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by

Michael Bleaney and Akira Nishiyama

Centre for Research in Economic Development and International Trade,
University of Nottingham

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Abstract
We investigate whether income inequality affects subsequent growth in a cross-country sample for 1965-90, using the models of Barro (1997), Bleaney and Nishiyama (2002) and Sachs and Warner (1997), with negative results. We then investigate the evolution of income inequality over the same period and its correlation with growth. The dominating feature is inequality convergence across countries. This convergence has been significantly faster amongst developed countries. Growth does not appear to influence the evolution of inequality over time.

Outline

1. INTRODUCTION

The relationship between income distribution and economic growth has attracted considerable interest recently, but several questions remain open. One is whether inequality is bad for growth. Although initial income inequality has often been found to enter cross-country growth regressions with a significant negative coefficient (Alesina and Rodrik, 1994; Clarke, 1995; Perotti, 1996), this finding appears not to be robust to variations in model specification (Deininger and Squire, 1998; Persson and Tabellini, 1994), and indeed when panel data are used a *positive* inequality coefficient is sometimes obtained (Forbes, 2000; Li and Zou, 1998). A second issue is how income equality evolves over time and the impact of growth on this (Ravallion, 2001; Sarel, 1997), which might be regarded as the first-difference form of the cross-sectional relationship between income distribution and per capita GDP investigated by Barro (2000), Chang and Ram (2000) and Li *et al*. (1998).

There are also major issues of reliability and international comparability in measures of income inequality (e.g. some measures refer to net income, others to gross income, and yet others to expenditure). Consequently, even the comprehensive recent data sets of Deininger and Squire (1996) and WIID (2000) confront the researcher with choices that may significantly influence empirical results.

This paper has two objectives. The first objective is to test whether income inequality at the beginning of the period significantly affects per capita growth over the years 1965-90 for a cross-country sample. We find that, although there is a significant negative pairwise correlation between these variables, inequality is not at all significant in a number of multivariate regression specifications that embody the latest research on the determinants of growth, even if its impact is allowed to vary with the level of per capita income. The second objective is to explore the determinants of changes in inequality over the same period. We find that the only robust feature is inequality convergence. Growth does not significantly affect the evolution of inequality, either in high-income or low-income countries. The convergence process differs significantly between developed and developing countries.

The paper is organised as follows. Theoretical and data issues are discussed in Section Two. Empirical results for the impact of initial income distribution on growth appear in Section Three, and for the evolution of income distribution in Section Four. Section Five concludes.

2. MODEL SPECIFICATION AND DATA ISSUES

To investigate the impact of income inequality on growth, we employ three growth models on a 1965-90 cross-country data set: those of Barro (1997), Bleaney and Nishiyama (2002) and Sachs and Warner (1997). We simply add a measure of income inequality in 1965 (or as near to that date as possible) to the regression specifications of these authors. We also test whether income inequality has an effect on growth at some levels of per capita GDP but not others.

In exploring the determinants of the evolution of income inequality, we use a general-to-specific modeling procedure to identify the preferred specification. The main issue is the choice of the candidate regressors, and we use a set of regressors based on the three growth models just mentioned, plus the 1965 measure of income inequality and the residuals from Bleaney and Nishiyama's (2002) growth regression. Since most of the candidate regressors are collinear with growth (having been found to be significant in growth regressions), the residuals from a growth regression capture the element of growth that is not explained by the other regressors. The 1965 measure of income inequality will capture inequality convergence across countries, if this occurs.

The most popular single measure of income inequality is the Gini coefficient, which represents the entire distribution of income. The most comprehensive cross-country data on Gini coefficients of which we are aware is WIID (2000). We use version 1.0, the latest version of the database, which was last updated on 12 September 2000. This database incorporates Deininger and Squire's (1996) dataset on income inequality (the Gini coefficients of income distribution), which is another popular dataset to use. Although the country coverage in WIID is large, it is a collection of data from various data sources rather than a synthesised dataset. For some countries it provides multiple data for the same year according to several different definitions, whereas for others it includes a large number of blanks. Consequently, even for the same country in the same year, the appropriate figures to use depend on researchers' purposes and sensitivity (see

Data Appendix 1).[1] The WIID database differentiates "reliable" data from "less reliable" data. We always preferred "reliable" data if it was available. To maintain consistency, we also always chose data of national coverage and not data of rural or urban coverage only.

The most plentiful data on income distribution are based on gross income. Theoretically, we are probably more interested in measures based on net income (after redistribution through taxes and transfers), but these data are much less frequently collected, so for reasons of international comparability we gave priority to gross-income-based data where available. Some data are based on household expenditures. Deininger and Squire (1996) report that, for reliable data, there is no significant difference between gross- and net-income-based measures, but that expenditure-based measures yield Gini coefficients that are on average smaller by 6.6. Like Deininger and Squire (1996), we therefore added 6.6 to expenditure-based Gini coefficients. This is not entirely satisfactory, but there is no more widely accepted method of data transformation than this.[2]

Income inequality measures are not available for every year. We used the observations closest to 1965 and 1990, and most refer to a date less than two years away, although we accepted deviations of up to seven years. The samples of "reliable data only" include the data which were categorised as "reliable" in WIID (2000), and for which neither observation of income inequality was more than five years from the target date.[3] In what follows we often refer to an *income equality index*, which is obtained by subtracting the Gini coefficient (on a 100 point-scale) from 100. To calculate the annual average rate of change in the income equality index, we divided the change in the index by the number of years between the initial observation and the final observation.

Basic statistics of inequality variables are summarised in Table 1. The data show that not all countries have experienced a reduction in income inequality over the period 1965-90. Twenty-four out of 58 countries (in the reliable data) experienced a

1 As a consequence, recent empirical studies (Knowles, 2001a; Odedokun and Round, 2001; Sylwester, 2000, 2002) on income inequality provide appendices of the actual figures of inequality data used in the research, as we do.

2 See Knowles (2001a), which provides good discussions on data transformation.

3 WIID (2000) follows Deininger and Squire (1996) in using three criteria for reliable data: 1) the data should be based on actual household surveys, not on estimates, 2) the data should have comprehensive coverage of all sources of income or expenditure, and 3) the data should be representative of the whole population.

deterioration of overall income inequality, and this is not a phenomenon of a particular income group within countries. Those countries with deteriorating inequality include some of the richest countries in the world such as Australia, Austria, the United Kingdom and the United States, as well as some of the poorest countries such as China, Niger, Senegal and Tanzania.

Table 1. Data Statistics on Equality Variables

Variable	Mean	Standard dev.	Minimum	Maximum	No. of obs
Average annual change in income equality index					
Reliable data only	0.0274	0.2896	-0.6429	0.6268	58
Largest possible sample	0.0201	0.3744	-1.2652	1.3995	79
Initial level of income equality index					
Reliable data only	58.0599	11.3917	36.0000	77.7700	65
Largest possible sample	56.7190	11.7118	20.5000	77.7700	90

Note: Change variables are annual average changes over the period 1965-90. Initial levels are data circa the year 1965.

Table 2 illustrates regional differences in income inequality. It is interesting to note that only sub-Saharan Africa countries, on average, have experienced a deterioration of overall income equality in the period 1965-90. The other regions have generally improved their overall income distributions. The OECD countries are the most successful group in equalising income distribution, followed by East Asia and Latin America.[4] Interestingly, income distribution in tropical regions as a whole remained almost unchanged over our concerned period. As expected, the initial level (circa 1965) of overall income equality is the highest in the OECD countries, followed by East Asia, Latin America, and sub-Saharan Africa.

4 "East Asia" means East Asia and South-east Asia, whilst by our definitions, Latin America includes Caribbean countries.

Table 2. Regional Differences in Income Equality

Variable	All countries	OECD	East Asia	Latin America	SS Africa	Tropics
Annual average change in income equality index	0.0153	0.0748	0.0452	0.0453	-0.1446	0.0110
Income equality index circa 1965	58.0599	64.4422	58.0333	50.3684	48.2925	50.2684

Note: Data are reliable data only. Change variables are annual average changes over the period 1965-90. Tropics are countries which score one in our variable for tropical climate (CLIMATE).

Table 3 shows that the relationship between real GDP per capita and the Gini coefficients is negative, i.e. wealthy countries tend to be more equal in overall income distribution than poor countries.

Table 3. Simple Correlations between Economic Development and Income Inequality

	Real GDP p.c. 1965	Real GDP p.c. 1990	Gini coefficient circa 1965	Gini coefficient circa 1990
Real GDP p.c.1965	1.000			
Real GDP p.c. 1990	0.886	1.000		
Gini coefficient circa 1965	-0.420	-0.503	1.000	
Gini coefficient circa 1990	-0.407	-0.537	0.779	1.000

Note: Data on Gini coefficients are the reliable data sample. All variables are in a natural log form.

Scatter plots of income inequality variables provide a good overview of the data. Figure 1 plots initial income equality against subsequent economic growth, and displays no obvious pattern. Figure 2 shows the expected positive correlation between income equality in 1965 and 1990.

Figure 1. Initial Income Equality and Economic Growth (Largest Possible Sample)

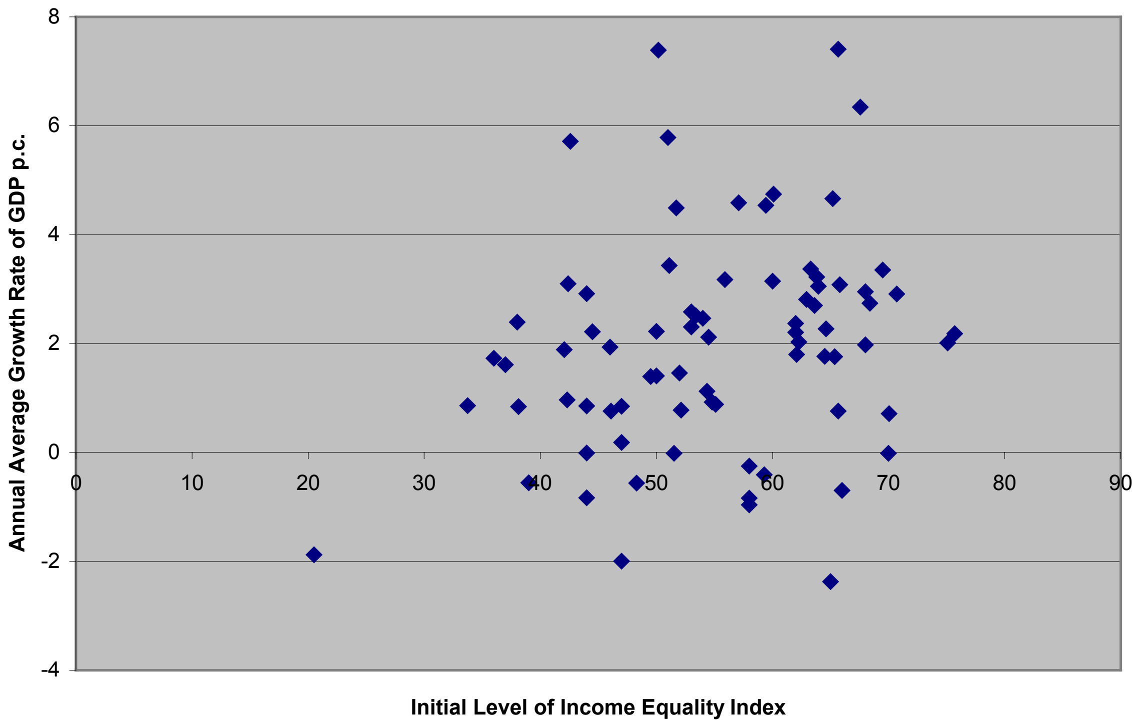
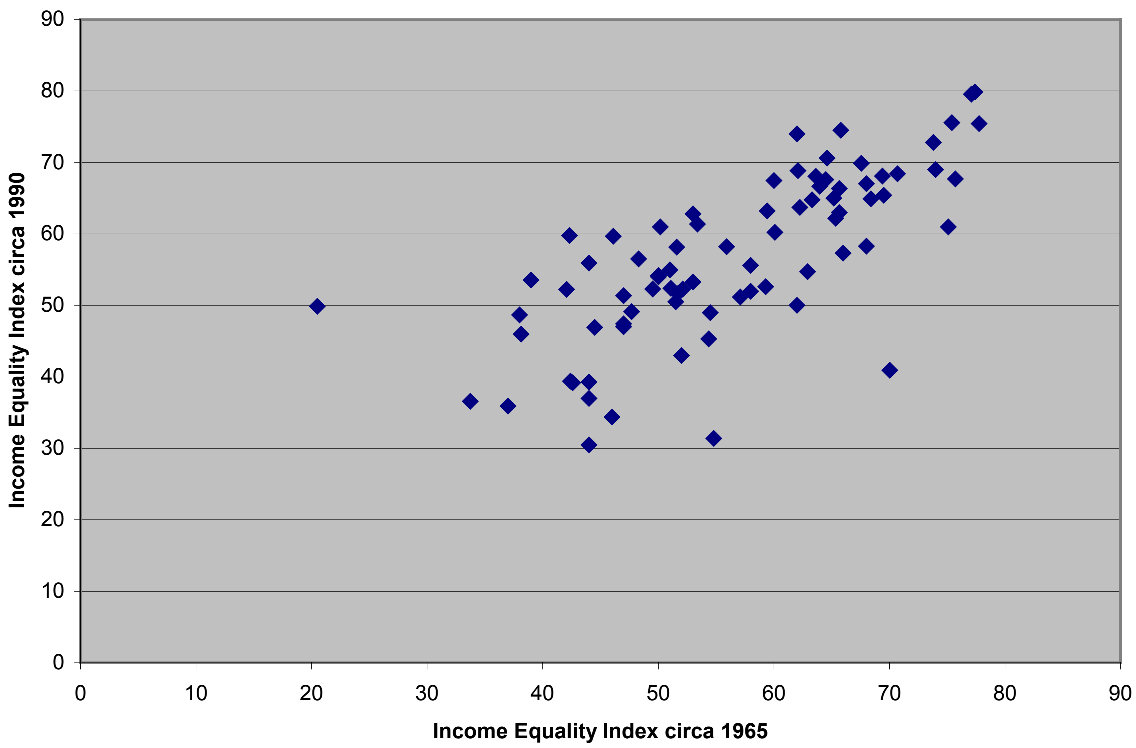


Figure 2. Income Equality of the Years 1965 and 1990 (Largest Possible Sample)



The basic methodology employed here to examine the determinants of a change in income equality is the general-to-specific procedure.[5] First of all, we regress income equality variables (measured by "change" terms) on all candidate regressors. The variable with the lowest *t*-statistic (in absolute value) is then excluded, and the procedure repeated until all of the included regressors are statistically significant at the 5% significance level. The regressors that survive this procedure qualify to be included in the preferred models. Then, each of the regressors that have not survived the procedure is added to the preferred regressions, and is recruited into the final regressions only if it shows statistical significance at the 5% level. Consequently, by the nature of the procedure, the final regressions are robust to the rejected variables.

3. INCOME INEQUALITY IN GROWTH REGRESSIONS

The majority of existing studies of the growth-inequality relationship rely on parsimonious specifications and report negative and significant coefficients for initial income inequality (Alesina and Perotti, 1996; Chang and Ram, 2000; Deininger and Squire, 1998; Odedokun and Round, 2001; Persson and Tabellini, 1994). Regressions 1 and 2 in Table 4 report the results of such a regression, with only initial GDP per worker included to capture other influences on growth. The coefficient of the income inequality variable is negative and significant at the 10% level for the largest possible sample in Regression 2 (p = 0.0697), but not significant (p = 0.1073) for the reliable data (Regression 1).

The picture changes radically, however, if we include further regressors to capture other influences on growth. In Regressions 3 and 4 of Table 4, we test the impact of income inequality upon subsequent economic growth in a more complete growth model. We use the Bleaney-Nishiyama (2002) model, which contains 13 explanatory variables. The coefficient on the inequality variable now has a *positive* sign and is not statistically significant at all, even at the 10% level (p = 0.2226 in Regression 3 for reliable data; and p = 0.5884 in Regression 4). In other words, initial income inequality now has the

5 Sarel (1997) also used the general-to-specific procedure for his investigations of the determinants of income inequality.

opposite sign and a much smaller *t*-statistic in our benchmark model than in a parsimonious model.[6]

To allow for the possibility that this result may hold for one specific model only, we performed the same test using the models of Sachs and Warner (1997) and Barro (1997). Regressions 5 and 6 report the results for the largest possible sample, using these two models. The inequality variable is statistically significant at the 10% level (*p*-value: 0.089) in the Sachs-Warner model, but the sign is positive.[7] The estimated coefficient on the inequality variable in the Barro model is not statistically significant at the 10% level (*p*-value: 0.189) and has a negative sign. It is clear, therefore, that the apparent negative correlation between initial income inequality and growth is not robust to the enrichment of the model.

Partridge (1997) and Barro (2000) have suggested that the correlation between income inequality and growth may be negative at low levels of per capita income and positive at high levels. We tested this by dividing the sample into high-income and low-income countries using Barro's estimated break point of 7.6279 in a natural logarithm of real GDP per capita (equivalent to $2054.74 in PPP-adjusted real GDP per capita). Table 5 shows the results of this test for the Bleaney-Nishiyama (2002) model. No evidence was found to support the Barro-Partridge hypothesis. The estimated coefficients of income inequality are remarkably similar for high-income and low-income countries for both samples.

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6 The differences in the income inequality coefficient are not the result of the smaller samples in Regressions 3 and 4 compared with Regressions 1 and 2. Regressions 1 and 2 yield virtually the same coefficients if estimated over the same samples as Regressions 3 and 4 respectively (results not shown).

7 We use our variables for tropical climate (CLIMATE) and land-lockedness (INLAND) for the Sachs-Warner model, which amend measurement errors in Sachs and Warner's equivalent variables (TROPICS and ACCESS, respectively). See Data Appendix 1 and Belaney and Nishiyama (2002) for details.

Table 4. Parsimonious Growth Model Specifications and Income Inequality

(Dependent variable: Annual average growth rate of PPP-adjusted real GDP per capita for 1965-90)

	(1) *A typical parsimonious model*	*(2)* *A typical parsimonious model*	*(3)* *BN (2002) model with Gini*	*(4)* *BN (2002) model with Gini*	*(5)* *SW (1997) model with Gini*	*(6)* *Barro (1997) model with Gini*
Type of Gini data sample:	*<Reliable data only>*	*<Largest possible sample>*	*<Reliable data only>*	*<Largest possible Sample>*	*<Largest possible Sample>*	*<Largest possible Sample>*
Variable						
Constant	10.09*	8.70*	-30.27**	-14.06	-18.24	3.08
	(1.70)	(1.73)	(-2.08)	(-1.27)	(-0.34)	(0.54)
Initial Gini coefficient	***-1.85***	***-1.79****	***0.82***	***0.24***	***0.93****	***-0.88***
	(-1.64)	***(-1.84)***	***(1.25)***	***(0.55)***	***(1.73)***	***(-1.33)***
Initial GDP per worker (Y)	-0.10	0.0031	4.68	1.55	-1.59***	-2.56***
	(-0.29)	(0.011)	(1.14)	(0.55)	(-6.02)	(-6.73)
Y squared			-0.42*	-0.22		
			(-1.74)	(-1.30)		
Openness			1.63***	1.73***	9.32***	
			(4.39)	(5.65)	(3.01)	
Life expectancy circa 1965			3.95***	3.61***		5.37***
			(3.22)	(4.00)		(3.50)
Life expectancy circa 1970					10.42	
					(0.39)	
Life expectancy squared					-0.86	
					(-0.25)	
Government savings			0.028	0.058**	0.096***	
			(0.70)	(2.48)	(3.75)	
Tropical climate			-0.98***	-0.74***	-0.80**	
			(-3.44)	(-2.97)	(-2.52)	
Institutional quality			0.34***	0.27***	0.25**	
			(3.94)	(3.78)	(2.55)	
Primary product exports			-2.26	-3.37***	-3.14**	
			(-1.59)	(-3.42)	(-2.34)	
Labour force growth minus pop. growth			1.40***	1.59***	1.40***	
			(3.76)	(4.53)	(3.22)	
Democracy			5.96***	5.06***		2.78
			(4.49)	(4.74)		(1.54)
Democracy squared			-4.95***	-4.38***		-2.08
			(-3.94)	(-4.40)		(-1.27)
Male schooling			0.33**	0.31**		5.86***
			(2.24)	(2.24)		(3.00)
Terms of trade growth			0.22***	0.14**		0.20**
			(3.14)	(2.14)		(2.17)
Openness times Y					-0.87**	
					(-2.31)	
Land-lockedness					-0.49	
					(-1.52)	
Male schooling times Y						-0.58***
						(-2.72)
Fertility ratio						-0.11
						(-0.17)
Government consumption						-9.01***
						(-2.78)
Rule of Law						3.28***
						(5.73)
Average inflation rate						-0.0084
						(-1.09)
Adjusted R-squared	0.016	0.024	0.922	0.918	0.847	0.765
Standard error	1.863	1.954	0.505	0.547	0.760	0.907
No. of observations	54	77	42	59	69	60

Note: Initial Gini coefficients are in a natural log form. Figures in brackets are *t*-statistics. Three asterisks *** denote significance at the 1% level. Two asterisks ** denote significance at the 5% level. One asterisk * denotes significance at the 10% level.

Table 5. Testing the Barro-Partridge Hypothesis

(Dependent variable: Annual average growth rate of PPP-adjusted real GDP per capita for 1965-90)

Type of Gini data sample:	***(7)*** *Reliable data only*	***(8)*** *Largest possible sample*
Constant	-30.17**	-14.32
	(-2.06)	(-1.28)
Initial Gini coefficient (High- income countries)	***0.92***	***0.26***
	(1.37)	***(0.57)***
Initial Gini coefficients (Low-income countries)	***0.84***	***0.29***
	(1.27)	***(0.64)***
Initial GDP per worker	4.84	1.43
	(1.17)	(0.50)
Initial GDP per worker squared	-0.44*	-0.21
	(-1.80)	(-1.21)
Openness	1.58***	1.74***
	(4.19)	(5.62)
Life expectancy	3.86***	3.72***
	(3.12)	(3.95)
Government savings	0.033	0.057**
	(0.82)	(2.38)
Tropical location	-1.00***	-0.76***
	(-3.47)	(-2.98)
Institutional quality	0.35***	0.27***
	(4.00)	(3.70)
Primary product exports	-2.04	-3.44***
	(-1.40)	(-3.41)
Labour force growth	1.37***	1.58***
	(3.62)	(4.47)
Democracy	6.10***	4.97***
	(4.53)	(4.52)
Democracy squared	-4.99***	-4.32***
	(-3.94)	(-4.27)
Male schooling	0.36**	0.29**
	(2.36)	(2.03)
Terms of trade growth	0.24***	0.14**
	(3.22)	(2.04)
Adjusted R-squared	0.921	0.916
Standard error	0.509	0.552
No. of observations	42	59

Note: Initial Gini coefficients are in a natural log form. Figures in brackets are *t*-statistics. Three asterisks *** denote significance at the 1% level. Two asterisks ** denote significance at the 5% level. One asterisk * denotes significance at the 10% level.

4. THE EVOLUTION OF INCOME INEQUALITY

We turn now to the dynamics of income inequality. We investigate what determines the evolution of a country's income distribution between 1965 and 1990. In the absence of significant theoretical guidance, we start with a rich specification including a large number of candidate variables, which are eliminated one by one using a general-to-specific modeling procedure. Initially we include all the variables from the growth models of Barro (1997), Bleaney and Nishiyama (2002) and Sachs and Warner (1997) – as listed in Table 4 - together with initial income equality and the residuals from the Bleaney-Nishiyama model, for both the reliable data and the largest possible sample. The residuals from a growth model are included in order to test whether the element of growth that is not correlated with the other regressors significantly influences the evolution of income inequality.

We could not detect any pattern to the order in which variables were eliminated during the procedure. Guatemala and Zambia are obvious outliers because of their extraordinarily large changes in income equality (see Appendix 2), so we exclude them from the sample throughout. The procedure for eliminating regressors resulted in somewhat different preferred models for the two samples, which is perhaps not surprising given the difference in the number of observations (47 for the sample of reliable data, and 69 for the largest possible sample). The results appear in Table 6. In the reliable sample (Regression 9), tropical location was found to have a strong negative impact on the change in income equality, whilst democracy and government savings have a significant positive impact. In the larger sample of less reliable data (Regression 10), the fertility ratio has a significant negative impact on the change in income inequality. The only variable which is significant in both samples is the index of initial income equality, which has a highly significant negative coefficient. This suggests strong convergence of income equality, independent of other factors (as Ravallion (2001) also found for a sample of regions within a given country). It is possible that this simply reflects measurement error – if measurement errors in income inequality (X) at different dates are only partly correlated, then there will be apparent mean-reversion in X because of mean-reversion in the measurement-error component of X. The measurement-error hypothesis would suggest, however, that mean-reversion would be weaker for more reliable data. The fact that this does not emerge from Table 6 suggests that convergence in income equality is a genuine feature of the data. In order to test the robustness of the results to outliers, we omitted the observations with the largest residuals. The results are shown in Table 7.

Table 6. Determinants of Changes in Income Equality

(Dependent variable: Annual average change in the income equality index for 1965-90)

Variable	(9) ***<Reliable data only>*** *Dependent variable: Change in income equality index (CEQ)*	(10) ***<Largest possible sample>*** *Dependent variable: Change in income equality index (CEQLP)* *(priori* excluding two outliers: Guatemala and Zambia)
Constant	1.33***	1.76***
	(4.49)	(4.68)
Government savings	0.044***	
(CGB7090)	(3.34)	
Tropical location	-0.39***	
(CLIMATE)	(-3.73)	
Democracy	0.29**	
(DEMO75)	(2.67)	
Log fertility ratio in 1965		-0.41***
(FERT65L)		(-3.81)
Initial income equality index	-0.024***	-0.020***
(EQ65 or EQ65LP)	(-5.17)	(-4.56)
Adjusted R-squared	0.414	0.227
Standard deviation of residuals	0.238	0.287
No. of observations	47	69
Order in which regressors were excluded from starting model(the top: excluded first; the bottom: excluded the last)	LGDPEA65 GRES GEAP-POP LLY OPEN6590 TOTGR SXPR ICRGE80 FERT65L LLIFE65 ETHLING SHM25 SHF25	LLY GRES CGB7090 LLIFE65 OPEN6590 SXPR LGDPEA65 ETHLING TOTGR ICRGE80 SHM25 DEMO75 CLIMATE SHF25 GEAP-POP

Note: Figures in brackets are *t*-statistics. Three asterisks *** denote significance at the 1% level. Two asterisks ** denote significance at the 5% level. One asterisk * denotes significance at the 10% level.

Table 7. Determinants of Changes in Income Equality

(Dependent variable: Annual average change in the income equality index for 1965-90)

Variable	*(11)* **<Reliable data sample>** *Excluding outliers*	*(12)* **<Reliable data sample>** *Adding economic growth rate*	*(13)* **<Reliable data sample>** *Adding two economic growth measures*	*(14)* **<Largest possible sample>** *Excluding outliers*	*(15)* **<Largest possible sample>** *Adding economic growth rate*	*(16)* **<Largest possible sample>** *Adding two economic growth measures*
Constant	1.40***	1.39***	1.39***	1.68***	1.63***	1.64***
	(4.98)	(4.91)	(4.84)	(4.98)	(4.65)	(4.02)
Government savings	0.037***	0.032**	0.032**			
	(2.90)	(2.25)	(2.18)			
Tropical location	-0.37***	-0.36***	-0.36***			
	(-3.76)	(-3.63)	(-3.50)			
Democracy	0.25**	0.24**	0.24**			
	(2.44)	(2.30)	(2.06)			
Fertility ratio				-0.36***	-0.34***	-0.34**
				(-3.64)	(-3.24)	(-2.33)
Initial income equality	-	-	-	-	-0.020***	-0.020***
index	0.024***	0.025***	0.025***	0.020***	(-4.88)	(-4.82)
Economic growth rate	(-5.61)	(-5.64)	(-5.53)	(-5.03)	0.014	
(GR6590)		0.017			(0.73)	
Economic growth rate		(0.76)				0.013
[High-income countries]			0.016			(0.37)
Economic growth rate			(0.46)			0.014
[Low-income countries]			0.017			(0.71)
			(0.75)			
Adjusted R^2					0.253	0.240
Standard error	0.430	0.425	0.410	0.263	0.261	0.263
No. of observations	0.225	0.226	0.229	0.254	64	64
	46	46	46	67		

Notes: The following outliers were detected and excluded: Sierra Leone from regressions (11) to (13), and Malawi and Sierra Leone from regressions (14) to (16).
Figures in brackets are *t*-statistics. Three asterisks *** denote significance at the 1% level. Two asterisks ** denote significance at the 5% level. One asterisk * denotes significance at the 10% level.

The first column of Table 7 (Regression 11) reproduces Regression 9 with the exclusion of the single outlier detected (Sierra Leone). This improves the fit slightly but otherwise makes little difference to the estimated model. We then add the per capita growth rate to this regression (Regression 12). Although the growth rate has a positive coefficient, it is statistically insignificant at any conventional level (p = 0.45). Regression 13 shows that there is no evidence that the growth effect differs between high-income and low-income countries, again using Barro's (2000) break point – the coefficient is almost identical for the two sets of countries.

Regressions 14 to 16 repeat the same exercise for the larger sample of less reliable data. Regression 14 excludes two outliers (Malawi and Sierra Leone) from Regression 10, which makes the fertility ratio coefficient slightly less negative but otherwise has little effect. Again the growth rate is insignificant (Regressions 15 and 16).

Table 8. Structural instability: developed versus developing countries

(Dependent variable: Annual average change in the income equality index for 1965-90)

Variable	*Largest possible sample (17)*	*Largest possible sample (18)*	*Largest possible sample (19)*	*Reliable data sample (20)*
Constant	1.68***	1.01**	0.40**	0.94***
	(4.98)	(2.41)	(2.48)	(2.83)
Fertility ratio	-0.36***	-0.18		
	(-3.64)	(-1.32)		
Government savings				0.034***
				(2.71)
Tropical climate				-0.25**
				(-2.10)
Democracy				0.23*
				(1.91)
Initial income equality index	-0.020***	-0.013***	-0.0071**	-0.017***
	(-5.03)	(-3.04)	(-2.46)	(-3.29)
OECD		1.64**	1.82***	1.39**
		(2.10)	(4.31)	(2.42)
OECD times fertility ratio		-0.043		
		(-0.14)		
OECD times initial income equality		-0.024***	-0.026***	-0.021**
		(-2.80)	(-3.86)	(-2.37)
Residuals sum of squares	4.142	3.435	3.815	1.803
Adjusted R^2	0.263	0.359	0.327	0.479
Standard error	0.254	0.237	0.233	0.215
No. of observations	67	67	74	46
Chow Tests		F (3, 61) =4.185***		F (5, 36) = 1.941

Note: Figures in brackets are *t*-statistics. Three asterisks *** denote significance at the 1% level. Two asterisks ** denote significance at the 5% level. One asterisk * denotes significance at the 10% level. The 10%, 5% and 1% significance level of F (3, 61) are 2.18, 2.76 and 4.13, respectively. The 10%, 5% and 1% significance level of F (5, 36) are 2.00, 2.45 and 3.51, respectively.

It is possible that the evolution of income distribution has followed a significantly different pattern in developing countries from in OECD countries. Indeed this is suggested by the data in Table 2: the OECD not only has the most equal income distribution in 1965, but also the greatest subsequent increase in equality, which seems inconsistent with all countries converging to a similar level of inequality in the long run.

This issue is investigated in Table 8, which uses the larger sample of less reliable data in order to maximise the number of developing countries in the sample. Regression 17 reproduces Regression 14 for the purposes of comparison. Regression 18 allows each coefficient to differ for the OECD countries. The resulting Chow statistic is significant at the 1% level, which indicates considerable structural instability. Since the fertility ratio coefficient becomes insignificant once differences between the OECD and the rest of the sample are allowed for, it is omitted from Regression 19, which increases the number of observations by seven.[8] It can be seen from Regression 19 that convergence is estimated to be much faster for the OECD countries (the coefficient of initial equality is –0.033 (= –0.007 – 0.026) rather than –0.007 for the developing countries, and the difference is significant at the 1% level). In addition the estimated long-run equilibrium level of equality is higher for the OECD [67 = (1.82 + 0.40)/0.033 (i.e. a Gini coefficient of 33)], being compared with 57 (= 0.40/0.007) for the developing countries, although the difference is not statistically significant.[9]

Finally Regression 20 shows the effects of adding an OECD dummy and OECD times initial equality to the preferred regression for the reliable data. In this case the other variables remain statistically significant (and there is no evidence that their coefficients are different for the OECD countries).[10]

5. CONCLUSIONS

In this study, we have investigated whether initial income inequality affects growth, and whether growth affects the evolution of income distribution. Our conclusions are negative in both cases. Although there is a negative partial correlation between income inequality and subsequent growth in a cross-country sample, income inequality is statistically insignificant in a multivariate growth regression, and in some specifications even has a positive coefficient.

8 Regression 19 is little altered if we use the same 67 observations as in Regression 17.

9 The point estimate of the long-run equilibrium is where the expected change in equality is zero, so it the ratio of the coefficient of the constant to minus one times the coefficient of initial income equality. The point estimate of the OECD coefficient would only have to be about one standard deviation lower to yield an estimated long-run equilibrium identical to that for developing countries.

10 In this case a Chow test does not reveal evidence of structural instability ($F(5, 36) = 1.94$, compared with a 10% critical value of 2.00), because of the inclusion of these other variables in the model.

The evolution of income inequality across countries appears to be dominated by convergence towards the mean, though at a much faster rate in OECD countries than in the developing world. Since OECD countries tend to have more reliable data, this finding suggests that apparent inequality convergence is not simply an artifact of measurement errors. Although fiscal conservatism, democracy and a temperate climate all appear to promote equality when the smaller sample of more reliable data is used, they lose their statistical significance when countries with less reliable data are included in the sample.

Appendix 1. Descriptions of variables and data sources

Variable	Data Source	**Variable Designation in Source**
[Reliable data sample] Annual average change in the income equality index for 1965-90	Authors, Created from WIDER WIID	CEQ
[Largest possible sample] Annual average change in the income equality index for 1965-90	Authors, Created from WIDER WIID	CEQLP
[Reliable data sample] Initial income equality circa 1965	Authors, Created from WIDER WIID	EQ65
[Largest possible sample] Initial income equality circa 1965	Authors, Created from WIDER WIID	EQ65LP
[Reliable data sample] Initial Gini coefficient circa 1965	Authors, Created from WIDER WIID	GINI65
[Largest possible sample] Initial Gini coefficient circa 1965	Authors, Created from WIDER WIID	GINI65LP
Central government savings/GDP	Sachs and Warner (1997)	CGB7090
Tropical climate	Authors, based on TROPICS in Sachs and Warner (1997)	CLIMATE
Democracy	Barro (1997)	DEMOCRACY75
Fertility rate in 1965 (log)	Barro and Lee (1994)	FERT65L
Annual growth rate of PPP-adjusted real GDP per capita for 1965-90	Sachs and Warner (1997)	GR6590
Growth residuals	Authors	GRES
Real GDP per economically active population in 1965 (log)	Sachs and Warner (1997)	LGDPEA65
Openness to international trade	Sachs and Warner (1997)	OPENNESS
Life expectancy circa 1965 (log)	Barro and Lee (1994)	LLIFE65
Life expectancy circa 1970 (log)	Sachs and Warner (1997)	LIFEE1L
Institutional quality	Sachs and Warner (1997)	ICRGE80
Primary product exports/GDP	Sachs and Warner (1997)	SXPR
Labour force growth minus population growth	Sachs and Warner (1997)	GEAP-POP
Male schooling (secondary plus higher) in 1965	Barro and Lee (1996)	SHM25
Female schooling (secondary plus higher) in 1965	Barro and Lee (1996)	SHF25
Terms of trade growth 1965-90	Authors, Constructed from World Bank (2000). For missing data, *World Tables* 1992 and 1994 were used for TOT70 and TOT90, respectively.	TOTGR
Land-lockedness	Authors, based on ACCESS in Sachs and Warner (1997)	INLAND
Government consumption/GDP	Barro and Lee (1996)	GVXDXE5X
Rule of Law index	Barro (1999)	RULELAW
Inflation rate average, 1965-90	Sachs and Warner (1997)	INFL6590
Ethno-linguistic diversity	Sachs and Warner (1997)	ETHLING
Financial depth average 1965-90	Barro and Lee (1994)	LLY

Note: We amended Sachs ands Warner's (1997) tropical climate variable so that it more accurately represents the proportion of the country that falls between the Tropics of Cancer and Capricorn. This involves some significant reclassifications including Hong Kong as 1 (not 0), Egypt as 0.2 (not 1) and Bangladesh as 0.5 (not 0.1), and rectifying some omissions in the Sachs ands Warner's dataset for this variable.

Appendix 2. Gini coefficients

Country Name	*Gini circa 1965*	*Data description Gini circa 1965*	*Gini circa 1990*	*Data description Gini circa 1990*
Argentina	42 (1961)	G, P, ?, AP	48 (1989)	G, P, M, AP
Australia	32 (1967)*	G, P, AA, AP	41.72 (1990)*	G, H, AA, AP
Austria	29.3 (1970)*	G, P, AA, IR	31.6 (1987) *	SPDS
Bahamas	48.41 (1970)*	G, H, AA, AP	41.83 (1991)*	G, H, AA, AP
Bangladesh	34.34 (1966)*	G, H, AA, AP	37 (1986)*	G, H, AA, AP
Barbados	36.2 (1962)	I, P, AA, T	NA	
Belgium	36.37 (1969)*	G, H, AA, T	31.9455 (1992)*	G, H, AA, AP
Bolivia	53 (1968)*	G, P, AA, AP	42.04 (1990)*	E, P, AA, AP
Botswana	57.4 (1971)	I, P, AA, EA	54.21 (1986)*	E, H, AA, AP
Brazil	57.61 (1970)*	G, H, AA, AP	60.6 (1990)*	G, HC, AA, AP
Bulgaria	22.23 (1965)*	G, P, AA, AP	24.53 (1990)*	SPDS
Canada	31.61 (1965)*	G, H, AA, AP	35.0807 (1991)*	G, H, AA, AP
Chad	35 (1958)	G, P, AA, AP	NA	
Chile	45.64 (1968)*	G, H, AA, AP	54.7 (1990)*	G, H, AA, AP
China	30.5 (1964)*	G, H, AA, AP	34.6 (1990)*	G, P, AA, AP
Colombia	62 (1964)*	G, P, AA, AP	51.32 (1991)*	G, P, AA, AP
Costa Rica	50 (1969)*	G, P, AA, AP	46 (1989)*	G, P, AA, AP
Côte d'Ivoire	51.7 (1970)	I, P, AA, EA	36.9 (1988)*	E, HC, AA, AP
Cuba	28.114 (1962)	G, P, AA, IR	NA	
Czechoslovakia	22.6 (1965)*	N, HC, AA, AP	20.1 (1988)*	SPDS
Dahomey (Benin)	42 (1959)	G, P, AA, AP	NA	
Denmark	24.908 (1966)*	G, H, AA, AP	39 (1990)*	G, H, AA, AP
Dominican Republic	45.5 (1969)	G, P, AA, AP	51 (1989)*	G, P, AA, AP
Ecuador	38 (1968)*	G, P, AA, AP	50 (1993)*	G, P, AA, AP
Egypt	40 (1965)*	E, H, AA, AP	32 (1991)*	E, HC, AA, AP
El Salvador	53 (1965)*	G, P, AA, AP	53 (1994)*	G, P, AA, AP
Fiji	46 (1968)*	G, P, AA, AP	NA	
Finland	34.2 (1966)*	G, H, AA, AP	25.5 (1990)*	G, H, AA, AP
France	47 (1965)*	G, H, AA, AP	37.2 (1984)*	G, HC, AA, AP
Gabon	64 (1960)*	G, P, AA, AP	NA	
Germany, West	38 (1964)*	N, H, AA, AP	26 (1990)*	N, H, AA, AP
Greece	44.1 (1965)	I, P, AA, T	35.16 (1988)*	E, H, AA, AP
Guatemala	29.96 (1966)	I, H, R, IR	59.06 (1989)*	G, P, AA, AP
Honduras	61.88 (1968)*	G, H, AA, AP	54 (1990)*	G, P, AA, AP
Hong Kong	49 (1966)*	G, H, AA, AP	45 (1991)*	G, H, AA, AP
Hungary	22.91 (1967)*	N, P, AA, AP	20.42 (1991)*	N, HC, AA, AP
India	31.14 (1965)*	E, P, AA, AP	29.69 (1990)*	SPDS
Indonesia	33.3 (1964)*	E, P, AA, AP	33.18 (1990)*	E, P, AA, AP
Iran	41.88 (1969)*	E, P, AA, AP	42.9 (1984)	E, P, AA, AP
Ireland	36.7 (1973)	N, H, AA, AP	35.2 (1987)*	SPDS
Israel	37.08 (1961)*	I, P, AA, T	45.3 (1992)*	I, P, AA, AP
Italy	40 (1967)*	N, H, AA, AP	32.5 (1991)*	SPDS
Jamaica	41.272 (1971)	E, H, AA, AP	41.1 (1991)*	E, HC, AA, AP
Japan	34.8 (1965)*	G, H, AA, AP	35 (1990)*	G, H, AA, AP
Kenya	63 (1964)	I, P, AA, T	57.5 (1992)*	E, HC, AA, AP
Korea, Republic of	34.34 (1965)*	G, H, AA, AP	33.64 (1988)*	G, H, AA, AP
Lebanon	55 (1960)*	G, P, AA, AP	NA	
Madagascar	53 (1960)*	G, P, AA, AP	46 (1993)*	E, HC, AA, AP
Malawi	45.2 (1969)	I, P, AA, IR	62 (1993)*	E, P, AA, AP
Malaysia	48.3 (1967)*	G, H, AA, AP	48.35 (1989)*	G, P, AA, AP
Mexico	55.5 (1963)*	G, H, AA, AP	53.09 (1989)*	G, P, AA, AP
Morocco	50 (1965)	G, P, AA, AP	39.2 (1991)*	E, HC, AA, AP

Myanmar	35 (1958)	G, P, AA, AP	NA	
Netherlands, The	35.4 (1967)*	N, H, AA, T	29.3846 (1991)*	N, HC, AA, AP
New Zealand	57.7 (1965)	I, P, AA, T	40.21 (1990)*	G, H, AA, AP
Niger	34 (1960)*	G, P, AA, AP	36.1 (1992)*	E, HC, AA, AP
Nigeria	57.94 (1970)*	N, P, AA, T	41.15 (1992)*	E, P, AA, AP
Norway	36.04 (1967)*	N, H, AA, AP	33.31 (1991)*	SPDS
Pakistan	35.51 (1966)*	G, H, AA, AP	32.38 (1988)*	G, H, AA, AP
Panama	48 (1969)*	G, P, AA, AP	57 (1989)*	G, P, AA, AP
Peru	61 (1961)*	G, H, AA, AP	46.43 (1991)*	G, H, AA, AP
Philippines	50.5 (1965)*	G, H, AA, AP	47.7 (1991)*	SPDS
Poland	26 (1965)	I, P, AA, AP	31 (1990)*	G, H, AA, AP
Portugal	40.58 (1973)	N, H, AA, AP	36.76 (1990)*	N, H, AA, AP
Puerto Rico	52.32 (1969)*	G, H, AA, AP	50.86 (1989)*	SPDS
Senegal	56 (1960)*	G, P, AA, AP	54.12 (1991)*	E, P, AA, AP
Sierra Leone	56 (1968)*	G, P, AA, AP	62.9 (1989)*	E, HC, AA, AP
Singapore	49.83 (1966)*	G, P, AA, EP	39 (1989)*	G, H, AA, AP
South Africa	56 (1965)	I, P, AA, AP	63 (1990)*	G, HC, AA, AP
Spain	31.99 (1965)*	G, H, AA, AP	32.99 (1991)*	G, H, AA, AP
Sri Lanka	47 (1963)*	G, H, AA, AP	46.7 (1987)*	SPDS
Sudan	38.72 (1968)*	G, H, AA, AP	NA	
Surinam	30 (1962)*	G, P, AA, AP	NA	
Sweden	37.9242 (1967)*	G, H, AA, AP	31.112 (1992)*	SPDS
Taiwan	32.43 (1966)*	N, P, AA, AP	30.11 (1990)*	SPDS
Tanzania	54 (1964)*	G, P, AA, AP	59.01 (1991)*	E, P, AA, AP
Thailand	42.9 (1968)*	G, H, AA, AP	48.8 (1990)*	G, H, AA, AP
Trinidad and Tobago	53.9 (1971)	G, H, AA, AP	40.3 (1992)	I, HC, AA, AP
Tunisia	42.3 (1965)*	E, P, AA, AP	41 (1990)*	E, P, AA, AP
Turkey	56 (1968)*	G, H, AA, AP	44.09 (1987)*	G, H, AA, AP
Uganda	40.7 (1970)	I, P, AA, AP	40.78 (1992)*	E, P, AA, AP
Ukraine	24.6 (1968)*	I, P, AA, EP	24.4 (1989)*	I, P, AA, EP
United Kingdom	24.3 (1965)*	N, H, AA, AP	32.3 (1990)*	SPDS
United States	34.64 (1965)*	G, H, AA, AP	37.8 (1990)*	SPDS
Uruguay	44.9 (1967)	I, H, AA, AP	NA	
USSR	26.2 (1968)*	I, P, AA, EP	27.2 (1989)*	I, P, AA, EP
Venezuela	42 (1962)	G, P, AA, AP	44.4 (1990)*	G, P, AA, AP
Yugoslavia	30.6 (1965)*	G, P, AA, IR	31.88 (1990)*	SPDS
Zambia	79.5 (1970)	I, P, AA, IR	43.51 (1991)*	E, P, AA, AP
Zimbabwe	66.27 (1968)	I, P, AA, IR	56.83 (1990)*	E, P, AA, AP

Note: Figures in brackets are the years of observations. In the second and the fourth columns, an asterisk "*" indicates that the data are categorised as reliable data in our dataset. Data were categorised as reliable in our dataset if they satisfied both of the two criteria: 1) data are categorised as "reliable data" in the WIID; 2) A gap between the year of observation and the year of concern (1965 or 1990) is no more than 5 years. In columns of data description, income definition, reference unit, area coverage and population coverage are shown in order. 1) Income definition: G= Gross income; N= Net income; I= other income, or no information on the type of income is available; E: Expenditure. 2) Reference unit: H= Household; P= Person; HC=Household per capita. 3) Area coverage: AA=All area; M= Metro Area; R= Rural area; ?= no information given. 4) Population coverage: AP=All population; IR=Income recipients; T=Tax payers; EA=Economically active population; EP=Employed population. In the fifth column, SPDS means that the data around 1990 are from the Same Primary Data Source of the data around 1965 and also the data share the identical data definition with the data employed for 1965. When data circa 1990 is available and data circa 1965 is not available, such country samples were not included in our dataset for the nature of our analysis. The figures shown are pre-adjustment values. For our analysis, +6.6 was added to the figures shown, if income definition is expenditure. Our income equality indices were constructed by [100 – Gini coefficient]. As for the change variables, which we created for the dependent variables, only if all the data used in the calculation are reliable data, the created figures were categorised as reliable data; otherwise, the created figures were included only in the largest possible sample.

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