RELATIONSHIPS BETWEEN GROWTH ABSOLUTE AND RELATIVE INCOME

by

RUCHIRA BANERJEE

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P.O. Box 1346
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Abstract

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Ruchira Banerjee

Adviser: Professor Thom Thurston

This study examines the relationship between absolute and relative real income of people and how these relationships are related to aggregate measures of per capita income and growth. The focus is on outcomes of the poor. The poor are defined per country as the lowest 20 percent of the population, in terms of income. We analyze the relationships between real per capita income and growth (which we call group A variables) and the following 2 variables: relative income or indicators (Gini coefficients, percentile shares of income, which we refer to as the group B1 variables); and absolute per capita income measurements of poor segments of the population (group B2 variables).

The motivation for studying these relationships arises from controversies as to (1) whether high income or growth is associated with high or rising inequality in income; and (2) whether, for this or other reasons, higher inequality tends to be associated with lower standards of living for poor people. To take one possible outcome of the second controversy, if higher growth and inequality are associated with rising absolute standards of living of poor people, it would be more difficult to argue that higher growth and inequality worsens outcomes for the poor.

The analysis relies mainly on cross-sectional data using correlations and simple OLS methodology. Panel analysis is not attempted because of the lack of time-series data across countries. The cross sectional data used is further disaggregated

into regions. one example of which would be countries with high versus low levels of aggregate per capita income and high versus low levels of inequality. Results of the analysis are presented in tables where the relationship between group A and B variables are presented by slope coefficients, t-statistics and R squared.

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Introduction

The interaction between economic growth and wealth inequality is not well understood. Wealth inequality determines investment in physical and human capital, which in turn affects the long-term growth rate. The presence of wealth inequality within a country means that the effect of growth is rarely uniformly distributed across the population. The absence of data on the distribution of wealth for a large number of countries means that proxies have to be used in empirical studies. The most common approach is to use income inequality as a proxy for wealth inequality.

The literature is contradictory in its treatment of the effect of growth on incomes of people through inequality, and the lack of consistent empirical evidence on the relationship between growth and income inequality means that the extent to which the poor share in the benefits from growth remains ambiguous. This ambiguity underscores the need to further investigate the interrelationships between growth, inequality and the relative and absolute incomes of the poor. Specifically, are high levels of income or growth associated with high levels of income inequality? And, are high levels of inequality associated with lower absolute or relative standards of living for the poor?

To answer these questions, this study addresses the following specific relationships: 1) between the level and growth rate of income per capita and the level of inequality; 2) between the level and growth rate of income per capita and both the relative and absolute incomes of people; and 3) the specific movements between relative and absolute incomes. These relationships are studied within a cross-section of countries using correlations and simple OLS methodology.

Across countries, this study finds a significant relationship between the level of income per capita and both the level of income inequality and the incomes of the poor. In particular, the level of income per capita across countries is negatively related to the level of income inequality and positively related to both the relative and absolute incomes of the poor. In contrast, there is no statistical support for a systematic relationship between the growth rate of income per capita and either the level of inequality or the incomes of the poor. The Kuznets curve emerges as an empirical regularity for this cross-sectional dataset and partitioning the dataset leads to different results for different partitions. To cite one example, across the developing country regions, the analysis finds a significant positive relationship between the level of income per capita and the level of income inequality.

This study is organized as follows: *Chapter 1* discusses the literature to date on two main questions: 1) Are high levels of income or growth associated with high levels of income inequality? 2) Are high levels of inequality associated with lower absolute or relative standards of living for the poor? This chapter highlights the lack of consensus among development economists that motivates the search for systematic relationships between the relative and absolute incomes of people and the level and growth rate of real income per capita. *Chapter 2* presents a brief survey of the measurement issues dealing with income inequality and a discussion of their implications in estimating the relationships between growth, inequality and poverty. *Chapter 3* describes the cross-sectional data used in this study and the coverage of the data across countries and regions. Three countries are highlighted from 3 regions of interest, and the coverage of the data within each country is reported for specific variables. This section continues by presenting the specific variables to be used in the analysis and the relationships of main interest to this study. *Chapter 4* uses the cross-sectional data to first address the relationships between the level and growth rate of income per capita (group A) and the level of income inequality and also the relationship between group A variables and the relative incomes of people (group B1). Second, the chapter addresses the relationships between group A variables and the absolute incomes of people (group B2) and finally the movements between group B1 and B2 variables.

Appendices at the end support each of the chapters above by presenting detailed information not covered by *chapters 1* through *4*. *Appendix 1* extends the review of the theoretical literature covered in *chapter 1*. Section I presents the theoretical background to the development of growth models and their impact on the income distribution and poverty. Section II reviews the limitations of the analytical tools that are commonly used by empirical studies on this topic. *Appendix 2* details the methods used and reviews the empirical literature on the link between growth and inequality. Section II discusses Axiomatic and Stochastic dominance approaches to choosing relevant inequality measures. Section III defines the various ways in which poverty is defined and measured at both the country and global level. Sections I and II of *Appendix 3* provides supporting data tables for *chapter 4* while Section III presents further formulations of the Kuznets curve analyzed in *chapter 4*. *Appendix 4* explains the origins of the data used in this study, and provides mathematical derivations of the Gini coefficient from both Lorenz curves and income shares data.

Chapter 1

CONTROVERSIES OF INTEREST

This study addresses two main questions: (1) are high levels of income or growth associated with high levels of income inequality; and (2) and, are high levels of inequality associated with lower absolute or relative standards of living for the poor. The extent to which the poor share, both absolutely and relatively, in a rising average standard of living has been extensively debated in the literature.

Some argue that the poor do not benefit relatively from global growth, with all benefits accruing instead to the middle and upper stratums in society. Others have concluded that a rising overall mean standard of living is typically associated with falling absolute poverty (Bruno, Ravillion and Chen, 1996, Ravillion and Datt, 1999). Bruno, Ravillion and Squire (1996) argue that sustainable economic growth generally benefits all layers of society roughly in proportion to their initial levels of living. This viewpoint is supported by the work of Dollar and Kray (2000) who find that the income of the poor almost always rises "one-for-one" during periods of significant growth. These authors find that, in terms of growth rates, just under half of the growth of incomes of the poor is explained by growth in mean income. A third viewpoint argues that while the poor may benefit somewhat in absolute terms, they benefit proportionally less than the average household, so that inequality within countries continues to be on the rise.

In general, the literature shows a lack of consensus on the issue of how the poor benefit, whether absolutely or relatively, from growth. And, while it is unanimously agreed that absolute poverty is undesirable, there is no such agreement on income inequalities. Increases in inequality can arise from a worsening in the incomes of the poor (clearly undesirable) or an improvement in the incomes of the rich (not necessarily undesirable). Thus while some degree of inequality may be a prerequisite for growth, growth should not be pursued without taking into consideration that growth can create further inequality.

The "inverted U" relationship between income and inequality was first proposed by Kuznets in 1955. This relationship states that, as economic development proceeds and per capita income increases, inequality will first rise and then fall. Until the 1970s, the Kuznets hypothesis seemed to account for the experience of both the US and most of the OECD countries. In these countries there appeared to be a virtuous circle: lower inequality would foster growth, which in turn would reduce inequality.[1]

In 1996, Deninger and Squire using a dataset of 108 countries, failed to find any empirical relationship between growth and equity as postulated by the Kuznets hypothesis. They also investigated a modified 'dynamic version' of the hypothesis that postulates that fast growth episodes tend to lead to higher inequality, regardless of the initial level of income. This is what is implied, for instance, by the popular observation that growth leads to 'the rich getting richer, while the poor get poorer'. Deninger and Squire found that periods of growth were equally associated with either an increase or decrease in inequality and concluded that there was no systematic relationship between growth and changes in aggregate inequality (1996).

However, Ravillion and Chen's (1997) analysis of the economic reform in the transition economies of Eastern Europe and Central Asia (ECA) disagreed with Deininger and Squire's conclusions. Looking at a sample of 64 changes in mean income and inequality between 1981 and 1994, Ravallion and Chen (1997) found a significant negative correlation between economic growth and changes in inequality. In other words, their sample suggested that growth was associated with greater equality. However, this effect vanished when the authors eliminated the ECA data from the sample.

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1 See Anand & Kanbur (1993), for an account of the literature dealing with the Kuznets curve.

The variety of contradictory associations between growth and inequality has led many economists to adopt a skeptical view about causal effects running from economic growth (a rising distribution mean) to inequality (increases in the dispersion of the distribution). But these results say nothing about the causal effect from growth to poverty. By shifting the income distribution function to the right, Ahuja et al. (1997) found some evidence that economic growth contributes to reductions in absolute poverty. Their work is supported by Ravallion and Chen (1997) who plotted the regression lines of changes in log poverty on growth rates, both for the ECA region and other countries, and found statistically significant negative slopes for both groups of countries. Deninger and Squire (1995) also found a strong positive relationship between growth and the reduction of absolute poverty. However, it is possible for individual periods of distributional change to drive a combination of growth in mean income and an increase in inequality that has the overall effect of increasing poverty. This combination of effects occurred in the Philippines between 1988 and 1991 (Ahuja et. al., 1997). In general however, the literature on the effect of growth on absolute poverty tends towards a negative association between these two variables.

The lack of a consistent relationship from economic growth to inequality led economists to investigate the possible causal link from initial inequality to subsequent growth. These studies drew heavily on models of endogenous growth, with support from earlier models of credit rationing and other market failures, while incorporating aspects of the new political economy.[2]

The proposal that initial inequality seems to be associated with lower growth rates was put forward by Persson and Tabellini (1994) and Alesina and Rodrik (1994). Both studies found that inequality variables had significantly negative coefficients in growth regressions, when controlling for a number of right-hand side variables such as initial

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[2] See Benabou (1996), Deininger and Squire (1996, 1998), Aghion and Bolton (1997), Bruno, Ravillion & Squire (1996), Ravillion (1997), Birdsall and Londono (1997). Also see Appendix 1 for details on endogenous growth theories.

income, schooling and physical capital investment. A survey by Benabou (1996a) listed a number of other cross-country empirical investigations of this relationship, and reported that the majority of them reached the same conclusion, i.e. a negative relationship between initial inequality and growth. However, a number of studies drawing on the Deininger-Squire (1996) dataset have since questioned this initial consensus.

The Deininger-Squire database is superior to those used by Persson and Tabellini or by Alesina and Rodrik, both in the number of countries and in the time-spans covered. Adding a number of methodological improvements to the Deininger-Squire data set, Forbes (1997) found a positive and significant relationship between initial inequality and growth. Other authors on this topic have since expressed similar concerns as Forbes (1997) and cautioned against a premature acceptance of the inverse relationship between initial inequality and growth.

The econometric problems that seem to beset the negative relationship between initial inequality and growth in the newer datasets appear to be specific to inequality variables defined in the *income* (or expenditure) space. For instance, Deininger and Squire (1996) found that the negative coefficient on initial income inequality in their growth regressions became insignificant only when a variable for *asset* inequality (the Gini coefficient for land ownership) was introduced[3]. Birdsall and Londono (1997) investigated a similar relationship for another asset crucially important for the poor, namely human capital. Using a subset of the Deininger-Squire dataset they concluded that the initial inequalities in the distribution of land and of human capital had a clear negative effect on economic growth, and that these effects were almost twice as large for the poor as for the population as a whole. Overall, these studies find that the significance of income inequality disappears, once certain asset distribution variables are included. Thus the issue of a link between initial inequality and subsequent growth remains unresolved.

[3] The distribution of land is sometimes used as a proxy for the distribution of wealth. See also Alesina & Rodrik (1994).

Nevertheless, the current state of the debate maintains that while initial income inequality may not directly affect an economy's aggregate growth potential, it does proxy for more fundamental inequalities of wealth. Once such measures for inequalities in wealth are included, there does seem to be a significant negative relationship between asset inequality and growth.

The search for a general postulate linking growth to inequality must however confront the empirical fact that the bulk of the variation in inequality is among countries, rather than within a given country over time. Looking at the coefficient of variation of per capita GDP across countries, Kanbur and Lustig (1999) observed that inequality across nations has steadily been on the rise since 1980. They argue that if the world behaved as predicted by the simple neoclassical growth model, then the per capita income of countries with the same preferences will eventually converge.[4] This argument implies that initial conditions do not matter and that transitory shocks do not alter the long term equilibrium. If however, the world is characterized by multiple and locally stable equilibria, then convergence may not ensue.[5] Different initial conditions or transitory shocks could push countries with even the same preferences into permanently different long-term equilibria. Countries caught in long-term equilibria with high poverty levels are often described as being in a "poverty trap."

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[4] In the neoclassical growth model, economic growth depends on the accumulation of capital, labour growth and productivity progress, and does not depend strongly on economic policy. Further, the neoclassical view assumes that capital has a high return when it is scarce. Together with assumptions of constant returns to scale and the existence of inalterable factors like labour supply, the assumption of diminishing returns leads to the following prediction: During the transition to a new steady state, growth in capital-scarce countries will be high because of the high returns to capital.

[5] The multiple equlibria world of growth theories contend that capital has a high return where it is already abundant, and growth is sensitive to shocks. In such a world, for growth to be a virtuous circle of capital accumulation attracting yet more capital accumulation, a critical mass of human and physical capital must be in place. That is, any economy will have to pass a minimum threshold level of human and physical capital in order to be able to grow. However, because of the sensitivity to shocks, a country on a steady growth path could move to a path of rapid decline in the face of a temporary shock like civil war.

Within the neoclassical framework, poverty traps typically arise because of differences between the steady state equilibrium of countries that result from low investments in human capital and political instability. A poverty trap can also result from a period of protracted economic transition due to a series of large adverse external shocks. Neoclassical reasoning implies that if poorer countries are further away from their steady states then their economies should grow at faster rates than those of wealthier countries.

On the other hand, economic growth may be better characterized by multiple equilibria, in which initial conditions matter and transitional shocks have long-term implications. In such a model, poverty traps would arise when countries are pushed, either by initial conditions or by shocks, into a low-level equilibrium. Similar low-level equilibrium trap models can be found in the early development literature. One such model is the 'insufficient savings theory', which predicts that at low levels of the capital-labour ratio, income per capita will be barely sufficient for subsistence and savings will fall below depreciation. The country is then be stuck in a low-level equilibrium trap because the country will be too poor to take advantage of good investment opportunities, even if they are available. In theory, the problem of investment opportunities could be corrected through private capital flows or through foreign aid.

However, the recent literature throws doubt upon the efficacy of aid in helping countries break out of such poverty traps. A popular claim is that the growth-oriented reform policies of the kind usually advocated by the International Financial Institutions (IFI) have worsened the lot of the poor. Dollar and Burnside (1997), Bruno, Ravillion and Squire (1996) and the World Bank (1998, 1999) are among those who make up the vast empirical literature on the effects of aid policy on growth. These authors are united in the conclusion that the attempt to break developing countries out of the poverty trap using aid policy has been ineffectual.

Whether the world is characterized by the simple neoclassical growth model or by multiple equilibria, the fact remains that the bulk of the variation in income inequality is across countries. Kanbur and Lustig (1999) find that the level of inequality across countries has steadily risen in the past 2 decades, but this viewpoint has recently been challenged by the work of Sala-i-Martin (2004). His research refutes the claim that income inequalities across countries have been on the rise and argues that global income inequalities over the past 2 decades have declined substantially. Sala-i-Martin argues that the variation in income inequalities across countries can be simply explained by differences in per capita income, and that a substantial part of the decline in global income inequalities is due to the high growth rates experienced by India and China.

However, economists have speculated that inequality slows growth because it generates political and macroeconomic instability. It has been argued that inequality leads to higher fiscal deficits reflecting the median voter's interests. Given weak capital markets and resulting liquidity constraints for the poor, inequality has the effect of reducing savings and investment, especially in human capital. While there are many theoretical models in the development literature for assessing the effects of inequality on economic growth, these models often have offsetting effects. The result is that the net effect of the evolution of inequality on growth performance remains ambiguous.[6] These theories can be broadly classed into four main categories corresponding to the features that they stress: credit-market imperfections, savings rate, political economy, and social unrest.[7]

The theoretical ambiguities of the models are reflected in the empirical literature. For example, Benabou (1996) reported an overall tendency for inequality to generate lower economic growth in cross-country regressions across seven regions. Persson and Tabellini (1994) found evidence for this negative relationship, but only in democracies. Using data from a broad panel of countries, Barro (1999) found little systematic

6 Benabou (1996) surveys some of these theories, as does Barro (1999) and Perotti (1996).

7 See Appendix 1 for details on these theories.

relationship between income inequality and the rates of growth and investment, while Deninger and Squire (1995) failed to find any systematic link between growth and changes in aggregate inequality.

The weak and unreliable effects of inequality on growth and investment mean that efforts to equalize incomes cannot be justified as a way to improve aggregate economic performance. Near equality of incomes is not a prerequisite for economic growth, but there is also no indication that inequality has to be tolerated as a way to promote economic growth.

The contradictory conclusions reached by the studies in the literature seem to depend on the econometric methods used, and the data considered to look at the link between growth and inequality and the subsequent impact on the incomes of the poor. Before the advent of the cross-country Deininger and Squire (D&S) database in 1996, most studies relied on household surveys for information on the income distribution (Ravillion and Chen, 1997). Since then, the majority of studies rely on the D&S database although each study differs in its usage of the data. For example, Barro (1999) used data based on national coverage to increase the number of observations for the Gini coefficient for his study, while Li, Zhou and Squire (1998) adjusted for differences between income-based and expenditure based Gini coeffcients by systematically increasing the latter by 6.6 points, this being the average difference observed by D&S. Dollar and Kray (2000) augmented the D&S 'high-quality' dataset by adding further observations from the World Development Indicators (WDI), while Lundberg and Squire (1999) augmented the number of countries by using information from household surveys and national coverage. Because the D&S data stringently avoids biases due to factors such as national representation, and sampling and survey methods,[8] additions and augmentation from other sources invalidate the quality of the D&S data. Unlike most of the studies in the

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[8] For details on the D&S database, see Deininger and Squire, 1996.

literature, this study relies primarily on the original D&S dataset (1996) for information on the income distribution without any modifications or additions.

The above discussion highlights the lack of consensus in the literature about a) are high levels of income or growth associated with rising inequality, and b) is rising inequality associated with lower standards of living for the poor. This study focuses on these two issues by looking at the inter-relationships between growth, inequality and the absolute and relative incomes of the poor. The choice of how the poor are defined can change the conclusions that are drawn from the analysis. For example, defining the poor as the bottom 10 percent of the income distribution, as opposed to the bottom 20 percent, not only changes the grouping of people defined as the poor but also their share of total income. Thus, for the purposes of this study, the poor are defined as the lowest 20 percent of the population, in terms of income.

Chapter 2

MEASUREMENT ISSUES

Although the concepts of inequality and poverty are distinct, they are often studied together as part of the broader analyses covering poverty. Inequality is a broader concept than poverty in that it is defined over the whole distribution, not only the censored distribution of individuals or households below a certain absolute poverty line. Incomes at the top and in the middle of the distribution may be just as important as those at the bottom for perceiving and measuring inequality, and as we will show, some measures of inequality can be driven largely by incomes in the upper portion of the distribution.

In this study, inequality is conceptualized as the dispersion in the income distribution. It follows that poverty reduction takes place inherently within this broader process of distributional dynamics, where absolute poverty is characterized by movements of the entire distribution and relative poverty is concerned with changes within the distribution. That is, for a given mean income, the more unequal the income distribution the larger the percentage of the population living in relative income-poverty. Absolute poverty, on the other hand is defined solely in relation to a given mean income.

The data currently in use to measure income inequality have improved, but international comparisons of distributional statistics are still plagued by both conceptual and practical problems. Data quality problems and the fact that existing measures are often based on different definitions hamper comparability between countries – and often within the same country over time – thus affecting empirical results in unpredictable ways. These concerns become more important as the complexity of theories about inequality and growth increases beyond the often simplistic mechanisms that characterized early models. Following is a brief survey of measurement issues dealing with inequality and a discussion of their implications in estimating the relationships between growth, inequality and poverty.

There are several methods by which to measure income inequality. While each of these measures has some intuitive or mathematical appeal, several of these apparently sensible measures behave in contrary ways. For example, variance which is one of the simplest measures of inequality is not independent of the income scale. That is, simply doubling all incomes leads to a fourfold increase in the estimation of income inequality. Other examples are the squared coefficient of variation and the variance of the log of income – the first is more sensitive to high incomes while the second is more sensitive to low incomes. None of these are desirable properties in a measure of inequality.

Picking income inequality measures by using the Axiomatic approach means a choice among the Generalised Entropy class, the Atkinson class of inequality measures, or the Gini coefficient.[9] These measures generally meet the set of desirable axioms although, because of differing sensitivity to income in different parts of the distribution, it is possible for them to rank the same set of income distributions in different ways.

However, the use of an inequality measure such as the Gini coefficient is widespread because of the ready availability of data across a majority of countries. The Gini also provides a convenient single statistic which summarizes the dispersion of the income shares across the whole income distribution. Its prevalence ensures comparability with similar studies within the literature, while its ready availability means a larger dataset of countries than studies using different measures of inequality. However, one disadvantage of such an aggregate measure is that it is not sensitive to movements within the distribution. The most frequently used techniques for studying movements within the distribution are decomposition and quintile regression.

[9] The Axiomatic approach, as discussed in Appendix 2, is any inequality measure that satisfies the axioms of Decomposability, Anonymity, Principle of Population, Income Scale Independence and the Pigou-Dalton Transfer Principle. See Appendix 2 for a detailed discussion.

Decomposition can be desirable for analytic reasons.[10] For example, using decomposition, analysts can assess the contribution to overall inequality of different sub-groups of the population, such as within and between group workers in agricultural and industrial sectors, or urban and rural sectors. Such decompositions shed light on both the structure and dynamics of inequality measures. Inequality decomposition is also a standard technique for examining the contribution to inequality of particular characteristics, and can be used to assess income recipient characteristics. The largest drawback of decomposition is that the importance of a particular characteristic may vary depending on the measure of inequality that is decomposed.

An alternative approach is quintile regression where the median of a dependent variable is estimated instead of the mean, conditional on the values of the independent variables. The quintile regression methodology relies on the income distribution being divided into shares of aggregate income received by households. Therefore, it becomes possible to estimate different percentiles of the dependent variables and so obtain estimates for different parts of the income distribution. Furthermore, it is possible to use different independent variables for different quintiles, reflecting the view that the data may be heteroskedastic with different factors affecting the rich and poor quintiles. Such regression techniques can also be used to model the effect of aggregate factors rather than the specific attributes of a household, and quintile regression (or the quintile income shares approach) provides a complementary measure to using a composite inequality measure like the Gini coefficient.

The disadvantage of the Gini coefficient is that there is no unique mapping between changes in the coefficient and the underlying income distribution. Thus, redistribution from the top quintile to the middle class quintile may be associated with the same change in the Gini coefficient as an increase in the share of income received by the bottom

[10] For details on decomposition techniques, see Appendix 2

quintile at the expense of the middle quintile. The quintile income shares approach overcomes this shortcoming by uncovering possible movements in the share of income received by individual groups in society.

In the income shares approach, households are ranked from lowest to highest on the basis of income and then divided into equal population groups, typically fifths (quintiles) or tenths (deciles). The aggregate income of each group is then divided by the overall aggregate income to derive shares which can then be compared.[11]

Briefly, the Gini coefficient incorporates the more detailed shares data into a single statistic which summarizes the dispersion of the income shares across the whole income distribution. The Gini coefficient can be expressed as a proportion or as a percentage and equals zero when the distribution is completely egalitarian. For example, if society's total income accrues to only one person/household unit, leaving the rest with no income at all, then the Gini coefficient will be equal to 1, or 100 percent, and the society has complete inequality. The Gini coefficient (G) can be thought of as corresponding to a weighted average of all absolute differences between per capita incomes (expressed relative to economy wide per capita income), where the weights are the corresponding population shares.[12]

$$G = \sum_{i=1}^{n} x_i \left(\sum_{j<i} y_j - \sum_{j>i} y_j \right)$$

In 1967, Theil put forward another interpretation of the Gini coefficient which used quintile income shares to calculate the Gini coefficient. According to Theil (1967), the Gini coefficient corresponds to a weighted average of all absolute differences between per capita incomes (expressed relative to economy wide per capita income), where the

[11] See Appendix 4 for more details on the derivation of the Gini coefficient.

[12] For a detailed mathematical derivation of the equation, see Appendix 4.

weights are the *products* of the corresponding population shares.[13] Briefly, if the underlying data are quintile income shares and if we assume that all persons in each quintile have the same income, then the Gini coefficient can be expressed in the following way in relation to quintile shares, Q_i, for i= 1..5.

Equation 1

$$G^* = 0.8\ (-1 + 2Q_5 + 1.5Q_4 + Q_3 + 0.5Q_2)$$

Since the quintile income shares sum to 1, substituting for Q_5 in equation (1) gives

Equation 2

$$G^* = 0.8\ (1 - 2Q_1 - 1.5Q_2 - Q_3 - 0.5Q_4)$$

where Q_i is the share of income accruing to the i^{th} quintile with group 1 being the poorest and group 5 the richest. Groups 2 through 4 together represent the middle class. The first form, equation 1, says that the Gini coefficient can be viewed as giving positive weights to quintile income shares 2 to 5, where the largest weight (2) applies to the richest quintile, Q_5 , and the least weight (0.5) to the second quintile. The second form, equation 2 says that the Gini coefficient can be alternatively viewed as giving negative weights to quintile shares 1 to 4, where the largest negative weight (2) applies to the first quintile and the smallest weight (0.5) attaches to the fourth quintile.

Calculating the Gini coefficient using these weights yields the supplementary Gini coefficient or G*. G* augments the missing annual data points for the Gini coefficient of any one country. For example, if a country has a total of 3 Gini coefficients for 3 years and 6 years of information on quintile income shares, then the calculated weights above can be used to construct a G* for each of the 3 additional years, thus increasing the total number of years with information on Gini coefficients for any one country.

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13 For the mathematical derivation of the weights used to calculate the supplementary Gini coefficient from per capita income shares, see Appendix 4.

While there is no one perfect measure of inequality, this study uses the Gini coefficient supplemented by the quintile income shares approach to provide adequate information about both the spread of the income distribution as well as movements of the different quintile groups within the distribution.

Chapter 3

THE DATA AND COVERAGE ACROSS THE DATASET

This chapter describes the data used in this study and briefly discusses the coverage across countries and regions. The decreased variability in inequality across regions motivated the within country discussion of three countries from 3 regions/groups of interest. The coverage of the data within each of these 3 countries is reported for specific variables. The chapter concludes by presenting the specific variables used in this study and the main relationships of interest between these variables.

The Data

Deininger and Squire (1996), D&S, have amassed the largest dataset of inequality measures to date. Their original file contains more than 2,600 observations, of which 682 (115 countries) are deemed to be 'high quality'. Exclusion from the high-quality dataset include the survey being of less than national coverage; the basing of information on estimates derived from national accounts, rather than a direct survey of incomes; limitations of the sample to the income earning population; and derivation of results from non-representative tax records. Data was also excluded if there is no clear reference to the primary source. One problem with this cross-sectional dataset is that the number of observations at the country level varies among countries over time. In order to conduct time series analysis, the dataset could be expanded by adding observations based on national coverage. However, it was felt that this would lead to a substantial reduction in the accuracy of measurement. Thus, this study chooses to use cross-sectional analysis based on the unbiased 'high-quality' dataset.

Data on both Gini coefficients and quintile income shares for a subset of only those countries with at least 2 periods of coverage for both variables for was picked for this study.[14] This sample contained 71 countries and was assigned regional codes primarily from the World Bank code of countries together with some modifications from the D&S 1996 paper. The 71 country dataset covers the 6 developing country regions of Sub-Saharan Africa (AFR), Eastern Europe (ECA), East Asia and Pacific (EAP), South Asia (SAR), Latin America and the Caribbean (LAC), Middle East and North Africa (MENA), and the group of countries designated as industrial countries.[15]

It is important to note that when information on income shares did not directly correspond to quintiles or when incomes shares but no Gini coefficient was reported, D&S used a statistical routine known as POVCAL to compute income quintile shares or Gini coefficients, or both, based on the estimation of a parametric Lorenz curve. Briefly, the POVCAL procedure fits a parametric Lorenz curve (general quadratic or beta) through the available distributional data. Where the estimated curve was valid, it was used to approximate the income shares obtained by different quintiles. D&S justify the procedure by noting that for a number of cases for which primary data was available, POVCAL produced estimates that were very close to the real distribution, even when based only on partial information.

Data on aggregate levels of real income per capita was extracted from the World Development Indicators (WDI) for a group of 203 countries, with a coverage period of 1975 to 1998.[16] Out of the group of 203 countries, 144 countries were chosen based on the criteria that each country must have at least 12 observations. The annual average growth rate of real income per capita was calculated for these 144 countries and the same regional codes applied to the subset of 144 countries as those used for the D&S dataset.

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14 For details on the Deininger and Squire dataset, see Appendix 4.

15 For further details on the regional classifications, see Appendix 4.

16 For details on the WDI and for a discussion on the merits of the WDI versus the PWT datasets, see Appendix 4.

There are 69 countries in common between the D&S dataset (for the group of countries for which 2 or more Gini coefficients and income quintile shares exist) and the WDI. For these countries, the mean level of real income per capita of each income quintile group was calculated in the following manner: If (I) represents the GDP/cap of a country, $(I)_i$ the GDP/cap of each quintile group and Q_i represents the proportion of total income that accrues to each quintile group, then:

$$(I)_i = \left(\frac{Q_i}{0.20}\right)(I) \qquad \text{for i= 1…5}$$

The Coverage of Data

The data coverage of the mean level and growth rate of GDP/cap is reported across the cross section of 71 countries while the coverage for Gini coefficients and income quintile shares are reported on three levels: 1) across all countries; 2) across regions; and, 3) within a select number of countries.

LEVEL 1: ACROSS ALL COUNTRIES

Across the 71 countries, the average growth rate of GDP/cap ranges from 1 to 12 percentage points, with a mean value of 6 percent. The mean aggregate level of GDP/cap is positively correlated with the growth rate of GDP/cap (0.098), whereas both the level and the growth rate of GDP/cap were found to be negatively correlated with the level of the Gini coefficient. Thus the data suggests a negative association between mean aggregate income and the level of income inequality.

Figures 1 and 2 illustrate the variability in the level and the growth rate of GDP/cap when plotted against the level of the Gini coefficient. The two figures can be used to make the case that although the level and the growth rate of GDP/cap are both negatively related to the level of the Gini coefficient, the level of GDP/cap clearly has a stronger negative relationship than the growth in GDP/cap. Sala-i-Martin (2004) makes the point that a substantial part of the decline in volatility in world income inequalities can be explained by the growth rates of China and India. However, excluding India and China from our dataset made no difference to the variability of the growth rate in GDP/cap across countries.

Figure 1

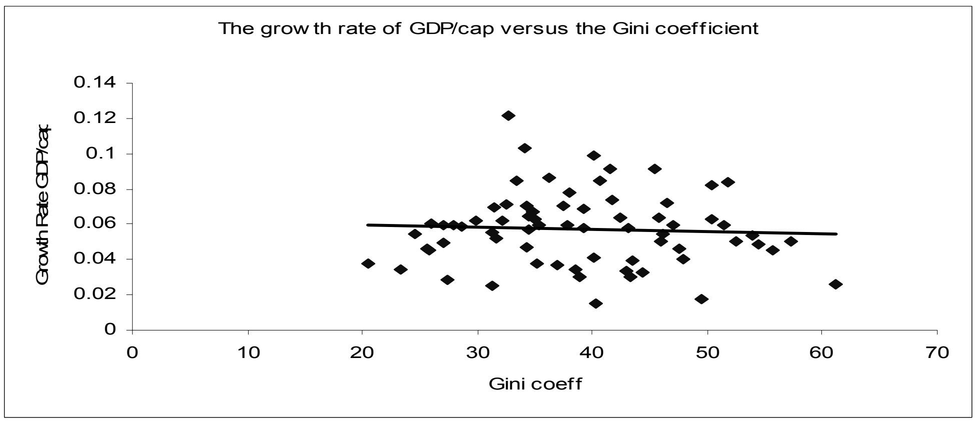


Figure 2

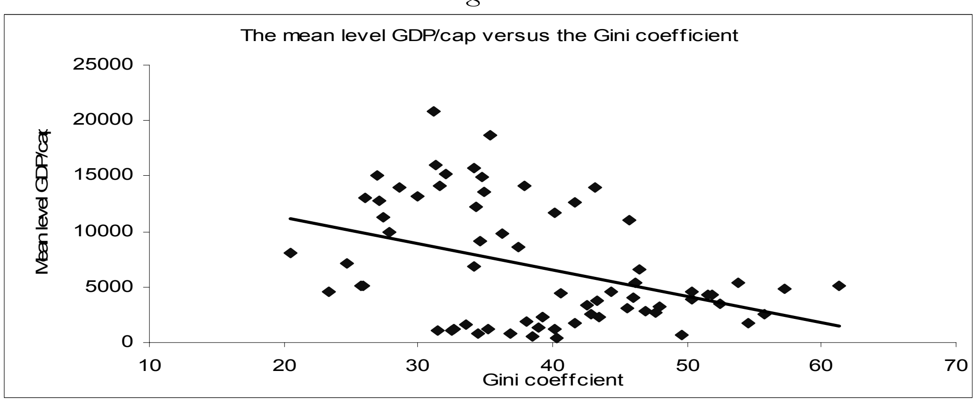
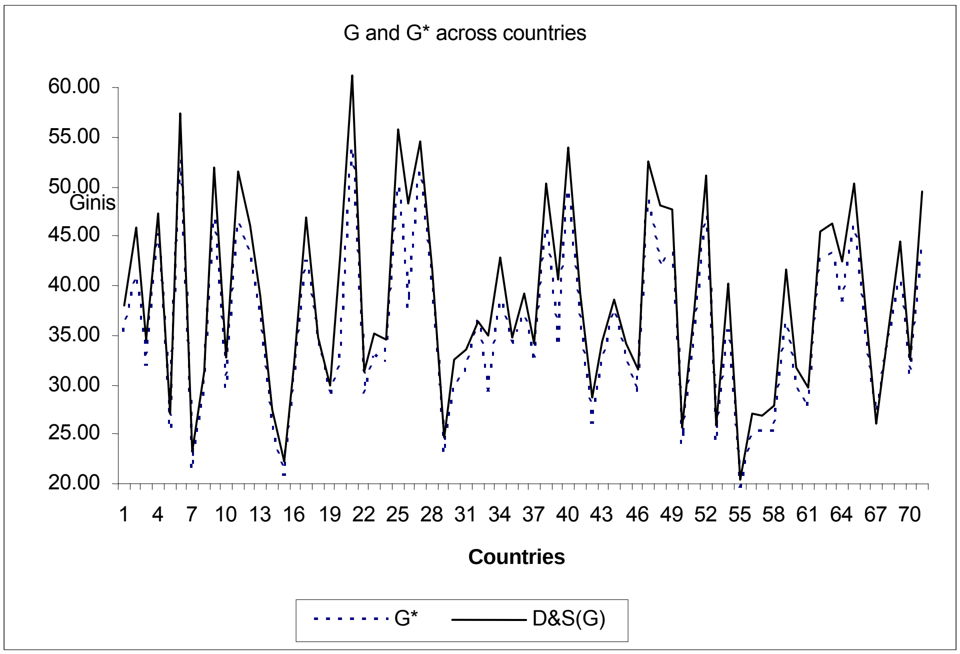


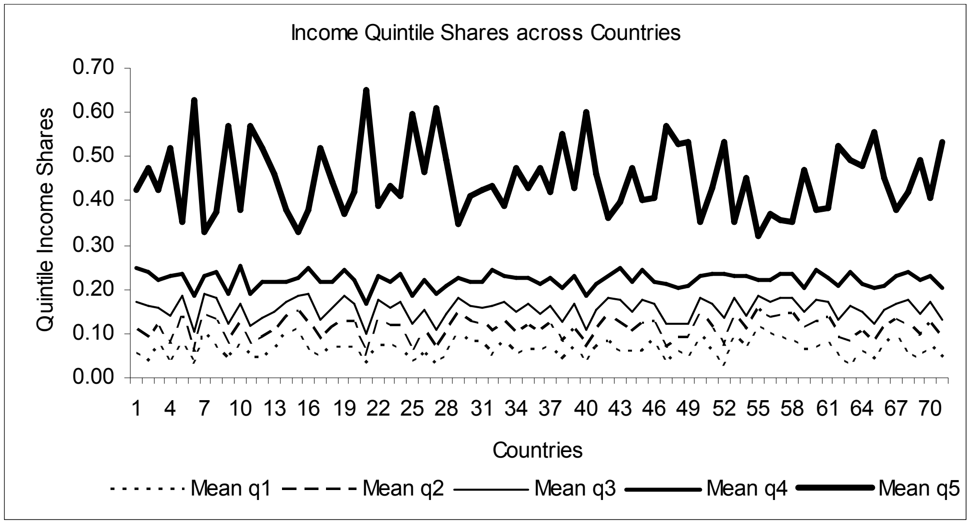
Figure 3 shows the variation in both the reported D&S Gini coefficient (G) and the supplementary Gini coefficient (G*) across all countries. The D&S(G) and G* are highly volatile with a variation of forty-one and thirty-five percentage points respectively, and the correlation coefficient between these two variables is extremely high (0.98). This is not surprising since the supplementary Gini coefficient is a function of the D&S(G) and errors, with 96 percent of the variation in the D&S(G) explained by G*.

Figure 3



As Figure 4 shows, income quintile groups 1 through 4 closely mimic each other's movements, whereas quintile group 5 mirrors each variation in the other quintile groups in the opposite direction. Separately, the poorest income quintile group (Q_1) shows almost no variation, while the richest income quintile group (Q_5) shows a 23 percentage point variation in the share of income for group 5. This is not surprising since the largest share of total income in any one country can be found in Q_5. For example, in four of the most "unequal" countries, Brazil, Mexico, Honduras and Gabon, the level of the Gini coefficient varies between 57 to 61 percentage points, with 60 percent or more of total income accruing to the richest quintile group while 3 percent goes to the poorest 20 percent of the population.

Figure 4



The estimated equation between the level of the Gini coefficient and the richest income quintile group, Q_5, reveals that 95 percent of the variability in the Gini coefficient can be explained by income quintile group 5. In addition, estimated coefficients from a simple regression between the level of the Gini coefficient and each of the other quintile income shares indicate that the Gini coefficient moves in opposite directions to the income quintile groups 1 through 4, although not as strongly as with quintile income group 5. This implies that results that use the Gini coefficient will be similar to those that use Q_5 but not as similar to those using the other quintile income shares. One reason that the correlations between the Gini coefficients and the Q_5 values are so high is that the Q_5 variables have much larger standard deviations than the other quintile shares.

Similarly, the estimated equation between the level of the Gini coefficient and the ratio of the share of income of the poorest 20 percent of the distribution to the share of income of the remaining 80 percent, reveals that 83 percent of the variation in the Gini coefficient can be explained by the ratio; although the ratio moves in the opposite direction to the Gini coefficient. This was to be expected as we have already shown that the Gini coefficient moves in the opposite direction to the share of income of the poorest income quintile (Q_1). Thus the ratio of the share of income of the poorest 20 percent to the share of income of the remaining 80 percent can be used as another supplementary measure of inequality to the Gini coefficient and Q_5.

Across the countries in our dataset we have found that the level and the growth of GDP/cap are both negatively related to the level of income inequality. The share of income of the poorest quintile group shows almost no variation as opposed to the share of income of the richest quintile group. This is related to the variability of the level of GDP/cap across countries, since the bulk of income in any one country is concentrated in the richest quintile group. In addition, a stable and strong positive relationship between the share of income of the richest quintile group and the Gini coefficient, as opposed to any other quintile group, makes it clear that Q_5 can be used as a supplement to the Gini coefficient as a measure of inequality.

LEVEL 2: ACROSS ALL REGIONS

The data coverage across regions and decades varies greatly. In particular, a comparison of the countries in the dataset reveals that whereas the SAR and ECA regions and the industrial countries are very well represented, MENA and AFR are underrepresented. In addition, the coverage within countries is sparse for some regions. For example, in AFR and the MENA regions, there are fewer than 2 observations on average for each country, compared with more than 10 observations per country in SAR and the industrial and high income developing countries.

The SAR countries and China (which is in the EAP region) exhibit the highest average growth rates of GDP/cap. The high growth SAR countries are dominated by Korea, Singapore and Thailand, with growth rates of GDP/cap between 9 and 10 percentage points, while China alone accounts for a growth rate in GDP/cap of 12 percent over the period of 1976-1998.[17]

Across the developing country regions and the group of industrial countries, the level of the Gini coefficient was found to be highly correlated with the richest quintile income share, Q_5, and not as highly correlated with the other quintile income shares – in all except for the MENA region.

In the MENA region, the level of the Gini coefficient is highly negatively correlated with Q_1 (-0.99) and not as highly correlated with Q_5 (0.56). Further ambiguity as to the relationship between the Gini coefficient and the quintile income shares is introduced through the paucity of observations for this region. As mentioned earlier, the MENA region encompasses 3 countries and the coverage of the Gini coefficient is extremely sporadic – 2 to 5 Gini coefficients in each country, with coverage years of 1980-91 for Jordan and Morocco and 1965-90 for Tunisia.

Across all countries, the variation in the level of the Gini coefficient was 41 percentage points. However, the six developing regions and the industrial countries show less variability. The variation in the level of the Gini coefficient is highest in AFR at 26 percentage points, followed by the industrial countries at 24 and ECA at 21 percentage points, respectively. The least amount of variability is shown by the MENA region (3 percent), but this could be due to the paucity of data for the region.

As with the Gini coefficients, the developing country regions and the group of industrial countries show less variation in the quintile income share of the poor and the middle class groups than across countries. However the variation in the quintile income share of the

[17] The WDI reports extremely high levels of GDP/cap for China with a maximum value of 19% and a standard deviation of 0.06. However, over the same period, the Penn World Tables report a mean growth rate for China of 6% with a standard deviation of 0.04 and a maximum value of 11%. This highlights that different datasets will differ in their reporting methods and that actual numbers for countries should be treated with caution.

richest group, Q_5, is fairly high ranging from 12 to 22 percentage points. The ECA region shows the least variation in the quintile income share of the richest group at 12 percentage points while the AFR region shows the most variability at 22 percentage points.

The group of industrial countries follows closely behind the AFR region with a variability of 20 percentage points in the quintile income share of the richest quintile group. A closer look within the industrial countries reveals that Turkey, with a quintile income share of the richest group at 55 percentage points, skews the data for this group upwards. Without Turkey, the variation in quintile income share of the richest group, Q_5, drops to 12 percent in the group of industrial countries, as opposed to 20 percent when Turkey is included.

Across most of the developing country regions and the group of industrial countries, the share of income of the richest twenty percent of the population, Q_5, falls below 50 percent of total income, with the exception of the LAC region. Within the LAC region, the quintile income share of the rich in half the countries is above 50 percent of total income. Since only 26 percent of the 71 countries in the dataset show Q_5 to be above 50 percent of total income, it means that 58 percent of countries in the dataset with Q_5 above 50 percent of total income belong to the LAC region. Across the countries in the LAC region where Q_5 exceeds 50 percent of total income, 3 percent of total income goes to the poorest, 38 percent to the middle class, and almost 60 percent of total income accrues to the top 20 percent of the population. These quintile income shares in the LAC region when compared to the other country groups makes the LAC region the most unequal among the country groups represented in this study.

In order to measure the variation in the Gini coefficient by region and among the industrial countries, regional dummies were used in a simple regression. The estimated coefficients indicate that the level of the Gini coefficient varies between 26.45 in ECA to

49.87 in LAC. Table 1 below roughly ranks the developing regions and the industrial countries by using both quintile income shares and the Gini coefficient. As mentioned earlier, income inequality is highest in LAC where the average country level Gini coefficient is approximately 50, ranging from 57 in Brazil to 42 in Jamaica.

Table 1

Using Qi (Quintiles)		*Using Gini coeffcients*	
Most	LAC	Highest Income	LAC
Unequal	AFR	Inequality	AFR
↓	MENA	↓	MENA
	EAP		EAP
	Overall*		Overall*
	SAR		SAR
Most	Industrial	Lowest Income	Industrial
Equal	ECA	Inequality	ECA

*Overall includes all countries in our dataset.

The EAP and SAR regions are characterized by average Gini coefficients in the middle to upper 30s that range from a high of about 50 percent in Malaysia and the Philippines to less than 30 percent in Taiwan. Average Gini coefficients in the mid 30s also characterize the industrial countries, followed by the historically low levels of Eastern Europe, which with Gini coefficients in the mid-20s appears to be the most egalitarian of all other groups of countries. (See Table 2)

Table 2: Decadal Averages of the Gini Coefficient, by Region/Group

Region	D&S Gini Coefficients				
	Overall Average	1960s	1970s	1980s	1990s
LAC (n=16)	49.87	53.72	50.07	50.75	47.73
AFR (n=7)	43.00	-	57.82	38.47	35.69
MENA (n=3)	40.30	42.30	44.00	40.42	40.03
EAP (n=9)	39.46	35.89	37.41	35.69	37.37
SAR (n=4)	35.07	33.22	33.71	35.00	30.63
Indus. ctries (	34.51	33.22	33.81	32.50	34.54
ECA (n=11)	26.45	23.90	23.21	25.18	28.30

Note: Figures reported are unweighted averages of the D&S Gini coefficients of cour

Notes:

1. Figures reported are unweighted averages of the Gini coefficients of countries in each region. Changes within regions may be caused by the fact that not all countries have observations for all regions.
2. "-"indicates data not available

Although the aggregate picture in Table 1 is similar when using the shares of income received by quintile groups to the one using Gini coefficients, the decadal averages of the share of income received by specific quintiles is not always completely congruent with the Gini coefficients at the regional level (Table 2). Table 3 presents the detailed data for all groups of countries and we illustrate with a specific example. Despite similar Gini coefficients in both the SAR region and the industrial countries, the richest and the poorest quintile groups in SAR receive a higher share of total income than in the industrial countries.

In conclusion, the coverage across regions and industrial countries shows that, excluding MENA, Q_5 can be used as a supplementary measure to the Gini coefficient as a measure of inequality. The data also illustrates that the AFR region contains the greatest amount of variability in the levels of inequality, while the ECA region shows the least variability. The LAC region proves to be the most unequal of all groups of countries, while the ECA region emerges as the most egalitarian, both in terms of levels of inequality and shares of income of the quintile groups.

Table 3: Income Shares of Different Quintiles, by Decade and Region

Quintile & Region	Overall Average	1960s	1970s	1980s	1990s
Lowest Quintile (Q1)					
LAC (n=16)	4.00	3.39	3.62	3.83	5.00
AFR (n=7)	6.00	-	3.47	6.83	6.84
MENA (n=3)	6.00	5.70	-	6.56	6.30
EAP (n=9)	6.00	6.79	6.65	7.01	6.61
SAR (n=4)	8.00	8.14	7.90	7.93	8.93
Indus. ctries (n=21)	6.00	6.83	6.61	6.87	6.07
ECA (n=11)	9.00	10.05	10.55	9.78	8.97
Middle class (Q2+Q3+Q4)					
LAC (n=16)	42.00	37.53	40.77	40.59	43.29
AFR (n=7)	45.00	-	34.40	48.78	50.70
MENA (n=3)	47.00	45.30	-	46.42	46.92
EAP (n=9)	47.00	48.37	48.40	50.25	50.14
SAR (n=4)	49.00	50.19	50.09	49.52	51.23
Indus. ctries (n=21)	53.00	53.00	52.81	53.84	53.67
ECA (n=11)	54.00	55.18	56.50	55.54	53.33
Top Quintile (Q5)					
LAC (n=16)	54.00	59.09	55.61	55.58	51.71
AFR (n=7)	49.00	-	62.13	44.39	42.46
MENA (n=3)	47.00	49.00	-	47.02	46.77
EAP (n=9)	46.00	44.83	44.94	42.94	43.25
SAR (n=4)	43.00	41.67	42.01	42.54	39.84
Indus. ctries (n=21)	41.00	40.17	40.58	39.29	40.26
ECA (n=11)	36.00	34.77	32.94	34.67	37.65

Note: "-"indicates data not available. All numbers are a percent of mean real income.

LEVEL 3: WITHIN A SELECT NUMBER OF COUNTRIES

The choice of individual countries was determined primarily by the availability of a large enough data-stream at the country level and partially by the location of the countries. The three countries were picked from the least unequal regions/group of countries where the most complete information on both quintile income shares and Gini coefficients were available: India (31), Bulgaria (28) and the US (45). These countries represent the regions of SAR, ECA and the industrial counties, respectively.[18] The data for India covers the years of 1951 through 1992, for Bulgaria from 1963 to 1993 and for the US from 1947 to 1991.

In India, the correlation coefficient between the level of the Gini coefficient and the richest quintile income share, Q_5, is 0.97 while in the US it is 0.98. This indicates that for both India and the US, results that use the Gini coefficient turn out to be similar to those that use Q_5 but not as similar to those using the other quintile income shares. This result is the same as for the SAR region and for the group of industrial countries as a whole.

However in Bulgaria, the correlation coefficient between the level of the Gini coefficient and the lowest quintile income share, Q_1, is -0.93 while that between the level of the Gini coefficient and the richest quintile income share, Q_5, is significantly smaller in magnitude. This result is at odds with the previous regional result for ECA which indicated a stronger positive correlation between the Gini coefficient and Q_5.

Given that the results for Bulgaria differ from that of India and the US as well as from the results for the ECA region, we conclude that the choice of a supplementary measure for the Gini coefficient using quintile income shares at the country level may depend on the particular country under analysis.

In both India and Bulgaria, estimated equations between the level of the Gini coefficient and each of the quintile income shares reveal that the relationship is similar to that for the overall sample of countries. Specifically, a negative relationship between the level of income inequality and the share of total income of the poorest and the middle class quintile groups, and a positive relationship with the share of total income for the richest quintile group.

[18] The numbers in parenthesis refers to the number of years for which data is available. Thus, there are 28 years of data available for Bulgaria. It should be noted that this data is not always sequential. See Appendix 4 for further details.

In the US, the estimated equations reveal a negative relationship between quintile income groups 1 through 3 and the level of the Gini coefficient and a positive relationship with quintile income groups 4 and 5. This suggests a negative relationship between the level of income inequality and the share of total income of the poorest quintile group. However, since the share of total income of two-thirds of the middle class decreases as that of one-third increases, no conclusions can be reached as to how the middle class are affected by increasing levels of income inequality.

The variability in the quintile income shares for India and the US are both very small, and they fall considerably below that of the overall sample. For example, India's variability for Q_1 and Q_5 is 2 and 9 percentage points respectively, while the overall sample figures are 9 and 33 percentage points. These numbers support the hypothesis that the majority of the variability in inequality is across countries rather than within a country over time.

It is surprising that the difference between Q_5 and Q_1 in the US is not only greater than that for India, at 37 percent for the US as compared to 33 percent for India, but also greater than that for the group of industrial countries.[19] However, the variability in the Gini coefficient for India when compared to the US is twice as much, at 4 percentage points for the US as compared to 8 percentage points for India. Thus, although the level of income inequality is similar in both India and the US, the level of the Gini coefficient is more volatile in India than in the US. In addition, the within-country disparity in the share of total income between the richest and the poorest quintile groups is greater in the US than in India.

In Bulgaria, the difference in the quintile income share between Q_5 and Q_1 is not only lower than that for both India and the US, but it is 16 percent lower than the overall sample. Thus, the disparity in the share of total income between the richest and the poorest quintile groups is lower in Bulgaria than in both India and the US. But, the

[19] The difference in the share of income (Q_5 - Q_1) for the group of industrial countries is 35 percent.

variation in the Gini coefficient is higher than in India, the US, and the whole ECA region.

In summary, our results within countries indicate a negative relationship between the level of income inequality and the share of total income of the poorest and the middle class groups, in both India and Bulgaria. While this relationship also holds true for the poorest and richest quintile groups in the US, it is ambiguous as to how the middle class are affected by increasing levels of income inequality.

The variability in the quintile income shares within these three countries lends credence to the hypothesis that the majority of the volatility in inequality is across countries rather than within a country over time. However, the analysis of the three countries highlights some differences when comparing the level of the Gini coefficient and the difference in the share of income between Q_5 and Q_1. For example, the Gini coefficient is more volatile in India than in the US, but the difference in the share of income between Q_5 and Q_1 is greater in the US than in India. Bulgaria, which belongs to the most equitable region in our dataset also shows a greater degree of volatility in its within country levels of income inequality than India and the US.

Relationships and Variables of Interest

In order to test whether a) high levels of income or growth are associated with high levels of income inequality? and, b) whether high levels of inequality are associated with lower absolute or relative standards of living for the poor?, the study isolates the following relationships: 1) the relationship between real per capita income and growth variables (referred to as group A variables), income inequality indicators and relative income variables (the latter is referred to group B1 variables); 2) the relationship between group A variables and absolute per capita income measurements (referred to as group B2 variables); and 3) the relationship between relative income variables and absolute per capita income measurements – i.e. the relationships between the variables in groups B1 and B2.

The following summarizes the variable groupings:

Group A – these variables are the mean aggregate level of GDP/cap and the growth rate of GDP/cap for each country.

Group B1 – the relative income indicators used in this study are the income quintile shares, and ratios constructed from the percentile shares of income, such as the average income of the top 20 percent of the distribution to the bottom 20 percent and the ratio of the share of income of the bottom 20 percent of the distribution to the share of income of the remaining 80 percent.

Group B2 – the absolute per capita income or the mean levels of GDP/cap of each income quintile group of the population. This was calculated from information on quintile income shares and the country level aggregate per capita income or the country level GDP/cap. To distinguish the quintile level per capita income, they will henceforth be referred to as $(GDP/cap)_{poor}$, $(GDP/cap)_{mid\ class}$, and $(GDP/cap)_{rich}$. .

Income Inequality variable – The Gini coefficient is used as an aggregate indicator of the level of income inequality. As previously mentioned, the Gini coefficient incorporates the more detailed shares data into a single statistic which summarizes the dispersion of the income shares across the whole income distribution.

Chapter 4

THE ANALYSIS

This chapter addresses three specific relationships: 1) between the level and growth rate of income per capita and the level of inequality; 2) between the level and growth rate of income per capita and both the relative and absolute incomes of people; and 3) the specific movements between relative and absolute incomes. These relationships are studied within a cross-section of countries using correlations and simple OLS methodology. At the heart of this study is how these variables affect the poor; however, we are also aware that incomes at the top and middle of the distribution can be just as important in revealing information about the relative incomes of people. Where appropriate, analysis results for these groups are reported.

The first section looks at the relationship of group A to both group B1 variables and the level of income inequality. This section continues on to test whether the Kuznets hypothesis is of empirical significance across countries, and whether countries are converging to the same level of inequality. As mentioned before group A variables are the levels and growth rates of GDP/cap. The Gini coefficient is used as an aggregate measure of income inequality, and the Group B1 variables refer to relative income indicators like the income quintile shares, Q_i.

The second section uses the cross-sectional data to look at the relationships between group A and B2 variables in order to determine if high levels of income or growth are associated with lower absolute incomes of people. Group B2 variables refer to absolute income variables used in this analysis. They are the quintile level per capita income, also referred to as $(GDP/cap)_{poor}$, $(GDP/cap)_{mid\ class}$, and $(GDP/cap)_{rich}$. .

The third section asseses the specific movements between relative (group B1) and absolute incomes (group B2) by looking at the relation between the quintile income shares and the quintile level GDP/cap for each group, focusing primarily on outcomes for the poor.

The the conclusions for the overall sample are tested by partitioning the cross sectional data in different ways: (1) countries with high versus low levels and growth rates of aggregate per capita income, (2) in developing versus industrial countries and (3) across regions. As this analysis shows, partitioning the data dramatically changes some of the conclusions that were reached for the overall sample.

Group A versus Group B1 & Inequality

The literature to date finds either no systematic relationship between growth and changes in inequality, or it finds some evidence of a negative relationship in very specific cases. However, little is said about the link between the level of GDP/cap and the level of income inequality.

Examining the relationship between group A variables and the level of the Gini coefficient, the analysis finds a negative relationship between both the level and growth rate of GDP/cap and the level of the Gini coefficient. However, the estimated coefficients in Table 4 indicate a statistically significant negative relationship between the level of the Gini coefficient and the mean level of GDP/cap but none with the growth of GDP/cap. The estimated relationship between the growth of GDP/cap and changes in the level of the Gini coefficient was also found to be negative but not statistically significant.[20] In other words, while growth in mean income and changes in inequality do not seem to be systematically related, there is a strong negative relationship between the mean levels of income and the level of income inequality.

[20] Estimated equations of the growth of GDP/cap against the growth of the Gini coefficient and the rate of change of the Gini coefficient were all found to be statistically insignificant. For details see Appendix 3.

Across countries, the correlation coefficients between the growth of GDP/cap and the quintile income share of the richest (Q_5) and poorest (Q_1) groups were negative, and positive for the middle class quintiles. However, the estimated coefficients while negative, fail to be jointly and individually significant. (Table 4)

The mean level of GDP/cap was found to be negatively correlated with the richest quintile's share of income (Q_5) and positively correlated with the share of income of the other quintile groups, and, the estimated coefficients were both individually and jointly significant. This implies a positive relationship between the mean level of GDP/cap and the relative incomes of the poor and the middle class quintile groups. (Table 4)

Thus in the answer to the questions of (1) are high levels of income or growth associated with high levels of income inequality; and, (2) are high levels of inequality associated with lower relative standards of living for the poor, this study finds a negative but insignificant association between growth and changes in inequality. However, there is a strong negative relationship between the mean level of income and the level of income inequality. In addition, the analysis finds significant empirical evidence to support a positive relationship between the mean level of income and the relative incomes of both the poorest and middle quintile groups.

Table 4: Group A versus Group B1 Variables

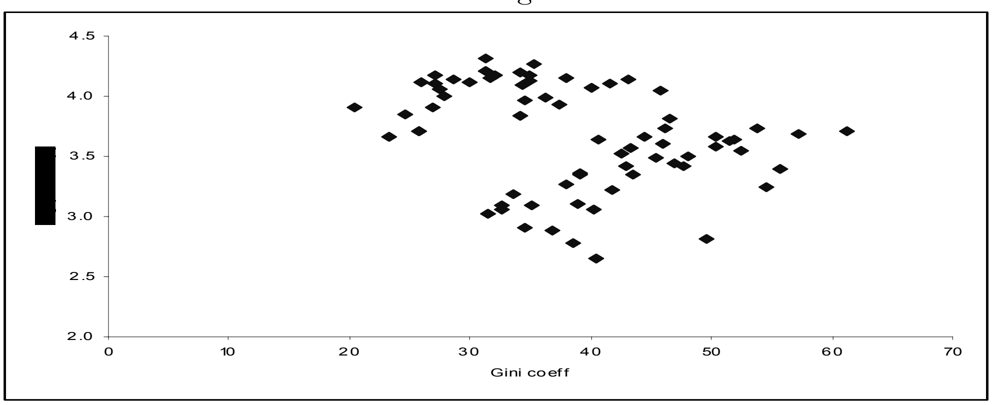
Group B1 var			Group A var		
			Level GDP/cap	Log GDP/cap	Growth GDP/cap
Relative Income Indicators	*Gini coeff*	Slope coeff	-237.63		-0.0001
		t stat	-3.68		-0.41
		R^2	0.17		0.2
	Q(poor)	Slope coeff	96469.20	5.99	-0.04
		t stat	3.89	1.06	-0.33
		R^2	0.19	0.018	0.002
	Q(rich)	Slope coeff	-32052.25	-4.48	-0.02
		t stat	-4.29	-3.23	-0.55
		R^2	0.23	0.14	0.005
	Q(md class)	Slope coeff	46342.40	6.60	0.03
		t stat	5.10	3.84	0.81
		R^2	0.29	0.19	0.01
	(GDP/cap)poor / *(GDP/cap)rest*	Slope coeff	47905.70	5.87	-0.04
		t stat	1.68	1.16	-0.34
		R^2	0.04	0.02	0.002
	(Q)poor / *(1-Q(poor))*	Slope coeff	42778.98	5.87	-0.04
		t stat	1.56	1.1.6	-0.39
		R^2	0.04	0.02	0.002

Kuznets Hypothesis: In order to test Sala-i-Martin's (2004) hypothesis that the bulk of the variation in across country inequality can be explained by differences in per capita incomes this study uses the Kuznets curve. Kuznets suggested an inverted U relationship between income and inequality. That is, as economic development proceeds and per capita income increases, inequality would first rise and then fall. The Kuznets curve was accepted on an empirical level throughout the 1970s, but subsequent work has suggested that the relation has weakened over time.[21] Li, Squire and Zou (1998) argue however that the curve works better for a cross section of countries at a point in time than for the evolution of inequalities over time within countries.

[21] See Deininger and Squire (1996) and Anand & Kanbur (1992) to name a few.

Thus across countries, the existence of a kuznets curve would show up as an inverted-U relationship between the level of the Gini coefficients and the aggregate levels of GDP/cap. Although this relationship is not obvious from the scatter plot in Figure 5, the estimated relation between the level of the Gini coefficient and a quadratic in the natural log of GDP/cap does prove to be statistically significant. (Table 5) The estimated relationship implies that the Gini values rise with the level of GDP/cap for values less than $5000 and declines thereafter.

Figure 5



Several other formulations of the Kuznets curve were attempted. The first used the growth rate of the Gini coefficient against the level and the level squared of GDP/cap. This did not change the results appreciably, although the significance of the variables decreased. However, when the growth rate of the Gini coefficients was used against the natural log and log squared of GDP/cap, the relationship became U-shaped. That is, as the growth rate of the Gini coefficient across countries increases, the log of GDP/cap seems to first fall and then increase.[22]

[22] For more details on these formulations and others see Appendix 3.

Table 5

Y=Gini coeff	Full sample (n=70)	
	Coeff. Est.	t Stat
Intercept	-161.42	-2.38
ln(GDP/cap)	120.86	3.15
ln(GDP/cap)^2	-17.83	-3.33
R^2	0.22	
Adjusted R^2	0.19	
F	9.38	

It is also possible to estimate the Kuznets curve for the quintile level shares of income. If the share of income of the poorest quintile (Q_1) is used as the dependent variable, then the estimated Kuznets-curve coefficients reveal that the share of income of the poorest and the middle class quintile groups tends to fall and subsequently increases (when GDP/cap passes $6,200 and $4,800 respectively for the two quintile groups) with the level of GDP/cap. The estimated coefficients for all three quintile groups were individually and jointly significant and the Kuznets curve in case suggests that the relative incomes of the poor and the middle class first fall and then rise with increasing levels of GDP/cap.

These formulations show that for this study the Kuznets curve does emerge as a clear empirical regularity. This may explain some of the variation in inequality across countries for it predicts the division of the dataset into two groups of countries. One group of countries where the mean levels of income are accompanied by increasing levels of inequality, and a second group where mean levels of income are accompanied by decreasing levels of income inequality.

Initial Inequality to Growth & Convergence: The lack of a systematic association between growth and changes in inequality motivates the search for a link between *initial* inequality and growth. The only consensus in the literature on this issue to date is that while initial inequality may not directly affect an economy's growth potential, it does proxy for more fundamental inequalities of wealth.

Across countries, there was a negative but insignificant association between the average growth of GDP/cap and the initial level of the Gini coefficient. In contrast, the negative and significant estimated coefficient on the initial level of the Gini coefficient suggests that high initial levels of inequality could affect the levels of mean income.

Since the Kuznets formulation found evidence of two groups of countries in our dataset, the average rate of change in the Gini coefficient was calculated to test whether these countries were converging to the same level of inequality.[23] Table 6 presents the estimated equations between the rate of change of the Gini coefficient and the initial value of the Gini coefficient. As the table shows the estimated coefficients on the initial Gini coefficients are individually and jointly significant, indicating a mean-reversion in inequality.

Table 6

Y=Gini growth rate	Full sample n=76		Countries with Gini obs ≥ 10 b/w 1st & last obs. N=21		Countries with 10 < Gini obs ≥ 2 b/w 1st & last obs. N=55	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	0.245	3.27	0.319	1.79	0.246	2.66
Initial Gini	-0.007	-3.77	-0.010	-1.83	-0.007	-3.19
R^2	0.16		0.15		0.16	
Adjusted R^2	0.15		0.11		0.15	
F	14.24		3.37		10.15	

One predicament with this test is that inequality and its rate of change are computed over different periods for different countries. The incompleteness of the data set does not permit the standard cross-sectional regression over a fixed ten or twenty year period.

[23] The average rate is the rate of change between the first and last available Gini observations for each country.

One way to circumvent this problem would be to extrapolate the missing data. However, restricting the overall sample to those countries where there are at least 10 observations separating the first and last Gini observations leads to virtually unchanged results. That is, a mean-reversion in inequality. Therefore, the missing data was not extrapolated as it was felt that this would introduce further biases into the dataset.

Motivations for Disaggregating the Data: This study finds a strong negative association between the mean level of income and the level of income inequality. In addition, there is empirical evidence to support the view that high levels of initial inequality could affect the level of mean income across countries. Finally, the analysis on the Kuznets curve provides some evidence that there might be two groups of countries within the dataset. Together, these factors motivate the partitioning of the data by 1) High vs Low income and growth countries; 2) Industrial vs Developing countries; and 3) developing country regions.

1) HIGH VS LOW INCOME AND GROWTH: Due to the large variation in the growth of real income per capita across countries, the growth data was split in two groups. High growth countries were defined as those with a growth rate of 5 percent or more while low growth countries were those with growth rates below 5 percent. [24] The correlation coefficients between the growth of GDP/cap and the level of the Gini coefficient were found to be negative and insignificant for both high and low growth rate countries. Furthermore, partitioning the dataset at a mean growth rate of 6 percent failed to make the estimated coefficients significant.[25]

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[24] Results of the Kuznets analysis as well as a histogram of frequency distributions were used to determine where the level of GDP/cap should be split.

[25] See Appendix 3 for more details on this analysis.

Similarly, the level of GDP/cap was partitioned into two groups of countries[26]: high income countries were those above the mean $5000/cap GDP mark and low income countries were those below. Partitioning the sample along these lines changes the initial conclusion of a negative relationship between the mean level of GDP/cap and the level of the Gini coefficient. That is, there is now an empirically robust negative relationship in high income countries and a positive relationship in low income countries.

The estimated coefficients in *high income countries* suggest a significant negative relationship between the mean level of GDP/cap and the level of Gini coefficient. The explanatory power of the equation was however very low (0.06).[27] This negative relationship in countries with a mean level of GDP/cap above $5000 is consistent with the result found for the overall sample of countries.

The estimated coefficients in *low income countries* suggest a significant positive relationship between the mean level of GDP/cap and the level of Gini coefficient. The same relationship was tested for this group of countries without India and China in the sample. This did not significantly alter the results. When the data partition was moved to mean levels of GDP/cap of $6000, countries that fell below that level continued to show a strong positive relationship between the mean level of GDP/cap and the level of the Gini coefficient.[28]

The relationship between the level of GDP/cap and the relative incomes of people was also tested for both the high and low income countries. As before, high income countries were those with mean levels of GDP/cap at and above $6000.[29] The estimated coefficients for both high and low income countries were statistically significant with the

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[26] Figure 13 in Appendix 3 reveals two clusters of countries.

[27] See Table 18 in Appendix 3.

[28] See Table 19 in Appendix 3.

[29] Changing the mean level of GDP/cap to $5000 made no difference to the results.

share of income of quintile groups 1 through 4 being negatively related to the level of GDP/cap.

Overall, these results seem to imply that in high income countries, there is a negative relationship between the level of GDP/cap and both the level of inequality and the relative incomes of the poor and the middle class. In low income countries, there is a positive relationship between the level of GDP/cap and the level of inequality, and a negative relationship with the relative incomes of the poor and the middle class.

2) INDUSTRIAL VS DEVELOPING COUNTRIES: Since the low income countries are dominated by developing countries the data was partitioned into industrial and developing countries. Growth rates of GDP/cap in industrial countries range between 2 to 8 percentage points, and between 1 to 12 percentage points in developing countries.[30] In developing countries, there is a small negative correlation between the growth rate of GDP/cap and the level of the Gini coefficient (-0.05), while in industrial countries the relationship is positive at 0.22.

For the *industrial* countries, the estimated equations reveal a significant and positive relationship between the growth rate of GDP/cap and the level of the Gini coefficient, although the explanatory power of the equation is very low. However, the estimated coefficients reveal a significant negative relationship between the growth rate of GDP/cap and the share of income of the poorest quintile group, Q_1.

Across the *developing* countries the relationship between the growth rate of GDP/cap and the level of the Gini coefficient is negative but insignificant.[31] Excluding China from the group of developing countries made no difference to these results. Similar to industrial countries, the estimated coefficients for the developing countries indicate a negative

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[30] The 12 percent growth rate in GDP/cap in developing countries is due to China.

[31] For analysis details on both industrial and developing countries, see Tables 34, 35 and 36 in Appendix 3.

relationship between the growth rate of GDP/cap and the share of income of the poorest quintile group, Q_1.

The data on the level of GDP/cap was also partitioned into industrial and developing countries. In developing countries the level of GDP/cap ranges between $451.27/cap and $12,731.10/cap, and in industrial countries between $3,841.81/cap and $20,809.14/cap.[32] Correlation coefficients and estimated equations show a significant and negative relationship between the level of GDP/cap and the level of the Gini coefficient for both groups of countries. This result for developing countries contradicts our earlier findings in low income countries where there was a positive relationship between the mean level of GDP/cap and the level of inequality.

In terms of the relative incomes of people, there now appears to be a positive relationship for both industrial and developing between the level of GDP/cap and the share of income of quintile groups 1 through 4. Again, this result contradicts our earlier analysis which found a negative relationship in both low and high income countries between the mean level of GDP/cap and the relative incomes of the poor and the middle class.

The contradictory results between the low-income and developing countries could be driven by the choice of countries within these two groups. As mentioned before, most low-income countries are also developing countries, and while most high income countries fall into the category of industrial countries, some are classified as developing countries. Thus the data is further partitioned into developing countries regions in order to access which of these two contradictory results actually reflect the true relationship between the mean level of real income per capita and the level of income inequality.

3) DEVELOPING COUNTRY REGIONS: Across the developing country regions, there is some evidence of a positive relationship between the level of GDP/cap and the

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[32] See Tables 16 and 17 in Appendix 3 for details.

level of the Gini coefficient. In terms of relative income, five of the six developing regions show a negative association between the mean level of GDP/cap and the share of income for the poor and the middle class. The sixth region ECA has been already established as the most equitable of the developing country regions. Thus it is not surprising to find a positive relationship between the level of GDP/cap and the share of income of the poorest 20 percent of the population. (Table 7)

Table 7: Correlation Coefficients between the Level of GDP/cap and Income Quintile Shares

Region / Mean GDP/cap	1 EAP	2 ECA	3 LAC	4 MENA	5 SAR	6 AFR	7 Hi Income
Q1	-0.12	0.06	-0.30	-0.99	-0.70	-0.58	0.28
(Q2+Q3+Q4)	-0.05	-0.82	-0.07	-0.07	-0.84	-0.47	0.60
Q5	0.07	0.64	0.12	0.62	0.80	0.48	-0.56
n	8	8	14	3	4	7	20

The developing country regions exhibit mixed results for the relationship between the growth rate of GDP/cap and the level of the Gini coefficient. In the regions of AFR and the EAP, correlation coefficients indicate a negative association between the growth rate of GDP/cap and the level of the Gini coefficient.[33] In the remaining regions of ECA, LAC, MENA and SAR, correlation coefficients indicate a positive association between these two variables. The results in these regions are far from robust due to the uneven country level representation of the data.

Table 8 presents the correlation coefficients between the growth rate of GDP/cap and the quintile income shares of each group within a region. In the regions of ECA, LAC, MENA and SAR, our previous analysis found some evidence of a positive association between the growth of GDP/cap and the level of the Gini coefficient. This implies that the relationship between the growth rate of GDP/cap and the share of income of the poor and the middle class should be negative. Table 8 shows this to be the case for all regions except ECA.

[33] The regional level correlations are presented in Table 45 in Appendix 3.

Table 8: Correlation Coefficients between Growth of GDP/cap and Income Quintile Shares

Region / Growth GDP/cap	1 EAP	2 ECA	3 LAC	4 MENA	5 SAR	6 AFR	7 Hi Income
Q1	0.55	-0.44	-0.34	-0.07	-0.31	0.41	-0.31
(Q2+Q3+Q4)	0.74	0.20	-0.37	-0.99	-0.50	0.53	-0.22
Q5	-0.71	0.01	0.40	0.83	0.44	-0.52	0.27
n	8	7	14	3	4	7	20

The ECA region shows the least amount of income inequality of all the developing country regions. And while there is a positive correlation between the growth rate of GDP/cap and the share of income of the rich, there is also a positive correlation between the growth rate of GDP/cap and the share of income of the middle class.

Group A versus group B2 Variables

This section looks at the relationship between the absolute incomes of the poor and the level and growth rate of GDP/cap. The absolute income variables are also referred to as the quintile level GDP/cap or $(GDP/cap)_{Qi}$, where i=1…5, for each of the quintile groups.

The consensus in the literature is that while growth may not always benefit the poor, some of the poor do benefit from pro-growth policy reforms. In other words, there is no systematic empirical support for the belief that pro-growth policies lead to an absolute reduction in poverty, although the literature continues to support a negative association between growth and absolute poverty.

The correlation coefficients between the growth of GDP/cap and the quintile level GDP/cap were very small, but there is some evidence of a negative but insignificant relationship between the growth of real GDP/cap and the quintile level GDP/cap of the poorest group (Table 9).

Table 9: Group A versus Group B2 Variables

Group B2 var			Group A var: Level GDP/cap	Group A var: Log GDP/cap	Group A var: Growth GDP/cap
Absolute Income Indicators	*(GDP/cap)poor*	Slope coeff	2.43		-2.45E-07
		t stat	20.41		-0.20
		R^2	0.87		6.38E-04
	(GDP/cap)mid class	Slope coeff	0.36		5.24E-08
		t stat	75.34		0.31
		R^2	0.99		1.54E-03
	(GDP/cap)rich	Slope coeff	0.51		1.69E-07
		t stat	38.96		0.69
		R^2	0.96		0.01

There is however a significant and positive relationship between the mean level of GDP/cap and the quintile level GDP/cap (Table 9). Caution should be used when interpreting this result since the real income of each quintile group is calculated from the share of income of each quintile group and the country level GDP/cap. This means that the mean level of GDP/cap and the real income of the quintile groups are highly correlated. In addition, the real income of the richest quintile group contains the largest share of total income in any one country. These facts combined may be biasing the results towards a positive relationship between the mean level of GDP/cap and the level of real income of each of the quintile groups.

In order to measure the extent to which the absolute incomes of the poor benefit from increases in the level of GDP/cap, the percentage effect of the level of GDP/cap was calculated by using the following formulation:

$$\log(GDP/cap(poor)) = a + b \log(GDP/cap) \quad \text{where } b = \text{percentage effect}$$

Thus, if the level of GDP/cap increases by 1 percentage point and the share of income of the other quintile groups stay the same, then the absolute incomes of the poorest quintile group increases by 1.05 percentage points. In contrast, a 1 percentage point increase in the level of GDP/cap could mean an increase of less than 1 percentage point for the absolute incomes of the richest quintile group.

In conclusion, this analysis finds no empirical support for a positive relationship between growth and the absolute incomes of the poor across countries. However, there is strong empirical evidence to support the claim of a positive relationship between the level of GDP/cap and the absolute incomes of the poor.

Motivations for Disaggregating the data: Although the above analysis finds no systematic relationship between the growth rate of GDP/cap and the absolute incomes of the poor, partitioning the data by industrial and developing countries changes this result. That is, there is substantial empirical evidence of a negative relationship between growth and the absolute incomes of quintile groups in industrial countries, and a positive relationship in developing countries and across most developing country regions. Thus, the data is partitioned by 1) Industrial vs. Developing countries; and 2) developing country regions.

1) INDUSTRIAL VS. DEVELOPING COUNTRIES: The correlation coefficients indicate that the relationship between the growth of GDP/cap and the quintile level GDP/cap is negative in industrial countries and positive in developing countries. In addition, the estimated coefficients for the quintile level GDP/cap are all individually and jointly significant in industrial countries, as is the estimated coefficient $(GDP/cap)_{Q5}$ in developing countries. (See Table 10)

Table 10

GDP/cap growth rate	Correlations	
	Industrial Countries	Developing Countries
$(GDP/cap)_{Q1}$	-0.56	0.01
$(GDP/cap)_{Q2+Q3+q4}$	-0.49	0.11
$(GDP/cap)_{Q5}$	-0.42	0.17

However, the strong positive relationship between the level of GDP/cap and the quintile level GDP/cap continues to be significant for both groups of industrial and developing countries.

2) REGIONAL RESULTS: The correlation coefficients between the mean level of GDP/cap and the quintile level GDP/cap were found to be positive for each of the 6 developing country regions.

In addition, the correlation coefficients between the growth of GDP/cap and the quintile level GDP/cap indicate that the relationship continues to be positive across the developing country regions – in all except the ECA region.

Group B1 versus B2 Variables

This section looks at the specific movements between the relative and absolute incomes of people by looking at the relation between the quintile income shares and the quintile level GDP/cap for each group, but in particular for the poor. The literature notes that while the poor may benefit in absolute terms, they benefit proportionally less than the average household so that inequality continues to be on the rise.

The relationships between the share of income and the quintile level GDP/cap become apparent in Table 11 below. The relationship between the share of income of each quintile group and the quintile level GDP/cap along the diagonal will always be positive and, at the country level perfectly correlated.

Table 11: The Relationship between Income Quintiles & Quintile level GDP/cap

		(Q2+Q3+Q4)	Q5
$(GDP/cap)_{Q1}$	+	+	-
$(GDP/cap)_{Q2+Q3+q4}$	+	+	-
$(GDP/cap)_{Q5}$	-	-	+

Additionally, the relationship between the share of income of the poorest group (Q_1) and the quintile level GDP/cap for the middle class should be positive. This is because we have already shown that the share of income of the poor and the middle class quintile groups move in the same direction as the level of GDP/cap and the level is positively related to the quintile level GDP/cap of these two quintiles. Similarly, since the share of income of the richest quintile Q_5 moves negatively with the share of income of the poorest and the middle class quintile groups, the following four relationships according to Table 11 should all be negative: 1) Q_1 and $(GDP/cap)_{Q5}$; 2) $(Q_2+Q_3+Q_4)$ and $(GDP/cap)_{Q5}$; 3) Q_5 and $(GDP/cap)_{Q1}$; 4)Q_5 and $(GDP/cap)_{Q2+Q3+Q4}$.

The estimated equations of the relationship between the share of income of the quintile groups and the quintile level GDP/cap are presented in Table 12. For the poor and middle class quintiles the estimated coefficients are all jointly and individually significant and the direction of the relationships follow the signs in Table 11. This means that across countries, the relative and absolute incomes of the poor and the middle class tend to move together.

Table 12: Group B1 versus Group B2 Variables

Group B2 variables		Group B1 variables: Gini coeff	Group B1 variables: Q (poor)	Group B1 variables: Q (rich)	Group B1 variables: Q (md class)	Group B1 variables: (GDP/cap)poor ------------------ (GDP/cap)rest
Absolute Income Indicators	*(GDP/cap)poor*	↑ -0.0003 -6.33 0.39	↑ 4.98E-06 4.48 0.25	↑ -2.51E-05 -6.73 0.43	↑ 2.02E-05 6.98 0.44	↑ 5.70E-06 4.46 0.25
	(GDP/cap)mid class	↑ -0.0003 -4.56 0.25	↑ 3.82E-07 2.26 0.08	↑ -2.95E-06 -5.21 0.31	↑ 2.56E-06 6.07 0.38	↑ 4.32E-07 2.21 0.07
	(GDP/cap)rich	↑ -0.0004 -3.07 0.13	↑ 1.18E-07 0.46 0.003	↑ -2.51E-06 -2.69 0.11	↑ 2.38E-06 3.35 0.16	↑ 1.28E-07 0.44 0.003

Note: The direction of the arrow indicates the LHS variable in the regression analysis

The remaining set of relationships between the share of income of the quintile groups and the quintile level GDP/cap of the richest quintile group does not follow the expected direction of movement. That is, they are positive when they should be negative and vice versa. As mentioned before, this is probably due to the fact that the real income of each quintile group is calculated from the share of income of each quintile group and the country level GDP/cap. In addition, the real income of the richest quintile group contains the largest share of total income in any one country.

In conclusion, we find that across countries the relative and absolute incomes of the poor and the middle class quintile groups move together, while the relationships between the relative income of the richest quintile group and the absolute incomes of the quintile groups are ambiguous. Our prior analysis between groups A and B1, and groups A and B2 variables have shown that partitioning the dataset can sometimes provide empirical evidence of relationships which were not valid in the cross-country sample. Thus the following level of comparison is between the developing and the industrial countries.

DEVELOPING VS. INDUSTRIAL COUNTRIES*:* The correlation coefficients between the share of income (Q_i) and the quintile level GDP/cap of each quintile group are presented in Table 13. However, the following analysis will concentrate on the correlation coefficients between the share of income of the richest quintile Q_5, and the quintile level GDP/cap of the quintile groups. For the *industrial* countries, prior analysis has shown a negative relationship between the level of GDP/cap and both the level of the Gini coefficient and the share of income of the rich, Q_5. If these relationships are true, then the relationship between the share of income of the richest quintile, Q_5, and the quintile level GDP/cap for the poorest and the middle class groups should be negative. Table 13 shows this to be the case.

Similarly, across the *developing* regions, prior analysis has shown a positive relationship between the level of GDP/cap and both the level of the Gini coefficient and the share of income of the rich, Q_5. If these results hold, then the relationship between the share of income of the richest quintile Q_5, and the quintile level GDP/cap for the poorest and the middle class quintile groups should be positive.

In 4 out of the 6 developing country regions there is a positive relationship between the share of income of the richest quintile, Q_5, and the quintile level GDP/cap of the poorest and middle class quintile groups. These regions were ECA, MENA, SAR and AFR.

The remaining developing country regions of EAP and the LAC are considered non-conformers. Non-conforming regions are those where there is a negative instead of a positive relationship between Q_5 and the quintile level GDP/cap for the poor and the middle class quintile groups. Previous analysis identified the LAC region as the most unequal of the developing country regions with EAP falling somewhat in the middle of the range.

Table 13: Correlation coefficients between quintile shares and the quintile level GDP/cap

Quintile GDP/cap \ Q	Poor Q_1	Middle class $(Q_2+Q_3+Q_4)$	Rich Q_5
Region 1 (EAP)			
$(GDP/cap)_{Q1}$	0.07	0.12	-0.11
$(GDP/cap)_{Q2+Q3+q4}$	-0.05	0.02	-0.004
$(GDP/cap)_{Q5}$	-0.22	-0.15	0.17
Region 2 (ECA)			
$(GDP/cap)_{Q1}$	0.26	-0.76	0.49
$(GDP/cap)_{Q2+Q3+q4}$	0.08	-0.79	0.59
$(GDP/cap)_{Q5}$	-0.02	-0.87	0.71
Region 3 (LAC)			
$(GDP/cap)_{Q1}$	0.43	0.23	-0.29
$(GDP/cap)_{Q2+Q3+q4}$	-0.16	0.27	-0.21
$(GDP/cap)_{Q5}$	-0.41	0.27	0.38
Region 4 (MENA)			
$(GDP/cap)_{Q1}$	-0.99	-0.08	0.62
$(GDP/cap)_{Q2+Q3+q4}$	-0.99	-0.02	0.57
$(GDP/cap)_{Q5}$	-0.99	-0.12	0.65
Region 5 (SAR)			
$(GDP/cap)_{Q1}$	-0.25	-0.46	0.39
$(GDP/cap)_{Q2+Q3+q4}$	-0.62	-0.78	0.73
$(GDP/cap)_{Q5}$	-0.78	-0.90	0.87
Region 6 (AFR)			
$(GDP/cap)_{Q1}$	-0.08	-0.01	0.02
$(GDP/cap)_{Q2+Q3+q4}$	-0.23	-0.17	0.18
$(GDP/cap)_{Q5}$	-0.62	-0.68	0.68
Industrialized Ctrs.			
$(GDP/cap)_{Q1}$	0.74	0.66	-0.75
$(GDP/cap)_{Q2+Q3+q4}$	0.32	0.67	-0.63
$(GDP/cap)_{Q5}$	0.81	0.44	-0.37

Conclusion

In order to test whether a) high levels of income or growth are associated with high levels of income inequality? and, b) whether high levels of inequality are associated with lower absolute or relative standards of living for the poor?, the study isolated the following relationships: 1) the relationship between real per capita income and growth variables (referred to as group A variables), income inequality indicators and relative income variables (the latter is referred to group B1 variables); 2) the relationship between group A variables and absolute per capita income measurements (referred to as group B2 variables); and 3) the relationship between relative income variables and absolute per capita income measurements – i.e. the relationships between the variables in groups B1 and B2. These relationships were tested within a cross-section of countries using correlations and simple OLS methodology.

Data analysis across countries shows that the level and the growth of GDP/cap are both negatively related to the level of income inequality. The share of income of the poorest quintile group shows almost no variation as opposed to the share of income of the richest quintile group. This is related to the variability of the level of GDP/cap across countries, since the bulk of income in any one country is concentrated in the richest quintile group. This leads to a high degree of correlation between the highest quintile share and Gini values. In addition, a stable and strong positive relationship between the share of income of the richest quintile group and the Gini coefficient, as opposed to any other quintile group, makes it clear that Q_5 can be used as a supplement to the Gini coefficient as a measure of inequality. One reason for the strong correlations between the Gini coefficients and highest quintile share is that the highest-quintile values have much larger standard deviations than the other quintile shares.

Across the developing country regions, the AFR region contains the greatest amount of variability in terms of levels of inequality, while the ECA region shows the least variability. The LAC region proves to be the most unequal of all groups of countries, while the ECA region emerges as the most egalitarian, both in terms of levels of inequality and shares of income of the quintile groups. Furthermore, time series within select countries supports the hypothesis that the majority of the variability in inequality is across countries rather than within any one country over time.

Our analysis across countries reveals that while there is no empirical evidence of a systematic relationship between growth and changes in inequality, there is a strong negative link between mean levels of income and inequality. There is also no empirical support for a systematic relationship between growth and the absolute incomes of the poor. However, our analysis finds a strong positive link between the mean level of income and both the relative and absolute incomes of the poorest and middle quintile groups.

The Kuznets curve emerges as a clear empirical regularity across countries and motivates the partitioning of our dataset, since the Kuznets curve predicts the presence of two groups of countries within this dataset: one group where mean levels of income are accompanied by increasing levels of inequality, and a second group where mean levels of income are accompanied by decreasing levels of inequality.

Partitioning the data changed our previous conclusions for the cross-section of countries. The relationship between the levels of real income and inequality were positive for low-income and negative for high-income countries. Low and high income countries also exhibit a strong negative relationship between level of real income and the relative income of the poor and the middle class.

Unlike low-income countries, developing countries showed a strong positive relationship between the levels of real income and both inequality and the relative incomes of the poor. Our analysis argued that the difference in results between these two groups of countries was driven by the choice of countries for each of these groups. That is, while most low-income countries are also developing countries, some high-income countries are also classified as developing countries within our dataset. Our analysis at the level of developing country regions reveals evidence of a positive relationship between the level of real income and inequality. However, five out of the six developing country regions show a negative relationship between the level of real income and the relative incomes of the poor. In both industrial and developing countries, our analysis found a significant positive relationship between the mean level of real income and the absolute incomes of the poor. In addition, the analysis finds that within the majority of developing country regions, the relative and absolute incomes of the poor move together.

Appendix 1

REVIEW OF THE LITERATURE:
INEQUALITY, GROWTH & POVERTY

This Appendix extends the review of the theoretical literature covered in *chapter 1*. Section I presents the theoretical background on the development of growth models and their impact on the income distribution and poverty. This section also contains a brief discussion of the theories that deal with the effect of initial inequality on growth performance. Section II reviews the limitations of the analytical tools that are commonly used by empirical studies on this topic.

I. THEORETICAL BACKGROUND

The review begins with Solow's "A Contribution to the Theory of Economic Growth", one of the most important contributions to the theory of economic growth. In this seminal paper, Solow outlined what has come to be considered as the baseline vision of economic growth, using a *neoclassical* production function that assumes constant returns to scale, and diminishing returns to input. In the Solow model (or the neoclassical growth model), economic growth depends on the accumulation of capital, labour growth and productivity progress, and does not depend strongly on economic policy. Further, the neoclassical view of growth assumes that capital has a high return when it is scarce. Together with assumptions of constant returns to scale and the existence of inalterable factors like labour supply, the assumption of diminishing returns leads to the following prediction. During the transition to a new steady state, growth in capital-scarce countries will be high because of the high returns to capital. Thus, poor countries will catch up fairly rapidly to richer countries. For an in-depth exposition on convergence within the neoclassical growth theory, see Barro and Sala-i-Martin (1992). The implications of the neoclassical growth theory for an open economy model is that if capital had high returns where it is scarce, then capital will flow from rich to poor countries.

In contrast to the assumptions of the neoclassical model, *endogeneous* growth theories contend that capital has a high return where it is already abundant, and that growth is sensitive to shocks. In such cases, growth leads to a virtuous circle of capital accumulation attracting yet more capital accumulation. However, for this to happen, a critical mass of human and physical capital must be in place. That is, any economy will have to pass a minimum threshold level of human and physical capital in order to be able to grow. But, because of the sensitivity to shocks, a country on a steady growth path could move to a path of rapid decline in the face of a temporary shock like civil war. In this case, an infusion of capital or foreign aid could bring the self-same country above the threshold and enable another climb up the growth path. The historical record of aid for countries to break out of such a 'poverty trap' has however, been dismal to non-existent.[34] Expanding the endogenous growth theory to an open economy model, means that both a human capital flow (brain drain) and a physical capital flow should move from poor to rich countries. This prediction is opposite to that derived from the neoclassical model.

This 'new' literature on endogenous growth was spurred by the seminal works of Romer (1986), Lucas (1988, 1993), Barro (1991) and Sala-i-Martin (1992a and b). In this body of literature, Romer's original growth-analysis criterion of a strong learning-by-doing externality to capital was followed by other new criteria of analysis such as geographic interactions, technology, choice by firms and size of the market, to name a few.[35] Additionally, it was found that an increase in per capita growth was associated with a positive effect of several policy indicators, such as average years of schooling, and the ratio of the government budget deficit to GDP. In short, these are all policies that increase the rate of return to private capital and make the minimum threshold for growth lower while increasing the possibility of growth.

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[34] For an exposition, see Barro and Sala-I-Martin (1995).

[35] For a discussion see Easterly (1996).

The question of how inequality is generated and how it multiplies over time has been of concern for social scientists for over a century. However, the relationship between inequality and the process of economic development is not well understood. The traditional viewpoint among development economists has been that broad-based economic growth should lead to an absolute reduction in poverty. However, as has been noted in the statistics of the past decade, growth may also be associated with rising inequality, which lowers the share of the poor in the benefits from growth. This apparent contradiction was first recognized by Kuznets in 1955. The subsequent Kuznets hypothesis states that as economic development proceeds and per capita income increases, inequality will first rise and then fall.

However in 1996, Deninger and Squire found the lack of any empirical relationship between growth and equity as postulated by the Kuznets hypothesis.[36] In fact, Li, Zou and Squire (1998) argued that inequality does not change very much in countries over time, and a fortiori, since per capita income does change considerably, there is no systematic relationship between inequality and per capita income for countries over time. This conclusion has far reaching policy implications. For example, if the income distribution does not change much over time, then the gains in per capita income must affect different segments of the society in much the same degree. This means that in countries with rapid growth, incomes of the poor will rise rapidly and the incidence of poverty will decline. However, in countries with no per capita growth and a stable income distribution, there will be no poverty distribution. This logic is flawed, since the factors that influence growth can also influence the income distribution.

Another theoretical approach that contains a similar logical fallacy is the "decomposition" of the poverty change into a "growth" component and a "redistribution" component. This concept was put forward by Kakwani in 1994. Kakwani began with two income

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[36] For details on the Deininger and Squire 1996 paper, see Chapter I.

distributions in periods t and t+1, which differ in their means and their inequality and are associated with different values of any given poverty index in P(t) and P(t+1). A synthetic intermediate distribution φ is then constructed which has the mean of the t+1 distribution and the spread of the t distribution, with an associated poverty number P(φ). Thus the change from P(t) to P(φ) is referred to as the "growth" component of the overall poverty change between the two periods, while the change from P(φ) to P(t+1) is the "redistribution" component.

Such a treatment leads to an implicit separability between the two components which can lead to policy implications about "growth" instruments (lower tariffs, privatizing SOEs[37]) separate from "redistribution" instruments (food subsidies, progressive taxation). This would imply that the growth component can now be accomplished independently of the redistribution component. And yet, there is no clear justification in economic theory for such a separation. Indeed, each of these policy instruments can have both growth and distributional components.[38] For an empirical treatment of the above discussion see Datt and Ravillion (1992).

In the latter half of the 1990s, the development literature grew to investigate the connections between growth and equity through a possible causal link between initial inequality and subsequent growth. While much empirical work has been conducted within this large body of literature, neither a positive nor a negative causal link from initial inequality to growth has been conclusively identified to date.

There are two arguments in the literature as to why initial distribution matters to subsequent rates of poverty. The first, sometimes known as the 'induced-growth argument', postulates that higher inequality may entail a lower subsequent rate of growth

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37 SOEs stand for State Owned Enterprises.

38 Kanbur & Lustig (1999).

in average income and hence lead to a slower rate in reducing absolute poverty. This implies that there are two links to this argument – one from initial distribution to growth, and one from growth to poverty reduction. The second argument states that even if the initial distribution is irrelevant to the rate of growth, it may be of relevance to how much the poor share in the benefits from growth. This 'growth-elasticity argument' is explored extensively in Ravillion (1997). Ravillion's results suggest that initial distribution matters to how much the poor share in rising average incomes, i.e. higher initial inequality tends to reduce the impact of growth on absolute poverty. By the same token, higher inequality also diminishes the adverse impact on the poor of overall contractions.

Examples of the latter argument from the literature include Deninger-Squire (1998) who use income shares to measure the change in income of the bottom 20[39] and 40 percent of the population, thus explicitly recognizing the fact that growth and the distribution of income evolve simultaneously, and that both can be affected by the initial distribution of assets. This methodology allows for the examination of how both initial inequality and contemporaneous changes in inequality influence the evolution of poverty. The authors conclude that the poor clearly suffer from the growth reducing effects of inequality but benefit from measures that promote medium-term growth. This is supported by the work of Birdsall and Londono (1997), who show that higher initial income inequality is negatively associated with long-term growth and that differences in the rate of capital accumulation account for an important part of the differences in growth rates across countries. Ravillion (1997) concurs that at any positive rate of growth, the higher the initial inequality, the lower the rate at which income-poverty falls. He concludes that it is possible for inequality to be sufficiently high to result in rising poverty, despite good underlying growth prospects at low inequality.

[39] The poor are defined as the bottom 20 percent of the population.

A. Growth models, Inequality and Poverty

It can be argued that growth is desirable because it can potentially be an important vehicle for improving the quality of life at all levels of society. A core set of institutions and policies have thus far been identified as pro-growth in the vast empirical growth literature and recent studies have begun to shed some light on the types of policies that can lead to such long-term growth.[40] While it is clear that these policies should be pursued by all economies, economists suspect that they are less effective and/or less well implemented in high-inequality countries. Regardless, economists agree with the principle that reducing inequality benefits the poor, not only in the short term but also in the longer run through the vehicle of higher growth. (Bruno, Ravillion & Squire, 1996)

It is intuitive that the poor will tend to obtain a higher share of the gains from growth in an economy where inequality is persistently low compared to an economy in which inequality is high. Using cross-country comparisons, Ravillion and Datt (1999) find that while measures of absolute poverty in developing countries tend to fall with growth in mean household income or consumption, there is considerable variance in the poverty reducing impact of a given rate of growth. Consistent with the cross-country evidence for developing countries, Ravillion and Datt (1996) found that absolute poverty measures in India tend to fall with economic growth. Additionally, the aggregate time series data for India indicates that poverty measures respond more to rural economic growth than urban, and that initial conditions related to rural development and human resource development accounted for much of the long-run differences between states in the rates of rural poverty reduction.

B. Theories on the effect of inequality on growth performance

As previously mentioned, there are many theories in the development literature for assessing the effects of inequality on economic growth, but, these theories sometimes

[40] This can range from fundamental institution and market incentives to the promotion of macro stability.

tend to have offsetting effects, with the result that the net effects of the evolution of inequality on growth performance become ambiguous.[41] These theories can be broadly classed into four main categories corresponding to the features they stress: credit-market imperfections, savings rate, political economy, and social unrest.

CREDIT-MARKET IMPERFECTIONS: Credit-market imperfections typically reflect asymmetric information and the limitation of legal institutions. With limited access to credit, the exploitation of investment opportunities depends on the individuals' levels of assets and incomes. Specifically, poor people will forego human-capital investments that offer relatively high rates of return. In this case, a distortion-free redistribution of assets and incomes from the rich to the poor tends to raise the average productivity of investment. Through this mechanism, a reduction in inequality raises the rate of economic growth - at least during a transition to the steady state.

An offsetting force arises if investment requires a set-up cost, which would imply that the concentration of asset ownership would be beneficial for the economy. As Barro (1999) illustrates, formal education may only be useful if carried beyond some minimal level. This creates a strong role for secondary, as opposed to primary, schooling in enhancing economic growth. This then tends to generate positive effects of inequality on investment and growth. If the capital markets and legal institutions tend to improve as the economy develops, then the effects related to credit-market imperfections are more important in poor than in rich economies. Therefore, the predicted effects of inequality on economic growth would be larger in magnitude for poor economies than for rich ones. Benabou (1996), Galor and Zeira (1993), and Aghion and Bolton (1997) are some of the authors who have dealt extensively with such models.

SAVINGS RATE: Some economists believe that individual savings rates rise with the level of income. If this holds true, then a redistribution of resources from rich to poor

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41 Benabou (1996) surveys some of these theories, as does Barro (1999) and Perotti (1996).

would tend to lower the aggregate rate of savings in an economy. Through this channel, a rise in inequality would tend to raise investment, and more inequality would enhance economic growth, at least in the transitional sense. The previous discussion of imperfect credit markets brings out a related mechanism by which inequality could promote economic growth – the case where investment requires a set-up cost. The present discussion of aggregate savings rates provides a complementary reason for a positive effect of inequality on growth.

POLITICAL ECONOMY: If the mean income in an economy exceeds the median, then majority voting will tend to favor redistribution of resources from rich to poor. These may involve explicit transfer payments but can also appear as public-expenditure programs, such as education and child care, and regulatory policies.[42] The greater the degree of inequality, the more is the degree of redistribution through the political process.[43] Typically, a greater amount of redistribution creates more distortions and tends to reduce investment. Economic growth declines, at least in the transition to the steady state. Thus, since a greater amount of inequality (measured before transfers) induces more redistribution, it follows that inequality would reduce growth.

The relation of ex-post inequality to economic growth is complicated in the political-economy models. The predicted relation between ex-post inequality and growth can change if countries differ by their tastes for redistribution. In this case, if countries look more equal ex-post, then they tend to have redistributed the most and thus caused the most distortions. Here, ex-post inequality will tend to be positively related to growth and investment. For a more in depth analyses of political economy models, see Alesina and Rodrik (1994), and Benabou (1996) among others.

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[42] Note that it is possible that the predicted negative effect of inequality on growth can arise even if no transfers are observed in equilibrium. The rich may prevent redistributive policies through lobbying and buying votes of legislatures. These activities would consume resources and promote official corruption, not to mention be adverse for economic performance.

[43] The degree of inequality can be measured, for example, by the ratio of mean to median income.

Note however, that the median-voter model may not be a plausible description of the political process governing decision-making in most developing countries. An alternative mechanism relies on lobbying. In its extreme form, the ability to lobby would be directly proportional to the amount of economic assets owned by an individual. Such inequality of asset ownership can lead to increasing inequality over time and to slower growth. For an empirical treatment see Bertola (1993) or Li, Zou, and Squire (1998).

SOCIAL UNREST: A highly unequal polarized distribution of resources can create strong incentives for organized individuals to pursue their interests outside the normal market activities or the usual channels of political representation. Thus in more unequal societies individuals are more prone to engage in rent-seeking activities or other manifestations of socio-political instability. This could in turn threaten the stability of political institutions so that political regimes have shorter expected duration and greater uncertainty. The participation of the poor in such anti-social actions represents a waste of resources and the threats to property rights deter investment. Through these various dimensions of socio-political unrest, more inequality will tend to reduce the productivity of an economy. Economic growth declines, at least in the transition to the steady state. An offsetting force is that economic resources are required for the poor to effectively cause disruptions and threaten the stability of the established regime. Hence, income equalizing transfers would promote political stability only to the extent that the first element – the incentive of the poor to engage in social unrest, and not work – is the dominant element. The tendency for redistribution to reduce crimes and riots provides a mechanism through which this redistribution, and the resulting increased income equality, would enhance economic growth.

II. ANALYTICAL BACKGROUND

Although the theoretical literature on income distribution, growth and poverty has expanded enormously in the past decade, it arrives at widely different conclusions depending on the underlying assumptions used. Which of these assumptions is more accurate is an empirical question that can only be decided by confronting the given hypotheses with actual data.

The single most important reason for the ambiguity in the empirical literature, as perceived by development economists, is the limitations of the existing cross-sectional data on income distribution, both in terms of availability of observations and in terms of the quality. Empirical work using cross-country data to draw inferences about the relationship between growth and inequality has a long tradition, but the lack of sufficiently long time series data prevents appropriate testing of the theoretical literature. And, although the data currently in use has improved, such conceptual and practical problems in the distributional statistics can affect empirical results in unpredictable ways. The following sub-sections provide a brief survey of some of the issues related to the empirics of the relationships between growth, poverty and inequality, and a discussion of their implications in estimating such relationships.

A. Comparison of Statistics on Poverty and the Income Distribution

Official exchange rates skew comparisons. One issue of interest is that official exchange rates are deceptive in making international comparisons of absolute levels of living. However, the problems of making purchasing-power parity currency conversions should not be understated. Estimates vary greatly with implications for, among other things, international comparison of poverty rates.

Inconsistent measures of living standards. Another is that of comparing different survey-based measures of living standards. For example, some surveys obtain income measures while others consumption measures of living standards. But, income-based measures have been shown to inflate the levels of inequality as compared to those based on consumption. That is, at any one survey date, income can be unusually low for some households and unusually high for others; with some opportunities for saving and borrowing, consumption will be less unequal. Also, experience has shown that in developing countries, measurement errors are greater for income which tends to inflate measured inequality. For example, income is a more common measure for inequality in many middle income developing countries, notably in Latin America, whereas consumption is more common elsewhere, including the Asian economies. Furthermore, since consumption inequality is bound to be lower than income inequality due to consumption smoothing, these differences alone would tend to yield an inverted U relationship as hypothesized by Kuznets, even if none existed using the same welfare measure.

A related issue concerns the most common measure of inequality found in practice – the Gini coefficient.[44] This is based on the Lorenz curve, which plots the share of population against the share of income received. Gini coefficients then quantify inequality by measuring the deviation in the Lorenz curve. Thus, the Gini coefficient varies between zero (perfect equality) and one (perfect inequality) and should be interpreted with caution, since available inequality measures for a particular country do not necessarily provide an accurate description of the country's degree of inequality.[45]

One source of the problem is the underreporting of income (and expenditures) that occur more frequently at the lower and higher ends of the spectrum. As a result, an inequality measure for the same country, using the same survey and for the same year can vary by several percentage points depending on whether the data on income was corrected for underreporting and on the method of the correction. Thus, the best that can be said for Gini coefficients is that they are an adequate means of comparison between countries, but are unreliable for within country comparisons.

A further problem with conventional inequality measures, such as the Gini coefficient, is that they do not take into account distributional changes of interest to policymakers.

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44 An overview and a detailed discussion of different measures of inequality is presented in Chapter 3.

45 For more details on the Gini coefficient, see Chapter 2 and Appendix 4.

Impacts on the middle strata of the income stream can be important to the political feasibility of policy reform, yet a measure such as the Gini may not capture changes in the share of income held by this stratum. This requires the use of some measure of polarization, which measures the extent to which a society is divided. Take for example Wolfson's polarization index which varies between zero and one. No polarization is zero, while complete polarization is one. When there is complete equality within a society there is also zero polarization. However, while maximum inequality entails that the richest person has all the income, maximum polarization occurs when half the population has zero income and the other half has twice the mean.

Thus claims about how inequality changes during a growth process could well have to do with polarization since inequality may well decrease with policy reform while the economy becomes more polarized. Ravillion and Chen (1997) use such a polarization measure to look at changes in inequality and distribution at a regional level. They conclude that while there is a clear conceptual distinction between the measures of inequality and polarization, there is a surprisingly close correspondence between them. Additionally, they find no evidence that some middle-income households become worse off during spells of growth while others grow. This, the authors say indicates that higher average consumption does not tend to be associated with higher inequality, or that inequality tends to increase independently of growth. Ravillion and Chen find that this same conclusion also holds for the polarization measure.

The above discussion highlights the specific determinants of "inequality" that are likely to matter in explaining how much the poor share in growth. As we have seen, potentially important factors in developing countries can include the extent of the income disparities between urban and rural sectors, the initial population distribution between urban and rural sectors, access to markets and infrastructure and ownership of physical and human assets, to name a few. Having highlighted the factors that matter *within* countries the section continues by looking at the problems that plague income distribution comparisons *between* countries.

B. Issues of Measuring Changes in the Income Distribution

More than most other variables that appear regularly in growth regressions, the quality of income distribution data across countries has been the most questioned. Income quintile shares and Gini coefficients are typically computed from surveys, which immediately suggest at least two types of potential problems. First, and for already stated reasons, in any given survey the raw figures may be subject to very large measurement errors. Second, it is hard to compare quintile shares across countries, as the surveys they are derived from can vary remarkably in at least three respects: the definition of the recipient unit, the income concept, and the coverage. For example, the existing data on surveys refer to four different recipient units: by household, by income recipients, by economically active persons and by individuals. In addition, these definitions themselves may change from survey to survey. That is, surveys can vary greatly in, for example, the measure of living standards used, with serious implications for summary statistics on distributions such as the Gini coefficient.

Yet, most of the empirical work in the field is still based on international survey data with growth, poverty and inequality measures for a large number of countries at a few points in time. Empirical studies focusing on a single country have relied on somewhat less satisfying methodologies. Researchers have either used single surveys to estimate the point elasticity of poverty to growth and inequality (which while useful for short-term comparative purposes say nothing about the long-term relationship between these variables), or they have decomposed changes in poverty measures over time into changes due to growth and inequality (which method rarely provides sufficient evidence for generalization because of the paucity of data).[46]

Thus, any exercise to empirically test the theoretical ambiguities of growth and poverty in developing countries must be aware of the limitations of the data available. While it is true that the quality of distributional data for developing countries continues to be uneven, the availability of such data has improved over the recent past. Therefore, household surveys continue to form the core of much empirical work in this field with continued unevenness in the coverage and quality of surveys.

C. Similarities across studies

Given the discussion above, it is not unusual to find a similarity between the various studies dealing with the impact of inequality, both in data and the methodology used. The underlying theory in these studies is that wealth inequality determines investment in physical and human capital, which in turn affects the long-run growth rate. As previously mentioned, the most common approach is to use data on income inequality as a proxy for wealth inequality. It is generally argued that this presents no problem since both measures of distribution vary together in cross-sections. Alternatively, the true distribution of wealth is sometimes proxied by the distribution of land. Perotti (1996) provides a good example of the first approach, while Alesina and Rodrik (1994), and Deininger and Squire (1998) utilize the second. In addition to the evidence that a more equal income distribution is beneficial to growth, the empirical literature also provides insights as to the channels through which inequality affects economic growth.

Such channels can involve the political economy argument and the capital market imperfection channel, to name two. As shown by Li, Zou and Squire (1998), both of these channels receive strong support from the empirical analysis, although the latter appears to have the greater influence. Other channels like socio-political instability and

[46] Wodon (1999)

the education/fertility decision also receive strong empirical support from authors such as Perotti (1996).

In looking at the effect of initial inequality on long-term growth, Deninger and Squire (1998) use data on the distribution of land as a proxy for the distribution of assets rather than measures of income distribution that have traditionally been used to substantiate a negative relationship between initial inequality and growth. They also use data on income shares to measure the change in income of the bottom 20 or 40 percent of the population – this makes clear the fact that growth and the distribution of income evolve simultaneously and allows examination of the growth-inequality interactions on the poorest groups in society. They find that there is a strong negative relationship between initial inequality in asset distribution and long-term growth and that inequality reduces income growth for the poor, but not for the rich. This negative relationship between initial inequality and subsequent growth is based on two theoretical hypotheses – lumpy investments and the median voter theorem.

LUMPY INVESTMENTS: If investment in human and physical capital is lumpy[47] and have to be financed through credit, agents will only be able to acquire credit if they posses collateral. This means that with a given level of per capita income, a more unequal distribution of assets would imply that a greater number of people are credit-constrained. In an economy where individuals make indivisible investments this implies lower aggregate growth, since investments such as schooling and education have to be financed through borrowing. Further, investment possibilities could be limited through a host of factors. In cases like this, inequality in the initial distribution of assets can be maintained over time through intergenerational bequests.

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[47] A lumpy investment in human and physical capital in this sense means a cycle of large initial investment today, nothing tomorrow, another large investment and so on – in short, an uneven investment path as opposed to a even investment path

In testing credit market imperfections, Deninger-Squire (1998) found inequality to be more important in low-income countries than in high-income ones. This conclusion provides tentative support for a credit market mediated link between the initial distribution of assets and subsequent growth. That is, lenders are generally more willing to accept physical capital as collateral for a loan than being ready to lend against a future stream of earnings associated with the acquisition of human capital. Therefore, effects of initial inequality that are transmitted through credit markets would be expected to have a more important effect on the stock of human capital than on the amount of physical capital available in the economy.

MEDIAN VOTER THEOREM: This in its simplest version relies on the democratic determination of tax rates. As the median voter's distance from the average capital endowment in the economy increases with the aggregate inequality of wealth, he/she will be led to approve a higher tax rate. This in turn reduces incentives for productive investment, resulting in lower growth. If this theory holds then it implies that democratic societies with a more unequal distribution of wealth should be characterized by 'exploitation of the rich by the poor' – that is, high taxes and consequently low investments and growth. The interpretation of the median voter then maintains that, if the underlying assumption is true, one would expect initial inequality to affect growth in democratic, but not in undemocratic countries.

Deninger-Squire (1998) tested this by splitting the sample into democratic and undemocratic regimes and performing regressions for each set. They found that initial inequality affects future growth in undemocratic countries, but not in democratic ones, providing little support for democratic voting as the root of the inequality-growth link. Deninger and Squire's conclusions were further validated by Ravillion and Chen in 1999, when they showed that imperfections based on financial markets for credit and insurance appear to be more relevant for investment in human capital rather than physical capital, and, that there is no support for a redistributive median-voter explanation of initial inequality's effect on growth.

Other empirical evidence from the recent literature that confirm the negative impact of initial inequality on growth, both in developing as well as developed countries, include Alesina and Rodrik (1994), Persson and Tabellini (1994) and Benabou (1996). Perotti (1996) however, finds that a greater income share of the middle class has a strong negative effect on fertility, which in turn has a significant positive impact on growth.

The theoretical literature provides an array of very different explanations for the positive correlation between equality and growth. Again, these range from credit-market imperfections to the political economy and social unrest. For example, in the political economy models, growth increases as distortionary taxation decreases. That is, redistributive government expenditure and therefore distortionary taxation decrease as equality increases and growth increases with the subsequent increase in equality. For an empirical treatment of this model, see Perotti (1996).

Appendix 2

THE MECHANICS OF INEQUALITY, GROWTH & POVERTY

The combination of academic interest and the recent expansion in the availability of household survey micro-data has refocused interest in the study of income distributions. The purpose of this Appendix is three-fold. Section I provides a detailed review of the empirical literature to explain the renewed interest in the link between growth and inequality, at a level not covered by *chapters 1* and *2*. Section II is a mathematical discussion of the Axiomatic and Stochastic dominance approaches to choosing relevant inequality measures. Section III defines the various ways in which poverty is defined and measured at both the country and global level.

I. GROWTH AND INEQUALITY

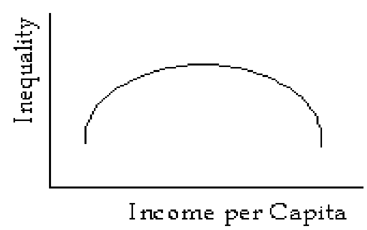
There is a renewed interest in inequality for a number of reasons. First, recent empirical work re-examining the link between inequality and growth tends to find a negative relationship, especially when looking at the impact of asset distribution and growth. This asserts that the more equal the distribution of assets such as land, the higher growth rates tend to be. Second, with poverty reduction in many countries being slow, the scope for public policies to have a poverty-reducing impact through redistributive effects – from safety nets to social expenditures – needs to be examined. Third, several empirical studies examine the impact of inequality – independent of the poverty level – on health outcomes, such as morbidity or mortality rates, or as a cause for violence.

There are several channels through which inequality influences economic and social outcomes. With imperfect capital markets, people with low incomes and little ability to provide collateral may find their access to capital curtailed. This hinders them moving out of poverty while at the same time distorting resource allocation within economies, and thereby lowering growth rates. Economic growth prospects can also be negatively influenced by inequality through the tax system. This would be the case if -- from a political economy perspective -- inequality leads to an inefficient tax structure.

A. The Effect of Growth on Distribution

Until recently, the most well established view on the link between growth and the income distribution was the Kuznets hypothesis. This postulated that growth would first lead to an increase and then to a decrease in income inequality. This was captured diagrammatically in the "Kuznets curve", depicted in Figure 6.

Figure 6: A Stylized Kuznets Curve



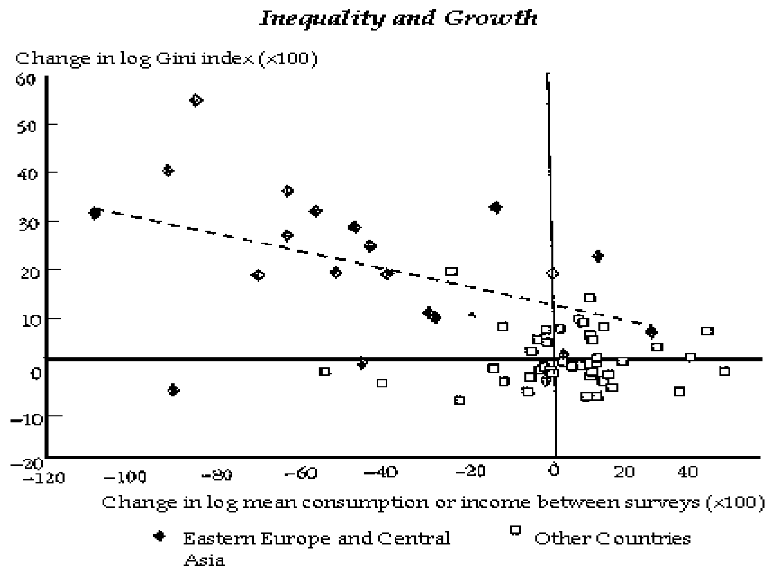
The empirical backing for this came from Kuznets's investigation of inequality indicators for England, Germany and the United States. In the 1950s, these were the only countries for which a sufficiently long time series was available and, by the 1950s, inequality was indeed falling in all three countries after having risen earlier. The economic mechanism thought to underlie this phenomenon was the transfer of labor from low-productivity sectors to high-productivity sectors. Thus, this result would hold provided that inequality between the sectors was substantially greater than the inequality within them.

Thus the Kuznets curve became one of the stylized facts of the study of income distribution for nearly four decades. It was only recently that tests of the hypothesis based on much larger data sets (both across countries and over time for individual countries) have consistently refuted it. These studies were largely made possible by the compilation, in 1995-6, of the Deininger-Squire (1996a) international inequality database, which contains 682 'high-quality' observations (of Gini coefficients and quintile shares) for 108 countries. Based on their own analysis, Deininger and Squire (1998), concluded that their data provided little support for an inverted-U relationship between levels of income and inequality. The authors tested the existence of the Kuznets curve on a country-by-country basis, and found no support for the existence of a Kuznets curve in about 90 percent of the countries investigated. On the basis of this new inequality database, there seems to be no support for the Kuznets hypothesis.

However, there was also a slightly modified 'dynamic version' of the hypothesis, which postulated that fast growth episodes tended to lead to higher inequality, regardless of the initial level of income. Deininger and Squire investigated this version of the hypothesis by considering growth episodes defined by the availability of distributional data that span at least one decade. Again, the authors concluded that there was very little support for a systematic relationship between growth and changes in aggregate inequality (Deininger and Squire, 1996).

More recently it seems that the economic reform in the transition economies of Eastern Europe and Central Asia (ECA) may have changed the nature of Deininger and Squire's (1996) empirical result. Ravallion and Chen (1997) looked at data between 1981 and 1994 and found a significant negative correlation between economic growth and changes in inequality. That is, the sample suggests that growth reduces inequality rather than increasing it. This effect vanished however, when the authors eliminated the ECA spells from the sample. This is brought out vividly by Figure 7 below, taken from Ravallion and Chen (1997).

Figure 7 - Source: Ravallion & Chen



It is reasonable to conclude that the negative link between growth and inequality detected in this study was brought about by the rather specific circumstances of transition in Eastern Europe and Central Asia. In the ECA countries negative growth and increasing inequality both prevailed since 1990, but not necessarily one because of the other. As the horizontal regression line in the above diagram suggests, countries outside that region show no evidence of a systematic relationship between growth and changes in inequality. Furthermore, the line's position at zero change in inequality suggests that, independently of the rate of growth, the average change in inequality in this sample of 'spells' was nil.

Results of this nature have led most economists to adopt a more skeptical view about systematic causal links running from economic growth to inequality. The skepticism seems to be justified whether they look for links in levels or changes. Thus, recent evidence seems to refute the Kuznets hypothesis about an inverted-U relationship between the level of income and the level of inequality. And outside transition economies, growth episodes do not on average seem to be associated with contemporaneous increases in inequality.

But it is important to recall that inequality should not be confused with poverty. By shifting the distribution function to the right, there is overwhelming evidence that economic growth contributes to reductions in poverty. Figures 8a and b (Ahuja et.al., 1997) illustrates the impact of economic growth on poverty in Thailand between 1975 and 1992.

Figure 8a

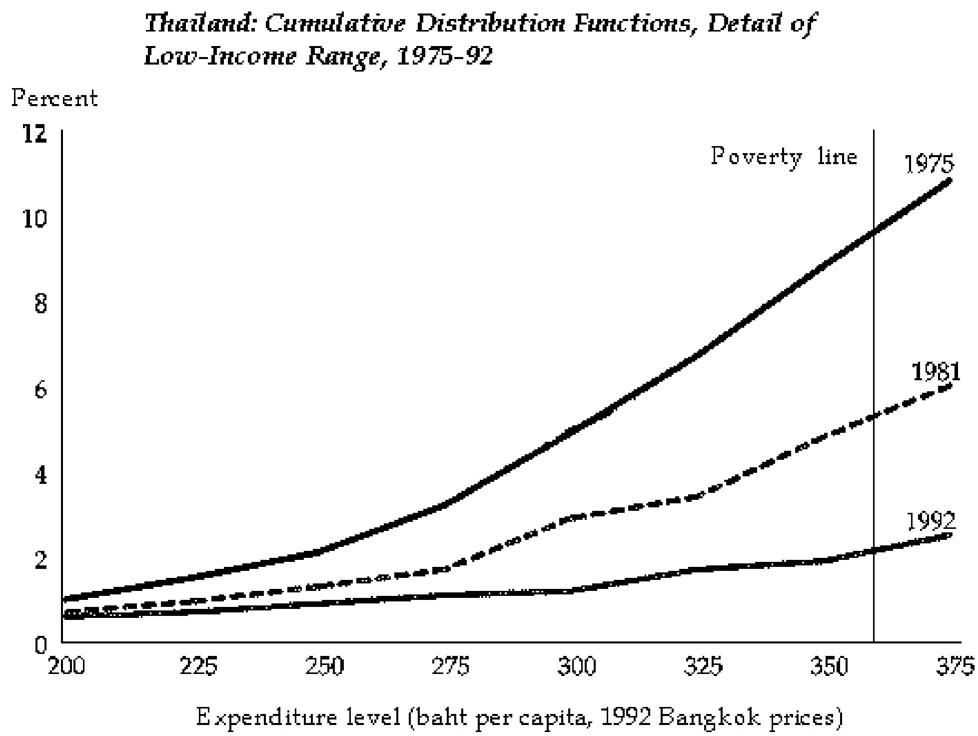
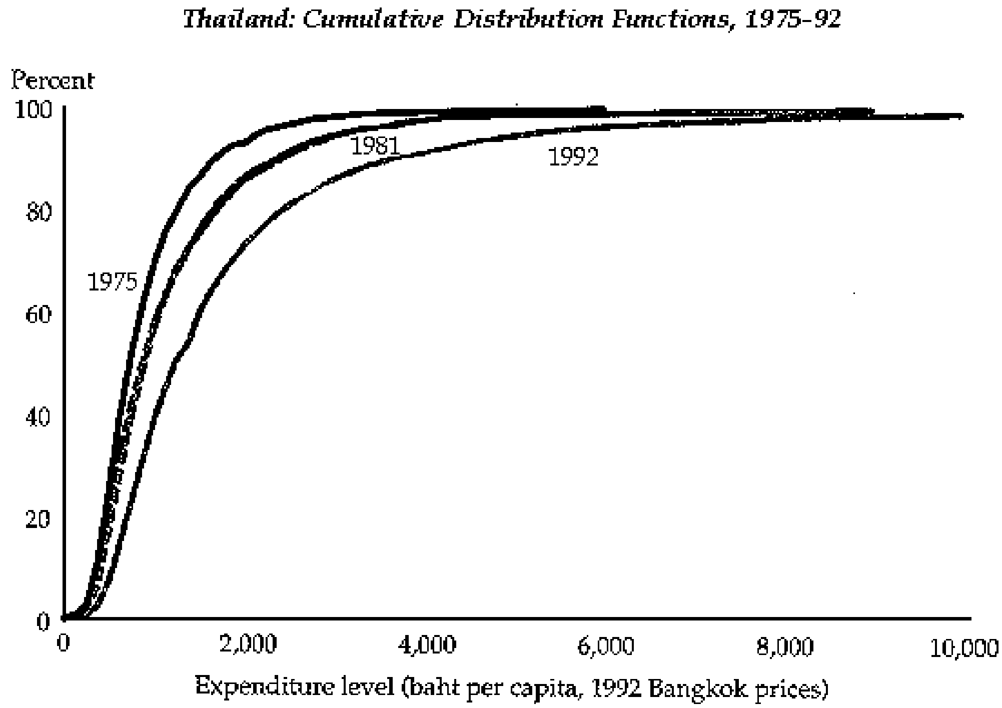


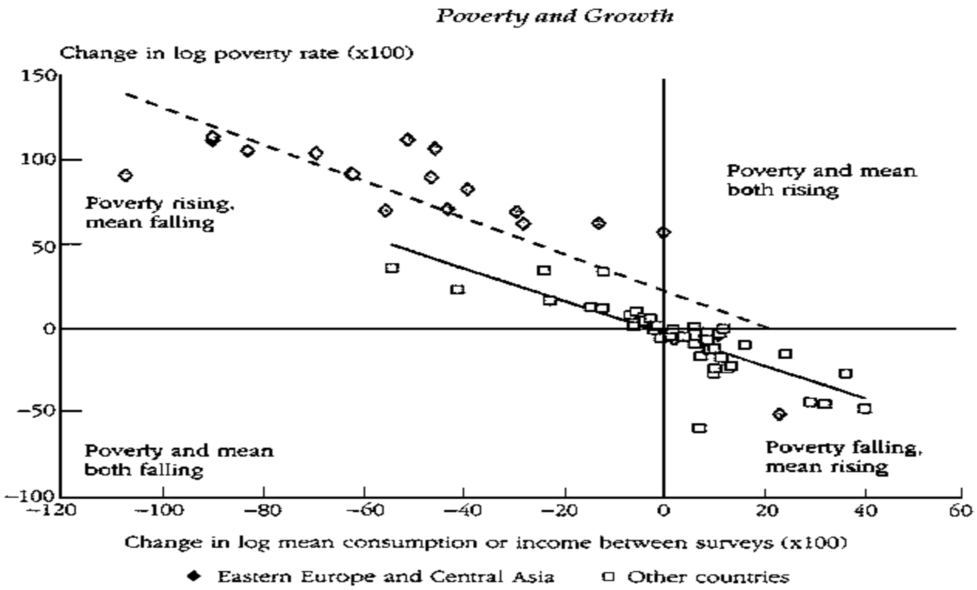
Figure 8b - Source: Ahuja et al (1997)



It is possible that individual episodes of distributional changes combine a growth in the mean with an increase in inequality large enough to increase poverty. This took place for instance in the Philippines, between 1988 and 1991 (Ahuja et. al). However these episodes are the exception. Figure 9 below, taken from Ravallion and Chen (1997), plots the regression lines of changes in log poverty on growth rates for both ECA and other countries.[48] The statistically significant negative slope for both groups of countries indicates the strong average association between growth and poverty reduction. The horizontal distance between the two lines can be interpreted as the extra growth needed to obtain the same reduction in poverty in ECA, given its increases in inequality.

[48] The poverty line was set at 75 percent of the initial mean welfare indicator by Ravallion and Chen.

Figure 9 - Source: Ravallion and Chen (1997)



Note however, that the first and third quadrants of Figure 9 (positive growth and rising poverty; and negative growth and falling poverty) are effectively empty. Thus while economists are still looking for a link between growth and contemporaneous inequality, they are in agreement that growth does help to reduce poverty.

B. The Effect of Distribution on Growth

The fact that contemporaneous changes in mean incomes and inequality do not seem to be systematically related does not imply that there is no link between the two variables. Some economists have put forward the view that countries with higher initial (i.e. ex ante) inequality grow more slowly than others. These economists look for causal links between the dispersion of an income (or expenditure, or wealth) distribution and economic growth and other aspects of economic performance.

By the 1990s the classical view that distribution (one aspect of which is measured by inequality indices) was not a final outcome, but in fact plays a central role in determining other aspects of economic performance had gained popularity. Much of the credit for pioneering this line of enquiry goes to Oded Galor and Joseph Zeira, whose 1993 paper on "Income Distribution and Macroeconomics" concluded that: "… the distributions of wealth and income are very important from a macroeconomic point of view. They affect output and investment in the short and in the long run and the pattern of adjustment to exogenous shocks. It is, therefore, our belief that this relationship between income distribution and macroeconomics will attract more studies in the future." (1993, p.51)

Most of the studies that followed Galor and Zeira concurred. Empirically, the proposition that initial inequality seemed to be associated with lower growth rates was put forward by Persson and Tabellini (1994) and Alesina and Rodrik (1994). Using the data sets available to them, both studies found that inequality variables had significantly negative coefficients in growth regressions, when controlling for a number of the usual right-hand side variables. A survey by Benabou (1996a) listed a number of other cross-country empirical investigations of this relationship, and reported that the vast majority of them reached the same conclusion.

But the debate is not as settled as Benabou's survey implies. Since then, a number of studies drawing on the Deininger-Squire database have questioned the budding consensus. The Deininger-Squire database is superior to those available to Persson and Tabellini or to Alesina and Rodrik, both in number of countries and in time-spans covered. Adding a number of econometric methodological improvements to the Deininger-Squire data set, Forbes (1997) for example, finds a positive and significant relationship between inequality and growth. Other researchers have echoed their concerns and cautioned against a premature acceptance of the inverse relationship between initial inequality and growth as a new stylized fact of development economics.

However, the econometric problems that seem to beset the negative relationship in the newer data sets appear to be specific to inequality variables defined in the income (or expenditure) space. Deininger and Squire themselves, for instance, find that the negative coefficient on initial income inequality in their growth regressions becomes insignificant only when a variable for asset inequality (the Gini coefficient for land ownership) is introduced. Birdsall and Londono (1997) investigate a similar relationship for the other asset crucially important for the poor, namely human capital. Also using a subset of the Deininger-Squire database, they concluded that: the initial inequalities in the distribution of land and human capital have a clear negative effect on economic growth, and that the effects were almost twice as great for the poor as for the population as a whole. Thus these researchers find that once asset distribution variables are included, the significance of income inequality disappears.

The empirical issue is clearly not settled. Nevertheless, it seems fair to report the current state of the debate as follows: while initial income inequality may not directly affect an economy's aggregate growth potential, others thing being equal, it does proxy for more fundamental inequalities of wealth. Once measures for those are included, there does seem to be a significant negative relationship between asset inequality and growth.

C. Growth & the Distribution

In sum, income and wealth distributions can no longer be seen as mere outcomes of the general equilibrium of an economy. The central processes that determine resource allocation – through capital markets, the political system, and social circumstances – are influenced by the distribution of wealth in important ways. More unequal societies tend to develop larger groups of people who are excluded from opportunities others enjoy – be they a better education, access to loans, or insurance – and who therefore do not develop their full productive potentials. Both theory and empirical evidence suggest that these incomplete realizations of economic potential are not only of concern to those who care about equity per se, but that they also affect aggregate economic potential, and therefore aggregate output and its rate of growth.

The inverted-U relationship between growth and inequality suggested by Kuznets has not survived recent empirical scrutiny. Instead, it is gradually being replaced by a perception that the main flow of causation may be in the other direction, with inequality hampering the rate and quality of economic growth.

II. MEASURING INCOME INEQUALITY

While there are several ways by which to measure income inequality this discussion is confined to only those measures of inequality that conform to a specific set of five axioms – the axiomatic approach. Even then, this may result in some inequality measures ranking income distributions in different ways, and when rankings are ambiguous, a complementary approach is to use stochastic dominance.

We begin with the axiomatic approach and outline five key axioms which inequality measures are required to meet. This is followed by a brief explanation of first and second order stochastic dominance. Finally we focus on how to make meaningful comparisons between estimates of inequality of different distributions using decomposition and regression analyses.

A. The Axiomatic Approach

(A) AXIOMS

1. *The Pigou-Dalton Transfer Principle (Dalton, 1920, Pigou, 1912).* This axiom requires the inequality measure to rise (or at least not fall) in response to a mean-preserving spread: an income transfer from a poorer person to a richer person should register as a rise (or at least not as a fall) in inequality and an income transfer from a richer to a poorer person should register as a fall (or at least not as an increase) in inequality (see Atkinson, 1970, 1983, Cowell, 1985, Sen, 1973). Consider the vector y' which is a transformation of the

vector y obtained by a transfer δ from y_j to y_i, where $y_i > y_j$, and $y_i + \delta > y - \delta$[49] The transfer principle is then satisfied iff the measure $I(y') \geq I(y)$. Most measures in the literature, including the Generalized Entropy class, the Atkinson class and the Gini coefficient satisfy this principle. The main exceptions being the logarithmic variance and the variance of logarithms (see Cowell, 1995).

2. *Income Scale Independence.* This requires the inequality measure to be invariant to uniform proportional changes: if each individual's income changes by the same proportion (as happens when changing currency unit) then inequality should not change. Hence for any scalar $\lambda > 0$, $I(y) = I(\lambda y)$. Again most standard measures pass this test except the variance since var $(\lambda y) = \lambda$ 2var(y). A stronger version of this axiom may also be applied to uniform absolute changes in income and combinations of the form λ $1y+\lambda_2$[17] (see Cowell, 1999).

3. *Principle of Population (Dalton, 1920).* The population principle requires inequality measures to be invariant to replications of the population: merging two identical distributions should not alter inequality. For any scalar $\lambda > 0$, $I(y) = I(y[\lambda])$, where $y[\lambda]$ is a concatenation of the vector y, λ times.

4. *Anonymity.* This axiom – sometimes also referred to as 'Symmetry' - requires that the inequality measure be independent of any characteristic of individuals other than their income (or the welfare indicator whose distribution is being measured). Hence for any permutation y' of y, $I(y) = I(y')$.

5. *Decomposability.* This requires overall inequality to be related consistently to constituent parts of the distribution, such as population sub-groups. For example if inequality is seen to rise amongst each sub-group of the population, then we would expect overall

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[49] Where y_i and y_j are the income of individuals, vector **y** is the income distribution and $I(\mathbf{y})$ is the inequality measure.

inequality to also increase. Some measures, such as the Generalised Entropy class of measures, are easily decomposed into intuitively appealing components of within-group inequality and between-group inequality: $I_{total} = I_{within} + I_{between}$. Other measures, such as the Atkinson set of inequality measures, can be decomposed; but the two components of within- and between-group inequality do not sum to total inequality. The Gini coefficient is only decomposable if the partitions are non-overlapping. That is, the sub-groups of the population do not overlap in the vector of incomes. See the section on decomposition techniques for further details.

Cowell (1995) shows that any measure I(y) that satisfies all of these axioms is a member of the Generalized Entropy (GE) class of inequality measures. The following discussion is thus focused on this reduced set of inequality measures although the formula for the Atkinson class of inequality measures is also presented. These are ordinally equivalent to the GE class of inequality measures and the Gini coefficient.

(B) INEQUALITY MEASURES

(i) Generalized Entropy class of inequality measures

Members of the Generalised Entropy class of measures have the general formula:

$$GE(\alpha) = \frac{1}{\alpha^2 - \alpha}\left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_i}{\bar{y}}\right)^{\alpha} - 1\right]$$

where n is the number of individuals in the sample, y_i is the income of individual i, i ∈ (1, 2, ... ,n), and $\bar{y} = (1/n) \sum y_i$, the arithmetic mean income. The value of GE ranges from 0 to ∞, with zero representing an equal distribution (all incomes identical) and higher values represent higher levels of inequality. The parameter α in the GE class represents the weight given to distances between incomes in different parts of the income distribution, and can take any real value. For lower values of α GE is more sensitive to changes in the lower tail of the distribution, and for higher values GE is more sensitive to changes that affect the upper tail. The commonest values of α used are 0, 1 and 2: hence a value of α =0 gives more weight to distances between incomes in the lower tail, α = 1 applies equal weights across the distribution, while a value of α = 2 gives proportionately more weight to gaps in the upper tail. The GE measures with parameters 0 and 1 become - with l'Hopital's rule - two of Theil's measures of inequality (Theil, 1967). The mean log deviation {GE(0)} and the Theil index {GE(1)} respectively, as follows:

$$GE(0) = \frac{1}{n}\sum_{i=1}^{n} \log \frac{\bar{y}}{y_i}$$

$$GE(1) = \frac{1}{n}\sum_{i=1}^{n} \frac{y_i}{\bar{y}} \log \frac{y_i}{\bar{y}}$$

With α = 2 the GE measure becomes 1/2 the squared coefficient of variation, CV:

$$CV = \frac{1}{\bar{y}}\left[\frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y})^2\right]^{1/2}$$

(i) The Atkinson class of inequality measures

The Atkinson class of measures has the general formula:

$$A_\varepsilon = 1 - \left[\frac{1}{n}\sum_{i=1}^{n}\left[\frac{y_i}{\bar{y}}\right]^{1-\varepsilon}\right]^{1/(1-\varepsilon)}$$

Where ε is an inequality aversion parameter, 0 < ε < ∞. The higher the value of ε, the more society is concerned about inequality (Atkinson, 1970). The Atkinson class of measures ranges from 0 to 1, with zero representing no inequality. Setting $\alpha = 1-\varepsilon$ for values of $\alpha < 1$, makes the GE class of measures ordinally equivalent to the Atkinson class (Cowell, 1995).

(ii) The Gini coefficient

The Gini coefficient satisfies axioms 1-4 above, but will fail the decomposability axiom if the sub-vectors of income overlap. There are ways of decomposing the Gini but the component terms of total inequality are not always intuitively or mathematically appealing (see for example Fei et al, 1978, and an attempt at decomposition with a more intuitive residual term by Yitzhaki and Lerman, 1991). It is defined as follows (Gini, 1912):

$$Gini = \frac{1}{2\, n^2 \bar{y}} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| y_i - y_j \right|$$

The Gini coefficient takes on values between 0 and 1 with zero interpreted as no inequality.

B. Stochastic Dominance

Although the inequality measures discussed above generally meet the set of desirable axioms, it is possible that they will rank the same set of distributions in different ways. When rankings are ambiguous, the alternative method of stochastic dominance can be applied. Three types of stochastic dominance approaches are discussed below.

The first two types of stochastic dominance measures are sensitive to the mean of the distribution, and are therefore not applicable to establishing inequality rankings.[50] However, they are presented first because they are logically prior to the dominance

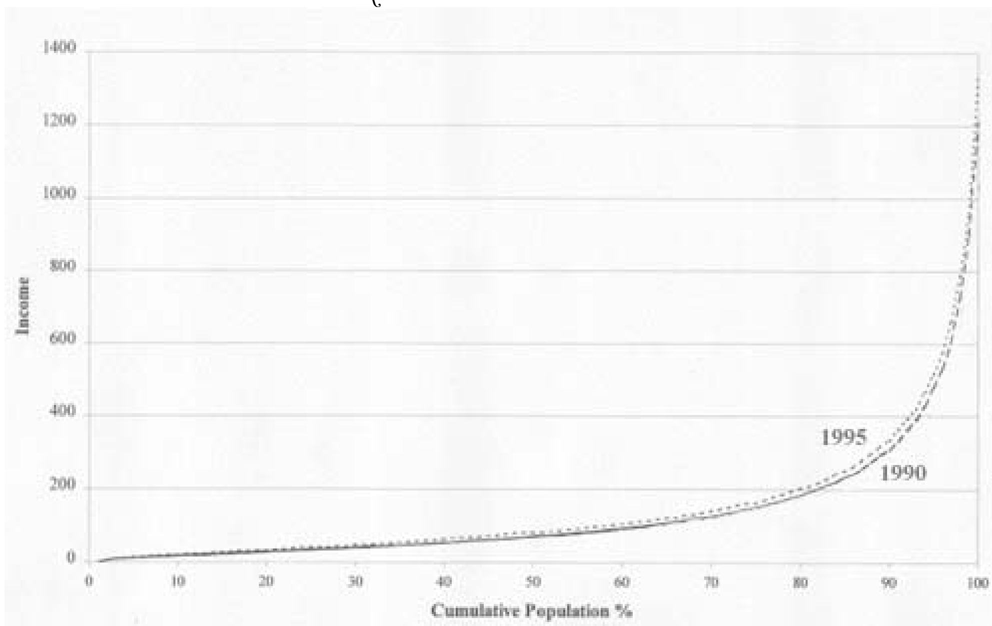
50 As the discussion suggests, first- and second- order stochastic dominance measures are fundamentally of use in comparisons of social welfare.

category which is associated with unambiguous comparisons of inequality across distributions: mean-normalized second-order dominance, or Lorenz dominance.

(a) *First order stochastic dominance*. Consider two income distributions y_1 and y_2 with cumulative distribution functions (CDFs) $F(y_1)$ and $F(y_2)$. If $F(y_1)$ lies nowhere above and at least somewhere below $F(y_2)$ then distribution y_1 displays first order stochastic dominance over distribution y_2: $F(y_1) \leq F(y_2)$ for all y.

Thus in income distribution y1 there are no more individuals with income less than a given income level than in distribution y_2, for all levels of income. We can express this in an alternative way using the inverse function $y=F^{-1}(p)$ where p is the share of the population with income less than a given income level: first order dominance is attained if $F_1^{-1}(p) \geq F_2^{-1}(p)$ for all p. The inverse function $F^{-1}(p)$ is known as a Pen's Parade (Pen, 1974). This plots incomes against cumulative population, usually using ranked income quartiles. The dominant income distribution is then the one whose Parade lies nowhere below and at least somewhere above the other income distribution. First order stochastic dominance of income distribution y_1 over y_2 implies that any social welfare function that is increasing in income, will record higher levels of welfare in income distribution y_1 than in income distribution y_2 (Saposnik, 1981, 1983).

Figure 10: First Order Stochastic Dominance
Brazil 1990-1995. Pen Parades



Source: Ferreira and Litchfield, 1999, "Inequality, Poverty and Welfare, Brazil 1981-1995". London School of Economics Mimeograph.

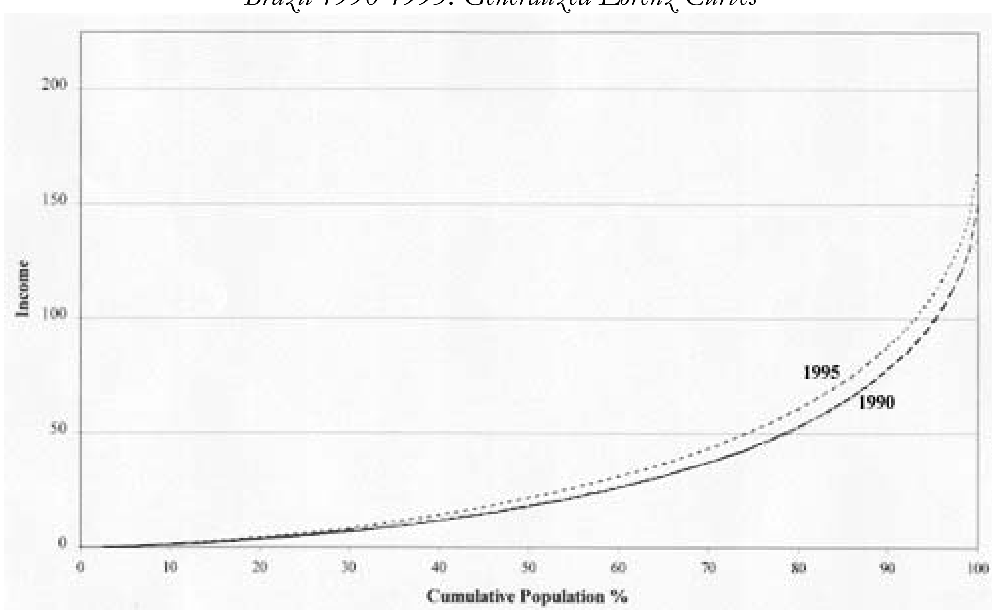
(b) *Second order stochastic dominance.* Consider now the deficit functions (the integral of the CDF) of distributions $\mathbf{y}_1$ and $\mathbf{y}_2$: $G(y_{i,k}) = \int_0^{y_i} F(y_i)dy$ i=1, 2. If the deficit function of income distribution $\mathbf{y}_1$ lies nowhere above and somewhere below that of income distribution $\mathbf{y}_2$, then distribution $\mathbf{y}_1$ displays second order stochastic dominance over distribution $\mathbf{y}_{2:}$ $G(\mathbf{y}_{1,k}) \leq G(\mathbf{y}_{2,k})$ for all y_k. The dual of the deficit curve is the Generalised Lorenz curve (Shorrocks, 1983) defined as $GL(p) = \int_0^{y_i} ydF(y)$, which plots cumulative income shares scaled by the mean of the distribution against cumulative population, where the height of the curve at p is given by the mean of the distribution below p.[51] As

[51] "p" is the share of the population with income less than a given income.

Atkinson and Bourguignon (1989) and Howes (1993) have shown, second order dominance, established by comparisons of the deficit curves for complete, uncensored distributions, implies and is implied by Generalised Lorenz dominance: $GL_1(\mathbf{p}) \geq GL_2(\mathbf{p})$ for all p.

Second order dominance of income distribution $\mathbf{y}_1$ over income distribution $\mathbf{y}_2$ implies that any social welfare function that is increasing and concave in income will record higher levels of welfare in $\mathbf{y}_1$ than in $\mathbf{y}_2$ (Shorrocks, 1983). It should now be apparent that second order stochastic dominance is therefore implied by first order stochastic dominance, although the reverse is not true.

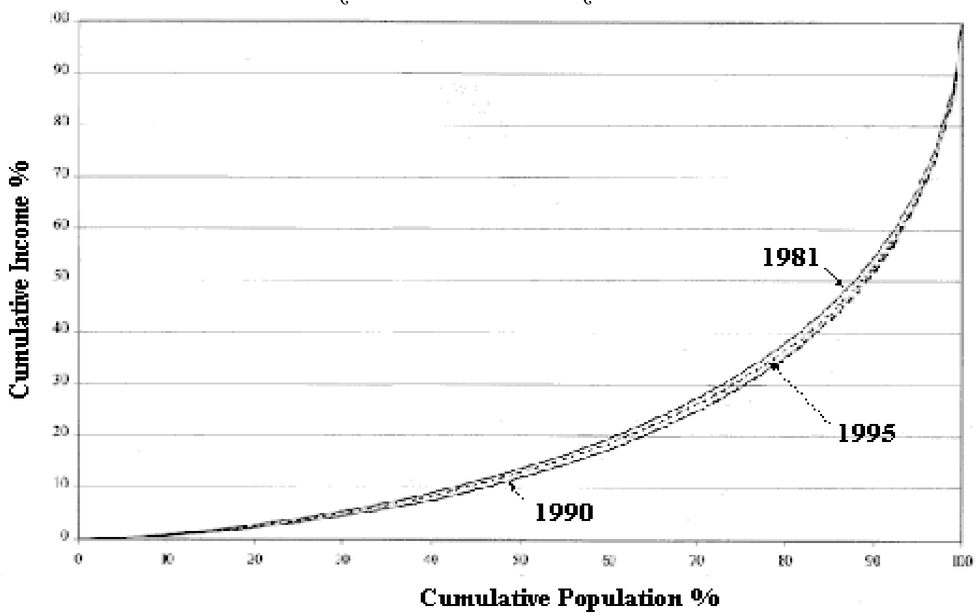
Figure 11: Second Order Stochastic Dominance
Brazil 1990-1995: Generalized Lorenz Curves



Source: Ferreira and Litchfield, 1999, "Inequality, Poverty and Welfare, Brazil 1981-1995". London School of Economics Mimeograph.

(c) *Mean-normalized second order stochastic dominance.* In order to rank distributions in terms of inequality alone, rather than welfare, a third concept (also known as Lorenz dominance) is applied. If the Lorenz curve, which is the plot of cumulative income shares against cumulative population shares, of income distribution $\mathbf{y}_1$ lies nowhere below and at least somewhere above the Lorenz curve of income distribution $\mathbf{y}_2$ then $\mathbf{y}_1$ Lorenz dominates $\mathbf{y}_2$. Any inequality measure which satisfies the axioms of anonymity and the Pigou-Dalton transfer principle will rank the two income distributions in the same way as the Lorenz curves (Atkinson, 1970).

Figure 12: Mean-normalized second order stochastic dominance
Brazil 1981-1995: Lorenz Curves



Note: 1995 Lorenz dominates 1990, but 1981 Lorenz dominates 1990 and dominates 1995.
Source: Ferreira and Litchfield, 1999, "Inequality, Poverty and Welfare, Brazil 1981-1995". London School of Economics, Mimeograph.

C. Statistical Inference & Sampling Variance

In order to make meaningful comparisons between estimates of inequality of different distributions and of the rankings implied by stochastic dominance, the statistical significance of the results needs to be examined. In the case of summary inequality measures the standard errors of the estimates needs to be examined. There are a number of ways this can be done, depending on the degree of sophistication one wishes to apply and the measure of inequality in question.

Cowell (1995) lists some rough approximations for a number of inequality measures if the sample size is large and if one is prepared to make assumptions about the underlying distribution from which the sample is taken. For example the coefficient of variation CV (which is a simple transformation of GE(2) – see above) has standard error $CV\sqrt{([1+2\mathrm{CV}^2]/2\mathrm{n})}$ if we assume the underlying distribution is normal. The Gini coefficient, again assuming a normal distribution, has standard error $0.8086CV/\sqrt{n}$.

This however may be too rough an approximation for some purposes, in which case a more accurate method is needed. Cowell (1989) shows that many inequality measures can be expressed in terms of their sample moments about zero. For example, the Atkinson class of inequality measures can be written as

$$A_\varepsilon = 1 - \frac{\left[\mu_r^{'}\right]^{1/r}}{\mu_1^{'}}$$

where $\mu_r^{'}$ is the r^{th} moment about zero, r=1-ε and $\mu_1^{'}$= the mean of the distribution. The GE class of inequality measures can be written as:

$$GE(\alpha) = \frac{1}{\alpha^2 - \alpha}\left[\mu_{1\alpha}\left[\mu_{11}\right]^{-\alpha}\left[\mu_{10}\right]^{\alpha-1} - 1\right], \alpha \neq 0,1$$

μ ν α are the moments about zero defined as:

$$\mu_{v\alpha} = \iint z^v y^\alpha dF(z, y)$$

where z is household size (or some other weighting variable), v=1,2 and $-\infty < \alpha < \infty$. The sample moments $m_{\nu\alpha}$ can be expressed as $m_{\nu\alpha} = 1/n \sum z_i^{\nu} y_{i\alpha}$. If both mean household size and mean income are known, then Var(GE(α)) is relatively easy to derive:

$$\hat{V} = \frac{1}{[n-1][\alpha^2 - \alpha]^2}[m_{11}]^{-2\alpha}[m_{10}]^{2\alpha-2}[m_{2,2\alpha} - m_{1\alpha}^2]$$

For the full details of the method and for the cases where α =0 and 1, and where the population mean income and household size are not known see Cowell (1989, 1995).

It is also possible to test the statistical significance of any stochastic dominance results. Howes (1993) describes one test based on a simple test of sample mean differences:

$$z_i = \frac{\hat{\xi}_i - \hat{\xi}_i^*}{\left(\frac{\hat{C}_{ii}}{N} + \frac{\hat{C}_{ii}^*}{N^*}\right)^{1/2}}$$

where $\xi = (\xi_1, \ldots \xi_w)$ is a vector of heights of curves (Pen's Parades, Lorenz or Generalized Lorenz curves), C_{ii} is the relevant element in the diagonal of the variance-covariance matrix associated with ξ and N is the sample size. Z_i is asymptotically normally distributed. See Howes (1993) for fuller details and an empirical application to China, and Ferreira and Litchfield (1996) for an application to Brazil.

(A) INEQUALITY DECOMPOSITION.

The preceding discussion of measurement and comparisons of inequality should have sufficed to establish the complexity involved in measuring income inequality. Since inequality is influenced by the welfare of any individual or household in a society, and welfare itself is affected by many factors and determined in general equilibrium, the study of causation or determination of inequality is a perilous field. Analytical techniques are in their infancy, and caution is both warranted and necessary.

Thus authors in the field often qualify every statement with cautionary remarks about how results are merely 'indicative' or 'suggestive'. They are at pains to point out that decomposition results are descriptive and inferences of causation merely suggestive. Nevertheless, once the appropriate caution of interpretation is internalized, some techniques do allow us to glimpse interesting patterns in inequality. In the absence of more definitive inference methods, some of these decomposition and regression analyses are often worthwhile exercises. We begin with decomposition techniques.

Decomposability can be desirable for both arithmetic and analytic reasons. Decomposition of inequality can be done by population sub-groups and income sources, to name two that are discussed below. This body of work was pioneered by Bourguignon (1979), Cowell (1980), and Shorrocks (1982a, 1982b, 1984). For details on the methodologies, see Deaton (1997), and Jenkins (1995). Fields (1980) provides summaries of applications to developing countries.

(i) Decomposition by population sub-group

This decomposition separates total inequality in the distribution into components of between-group (I_b), and the remaining within-group inequality (I_w). Two types of decomposition are of interest: first, the decomposition of the level of inequality in any one year, i.e a static decomposition, and second, a decomposition of the change in inequality over a period of time, i.e. a dynamic decomposition.

The static decomposition: When total inequality, I, is decomposed by population subgroups, the Generalised Entropy class can be expressed as the sum of within-group inequality, I_w, and between group inequality, I_b. Within-group inequality I_w is defined as:

$$I_w = \sum_{j=1}^{k} w_j GE(\alpha)_j$$
$$w_j = v_j^{\alpha} f_j^{1-\alpha}$$

where f_j is the population share and v_j the income share of each partition j, j=1,2,..k. In practical terms the inequality of income within each sub-group is calculated and then summed, using weights of population share, relative incomes or a combination of these two, depending on the particular measure used. Between-group inequality, I_b, is measured by assigning the mean income of each partition j, $\bar{y}_j$, to each member of the partition and calculating:

$$I_b = \frac{1}{\alpha^2 - \alpha}\left[\sum_{j=1}^{k} f_j \left(\frac{\bar{y}_j}{\bar{\bar{y}}}\right)^{\alpha} - 1\right]$$

Cowell and Jenkins (1995) show that the within- and between- group components of inequality, defined as above, can be related to overall inequality in the simplest possible way: $I_b + I_w = I$. They then suggest an intuitive summary measure, R_b, of the amount of inequality explained by differences between groups with a particular characteristic or set of characteristics, Rb = I_b / I. Thus x% of total inequality is "explained" by between group inequalities, and (100-x)% is accounted for by inequalities within groups. By increasing the number of partitions we can account for the effect of a wider range of structural factors.

The dynamic decomposition:. Accounting for changes in the level of inequality by means of a partition of the distribution into sub-groups must entail at least two components of the change: one caused by a change in inequality between groups and one by a change in inequality within groups. The second within-group inequality is the "pure inequality" effect. However, between-group inequality can be further disaggregated into two effects. The first is due to changes in relative mean incomes between the subgroups - an "income effect" - and the second is due to changes in the size of the subgroups - an "allocation effect". Thus we decompose the change in total inequality into three components: an allocation effect arising from changes in the number of people within different partitions, an income effect arising from changes in relative incomes between partitions, and finally a pure inequality effect arising from changes in inequality within partitions (Mookerjee and Shorrocks, 1982). The arithmetic becomes complicated for some measures, so this is usually only applied to GE(0), as follows:

$$\Delta GE(0) = \left[\begin{array}{c} \sum_{j=1}^{k} \overline{f_j} \Delta GE(0)_j \\ + \sum_{j=1}^{k} \overline{GE(0)_j} \Delta f \quad + \sum_{j=1}^{k} \left[\overline{\lambda_j} - \overline{\log(\lambda_j)} \right] \Delta f_j \\ + \sum_{j=1}^{k} \left(\overline{v_j} - \overline{f_j} \right) \Delta \log(\mu(y))_j \end{array} \right]$$

where y is income, Δ is the difference operator, λ_j is the mean income of group j relative to the overall mean, i.e. $\mu(y_j)/\mu(y)$ and the over-bar represents a simple average. The first term captures the pure inequality effect, the second and third terms capture the allocation effect and the final term the income effect. By dividing both sides through by the initial value of GE(0) proportionate changes in inequality can be compared to proportionate changes in the individual effects.

(ii) Decomposition by income source

Total income is usually made up of more than one source: labour earnings, income from capital, private and public transfers, etc. Hence it is useful to express total inequality I as the sum of factor contributions, where each contribution depends on the income from a given factor source, f, i.e.

$$I = \sum_f S_f$$

where S_f depends on incomes from source f. Factor income source f provides a disequalising effect if $S_f > 0$, and an equalising effect if $S_f < 0$. Now define

$$s_f \equiv \frac{S_f}{I} \text{ so } \sum_f s_f = 1 .$$

S_f is the absolute contribution of factor f to overall inequality, while s_f is the proportional factor contribution.

The exact decomposition procedure depends on the measure of inequality used. However, whichever measure is used must be decomposable and, given the large number of income sources, must be defined for zero incomes. In practice the easiest measure to decompose in this way is GE(2). In which case:

$$S_f = s_f GE(2) = \rho_f \chi_f \sqrt{GE(2).GE(2)_f}$$

where p_f is the correlation between component f and total income and $x_f = \mu_f / \mu$ is f's factor share. A large value of S_f suggests that factor f is an important source of total inequality.

For the dynamic decomposition we can write

$$\Delta GE(2) = GE(2)_{t+1} - GE(2)_t = \sum_f \Delta S_f = \sum_f \Delta\left[\rho_f \chi_f \sqrt{GE(2).\,E(2)_f}\right]$$

and proportionate inequality changes as

$$\%\Delta GE(2) = \Delta GE(2) \,/\, GE(2)_t = \sum_f s_f \%\Delta S_f$$

A large value of $s_f \%\Delta S_f$ suggests that changes in factor f have a large influence in changes in total inequality. See Jenkins (1995) for the complete methodology and an application to the UK.

D. REGRESSION ANALYSES

The decomposition techniques described above are very suitable for assessing the contribution of a set of factors (household-specific attributes or income sources) to inequality although the importance of a particular attribute may vary depending on the measure of inequality that is decomposed. Thus Fields (1997) proposes an alternative decomposition technique. This allows the assessment of the importance of household specific attributes in explaining the level of inequality. The amount explained by each factor is independent of the inequality measure used. The methodology involves running a standard set of regressions of the form:

$$\ln(y_{ij}) = \alpha_j + \beta_j X + \varepsilon_j$$

where the subscript i refers to the individual, j refers to the population sub-group and X is a vector of explanatory variables. Then the relative contributions, s_j , of each factor can then be estimated as:

$$s_j = \mathrm{cov}[a_j Z_j, Y] / \sigma^2(Y) = a_j * \sigma(Z_j) * cor[Z_j, Y] / \sigma(Y)$$

where a is the vector of coefficients (α , β_j), Z is the vector of explanatory variables plus a constant (1, x_i, and Y is log income. The change in inequality over time can also be decomposed using the s_j's estimated above, although the estimates will again be sensitive to the inequality measure used. See Fields (1997) for further details and an application to data from Bolivia and Korea.

Another alternative approach is the *quartile regression* methodology, where the median instead of the mean of a dependent variable is estimated, conditional on the values of the independent variables. That is, minimizing the sum of the absolute residuals rather than the sum of squares of the residuals as in ordinary regressions. This makes it possible to obtain estimates for different parts of the income distribution. [52] The quartile regression methodology can also be used to model the effect of aggregate factors rather than the specific attributes of a household. One method regresses the level of inequality in each year (or each country, population sub-group etc.) on a set of explanatory variables, such as the rates of unemployment (UE) and inflation (INF), such as:

$$I(y)_t = \alpha + \beta_1 UE_t + \beta_2 INF_t + u_t$$

A second method often applied in this macro-economic context is to regress a set of income shares on the independent variables, as follows:

$$s_{it} = \alpha_i + \beta_{1i} UE_t + \beta_{2i} INF_t + u_{it}$$

where s_{it} denotes the income share of the ith quartile group in year t. The i quartile share regressions are a set of seemingly unrelated regressions (see Zellner, 1962) but since the right hand side variables are the same in each equation, the SURE estimation technique suggested by Zellner is equivalent to a set of simple OLS regressions. See Blinder and Esaki (1978) for an application to the USA, Buse (1982) on Canadian inequality, Ferreira and Litchfield (1999) on Brazil and Nolan (1987) on UK inequality.

III. MEASURING POVERTY

The international poverty target proposed by DAC is to half the proportion of people living in extreme poverty by 2015. But what this target means is obscured by the

52 See Deaton (1997) for an introduction to quartile regressions and some applications to developing country data

bewildering ambiguity with which the term 'poverty' is used and by the many different indicators proposed to monitor poverty.

The United Nations Development Program (UNDP) talks about 'human poverty': 'a denial of choices and opportunities for living a tolerable life'; the World Bank of 'income poverty' – 'living on less than a dollar a day'. Then there is 'absolute' poverty – those below a defined poverty line or threshold – and 'relative' poverty – where the lowest segments of a population are compared with upper segments[53]. Each of these different poverty concepts implies a different indicator.

At first glance, the statistics for poverty look promising. Living standards have risen dramatically over the last decades. Per capita private consumption growth in developing countries has averaged about 1.4 percent a year between 1980 and 1990 and 2.4 percent between 1990 and 1999. The proportion of the developing world's population living in extreme economic poverty -- defined as living on less than $1 per day (in 1993 dollars, adjusted to account for differences in purchasing power across countries) -- has fallen from 28 percent in 1987 to 23 percent in 1998. But population in the developing world has also grown rapidly -- from 2.9 billion people in 1970 to 5.1 billion in 1999. This means that the absolute number of poor people is increasing as the world's population increases.[54]

In the 1960s, the main focus on poverty was on the level of income, reflected in macro-economic indicators like Gross National Product per capita. In the 1970s, the concept of income poverty was broadened to a wider set of 'basic needs', including those provided socially. Thus, from the mid-1970s, poverty came to be defined not just as lack of income, but also as lack of access to health, education and other services.

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[53] These are usually measured in income quintiles or deciles.

[54] Source: WB data

New layers of complexity were added in the 1980s. The principal innovations were:

1) The incorporation of non-monetary aspects;
2) A new interest in vulnerability, and its counterpart, security, associated with better understanding of seasonality and of the impact of shocks, notably drought;
3) A broadening of the concept of poverty to a wider construct, livelihood, which popularized the term sustainable livelihood;
4) Theoretical work by Amartya Sen, who had earlier contributed the notion of food entitlement, or access, emphasized that income was only valuable in so far as it increased the 'capabilities' of individuals and thereby permitted 'functionings' in society.
5) Finally, the 1980s was characterized by a rapid increase in the study of gender with the debate moving from a focus on women alone to wider gender relations.

The 1990s saw further development of the poverty concept. The idea of well-being came to act as a metaphor for the absence of poverty, with a concomitant emphasis on how poor people themselves view their situation. At the same time, inspired by Sen, the UNDP developed the idea of human development: 'the denial of opportunities and choices… to lead a long, healthy, creative life and to enjoy a decent standard of living, freedom, dignity, self-esteem and the respect of others...'.

As can be seen, differing concepts of poverty has developed rapidly over the last three decades with this conceptual debate being carried over to measurement. The complexity of measurement mirrors the complexity of definition, and the complexity increases where participatory methods are used and people define their own indicators of poverty.

A. Measuring Poverty at the Country Level

The most commonly used poverty measure is based on incomes or consumption levels. This approach to poverty measurement assumes that individuals and households are poor if their income or consumption falls below a certain threshold, usually defined as a minimum, socially acceptable level of well being by a population group. The emphasis is placed on material well being, and income, a "means" indicator, is employed as a proxy for poverty.

The 'threshold' below which an individual or household falls is usually called the "poverty line". What is necessary to satisfy basic needs varies across time and societies. Therefore, poverty lines vary in time and place, and each country uses lines which are appropriate to its level of development, societal norms and values.

The most widely utilized income poverty indicators are the headcount index and per capita GNP. The *headcount index* is based on a poverty line (or set of lines) that are established by costing a minimum basket of essential goods for basic human survival, using income, consumption or expenditure data of non- poor households. The *incidence* of poverty is then calculated as the percentage of the population whose incomes fall below that threshold. Income indicators can also be used to measure the depth and severity of poverty. The *poverty gap index* measures the degree to which the mean income of the poor differs from the established poverty line (depth of poverty). Distributionally sensitive measures, such as the *squared poverty gap index*, capture differences in income levels among the poor (severity of poverty).

Information on consumption and income is obtained through sample surveys, during which households are asked to answer detailed questions on their spending habits and sources of income. Such surveys are conducted more or less regularly in most countries. These sample survey data collection methods are increasingly being complemented by participatory methods, where people are asked what their basic needs are and what poverty means for them. Interestingly, new research shows a high degree of concordance between poverty lines based on such objective and subjective assessments of needs.

However, obtaining information through household survey data can be problematic. One issue is that of comparing different survey-based measures of living standards. A further issue is that survey questionnaires can differ widely in, for example, the number of distinct categories of consumer goods that they identify and the order in which they ask questions. A convincing questionnaire should require a careful and complete accounting of revenues and costs in the household enterprises, recognizing the fact these might be tangled with other activities. Thus, survey quality varies, and even seemingly similar surveys might not be comparable. This could become a serious problem for the cross-country comparison of the levels of income and of summary measures based on their distribution. Most of the empirical literature compares the levels of summary measures (such as inequality measures and poverty rates) across countries; the existence of country-level fixed effects in distribution – arising from, among other things, survey design - can make such comparisons deceptive.

In the absence of household survey data, income poverty is sometimes measured in *per capita GNP* terms. However, this latter indicator is a very crude measure and can often be misleading since it is possible for per capita GNP to grow while personal incomes remain static or even decline among particular population groups. For this reason, *per capital personal income* is a preferable aggregate income indicator.

Some of the attractions of income poverty indicators are that they are aggregates of multiple inputs; they are expressed in units that are of immediate and widespread relevance, and they are theoretically objective, i.e., they weigh inputs to well being according to how the "real world" values them.

The limitations associated with income indicators of poverty have been extensively documented. In short, the drawbacks pertain to price and commodity differentials, the exclusion of non-cash and "free" items (such as publicly provided goods and services), and the omission of other factors, such as time required to obtain a commodity.

Although practitioners agree on the inherent limitations of the income approach, it nevertheless continues to be the most widely used means of measuring poverty, partly because of the relative abundance of data and partly because of its simplicity.

B. Measuring Poverty at the Global Level

When estimating poverty world-wide the same reference poverty lines can be used, although expressed in a common unit across countries. For the purpose of global aggregation and comparison, the World Bank uses reference lines set at $1 and $2 per day in 1993 Purchasing Power Parity (PPP) terms (where PPPs measure the relative purchasing power of currencies across countries). It has been estimated that in 1998 1.2 billion people world-wide had consumption levels below $1 a day -- 24 percent of the population of the developing world and 2.8 billion lived on less than $2 a day. These figures are lower than earlier estimates, indicating that some progress has been made in alleviating absolute poverty.

Because of the time involved in collecting and processing the household survey data upon which these figures are based, and - because of the complexities of the estimation exercise, these figures appear with a lag, and are updated only every three years.

Indicators of *inequity* are also highly relevant to global poverty measurement. This is partly because one of the purposes of poverty measurement is to identify who are the poor. Indicators of inequity help to do just that, and the relationship between poverty and inequity is such that the latter can be used for making educated guesses about the former in the absence of poverty data. There are three main data sources for measuring inequity: income distribution, disaggregation of other indicators by subgroups and time-use studies.

With regard to the income distribution, a change in some summary index of income distribution such as the Gini coefficient may not be a relevant measure of the change in income distribution, just as per capita GNP may not be the appropriate summary index for determining income poverty. Here, the relevant measure would be the change in the appropriate segment of the Lorenz distribution. For example, an unchanged Gini coefficient may be consistent with worsening poverty—given unchanged average income—if there is an adverse change in distribution between the deciles of income groups just below and above the PIT (personal income threshold), which is exactly offset by a favorable distribution between the top two deciles of income groups. Although Lorenz curves are usually used for examining income distribution, they can also be plotted for land distribution, which can be revealing from a poverty perspective. Unfortunately, the required data is derived from agricultural censuses, which many countries have discontinued.

Thus, if the concept of poverty is primarily lack of household income, and if one settles for income or expenditure as the single most important indicator of poverty, then the logical strategies to reduce poverty would centre on economic mobility.

Anti-poverty strategies aimed at stimulating economic mobility of the poor are based on an analysis of sources of personal income (both primary and secondary). The entry points are twofold—increasing the processes of production, output and exchange, and, of the distribution. To increase primary income, strategies include augmenting the volume of output, increasing productivity and changing the relative prices of factor inputs. To increase secondary income, strategies focus on raising the level of transfers to the poor either through public transfers or safety nets.

Appendix 3

GROWTH & THE DISTRIBUTION

The analysis in *chapter 4* addresses the following specific relationships: 1) between the level and growth rate of income per capita and the level of inequality; 2) between the level and growth rate of income per capita and both the relative and absolute incomes of people; and 3) the specific movements between relative and absolute incomes. These relationships are studied within a cross-section of countries using correlations and simple OLS methodology. This appendix provides supporting regression data tables for the analysis in *chapter 4* and presents further formulations of the Kuznets curve analyses in *chapter 4*.

Appendix 3 has three main sections. Section I presents further analysis of the effect of the level of GDP/cap on group B1 and B2 variables. That is, analysis of the relationship between the level of GDP/cap and the relative and absolute incomes of people. The section is divided into cross-sectional analysis across countries and regions and, time series analysis within a select group of countries. Section II reports on the effect of the growth of GDP/cap on group B1 and B2 variables. Here the discussion is focused primarily across countries. Section III presents some further formulations of the Kuznets curve following on the detailed analysis in *chapter 4*.

I. THE LEVEL OF GDP/CAP VERSUS GROUPS B1 AND B2

ACROSS COUNTRIES: The analysis begins with 71 countries covering 6 developing country regions and the group of industrial countries. The correlation coefficient between the level GDP/cap and the level of the Gini coefficient was found to be negative. Summary statistics for these two variables can be found in Tables 14 and 15.

Table 14

	Level of GDP/cap	Gini
Corr.coeff.	-0.41	
Mean	6788.55	38.81
Std. Dev.	5345.84	9.17
Kurtosis	-0.68	-0.55
Skewness	0.71	0.25
Minimum	451.27	20.49
Maximum	20809.14	61.23

Table 15

Y=Level of GDP/cap	n=70	
	Coeff. Est.	t Stat
Intercept	16012.08	6.22
Gini	-237.63	-3.68
R^2	0.17	
Adjusted R^2	0.15	
F	13.55	

Figure 13

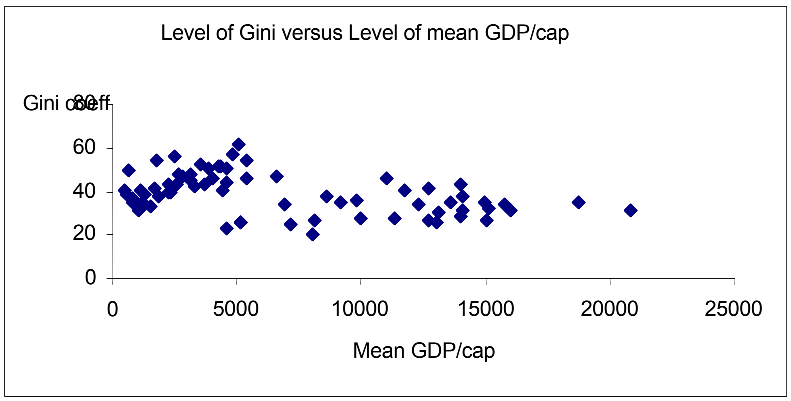


Figure 13 plots the level of the Gini coefficient and the level of GDP/cap across countries. The figure illustrates the variability of the level of GDP/cap which ranges between $451.27/cap in Tanzania to $20, 809.14/cap in Germany. The data was partitioned into developing and industrial and, low and high income countries. Correlation and estimated coefficients are presented in Table 16 for industrial countries and Table 17 for developing countries. Similarly, Table 18 presents the correlation and estimated coefficients for high income countries[55] and Table 19 for low income countries[56]. Table 20 and 21 presents the correlation and estimated coefficients between

55 Here the mean level of GDP/cap is equal to or greater than $5000. These are dominated by the industrial countries.

56 Here the mean level of GDP/cap is below $5000. These are dominated by the developing countries.

the level of GDP/cap and the share of income of each quintile group. For a detailed discussion of these tables, see *chapter 4*.

Table 16: Industrial Countries

	Level of GDP/cap	Gini
Corr.coeff.	-0.47	
Mean	13163.21	34.83
Std. Dev.	3572.93	6.13
Kurtosis	1.57	0.76
Skewness	-0.42	0.91
Minimum	3841.81	25.98
Maximum	20809.68	50.36

Y=Level of GDP/cap	n=22	
	Coeff est.	t stat.
Intercept	22805.16	5.62
Gini	-276.84	-2.41
R^2	0.23	
Adjusted R^2	0.19	
F	5.82	

Table 17: Developing Countries

	Level of GDP/cap	Gini
Corr.coeff.	-0.26	
Mean	3866.82795	40.6415805
Std. Dev.	2917.495591	9.79132317
Kurtosis	1.792194456	-0.5975039
Skewness	1.342010745	-0.1179481
Minimum	451.2709073	20.494
Maximum	12731.09556	61.225

Y=Level of GDP/cap	n=48	
	Coeff est.	t stat.
Intercept	6985.148314	3.938312
Gini	-76.72734	-1.807417
R^2	0.07	
Adjusted R^2	0.05	
F	3.27	

Table 18: High Income Countries with GDP/cap > $5000

	Level of GDP/cap	Gini
Corr.coeff.	-0.24	
Mean	11306.38	34.59
Std. Dev.	4103.19	8.79
Kurtosis	-0.57	1.51
Skewness	0.11	1.12
Minimum	5073.42	20.49
Maximum	20809.14	61.23

Y=Level of GDP/cap	n=34	
	Coeff est.	t stat.
Intercept	15133.98	5.29
Gini	-110.66	-1.38
R^2	0.06	
Adjusted R^2	0.03	
F	1.9	

Table 19: Low Income Countries with GDP/cap ≤ $5000

	Level of GDP/cap	Gini
Corr.coeff.	0.44	
Mean	2521.71	42.80
Std. Dev.	1382.66	7.70
Kurtosis	-1.33	-0.17
Skewness	0.18	-0.18
Minimum	451.27	23.30
Maximum	4794.71	57.28

Y=Level of GDP/cap	n=36	
	Coeff est.	t stat.
Intercept	-874.74	-0.73
Gini	79.35	2.87
R^2	0.20	
Adjusted R^2	0.17	
F	8.3	

Table 20

Correlation Coefficients	
	Level GDP/cap
Level GDP/cap	1
Q1	0.19
Q2	0.44
Q3	0.55
Q4	0.55
Q5	-0.47

Table 21

Y=Level GDP/cap	n=65		n=65		n=65		n=65		n=65	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	-3476.28	-1.25	3921.21	1.86	-12392.84	-3.29	-28662.36	-4.16	21537.63	6.31
Q1	96469.20	3.89								
Q2			50081.23	1.58						
Q3					125324.32	5.24				
Q4							161694.57	5.21		
Q5									-32052.25	-4.29
R^2	0.19		0.038		0.3		0.3		0.23	
Adjusted R^2	0.18		0.023		0.29		0.29		0.21	
F	15.19		2.52		27		27.17		18.46	

Since the level of GDP/cap showed a large degree of variability across countries, the log of GDP/cap was used to assess the relationship with the relative incomes of people. As with the level of GDP/cap, a positive relationship exists between the mean log of GDP/cap and the share of income of quintiles 1 through 4, and a negative relationship with the share of income of quintile 5.

Table 22

Y=ln(GDP/cap)	n=65		n=65		n=65		n=65		n=65	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	8.12	21.58	7.06	13.73	5.71	8.02	3.22	2.49	10.15	16.58
Q1	5.99	1.06								
Q2			13.16	2.87						
Q3					17.96	3.97				
Q4							23.87	4.10		
Q5									-4.48	-3.23
R^2	0.0176		1.20E-01		0.2		0.21		0.14	
Adjusted R^2	0.002		0.1		0.19		0.2		0.13	
F	1.31		8.27		15.76		16.84		10.46	

OLS methodology was used to look at the relationship between the level of GDP/cap and changes in the Gini coefficient, with changes in the Gini coefficient as the right-hand side variable. This relationship although positive, was found to be insignificant.[57]

A further test of the relationship between the level of GDP/cap and the relative incomes of the quintile groups is by looking at the ratio of the richest quintile's share to the poorest quintile's share of income, (Q_5/Q_1). The coefficients in Table 23 indicate a negative relationship between the level of GDP/cap and the ratio of income of the top 20 percent to the bottom 20 percent of the population. This negative relationship could be attributed to one of three scenarios:

1. Either the share of income of the top quintile group (Q_5) falls as Q_1 stays unchanged; → the relative incomes of the richest group decreases, or
2. The share of income of the bottom quintile group (Q_1) increases as Q_5 stays unchanged; → the relative incomes of the poorest group increases, or
3. The share of income of the top quintile group (Q_5) falls further than the share of income of the bottom quintile (Q_1) increases → the poor are better off .

[57] The results are thus not presented.

Table 23 also illustrates the negative relationship between the ratio of the share of income of the middle class to the poor and the level of GDP/cap.

Table 23

Y=Level of GDP/cap	n=65		n=65		n=65	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	10121.65	7.69	7728.53	3.04	-2780.81	-1.30
Q5/Q1	-356.21	-2.63				
(Q2+Q3+Q4)/Q1			-75.56	-0.26		
(Q2+Q3+Q4)/Q5					8710.18	4.79
R^2	0.10		0.00		0.27	
Adjusted R^2	0.09		-0.014		0.26	
F	6.92		0.067		23.02	

Next, our analysis looks for a systematic relationship between the level of GDP/cap and the absolute incomes of the quintile groups. These are also referred to as the quintile level GDP/cap or $(GDP/cap)_{Qi}$, where i=1…5, for each of the quintile groups. Earlier analysis suggested that the level of GDP/cap across countries was negatively related to the level of income inequality and to the relative income of the richest quintile, Q_5. Thus, in any one country, we would expect the country level GDP/cap to be positively related to the absolute incomes of each of the quintile groups. The correlation coefficients in Table 24 show a positive relationship for all quintile groups, and the estimated coefficients for these quintile groups were also found to be jointly and individually significant.

Table 24

Correlations	
	Ctry GDP/cap
Ctry GDP/cap	1.00
$(GDP/cap)_{Q1}$	0.93
$(GDP/cap)_{Q2}$	0.98
$(GDP/cap)_{Q3}$	0.99
$(GDP/cap)_{Q4}$	0.99
$(GDP/cap)_{Q5}$	0.98

ACROSS REGIONS: Table 25 also presents the correlation coefficients between the country level GDP/cap and the quintile level GDP/cap for each group, all of whom are positive. For a detailed discussion of the effect of the level of GDP/cap at the regional level, see *chapter 4*.

Table 25

Region / Ctry GDP/cap	1 EAP	2 ECA	3 LAC	4 MENA	5 SAR	6 AFR	7 Hi Income
$(GDP/cap)_{Q1}$	0.97	0.99	0.71	0.99	0.87	0.88	0.83
$(GDP/cap)_{Q2}$	0.97	0.99	0.86	0.99	0.98	0.85	0.97
$(GDP/cap)_{Q3}$	0.99	0.99	0.90	0.99	0.99	0.93	0.99
$(GDP/cap)_{Q4}$	0.99	0.99	0.95	0.99	0.99	0.97	0.99
$(GDP/cap)_{Q5}$	0.99	0.99	0.96	0.99	0.99	0.97	0.97
D&S(Gini)	0.08	0.41	0.03	0.99	0.81	0.61	-0.47
n	8	8	14	3	4	7	20

TIME SERIES FOR SELECT COUNTRIES: The choice of countries for this series of analysis was determined partially by the data and by the countries themselves. The three countries with the most complete information on both income quintiles and the Gini coefficient were: India (31), Bulgaria (28) and US (45) representing the regions of SAR, ECA, and the industrial countries, respectively.[58] The data for India covers the years of 1951 through 1992, for Bulgaria from 1963 to 1993 and for the US from 1947 to 1991. India and Bulgaria belong to the developing country regions of SAR and ECA, while the US represents the industrial countries.

Table 26 presents the correlation coefficients between the level of the Gini coefficient and the quintile level GDP/cap for Bulgaria, India and the US. In these countries, correlation coefficients indicate a negative relationship between the level of the Gini coefficient and the quintile level GDP/cap of the poorest and middle class groups, and a positive relationship with the quintile level GDP/cap of the richest group.

[58] The numbers in brackets refers to the number of years for which data is available. Thus, there are 28 years of data available for Bulgaria. It should be noted that this data is not always sequential. See Appendix 4 for further details.

Table 26

Ctris. / Level Gini	n=28 Bulgaria	n=31 India	n=45 US
$(GDP/cap)_{Q1}$	-0.93	-0.90	-0.64
$(GDP/cap)_{Q2+Q3+q4}$	-0.72	-0.82	-0.88
$(GDP/cap)_{Q5}$	0.85	0.97	0.98

The estimated coefficients between the level of the Gini coefficient and the quintile level GDP/cap of each quintile group were found to be jointly and individually significant in in all three countries. These regressions are presented in Table 27.

Table 27

Bulgaria

Y= Gini	n=28		n=28		n=28	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	56.10	21.16	82.81	7.41	-7.96	-2.09
$(GDP/cap)_{Q1}$	-0.010	-12.42				
$(GDP/cap)_{Q2+Q3+q4}$			-0.014	-5.33		
$(GDP/cap)_{Q5}$					0.004	8.25
R^2	0.85		0.52		0.73	
Adjusted R^2	0.85		0.50		0.71	
F	154.45		28.46		68.10	

India

Y= Gini	n=28		n=28		n=28	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	56.03	26.76	120.40	10.71	-24.03	-8.61
$(GDP/cap)_{Q1}$	-0.05	-11.25				
$(GDP/cap)_{Q2+Q3+q4}$			-0.09	-7.81		
$(GDP/cap)_{Q5}$					0.02	20.30
R^2	0.81		0.68		0.93	
Adjusted R^2	0.80		0.67		0.93	
F	126.48		4.03		412.20	

The United States

Y= Gini	n=28		n=28		n=28	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	45.34	24.74	99.93	19.40	-12.05	-8.53
$(GDP/cap)_{Q1}$	-0.002	-5.51				
$(GDP/cap)_{Q2+Q3+q4}$			-0.004	-12.55		
$(GDP/cap)_{Q5}$					0.001	33.52
R^2	0.41		0.79		0.96	
Adjusted R^2	0.40		0.78		0.96	
F	30.34		157.54		1123.85	

At the country level, the high degree of correlation between the relative and absolute incomes of the quintile groups becomes apparent in Table 28.

Table 28

Quintile GDP/cap \ Q_i	Poor Q_1	Middle class $(Q_2+Q_3+Q_4)$	Rich Q_5
Bulgaria (ECA)			
$(GDP/cap)_{Q1}$	1	0.64	-0.81
$(GDP/cap)_{Q2+Q3+q4}$	0.64	1	-0.96
$(GDP/cap)_{Q5}$	-0.81	-0.96	1
India (SAR)			
$(GDP/cap)_{Q1}$	1	0.55	-0.83
$(GDP/cap)_{Q2+Q3+q4}$	0.55	1	-0.92
$(GDP/cap)_{Q5}$	-0.83	-0.92	1
US (Industrial)			
$(GDP/cap)_{Q1}$	1	0.26	-0.58
$(GDP/cap)_{Q2+Q3+q4}$	0.26	1	-0.93
$(GDP/cap)_{Q5}$	-0.58	-0.93	1

The relationship between the share of income of each quintile group and the quintile level GDP/cap of each quintile group along the diagonal will always be positive, and at the individual country level, perfectly correlated. Additionally, the relationship between the share of income of the poorest group, Q_1, and the quintile level GDP/cap of the middle class will be positive, as will the relationship between the share of income of the middle class group and the quintile level GDP/cap of the poorest group. Also, since the share of income of the richest quintile, Q_5 moves negatively with the share of income of the poorest and the middle class quintile groups, the following relationships will all be negative: The relationships between Q_1 and $(GDP/cap)_{Q5}$, $(Q_2+Q_3+Q_4)$ and $(GDP/cap)_{Q5}$, Q_5 and $(GDP/cap)_{Q1}$ and between Q_5 and $(GDP/cap)_{Q2+Q3+Q4}$.

In conclusion, correlation coefficients suggest a positive association between levels of income inequality in Bulgaria, India and the US and the absolute income of the rich, and a negative association with the absolute income of the poor and middle class groups.

II. THE GROWTH OF GDP/CAP VERSUS GROUPS B1 AND B2

ACROSS COUNTRIES: The analysis begins with 69 countries covering 6 developing country regions and the group of industrial countries. Across countries, the average growth of GDP/cap for the period of 1976-1998 ranges from 1 percent to 12 percent with a mean value of 6 percent. Although the correlation coefficient suggests a negative relationship between the average growth of GDP/cap and the level of the Gini coefficient, the estimated coefficients in Table 29 reveal no significant relationship between these two variables.

Table 29: Growth rate of GDP/cap vs. Gini

Y=Avg. GDP/cap growth rate	n=69	
	Coeff. Est.	t Stat
Intercept	0.06	5.59
D&S Gini	-0.00011	-0.41
R^2	0.20%	
Adjusted R^2	-1.20%	
F	0.12	

Figure 14: Growth versus the Gini coefficient

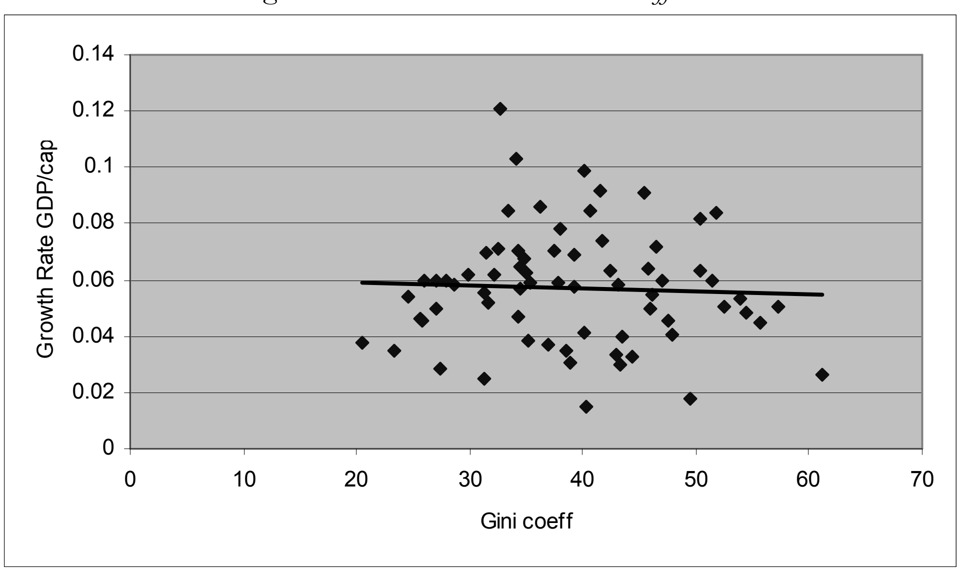


Figure 14 above plots the growth rate of GDP/cap against the level of the Gini coefficient and clearly shows the large variation in the growth of GDP/cap across countries. The data was partitioned into high and low growth countries. High growth countries are defined as those with a growth rate of 5 percent or more and low growth countries as those with growth rates below 5 percent.[59]

As Tables 30 and 31 indicate, there is still no evidence of a statistically significant relationship between the average growth of GDP/cap and the level of the Gini coefficient. Partitioning the data at an average growth rate of 6 percent failed to make the estimated coefficients significant. However correlation coefficients do give some indication of a positive association between the growth of GDP/cap and the level of Gini coefficient in high growth countries, and a negative relationship in low growth countries.

Table 30: Low growth countries

	Avg GDP/cap growth rate (76-98)	Avg. Gini
Corr.coeff.	-0.10	
Mean	0.04	39.28
Std. Dev.	0.01	10.66
Kurtosis	-0.24	-0.57
Skewness	-0.57	0.06
Minimum	0.01	20.49
Maximum	0.05	61.23

Y=Avg. GDP/cap growth rate	n=25	
	Coeff. Est.	t Stat
Intercept	0.04	5.28
Gini	-0.00009	-0.46
R^2	0.90%	
Adjusted R^2	-3.40%	
F	0.21	

[59] A histogram of frequency distributions was used to determine where the data should be split.

Table 31: High Growth countries

	Avg GDP/cap growth rate (76-98)	Avg. Gini
Corr.coeff.	-0.03	
Mean	0.07	38.82
Std. Dev.	0.02	8.25
Kurtosis	2.00	-0.67
Skewness	1.40	0.41
Minimum	0.05	24.65
Maximum	0.12	57.28

Y=Avg. GDP/cap growth rate	n=44	
	Coeff. Est.	t Stat
Intercept	0.07	6.21
Gini	-0.00006	-0.19
R^2	0.09%	
Adjusted R^2	-2.30%	
F	0.04	

To investigate movements between the growth of GDP/cap and the growth of the Gini coefficient, two formulations were run. Analysis results are presented in Tables 32 and 33. As Table 32 suggests, there appears to be a negative relationship between the growth of GDP/cap and the growth of the Gini coefficient, although the estimated coefficients fail to be jointly or individually significant. Table 33 however indicates a possible positive relationship between the growth of the Gini coefficient and the level of GDP/cap, although the estimated coefficients were again not statistically significant.

Table 32

Y=GDP/cap growth rate	Full sample n=69	
	Coeff. Est.	t Stat
Intercept	0.00250	22.41
Growth rate Gini coeff	-0.00900	-0.67
R^2	0.0066	
Adjusted R^2	-0.008	
F	0.44	

Table 33

Y=Growth rate Gini coeff	Full sample n=70	
	Coeff. Est.	t Stat
Intercept	-0.06	-1.64
Level GDP/cap	3.73E-06	0.93
R^2	0.01	
Adjusted R^2	-0.001	
F	0.86	

The growth data was then partitioned into industrial and developing countries. The estimated equations for both industrial and developing countries are presented in Table

34. For a detailed discussion of this table, see *Chapter 4*, the section on industrial and developing countries.

Table 34

Group of industrial Countries

Y=Avg. GDP/cap growth rate	n=21	
	Coeff. Est.	t Stat
Intercept	0.05	3.21
Gini	4.10000E-04	1.06
R^2	0.05	
Adjusted R^2	4.00E-04	
F	1.03	

Group of developing countries

Y=Avg. GDP/cap growth rate	n=48	
	Coeff. Est.	t Stat
Intercept	0.06	4.03
Gini	-1.30000E-04	-0.36
R^2	2.90E-03	
Adjusted R^2	-1.90E-02	
F	0.13	

Since our prior analysis indicated the existence of a positive relationship in high growth countries both industrial and developing countries were partitioned into high and low growth countries. Due to the small number of countries in each group, the results were not very robust and are therefore not presented. However, correlation coefficients indicate that within both industrial and developing countries, there appears to be a negative association between the growth of GDP/cap and the level of the Gini coefficient in high growth countries and a positive relationship in low growth countries.

The correlation coefficients in Table 35 indicate a negative relationship between the growth of GDP/cap and the share of income of the richest and poorest groups and a positive relationship with the middle class group. However, the estimated coefficients were not significant.

Table 35: Correlation coefficients

	n=64 Growth rate GDP/cap
Q1	-0.04
Q2	0.05
Q3	0.05
Q4	0.22
Q5	-0.07
Q5/Q1	-0.09
(Q2+Q3+Q4)/Q1	0.02
(Q2+Q3+Q4)/Q5	0.03

Table 36

Y=Avg GDP/cap growth rate	n=64		n=64		n=64		n=64		n=64	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	0.06	7.52	0.054	4.62	0.05	3.04	0.01	0.18	0.07	4.51
Q1	-0.04	-0.33								
Q2			0.040	0.39						
Q3					0.04	0.41				
Q4							0.24	1.76		
Q5									-0.02	-0.55
R^2	0.0017		2.00E-03		0.002		0.047		0.0048	
Adjusted R^2	-0.014		-0.01		-0.01		0.032		-0.011	
F	0.11		0.15		0.17		3.11		0.3	

Using the ratio of the top quintile's share of income to the bottom quintile's share (Q_5/Q_1) as a RHS variable, there is a negative but insignificant relationship between the ratio and the growth of GDP/cap.

Table 37

Y=Growth rate GDP/cap	n=64		n=64		n=64	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	0.061	11.77	0.057	5.95	0.056	5.93
Q5/Q1	-0.0004	-0.72				
(Q2+Q3+Q4)/Q1			0.0001	0.13		
(Q2+Q3+Q4)/Q5					0.002	0.27
R^2	0.008		0.000		0.001	
Adjusted R^2	-0.008		-0.016		-0.015	
F	0.519		0.017		0.075	

Since partitioning the sample into industrial and developing countries produced some significant results between the growth of GDP/cap and the level of the Gini coefficient, the same analysis was attempted with the quintile income shares. Previously, empirically significant results for the industrial countries indicated a positive relationship between the growth of GDP/cap and the level of inequality. Our regression results in Table 38 suggest a significant negative relationship between growth and the poorest quintile share, Q_1.

Table 38: Industrial countries

Y=GDP/cap growth rate	n=64		n=64		n=64	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	0.07	7.15	0.10	2.63	0.03	1.47
Q1	-0.23	-1.45				
(Q2+Q3+Q4)			-0.07	-1.05		
Q5					0.07	1.29
R^2	0.10		0.05		0.08	
Adjusted R^2	0.05		0.01		0.03	
F	2.11		1.10		1.66	

In developing countries, the growth of GDP/cap was previously found to be negatively correlated with the level of income inequality, although the estimated coefficients were not significant. Table 39 presents the estimated coefficients and although the results are not significant, they hint at a possible positive relationship between the growth of GDP/cap and the share of income of the middle class.

Table 39: Developing countries

Y=GDP/cap growth rate	n=64		n=64		n=64	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	0.06	5.56	0.04	1.34	0.07	3.28
Q1	-0.01	-0.04				
(Q2+Q3+Q4)			0.04	0.77		
Q5					-0.02	-0.56
R^2	3.12E-05		0.01		0.01	
Adjusted R^2	-0.02		-0.01		-0.02	
F	1.28E-03		0.59		0.31	

Partitioning the dataset into low and high growth countries gave us very similar results to those for the industrial and developing countries. High growth countries exhibit a positive correlation between the growth of GDP/cap and the share of income of the richest and the poorest quintile groups, Q_5 and Q_1. The estimated coefficients were however not significant. Low growth countries have the same relationship between the growth of GDP/cap and the quintile income shares as in developing countries. That is, a negative relationship between the growth of GDP/cap and the share of income of the richest and poorest quintile groups, Q_5 and Q_1. But, as before, none of the estimated coefficients were found to be significant (Tables 40 and 41).

Table 40: High growth countries

Y=GDP/cap growth rate	n=64		n=64		n=64	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	0.07	5.26	0.09	2.62	0.07	2.74
Q1	0.06	0.28				
(Q2+Q3+Q4)			-0.03	-0.37		
Q5					0.01	0.23
R^2	3.44E-03		0.01		2.40E-03	
Adjusted R^2	-0.04		-0.04		-0.04	
F	0.08		0.13		0.05	

Table 41: Low growth countries

Y=GDP/cap growth rate	n=64		n=64		n=64	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	0.05	8.86	0.03	2.46	0.05	5.71
Q1	-0.02	-0.22				
(Q2+Q3+Q4)			0.03	1.18		
Q5					-0.02	-0.85
R^2	1.31E-03		0.04		0.02	
Adjusted R^2	-0.02		0.01		-0.01	
F	0.05		1.38		0.72	

Next, the analysis focused on the relation between the growth of GDP/cap and changes in the Gini coefficient. The correlation coefficient between the growth of GDP/cap and changes in the level of the Gini coefficient were found to be negative (-0.04), although the estimated coefficients were not significant.

Correlation coefficients between the growth of GDP/cap and the quintile level GDP/cap of the quintile groups are presented in Table 42. For reasons previously mentioned, the growth of GDP/cap is highly correlated with the level of GDP/cap of the richest quintile and not so highly correlated with the others. Table 43, presents the estimated coefficients although they were found to be not significant.

Table 42

Correlations	
	GDP/cap growth rate
$(GDP/cap)_{Q1}$	-0.03
$(GDP/cap)_{Q2+Q3+q4}$	0.04
$(GDP/cap)_{Q5}$	0.09

Table 43

Y=GDP/cap growth rate	n=64		n=64		n=64	
	Coeff. Est.	t Stat	Coeff. Est.	t Stat	Coeff. Est.	t Stat
Intercept	0.06	15.06	0.06	14.25	0.06	12.43
$(GDP/cap)_{Q1}$	-2.45E-07	-0.20				
$(GDP/cap)_{Q2+Q3+q4}$			5.24E-08	0.31		
$(GDP/cap)_{Q5}$					1.69E-07	0.69
R^2	6.38E-04		1.54E-03		0.01	
Adjusted R^2	-0.02		-0.01		-0.01	
F	0.04		0.09		0.47	

ACROSS REGIONS: Regional correlation coefficients between the growth of GDP/cap, the Gini coefficient and the quintile level GDP/cap are presented in Table 45. For a detailed discussion of this Table see *Chapter 4*, the section on developing country regions.

Table 44

Region / Growth GDP/cap	1 EAP	2 ECA	3 LAC	4 MENA	5 SAR	6 AFR	7 Hi Income
$(GDP/cap)_{Q1}$	0.24	-0.17	0.09	0.08	0.99	0.81	-0.56
$(GDP/cap)_{Q2+Q3+q4}$	0.20	-0.08	0.19	0.02	0.93	0.72	-0.49
$(GDP/cap)_{Q5}$	0.09	-0.10	0.41	0.12	0.83	0.22	-0.42
Q5/Q1	-0.60	0.97	0.27	0.22	0.41	-0.42	0.31
(Q2+Q3+Q4)/Q1	-0.43	0.50	0.14	-0.11	0.29	-0.30	0.35
(Q2+Q3+Q4)/Q5	0.73	-0.93	-0.42	-0.95	-0.44	0.59	-0.28
D&S(G)	-0.66	0.12	0.36	0.01	0.46	-0.34	0.21
n	8	7	14	3	4	7	20

III. TESTING KUZNETS

Chapter 4 presents a detailed discussion of the Kuznets hypothesis. This section presents some additional formulations of the Kuznets curve. Since the estimated relation between the level of the Gini coefficient and a quadratic in the level of GDP/cap proved to be statistically significant (see *chapter 4*), several other formulations of the Kuznets curve were also run. The first used the growth rate of the Gini coefficient against the level and the level squared of GDP/cap. This did not change the results appreciably, although the significance of the variables decreased. However, when the growth rate of the Gini coefficient was run against the log and log squared of GDP/cap, the relationship became U-shaped. The presence of a U-shaped relationship suggests that as the growth rate of the Gini coefficient increases across countries, the log of GDP/cap first falls and then increases. The U-shaped relationship was also prevalent when the log of GDP/cap was used as the left –hand variable, and the level and square of the Gini coefficient as the right hand variables. This formulation was also individually and jointly significant in its variables. But when logged values of the Gini coefficients were used, the formulation was no longer significant although consistent in its U-shaped relationship.

Several other formulations were also tried based for the Kuznets curve analysis:

i) growth rate of GDP/cap = f (log[GDP], log[GDP]^2, Gini)
ii) growth rate of GDP/cap = f (log[GDP], log[GDP]^2, Q_1, Q_4)

The estimated coefficients for these two formulations were not significant, although they improved slightly when income quintiles were used.

Appendix 4

DATASET EXPLANATIONS

The data for this analysis came from two primary sources. These are the Deininger and Squire (D&S) dataset from 1996 and the World Development Indicators (WDI).

The D&S dataset: Information on Gini coefficients and income quintiles are from the "high quality" data within the D&S dataset. 115 countries were found to have some information on Gini coefficients and income quintiles. Information on these two variables ranged from 1 to 45 years for the 115 countries, with the coverage differing from country to country. On average there are 9 observations (or years) per country, with 30 countries showing 9 or more Gini coefficients and income quintiles. For the purposes of analysis, only countries with at least 2 years of coverage for both Gini coefficients and income quintiles were considered. Constraining on this condition reduced the un-partitioned sample to 71 countries. Other constraints were considered for the 115 countries and are presented in the table below.

Table 45: Gini and Quintiles in the D&S dataset

		Countries in Each Region (#)						
	No. of countries	1	2	3	4	5	6	7
D&S High Quality	115	12	19	20	7	5	30	22
2 or more G	76	9	11	16	5	4	10	21
3 or more G	66	9	8	14	4	4	6	21
4 or more G	55	9	6	12	3	4	3	18
2 or more G & Q_i	71	9	11	16	3	4	7	21
3 or more G & Q_i	58	9	8	12	1	4	4	20

NB G is the Gini coefficient & Q_i are the income quintiles.

To ensure the maximum number of countries the sample of 71 countries was used for the analysis. Average Gini coefficients and income quintiles for each country were calculated for cross country comparisons. Gini coefficients for the 71 countries range from 20.49 to 61.23. Summary statistics for the Gini coefficients and income quintiles for the 71 countries are presented in the table below.

Table 46: Summary statistics of Ginis & Income quintiles

	Mean	Median	Standard Deviation	Sample Variance	Minimum	Maximum
D&S Gini	38.46	36.89	9.57	91.62	20.49	61.23
Q_1	0.06	0.06	0.02	0.00	0.03	0.12
Q_2	0.11	0.11	0.02	0.00	0.05	0.15
Q_3	0.16	0.16	0.02	0.00	0.10	0.19
Q_4	0.22	0.22	0.02	0.00	0.17	0.26
Q_5	0.45	0.43	0.08	0.01	0.32	0.65

The 71 countries cover 6 developing country regions and the group of industrial countries. These are presented in the table below.

Table 47: Regional Codes

Region/Group Number	Name	Code
1	East Asia and Pacific	EAP
2	Europe and Central Asia/Eastern Europe	ECA
3	Latin America and the Caribbean	LAC
4	Middle East and North Africa	MENA
5	Sout Asia	SAR
6	Sub-Saharan Africa	AFR
7	Industrial Countries	

<u>The WDI dataset</u>: Data on the level of GDP per capita in the WDI is based on purchasing power parity (PPP). GDP PPP is the gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar in the United States. GDP measures the total output of goods and services for final use occurring within the domestic territory

of a given country, regardless of the allocation to domestic and foreign claims. Gross domestic product at purchaser prices is the sum of gross value added by all resident producers in the economy plus any taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. The residency of an institution is determined on the basis of economic interest in the territory for more than a year. This data are in current international dollars.[60]

The yearly data on the level of GDP/cap has a coverage period of 1975 to 1998 (24 observations). Of the 203 countries in the dataset, 158 countries were found to have some information on GDP/cap, ranging from 7 to 24 observations per country. While the initial analysis is carried out using these 158 countries, a subset of these countries were selected based on the following criterion: *there must be 50% or more coverage per country, or each country must have at least 12 observations*. Applying this criterion produced 144 countries. The annual average growth rate of GDP/cap was calculated for both these groups of countries. The regional codes applied to the subset of 158 and 144 countries are the same as those used for the D&S dataset, and the breakdown of the number of countries per region or group is presented below.

Table 48: Regional Breakdown of the Level of GDP/Cap

	No. of countries*	1	2	3	4	5	6	7
Level of Real GDP/Cap	158	18	21	29	14	7	42	27
	144	16	14	28	12	7	41	26

[60] For more information, see WDI tables 1.1, 4.11, and 4.12.

The Penn World Tables (PWT 5.6a) produced by Summers and Heston also provides information on the level of GDP/cap. The yearly information is available for 152 countries ranging from 1960 to 1992 (33 observations). However, only 148 countries were found to contain some information over this period, and of those only 84 countries had all 33 observations. These 84 countries did not represent our regional breakdowns as well as the WDI data. The regional breakdowns for real per capita GDP from the PWT are presented below.

Table 49: PWT- Regional Breakdown of the Level of GDP/Cap

	Regions/Groups of countries							
	PWT	1	2	3	4	5	6	7
Number of Countries	84	8	0	16	6	4	27	23

The lack of country and regional level information in the PWT dataset led to the use of the WDI data in this analysis.

<u>Summary Statistics of the Data</u>: The tables below present country level data on Gini coefficients, quintile income shares and the level and growth rates of GDP/cap.

Table 50: EAP: Regional Avg. of Gini, Q_i & GDP/cap

Region No	Country	Gini Coefficient	Quintile Income Shares (Percent) Q_1	Q_2	Q_3	Q_4	Q_5	US $ Level of GDP/cap (75-98)	Percent Growth rate of GDP/cap
1	China	32.68	0.08	0.12	0.17	0.26	0.08	1232.94	0.12
1	Hong.Kong	41.58	0.05	0.10	0.15	0.21	0.05	12665.83	0.09
1	Indonesia	33.49	0.08	0.12	0.16	0.22	0.08	1550.74	0.08
1	Korea,.R.	34.19	0.07	0.12	0.16	0.23	0.07	6900.85	0.10
1	Malaysia	50.36	0.04	0.08	0.13	0.20	0.04	4616.02	0.08
1	Philippines	47.62	0.05	0.09	0.12	0.21	0.05	2640.51	0.05
1	Singapore	40.12	0.07	0.11	0.14	0.23	0.07	11732.13	0.10
1	Thailand	45.48	0.05	0.09	0.13	0.21	0.05	3097.38	0.09

Table 51: ECA: Regional Avg. of Gini, Q_i & GDP/cap

Region No	Country	Gini Coefficient	Quintile Income Shares (Percent) Q_1	Q_2	Q_3	Q_4	Q_5	US $ Level of GDP/cap (75-98)	Percent Growth rate of GDP/cap
2	Bulgaria	23.30	0.10	0.15	0.19	0.23	0.10	4545.41	0.03
2	Czech.Rep	27.43	0.10	0.14	0.17	0.22	0.10	11328.06	0.03
2	Hungary	24.65	0.10	0.15	0.18	0.23	0.10	7122.61	0.05
2	Poland	25.69	0.10	0.14	0.18	0.23	0.10	5165.83	0.05
2	Romania	25.83	0.09	0.14	0.18	0.23	0.09	5120.85	0.05
2	Slovak	20.49	0.12	0.15	0.19	0.22	0.12	8033.65	0.04
2	Slovenia	27.07	0.10	0.14	0.17	0.22	0.10	12731.10	0.05

Table 52: LAC: Regional Avg. of Gini, Q_i & GDP/cap

Region No	Country	Gini Coefficient	Quintile Income Shares (Percent) Q_1	Q_2	Q_3	Q_4	Q_5	US $ Level of GDP/cap (75-98)	Percent Growth rate of GDP/cap
3	Brazil	57.28	0.03	0.06	0.10	0.18	0.03	4794.71	0.05
3	Chile	51.84	0.04	0.08	0.12	0.19	0.04	4327.73	0.08
3	Colombia	51.51	0.04	0.08	0.12	0.19	0.04	4300.27	0.06
3	Costa.Rica	46.00	0.04	0.09	0.13	0.22	0.04	4022.38	0.05
3	Dom..Rep..	46.94	0.05	0.09	0.13	0.22	0.05	2796.14	0.06
3	Guatemala	55.68	0.04	0.06	0.12	0.19	0.04	2493.03	0.05
3	Guyana	48.19	0.05	0.10	0.15	0.22	0.05	2225.52	0.04
3	Honduras	54.49	0.03	0.06	0.11	0.19	0.03	1764.91	0.05
3	Jamaica	42.90	0.06	0.10	0.15	0.23	0.06	2590.24	0.03
3	Mexico	53.85	0.04	0.07	0.11	0.18	0.04	5347.79	0.05
3	Panama	52.43	0.03	0.07	0.12	0.21	0.03	3544.39	0.05
3	Peru	47.99	0.06	0.09	0.12	0.20	0.06	3161.99	0.04
3	Trinidad	46.21	0.03	0.08	0.16	0.24	0.03	5412.10	0.05
3	Venezuela	44.42	0.05	0.09	0.15	0.22	0.05	4588.69	0.03

Table 53: MENA: Regional Avg. of Gini, Q_i & GDP/cap

Region No	Country	Gini Coefficient	Quintile Income Shares (Percent) Q_1	Q_2	Q_3	Q_4	Q_5	US $ Level of GDP/cap (75-98)	Percent Growth rate of GDP/cap
4	Jordan	39.19	0.07	0.10	0.14	0.21	0.07	2307.44	0.07
4	Morocco	39.20	0.07	0.11	0.15	0.21	0.07	2242.81	0.06
4	Tunisia	42.51	0.06	0.10	0.15	0.21	0.06	3303.72	0.06

Table 54: SAR: Regional Avg. of Gini, Q_i & GDP/cap

Region No	Country	Gini Coefficient	Quintile Income Shares (Percent) Q_1	Q_2	Q_3	Q_4	Q_5	US $ Level of GDP/cap (75-98)	Percent Growth rate of GDP/cap
5	Bangladesh	34.51	0.08	0.12	0.16	0.22	0.08	811.80	0.06
5	India	32.55	0.08	0.12	0.16	0.22	0.08	1135.67	0.07
5	Pakistan	31.50	0.09	0.13	0.17	0.22	0.09	1058.86	0.07
5	Sri.Lanka	41.71	0.06	0.11	0.15	0.20	0.06	1683.79	0.07

Table 55: AFR: Regional Avg. of Gini, Q_i & GDP/cap

Region No	Country	Gini Coefficient	Quintile Income Shares (Percent) Q_1	Q_2	Q_3	Q_4	Q_5	US $ Level of GDP/cap (75-98)	Percent Growth rate of GDP/cap
6	Cote.d'Ivoire	38.95	0.06	0.11	0.15	0.22	0.06	1284.14	0.03
6	Gabon	61.23	0.03	0.05	0.10	0.17	0.03	5073.42	0.03
6	Ghana	35.13	0.07	0.12	0.16	0.22	0.07	1230.84	0.04
6	Mauritius	40.67	0.07	0.11	0.17	0.23	0.07	4392.38	0.08
6	Nigeria	38.55	0.06	0.10	0.15	0.21	0.06	601.03	0.03
6	Uganda	36.89	0.08	0.11	0.15	0.21	0.08	766.53	0.04
6	Zambia	49.58	0.05	0.09	0.13	0.20	0.05	659.52	0.02

Table 56: Indus Ctries: Regional Avg. of Gini, Q_i & GDP/cap

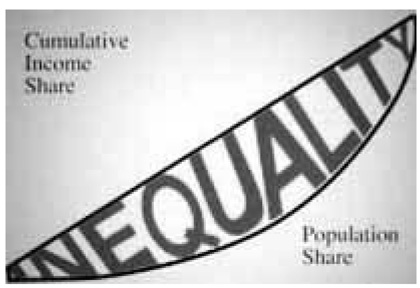
			Quintile Income Shares (Percent)					US $	Percent
Nmber	Country	Gini Coefficient	Q_1	Q_2	Q_3	Q_4	Q_5	Level of GDP/cap (75-98)	Growth rate of GDP/cap
7	Australia	37.88	0.05	0.11	0.17	0.25	0.05	14086.82	0.06
7	Belgium	27.01	0.08	0.14	0.19	0.24	0.08	15010.25	0.06
7	Canada	31.27	0.07	0.13	0.18	0.24	0.07	16036.32	0.06
7	Denmark	32.08	0.06	0.12	0.19	0.25	0.06	15138.51	0.06
7	Finland	29.93	0.07	0.13	0.19	0.25	0.07	13110.67	0.06
7	France	43.11	0.07	0.12	0.17	0.22	0.07	13969.97	0.06
7	Germany	31.22	0.07	0.13	0.18	0.23	0.07	20809.14	0.03
7	Greece	34.53	0.06	0.12	0.17	0.24	0.06	9204.17	0.06
7	Ireland	36.31	0.05	0.11	0.16	0.25	0.05	9805.78	0.09
7	Italy	34.93	0.08	0.13	0.17	0.23	0.08	13585.94	0.06
7	Japan	34.82	0.06	0.12	0.17	0.23	0.06	14962.45	0.07
7	Netherlands	28.59	0.08	0.14	0.18	0.23	0.08	13949.82	0.06
7	New.Zealand	34.36	0.06	0.12	0.18	0.25	0.06	12276.80	0.05
7	Norway	34.21	0.06	0.12	0.17	0.24	0.06	15734.88	0.07
7	Portugal	37.44	0.06	0.11	0.17	0.23	0.06	8620.33	0.07
7	Spain	27.90	0.08	0.14	0.18	0.24	0.08	9984.08	0.06
7	Sweden	31.63	0.07	0.13	0.18	0.25	0.07	14090.05	0.05
7	Turkey	50.36	0.04	0.08	0.12	0.20	0.04	3841.81	0.06
7	UK	25.98	0.09	0.13	0.17	0.23	0.09	12983.89	0.06
7	USA	35.28	0.05	0.12	0.18	0.24	0.05	18710.33	0.06

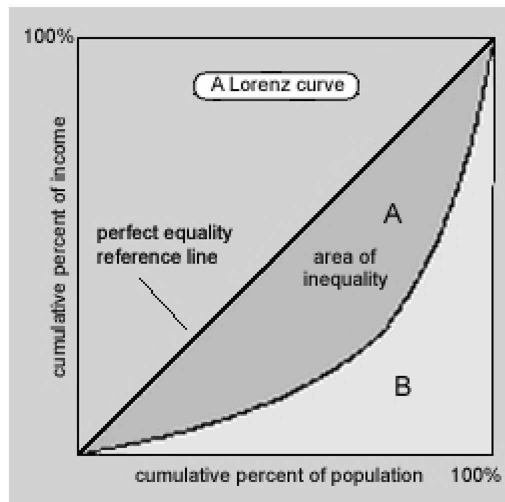
Derivation of the Gini coefficient

In its most simple incarnation, the Gini coefficient can be defined as a summary measure of the deviation in the Lorenz curve. However, Gini coefficients can also be derived from quintile income shares data.

A. DERIVING THE GINI COEFFICIENT FROM THE LORENZ CURVE

Figure 135





Source: World Bank Web Page

<u>Lorenz Curve:</u> Lorenz curves are an effective way of showing inequality of income within and between countries (Figure 13 above). Typically, the population is ranked by income from lowest to highest with the percentage of population plotted along the horizontal axis whilst the corresponding percentage of income is plotted along the vertical axis. Thus, the curve shows the actual relationship between the percentage of income recipients and the percentage of income that they do in fact receive. To construct the Lorenz curve, all individuals or households in a country are first ranked by their income level from the poorest to the richest. Then these individuals or households are divided into n groups and the income of each group is calculated and expressed as a percentage of GDP. Typically,

the groups are either divided into quintiles or deciles. Next, the income share of the poorest quintile is plotted against 20 percent of population, the share of the poorest and the next (fourth) quintile against 40 percent of population, and so on, until the aggregate share of all five quintiles (which equals 100 percent) are plotted against 100 percent of the population. Connecting these points on the chart - starting with the 0 percent share of income received by 0 percent of the population - gives the Lorenz curve for a particular country.

The 45 degree line shows the situation when there is an even distribution of income i.e. 20 percent of the population earns 20 percent of the income and 50 percent of the households earn 50 percent of the income and so on. This is called the line of absolute equality (egalitarian line). By contrast, a perfectly unequal distribution would be one in which one person has all the income and everyone else has none. In that case, the curve would be at $y=0$ for all $x<100$, and $y=100$ when $x=100$. This curve is called the line of perfect inequality.

The closer the Lorenz curve of a country is to the 45-degree line the more equal the distribution of income. The more the Lorenz curve bends away from the 45-degree line of absolute equality, the less equal is the distribution of income. In reality no country exhibits a totally equitable distribution of income. It should be noted that providing incomes cannot be negative, it is impossible for the Lorenz curve to rise above the line of perfect equality, or sink below the line of perfect inequality. The curve must be increasing and concave.

Assume, for example, a dualistic society with a modern industry and a trade sector. Then theoretically, different effects of growth translate into the following movements of the Lorenz curve.

a) *Traditional Sector Enrichment Growth:* All benefits of growth accrue to the trade sector with little or no growth in the modern sector. Growth → higher income → more equal relative distribution of income → reduction in poverty. The Lorenz curve bends closer to the diagonal reducing the area of inequality.

b) *Modern Sector Enrichment Growth:* The economy grows but growth is limited to a fixed number of people. Growth takes place → higher income → less equal distribution of income → NO change in poverty. The Lorenz curve bends away from the diagonal increasing the area of inequality.

c) *Modern Sector Enlargement Growth:* Constant wages in both sectors, but size of modern sector grows. Growth takes place → absolute incomes rises → absolute poverty is reduced. Nothing can be said about inequality, it may worsen or improve.

Gini Coefficient: The Gini coefficient (G) is calculated by using the areas on the Lorenz curve. Given that the 45 degree line reflects absolutely even distribution of income, the coefficient can be calculated as the area between the Lorenz curve and the line of absolute equality, expressed as a percentage of the triangle under the line. That is, the area A between the line of perfect equality and Lorenz curve reflects inequality. The area underneath the Lorenz curve is B, and the Gini coefficient can now be calculated as A/(A+B). Alternatively, the Gini coefficient (G) can be thought of as corresponding to a weighted average of all absolute differences between per capita incomes (expressed relative to economy wide per capita income), where the weights are the corresponding population shares.

$$G = \sum_{i=1}^{n} x_i \left(\sum_{j<i} y_j - \sum_{j>i} y_j \right)$$

Gini coefficients are most commonly expressed as percentages. Thus a Gini coefficient of 0 percent represents perfect equality - the Lorenz curve coincides with the straight line of absolute equality. Alternatively, when per capita incomes are all equal,

$$\text{Min value} = 0 \text{ OR } G=0 \Rightarrow \text{Perfect Equality}$$

A Gini coefficient of 100 percent implies perfect inequality - the Lorenz curve coincides with the x axis and goes straight upward against the last entry (that is, the richest individual or household). That is, if one group, say the first, earns all the income so that $y_1=1$, $y_j=0$ for all $j > 1$, then

$$G = 1 - x_1$$

which approaches 1 when the population share of the first group becomes smaller and smaller and

$$G=1 \Rightarrow \text{Perfect Inequality}$$

Since in reality, neither perfect equality nor perfect inequality is possible, the Gini coefficient is always greater than 0 percent but less than 100 percent. For example, in the sample of countries of 71 countries used for this analysis, Gabon was the country with the highest level of inequality at 61.23 percent while Slovak had the least amount of inequality at 20.49 percent.

Mathematically, if

N = groups of individuals

X_i = population share of the i^{th} group

Y_i = income share of the i^{th} group

Based on an arrangement of n groups according to increasing per capita income values:

$$\frac{y_1}{x_1} \leq \frac{y_2}{x_2} \leq \ldots \leq \frac{y_n}{x_n}$$

For complete equality ($\frac{y_i}{x_i}$ independent of i), the Lorenz curve coincides with the diagonal which cuts the square into two equal parts. The area below the curve consists of n triangles, whose total area is:

$$\frac{1}{2}\sum_{i=1}^{n} x_i y_i \qquad (1)$$

and of $\frac{1}{2}$ n (n – 1) rectangles with the following combined area:

$$\sum_{i=1}^{n} \sum_{j<i} x_i y_i = \frac{1}{2}\sum_{i=1}^{n} x_i \left(\sum_{j<i} y_j + 1 - \sum_{j \geq i} y_j \right) \qquad (2)$$

Adding equations (1) and (2) gives us the total area below the Lorenz curve:

$$\frac{1}{2}\sum_{i=1} x_i \left(1 + y_i + \sum_{j<i} y_j - \sum_{j \geq i} y_j \right) \qquad (3)$$

$$= \frac{1}{2}\sum_{i=1}^{n} x_i (1 + y_i) + \frac{1}{2}\sum_{i=1}^{n} x_i \left(\sum_{j<i} y_j - \sum_{j>i} y_j \right) \qquad (4)$$

The Gini coefficient is defined as twice the area between the diagonal and the Lorenz curve, and since the second expression in equation (4) is the area between the curve and the diagonal, the Gini coefficient becomes:

$$G = 2\left[\frac{1}{2}\sum_{i=1}^{n} x_i\left(\sum_{j<i} y_j - \sum_{j>i} y_j\right)\right]$$

$$G= \sum_{i=1}^{n} x_i\left(\sum_{j<i} y_j - \sum_{j>i} y_j\right) \qquad (5)$$

B. DERIVING THE GINI COEFFICIENT FROM INCOME SHARES

In order to construct a Gini coefficient from the quintile data, the weights first have to be constructed. The following derivation was done for n=5, x_i=0.20 and Q_i for i = 1 to n.

For i = 1:

$$= Q_1\left(\sum_{j<1} y_j - \sum_{j>1} y_j\right)$$

$$= Q_1\ (-x_2 - x_3 - x_4 - x_5)$$

$$= -0.8\ Q_1$$

For i = 2:

$$= Q_2\left(\sum_{j<2} y_j - \sum_{j>2} y_j\right)$$

$$= Q_2\ (x_1 - x_2 - x_3 - x_4 - x_3)$$

$$= -0.4\ Q_2$$

For i = 3:

$$= Q_3\left(\sum_{j<3} y_j - \sum_{j>3} y_j\right)$$

$$= Q_3\ (x_1+x_2-x_4-x_5)$$

$$= 0$$

For i = 4:

$$= Q_4\left(\sum_{j<4} y_j - \sum_{j>4} y_j\right)$$

$$= Q_2\ (x_1+x_2+x_3-x_5)$$

$$= 0.4\ Q_4$$

For i = 5:

$$= Q_5\left(\sum_{j<5} y_j - \sum_{j>5} y_j\right)$$

$$= Q_2\ (x_1+x_2+x_3+x_4+x_5)$$

$$= 0.8\ Q_5$$

Therefore,

$$G^* = 0.8\ Q_5 - 0.8\ Q_1 - 0.4\ Q_2 + 0.4\ Q_4 \qquad (6)$$

But. since

$$Q_1 + Q_2 + Q_3 + Q_4 + Q_5 = 1$$

Then, by substituting for Q_1, we get

$$Q_1 = 1 - Q_2 - Q_3 - Q_4 - Q_5$$

And,

$$G^* = 0.8\ (Q_5 - 1 + Q_2 + Q_3 + Q_4 + Q_5 - 0.5\ Q_2 + 0.5\ Q_4)$$

$$G^* = 0.8\ (-1 + 0.5Q_2 + Q_3 + 1.5Q_4 + 2Q_5) \qquad (7)$$

Since we know each of the Q_is, we can calculate G*, or the supplementary Gini, for each country by using equation (7).

We can also calculate the GDP/cap of each group of the population in the following manner. If (I) represents the GDP/cap of a country and Q_1 represents the proportion of total income that accrues to the bottom 20 percent of the population, then $Q_1 = (I)_1$, or alternatively,

$$(I)_1 = \left(\frac{Q_1}{0.20}\right)(I)$$

Thus for each i = 1…5,

$$(I)_i = \left(\frac{Q_i}{0.20}\right)(I) \qquad (8)$$

Once the GDP/cap of each group is known, this can be used to compute another supplementary Gini or G_1* for each country. We begin with equation (6):

$$G^* = 0.8\ Q_5 - 0.8\ Q_1 - 0.4\ Q_2 + 0.4\ Q_4 \qquad (6)$$

Keeping in mind that.

$$\sum_{i=1}^{5} Qi = 1, \text{ and that } \sum_{i=1}^{5} (I)i = (I)$$

From equation (8), we can write,

$$Q_i = 0.2\left[\frac{(I)_i}{(I)}\right]$$

Then,

$$G_1{*} = -0.8 + (0.32)\left[\frac{(I)_5}{(I)}\right] + (0.24)\left[\frac{(I)_4}{(I)}\right] + (0.16)\left[\frac{(I)_3}{(I)}\right] + (0.08)\left[\frac{(I)_2}{(I)}\right]$$

And,

$$G_1{*} = \left(\frac{1}{(I)}\right)\left(-0.8 + 0.32[I]_5 + 0.24[I]_4 + 0.16[I]_3 + 0.08[I]_2\right) \qquad (9)$$

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