domestic demand has a larger effect on growth. As aggregate capital grows, aggregate consumption can be raised by a more equal distribution of incomes, especially if savings rates are lower among the poor. Increasing social disorganization may also have contributed to the negative effect of inequality on growth in developed economies by lowering productivity and social capital.

5 Conclusions

The results imply that inequality's different impacts on growth rates in developing and developed economies could result in different weightings of savings and consumption in different stages of economic development. Both inequality and domestic investments had a clear positive effect on the growth rates in developing economies. Thus, domestic savings seem to play a clear role in the economic development of poor economies. One reason for this could be that large-scale overseas borrowing can result in problems in installment of loans. Therefore, the most risk-neutral option for a developing country is to finance domestic investments independently. Because capital is scarce, the growth of aggregate savings requires that exiguous assets are centralized.

In developed economies the abundance of capital requires a higher level of aggregate consumption than in developing economies. The results showed that domestic investments had no effect on the growth rates in more developed economies. The results also show that in rich economies the effect of inequality of incomes on growth rates was negative. A large service sector and the limited mobility of services across national borders enhance the effect of domestic consumption on growth in developed economies. Equality of incomes raises consumption if marginal saving rates are equal among income brackets or if the poor have lower saving rates than the rich and the measures used to redistribute incomes are efficient. Inequality can also have a stronger negative indirect effect on growth in developed economies, due to a more money- and individual-oriented culture. If money is highlighted as a norm of success, increasing inequality may increase crime and diminish social capital more easily than in societies with more community-oriented cultures.

The results may have been influenced by the endogeneity of explanatory variables, sample selection bias, and measurement error. Exogeneity assumptions were tested only for country-specific effect. Interactions between income inequality and growth rate may extend beyond several years, and because only the first and second lags of the difference were used as instruments for Gini index, there are no guarantees that the possible time-dependency has been cancelled. At its best, the data included only about one-fourth of all the countries in the world. For example, the data did not include any of the former socialistic countries that converted to market economies at beginning of the 1990s. Therefore, systematic errors may have influenced the results. The Gini index is also not unflawed as an estimate of income distribution because it is only a representation of statistical summaries. Thus, the level of inequality given by EHII2.1 Gini may not have represented the true level of inequality in the countries in question.

Owing to the inevitable restrictions, the results suggest that further research is needed. As the results are congruent with the theory and if some form of inverted relation is proven to exist, a major source of ambiguity in the field of study may be able to be cancelled. Previous studies have suffered from inconsistent measures of income distribution, but the examination of the inverted relation has also been complicated by statistical obscurities. The use of country-related constants in estimation is statistically dubious, and estimators' asymptotic properties suffer greatly if several parameters are estimated with a few dozen observations. However, with non-linear estimators the vagueness relating to the use of country constants can be bypassed in a statistically meaningful way.

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APPENDIX

Appendix 1: Solow's neo-classical growth model

In Solow's (1956) growth model an economy's production level originates from

$$Y = F(K, AL), \tag{1}$$

where Y is output, K is physical capital, A is technical development and L is labor. Technical development is assumed to be Harrod -neutral type:

$$A(t) = A(0)e^{gt}.$$

Taking logarithms and differentiating $A(t)$ against time gives us:

$$\frac{\dot{A}}{A} = g \tag{2}$$

Labor is assumed to be a constant fraction of the population and exogenous

$$L(t) = L_0 e^{nt}.$$

Taking logarithms from $L(t)$ and differentiating it against time gives:

$$\frac{\dot{L}}{L} = n \tag{3}$$

Model assumes constant returns to scale on capital and effective labour. This allows equation (1) to be written as

$$\frac{Y}{AL} = F\left[\frac{K}{AL}, 1\right] \equiv f(k) \equiv k \tag{4}$$

The intensive form of production function, $f(k)$, is assumed to satisfy $f(0) = 0$, $f'(k) > 0$ and $f''(k) < 0$, and Inada (1963) conditions: $\lim_{k \to o} f'(k) = \infty$ and $\lim_{k \to \infty} f'(k) = 0$.

Supply of capital is assumed to be inflexible, so capital depends only on savings (s) and depreciation (d):

$$\dot{K} = s(y) - dK, \tag{5}$$

where s is marginal propensity to save and d is the rate of capital depreciation.

Taking logarithms on (4) we get

$$\ln k(t) = \ln K(t) - \ln A(t) - \ln L(t).$$

Differentiating this against time and combining it with equations (2) and (3) brings us to

$$\frac{\dot{k}}{k} = \frac{s(Y) - dk}{K} - n - g, \tag{6}$$

from which we get

$$\dot{k} = sy - (n + g + d)k. \tag{7}$$

In the steady-state, an economy's level of capital is

$$k^* = \left(\frac{s}{n + d + g}\right)^{\frac{1}{1-\alpha}},$$

and the steady-state growth rate is

$$y = \frac{Y}{L} = \left(\frac{s}{g + n + d}\right)^{\frac{\alpha}{1-\alpha}} A(0)e^{nt}.$$

Appendix 2: Hausman's (1978) specification test

Let us study a linear model

$$y = X\beta + \tilde{X}\alpha + v, \tag{1}$$

where y represents the T-dimensional vector of observed values of the dependent variable and v stand for the corresponding vector of error terms ($Ev \equiv 0$). The explanatory variables $\tilde{X}$ and the error vector v are assumed to be mutually uncorrelated ($E\tilde{X}'v = 0$), whereas v and X might be correlated ($EX'v \neq 0$). Denote the number of these problematic explanatory variables by K ($\beta \in \Re^K$). We further assume that there exists an estimator $\hat{\beta}_0$ for β that is $\sqrt{T}$-consistent, asymptotically normal and asymptotically most efficient under the hypothesis $H_0 : EX'v = 0$ (such as the OLS-estimator), but *inconsistent* under the alternative $H_1 : EX'v \neq 0$. Let $\hat{\beta}_1$ be any $\sqrt{T}$-consistent, asymptotically normal estimator for β that is *consistent* even under the alternative H_1. In this case, the difference $\hat{q} = \hat{\beta}_1 - \hat{\beta}_0$ could be used to test the hypothesis H_0 against H_1. (Hausman 1978, p.1252-53, Rahiala 2006)

In order to formulate a one-dimensional test statistic based on the difference $\hat{q}$, we need to know the asymptotic covariance matrix of $\hat{q}$. Because the estimators $\hat{\beta}_1$ and

$\hat{\beta}_0$ used the same data they will be mutually correlated. For brevity, let us denote the asymptotic covariance matrix under H_0 of $\sqrt{T}(\hat{\beta}-\beta)$ for any $\sqrt{T}$-consistent estimator $\hat{\beta}$ by $V(\hat{\beta}) = Asy.\text{cov}(\sqrt{T}(\hat{\beta}-\beta)$ and further $V_1 = V(\hat{\beta}_1)$ and $V_0 = V(\hat{\beta}_0)$ (Hausman 1978, p. 1253, Rahiala 2006).

<u>Proposition 1:</u> Under H_0, $V(\hat{q}) = Asy.\text{cov}(\sqrt{T}\hat{q}) = V_1 - V_0$.

<u>Proof:</u> Let us assume that the proposition is *not* true and that $V(\hat{\beta}_1) \neq V(\beta_0) + V(\hat{g})$, because $C = Asy.\text{cov}(\sqrt{T}(\hat{\beta}_0-\beta), \sqrt{T}\hat{q}) = \lim_{T\to\infty} T \cdot E\left[(\hat{\beta}_0-\beta)\hat{q}'\right] \neq 0$. By studying the properties of the estimators $\hat{\beta}^{(r)} = \hat{\beta}_0 rC'\hat{q}$ (where r is a scalar) we would note that these new estimators would be $\sqrt{T}$-consistent for β under H_0 and $V(\hat{\beta}^{(r)})$ would be of the form

$$V(\hat{\beta}^{(r)}) = V(\hat{\beta}_0) - rC'C - rC'C + r^2C'V(\hat{q})C\,. \tag{2}$$

The first derivative of the matrix-valued function

$$F(r) = V(\hat{\beta}^{(r)} - V(\hat{\beta}_0) = -2rC'C + r^2C'V(\hat{q})C \tag{3}$$

with respect to r would then be of the form

$$F'(r) = -2C'C + 2rC'V(\hat{q})C\,. \tag{4}$$

Thus, $F'(0) = -2C'C \leq 0$ in the sense of being non-positive definite. But $F(0) = 0$, which means that there would exist some small positive values of r that would correspond to an asymptotically more efficient estimator $\hat{\beta}^{(r)}$ than $\hat{\beta}_0$ under H_0. Because this contradicts our basic assumption, we can conclude that C must be equal to a zero-matrix. (Hausman 1978, p. 1254, Rahiala 2006).

<u>Corollary:</u> $V_1 - V_0 \geq 0$ in the sense of being non-negative definite (Hausman 1978, p. 1254).

<u>Proof:</u> Because $V(\hat{q})$ is an asymptotic covariance matrix, it has to be non-negative definite.

Hausman's test statistic, based on above results, is of the form

$$H = T \cdot (\hat{\beta}_1 - \hat{\beta}_0)'\left[V(\hat{\beta}_1) - V(\hat{\beta}_0)\right]^{-1}(\hat{\beta}_1 - \hat{\beta}_0)\ , \tag{6}$$

which should be asymptotically χ^2_K -distributed under H_0, because both estimators $\hat{\beta}_0$ and $\hat{\beta}_1$ were assumed to be asymptotically normal.

However, if $\hat{\beta}_0$ is not asymptotically fully efficient, $C = Asy.\text{cov}(\sqrt{T}(\hat{\beta}_0 - \beta), \sqrt{T}\hat{q}) \neq 0$,and $V(\hat{\beta}_1) = V(\hat{\beta}_0 + \hat{q}) = V(\hat{\beta}_0) + V(\hat{q}) - C - C'$, which would result in

$$V(\hat{\beta}_1) - V(\hat{\beta}_0) = V(\hat{q}) - C - C' . \qquad (7)$$

Thus the rationale behind the test statistics (6) would no longer be valid. If, moreover, the estimators $\hat{\beta}_0$ and $\hat{\beta}_1$ would be highly correlated, there would be no guarantee of the definiteness of the matrix $V(\hat{\beta}_1) - V(\hat{\beta}_0)$. Note also that the above results are highly asymptotic, and with finite data sets, the definiteness of the estimated matrix $V(\hat{\beta}_1) - V(\hat{\beta}_0)$ can never be guaranteed either (Rahiala 2006).

Appendix 3: Country list

AUSTRALIA
ALGERIA
BANGLADESH
BOLIVIA
BURUNDI
CAMEROON
CANADA
CENTRAL AFRICAN REPUBLIC
CHILE
COLOMBIA
DENMARK
DOMINICAN
ECUADOR
EL SALVADOR
EGYPT
FIJI
GHANA
GREECE
GUATEMALA
HAITI
HONDURAS
ICELAND
INDIA
INDONESIA
ISRAEL
IRELAND
ITALY
JAMAICA
JAPAN
KENYA
KUWAIT
MADAGASCAR
MALAYSIA
MALTA

MAURITIUS
MEXICO
MOROCCO
NETHERLANDS
NEW ZEALAND
NIGERIA
NORWAY
PAKISTAN
PAPUA NEW GUINEA
PHILIPPINES
PORTUGAL
SINGAPORE
SOUTH AFRICA
SPAIN
THAILAND
UNITED KINGD
UNITED STATES
VENEZUELA
ZIMBABWE

Appendix 4: Descriptive statistics

Descriptive statistics: rich countries

variable	mean	std. deviation	min.	max.
GDP	12573.25	4733.59	6055.00	38562.43
GDP growth rate (%)	2.3415	4.3286	-14.4909	20.4806
domestic investments (%)	22.6989	5.7152	10.2240	39.0160
Gini index	33.7140	4.4289	27.7700	48.5000

Descriptive statistics: middle-income countries

variable	mean	std. deviation	min.	max.
GDP	5448.42	2945.54	2028.00	15838.30
GDP growth rate (%)	3.6159	3.3142	-5.0502	12.4545
domestic investments (%)	24.4290	7.0816	9.9300	46.3420
Gini index	37.1244	3.5676	30.2700	47.3000

Descriptive statistics: poor countries

variable	mean	std. deviation	min.	max.
GDP	1458.46	705.11	341.00	4891.00
GDP growth rate (%)	1.7118	4.0736	-10.2099	20.9099
domestic investments (%)	20.3659	7.7628	4.5308	45.1300
Gini index	41.0506	2.5870	33.5000	48.0400