AN EMPIRICAL ANALYSIS OF THE RELATIONSHIP BETWEEN INCOME INEQUALITY AND GROWTH VOLATILITY IN 70 COUNTRIES FOR 1960-2002

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Abstract
The aim of this paper is to study the potentially simultaneous relationship between income inequality and growth volatility for seventy countries between 1960 and 2002. Two types of analysis are performed; a cross-sectional analysis based on country averages of all available annual observations, and a panel-data analysis with fixed effects based on 6-year averages. The cross-sectional and panel estimation results are markedly different. In the first case, there seems to be a mutual relationship between inequality and volatility across countries, but several significant coefficients have illogical signs. In the second case, there is no evidence of simultaneity within a country; inequality is influenced by volatility, but inequality does not have a direct effect on volatility. Given the limitations of the cross-sectional analysis, we believe that the simultaneous relationship found in the cross-sectional model is rather spurious than real.

JEL classification: C33, O11, O15, O49
Key words: income inequality, GDP growth volatility, panel data.

1. Introduction

During the 1960s and 1970s economic growth was in the focus of mainstream economics and with the emerging literature on endogenous growth the 1980s experienced a startling revival of interest in this issue. Yet, the possibility of a one-way or mutual relationship between income inequality and growth volatility is a relatively new research area, only beginning to gather momentum at the early 1990s. Many papers have been published since then on his topic. Some of them study the factors that are likely to affect income or wealth inequality, the rate of economic growth or its volatility, and thus have potential ramifications for the link between them. Others consider the possible determinants of inequality and volatility in their direct attempt to explain the relationship between them.

For example, Galor and Zeira (1993) discuss the theoretical link between wealth and income distribution on the one hand and macroeconomic issues, such as economic growth and sectoral adjustment, on the other hand, through investment in human capital. Using an open economy equilibrium model with overlapping generations, inter-generational

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Acknowledgement: We are grateful to Michael Schneider and Gábor Körösi for their helpful comments. The usual caveat applies for responsibility.
The views expressed in this paper are of the authors and not those of the State Government of Victoria or the Victorian Department of Treasury and Finance.

altruism and credit market imperfections the authors show that wealth distribution can have significant impact on aggregate economic activity both in the short and in the long run. They demonstrate that, in accordance with Kuznets' hypothesis, richer countries are characterized by more equal income distribution, and that countries with more equal initial wealth distribution enjoy faster growth and become richer in the long run.

Durlauf (1994) surveys a body of literature that seeks to explain long-run income inequality by strong neighbourhood spillover effects which preserve economic status across generations. For instance, drawing on the theories of endogenous growth and endogenous policy, Persson and Tabellini (1994) argue that economic growth is largely determined by the accumulation of physical and human capital. The incentive to do so is due to the ability of individuals to ripe the benefits of their efforts, which in turn is crucially determined by tax and regulatory policies. The authors set up an overlapping-generations model to capture this idea. This model implies a negative relationship between income inequality and subsequent growth, and on the basis of two different samples the authors find evidence to support this proposition. Based on a different model and data set, the theoretical analysis and empirical results of Alesina and Rodrik (1994) also reinforce this finding.

Ramey and Ramey (1995) present evidence for higher business cycle volatility inducing slower economic growth. Namely, on the basis of two panels of countries, they show that countries with higher volatility have lower mean growth rate, and that this relationship holds even after controlling for other country-specific correlates, or for both time- and country-fixed effects. Apparently, the negative impact of volatility on growth stems primarily from the volatility of innovations, while the share of investment in GDP seems to have no role in this relationship as a control variable. Alesina and Perotti (1996) examine how income inequality might fuel social discontent and political instability, and the subsequent adverse reactions by investors. They hypothesize that prolonged inequality increases the likelihood of social unrests and political turmoils, which in turn results in decreased investment and other adverse effects on growth, and they manage to back up this hypothesis empirically.

Bruno and Easterly (1998) challenge the negative relationship between economic growth and high inflation typically found in high frequency data. Examining discrete high inflation crises, they suggest that when the rate of inflation exceeds a certain threshold level (forty percent annually) growth declines sharply but recovers rapidly when the rate of inflation drops back below this threshold value. It is also possible, that the more frequently this happens, the more intensive the growth fluctuations.

Comparing the income distributions of almost fifty countries, Li, Squire and Zou (1998) show that inequality is quite stable within countries but varies considerably among countries. Consequently, inequality must be largely determined by factors that change slowly within countries but differ substantially across countries. Their explanation is twofold. On the one hand, it is a political economy argument whereby the rich have the capacity to protect their wealth; on the other hand, it is a capital imperfection argument whereby the poor have limited access to credit and thus are prevented to make productive investments like education. Their main empirical finding is that the key variables behind inequality are civil liberty, initial educational attainment, financial development, and the initial distribution of land, and that the market imperfection argument is more plausible than the political economy argument.

Aghion, Banerjee and Piketty (1999) argue that permanent volatility in GDP, investment, and interest rates might be due to market imperfection and to unequal access to high-yield investment opportunities across individuals. Aghion, Caroli and Garcia-Peñalosa (1999) study the theoretical framework of the inequality, economic growth relationship from two directions. First they examine the effect of inequality on growth and show that in case of imperfect capital markets greater inequality may have a negative impact on growth, especially in less developed countries. Then the authors review several possible explanations for growth increasing inequality, focusing on trade liberalization, skill-based technical change and organizational change within firms.

Based on cross-country evidence, Banerjee and Duflo (2000) show that the relationship between changes in inequality and the rate of growth is most likely non-linear. In particular, they argue that changes in inequality in any direction are likely to be associated with slower growth in the future, and that this inverted U-shape pattern is consistent with their simple political economy model. Moreover, they find a strong negative relationship between the current change in inequality and past inequality, and also between growth rate and lagged inequality.

According to Easterly, Islam and Stiglitz (2000), many previous attempts to explain growth volatility overemphasised the role of wage and price rigidity while underemphasised the role of the financial system, though the latter one is more important in explaining growth volatility. They find that both access to credit and the development of the financial system have significantly negative effect on volatility.

On the basis of a broad panel of countries, Barro (2000) concludes that, although in line with the Kuznets' hypothesis, inequality retards growth in poor countries while encourages it in rich countries, there is little evidence for an overall relationship between income inequality and the rate of growth.

Forbes (2000) argues that cross-country empirical works supporting a negative relationship between inequality and growth have three common problems.[1] First, the significant negative effect of inequality on growth is often sensitive to the inclusion of additional independent variables, such as regional dummy variables. Second, they suffer from measurement error and from omitted-variable bias. Third, they are unable to tell how a change in a country's level of inequality is related to growth in that country. In order to address these issues, the author performs a panel-data analysis of growth for a sample of 45 countries from 1966 to 1995, and models the five-year average annual growth rate on lagged inequality, per capita income, male and female education, market distortion, country dummy variables to control for time-invariant omitted-variable bias, and with period dummies to control for the effects of global shocks that are not captured by the other explanatory variables. The results suggest that, at least in the short- and

[1] See e.g. Alesina and Perotti (1994) and Persson and Tabellini (1994).

medium-run, an increase in a country's level of income inequality is positively correlated with subsequent economic growth. Iyigun and Owen (2004) study the relationship between income inequality and volatility in aggregate consumption and also in income growth. In particular, the authors focus on causality from inequality to volatility, without explicitly considering the possibility of reverse causation from volatility to inequality. Their principal line of reasoning is that borrowing constraints faced by individuals vary with income, and if the degree of constraint faced by the middle class is reflected by the country's per capita income, then in poorer countries greater inequality is likely to lead to less fluctuation in aggregate consumption, while in rich countries greater inequality is likely to result in more fluctuating aggregate consumption. To support these predictions empirically, the authors estimate panel-data models of income and consumption volatility measured over nine-year periods for a sample of 27 countries from 1969 to 1992 as functions of lagged income inequality, real per capita income, the interaction between them, the growth rate of income or consumption, the mean and standard deviation of inflation, and fixed country-specific and period-specific effects. They find a robust link from income inequality to consumption growth variability, and also evidence in favour of the hypothesis that poorer countries characterised by greater income inequality experience less fluctuation in consumption growth, whilst richer countries characterised by greater income inequality experience more fluctuation. However, as regards the relationship between income inequality and volatility in real GDP per capita growth, the results are far less convincing.

Unlike Iyigun and Owen (2004) who concentrate on the possible causal relationship from income inequality to macroeconomic volatility, Breen and Garcia-Peñalosa (2004) focus on the impact of macroeconomic volatility on income inequality across countries. They argue that if volatility affects income distribution at all, it must be via its effect on the perception of risk through wage setting, human capital investment, or labour supply decisions. Based on this idea, the authors run cross-country regressions for 80 countries regressing inequality in or around 1990 on growth rate volatility over 1960-1990, squared volatility, and average measurements of civil liberty, relative labour productivity, and other explanatory variables. Their reasoning in favour of a cross-sectional analysis as opposed to a fixed-effects panel-data analysis is threefold: the use of panel data halves the number of countries that can be included in the analysis, single averages calculated from a long span of data assure that risk is not disguised by output shocks, and about 90% of the sample variation in inequality is due to variations across countries rather than over time.[2] Overall, Breen and Garcia-Peñalosa (2004) conclude that greater GDP volatility is associated with a higher degree of inequality, and that civil liberties and relative labour productivity are also important determinants of income distribution.

Combining the arguments of Iyigun and Owen (2004) and Breen and Garcia-Peñalosa

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[2] On the basis of five-year periods, Breen and Garcia-Peñalosa (2004) also experimented with time varying Gini coefficients. However, instead of estimating a country fixed-effects model, they regressed this dependent variable on its own lagged value, on the time-invariant measure of volatility, and on other time varying explanatory variables. The results indicate that volatility and lagged inequality have significant impact on current volatility, while the other explanatory variables, except some regional dummies, are insignificant.

(2004), the aim of this paper is to study the potentially simultaneous relationship between income inequality and growth volatility in a panel of seventy countries during the period 1960-2002. Building on earlier studies we perform two types of analysis. First we derive a cross-sectional dataset from all available annual observations and perform a cross-country analysis. Then we break the sample period into seven 6-year sub-periods and perform a panel-data analysis with fixed country and period effects. Our results demonstrate that the two approaches are not interchangeable, they lead to completely different conclusions. In the first case, there seems to be a mutual relationship between inequality and volatility across countries, but several significant coefficients have illogical signs. In the second case, there is no evidence of simultaneity within a country; inequality seems to be influenced by volatility, but inequality does not have a direct effect on volatility. We agree with Forbes (2000) regarding the limitations of the cross-country analysis and believe that the simultaneous relationship found in the cross-sectional model is rather spurious than real.

The rest of this paper unfolds as follows. In Section 2 we discuss the technical details, including the model, the data, and the estimation method. The empirical results are presented and discussed in Section 3, and the concluding remarks are in Section 4.

2. Technical Details

Model: Building on earlier studies, our purpose is to model the relationship between income inequality and growth volatility in a sample of 70 countries between 1960 and 2002. There are several key elements behind our analysis, such as the role of inflation (Bruno and Easterly; 1998; Iyigun and Owen, 2004), government expenditure (Breen and Garcia-Peñalosa, 2004), education and human capital (Persson and Tabellini, 1994; Li, Squire and Zou, 1998; Checchi and Garcia-Peñalosa, 2004), economic and financial development (Li, Squire and Zou, 1998; Easterly, Islam and Stiglitz, 2000; Breen and Garcia-Peñalosa, 2004), civil liberty and socio-political stability (Alesina and Perotti, 1996; Li, Squire and Zou, 1998; Breen and Garcia-Peñalosa, 2004), but the two most important ones are access to credit (Galor and Zeira, 1993; Li, Squire and Zou, 1998; Easterly, Islam and Stiglitz, 2000; Iyigun and Owen, 2004), and the perception of risk (Caroli and Garcia-Peñalosa, 2002; Checchi and Garcia-Peñalosa, 2004; Breen and Garcia-Peñalosa, 2004).

According to Owen and Iyigun (2004), in rich countries where credit access is abundant, greater inequality increases aggregate consumption volatility, while in poorer countries where credit access is constrained, greater inequality is expected to result in more even aggregate consumption. Complementing this argument with Breen and Garcia-Penalosa's (2004) regarding the effect of volatility on inequality via the perception of risk, we can establish the following two scenarios. On the one hand, in high-income economies greater income inequality incites more agents to seek credit in order to keep up their consumption during downturns, leading to higher aggregate consumption variability and growth volatility. This in turn increases the perception of risk involved in economic decisions concerning labour supply, human capital investment and wage setting, prompting lower wage demand and higher labour supply, and thus further increasing inequality. On the other hand, in low-income economies greater income inequality implies that fewer agents have access to credit, and consumption variability and growth volatility are likely to fall. This decreases the perception of risk, encouraging wage demands, lowering labour supply, and ultimately reducing inequality. Moreover, smaller volatility might induce faster growth, raising aggregate income to a high-income level where the majority of agents gains access to credit.

In order to capture the interrelationship between income inequality and growth volatility, we build our empirical analysis on a simultaneous model consisting of the following 'Volatility' and 'Inequality' equations:

$$V_{i,t} = b_{10} + b_{11}I_{i,t} + b_{12}I_{i,t}*Y_{i,t} + g_1\boldsymbol{X}_{1,i,t} + e_{1,i,t}$$
$$I_{i,t} = b_{20} + b_{21}V_{i,t} + b_{22}V^2_{i,t} + g_2\boldsymbol{X}_{2,i,t} + e_{2,i,t}$$

where $V_{i,t}$ denotes some measure of volatility, $I_{i,t}$ is a measure of income inequality, $Y_{i,t}$ is the average real per capita income, $\mathbf{X}_{1,i,t}$ and $\mathbf{X}_{2,i,t}$ are matrices of additional explanatory variables, and $e_{1,i,t}, e_{2,i,t}$ are classical error terms, all for period t and for country i.

Since we estimate these equations simultaneously, there is no need to lag the right-hand side endogenous variables in order to avoid simultaneity bias. The other possible reason to use lagged regressors would be that the dependence of $V_{i,t}$ or $I_{i,t}$ on the explanatory variables is not instantaneous. However, as will be discussed soon in our analysis, the shortest time period is six years, long enough to make lags unnecessary.

Data: Our basic data set is unbalanced; it comprises annual measures of 70 countries over the years 1960-2002. The countries represent all continents: 22 countries from Africa and the Middle East (Algeria, Botswana, Burkina Faso, Central African Republic, Cote d'Ivore, Egypt, Gambia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Morocco, Niger, Nigeria, Senegal, South Africa, Tunisia, Zambia, Zimbabwe), 16 from Europe (Austria, Belgium, Denmark, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Turkey, United Kingdom), 13 from Asia (Bangladesh, Hong Kong, India, Indonesia, Japan, South Korea, Malaysia, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand), 15 from Latin America and the Caribbean (Bolivia, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Venezuela), 2 from North America (Canada, United States), and 2 from Oceania (Australia, New Zealand). In 1995, all OECD countries in our sample but Turkey, as well as Hong Kong and Singapore had at least 50,000 US$ GDP per capita. The variables, for country *i* and period *t*, are defined as follows.

The endogenous variables ($V_{i,t}, I_{i,t}$) are
SDGDPGR: standard deviation of the annual percentage growth rate of real per capita GDP;[3]

[3] It is worth to mention that although the standard deviation is a widely accepted measure of volatility across cross-sectional units, it might not fully capture volatility across time-series observations because it is invariant to ordering. In order to control this possibility, we calculated not only the standard deviation of the annual percentage growth rate of real per capita GDP but also of its first difference. However, in our data sets the two sets of measurements are so strongly correlated with each other ($r \approx 0.92$) that we decided to use only SDGDPGR in this study.

GINI: Gini coefficient;
and $Y_{i,t}$ is defined as *GDPPC*: GDP per capita ('000, constant 1995 US$).

The other exogenous variables included in the $\mathbf{X}_{1,i,t}$ matrix of the 'Volatility' equation are
GRCAP: growth rate of GDP per capita (annual, %);
PGCF: ratio of gross capital formation to GDP (%);
INFL: inflation (consumer price index, annual, %);
SDINFL: standard deviation of inflation (consumer price index, annual, %);
CRED: ratio of credit provided by the domestic banking sector to GDP (%);
FNDP: financial development measured by the ratio of demand, time and saving deposits in deposit money banks and other financial institutions to GDP (%);
RPROD : relative productivity in agriculture, defined as the proportion of agricultural value-added over the proportion of non-urban population (index number, 1995=100);
AS, *AF*, *AM*, *OC*: regional dummy variables for Asia, Africa, America and Oceania.
In the 'Inequality' equation $\mathbf{X}_{2\,j,t}$ contains *GRCAP*, *FNDP*, *RPROD*, *HINC*, *AS*, *AF*, *AM*, *OC*, and
PRGOV: ratio of general government final consumption expenditure to GDP (%);
BSEC: secondary educational attainment of the population aged 25 or over (%);
POLITY: polity score (ranging from -10: strongly autocratic to 10: strongly democratic).

The data have been collected from six sources. The Gini coefficients are from Deininger and Squire (1996), World Development Indicators Online (2004), and World Income Inequality Dataset (UNU/WIDER, 2004).[4] Most of the remaining data are from World Development Indicators Online (2004). The few exceptions are *BSEC* (Barro and Lee, 2000), *POLITY* (Polity2 score from the Polity IV Project[5]), and *PGCF* (dX EconData, World Bank World Tables).

Since two variables are defined as standard deviations (*SDGDPGR*, *SDINFL*), their values had to be computed from several annual observations. Accordingly, the measurements for all other quantitative variables are arithmetic means of the annual observations over the same time periods. From the raw data we derived two datasets. The first is a cross-sectional dataset, calculated from all available annual observations. The second is a panel dataset, calculated from seven blocks of six-year data (1961-66, 1967-72, …, 1997-2002). As part of our preliminary data analyses, we looked for values in the cross-sectional dataset which can distort the regressions. We found only one *SDGDPGR* value which is further from its sample mean than three standard deviations and hence can be deemed an outlier but, as subsequent sensitivity analyses verified, even this value is close enough to the rest of the data points so that not to have a major impact on the results.[6] Then, to check for severe multicollinearity, we calculated pairwise correlation coefficients for the potential explanatory variables. In both data sets, there are only two

[4] Despite our best effort, our compiled annual dataset has Gini coefficient for only one third of all year-country combinations.
[5] Marshall and Jaggers (2002), p. 15.
[6] We estimated several regressions with and without this particular data point, but the results were similar.

correlation coefficients above 0.8. In the 'inequality' equation *GDPPC* is highly correlated with *BSEC*, while in the 'volatility' equation the means and standard deviations of *INFL* are closely related to each other.

Estimation: We performed two types of analysis: cross-sectional regressions and panel regressions with specific effects. Since in the panel regressions our aim was to analyse the country and period effects, we treated them as fixed unknown parameters (fixed effects approach). In order to avoid perfect multicollinearity, we excluded the *AS, AF, AM, OC* dummy variables from the panel regressions, but included a constant term so that the fixed effects estimates add up to zero and represent the deviations from the overall mean. In each case we followed the top-down approach, that is we started with the most general specification and then dropped those right-hand side variables, except $I_{i,t}$ and $V_{i,t}$, which both individually and as a group proved insignificant, and whose omission had no adverse affect on the reduced models.[7] Allowing for simultaneity between *SDGDPGR* and *GINI*, we first estimated system (1) equation-by-equation with the two-stage least-squares (TSLS) method. Our panel-data set is unbalanced, so we tried to select instrumental variables which impose the least restrictions on our sample. We performed two diagnostic tests: the Hausman-Wu test for simultaneity and the Sargan test for the validity of instruments. In order to cope with heteroscedasticity, we used White heteroscedasticity consistent standard errors.

3. Empirical Results

The final TSLS regressions are presented in *Table 1*.[8] The most striking feature of these results is the sharp contrast between the *Cross-sectional* and *Panel* regressions. Firstly, in the cross-sectional 'Volatility' regression inequality has a significant influence on real GDP per capita growth volatility, both on its own and in interaction with the level of real GDP per capita. The estimated marginal effect of *GINI* on *SDGDPGR* is zero when *GDPPC* is 95,710 (1995$), it is positive below this threshold and negative above it. Since in our sample even the highest *GDPPC* value is well below this threshold, in effect inequality increases volatility in each country, but its marginal effect is larger in poorer countries than in richer countries. Four other variables have significantly positive coefficients, implying that, ceteris paribus, on average volatility increases with the ratio of gross capital formation to GDP (*PGCF*), inflation (*INFL*), financial development (*FNDP*), and it is relatively higher in African countries (*AF*). While the second and fourth of these positive relationships are acceptable, the allegedly positive effects of *PGCF* and *FNDP* on *SDGDPGR* can be deemed illogical. On the other hand, in the panel 'Volatility' TSLS regression inequality does not exert any significant influence on real GDP per capita growth volatility, neither directly nor indirectly. Volatility seems to increase with inflation (*INFL*), but decreases with the ratio of gross capital formation to GDP (*PGCF*) and the standard deviation of inflation (*SDINFL*).

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[7] Inevitably, this strategy involved some data mining. Let it be said in our excuse that, as regards the two endogenous variables, economic theory fails to lead to a unique model, and that we tried to keep specification search at its minimum. In order to avoid omitted variable bias, we used a relatively generous, 10 percent significance level.

[8] All calculations were performed with EViews 5.1.

Table 1: Regression Results - TSLS and White standard errors

Independent variables	'Volatility' Equation		'Inequality' Equation	
	Cross-sectional	Panel with fixed effects	Cross-sectional	Panel with fixed effects
Constant	-0.264	2.034	12.011	50.511***
GINI	0.067*	0.008		
GINI ´ GDPPC	-0.0007**	0.0009		
SDGDPGR			13.055***	-2.748*
SDGDPGR^2			-1.067*	0.254*
GRCAP	-0.188			
PGCF	0.131**	-0.044*		
INFL	0.002***	0.012***		
SDINFL		-0.005***		
FNDP	0.922***		-7.658***	
RPROD				-1.386**
BSEC				-0.109**
AF	1.143***			
AM			4.005**	
OC			5.115***	
nobs (ncountry)	70 (70)	314 (70)	69 (69)	320 (69)
R^2	0.619	0.440	0.493	0.790
Adj. R^2	0.575	0.248	0.452	0.722
Hausman-Wu-test	1.251	0.516	3.700**	2.065
Sargan test	0.657	7.544	6.711)	7.257

Notes: a) *, **, and *** indicate significance at the 10, 5, and 1% levels. b) In the 'Volatility' equations we used BSEC and RPROD as instrumental variables for GINI, while in the "Inequality' equations we used GOVGR, SAV, GDPPC and POLITY as instrumental variables for SDGDPGR.

Secondly, in the 'Inequality' regressions expected inequality is a quadratic function of real GDP per capita growth volatility. In the cross-sectional regression this relationship has an inverted U shape[9], the turning point is at *SDGDPGR* = 6.12, and the marginal effect of *SDGDPGR* on *GINI* is positive below this threshold and negative above it. On the other hand, in the panel regression the inequality-volatility relationship has a U shape, the turning point is at *SDGDPGR* = 5.41, and volatility reduces inequality below this threshold but increases it above this threshold. Given that during the sample period only 10% of the countries experience growth volatility above these thresholds, and that high growth volatility seems to be more of a characteristic of poorer countries than of richer ones,[10] the U shape is probably more plausible. It suggests that at low rates growth volatility reduces inequality, but at higher rates volatility and the accompanying uncertainty lead to more unequal income distribution. As for the other regressors, in the cross-sectional regression financial development (*FNDP*) reduces inequality, while in the

[9] In this sense, our cross-sectional results are similar to those of Breen and Garcia-Peñalosa (2004).

[10] The correlation between *GDPPC* and *SDGDPGR* is -0.56 in the cross-sectional sample and -0.33 in the panel sample, suggesting that richer countries tend to experience less growth volatility than poorer countries. In the cross-sectional data set 91% of the countries have smaller *SDGDPGR* than 6.12. In the panel data set 87% of the *SDGDPGR* values are smaller than 5.41.

panel regression larger relative productivity in agriculture (*RPROD*) and higher secondary educational attainment (*BSEC*) lead to more equal income distribution.

Thirdly, in the two cross-sectional regressions the explanatory endogenous variables are strongly significant and the Hausman-Wu test also supports simultaneity between *SDGDPGR* and *GINI*, at least in the 'Inequality' regression. On the other hand, in the panel 'Volatility' regression inequality does not have any significant influence on volatility, and accordingly the Hausman-Wu test does not indicate simultaneity between *SDGDPGR* and *GINI* in either regressions.

Due to this lack of simultaneity in the panel model, the TSLS estimators are inferior to the OLS estimators, so we re-estimated this model with OLS. The results are shown in *Table 2*. As regards the significant regressors and the signs of their coefficients, there is not much difference between the OLS and TSLS results. Most importantly, volatility does not seem to depend on inequality, while inequality appears to be a quadratic function of volatility. Again, this latter relationship has a U shape, but its coefficients are much smaller in absolute value than before, bringing down the turning point to *SDGDPGR* = 4.54. It is also worth to mention that in both equations the fixed effects are jointly significant, though in the 'Volatility' equation only at the 7% level, mainly due to the country effects. Surprisingly, the period effects themselves are jointly insignificant in both equations, but we decided to keep them because more than half of the period dummy variables are significant individually. The crucial differences between the cross-sectional and panel regressions raise the question: which model is better.

Table 2. Regression Results - OLS and White standard errors

Independent variables	Panel with fixed effects	
	'Volatility' Equation	'Inequality' Equation
Constant	3.315***	46.382***
GINI	0.001	
GINI ´ GDPPC	0.0004	
SDGDPGR		-0.554*
SDGDPGR^2		0.061**
GRCAP		0.298**
PGCF	-0.054***	
INFL	0.011***	
SDINFL	-0.005***	
FNDP		
RPROD		-1.437*
BSEC		-0.124**
F-Tests:		
fixed effects	1.304*	8.550***
country fixed effects	1.298*	9.084***
period fixed effects	1.542	1.589
nobs (ncountry)	329 (70)	331 (70)
R^2	0.426	0.810
Adj. R^2	0.243	0.749

Notes: see Table 1, note (a).

First of all, we believe that these differences are not due to output shocks in the panel data set. Income inequality is typically changing very slowly, and as regards the more volatile growth rate of real per capita GDP, six-year averages are most likely sufficient to smooth out sudden changes. On the other hand, given that the cross-sectional model disregards all factors that change in time, as well as those country specific factors that are not sufficiently represented by the included explanatory variables; the cross-sectional parameter estimates are likely to suffer from omitted variable bias. These biases might account for both the seemingly significant inequality to volatility relationship and for the previously mentioned illogical signs of some of the coefficients. Contrary to the cross-sectional model, in the panel model the fixed country and period effects are able to capture all those country- or time-varying factors that are not directly considered in the specification. Finally, as emphasized by Forbes (2000), these fixed effects make possible to study what impact a change in a country's level of income inequality might have on the same country's growth volatility, and vice versa. All things considered, we believe that the panel model is superior, the simultaneous relationship found in the cross-sectional model is rather spurious than real.

4. Summary

In this paper we studied the relationship between income inequality and growth volatility for seventy countries between 1960 and 2002. Building on earlier studies, in particular on Forbes (2000), Owen and Iyigun (2004) and Breen and Garcia-Penalosa (2004), we set up a simultaneous-equation system of 'Volatility' and 'Inequality' and performed two different analyses. First we ran a TSLS cross-sectional regression based on average values computed from all available annual observations for each country and variable. Then we broke the sample period into seven 6-year sub-periods and ran a TSLS panel regression with fixed country and period effects. One of our most important but certainly not unexpected findings is that the two analyses lead to strikingly different results. Namely, in the cross-sectional analysis the data seem to verify a mutual relationship between inequality and volatility across countries, while the panel analysis does not support simultaneity within a country. Since the cross-sectional model is exposed to omitted variable bias which most likely showed up in the illogical signs of some of the significant coefficients, we rejected it and also simultaneity between inequality and volatility, and re-estimated the panel regressions with OLS.

The OLS panel regressions support the TSLS panel results; inequality is unlikely to have a direct effect on volatility, but volatility has a significant influence on inequality. This latter relationship is quadratic, at low rates growth volatility reduces inequality, but at higher rates it leads to more unequal income distribution.

References

Aghion, P., Caroli, E. and Garcia-Peñalosa, C. (1999): Inequality and Economic Growth: The Perspective of New Growth Theories, *Journal of Economic Literature,* vol. 37, pp. 1615-1660.

Alesina, A. and Perotti, R. (1994): The Political Economy of Growth: A Critical Survey of the Literature, *World Bank Economic Review*, vol. 8, pp. 351-371.

Alesina, A. and Perotti, R. (1996): Income Distribution, Political Instability and Investment, *European Economic Review*, vol. 40, pp. 1203-1226.

Barro, R.J. (2000): Inequality and Growth in a Panel of Countries, *Journal of Economic Growth*, vol. 5, pp. 5-32.

Barro, R.J. and Lee, J. (2000): International Data on Educational Attainment: Updates and Implications, *CID Working Paper*, No. 42.

Breen, R. and Garcia-Peñalosa, C. (2004): Income Inequality and Macroeconomic Volatility: An Empirical Investigation, *Mimeo*, Nuffield College, Oxford, p. 36.

Bruno, M. and Easterly, W. (1998): Inflation Crises and Long Run Growth, *Journal of Monetary Economics*, vol. 41, pp. 3-26.

Caroli, E. and Garcia-Peñalosa, C. (2002): Risk Aversion and Rising Wage Inequality, *Economics Letters*, vol. 77, pp. 21-26.

Checchi, D. and Garcia-Peñalosa, C. (2004): Risk and Distribution of Human Capital, *Economics Letters*, vol. 82, pp. 53-61.

Davidson, R. and MacKinnon, J.G. (1989): Testing for Consistency using Artificial Regressions, *Econometric Theory*, vol. 5, pp. 363-384.

Deininger, K. and Squire, L. (1996): Measuring Income Inequality: A New Database', World Bank.

Durlauf, S.N. (1994): Spillovers, Stratification, and Inequality, *European Economic Review*, vol. 38, pp. 836-845.

Easterly, W., Islam, R. and Stiglitz, J.E. (2000): Shaken and Stirred: Explaining Growth Volatility, in *Annual World Bank Conference on Development Economics*, World Bank.

Forbes, K.J. (2000): A Reassessment of the Relationship between Inequality and Growth, *American Economic Review*, vol. 90, pp. 869-887.

Galor, O. and Zeira, J. (1993): Income Distribution and Macroeconomics, *Review of Economic Studies*, vol. 60, pp. 35-52.

Garcia-Peñalosa, C. and Turnovsky, S.J. (2005): Production Risk and the Functional Distribution of Income in a Developing Economy: Tradeoffs and policy Responses, *Journal of Development Economics*, vol. 76, pp. 175-208.

Iyigun, M.F. and Owen, A.L. (2004): Income Inequality, Financial Development and Macroeconomic Fluctuations, *Economic Journal*, vol. 114, pp. 352-376.

Li, H., Squire, L. and Zou, H. (1998): Explaining International and Intertemporal Variations in Income Inequality, *Economic Journal*, vol. 108, pp. 26-43.

Marshall, M.G. and Jaggers, K. (2002): Policy IV Project, Political Characteristics and Transitions, 1800-2002, *Dataset Users' Manual*, University of Maryland.

Persson, T. and Tabellini, G. (1994): Is Inequality Harmful for Growth?, *American Economic Review*, vol. 84, pp. 600-621.

Ramey, G. and Ramey, V. (1995): Cross-Country Evidence on the Link between Volatility and Growth, *American Economic Review*, vol. 85, pp. 1138-1151.

UNU/WIDER (2004): World Income Inequality Database, Version 2.0 beta, United Nations University.

Zeldes, S.P. (1989): Consumption and Liquidity Constraints: An Empirical Investigation, *Journal of Political Economy*, vol. 97, pp. 305-346.

World Development Indicators Online (2004), *World Bank*.

Journal published by the Euro-American Association of Economic Development. http://www.usc.es/economet/eaa.htm