The Causal Relationship between Inequality and Growth

Literature Review

Girija Bahety
Yvonne Giesing
Emel Kayihan
Frederico Lima
Thomas Oechsle
Qianfu Xue

University of Cambridge

February 2010

Introduction

The study of the relationship between growth and inequality, and of the causal links between the two has always been of great interest not only to the economists but to the whole of the social science field. The work done by Nicholas Kaldor and Simon Kuznetz in the 1950s and 1960s (see Kuznetz (1955) and Kaldor (1960)), established a broad consensus within the economics profession that there was an inverse relationship between equality and growth, and that countries must face a trade-off between reducing inequality and promoting growth. However, this view has been challenged by the empirics of the last few decades. Many East-Asian countries started, from relatively low levels of inequality, to experience tremendous economic growth, while many Latin and South American countries, where inequality levels have traditionally been much higher, have performed rather poorly in comparison. This has rekindled interest in the topic and prompted economists to re-examine the relation between growth and inequality once again.

Theoretical Background

Since the empirical work of Kuznets (1955) in particular, the relationship between growth and inequality has intrigued economists focussing on developing and industrialised countries alike. Theoretical arguments for an effect of inequality on economic growth have of late tended to a conclusion of a negative relationship though earlier investigation found distinct incentives for growth embodied in inequality.

Kuznets (1955) found an arching relationship between inequality and income levels. For lower levels of income low inequality was found, increasing to a peak with a middling level of income and decreasing to the initial value when income was maximised.

Many contemporary economists endeavoured to explain the initial trend, that increasing inequality was met by increasing rates of growth. Kaldor (1956) argued that income inequality generates incentives for entrepreneurial activity, that is to say it creates incentives for resources to be channelled into more efficient uses and is therefore conducive to the saving and capital-accumulation required for increasing growth. More recently Edin and Topel (1997) and Siebert (1998) have extended this argument suggesting it encourages more investment in human capital, together with labour specialisation and more risk-taking respectively.

However, the view of a negative relationship between inequality and growth has found greater favour with recent studies, stemming from three main arguments. Wealth effect arguments and Political Economy arguments together with issues surrounding credit market imperfections have been at the heart of most theoretical studies though the savings rates and socio-political unrest have also been given mention (Barro 2000).

Wealth effect arguments stem from the initial premise that there is some relationship between current and future wealth. They suggest that given any initial distribution of wealth both inequality and growth will decrease over time leading to zero growth and complete equality in the long run. This means that the initial endowments determine growth rates in the short run. With unequal endowments the growth rate will be lower if any agent cannot afford the optimal level of investment (Bannerjee and Duflo, 2003).

Political Economy arguments in this field are compelling. If growth is viewed as a hold-up game with two groups of agents, those with relatively great endowments (the rich) and those with lesser endowments (the poor), it may be found that the poor “hold up” by choosing high levels of redistribution even though it hurts growth. This conclusion has been put forward by Alesina and Rodrik (1994), Persson and Tabellini (1991) and Benhabib and Rustichini (1998).

Further arguments in the area of Political Economy suggest that government policies will tend to support redistribution of wealth from the rich to the poor with a greater degree of inequality motivating more redistribution through the political process (see Barro 2000). Such policies have a tendency to distort economic decisions often discouraging work effort through various benefit schemes and so in the long run reducing investment leads to lower growth rates. As a greater amount of inequality encourages greater governmental redistribution it follows that greater inequality has a greater negative impact on growth.

Credit market imperfections have also been argued to cause lower investment as they reflect asymmetric information and the limitations of institutions surrounding investment (Barro 2000). The limited access to credit, which then ensues particularly in the case of the poorer population who have less to use as collateral and to prove themselves creditworthy, reduces investment. In a more equal economy poorer agents would not find themselves in this situation and investment would be increased leading to increased growth.

In addition to the more pivotal theoretical implications of income inequality outlined above, socio-political unrest may also link inequality and growth in a negative fashion. A rise in inequality often leads to increased social unrest, which may involve crime, riots and other disruptive behaviour, leading to a waste of resources. Also unstable political systems often fail to uphold property rights fully, negatively impacting confidence to invest and so leading to lower rates of growth.

Clearly the insight into the relationship between income inequality and growth which theoretical work can give us is limited due to its conflicts. The strength of each argument is clearly dependent on the level of development within each country, which will indicate the power of the poor to hold up growth as in political economy arguments and the ability and willingness of governments to intervene and reallocate endowments.

Whilst the impact of inequality on economic growth is widely discussed in contemporary literature, the inverse relationship has found substantially less favour in economic investigation. Where it is mentioned it is usually assumed that economic growth has a beneficial effect on inequality in the long run or at high levels of growth i.e. when growth spreads across all sectors, though may bequeath adverse effects in the short run or at low to medium levels of growth where only a few agents see the returns of growth (wealth condensation) e.g. in the case of a positive productivity shock in one sector. This thinking is in line with that put forward by Kuznets (1955) and it appears that little substantial work to argue against this conclusion has occurred since that time.

Estimation of the Relationship

Cross Section Regressions

When income growth is regressed on inequality, in general several inequality measures may be used. For example, Clarke (1995) uses four measures: the Gini coefficient, the coefficient of variation, the Theil's index and the ratio of the share of total income earned by the poorest 40 percent of the population to the share of income earned by the richest 20 percent of the population. In order to avoid problems of endogeneity and reverse causation the variables are intended to represent initial inequality.

Computing the simple correlations between inequality measures and the Barro regressors and related variables, Clarke (1995) concludes that inequality is not significantly correlated with any variables except for growth of per capita GDP, level of per capita GDP and enrollment rates in secondary education (and to a lesser extent enrollment rates in primary education). The base cross-country growth regression in Clarke (1995) adds the four inequality variables defined above "to a 'Barro-type' growth regression that includes variables to proxy political instability measures, levels of human capital, size of government and initial GDP per capita (Barro, 1989) (Clarke, 1995, p. 408)". In more detail, the independent variables are initial (i.e. 1970) per capita GDP in constant dollars, primary and secondary enrollment rates lagged ten years, the average number of revolutions and coups per year between 1970 and 1985, the number of assassinations per million people per year between 1970 and 1985, the deviation of the price level for investment in 1970 from sample mean and average government share of GDP between 1970 and 1988. In this regression, the coefficients on all inequality measures are significantly negative, i.e. the regression suggests that high initial inequality is correlated with slow long-run growth (Clarke, 1995, p. 409). Since a primary concern in cross country regressions is that one or two outliers drive the result, Clarke (1995) presents a partial scatter of the residuals from growth and the Gini coefficient regressed on the Barro variables in order to show that this is not the case in his base regression. The coefficients on all inequality variables continue to be significant even after correcting for possible heteroscedasticity.

In order to overcome both the problem regarding the bad quality of the income distribution data (measurement error) and potential endogeneity issues (some of the observations are from the early seventies and a few from the eighties), Clarke (1995) next carries out a two-stage least squares regression. In addition to the Barro regressors the following instruments are used: four regional dummies for Sub-Saharan Africa, Latin and Central America, Asia (excluding Japan), and the Middle East and North Africa, and the square of initial per capita GDP. As a result the coefficients become even more negative than in the OLS regression (and remain significant at the five percent level).

Finally, he also runs an extended regression that includes additional variables, suggested in the empirical growth literature, to the base Barro regression, the sign and significance of the coefficients on the inequality measures is not affected. Moreover, adding an interaction term between regime type (democracy or not) and inequality variables has no effect on the sign or the significance of the inequality variables.

Alesina and Rodrik (1994) and Persson and Tabellini (1994) come to similar conclusions as Clarke (1995) regarding the relationship between inequality and growth. Their cross country growth regressions suggest that greater inequality will slow growth. Levine and Renelt (1992), find however that most variables in the empirical growth literature are highly sensitive to the inclusion, or exclusion, of variables that are found to be significant in other studies.

Keefer and Knack (2002) argue that social polarization reduces the security of property and contract rights. The deterioration of property and contract rights again leads to reduced growth. Polarization in the form of income inequality, land inequality, and ethnic tensions is inversely related to the security of contractual and property rights as measured by the International Country Risk Guide (ICRG). Cross-country evidence suggests that each 5-point rise in Gini corresponds to a decrease in the ICRG index of nearly 1 point, whereby in the ICRG index higher scores are "better" (Keefer and Knack, 2002, pp. 139).

When the security of property rights is controlled for, the relationship between inequality and growth in cross-country regressions declines considerably. The addition of the property rights index reduces the coefficient on income inequality by nearly one-half (Keefer and Knack, 2002, p. 146), which suggests that inequality reduces growth in part through its negative effect on the security of property and contract rights.

Econometric Problems in the Estimation Process

Most of the attempts to measure the relationship between inequality and growth have added inequality as the additional explanatory variable to some variant of Robert J. Barro's cross-country growth regression. These studies mostly found a negative and near-significant coefficient on inequality, hence concluding that there is a negative relationship between growth and inequality. In most of the models the negative association depends on various exogenous factors such as aggregate wealth, political institutions, or the level of development. These studies have predicted multiple equilibria so that under certain initial conditions, inequality could have a positive relationship on growth. Important studies finding a positive relationship are by Gilles Saint-Paul and Thierry Vender (1993), Benabou (1996a) and Oded Galor and Daniel Tsiddon (1997a, b). These studies are, however, subject to a number of potential problems.

Many of the estimates suggesting a significant negative effect of inequality on growth are not robust. When additional explanatory variables or regional dummy variables are included, the coefficient on inequality often becomes insignificant (while still being negative).

If a variable that helps in explaining the economic growth of a country is not included in the cross-country growth regression, coefficient estimates and standard errors will be biased. In a multivariate regression, it is impossible to predict the direction of omitted-variable bias. However, strong univariate correlation between an omitted variable, inequality and growth can outweigh the multivariate effects and generate a significant predictable bias. Omitting variables like a country's degree of capitalism, support for entrepreneurship or amount of labour-market flexibility can result in a significant positive bias in the estimate, while omitting variables like the level of corruption can generate a negative bias. Also, since the explanatory variables affecting growth are numerous, it is impossible to explain or measure the impact of omitted variables on estimates in growth regressions. Regional dummy variables with significant coefficients included in the regression indicate that region-specific factors affecting growth are not captured by the explanatory variables and hence pose the problem of omitted-variable bias.

The issue of measurement error is pervasive in all econometric work, and the study of growth and inequality is no exception. It is especially important to consider it since it can lead to potentially strong biases, whose direction can be difficult to establish.

The main issues here are with regard to the measurement of income and inequality. Income is a variable naturally prone to measurement error. It is sensitive to survey design, and therefore it is important to know the characteristics of the survey through which the data was collected. In particular, it is important to know whether income was reported as a number or as a range, since in the latter the top range also defines the top income and that obviously creates measurement error at the top of the income scale. Knowing these cut-off points in the survey is of interest. Some surveys also allow households to report negative incomes, while most do not, and some look at pre-tax income, while others focus only on post-tax values (Clarke, 1995, p. 406). Different countries use different survey instruments and methodologies, so any cross-country comparison requires knowledge of any potential discrepancies. While this may not be a huge issue for cross-country comparisons within the OECD, it is important to consider when extending the analysis to other countries. In addition, response rates vary greatly over countries and over time. For example, response rates are usually higher in the US compared to Western Europe. Typically, response rates are lower for rich households and for the poorest households. This is another potential source of bias at both ends of the income scale, and has been analysed by a recent paper by Korinek, Mistlaen and Ravallion (2006).

Even if measurement error does not massively affect the estimation of mean income, it will certainly increase the measure variance of income, and thus inflate measured income inequality. As described in Deaton (2003), there are conceptual and practical issues with measuring inequality. Following work by Atkinson (1970) and Sen (1973), there is a set of axioms, which any reasonable measure of inequality should follow. However, these merely lead to only a partial ordering of income distributions. This means that sometimes it is possible to say unambiguously that one distribution is more unequal than another, but at other times the ranking of one distribution over another will depend on the specific measure of inequality we choose, with different measures giving potentially different results. In fact, different measures give emphasis to different aspects of the income distribution. For example, the Gini coefficient is more sensitive to inequality at the top of income distribution, and measures using the log of income or its variance will be more sensitive to inequality at the bottom. Hence it follows that the Gini coefficient will be quite sensitive to measurement error at the top of the income distribution, and therefore will tend to overstate the level of inequality. The choice of a measure of inequality should consider underlying problems with the data and always carries some value judgement.

Anand and Segal (2008) review the issues in inequality measurement from a global perspective and make the following argument. When income is reported in ranges or bands, as it is most common, most studies assume equal incomes inside those intervals, that is, they assume minimum inequality within bands. This is another source of measurement error that leads to downward bias of within country inequality, and sets a lower bound for true inequality. The authors suggest computing an upper bound for inequality by computing the same estimates but assuming maximum inequality within bands. Comparison of the two values is a good way of determining if this has any significant effect on inequality measurement.

Panel Data Regressions

In cross-section analysis, observations drawn from countries at different income levels are used to approximate the evolution of income in a single country. Panel data estimation involves observations across time for each country as well as across countries. Using panel data estimation instead of the standard cross country data reduces the omitted variable bias. Panel estimation controls for differences in time-invariant, unobservable country-specific characteristics, hence removing any bias that can result from the correlation of these characteristics with the explanatory variables. Though panel data cannot entirely remove the omitted variable bias especially with variables whose value change over time, recent studies have shown that panel data estimation can significantly change coefficient estimates. Panel data specifically helps in explaining how a change in a country's level of inequality can help predict the change in the country's economic growth rate. However, panel data estimation requires observations across time for each country, as well as across countries and the scarcity of inequality or any other variable data for such long periods poses problems in the estimation.

Deininger and Squire (1996) have compiled a more comprehensive and consistent data on inequality by assembling as many income distribution variables as possible and later filtering them based on some qualifying standards. The data covers a significantly greater number of countries and hence has a greater number of observations than any other studies done so far. This data set has minimised the problems of measurement error and omitted-variable bias and hence increased the efficiency of the estimates.

While considering various techniques of estimation, three factors have to be considered: the relationship between the country-specific effect and the regressors, the presence of a lagged endogenous variable (like income) and the potential endogeneity of other explanatory variables. The methods of estimation will be either fixed effects or random effects. The fixed effects estimates are calculated from differences within each country across time. The random effects method estimates incorporate information across countries as well as across time periods and hence are efficient. But it is consistent only if the country-specific effects are uncorrelated with the other explanatory variables. The Hausman specification test can then be used to validate the identification assumption.

The regression uses income growth as the dependent variable, hence the problem with the fixed or random effects estimation is that the equation contains a lagged endogenous variable (income variable after rewriting the growth formula as difference in income levels). Monte Carlo simulation has shown that in panel data estimation with a comparable time dimension, the bias of the coefficient on the lagged dependent variable can be significant, although the bias for the coefficients on the other explanatory variables tends to be less. The bias has been suggested to be reduced by the use of Chamberlain's Π-matrix technique.

Forbes (2000) suggests that in the short and medium term, an increase in a country's level of income inequality has a significant positive relationship with subsequent economic growth. This relationship has been found to be very robust across samples, variable definitions and model specifications. The paper estimates growth as a function of initial inequality, income, male and female human capital, market distortions and country and period dummy variables. The country dummy variables control for time-invariant omitted variable bias and the period dummy variables control for certain global shocks which might affect aggregate growth in any period but are not otherwise captured by other explanatory variables. The problem of endogeneity is reduced by including the stock variables (initial values) rather than flow variables (measured throughout the periods). The simple model specification maximises the degree of freedom (since the estimation requires income inequality data which is highly limited and reduces the number of observations in panel data).The study involves a sample of 45 countries and 180 observations for the period 1966-1995. Growth rate is averaged over five-year periods to reduce yearly serial correlation from business cycles. However, the data set was subject to the following problems: limited number of observations available for many countries and for earlier time periods; regional coverage was far from representative; There were no countries from Sub-Saharan Africa and nearly half the countries were from the OECD; and finally Gini coefficients were not based on identical units of account, , since they were based on either households, expenditure, income or individual. Manuel Arellano and Stephen R. Bond (1991) used Generalised Methods of Moment (GMM) estimation where they first differenced each variable to eliminate the country-specific effect and then used all possible lagged values of each of the variables as instruments. The estimation reduced the bias due to the lagged endogenous variables while still permitting a certain degree of endogeneity in other explanatory variables. Benhabib and Spiegel (1998) used fixed effects estimates to study the relationship since omitted country specific effects can bias the OLS estimates. They find that non-financial variables enter the growth regression indirectly as a determinant of physical capital accumulation. They also find that political instability has negative impact on physical and human capital accumulation as predicted and that the skewness of income distribution is negatively related to the rate of human capital accumulation when country fixed effect is excluded. Li and Zou (1998) also use fixed effects and random effects estimation using the baseline regression from Alesina and Rodrik which accounts for the relationship after controlling for the effects of GDP and education level. The results estimated a positive relationship between the income inequality and economic growth. They also show theoretically that income inequality may lead to higher economic growth if public consumption enters the utility function. Barro (2000) used a three-stage least squares (3SLS) estimator, which treats the country-specific error terms as random. The argument is that the differencing implicit in the fixed effects regressions can exacerbate the biases due to measurement error.

Banerjee points out that variation in inequality is likely to be correlated with a range of unobservable factors affecting growth and none of the underlying theories gives strong reasons to believe that omitted-variable bias can be solved by including a country fixed effect in a linear specification. His paper uses cross-state panel data for the United States to assess the relationship between the income inequality and growth. Both standard fixed effects and GMM estimation do not give clear evidence of a positive relationship between inequality and growth. Instead, evidence is found for a negative relationship. The study also indicates that the relationship between income and growth is not robust and that small differences in the method used to measure inequality can result in large differences in the estimated relationship. The panel data covers the 48 US states for the time period 1940-1980. Finally, Partridge (1997) using cross-state data and pooled OLS estimation found a negative relationship between inequality and growth when inequality was measured with the income share of the third quintile and found a positive relationship when inequality was measured with the Gini index. With respect to the Deininger and Squire data, Atkinson and Brandolini (1999) and Szekely and Hilgert (1999) show that in the cases of OECD and Latin American countries, even this high quality data set is plagued by the problems of data comparability and quality.

More recently, Dustin and Krause (2010) used an unbalanced panel of 294 observations and 54 countries, covering eight 5-year periods, to test the theory of inequality and growth proposed by Galor and Moav (2004). The latter aims to combine the two main ideas in the field: the classical approach that inequality should have a positive effect on growth by promoting the accummulation of physical capital; and the credit market imperfections approach, whereby inequality should reduce growth by making investment in human capital more difficult, particularly in countries where credit constraints are binding. The point advanced by Galor and Moav (2004) is to link the effect of inequality on growth with the development stage of the country. In less-developed countries, with low levels of physical and human capital, inequality should promote growth by shifting resources to richer people who have higher propensities to save. As the physical capital stock increases, the relative return to human capitla also increases, and that becomes the main driver of growth. Therefore, at that second stage of development, higher equality would actually promote growth, by minimising the obstacles to investment capital investment imposed by credit constraints. In the more developed countries, these credit constraints cease to be so important, and thus inequality should neither promote or hinder growth.

Dustin and Krause (2010) run a standard growth regression but allow the coefficient on the gini variable to be a continuous function of the capital stock and education (as a proxy for human capital). They use semi-parametric estimation and instrumental variables, and apply an iterative procedure to make their results robust to high multicollinearity. They find an overall negative relation between inequality and growth. This negative effect of inequality is increasing in the capital stock in countries with low education, but decreasing in the capital stock in countries with high education, as the theory above predicts. However, they do not find a positive relation between inequality and growth in less-developed countries.

The problem of non-linearity

Earlier growth literature's consensus on this relationship is that inequality between countries is negatively associated with economic growth (see, for example, Galor and Zeira (1993), Bertola (1993), Alesina and Rodrik (1994), Garcıa-Penalosa (1995) or Perotti (1996)).

In contrast, much research starting from the 1990s, such as Deininger and Squire (1998), Forbes (2000), Barro (2000), and Panizza (2002), suggested an unstable or positive relationship instead despite all the estimation constraints explained in the previous part. This first gave rise to the possibility of a complex nonlinear link between the two factors of interest. Again, Forbes (2000) discovers that high initial inequality causes higher long-run growth. However, this is the medium run effect. High initial inequality causes low subsequent long-run growth, which is the short-term effect. Barro (2000)'s results implied that inequality might be good for growth especially in rich countries. To complicate the matter, the causality can be more than a simple one-way effect.

Many later studies proved and expanded on the original assertion by Kuznets that income growth may bring first increasing, eventually decreasing inequality, such as Aghion and Bolton (1997). This non-monotonic relationship added to the existing body of evidence of non-linearity.

As Barro (2000) put it "many theories have been constructed to assess the macroeconomic relations between inequality and economic growth" These proposed theories shed a light on the empirical relationship implied in the data. For the sake of illustrating the non-linearity problem, we can have a quick review of the main theoretical explanation. Banerjee and Duflo (2000) concluded that greater inequality might also increase upheaval and uncertainty that reduces short-run growth. Aghion, Caroli, García-Peñalosa (1999) suggest that increased inequality is associated with liquidity and credit constraints. It can produce greater cyclical volatility that can depress short-run investment and growth. Galor and Zeira (1993) and Aghion and Bolton (1997) argue that capital market imperfections limit the ability of low-income individuals to invest in human capital, leaving productivity gains unexploited. Kucera (2002) tried to explain Forbes' findings by proposing a "middle-class consensus". This consensus leads to greater taxes used to fund an improved education system. Short-run growth may decline through higher taxes, but the long-run effects are positive as the workforce becomes more productive. A similar result is also suggested by Furman and Stiglitz (1998), who conclude that inequality may reflect more flexible labour markets that bring about higher levels of work effort and entrepreneurial energy leading to stronger economic growth. However, according to Barro, the problem is that these theories tend to have offsetting effects and that the net effects of inequality on investment and growth are ambiguous.

Furthermore, Rehme (2007) points out something else: The changing number of high-skilled workers in the economy as it develops first brings increasing and then decreasing level of inequality which is consistent with Kuznets's prediction. Also, de la Croix and Doepke (2003) argue that fertility affects the accumulation of human capital, which will cause a nonlinear relationship as well.

Pure empirical studies such as World Bank (1993:29) also imply conflicting results between the experiences between many East Asian countries and that of the Latin American countries. Banerjee and Duflo (2003) made a contribution to the existing literature on ways to model non-linearity. They proposed a 'Hold-up model', which rests on the assumption that inequality leads to redistribution and redistribution hurts growth. The growth rate in this economy following a distributional conflict is found to be lower than when there is no conflict. However, the relationship derived is discontinuous and it does not take into account the effect of reverse causality. From the wealth effect perspective, they find that there is no strong evidence of a correlation between inequality and growth in the short run. Their work is faced with a few non-neglectable issues, the most important of which is measurement error as high quality data especially for poor countries are limited. Even without measurement error, the relationship between inequality and growth may not be causal.

Granger Causality

Investigating whether there is Granger-causality between growth and inequality, in either direction, is of great interest. However, very few studies have been carried out. Using US annual data for the period 1960-1996, Assane and Grammy (2003) estimate a three-variable VAR including real GDP per capita, the Gini coefficient and a human capital proxy variable. They find that growth unidirectionally and significantly Granger-causes inequality when more than one lag is included. Moreover, there is a negative correlation between inequality and growth, and a positive correlation between education and growth. They interpret these results as showing that when growth accelerates the more active agents are able to seize upon new opportunities and capitalize upon new technologies. Their incomes tend to increase more rapidly, hence widening the equality gap. However, it is difficult to extrapolate from these results, since they may not hold for different or longer periods, and for other countries in the world.

Bayesian Model Averaging (BMA)

When estimating complex relationships, such as the correlation between inequality and growth, one typically has to decide on one model. However, this choice is difficult especially in the context of growth equations, as there exist various different models and a huge amount of variables, which could be included. Yet, due to data constraints, only a limited number of variables can be incorporated and it is thus a crucial question to identify those that are relevant.

To overcome this problem of model uncertainty, Bayesian Averaging was developed, where the true model is viewed as unobservable. When using this econometric method, many possible models are estimated and the parameter of interest is then calculated as the weighted average of the parameters estimated in the different models, where the weights represent the probability that the model is the correct one. While the original idea is more than 30 years old, it only recently became feasible and thus more popular, as more elaborate statistics programmes became available. Draper (1995) and Raftery, Madigan, and Hoeting (1997) significantly contributed to the development of the framework in the 1990s and since then it has found applications in different fields of economics and finance where model uncertainty in prevalent.

Fernandez, Ley, and Steel (2000) introduce the method of BMA to growth models. Building on previous work by Sala-i-Martin (1997), they allow for every combination of up to 41 regressors in their growth equation, which results in over 2 trillion different models. They then rank these various exogenous determinants of growth to identify the significant ones and, using BMA, provide a sound mathematical tool for doing so. Their main conclusion is that the regressors: GDP level in 1960, fraction Confucian, life expectancy and investment in equipment are most significant. Durlauf, Johnson and Temple (2004) provide a detailed description about following research involving Bayesian Averaging in growth equations. They argue that the Bayesian Framework is a very strong tool in accounting for model uncertainty and specifically apply it to economic policy.

Cuaresma, Doppelhofer and Feldkirchner (2009) further develop Bayesian Model Averaging to estimate the determinants of economic growth in European regions. Applying the method to a cross-section of region, and allowing for special autocorrelation, they conclude that conditional income convergence is the biggest determinant of growth. Masanjala and Papageorgiou (2007) pioneered using BMA in development economics. By running different growth regressions and averaging, they determined the growth determinants relevant for Sub-Saharan Africa and found that they differ significantly from growth determinants in other regions. Klump and Pruefer (2009) further used BMA in development economics to identify pro-poor growth policies in Vietnam. They average over both growth and poverty regressions to extract significant determinants and conclude with development policy implications.

All above-mentioned studies are built on the assumption that a linear relationship exists between the exogenous variables, such as inequality, and the growth rate. However, as this is a strong and controversial assumption, Cuaresma and Doppelhofer (2007) include the issue of non-linearity in BMA. To allow for uncertainty over nonlinear threshold effects, they apply a Bayesian Averaging of Thresholds (BAT) approach to a long-term economic growth equation. They assume that both initial level of GDP per capita and the proportion of years an economy has been open during 1950-1994 have non-linear effects on growth rates. They also find that the non-linear growth effect of the initial level of GDP variable is not robust once model uncertainty is taken into account. On the other hand, the openness to trade variable shows non-linear effects on growth. Thus, in general one has to test for non-linearity in growth equations and it is reasonable to believe that there exists a non- linear relationship between inequality and growth.

Further problems arise with respect to the specification of probabilities across models. It is difficult to determine with which probabilities the different parameter values should be weighted. While some researchers put equal weight on all models, others put higher weights on certain models. This might become problematic, as this is likely to involve subjective judgements as to which models are most relevant. As an increasing number of researchers recognize model uncertainty and discover Bayesian Averaging as a useful tool, more research on these problems seems necessary. Moreover, further research is required in specific areas, which have not been explored by using BMA techniques such as the relationship between inequality and growth.

Conclusion

There is an extensive set of literature focussed on analysing the relationship between growth and inequality. We find the majority of this gives insight to the impact of inequality on growth rather than growth on inequality. While cross-section studies largely agree on a negative relationship between inequality and growth, one has to bear in mind that the cross-section analysis of this relationship is subject to high sensitivity to the inclusion, or exclusion, of variables that are found to be significant in other studies. The panel data estimation of growth regressions control for differences in time-invariant, unobservable country-specific characteristics and also lead to reduction in the omitted variable bias. Most of the studies on determining the relationship have used fixed effects or random effects or GMM estimation to conclude results. However, one has to keep in mind that the relationship is likely to be non-linear.

Measurement error is an important problem in all empirical work, and particularly when studying inequality. Careful thought must given to the measure of inequality used, and the way possible biases in the data and underlying surveys may influence such measure, particularly when looking at less developed countries. Recently the new method of Bayesian Averaging has been developed to account for model uncertainty. However, further research in this area is needed to model non-linearity.Bibliography

Alesina, A. and D. Rodrik (1994), ‘Distributive Politics and Economic Growth’, The Quarterly Journal of Economics, 109, 465-490.

Aghion, P. and Bolton, P (1997), ‘A Theory of Trickle-Down Growth and Development’, The Review of Economic Studies. Vol.64, No 2, 151-172

Anand, S. and Segal, P. (2008), What do we know about global income inequality?, Journal of Economic Literature, 2008, 46 (1), 57-94.

Assane, D. and Grammy, A. (2003), An assessment of the growth and inequality causality relationship, Applied Economics Letters, 2003, 10, 871-873.

Atkinson, A. (1970), On the measurement of inequality, Journal of Economic Theory, 2, 244-263.

Atkinson, A. and A. Brandolini (2009). On data: a case study of the evolution of income inequality across time and across countries. Cambridge Journal of Economics, Vol. 33, No. 3.

Banerjee, A. and Duflo, E. (2003), Inequality and Growth: What can the data say?, Journal of Economic Growth, issue 8, 2003.

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

Chambers, D. and Krause, A. (2010), Is the relationship between inequality and growth affected by physical and human capital accumulation?, Journal of Economic Inequality, 8, 153–172

Deininger, K. and Squire, L. (1998), New ways of looking at old issues: inequality and growth. Journal of Development Economics, Volume 57, Issue 2, 259-287

Clarke, G.R.G. (1995), 'More evidence on income distribution and growth', Journal of Development Economics, 47, 403-427.

Crespo-Cuaresma, J. and Doppelhofer, G. (2007). Nonlinearities in Cross-Country Growth Regressions: A Bayesian Averaging of Thresholds (BAT) Approach. Journal of Macroeconomics, 29:541–554.

Cuaresma, J., Doppelhofer, G. & Feldkirchner, M. (2009), The Determinants of Economic Growth in European Regions. Working paper, University of Innsbruck.

Deaton, A. (2003), Health, Inequality and Economic Development, Journal of Economic Literature, 2003, vol. XLI, 113-158.

Doppelhofer, G., R. I. Miller and X. Sala-i-Martin (2000), "Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (Bace) Approach", OECD
Economics Department Working Papers, No. 266, OECD Publishing.

Draper, D. (1995) Assessment and propagation of model uncertainty (with Discussion), Journal of the Royal Statistical Society.

Durlauf, Johnson and Temple (2004). Growth Econometrics. University of Wisconsin.

Fernandez, C., Ley, E. and M.F. Steel (2000), Model uncertainty in cross-country growth regressions. Journal of Applied Econometrics 16, 563-576.

Forbes, K. (2000), A Reassessment of the Relationship between Inequality and Growth, The American Economic Review, 90 (4), 2000, 869-887.

Galor, O. and Moav, O. (2004), From physical to human capital accumulation: inequality and the process of development. Review of Economic Studies, 71, 1001–1026

Kaldor, N. (1960), Essays on value and distribution, 1960, Glencoe, Free Pres.

Keefer, P. and S. Knack (2002), 'Polarization, politics and property rights: Links between inequality and growth', Public Choice, 111, 127-154.

Klump, K., and Pruefer, P. (2009), A robust ranking of pro-poor growth policies: the case of Vietnam. CentER DP No. 2006-117.

Korinek, Anton, Mistiaen, J., and Ravallion, M. (2006), Survey Nonresponse and the Distribution of Income, 2006, Journal of Economic Inequality, 4(1): 33–55.

Korzeniewicz, R.P., and Moran, T. P (2005), 'Theorizing the Relationship between Inequality and Economic Growth', Theory and Society, Vol. 34, No. 3: 277-316.

Kuznetz, S. (1955), Economic Growth and Income Inequality, The American Economic Review, Vol. 45, No. 1. (Mar., 1955), 1-28.

Levine, R. and D. Renelt (1992), 'A sensitivity analysis of cross country growth regressions', American Economic Review, 82, 942-963.

Masanjala, W. and Papageorgiou, C. (2007), Rough and Lonely Road to Prosperity: A reexamination of the sources of growth in Africa using Bayesian Model Averaging. Journal of Applied Econometrics. Vol. 23, Issue 5, pages 671–682.

Panizza, U (2002), Income Inequality and Economics Growth: Evidence from American Data. Journal of Economic Growth, 7, 25-41

Persson, T. and G. Tabellini (1994), 'Is Inequality Harmful for Growth ?', The American Economic Review, 84, 600-621.

Raftery, A.E., D. Madigan, and J.A. Hoeting (1997), 'Bayesian Model Averaging for Linear Regression Models', Journal of the American Statistical Association, 92, 179–191.

Rehme, G (2007), 'Education, Economic Growth and Measured Income quality', Economica 74, 493-514.

Sala-i-Martin, X. (1997a), I just ran two million regressions. American Economic Review 87, 178-183.

Sen, A. (1973), On Economic Inequality, Oxford: Clarendon Press.

Summary Table

Author	Title	Time Period	Countries	Methodology	Conclusion
Alesina and Rodrik	Distributive Politics and Economic Growth	1960-1985	OECD + 29 developing countries	Cross-section	High initial inequality is correlated with slow long-run growth.
Barro, Robert J.	Inequality and Growth in a Panel of Countries	1960-90	84	Three-stage least squares (3SLS) estimation	Kuznets curve emerges as a clear empirical regularity. Income inequality retards growth in poor countries but promotes growth in richer countries.

Benhabib, Jess & Spiegel, Mark M.	Cross-Country Growth Regressions	1960-85	92	Fixed effects estimation with time-specific and country specific dummy variables	Skewness of income distribution is negatively related to the rate of human capital accumulation.
Clarke	More Evidence on income distribution and growth	1970-1988	OECD + others	Cross-section	High initial inequality is correlated with slow long-run growth.
Cuaresma, J., Doppelhofer, G. & Feldkirchner, M	The Determinants of Economic Growth in European Regions	1995-05	255 European regions	Bayesian Averaging Framework	Conditional income convergence is the biggest determinant of growth.
Crespo-Cuaresma, J. and Doppelhofer, G.	Nonlinearities in Cross-Country Growth Regressions: A Bayesian Averaging of Thresholds (BAT) Approach	1960-96	88	Bayesian Averaging of Thresholds (BAT) approach	One has to test for non-linearity in growth equations and it is reasonable to believe that there exists a non- linear relationship between inequality and growth.
Deininger, K. and Squire, L.	New ways of looking at old issues: Inequality and growth	1960-92	108	Panel Data	Inequality reduces income for the poor not for the rich. Logitudinal data provides little support for Kuznet's effect
Fernandez, C., Ley, E. and M.F. Steel	Model uncertainty in cross-country growth regressions	1960-92	140	Bayesian Averaging Framework	Identification of variables that are important regressors for explaining cross-country growth patterns
Forbes, Kristin J.	A Reassessment of the Relationship between Inequality and Growth	1966-95	45	Fixed effects estimation	Positive relationship between income inequality and economic growth.
Keefer and Knack	Polarization, politics and property rights: Links between inequality and growth	1970-1992	OECD + others	Cross-section	Social polarization reduces the security of property and contract rights and therefore reduces growth.
Klump, K., and Pruefer, P.	A robust ranking of pro-poor growth policies: the case of Vietnam	1998-02	1	Bayesian Averaging Framework	They average over both growth and poverty regressions to extract significant determinants and conclude with development policy implications.
Levine and Renelt	A sensitivity analysis of cross country growth regressions	1960-1989	119 countries (excluding the major oil exporters)	Cross-section	Most variables in the empirical growth literature are highly sensitive to the inclusion, or exclusion, of other variables.
Li, Hongyi & Zou, Heng-fu	Income Inequality is not harmful for growth: Theory and Evidence	1947-94	112	Fixed effects and random effects estimation	Positive relationship between income inequality and economic growth.
Masanjala, W. & Papageorgiou, C.	Rough and Lonely Road to Prosperity: A reexamination of the sources of growth in Africa using Bayesian Model Averaging	1960-92	104	Bayesian Averaging Framework	Growth determinants relevant for Sub-Saharan Africa differ significantly from growth determinants in other regions.
Panizza, U.	Income Inequality and Economic Growth: Evidence from American Data	1940-1980	1	Fixed effects and GMM estimation	No clear and robust relationship between inequality and growth and small differences in methods in measuring inequality and econometric specification yields very different conclusion about the two's relationship
Persson and Tabellini	Is Inequality Harmful for Growth ?	1830-1985 (Panel), 1960-1985 (cross-section)	9 OECD countries for Panel, OECD + non-OECD for cross-section	Panel-Data and cross-section	Significant negative relation between inequality and growth only present in democracies.