INCOME INEQUALITY AND

ECONOMIC DEVELOPMENT

By

SANDRA ROXANA TREJOS

Master of Science

Oklahoma State University

Stillwater, Oklahoma

1994

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
December, 2000

INCOME INEQUALITY AND

ECONOMIC DEVELOPMENT

Thesis Approved:

Ronald L. Moomaw

Thesis Adviser

Dan Rickman

Alfred Carlozzi

Dean of the Graduate College

To my Godmother (Tía Vera)

ACKNOWLEDGMENTS

I need to thank God for being my source of strength in the process of accomplishing my doctoral degree. Special thanks to my beloved husband, parents and Godmother Vera to whom I dedicate this dissertation. Their encouragement, advice and support have been key during these years. Inspiring have been my three daughters Sofía, Mónica and Eugenia. Their eyes, smiles and future are always a special motivation.

I thank to all committee members, Dr. Michael Applegate, Dr. Dan Rickman, Dr. Orley Amos, and Dr. Wade Brorsen for valuable comments and suggestions. Particular recognition to Dr. Brorsen's Research Methodology class and technical guidance. Last but not least, I would like to thank Dr. Ronald Moomaw for being my mentor in such a supportive way.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Generating economic development has traditionally been one of the major concerns of economists and policy makers. Less-developed countries struggle to increase their standard of living, whereas developed countries work hard to maintain and/or increase their rates of economic growth. What is the price that an economy pays to achieve economic development? Has income inequality been considered when a developed country is classified as "wealthy"? Or is it that this country is rich only in the sense that a certain proportion of the population is "wealthy"? What about a less developed country? Following Meier, "for the less developed countries, 'economic development' involves a process of emerging from poverty" (1989,p. 9).

Previous studies have shown that economic development and income inequality are correlated (Anand and Kanbur 1993; Ahluwalia and Chenery, 1979; Kuznets, 1955; Robinson, 1976, and others[1]). However, the causation aspect of this relationship is controversial. Some authors would argue that greater income inequality is a necessary condition for attaining economic growth, especially at the early stages of development (Kuznets, 1955); on the other hand, some argue that greater income equality enhances

[1] See Bénabou for a thorough review.

productivity and investment, and hence economic growth (Alesina and Perotti, 1993; Kaldor, 1978) .

High levels of poverty could be present as a result of a skewed income distribution even in the richer countries. Less income inequality is vital for a nation to attain acceptable levels of distributive justice. Economic development can be defined as emerging from poverty in a context of redistribution and growth. What is definitely true is that economic growth, specifically "shared" economic growth, is tremendously important for any policymaker who wishes to overcome absolute poverty. The primary research question of this paper is then: ' Are there tradeoffs between increasing the standard of living and reducing income inequality in a sample of developed and developing countries?'

This study determines the relationship between economic development (economic growth and other variables related to economic development) and income inequality for a sample of both developed and developing countries. Previous studies have estimated the relationship between income inequality and economic growth. However, most studies have used ordinary least squares estimation procedures only with balanced data. Moreover, most studies in the past have used cross-section data. This paper uses the PROC MIXED procedure from S.A.S (Statistical Analysis System) to include a random components estimation. This method is a generalization of the standard linear model used in the GLM (General Linear Model) procedure, that allows *unbalanced data* to exhibit correlation and nonconstant variability. That is, it takes into account variability and correlation because it contains both fixed and random-effects parameters. Furthermore, this study considers three different data sets: an overlapping data set and two non overlapping data sets (one constructed as averages over five year periods and the other one constructed as averages over 10 year periods). Finally, the study's income inequality data were extracted from the Deininger-Squire Database (1996), data which are of higher quality and greater coverage than data used in earlier studies. This data set makes possible a panel estimation.

The crucial hypotheses to test in this work are that (a) income inequality in the present period is positively associated with last period's growth of income per capita ($G\dot{D}P_{t-1}$), and that (b) the next period's growth rate of per capita income ($G\dot{D}P_t$) is negatively associated with income inequality, after controlling for some other variables that explain economic development.

CHAPTER II

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Literature Review

Achieving higher levels of economic development is a fundamental goal of economists and policy makers. In this process, less developed regions struggle to increase their standard of living, whereas developed areas work hard to maintain and/or increase their rates of economic growth. However, economic development is a broader concept associated with more than the growth rate of output. In general, economic growth is a necessary but not a sufficient condition for economic development. Two performance measures are fundamental for economic development: income distribution and poverty with poverty being key. In this regard, Meier (1989, p. 9) argues that, "for the less developed countries, 'economic development' involves a process of emerging from poverty."

Economic growth, income inequality, and poverty are closely related components in the process of economic development. In a broad sense, economic development implies that real per capita income increases over a long period of time while reducing the proportion of the population that lives in poverty. In this regard, income distribution plays a key role when measuring the level of economic development across countries. Accordingly, Meier (1989) states: "the quality of development is completely masked if the policy maker does not pierce the aggregate measure of Gross National Product (GNP) and consider its composition and distribution" (p.8). Griffin (1989) argues that "if a development strategy has as one of its objectives the reduction of poverty, it will have to address itself to the question of inequality" (p.14). That is, when studying economic development it is unavoidable to study income inequality and their relationship is what occupies us here. Bladen (1974) points out that his concern for the increase of wealth is based on his concern to see poverty reduced, and ultimately eliminated. Thus, measuring economic development is a difficult process because multiple and complex relationships among economic, political and sociological factors take place.

Previous studies such as Anand and Kanbur (1993b); Persson and Tabellini (1994); Alesina and Rodrik (1994); Bourguinon (1996); Ahluwalia and Chenery (1974); Kuznets (1955); Robinson (1976), and others indicate that economic development and income inequality are associated. However, the relationship between the level of income and income inequality is *controversial*. Kuznets (1955) argues that greater income inequality is a necessary condition for attaining economic growth - especially at the early stages of development. Alesina and Perotti (1993); among others say that greater income equality (less income inequality) enhances productivity and investment, and therefore promotes economic growth. On the other hand, Saint-Paul and Verdier (1993) show that there is no need for a negative relationship between growth and redistribution, if redistribution is in the form of public education. This controversy still continues as presented by Forbes (2000), Deininger and Squire (1998), Li and Zou (1998) and ohers recently. However, recent studies based on the higher quality Deininger & Squire Data set have found support for a direct –positive- relationship between inequality and subsequent economic growth. Forbes (2000) and Li and Zou (1998) challenge previous results by arguing that both more adequate data and methods throw evidence in support of the idea that inequality is not harmful for growth.

Economic Growth Theory

The pioneering work of Solow (1956) has been used as a benchmark to determine the sources of output growth and those factors that determine economic development. Solow (1956) assumes a simple production function with constant returns to scale to all factors. Physical capital is the only reproductible factor and an exogenous technological residual (total factor productivity) explains the remaining output growth. More recently however, there has been an increased interest in the determination of additional sources of economic growth. The main areas of analysis have been concentrated in the inclusion of human capital (Mankiw, Romer, and Weil (1992), among others), the role of international trade and exogenous technological change (Knight, Loayza, Villanueva (1993); Quah and Rauch (1990); Barro (1991); Edwards (1992); among others), and political factors among others. Benhabib and Spiegel (1994), for instance, introduce a model that allows human capital levels to directly affect aggregate factor productivity through two channels: innovation of new technologies suited to domestic production and technological catch up and diffusion. Adelman (1961) mentions among significant sources of external economies the following: the construction of a transportation system and other public utilities, investment in education, and improvements in public health. According to her, "investment in social capital should not be neglected in any overall development plan." (p. 147).

For the purpose of this study factors such as human capital, investment and political stability among others are considered as relevant variables in the development process. Adelman (1961) argues that " both by direct argument and by elimination then, we must assign to the technical and socio-cultural variables the role of prime movers in the *initiation* of economic development" (p. 147).

According to the above, consumption, capital, technology and knowledge - all factors that would increase the long-run aggregate supply - are determinants of a country's economic growth. In this context, Leibenstein (1957) states that development implies the "enhancement of an economy's power to produce goods and services per capita and, that such enhancement is the prerequisite to raising levels of living" (p.11).

A. Population

As far as population growth is concerned, Malthus stated it would retard economic development as measured by per capita income. Mankiw, Romer, and Weil (1992); Knight, Loayza and Villanueva (1993); and Leibenstein (1957) indicate that for a given level of physical capital, increments in the rate of growth of population result in lower labor productivity, because physical capital is spread out more thinly among the growing population. Accordingly, in the Solow model, population growth reduces the rate of growth of output per effective unit of labor, other things given.

The rate of population growth is directly affected not only by changes in fertility rates and birth rates but also by changes in mortality rates. Moreover, the drop in the death rate in the 1940s in the developing countries resulted from improvements in medicine and public health rather than of improvement in nutrition (Alonso 1980, p. 8).

The drop in mortality rates is the result of medical and public health discoveries and income effect due to increases in the economy's level of production (Leibenstein1957). Barro (1991) obtained a strong negative interaction between population growth and investment in human capital as measured by the fraction of relevant age group in the 1970s enrolled in secondary schools.(p.34).

B. Human Capital

Human capital accumulation is expected to promote economic growth through an increased productivity. Higher labor productivity increases the returns to human capital and enhances productivity of other factors (Mankiw, Romer and Weil 1992; Knight, Loayza, and Villanueva 1993; Barro 1991; among others). Tilak (1990) makes a distinction though and indicates that, historically, "in the industrialized countries significant growth of formal education largely followed rather than preceded economic growth, while in the present developing countries economic growth follows education expansion" (pp. 21-22). Tilak (1990) also argues that the greater the country's development the lower the returns of education at all levels given the less relative scarcity of human capital. Barro (1991, 1994) argues that economies that start out with a relatively large ratio of human capital to physical capital tend to grow faster than otherwise because the existence of a large human capital base enhances the process of technology adoption and introduction of new goods. Tilak (1990) found that secondary education had a positive influence on growth in both LDCs and DCs during 1955-1970. Nevertheless, during 1965-1980 that influence had weakened (p.18). Mankiw, Romer and Weil (1992) identify the presence of a positive relationship between secondary enrollment (proxy of human capital accumulation) and the rate of growth of per capita income. This same result can be found in Knight and Loayza and Villanueva (1993). Barro (1991) includes both primary and secondary enrollment and still finds a positive significant association with the growth rate of income. Barro (1994) measures initial human capital using four variables in the regressions: male and female average years of attainment in secondary and higher schools for the adult population at the start of each period, the log of life expectancy at birth at the start of each period, and an interaction between the log of initial GDP and an overall human capital variable[2]. He found that if life expectancy is included in the regressions it seems to proxy for the level of human capital and, then, the level of educational attainment has no additional explanatory power for growth.

C. Political Instability and Freedom

Political instability has important consequences in terms of economic growth and income inequality. According to Kwabena (1996), characteristic of political instability is the uncertainties that it generates about the stability of the political system and/or government which undermines the government's effectiveness (p. 183). According to Kwabena (1996) "drastic and frequent changes in laws governing property rights and profit repatriation, as well as increased uncertainty that accompany political instability make this long term planning impossible" (p. 187). In addition, political stability promotes domestic and foreign investment which results in economic growth (Bénabou (1996); Alesina et al (1996); Barro (1991); among others). Accordingly, Perotti (1994) finds a negative association between political instability and investment. A stable environment is one of the three factors that Cardoso and Helwege (1995) mention as "essential to sustain the basis on which to build a better income distribution" (pp. 68-69).

[2] The overall human capital variable is the sum of the levels of male and female school attainment and the log of life expectancy, where each variable is multiplied by its coefficient in the regression.

What occurs is that a more stable environment may enhance economic growth, and economic growth, in turn, may reduce –on the basis of shared economic growth- income inequality.

According to Alesina et al., (1996) economic growth and political stability may be interrelated. That is, on one hand, the uncertainty of an unstable political environment reduces private investment and economic growth. On the other hand, government collapse and political unrest may result from poor economic performance (p. 190). They point to the problem of endogeneity of political stability and economic growth whereby political instability reduces growth but also low growth may increase political instability (p. 197). Their basic result that political instability is harmful to growth is robust to different model specifications (p. 204-205). Kormendi and Meguire (1985) and Scully (1988) indicate that political freedom has positive effects on the rate of growth of per capita income. Scully (1988) found that societies that bind themselves to the rule of law, to private property, and to market allocation of resources, grow at three times the rate and are two and one-half times as efficient as societies in which these freedoms are circumscribed or prescribed. In contrast, Londregan and Poole (1990) found that growth was unaffected by political instability as measured by coup d'états[3]. In turn, De Haan and Siermann (1996) found little support for the view that political repression affects negatively economic growth trough its influence on capital formation[4]. They measure political repression (political freedom) using a dummy variable based on Gastil's political rights index. The dummy is one if the average Gastil's political rights index for the period

[3] Alesina et al., 1996 indicate that there is no evidence for conditional effect of democracy on output growth after controlling for other factors.
[4] When the investment-income ratio is not included, both the coefficient of political freedom (political repression) and its significance increase, although the coefficient remains insignificant.

1973-86 is three or higher, and it is zero otherwise. They found that political repression reduces economic growth in Latin America and that political repression and economic growth are positively associated in Asia. De Haan and Sierman (1996) found that only in Africa political instability (as measured by total number of government changes) reduces growth, both directly and trough its effect on capital growth. Kwabena (1996) contends that "non elite political instability [NEPI] affects economic growth directly through its impact on the productivities of existing resources and indirectly through a reduction in capital formation" (p. 200). He also found that there is a bi-directional relationship between non elite political instability and economic growth. Furthermore, he found that NEPI is the indirect mechanism through which political instability affects economic growth. De Haan and Siermann (1996) explain that political instability discourages investment due to increased risk of capital loss, and that political turmoil causes capital flight and brain drain which hampers economic growth. (p. 340). Bénabou (1996) mentions the case of Korea in which the general security of property rights was probably instrumental not only in creating a favorable climate for business investment but also in inducing Korean households to entrust much of their savings to a state-controlled banking system which channeled credit towards the industrial sector. (p.62). Furthermore, as he states it, a high probability of government change creates uncertainty about future policies so that risk-averse economic agents wait to take productive economic incentives or invest abroad (p. 191).

D. Democracy

Alesina and Rodrik (1994) argue that growth may be "particularly sensitive in a democracy to the income shares of the middle class and of the richest quintile." They explain this based on the idea that these groups are more active politically than the poorest individuals. (p. 38). Furthermore, democracies with more concentrated wealth are more likely to have lower rates of economic growth given that more people would be willing to "tax" physical and human capital since they are being deprived of the expanding assets. (Alesina and Rodrik 1994 pp. 23, 32). They argue that the highest growth is achieved in technocratic or right-wing regimes whereas the lowest growth may take place in "kleptocratic" dictatorships. (pp. 32-33). According to Alesina and Rodrik (1994) democracies with an uneven distribution of wealth should exhibit lower growth than democracies with more equally distributed resources. Democracies tend to be important in terms of economic growth because a prosperous middle class in which more people have access to the production assets would reduce the desire to tax them, which in turn would enhance economic growth (p. 466). Barro (1994) indicates that democracy enhances growth at low levels of political freedom but depresses growth when a moderate level of political freedom has already been attained (p.25). Empirical evidence according to Barro (1994) indicates that a one-standard-deviation increase in democracy reduces growth by 0.002 per year (p. 117). Alesina et al., (1996) indicate that a change from zero (no government change) to 1 (government change) implies a reduction in growth of about 1.3 to 1.4 percent a year.[5] However, after controlling for government changes, democracy is not a statistically significant determinant of growth. Saint Paul and Verdier (1993) argue that "democratization and extensions of political rights will produce more redistribution, larger spending on public education and a boost on growth and equalization of income" (p.405).

[5] This result is robust to changes in model specification.

E. Natural Resource Endowments

Sachs and Warner (1995a) document a statistically significant, inverse, and robust association between natural resource intensity and subsequent growth. They control for initial GDP, trade policy, investment rates, terms of trade volatility, inequality, and the effectiveness of the bureaucracy. Their results remain unchanged when including regional dummy variables and introducing alternative measures of natural resource abundance.

F. Physical Capital

The literature has argued in favor of both public and private capital. Alesina and Rodrik (1994) distinguish public physical capital as one of three important determinants of growth. They argue that "public capital stock has positive and statistically significant effects on per capita personal income"[6] (p.339). With respect to the investment ratio, the literature has consistently found that it has a significant and positive effect on economic growth with Kormendi and Meguire (1985) finding major effects.

G. Economic Convergence

Another relevant area in the economic growth and economic development literature refers to the empirics of conditional and unconditional convergence of per capita income. According to the neoclassical growth model, convergence is determined by the negative effect of the initial level of per capita income on output growth. This is, the lower the initial level of per capita income the faster an economy grows, other things held constant. (Barro 1994; Mankiw, Romer and Weil 1992 ; Knight, Loayza and Villanueva 1993; Quach and Rauch 1990; among others)[7]. It means that countries that

---

[6] "The effects come through two channels. The first is through the actual construction of the public capital stock. The second effect comes through public capital stock as an unpaid factor in the production process and a consumption good of households" (Duffy-Deno and Eberts, p. 340).

[7] Barro found that a country's growth rate is more sensitive (inversely) to its starting level of per capita output the greater is its initial stock of human capital (p.5).

start with higher level of per capita income tend to have a lower rate of growth of per capita income because of the presence of diminishing returns to investment.[8] Sachs and Warner (1995b) present evidence that a *sufficient* condition for higher than average growth of poorer countries and therefore convergence, is that poorer countries follow reasonable political and economic policies, "such as civil peace, basic adherence to political and civil rights, and an open economy (absence of trade quotas, export monopolies or inconvertible currencies)" (p.23).

In the framework of endogenous growth models there should be no convergence of any sort, even in the case where countries have the same savings rate. Therefore, discrepancy on per capita income can persist indefinitely. On the other hand, most empirical evidence for the convergence hypothesis indicates no support for unconditional convergence. However, the evidence indicates that there is conditional convergence once other factors have been controlled for[9]. Convergence is therefore conditioned by the existing levels of technology diffusion and values of other relevant variables.

Barro (1994) argues that the speed of conditional convergence is directly affected by the predominant economic structure of each country. For instance, a low income country that does not promote the respect for property rights (or any other policy that promotes investment) need not to grow faster than a country which start off with a higher initial level of per capita income (Barro 1994)[10]. This argument is also valid in terms of technology adoption from abroad, which in turn affects the speed of conditional

---

[8] This statement may even hold true in the case of endogenous changes in other variables, because diminishing returns to investment will eventually dominate.

[9] The correspondent speed of convergence can be calculated directly from $\frac{\partial \ln(y_t)}{\partial t} = \lambda[\ln(y^*) - \ln(y_t)]$ where λ is the speed of convergence. For a complete description see Mankiw, Romer, and Weil (1992).

[10] Barro (1991) includes the square of the starting per capita product to test if the force toward convergence attenuates as per capita GDP rises.

convergence. Saint-Paul and Verdier find that "during the convergence process, income distribution becomes more equal, tax rates decline as well as the growth rate". They explain this based on the idea that as the distribution of human capital gets more even through public education, the median voter gets relatively richer, so that his children will benefit less from public education relative to inherited human capital, which makes the level of public education implied by the political equilibrium decline."(p.400) However, Grier and Tullock (1989) found that economic convergence is not a ubiquitous phenomenon[11].

Income Inequality

The Income Inequality-Development relationship has been widely discussed in the economic literature. The classic article by Simon Kuznets on "Economic Growth and Income Inequality" (1955) is the starting point for the debate on economic growth and income inequality. Kuznets (1955) argued that income inequality worsens at the early phases of economic development and it improves in its late stages. This argument is known as the Inverted-U-Hypothesis.

The increasing portion of the Kuznets curve is generally explained based on Lewis' dual sector model, which describes the process by which labor surplus is transferred from the traditional (agricultural or rural) to the nontraditional sector (industrial or urban). Given that profits in the nontraditional sector are saved and reinvested, the structural transformation from the traditional to the nontraditional sector

[11] They estimated separate growth equations for Africa, the Americas, and Asia and found lack of convergence effects on growth. Positive and significant coefficients for Africa and Asia for the starting level of income are consistent, according to them, with the proposition that there are increasing returns to technology at low initial conditions where the relatively rich countries get even relatively richer.

enhances growth in the early stages of development.[12] According to Yung-Peng Chu , Kuznets explains the rising portion of his curve based on the emergence of a high-productivity sector from the traditional (agricultural) sector, whose income had been equally distributed. He argues that the adoption of more egalitarian taxation and welfare policies by the state, explains the downward sloping portion of the curve. Furthermore, Kuznets (1963) stated that the "long swing" in income inequality must be viewed as part of a wider process of economic growth, interrelated with similar movements in other elements.

A. Income Inequality and Economic Development

In relation to the production function in the theory of economic development, Adelman (1961) defines output (Y_t) as follows:

$$Y_t = f(K_t, N_t, L_t, S_t, U_t)$$

where K_t is capital stock employed at time t; N_t is the rate of use of natural resources, L_t is the employment of the labor force; S_t is the society's fund of applied knowledge to deal with factor productivity variations stemming from technological innovations and from changes in the skills of the labor force; and, U_t is the socio-cultural milieu within which the economy operates: impact of social, cultural and institutional changes upon the productivity of the economy (p.9). Among these variables income distribution has proved to have an important place in the literature.

Previous studies recognized that distributive aspects of the process of economic development are relevant. Alesina and Perotti (1993) review the literature on the political

---

[12] However, Seers finds that the need for savings to justify inequality is not a convincing argument in the Third World, based on the fact that saving propensities are very low in countries with unequal distribution. Moreover, in countries with high unequal distribution saving could flow abroad and not to have an impact in the development of the country (Seers).

economy of growth, focusing on the research that has developed at the intersection of the endogenous growth literature and the new political economy. According to Griffin (1989), the relevant question is not whether inequality has increased but whether it is inevitable. Griffin (1989) argues that "the balance of evidence suggests that the degree of inequality is not closely related to the level of income per head, as was once thought, but to factors dependent upon the strategy of development that is followed." (p.16). This statement highlights the controversy on what development path to choose since different development strategies may have different impacts on national levels of production, and, hence on per capita income levels. Thus, if, as Griffin (1989) states, the degree of inequality depends on the strategy of development that is followed, the degree of inequality will also be, at the end, associated with the resultant levels of income from such strategy, and, hence, income per capita.

Following Dasgupta (1985), economic growth and distribution are interdependent. That is, the distribution of wealth is affected by the stage of development and the pattern of distribution affects the possibilities of growth (p. 20). In this respect Li and Zou (1998) argue that income inequality and economic growth, in general, relate to each other ambiguously. They find a positive relationship between income inequality and economic growth, "sometimes". Perotti (1993), Lewis (1954), Kaldor (1957) found a positive association between income inequality and economic growth. Sarel (1997) finds higher growth rate to be associated with an improvement in income distribution, along with other variables such as higher investment rate, real depreciation, and improvement in terms of trade.

Barro (2000) finds that "higher inequality tends to retard growth in poor countries and encourage growth in richer places". Galor (2000) presents a unified model that encompasses the transition between distinct regimes that have characterized the relationship between income inequality and the process of development. He differentiates between the classical approach, in which there is a positive effect of inequality on economic development in early stages of industrialization, and the credit market imperfection approach, where in later stages of development there is a positive effect of equality on economic growth. In turn, Wallich argues that economies must tolerate some degree of inequality if faster progress is desired.

Further evidence by Alesina and Rodrik (1994) found that an increase in the income share of the middle class at the expense of the richest quintile of the population enhances growth. However, Alesina and Rodrik (1994) state that an increase in the income share of the poorest quintile at the expense of the middle class 'may not have positive effects on growth" (1991, p. 26). They state that "policies that maximize growth are optimal only for a government that cares solely about pure 'capitalists'" (1994, p.465). They explain the negative association between economic growth and income inequality through the effect of greater inequality on the rate of taxation. That is, the greater the inequality of wealth and income, the higher the rate of taxation (as more redistribution is sought by a majority of the population), and the lower the growth given the introduction of distortions from the redistributive policies. Their empirical results show that inequality in land and income ownership is negatively correlated with subsequent economic growth. In turn, Alesina and Perotti (1993) claim that fiscal redistribution may actually spur economic growth since "the net effect of redistributive policies on growth has to weigh the costs of distortionary taxation against the benefits of reduced social tensions" (p.1226). Their argument is that income inequality increases uncertainty in the politico-economic environment which reduces investment. Thus, Alesina and Perotti (1993) argue that through the negative effect of income inequality on investment, income inequality and economic growth are inversely related. On the other hand, Lee and Romer (1999) argue -contrarily to Alesina and Rodrick (1994), and Person and Tabellini (1994)- that increasing inequality can induce less public spending which may increase investment and economic growth. Clarke (1995) finds robust statistical evidence to indicate that i) inequality is negatively, and robustly, correlated with growth; ii) although statistically significant, the size of the relationship between inequality and growth is fairly small; and iii) the correlation between inequality and growth holds for both democracies and non-democracies. Following Forbes (2000) previous studies that estimated a significant negative effect of inequality on growth are not robust and have two potential econometric problems: measurement error in inequality and omitted variable bias.[13]

Budd (1967) argues for a broad range of factors around the relationship between growth and income distribution. Some of these elements are population growth and migration, the availability of land and natural resources, the possibilities of labor absorption and productivity growth in different economic sectors (i.e., agriculture versus industry), and the factors affecting asset accumulation and control." (pp. 245-46).

Based on theories of endogenous economic growth and endogenous economic policy, Persson and Tabellini (1994) found that inequality is harmful for growth because

[13] What happens is that measurement error could lead to either positive or negative bias, depending on the correlation between the measurement error and the other variables in the regression.

it leads to policies that do not protect property rights and do not allow full private appropriation of returns from investment. Likewise, Alesina and Rodrik (1994) indicate the presence of a negative relationship between income distribution and economic growth. Finally, Bourguinon argues that there is a possible negative effect of initial unequal distribution of factors on the rate of growth of output. However, he stresses that these effects of income distribution on growth are relevant only when the economies are off their steady-states path. Bénabou (1996) indicates that Perotti (1996) finds statistical support to conclude that a greater share of the middle class has a positive effect on growth through a reduction on fertility. In this same regard, Bénabou (1996) based on Murphy, Schleifer and Vishny argues that an excessive concentration of wealth may represent an obstacle to growth: "for industrialization to take place, benefits from such a boom (boom in the leading sector, i.e., agriculture or exports) must be equally enough distributed to create large markets for domestic manufactures." (p.560).

Cross-section and time series studies have been performed for developed and developing countries to test for the Inverted-U Hypothesis. For instance, Kuznets (1963), Morgan (1953), and Kravis (1960) indicated that the size distribution of family income is more unequal for underdeveloped than for developed countries. Cross-country comparisons have been undertaken by Adelman and Morris (1971 and 1973), Loehr (1980) and Anand and Kanbur (1993a). Ahluwalia's (1976) study found support for the Inverted-U-Hypothesis. Ahluwalia indicates that income inequality depends on other variables besides per capita income such as intersectoral shifts in the structure of production, expansion in educational attainment and skill level of labor force and reduction in the rate of growth of population. On the contrary, Anand and Kanbur's

(1993b) estimates of the inequality-development relationship display, a reversal of the commonly accepted U-hypothesis. With respect to longitudinal data, the advantages of time-series studies are that results can be interpreted in the country's particular historical background, and, they allow an evaluation of the evolution of the income distribution. Ahluwalia (1974) uses a compilation of a set of time series data by Iain and Tieman and finds "no evidence for income distribution deterioration over time." Papanek and Kyn (1986) based on a sample of 83 countries concludes that 'inequality increases as per capita income rises to about $400 (turning point) and declines, with further income increase, but the empirical support is not strong and may be weakening over time". Thus, empirical evidence for the Kuznets hypothesis has not arrived at a firm conclusion. The debate has motivated research on enriching the measures and the estimation results. Fields (1987), for example, analyses how to measure changes in inequality in an economy with income growth distinguishing three kinds of economic growth; Anand and Kanbur (1993a) present a formalization of the Kuznets process, conduct a general analysis of distributional change under this process, and derive the functional forms of, and conditions for a turning point for six indices of inequality.

B. Determinants of Income Inequality

B1. *Education*

Tilak (1990) emphasizes the importance of education for income equality. In particular, he hypotheses a negative relationship between schooling and income inequality. Tilak (1990) finds that as levels of schooling of the labor force rise, the income shares of both the bottom 40 percent population and middle 40 percent population rise. Moreover, he finds that "as the labor force gets more and more educated, income gets redistributed from the top income quintile to the bottom 80 percent population" (p. 77). Knight and Sabot (1987) conclude that "post primary educational expansion, as in Kenya, is an effective means of compressing wages", i.e., has an equalizing effect (p. 201). However, Meade (1967) recognizes two ways in which an increase in higher education can be less equalizing based "in their effects upon ability to earn and to accumulate property" (p. 119). Accordingly, Tilak (1990) states that "the *increase in variance* in education of the labor force is found to be responsible for increase in income inequality."(p. 39). Lam and Levison (1992) found, for instance, that the reduction in schooling inequality represents a fundamental improvement in the determinants of earnings inequality in Brazil. Higher levels of education increase the probability of higher paid jobs and better employment opportunities which in turn tend to less unequal income distribution patterns (Bardhan 1996).

B2. *Female Labor Force and Population*

The role of women is another factor to consider in the context of economic development. As Alonso (1980) indicates, "the changing composition of households, both as to the number of working number and the number of dependents is largely the effect of the changing economic role of women" (p. 14). Cué (1985) argues that female labor force is important because a larger female labor force may mean higher household income in intact families, more families headed by females who are generally at the bottom of the income scale. In addition, female labor force participation may be confined to certain occupations with traditionally lower wages.

When explaining the relationship between female labor force and income inequality, female headship is relevant since it is believed to have a direct effect on female labor force. Buvinic and Gupta (1997) and Bardhan (1996) state that a positive association between female headship and poverty exists. Three major reasons support this relationship: i) female-headed households tend to have a higher ratio of nonworkers than do other households, ii) the main earners of female headed families are by definition women, who usually earn less than men and have less access to remunerative jobs and productive resources, and iii) women who head households also fulfill work at home roles face discrimination in access to jobs and may have a history of premature parenthood and family instability.

With respect to population, Alhuwalia (1976b) argues that high growth rates of population are likely to generate greater inequality by perpetuating the phenomenon of "surplus labor in the sense that a large proportion of the work force remains locked into low income employment in the traditional or informed sectors of the economy.

B3. *Sectoral Income Ratio*

The ratio of non-agricultural to agricultural income per person has been recognized as important in determining income inequality given that per capita productivity in the urban sector increases relatively faster than that in the agricultural sector (Kuznets). Kuznets (1955) and Alhuwalia (1974) have argued that intersectoral shifts toward the non-agricultural sector allowing more people from the traditional sector to participate in the higher productivity sector would have an offsetting impact on the widening of income inequality.

B4. *Resource Endowments*

Adelman and Morris (1973) argue that "development strategies that stress the growth of more diversified manufacturing exports also tend to have favorable distributional effects" (p. 195). That is, a higher proportion of agricultural exports can be expected to have negative effects on income inequality. Accordingly, Bourguignon and Morrison (1990) show that endowments in mineral resources and land concentration in agricultural exports may determine differences in income inequality across developing countries.

According to Rauch (1993), Kuznets believed that incomes are more equally distributed in the agricultural sector than in the urban sector. Alhuwalia (1974) contends that "... a viable strategy for raising incomes of the lowest 40 percent of the population must necessarily focus on the agricultural sector... The impact of government policies on the target population will also depend upon the distributional incidence of these policies within the agricultural sector." (pp. 19-21). Alhuwalia (1976b) has tried to capture the effect of changes in the structure of production in favor of the modern sector by using two explanatory variables, the share of agriculture on total GDP and the share of urban population in the total population. He found that the share of agriculture in GDP was not significantly related to the income shares of the lowest income groups, but positively related to the income shares of the middle groups and negatively related to the income shares of the top 20 percent. The share of the urban population in the total had no effect on the income share of the middle group, a positive effect on the lowest groups and a negative effect on the top 20 percent.

B5. *Government*

Government programs and macroeconomic policies are important factors to take into consideration as far as income inequality, economic development and poverty are concerned. (Cardoso and Helwege 1995, p. 67). As Morley (1995) states it, " there is a clear link between macroeconomic conditions and inequality", and "government wage policy (for instance) has to depend on conditions in the economy." Among the factors that Cardoso and Helwege (1995) believe are part of a "successful strategy for growth with equity" are: overall fiscal balance; the avoidance of unrealistic wage increases; concentration of antipoverty action on government spending on low-end social services, especially in rural areas; an open-trade model for efficiency and greater labor intensity; and firm anti-inflation programs, because inflation is the biggest enemy of the poor." (p. 74).

One factor that has been related to less inequality in the distribution of income is the level of public transfers. It seems that they are negatively related (Hedstrom and Ringen p. 96). Furthermore, according to Slesnick (1996), in kind transfers of food, capital services (which includes housing) and consumer services, are an effective means of providing support to the poor even at high levels of subsidization (p. 1527). However, following Alesina and Rodrik (1994), direct redistribution is "harmful to growth as it reduces the provision of productive public services." (p. 27). In this context, Altimir (1982) argues that instead of current transfers of income, investment is required to raise low income permanently. This investment plan would require investments in infrastructure, training, additional financing, bureaucratic machinery and administering new redistribution. (p. 92).

This chapter has reviewed the state of the literature on the controversial relationship between income inequality and economic growth. It also has revised variables that, theoretically, may explain both economic growth and income inequality. Next chapter proceeds to present data, methods and procedures used in this work to study the relationship of interest, and both the economic and statisitcal significance of the aforementioned variables, according to data availability.

CHAPTER III

METHODS AND PROCEDURES

This chapter describes the data sets, methods and procedures used in the present study. It is organized as follows: first, a description of the data; second, methods used for the inequality and the growth equations, and, third, additional comments.

Data

Variables

This section describes the data first considered for estimation of the model. Data on income inequality are from the Deininger and Squire data set to reduce measurement error in equality. The three main reasons for this choice are: (a) it contains a substantially larger number of high-quality observations than any other data set (Jain's 1975, Paukert's 1973 and Fields' 1989) that have been used in the existing literature on inequality and growth, (b) it has a much greater coverage of economies-three times as many as the next largest data set, and (c) it provides a more reliable basis for time-series analysis: compared with an average of about two high-quality observations for each country in Fields and Jain, this data set contains an average of more than six high-quality observations for each country (Deininger and Squire 1996, pp. 572-573). These data on income inequality are based on actual observation of individual units drawn from household surveys (either the household or the individual). They are based on a nationally representative sample covering all of the population so that estimates are not biased. Moreover, measures of income inequality are based on comprehensive coverage of different income sources (wage and non-wage income such as assets, savings and pensions) as well as of population groups (urban, rural, household and personal income)[14]. The information on the Gini coefficients and quintiles are either income-based (Gini calculated based on income) or expenditure-based (Gini calculated based on expenditure). Deininger and Squire (1996) report a mean difference between income based and expenditure based Gini coefficients equal to 6.6 in a scale from 1 to 100. To standardize all income inequality data and to avoid excluding countries for which Gini coefficients are based on expenditures, Deininger and Squire (1996) suggest adding the difference of 6.6 to the expenditure-based Gini coefficients. Thus, the expenditure-based Gini coefficients are transformed to have the same mean as income based coefficients.

Data on schooling were extracted from the Nehru and Dhareshwar Data Set (1993) on Physical Capital Stock that provides yearly data[15] on human capital stock. Human capital accumulation will be approximated by total mean years of education (*SCHOOL)*.[16] Education is expected to reduce inequality by allowing more people to join professional and entrepreneurial ranks and become part of higher income levels of the population. (Kuznets, 1955) and by increasing marginal productivity.

Capital per units of labor (*KPUL*) is calculated from the Nehru and Dhareshwar (1995) data set as follows:

---

[14] Deininger and Squire found no reason to expect a large systematic bias in empirical work as a result of using both household-based and individual-based Gini coefficients.
[15] These data were compiled by Vkram Nehru and Ashok Dhareshwa in their paper "New Database on Physical Capital Stock: Sources, Methodology and Results".
[16] This variable is preferred to an enrollment variable based on the idea that endogeniety is reduced if stock variables are used en lieu of flow variables.

$$KPUL = \frac{K}{Q} \cdot \frac{Q}{L},$$

where K is total physical capital, Q is GDP at market prices, and Q/L is output per worker in PPP$ (from the Summers and Heston data base). This variable will approximate physical capital accumulation.

Data on Urbanization (*UPOP*), Female Labor Force (*FEMN*) and Primary Exports (*PRIMXY*) are from the World Bank Stars Database on Social Indicators (1995). Urbanization refers to the percentage of urban population to total population and female labor force is a percentage of the total labor force. Primary exports is the share of Non-fuels and Fuels Exports to Total GDP. They are used to test for a possible association between resource abundance and income inequality based on Sachs and Warner (1995a) statement. These authors suggest possible welfare implications of resource abundance that can be different from the growth implications[17].

Total Domestic Investment as a percentage of GDP (*INVEST*) and the real per capita GDP based on the Laspeyres index (*RGDPL*) were extracted from the Penn World Tables by Summers and Heston, version 5.6. *INVEST* is expected to have a positive effect on the growth rate of per capita income in the subsequent period.

Measures of freedom were taken from various Freedom in the World Yearbooks. The relevant variable is freedom status (*FREEDOM*), which is a simple average of political rights and civil liberties. *FREEDOM* is expected to have a positive sign for the Growth Equation. Political stability data on major government changes MJCHAN are available from the Alesina, Özler, Roubini and Swagel data set (1996). This variable

[17] Sachs and Warner specifically argue the following: "[r]esource abundance may be good for consumption even if not good for growth.; policies might be good for GDP growth, while reducing real consumption" (p.23).

includes all irregular transfers of power such as coups, along with the subset of regular transfers that imply a substantial change in the party or coalition or parties in office.

YINDYAGR is the ratio of the per capita income in industry to the per capita income in agriculture to account for sectoral differences in income due to productivity differentials (Kuznets, 1955, p.8). As Cué (1985) points out, urban areas have greater employment opportunities, and the income of rural residents is more irregular than that of urban residents due to seasonality of agriculture employment. *YINDYAGR* is proxied by value added per worker in industry relative to value added per worker in agriculture. Value added and the percentage of the labor force in industry and agriculture are from the World Bank Social Indicators of Development.

This study constructs three data sets. First, a suggested overlapping data set (overlapping data) to allow one or more observations per decade and overlapping 10 year growth rates of per capita income. The second data set (nonoverlapping data for ten year averages) is divided into 10 year period groups as follows: 1960-69, 1970-79, 1980-89, so that nonoverlapping growth rates on per capita income are calculated. The third data set (nonoverlapping data for five year averages) is divided into 6 year period groups as follows: 1960-64, 1965-1969, 1970-74, 1975-1979, 1980-1984, 1985-1990. The study estimates the model under the three data sets for comparative purposes.

Data Sets

Overlapping Data

The overlapping data are used to maximize the use of all available and relevant information in the determination of the factors affecting economic growth. That is, instead of having one observation per decade there will be one or more observations per decade, which will make the estimation procedure more efficient. Thus, a 10 year growth rate could be calculated not only from the first year to the tenth year, but also as consecutive 10 year period changes. For instance, a ten year growth could be calculated from 1950 to 1959, the next one from 1951 to 1960 and so on. These two periods just mentioned would have a 9 year overlapping level.

Because observations on income inequality are missing, the income inequality data are unbalanced. All other variables are matched to the available income inequality data. For instance, the lagged growth rate of per capita GDP ($G\dot{D}P_{t-1}$) is the log difference of the real per capita GDP in year *t* minus the logarithm of real per capita GDP in year (*t*-1) (measured as 1985 PPP-Laspeyres Method from Summers and Heston) divided by 9, i.e., by the number of annual growth periods[18] as follows:

$$G\dot{D}P_{t-1} = \frac{\ln RGDPL_t - \ln RGDPL_{t-1}}{9}$$

Thus, the 10-year period change for $G\dot{D}P_{t-1}$ is calculated for the 10 years that precede the different years for which income inequality data are available. The next period's growth of per capita GDP ($G\dot{D}P_t$) corresponds to the 10-year change for the period t for which income inequality data are available. If last period's GDP growth ($G\dot{D}P_{t-1}$) is from 1960 to 1969, this period's growth ($G\dot{D}P_t$) would be from 1970 to 1979. Calculating growth rates of real per capita income in this fashion gives the overlap. For instance, for Australia 1976, $G\dot{D}P_{t-1}$ is the log of GDP in 1975 minus the log of GDP in 1966, divided by 9; $G\dot{D}P_t$ is the log of GDP in 1985 minus the log of GDP in 1976, divided by 9. This division by 9 is a linear transformation and, therefore, has no effect other than to re-scale the coefficients. If the next observation available for income inequality for Australia is, for instance, the year 1978, the corresponding $G\dot{D}P_{t-1}$ and $G\dot{D}P_t$ for this year overlap with the 1976 growth rates. That is, an overlapping level of 8 years either backwards or forwards exists. The "backward overlapping" would be for 1968, 1969, 1970, 1971, 1972, 1973, 1974 and 1975. Accordingly, the "forward overlapping" would be for 1978, 1979, 1980, 1981, 1982, 1983, 1984, and 1985. In sumation notation this would be:

$$\ln GDP_t - \ln GDP_{t-9} = \sum_{i=0}^{8} \left(\ln GDP_{t-i} - \ln GDP_{t-i-1} \right).$$

The overlapping of observations creates a moving average error term problem and the OLS parameter estimates would be inefficient and hypothesis tests would be biased. Thus, this has to be corrected for. See the Annex for Harri and Brorsen (1997) proposed correction. However, this correction applies only when the explanatory variables in the regression are all averages of the year periods(!). The growth equation that occupies this study is testing for economic convergence and that requires to include in the growth equation the initial level of income which is not an average.

Non Overlapping Data

There are two non overlapping data sets used in this study. First, a non overlapping data set constructed over ten year periods. Second, a non overlapping data set constructed over five year periods. These averaging data sets seek to reduce serial correlation from business cycles.[19] Both five and ten year average data sets are considered based on the belief that the length of the period under study makes a difference when estimating the relationship between inequality and growth.

---

[18] This approach follows Barro's methodology when calculating growth rates of per capita income.
[19] Given that yearly growth rates may imply short run disturbances.

Non Overlapping Five Year Average Data Set

This data set is a non-overlapping data set for which $G\dot{D}P_{t-1}$ and $G\dot{D}P_t$ are calculated for the periods 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1985, 1986-1990. Thus, the growth rates of GDP do not overlap. The remaining variables in this data set are the same as in the non overlapping data set; however, they are the value corresponding to the average of the five year period. Since this data set has more periods, it will have more degrees of freedom than the non overlapping data set with ten year periods.

Table 1. Summary Statistics (Five Year Periods)

Variable	N	Mean	Std Dev	Minimum	Maximum
AGLAND	164	38.84	22.33	2.65	82.99
FREEDOM	142	1.53	0.64	1.00	3.00
MJCHAN	142	0.12	0.16	0.00	0.67
INVEST	182	2.89	0.52	1.06	3.68
LNRGDPL	182	8.26	0.93	5.98	9.76
RGDPLAVG	182	5569.86	4317.25	397.60	17284.60
INVRGDPL	182	0.00	0.00	0.00	0.00
GRRGDPL	182	0.03	0.03	-0.07	0.12
INIRGDPL	182	8.21	0.92	5.91	9.72
RGDPLAST	180	0.03	0.03	-0.07	0.12
SEC	182	1.02	0.80	0.02	3.60
TERC	182	0.22	0.22	0.00	1.51
SCHOOL	182	6.14	2.85	0.74	15.01
FEMN	166	30.10	10.36	5.13	50.73
UPOP	166	55.71	24.32	4.90	100.00
LIFEEXP	166	66.47	8.81	43.63	78.21
GINIADJ	182	40.71	8.46	23.38	60.18
IN2040	153	3.04	1.56	1.47	8.76
YINDYAG	154	3.93	4.33	0.46	45.51
KPUL	182	36439.27	28948.26	1277.34	117188.30
PRIMXY	163	0.11	0.11	0.00	0.65
LPRIMXY	163	-2.63	1.00	-5.96	-0.43
AVGLPOP	182	-1.77	0.34	-2.93	-1.36
LINVEST	182	1.04	0.22	0.05	1.30
LSCHOOL	182	1.68	0.56	-0.30	2.71
LSEC	182	-0.34	0.95	-3.96	1.28
LKPUL	182	10.06	1.07	7.15	11.67
LYINDYAG	154	1.10	0.68	-0.77	3.82
REGINEQ	182	87.89	60.15	23.38	253.00

Summary statistics are presented in Table 1, for a list of the variables considered and their corresponding number of observations, mean, standard deviation, and minimum and maximum values. This table is important to take into account when interpreting the regression coefficients.

Non Overlapping Ten Year Average Data Set

This data set is a non-overlapping data set for which $G\dot{D}P_{t-1}$ and $G\dot{D}P_t$ are calculated for the periods 1960-69, 1970-79, 1980-89. Summary statistics are presented in Table 2, for a list of the variables considered and their corresponding number of observations, mean, standard deviation, and minimum and maximum values.

Table 2. Summary Statistics (Ten Year Periods)

Variable	N	Mean	Std Dev	Minimum	Maximum
AGLAND	141	40.29	21.64	2.52	82.74
FREEDOM	96	1.65	0.68	1.00	3.00
MJCHAN	141	0.12	0.14	0.00	0.67
INVEST	144	2.83	0.55	0.78	3.61
LNRGDPL	144	8.07	0.94	5.89	9.70
RGDPLAVG	144	4738.44	3984.01	363.00	16373.90
INVRGDPL	144	0.00	0.00	0.00	0.00
GRRGDPL	144	0.03	0.02	-0.03	0.09
INIRGDPL	144	7.95	0.93	5.75	9.64
RGDPLAST	130	0.03	0.02	-0.02	0.09
SEC	144	0.81	0.72	0.00	3.53
TERC	144	0.17	0.20	0.00	1.38
SCHOOL	144	5.50	3.01	0.29	15.81
FEMN	144	29.16	10.94	5.13	50.73
UPOP	144	51.89	24.59	2.96	100.00
LIFEEXP	144	64.22	9.45	43.46	77.54
GINIADJ	114	41.09	8.33	24.30	60.06
LAGINI	69	41.39	8.58	24.30	60.06
IN2040	99	3.03	1.48	1.49	7.86
YINDYAG	130	4.78	6.21	0.51	49.17
KPUL	144	31188.70	26683.47	599.71	110887.98
PRIMXY	137	0.12	0.12	0.00	0.68
LPRIMXY	137	-2.53	0.98	-5.70	-0.39
AVGLPOP	143	-1.76	0.34	-2.99	-1.37
LINVEST	144	1.02	0.25	-0.24	1.29
LSCHOOL	144	1.52	0.68	-1.23	2.76
LSEC	144	-0.70	1.19	-5.45	1.26
LKPUL	144	9.87	1.10	6.40	11.62
LYINDYAG	130	1.22	0.74	-0.67	3.90
REGINEQ	114	112.68	84.33	31.51	336.00

In this ten year period data set the growth rates of GDP do not overlap. The remaining variables in this data set are the same as in the five year period data set and they are the value corresponding to the average of the previous decade (initial value).

Methods

Recursive Equation System

The two variables of interest, income inequality and per capita GDP growth, are determined sequentially within the context of a *Recursive Equation System* using panel estimation as follows:[20]

(1) Inequality: $Gini_{jt} = \vartheta_0 + \vartheta_1 G\dot{D}P_{j,t-1} + \sum_{i=3}^{K} \vartheta_i x_{ijt} + \sum_{i=1}^{P} \gamma_i z_{ijt} + \varepsilon_{jt}$

(2) Growth: $G\dot{D}P_{jt} = \pi + \pi_1 Gini_{jt} + \sum_{i=3}^{k_1} \pi_i x_{ijt} + \sum_{i=k_1+1}^{k_2} \gamma_i z_{ijt} + u_{jt}$

where x_{ijt} is the known matrix of explanatory variables (fixed effects); ϑ and π are the unknown fixed-effects parameter vectors. K is the number of fixed effects; P is the number of random components; the γ's are the random-effects parameters and z_{ijt} are constants associated with the random effects and they can contain either continuous or dummy variables, just like the x's[21]. j represents the j^{th} country where $j = 1,\ldots,N$; the i's represent the ith explanatory variable where i = 1, …, K; and t represents the tth period where t=1,…,T. The e_{jt} and u_{jt} are unknown independent and identically distributed

[20] Panel instead of cross country estimation reduces omitted variable bias. It controls for differences in time-invariant, unobservable country characteristics (Forbes). As Sylwester points out "using more than one observation for a country implicitly controls for more idiosyncratic factors than using a cross section." (p.383).

[21] Simple random effects are a special case of the general specification with **z** containing variance components in a diagonal structure, and $R = \sigma^2 I_n$ where I_n denotes the $n \times n$ identity matrix. The general linear model is a further special case with **z** = 0 and $R = \sigma^2 I_n$.

normal (Gaussian) random errors with mean 0 and variance σ^2. The system is estimated using *O.L.S.* and the *PROC MIXED* procedure for mixed linear models as presented in SAS to account for country random effects. The random effects are more efficient than the fixed effects estimates since they incorporate information across individual countries as well as across periods. However, it is only consistent if country-specific effects are assumed to be uncorrelated with the other explanatory variables. A Hausman Test has to be performed to check for the random model statistical adecuacy.

Given that the growth of per capita GDP $\left(G\dot{D}P_{t-1}\right)$ is lagged in the inequality equation, there is no direct feedback from the Growth of Pper Capita GDP ($G\dot{D}P_t$) equation into the Inequality Equation. If $\mathrm{cov}\left(\varepsilon_t, u_t\right) = 0$ then ordinary least squares (O.L.S.) would give consistent parameter estimates. The dependent variable in (1) is the degree of inequality. There are several measures of income inequality that could be used such as the Gini and Kuznets ratios, the coefficient of variation of income, the variance of the logs of income and ordinal shares of income[22]. The chosen measure of income inequality for the present study is the Gini coefficient (*GINI*) as reported by Deininger and Squire.

Contemporaneous Correlation

Estimations of the recursive system in (1) and (2) using O.L.S. are appropriate since $G\dot{D}P_{t-1}$ is predetermined and therefore uncorrelated with ε_t, and because $GINI_t$ is uncorrelated with the error term u_t (since the error term affecting $GINI_t$ is ε_t, and ε_t is uncorrelated with u_t). The Lagrange Multiplier statistic for testing the null hypothesis of a diagonal covariance matrix, Σ is given by:

(3) $$\lambda_{LM} = T\sum_{i=2}^{M}\sum_{j=1}^{i-1} r^2_{ij}$$

where the correlation coefficient r_{ij} is equal to the ratio $\frac{\hat{\sigma}_{ij}}{\sqrt{\hat{\sigma}_{ii}\hat{\sigma}_{jj}}}$. Under the null, λ_{LM} has an asymptotic $\chi^2[M(M-1)/2]$ distribution[23]. A Lagrange Multiplier Test (LM) was performed to test for contemporaneous correlation between ε_t and u_t for the Recursive System of equations (1) and (2) for the basic model specifications of the three different data sets. For the non overlapping five year average data set the correlation coefficient in the cross model correlation results is -0.1215. For a t of 182 the LM is 2.68 which is smaller than the critical value of the corresponding χ^2. This result fails to reject the null hypothesis of no contemporaneous correlation between the error terms of equations (1) and (2) above. In the case of nonoverlapping ten year period data set, the reported correlation coefficient yields of –0.1212 for a LM statistic of 1.6452. That is, there is evidence not to reject the null hypothesis of no contemporaneous corretions between the error terms of the economic growth and the income inequality equations. In sum, there is no evidence in support of contemporaneous correlation between ε_t and u_t. Therefore, the equations are estimated separately.

The Mixed Linear Model

An ordinary least squares (*O.L.S.*) estimation is performed for the different specifications of the model in which there is no random effects[24]. The mixed linear

---

[22]For a brief evaluation of those indexes see Foxley (p.31).

[23] Note that $M(M-1)/2$ is half the number of off-diagonal elements in the Covariance Matrix, Σ.

[24] A mixed linear estimation of these specifications without random components report the same results as those from the OLS estimation.

estimation is used to estimate both fixed effect and random effect parameters[25]. One of the advantages of the mixed model is that it extends the general linear model by allowing a "more flexible specification" of the covariance matrix of e_{jt} and u_{jt}. In other words, it "allows for both correlation and heterogeneous variances although still assuming normality" (Littell et al., p.492). In the present study, the model assumes that the data are normally distributed (Gaussian) and independent.

The *mixed effects model* generalizes the standard linear model as follows:

(4) $$y_{jt} = \sum \beta_i x_{ij_t} + \sum \gamma_k z_{kjt} + \varepsilon_{jt}$$

where j refers to the j^{th} observation; t refers to time period; the β_i's are unknown fixed effect parameters to be estimated; the x_{ij} are constants associated with the fixed effects, γ_k's are the random effect parameters and z_{kjt} are constants associated with the random effects and they here contain country effects, just like the x's[26]. The ε are random errors whose elements are no longer required to be independent and homogeneous and they are defined as $\varepsilon = y_{jt} - E\left(y_{jt} / \gamma_k \right) = \sum \beta_i x_{ijt} + \sum \gamma_k z_{kjt}$ and $E(y_{jt}) = \sum \beta_i x_{ijt}$. γ and ε are normally distributed and they are uncorrelated random variables with zero mean and covariance matrices ***G*** and ***R*** respectively as follows:

(5) $$E\begin{bmatrix} \gamma \\ e \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad \text{Var}\begin{bmatrix} \gamma \\ e \end{bmatrix} = \begin{bmatrix} \mathbf{G} & 0 \\ 0 & \mathbf{R} \end{bmatrix}$$

[25] Actually, the name mixed model comes from the fact that the model contains both fixed effects parameters (ϑ and π), and random effects parameters (γ).

The covariance matrix of the data vector $\boldsymbol{y}$ is $\boldsymbol{V} = \boldsymbol{ZGZ'} + \boldsymbol{R}$ [27].

In the mixed model there are not only βs to estimate but also unknown parameters in γ, $\boldsymbol{G}$ and $\boldsymbol{R}$ as well. Least Squares is no longer the best method. The goal is finding an estimate of $\boldsymbol{G}$ and $\boldsymbol{R}$. *PROC MIXED* uses likelihood methods based on the assumption that γ and ε are normally distributed. It constructs an objective function associated with maximum likelihood or restricted[28] maximum likelihood and maximizes it over all unknown parameters. The corresponding log likelihood function for the *REML* estimation is:

$$l_R(\mathbf{G},\mathbf{R}) = -\frac{1}{2}\log|\mathbf{V}| - \frac{1}{2}\log|\mathbf{X'V^{-1}X}| - \frac{n-p}{2}\log \mathbf{r'V^{-1}r} - \frac{n-p}{2}\left\{1+\log\left[2\pi/(n-p)\right]\right\}$$

where $\boldsymbol{r} = \boldsymbol{y} - \boldsymbol{X}(\boldsymbol{X'V^{-1}X}) - \boldsymbol{X'V^{-1}}$ and p is the rank of $\boldsymbol{X}$. The objective function of the mixed linear estimation is -2 times the logarithm of the restricted maximum likelihood (*REML*) plus a constant. This value is obtained by evaluating the likelihood function at the selected estimators. The mixed model estimation attempts to minimize this objective function. *PROC MIXED* minimizes the -2 times these functions using a ridge-stabilized Newton-Raphson algorithm. With *REML*, *PROC MIXED* provides estimates of the standard errors of the estimates of the variance components that are computed from the

---

[26] Simple random effects are a special case of the general specification with **z** containing variance components in a diagonal structure, and $R = \sigma^2 I_n$ where I_n denotes the $n \times n$ identity matrix. The general linear model is a further special case with $\mathbf{z} = 0$ and $R = \sigma^2 I_n$.

[27] Note that simple random effects are a special case of the general specification with $\boldsymbol{Z}$ containing dummy variables, $\boldsymbol{G}$ containing variance components in a diagonal structure and, $\boldsymbol{R} = \sigma^2 I_n$ denotes the n x n identity matrix.

inverse of the estimated information matrix. For a given covariance structure, the value of *-2 REML Log Likelihood* is smallest for the *REML* estimates given that the *REML* estimates are selected to minimize *-2 REML Log Likelihood.*

REML provides estimates of **G** and **R**. To obtain estimates of β and γ, the following mixed model equations are solved:

$$\begin{bmatrix} X'\hat{R}^{-1}X & X'\hat{R}^{-1}Z \\ Z'\hat{R}^{-1}X & Z'\hat{R}^{-1}Z+\hat{G}^{-1} \end{bmatrix} \begin{bmatrix} \hat{\beta} \\ \hat{\gamma} \end{bmatrix} = \begin{bmatrix} X'\hat{R}^{-1}y \\ Z'\hat{R}^{-1}y \end{bmatrix}$$

the solutions of the mixed model equations for β and γ can also be written as

$$\hat{\beta} = \left(X'\hat{V}^{-1}X\right)^{-1} X'\hat{V}^{-1}y \text{, and}$$

$$\hat{\gamma} = \hat{G}Z'\hat{V}^{-1}(y - xb) \ .$$

Growth Equation

As stated before, the growth equation (2), is as follows:

$$G\dot{D}P_{jt} = \pi + \pi_1 Gini_{it} + \sum_{k=3}^{k1} \pi_i x_{ijt} + \sum_{k=k1+1}^{k2} \gamma_k z_{kjt} + u_{jt} \ .$$

Since the dependent variable in the growth equation represents a change in per capita income, the overlapping data problem arises and it requires correction when the explanatory variables x_{ijt} are averages. However, in the above equation these variables do not correspond to averages. See the Appendix for a brief note on the overlapping problem.

Heteroskedasticity

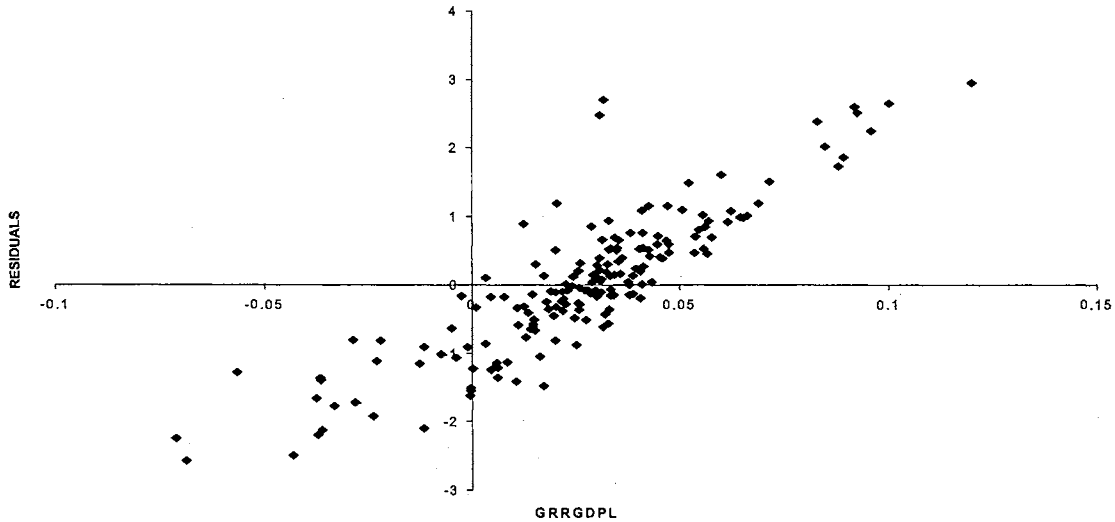
Correction for the existence of heteroskedasticity may be necessary given that economic growth may be explained differently for low income countries and high income countries.

---

[28] Restricted in the sense that differs from the unrestricted estimator by a linear function of a vector of

It is reasonable that error terms associated with higher income countries have larger

Figure 1
Plot of Unadjusted GRRGDPL and RESIDUALS



variances than error terms associated with lower income countries. A plot of the *O.L.S.* residuals of the growth equation against next period's per capita income growth for the base model also suggests that the errors are heteroskedastic (Figure 1). A Lagrange Multiplier test for the existence of heteroskedasticity is estimated for each specification of the growth equation in the context of an alternative hypothesis of multiplicative heteroskedasticity. The Lagrange multiplier statistic is given by:

$$\lambda_{LM} = \frac{q'Z(Z'Z^{-1})Z'q}{2\tilde{\sigma}^4{}_0} ,$$

where q is a T-dimensional vector with the t[th] element equal to $\hat{e}^2{}_t - \tilde{\sigma}^2{}_0$. If the log likelihood function of the multiplicative heteroskedastic error model is :

$$L(\beta, \sigma^2, \alpha^*) = -\frac{T}{2}\ln 2\pi - \frac{T}{2}\ln \sigma^2 - \frac{1}{2}\sum_{t=1}^{T} z_t{*}'\alpha^* - \frac{1}{2\sigma^2}\sum_{t=1}^{T}\exp\{-z_t{*}'\alpha^*\}(y_t - x_t'\beta)^2$$

linear equality restricions See Judge et. al. , pp. 235-237.

The Multiplicative Heteroskedasticity function has been chosen given that: (a) it presents some advantages such as more efficient estimates of the heteroskedasticity parametrs, α. That is, the small sample properties of the estimator of β are likely to be improved[29]; and, (b) is popular in applied work (Judge et al., p.366). The null hypothesis of homoskedastic errors $H_0 : \alpha^* = 0$ is rejected in favor of the alternative $Var(e_i) = \sigma_i^2 = \exp[Z_t'\alpha]$ [30], more precisely, $H_A : \alpha^* \neq 0$. That is, there is evidence that supports the existence of heteroskedasticity in the different specifications of the growth equation of the model (Table 3).

Table 3. Tests for Multiplicative Heteroskedasticity

Equation	Data Set	Model	Lagrange Multiplier	LM Probability
Growth	Five Year Average			
		Base	17.301	0.000
		Base with Regineq	15.409	0.000
		Extended	16.749	0.000
		Extended with Regineq	13.574	0.000
	Ten Year Average			
		Base	11.260	0.001
		Base with Regineq	10.087	0.001
		Extended	12.047	0.001
		Extended with Regineq	10.868	0.001

Consequently, an *O.L.S.* estimation would not be appropriate because the least squares estimator would no longer be the *best linear unbiased estimator* of the model's

[29] See Harvery (1976) for a further discussion on the advantage of the multiplicative heteroskedasticity assumption.

[30] Where $Z'_t = (z_{t1}, z_{t2}, ..., z_{ts})$ is a (1xS) vector containing the t[th] observation on S nonstochastic explanatory variables and $\alpha = (\alpha_1, \alpha_2, ..., \alpha_s)$ is an (Sx1) vector of unknown coefficients.

parameters. *O.L.S.* parameter estimates would no longer be efficient; i.e., the variances of the estimated parameters would not be the minimum variances. Therefore, the model is transformed to correct for heteroskedasticity, assuming multiplicative heteroskedasticity. If $\boldsymbol{P}$ is a transformation matrix with diagonal elements equal to the inverse of $\exp[z'_t\,\alpha]^{1/2}$, the transformed x's and y's are $\widetilde{X} = PX$ and $\widetilde{\mathbf{y}} = P\mathbf{y}$ where X and y are the x's and y's of equation (4). This transformation is performed using the Statisitical Analysis System/Iterative Matrix Language (S.A.S./I.M.L.) Software. The O.L.S and mixed linear estimations will be performed on the transformed model

(6) $$\widetilde{GDP}_{jt} = \pi + \pi_1 \widetilde{Gini}_{jt} + \sum_{i=3}^{K} \pi_i \widetilde{x}_{ijt} + \sum_{i=k1+1}^{P} \gamma_i z_{ijt} + \widetilde{u}_{jt}$$

where $\widetilde{\mu}_{it} = P\,\mu_{it}$.

Interaction Variable

An interaction variable is considered to capture the interaction effect *REGINEQ* of income inequality and regions on economic growth: (*REGION*GINIADJ*). With this term it is assumed that the coefficient of income inequality in the growth equation is region varying. Indeed, this variable tests the hypothesis that income inequality as measured by *GINIADJ* has a differential impact on economic growth depending on the region a country belongs to.

Inequality Equation

As stated before, the inequality equation (1) is

$$Gini_{jt} = \vartheta_0 + \vartheta_1 G\dot{D}P_{j,t-1} + \sum_{k=3}^{k1} \vartheta_i x_{ijt} + \sum_{k=k1+1}^{k2} \gamma_k z_{kjt} + \varepsilon_{jt} \quad .$$

Since the dependent variable does not represent a change in income inequality, the overlapping data problem does not occur in the inequality equation.

Homoskedasticity

A plot of the least squares residuals of the inequality equation against the adjusted Gini coefficient (*GINIADJ*) -for the base model- does not suggest that the errors are heteroskedastic. A Lagrange Multiplier test for the existence of multiplicative heteroskedasticity in the inequality equation, indeed, fails to reject the null hypothesis of existence of homoskedasticity for the different model specifications.

Table 4. Tests for Multiplicative Heteroskedasticity

Equation	Data Set	Model	Lagrange Multiplier	LM Probability
Inequality	Five Year Average			
		Base	0.119	0.730
		Base with Regineq	0.168	0.682
		Extended	0.048	0.826
		Extended with Regineq	0.017	0.897
	Ten Year Average			
		Base	0.488	0.485
		Base with Regineq	0.004	0.951
		Extended	0.032	0.858
		Extended with Regineq	0.001	0.972

The null hypothesis (H_o: $Var(e_{jt}) = \sigma^2$) for which $H_0 : \alpha^* = 0$ is not rejected, against the alternative (H_a: $Var(e_{jt}) = \sigma_i^2 = \exp[\mathbf{Z'}_t, \boldsymbol{\alpha}]$, i.e., $H_A : \alpha^* \neq 0$. Therefore, there is no evidence that supports the existence of heteroskedasticity in the inequality equation of the recursive system and no data transformation is needed.

Interaction Variable

Similarly to *REGGR* in the growth equation, an interaction term *REGGR* of regions and economic growth (*REGION*RGDPLAST*), is included assuming that the coefficient of economic growth in the inequality equation is region varying. The above econometric

explanatory variables and $\alpha = (\alpha_1, \alpha_2, ..., \alpha_s)$ is an (Sx1) vector of unknown coefficients.

methods are applied to the data to obtain the empirical results provided in the next chapter.

CHAPTER V

EMPIRICAL RESULTS

Based on the preceding chapter, this section reports the results from different empirical estimations. Because the theory does not imply a unique specification, alternative specifications were estimated for both the inequality and the growth equation. Additional variables – suggested by the literature- were chosen based on: (i) some pretest estimation, (ii) quality income inequality data availability, and, (iii) having in mind that simpler model specifications maximize the degrees of freedom. Statistical tests were performed to find evidence of the most appropriate specification. First, F tests were performed to determine whether or not to include different country or region intercepts in the different specifications of the inequality and growth equations. For the five year period data, concerning the base estimation of the economic growth equation, a joint test based on the sum of the squared errors of the restricted (no country effects) and unrestricted (with country effects) models was performed. A calculated F value of 21.96 compared to a $F_{47,129}$ of 1.50 rejectes the null hypothesis in favor of the alternative of existence of country intercepts. Similarly was done for the ten year period data estimation. In this case the calculated F value of 19.5094 compared to a $F_{47,60}$ of 1.94 also rejects the null hypothesis on the inexistence of country effects.

Another F test (joint test) was performed to choose between country and region effects and there is statisitical support to incluude country effects instead of region effects. That is, the calculated F values yield statistics greater than the different critical values from the F-distribution given the corresponding degrees of freedom.

Likelihood ratio (*L.R.*) tests were calculated to find evidence on whether to consider random or fixed effects. These *L.R.* tests were calculated in two ways. First, based on the values of the maximized log likelihood functions from the mixed linear estimation, and second, using the sum of squared errors from the *O.L.S.* estimations. These tests reject the null hypothesis of the existence of fixed effects in favor of the alternative of random effects. This result is according to Li, Squire and Zou (1998) recent finiding that inequality differs significantly across countries. They obtain based, on the Deininger and Squire (1996) income inequality data, that income inequality is relatively stable within countries; and that it varies significantly among countries.

The base model specifications are estimated -as mentioned before- for both five and ten year periods to study if the length of the period under consideration does affect the relationship between income inequality and economic growth, as stated by Forbes (2000, p.16). There are four sets of eight model specifications each: one set for each of the two equations of the two data sets. The first four specifications (models **1**, **2**, **3**, and **4**) in each set correspond to: the base model (model **1**), base model with the corresponding interation term (model **2**), base model with country random effects (model **3**), and base model with both interation term and country random effects (model **4**). The next four specifications in each set (models **5**, **6**, **7**, and **8**) add to models **1**, **2**, **3**, and **4** an additional variable, respectively –these are the extended models **5**, **6**, **7**, and **8**-.

Non Overlapping Five Year Average Data Set

Growth Equation

As discussed above, the heteroskedastic model is corrected being the transformation matrix the inverse of the square root of the heteroskedasticity function, $\frac{1}{\sqrt{\exp(Z\alpha)}}$. Figure 2 is a plot of *GRRGDPLT* (Transformed Growth of Income when adjusted for Multiplicative Heteroskedasticity) and the new residuals. The diagram is now homoskedastic, that is, the prediction errors should be similar in size all along the regression line.

Figure 2
Plot of Transformed GRRGDPL and RESIDUALS

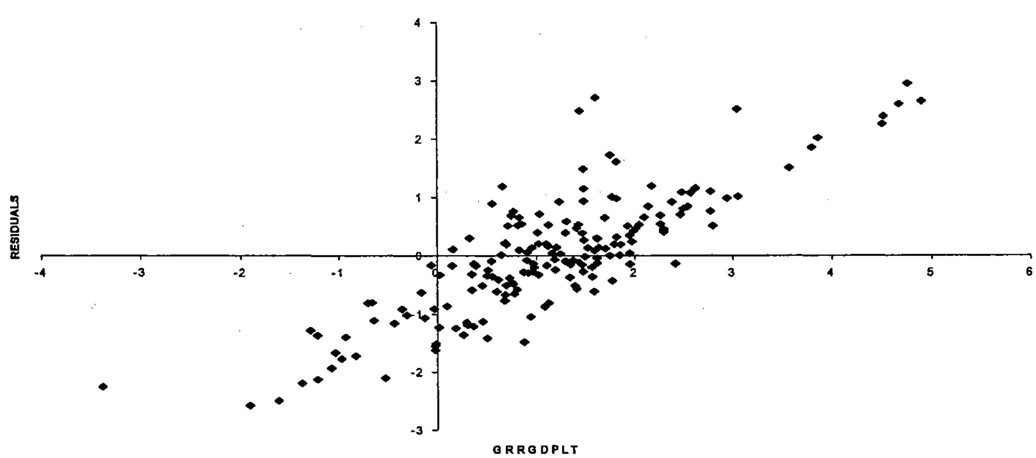


Table 5 presents the Growth Estimates for the different models[31]. The base model (model **1**) of the growth equation has as regressors: the initial adjusted gini coefficient (*GINIADJT*), the initial level of income (*INIRGDPT*), the average log of schooling (*LSCHOOLT*), the average log of investment (*LINVESTT*) and the average log of population growth (*AVLPOPT*). Schooling and investment are expressed in natural logarithms following Mankiw, Romer and Weil 1992; and Bourguignon. Income inequality is positively associated to the subsequent growth of per capita income (p-value of 0.003), initial income is negatively associated to the subsequent growth of per capita income (p-value of 0.001), investment is positively associated to subsequent growth (p-value of 0.000), and population growth is negative and statistically insignificant.

When including *MJCHANT* to account for political instability in model **5,** results do not change. The negative coefficient of *MJCHANT* follows Alesina, Özler, Roubini and Swagel (1996) finding that political instability given by all irregular transfers of power such as coups, along with the subset of regular transfers that imply a substantial change in the party or coalition of parties in office, reduces growth.

[31] The *T* at the end of the variable names stands for *transformed* as these data were corrected for heteroskedasticity.

Table 5. Growth Estimates (Five Year Periods) *

Variable	1	2	3	4	5	6	7	8
INTERCEP	-3.777	-3.419	-1.106	-2.216	-3.242	-3.174	-2.629	-2.907
	(0.005)	(0.028)	(0.449)	(0.259)	(0.002)	(0.011)	(0.024)	(0.055)
GINIADJT	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.003
	(0.003)	(0.005)	(0.146)	(0.072)	(0.001)	(0.001)	(0.003)	(0.008)
INIRGDPT	-0.010	-0.010	-0.019	-0.014	-0.013	-0.012	-0.019	-0.014
	(0.001)	(0.002)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
LSCHOOLT	0.008	0.006	0.017	0.008	0.011	0.009	0.013	0.008
	(0.202)	(0.342)	(0.008)	(0.273)	(0.081)	(0.149)	(0.056)	(0.269)
LINVESTT	0.060	0.056	0.080	0.064	0.065	0.061	0.084	0.068
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AVLPOPT	-0.003	-0.002	-0.017	-0.010	-0.002	-0.002	-0.013	-0.006
	(0.653)	(0.716)	(0.004)	(0.215)	(0.785)	(0.808)	(0.084)	(0.510)
MJCHANT					-0.031	-0.032	-0.027	-0.031
					(0.014)	(0.012)	(0.002)	(0.015)
REGINEQT		0.000		0.000		0.000		0.000
		(0.080)		(0.091)		(0.187)		(0.167)
Country Random Effects								
Australia			0.227	-0.112			-0.047	-0.225
			(0.470)	(0.773)			(0.894)	(0.581)
Bangladesh			1.621	0.727			1.097	0.434
			(0.000)	(0.097)			(0.007)	(0.315)
Belguim			0.341	0.170			0.283	0.076
			(0.432)	(0.715)			(0.562)	(0.874)
Brazil			-0.085	0.081			0.171	0.154
			(0.802)	(0.836)			(0.633)	(0.697)
Canada			0.833	0.392			0.849	0.353
			(0.007)	(0.285)			(0.013)	(0.356)
Chile			-0.704	-0.346			-0.843	-0.451
			(0.022)	(0.360)			(0.012)	(0.257)
China			-0.655	-0.298				
			(0.101)	(0.512)			0.000	0.000
Colombia			0.148	0.199			0.418	0.269
			(0.663)	(0.624)			(0.287)	(0.534)
Costa Rica			-0.485	-0.234			-0.392	-0.191
			(0.084)	(0.510)			(0.204)	(0.611)
Cote d'Ivoire			-0.650	-0.319				
			(0.179)	(0.529)			0.000	0.000
Denmark			-0.084	-0.160			0.288	0.103
			(0.809)	(0.696)			(0.473)	(0.813)
Egypt			1.179	0.845			1.031	0.652
			(0.004)	(0.074)			(0.013)	(0.152)

* Values in parenthesis are p-values

Table 5. Growth Estimates (Five Year Periods) *, continued

Variable	1	2	3	4	5	6	7	8
Finland			-0.207	-0.127			-0.368	-0.239
			(0.534)	(0.737)			(0.285)	(0.536)
France			-0.125	-0.211			-0.143	-0.215
			(0.641)	(0.551)			(0.601)	(0.544)
Greece			-0.739	-0.529			-0.668	-0.349
			(0.030)	(0.202)			(0.090)	(0.423)
India			-0.588	-0.598			-1.134	-0.791
			(0.054)	(0.101)			(0.001)	(0.038)
Indonesia			0.117	0.019			-0.019	-0.009
			(0.682)	(0.957)			(0.952)	(0.980)
Iran			1.275	0.658			1.095	0.537
			(0.001)	(0.127)			(0.004)	(0.198)
Ireland			-0.638	-0.387			-0.632	-0.308
			(0.092)	(0.364)			(0.150)	(0.493)
Italy			-0.062	-0.180			-0.244	-0.224
			(0.836)	(0.631)			(0.464)	(0.573)
Jamaica			-0.908	-0.422			-0.981	-0.449
			(0.008)	(0.303)			(0.012)	(0.299)
Japan			0.534	0.430			0.426	0.284
			(0.071)	(0.223)			(0.198)	(0.450)
Jordan			-1.193	-0.458			-0.535	-0.083
			(0.002)	(0.328)			(0.255)	(0.863)
Korea			1.690	1.333			1.284	0.956
			(0.000)	(0.000)			(0.000)	(0.010)
Malaysia			0.211	0.189			0.324	0.195
			(0.487)	(0.617)			(0.340)	(0.625)
Mauritius			0.990	0.742			0.116	0.103
			(0.010)	(0.104)			(0.807)	(0.829)
Mexico			-0.143	-0.004			0.060	0.055
			(0.648)	(0.991)			(0.857)	(0.886)
Morocco			-0.217	-0.020			-0.176	0.015
			(0.652)	(0.968)			(0.713)	(0.976)
Netherlands			0.185	-0.089			0.247	-0.024
			(0.628)	(0.835)			(0.574)	(0.958)
Norway			-0.156	-0.185			0.056	0.021
			(0.571)	(0.582)			(0.851)	(0.953)
Pakistan			0.218	-0.187			-0.264	-0.284
			(0.557)	(0.654)			(0.526)	(0.509)
Panama			-0.876	-0.472			-0.466	-0.206
			(0.006)	(0.219)			(0.174)	(0.606)
Peru			-1.117	-0.622			-0.624	-0.292
			(0.001)	(0.127)			(0.110)	(0.498)

* Values in parenthesis are p-values

Table 5. Growth Estimates (Five Year Periods) *, continued

Variable	1	2	3	4	5	6	7	8
Philippines			-0.360	-0.198			-0.218	-0.127
			(0.254)	(0.608)			(0.528)	(0.753)
Portugal			0.221	0.023			0.222	0.086
			(0.563)	(0.959)			(0.567)	(0.844)
Rwanda			0.660	0.251			0.335	0.126
			(0.190)	(0.625)			(0.507)	(0.795)
Singapore			1.434	1.003			1.171	0.699
			(0.000)	(0.009)			(0.001)	(0.086)
Spain			0.504	0.215			0.098	-0.008
			(0.099)	(0.568)			(0.774)	(0.983)
Sri Lanka			-0.214	-0.212			-0.171	-0.170
			(0.469)	(0.562)			(0.607)	(0.661)
Sweeden			-0.478	-0.401			-0.527	-0.332
			(0.157)	(0.306)			(0.183)	(0.428)
Tanzania			-0.094	0.032			-0.275	-0.036
			(0.819)	(0.945)			(0.503)	(0.935)
Thailand			0.413	0.322			0.470	0.377
			(0.143)	(0.364)			(0.115)	(0.296)
Tunisia			-0.224	0.187			-0.209	0.105
			(0.459)	(0.648)			(0.536)	(0.803)
Turkey			0.119	-0.058			0.407	0.139
			(0.723)	(0.892)			(0.307)	(0.754)
United Kingdom			0.502	0.384			0.744	0.454
			(0.184)	(0.341)			(0.092)	(0.291)
Unites States			0.264	-0.017			0.330	0.020
			(0.362)	(0.963)			(0.302)	(0.957)
Venezuela			-0.697	-0.540			-0.830	-0.542
			(0.024)	(0.160)			(0.019)	(0.184)
Zambia			-1.989	-0.816			-1.756	-0.658
			(0.000)	(0.108)			(0.000)	(0.169)

* Values in parenthesis are p-values

When the base model **1** takes into account country random effects in model **3**, the parameter estimates of *LSCHOOLT* and *AVLPOPT* are now significant. The income inequality estimate bearly loses significance, but it is still significantly different from zero at the 15 percent level. When extending the base model by *MJCHANT* with country random effects, *MJCHANT* is statistically significant and negative, all additional variables are statistically significant at the 10 percent level of significance.

AVLPOP is not statistically different from zero for neither the base (model **1**) nor the extended base (model **5**) regressions. However, when adding country random effects both variables gain significance in models **3** and **7**. *SCHOOLT* is always positive but significant only when considering political instability (*MJCHANT*- model **5**) and country random effects (model **3**) or both (model **7**).

Investment (*LINVESTT*) and the initial level of income are always significant statistically in all 8 models. Investment appears to be positively associated to growth, whereas the initial level of income appears negatively related, as expected from previous studies. Finally, the income inequality estimate (*GINIADJT*) is positive consistently different from zero and significant at the 15 percent significance level. This result is in line with Forbes (2000), Li and Zou (1998), Barro (2000), Lee and Roemer (1999) and Sylwester (2000).

If including the interaction effect *REGINEQ* of regions and income inequality, in both the base (model **2**) and the extended model (model **6**) results remain invariant compared to the base models **1** and **5**. Moreover, if both *REGINEQ* and country random effects are added to the basic regressions schooling and population growth are still statistically insignificant. For specifications **3** and **7** where base model **1** and **5** add country random effects only, all parameter estimates are statistically significant at the 10 percent level.

Following, Table 6 presents the Growth Estimate Statistics for the five year period estimations. The statistics are: number of observations, the adjusted R squared, the

Aikaike Information Criterion (A.I.C.), the F value, the probability greater than the F value, the Sum of Squared Errors (S.S.E.), and –2 the Restricted Log Likelihood. Models **3** and **7** both minimize numerically the A.I.C. which is an additional statistical argument in favor of these models.

Table 6. Growth Estimate Statistics (Five Year Periods)

Variable	1	2	3	4	5	6	7	8
Observations	181	181	181	181	141	141	283	141
R Adjusted	0.293	0.3053 [1]	0.655 [1]	0.6563 [1]	0.3613	0.3831 [1]	0.693 [1]	0.6965
A.I.C.	-288.996	-299.082	-504.351	-291.889	-237.086	-246.822	-415.79	-243.758
F Statistic	14.59	12.82	4.71	4.61	14.291	11.89	10.27	3.93
Prob F Statistic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
SSE	195.7349	192.3362	93.6161	95.1561	152.3696	155.2143	152.969	76.3558
-2 ResLogLikelihood	575.992	596.1632	1004.701	579.779	472.1728	491.6435	827.5792	483.5161

[1] R-square

Inequality Equation

The basic model of the inequality equation has as regressors: last period's growth of per capita income (*RGDPLAST*), the level of real per capita income (*RGDPLAVG*) and its inverse (*INVRGDPL*) to test the Kuznets hypothesis, and schooling (*LSCHOOL*). *RGDLAVG* and *INVRGDPL* both have to be negative to support the Kuznets hypothesis.

Table 7. Income Inequality Estimates (Five Year Periods) *

Variable	1	2	3	4	5	6	7	8
INTERCEP	10.085	9.958	8.462	8.768	10.161	10.085	9.586	10.031
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RGDPLAST	23.547	-38.211	37.082	31.669	7.374	-75.450	21.022	-3.934
	(0.159)	(0.199)	(0.000)	(0.106)	(0.641)	(0.011)	(0.038)	(0.859)
RGDPLAVG	-0.0014	-0.001	-0.0005	-0.001	-0.0012	-0.001	-0.0006	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
INVRGDPL	-13964.000	-13330.964	-7351.228	-7756.223	-14882.000	-14059.879	-8619.492	-9081.786
	(0.000)	(0.000)	(0.003)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
LSCHOOL	-6.039	-4.739	-4.440	-4.389	-5.588	-4.075	-5.416	-5.034
	(0.000)	(0.001)	(0.011)	(0.010)	(0.000)	(0.008)	(0.006)	(0.008)
LYINDYAG					4.129	4.147	1.349	1.437
					(0.000)	(0.000)	(0.124)	(0.095)
REGGR		44.612		18.895		43.561		19.485
		(0.000)		(0.010)		(0.000)		(0.014)
Country Random Effects								
Australia			-0.279	-0.197			0.260	0.382
			(0.342)	(0.515)			(0.467)	(0.304)
Bangladesh			-1.088	-1.124			-1.275	-1.317
			(0.000)	(0.000)			(0.000)	(0.000)
Belguim			-1.619	-1.578			-1.555	-1.507
			(0.000)	(0.000)			(0.000)	(0.000)
Brazil			1.908	1.904			2.011	2.019
			(0.000)	(0.000)			(0.000)	(0.000)
Canada			-0.924	-0.829			-0.715	-0.568
			(0.001)	(0.004)			(0.026)	(0.093)
Chile			1.235	1.202			1.280	1.235
			(0.000)	(0.000)			(0.000)	(0.000)
China			-1.347	-1.378			-1.497	-1.550
			(0.000)	(0.000)			(0.000)	(0.000)
Colombia			1.177	1.154			1.207	1.190
			(0.000)	(0.000)			(0.000)	(0.001)
Costa Rica			0.618	0.577			0.613	0.548
			(0.016)	(0.029)			(0.040)	(0.079)
Cote d'Ivoire			-0.005	0.125			-0.280	-0.117
			(0.992)	(0.795)			(0.579)	(0.825)
Denmark			-0.890	-0.815			-0.713	-0.615
			(0.005)	(0.013)			(0.042)	(0.091)
Egypt			0.489	0.269			0.543	0.316
			(0.152)	(0.459)			(0.142)	(0.426)

* Values in parenthesis are p-values

Table 7. Income Inequality Estimates (Five Year Periods) *, continued

Variable	1	2	3	4	5	6	7	8
Finland			-1.439	-1.382			-1.366	-1.299
			(0.000)	(0.000)			(0.000)	(0.000)
France			0.537	0.730			-0.102	0.056
			(0.041)	(0.008)			(0.785)	(0.886)
Greece			0.063	0.171			0.211	0.328
			(0.832)	(0.578)			(0.510)	(0.329)
India			-0.552	-0.545			-0.619	-0.602
			(0.050)	(0.060)			(0.051)	(0.067)
Indonesia			-0.235	-0.207			-0.405	-0.370
			(0.403)	(0.475)			(0.195)	(0.254)
Iran			0.238	0.214			0.274	0.281
			(0.582)	(0.627)			(0.567)	(0.566)
Ireland			-0.272	-0.173			0.123	0.228
			(0.428)	(0.623)			(0.759)	(0.584)
Italy			-0.517	-0.394			-0.499	-0.353
			(0.062)	(0.173)			(0.093)	(0.259)
Jamaica			1.227	1.192			1.094	1.002
			(0.000)	(0.000)			(0.005)	(0.012)
Japan			-0.524	-0.328			-0.452	-0.224
			(0.063)	(0.272)			(0.161)	(0.520)
Jordan			0.221	-0.303			0.191	-0.365
			(0.510)	(0.451)			(0.595)	(0.403)
Korea			-1.085	-1.123			-0.990	-0.996
			(0.000)	(0.000)			(0.001)	(0.001)
Malaysia			1.023	1.105			1.089	1.185
			(0.000)	(0.000)			(0.000)	(0.000)
Mauritius			0.548	0.414			0.764	0.624
			(0.101)	(0.237)			(0.043)	(0.117)
Mexico			1.652	1.649			1.626	1.623
			(0.000)	(0.000)			(0.000)	(0.000)
Morocco			-0.103	-0.471			-0.374	-0.758
			(0.823)	(0.339)			(0.453)	(0.157)
Netherlands			-1.489	-1.460			-1.028	-1.038
			(0.000)	(0.000)			(0.031)	(0.036)
Norway			-0.590	-0.474			-0.517	-0.359
			(0.023)	(0.078)			(0.081)	(0.250)
Pakistan			-1.036	-1.055			-1.208	-1.190
			(0.002)	(0.002)			(0.002)	(0.003)
Panama			1.533	1.520			1.724	1.705
			(0.000)	(0.000)			(0.000)	(0.000)
Peru			1.207	1.210			1.064	1.048
			(0.000)	(0.000)			(0.003)	(0.004)

* Values in parenthesis are p-values

Table 7. Income Inequaity Estimates (Five Year Periods) *, continued

Variable	1	2	3	4	5	6	7	8
Philippines			1.274	1.310			1.265	1.263
			(0.000)	(0.000)			(0.001)	(0.001)
Portugal			-0.940	-0.846			-1.009	-0.959
			(0.006)	(0.018)			(0.028)	(0.046)
Rwanda			-0.709	-0.838			-1.084	-1.244
			(0.119)	(0.075)			(0.038)	(0.022)
Singapore			-0.303	-0.284			-0.108	-0.001
			(0.274)	(0.325)			(0.738)	(0.997)
Spain			-1.208	-1.144			-1.195	-1.250
			(0.000)	(0.000)			(0.010)	(0.010)
Sri Lanka			0.335	0.361			0.285	0.297
			(0.215)	(0.193)			(0.363)	(0.360)
Sweeden			-0.844	-0.773			-0.784	-0.741
			(0.005)	(0.012)			(0.043)	(0.064)
Tanzania			1.536	1.494			1.542	1.567
			(0.004)	(0.007)			(0.009)	(0.011)
Thailand			0.177	0.209			-0.070	-0.080
			(0.491)	(0.428)			(0.831)	(0.815)
Tunisia			0.842	0.571			0.909	0.626
			(0.003)	(0.062)			(0.004)	(0.071)
Turkey			0.791	0.921			0.592	0.737
			(0.013)	(0.006)			(0.088)	(0.044)
United Kingdom			-1.980	-1.976			-1.832	-1.822
			(0.000)	(0.000)			(0.000)	(0.000)
Unites States			-0.055	0.058			0.229	0.394
			(0.853)	(0.851)			(0.516)	(0.284)
Venezuela			0.257	0.251			0.106	0.089
			(0.372)	(0.395)			(0.737)	(0.785)
Zambia			1.145	1.087			0.677	0.582
			(0.009)	(0.017)			(0.221)	(0.308)

* Values in parenthesis are p-value

Table 7 shows consistently negative and statistically significant estimates for *RGDPLAVG*, *INVRGDPL* and *LSCHOOL*. This in support of the Kuznets Hypothesis and the hypothesis that there is a negative relationship between the numbers of years of schooling and income inequality. These results are not variant to the inclusion of the sectoral income ratio variable (*YINDYAG*) in models **5**, **6**, **7**,and **8**. The *YINDYAG* estimate is positive and significant at acceptable (12 percent) levels of significance. This result throws evidence in favor of the idea that the greater the ratio of per capita income in industry to per capita income in agriculture the more unequal the income is within a country. Last period's economic growth effect on income inequality is positive in the base models, models **1** and **5** and in models **3** and **7** that add country random effects to these models **1** and **5**. When only the interation variable *REGGR* is added to the base model the coefficient of last period's economic growth is negatively associated to income inequality. However, *REGGR* loses significance when country random effects are added. Moreover, the sign of last period's economic growth varies for models **4** and **8** -where both the interaction term and the country random effects are simultaneously considered- depending on whether the sectoral income ratio variable *YINDYAG* is included or not.

Table 8. Income Inequality Estimates Statistics (Five Year Periods)

Variable	1	2	3	4	5	6	7	8
Observations	179	179	179	179	153	153	153	153
R Adjusted	0.4316	0.5084	0.9278 [1]	0.9301 [1]	0.5249	0.5948 [1]	0.9385 [1]	0.9396 [1]
AIC	-252.913	-250.010	-172.909	-175.962	-215.324	-212.419	-160.751	-163.608
F Statistic	34.978	35.99	32.27	32.51	34.803	35.96	29.62	29.40
Prob F Statistic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
SSE	180.0847	180.3804	23.3828	25.6369	154.0331	154.1027	20.6212	22.9381
-2 ResLogLikelihood	503.8261	498.0210	341.8174	347.9243	428.6489	422.8373	317.5017	323.2156

[1] R-square

Table 8 presents the statistics for the inequality specifications for the five year period data. The likelihood ratio test statisitics calculated based on the sum of the squared errors throws evidence in support of specifications with country random effects as the unrestricted model compared to the respective non country random specifications as the restricted model.

Following, the above estimations are presented for the ten year period data set to study if short and medium term results differ.

Non Overlapping Ten Year Average Data Set

Growth Equation

The same model specifications estimated for the five year average data set are presented in this section with the ten year average data set. The base model (model **1**) relates growth of per capita income to the initial Gini coefficient as measured by the contemporaneous decade's average Gini index, the initial level of income, the average schooling and the average investment ratio. Both investment and initial income inequality are consistently and robustly positive and significant across the eight models in Table 9 at the 0 and 5 percent levels of significance, respectively. The starting level of per capita income is significantly negative at 1 percent level of significance, in favor of the economic convergence thesis. Schooling (*LSCHOOLT*) is only statistically significant in models **5**, **6**, **7**, and **8** at the 11 level where political instability -as measured by *MJCHANT*- is added to models **1**, **2**, **3**, and **4**. Moreover, the political instability estimates are not significantly different from zero, not even in model **7** for which it was significant in the five year period estimations. In all models of Table 9 population growth is not statistically different from zero. Again, not even when country random were included as in models **3** and **7**. The base regressions results remain invariant to the inclusion of the interaction term *REGINEQ* and the country random effects. However, *REGINEQ* is not a statistically significant estimate.

Table 9. Growth Estimates (Ten Year Periods) *

Variable	1	2	3	4	5	6	7	8
INTERCEP	-4.180	-4.505	-4.113	-4.372	-3.581	-3.916	-3.614	-3.849
	(0.001)	(0.002)	(0.008)	(0.009)	(0.001)	(0.001)	(0.004)	(0.005)
GINIADJT	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.003
	(0.001)	(0.001)	(0.005)	(0.002)	(0.001)	(0.000)	(0.002)	(0.001)
INIRGDPT	-0.012	-0.010	-0.014	-0.013	-0.012	-0.011	-0.015	-0.013
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
LSCHOOLT	0.007	0.008	0.008	0.009	0.008	0.010	0.009	0.010
	(0.167)	(0.132)	(0.176)	(0.148)	(0.094)	(0.070)	(0.111)	(0.094)
LINVESTT	0.024	0.048	0.027	0.056	0.024	0.047	0.027	0.054
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AVLPOPT	-0.003	-0.003	-0.006	-0.005	-0.003	-0.003	-0.006	-0.005
	(0.580)	(0.636)	(0.384)	(0.439)	(0.567)	(0.605)	(0.371)	(0.421)
MJCHANT					-0.014	-0.017	-0.013	-0.015
					(0.192)	(0.142)	(0.237)	(0.180)
REGINEQT		0.000		0.000		0.000		0.000
		(0.642)		(0.512)		(0.747)		(0.562)
Country Random Effects								
Australia			-0.141	-0.149			-0.244	-0.264
			(0.740)	(0.739)			(0.577)	(0.567)
Bangladesh			0.591	0.682			0.599	0.699
			(0.207)	(0.191)			(0.210)	(0.188)
Belguim			0.072	0.081			0.117	0.130
			(0.877)	(0.868)			(0.805)	(0.791)
Brazil			0.354	0.387			0.378	0.410
			(0.412)	(0.390)			(0.388)	(0.366)
Canada			0.496	0.567			0.497	0.557
			(0.254)	(0.219)			(0.262)	(0.235)
Chile			-0.240	-0.278			-0.216	-0.248
			(0.556)	(0.505)			(0.602)	(0.557)
China			-0.265	-0.237				
			(0.603)	(0.656)				
Colombia			0.134	0.112			0.196	0.188
			(0.764)	(0.809)			(0.668)	(0.688)
Costa Rica			-0.167	-0.239			-0.143	-0.204
			(0.682)	(0.567)			(0.730)	(0.630)
Cote d'Ivoire			-0.508	-0.575			-0.509	-0.581
			(0.315)	(0.278)			(0.321)	(0.278)
Denmark			-0.217	-0.235			-0.180	-0.184
			(0.630)	(0.612)			(0.696)	(0.697)
Egypt			0.792	0.956			0.735	0.877
			(0.090)	(0.058)			(0.121)	(0.085)

* Values in parenthesis are p-values

Table 9. Growth Estimates (Ten Year Periods) *, continued

Variable	1	2	3	4	5	6	7	8
Finland			-0.325	-0.119			-0.407	-0.196
			(0.447)	(0.783)			(0.352)	(0.657)
France			-0.062	-0.073			-0.087	-0.097
			(0.876)	(0.859)			(0.832)	(0.816)
Greece			-0.275	-0.313			-0.274	-0.303
			(0.539)	(0.498)			(0.548)	(0.518)
India			-0.751	-0.866			-0.804	-0.908
			(0.080)	(0.054)			(0.067)	(0.047)
Indonesia			-0.068	-0.116			-0.128	-0.172
			(0.870)	(0.789)			(0.763)	(0.695)
Iran			0.154	0.206			0.172	0.210
			(0.716)	(0.645)			(0.690)	(0.642)
Ireland			-0.297	-0.332			-0.234	-0.239
			(0.520)	(0.490)			(0.629)	(0.635)
Italy			-0.169	-0.180			-0.228	-0.246
			(0.703)	(0.694)			(0.614)	(0.596)
Jamaica			-0.476	-0.535			-0.433	-0.481
			(0.291)	(0.250)			(0.344)	(0.307)
Japan			0.355	0.472			0.230	0.334
			(0.401)	(0.279)			(0.599)	(0.455)
Jordan			-0.508	-0.535			-0.525	-0.562
			(0.312)	(0.314)			(0.303)	(0.296)
Korea			0.965	1.022			0.966	1.022
			(0.036)	(0.032)			(0.040)	(0.036)
Malaysia			0.117	0.113			0.099	0.097
			(0.793)	(0.809)			(0.826)	(0.837)
Mauritius			0.579	0.589			0.599	0.613
			(0.251)	(0.266)			(0.243)	(0.253)
Mexico			0.317	0.296			0.318	0.296
			(0.453)	(0.499)			(0.459)	(0.504)
Morocco			0.059	0.070			0.107	0.124
			(0.906)	(0.895)			(0.835)	(0.817)
Netherlands			-0.044	-0.057			-0.017	-0.023
			(0.925)	(0.906)			(0.972)	(0.963)
Norway			-0.111	-0.025			-0.098	0.001
			(0.786)	(0.952)			(0.815)	(0.998)
Pakistan			0.101	-0.009			0.101	-0.001
			(0.819)	(0.986)			(0.824)	(0.998)
Panama			-0.341	-0.375			-0.290	-0.317
			(0.449)	(0.421)			(0.526)	(0.500)
Peru			-0.514	-0.574			-0.486	-0.544
			(0.254)	(0.218)			(0.288)	(0.248)

* Values in parenthesis are p-values

Table 9. Growth Estimates (Ten Year Periods) *, continued

Variable	1	2	3	4	5	6	7	8
Philippines			-0.362	-0.487			-0.377	-0.490
			(0.383)	(0.262)			(0.371)	(0.264)
Portugal			0.120	0.128			0.162	0.184
			(0.787)	(0.780)			(0.721)	(0.694)
Rwanda			-0.315	-0.327			-0.390	-0.416
			(0.535)	(0.544)			(0.451)	(0.448)
Singapore			0.756	0.898			0.712	0.847
			(0.098)	(0.059)			(0.125)	(0.078)
Spain			0.331	0.393			0.310	0.368
			(0.418)	(0.349)			(0.457)	(0.388)
Sri Lanka			-0.033	-0.202			-0.108	-0.277
			(0.938)	(0.645)			(0.801)	(0.532)
Sweeden			-0.192	-0.234			-0.262	-0.314
			(0.656)	(0.599)			(0.552)	(0.489)
Tanzania			0.122	0.196			0.143	0.213
			(0.792)	(0.684)			(0.760)	(0.662)
Thailand			0.213	0.136			0.244	0.188
			(0.602)	(0.749)			(0.562)	(0.665)
Tunisia			0.192	0.265			0.178	0.236
			(0.639)	(0.545)			(0.669)	(0.593)
Turkey			0.057	0.182			0.130	0.255
			(0.890)	(0.677)			(0.758)	(0.566)
United Kingdom			0.565	0.500			0.535	0.437
			(0.219)	(0.294)			(0.263)	(0.374)
Unites States			0.125	0.089			0.110	0.067
			(0.768)	(0.841)			(0.798)	(0.882)
Venezuela			-0.583	-0.682			-0.623	-0.730
			(0.200)	(0.146)			(0.178)	(0.126)
Zambia			-0.605	-0.584			-0.571	-0.555
			(0.232)	(0.269)			(0.266)	(0.298)

* Values in Parenthesis are p-values

The Growth Estimate Statistics for the ten year period estimations are presented in Table 10. The statistics are, as mentioned for Table 6, number of observations, the adjusted R squared, the Aikaike Information Criterion, the F value, the probability greater than the F value, the Sum of Squared Errors, and –2 the Restricted Log Likelihood. Models **2** and **6** both minimize the A.I.C.

Table 10. Growth Estimates Statistics (Ten Year Periods)

Variable	1	2	3	4	5	6	7	8
Observations	112	112	112	112	111	111	111	111
R Adjusted	0.4537	0.4498 [1]	0.8231 [1]	0.8191 [1]	0.4916	0.4923 [1]	0.8295 [1]	0.8255 [1]
AIC	-192.543	-200.621	-191.643	-199.082	-196.505	-204.173	-195.572	-202.654
F Statistic	19.603	14.45	5.37	5.04	18.89	14.4	5.52	5.18
Prob F Statistic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
SSE	120.2236	119.4023	40.7408	39.2624	122.3629	120.7242	43.3674	41.4792
-2 ResLogLikelihood	383.0868	399.2414	379.2861	394.1633	391.0109	406.3453	387.1433	401.3086

[1] R-square

If pairwise model comparisons are allowed based on the A.I.C. for the equivalent specifications (model **5** to **1**, model **6** to **2**, model **7** to **3** and model **8** to **4**), it follows that the A.I.C. is minimized in estimations **5** through **8** where political instability is taken into consideration. Models **3** and **7** show the highest levels of the R squared.

Inequality Equation

The same model specifications estimated for the five year average data set are presented in this section with the ten year period data set.

Table 11. Income Inequality Estimates (Ten Year Periods) *

Variable	1	2	3	4	5	6	7	8
INTERCEP	9.399	9.324	8.406	8.439	10.021	9.616	9.433	9.256
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RGDPLAST	174.591	80.295	181.638	116.940	35.143	10.299	38.945	41.395
	(0.000)	(0.036)	(0.000)	(0.000)	(0.232)	(0.777)	(0.051)	(0.157)
RGDPLAVG	-0.001	-0.002	-0.001	-0.001	-0.001	-0.001	0.000	-0.001
	(0.000)	(0.000)	(0.007)	(0.003)	(0.000)	(0.000)	(0.015)	(0.008)
INVRGDPL	-12408.000	-11075.513	-6286.568	-5432.352	-13367.000	-12001.984	-6592.778	-6058.907
	(0.000)	(0.000)	(0.044)	(0.080)	(0.000)	(0.000)	(0.027)	(0.041)
LSCHOOL	-5.400	-3.535	-6.413	-5.070	-4.924	-3.297	-5.874	-4.920
	(0.005)	(0.073)	(0.003)	(0.022)	(0.007)	(0.076)	(0.005)	(0.022)
LYINDYAG					3.617	3.547	1.682	1.665
					(0.001)	(0.000)	(0.107)	(0.108)
REGGR		24.484		15.567		23.063		13.841
		(0.007)		(0.073)		(0.010)		(0.109)
Country Random Effects								
Australia			-0.343	-0.211			0.189	0.341
			(0.309)	(0.550)			(0.638)	(0.417)
Bangladesh			-1.204	-1.159			-1.254	-1.203
			(0.002)	(0.003)			(0.002)	(0.004)
Belguim			-1.524	-1.514			-1.544	-1.525
			(0.000)	(0.000)			(0.000)	(0.000)
Brazil			1.695	1.809			1.668	1.776
			(0.000)	(0.000)			(0.000)	(0.000)
Canada			-0.660	-0.787			-0.749	-0.851
			(0.055)	(0.029)			(0.036)	(0.023)
Chile			1.027	1.061			1.093	1.095
			(0.002)	(0.002)			(0.001)	(0.002)
China			-1.233	-1.235			-1.436	-1.412
			(0.011)	(0.014)			(0.005)	(0.007)
Colombia			1.014	1.077			1.133	1.184
			(0.006)	(0.004)			(0.003)	(0.003)
Costa Rica			0.848	0.806			0.988	0.964
			(0.007)	(0.013)			(0.004)	(0.006)
Cote d'Ivoire			-0.401	-0.450			-0.420	-0.497
			(0.417)	(0.375)			(0.409)	(0.343)
Denmark			-0.739	-0.716			-0.717	-0.680
			(0.049)	(0.063)			(0.067)	(0.091)
Egypt			0.359	0.221			0.541	0.401
			(0.334)	(0.570)			(0.171)	(0.333)

* Values in parenthesis are p-values

Table 11. Income Inequality Estimates (Ten Year Periods) *, continued

Variable	1	2	3	4	5	6	7	8
Finland			-1.111	-1.113			-1.116	-1.105
			(0.001)	(0.001)			(0.001)	(0.002)
France			0.538	0.605			0.108	0.187
			(0.094)	(0.069)			(0.775)	(0.633)
Greece			0.284	0.306			0.404	0.441
			(0.430)	(0.410)			(0.283)	(0.256)
India			-0.858	-0.793			-0.897	-0.824
			(0.020)	(0.037)			(0.021)	(0.039)
Indonesia			-0.400	-0.269			-0.540	-0.431
			(0.272)	(0.481)			(0.159)	(0.284)
Iran			0.381	0.438			0.529	0.537
			(0.381)	(0.326)			(0.247)	(0.251)
Ireland			0.167	0.075			0.399	0.354
			(0.686)	(0.861)			(0.379)	(0.449)
Italy			-0.482	-0.422			-0.562	-0.501
			(0.179)	(0.254)			(0.128)	(0.190)
Jamaica			1.313	1.281			1.134	1.083
			(0.001)	(0.001)			(0.011)	(0.017)
Japan			-0.403	-0.223			-0.433	-0.293
			(0.260)	(0.554)			(0.241)	(0.457)
Jordan			0.090	-0.689			0.281	-0.454
			(0.849)	(0.297)			(0.560)	(0.495)
Korea			-1.056	-0.835			-0.921	-0.767
			(0.005)	(0.038)			(0.017)	(0.067)
Malaysia			1.033	1.234			1.101	1.300
			(0.004)	(0.001)			(0.003)	(0.001)
Mauritius			0.614	0.196			0.882	0.521
			(0.175)	(0.705)			(0.072)	(0.350)
Mexico			1.654	1.741			1.642	1.721
			(0.000)	(0.000)			(0.000)	(0.000)
Morocco			-0.317	-0.458			-0.382	-0.544
			(0.513)	(0.363)			(0.444)	(0.296)
Netherlands			-1.303	-1.289			-1.104	-1.065
			(0.001)	(0.001)			(0.023)	(0.033)
Norway			-0.392	-0.373			-0.446	-0.413
			(0.225)	(0.261)			(0.180)	(0.227)
Pakistan			-1.421	-1.243			-1.367	-1.201
			(0.000)	(0.004)			(0.002)	(0.010)
Panama			1.645	1.623			1.828	1.823
			(0.000)	(0.000)			(0.000)	(0.000)
Peru			1.356	1.403			1.271	1.290
			(0.000)	(0.000)			(0.002)	(0.002)

* Values in parenthesis are p-values

Table 11. Income Inequality Estimates (Ten Year Periods) *, continued

Variable	1	2	3	4	5	6	7	8
Philippines			1.266	1.340			1.234	1.328
			(0.001)	(0.000)			(0.001)	(0.001)
Portugal			-0.965	-0.874			-1.077	-1.023
			(0.008)	(0.020)			(0.004)	(0.009)
Rwanda			-0.875	-0.940			-1.328	-1.367
			(0.079)	(0.067)			(0.018)	(0.017)
Singapore			-0.335	0.009			-0.045	0.239
			(0.363)	(0.984)			(0.909)	(0.593)
Spain			-1.227	-1.164			-1.192	-1.152
			(0.000)	(0.001)			(0.011)	(0.017)
Sri Lanka			0.311	0.340			0.388	0.419
			(0.340)	(0.312)			(0.258)	(0.234)
Sweeden			-0.676	-0.669			-0.702	-0.670
			(0.045)	(0.053)			(0.078)	(0.101)
Tanzania			1.157	1.061			1.249	1.167
			(0.085)	(0.121)			(0.070)	(0.098)
Thailand			0.129	0.231			-0.189	-0.095
			(0.676)	(0.475)			(0.609)	(0.805)
Tunisia			0.826	0.572			1.007	0.771
			(0.021)	(0.144)			(0.009)	(0.068)
Turkey			0.700	0.486			0.588	0.375
			(0.039)	(0.186)			(0.098)	(0.332)
United Kingdom			-1.686	-1.748			-1.728	-1.752
			(0.000)	(0.000)			(0.000)	(0.000)
Unites States			0.248	0.165			0.156	0.097
			(0.499)	(0.665)			(0.689)	(0.810)
Venezuela			0.195	0.276			0.055	0.114
			(0.596)	(0.468)			(0.887)	(0.776)
Zambia			0.762	0.819			0.278	0.300
			(0.097)	(0.084)			(0.637)	(0.618)

* Values in parenthesis are p-value

In this case, last period' s growth of income is positively related to this period's income inequality for all models. However, it loses statistical significance when the sectoral income ratio variable (industry to agriculture) is considered (models **5**, **6**, **7**, and **8**). Whith country random effects in models **7** and **8** this statistical significance is improved. Estimates of the level of income and its inverse are negative and significant at the 8 percent level of significance, as predicted by Kuznets, in all specifications excepting model **7** where the estimate of *RGDPLAVG* is positive. Human capital is economically and statistically significant, supporting the hypothesis of a negative relationship between schooling and income inequality as expected. Income share of industry to agriculture is positive and significant at the 11 percent significance level in all models.

Models **1** and **5** remain invariant to the inclusion of the interaction term *REGGR* in models **2** and **6**. *REGGR* in model **2** and **6** loses significance when country random effects are added in model **4** and **8**. Country random models **3** and **7** report similar results to the restricted models **1** and **5**, but in **7** now the estimate of last period's income growth is statistically significant. Model **7** is the only specification for which this variable is significant statistically when considering the sectoral income ratio.

Table 12 presents the Income Inequality Estimates Statisitics. When considering country random effects in models **3** and **4**, and **7** and **8**, the A.I.C. is minimized numerically if the interaction term *REGGR* is not included.

Table 12. Income Inequality Estimates Statistics (Ten Year Periods)

Variable	1	2	3	4	5	6	7	8
Observations	107	107	107	107	101	101	101	101
R Adjusted	0.5025	0.5415 [1]	0.95207 [1]	0.9510 [1]	0.526	0.5868 [1]	0.9582 [1]	0.9592 [1]
AIC	-149.507	-146.424	-120.269	-119.416	-139.852	-137.017	-116.454	-115.489
F Statistic	28.023	24.09	21.81	20.54	23.415	22.49	21.58	21.28
Prob F Statistic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
SSE	108.8323	108.6217	10.8916	11.6005	102.0405	102.142	228.9075	10.0927
-2 ResLogLikelihood	297.0134	290.8477	236.5382	234.8321	277.703	272.0345	228.9075	226.9786

[1] R-square

Overlapping Data

Estimations were performed and results differed with respect to those of the non-overlapping data as expected. That is, given that the initial income level is not an average the overlapping estimation as suggested by Harri and Brorsen does not apply fully to the here proposed growth equation. Thus, a further correction has to be done before the overlapping estimation results are meaningful. However, the overlapping estimation seems a step to strongly consider in further research on economic growth!

Summary

Growth Equation

In summary, as far as the growth equation is concerned, results throw evidence in support of the idea that the length of time in the year periods used in the estimations does not make a big difference. Some basic results are consistent regardless of time spans. For instance, following Forbes (2000), Li and Zou (1998), Barro (2000) , Lee and Roemer (1999) and Sylwester (2000) income inequality has a statistically significant positive effect on economic growth throughout all specifications at the 15 percent level of significance The same occurs with the initial income level estimate: always negative and statisitically significant in support of the economic convergence hypothesis. Similarly, investment is always positive and statistically significant, following previous empirical evidence of the strong positive association between investment and economic growth. Moreover, even when population growth presents, as expected, a negative sign it is significant statistically in just a few cases in the five year period estimation when additionally controlling for political instability. It loses all statistical significance in the medium term (ten year period estimation). The interation term *REGINEQ*, that tells about how the effect of income inequality on economic growth is region varying, is statistically significant only for models **1** through **4** of the five year period estimation. Schooling is positive in all specifications, and, in the five year period is statistically significant only when considering political instability, country random or both. Similarly, in the case of the ten year period results, schooling is only statistically significant when political instability is taken into account. Political instability, in turn, is always negative, but only statistically significant for the short run estimation results.

Inequality Equation

In summary, the effect of last period's growth of income is clearer in the medium run than in the short run as this variable is consistenly positive in the ten year period estimation. However, this is true only for the models **1** trough **4** where the sectoral income ratio is not added to the estimations. Schooling proves to be robustly and negatively related to income inequality and so do the level of income and its inverse in support of the Kuznet hypothesis. The sectoral income ratio (industry to agriculture) is consitently positive in all models for both the short and the medium run estimations at the 12 percent significance level, suggesting that as the per capita income in industry increases relative to the per capita income in agriculture, income differentials due to productivity differentials are positively related to income inequality. The interaction term *REGGR* is both economically and statistically significant in all models; this fails to reject the hypothesis that the effect of economic growth on income inequality is region varying. This supports the argument that the increase in income inequality resulting from an increase in last period's economic growth increases as we move troughout regions from the High Income Country Region to Asia, Latin America, Sub-Saharan Africa, and

Middle East and North Africa at the end. This supports Kuznets argument that at earlier stages of economic development increases in economic growth result in greater increases in income inequality compared to later stages of development (inverted-U-curve idea).

CHAPTER VI

CONCLUSIONS

Literature reveals there has been much controversy on the relationship between income inequality and economic growth. The present study supports new results -Forbes (2000), Li and Zou (1998), Barro (2000), Lee and Roemer (1999) and Sylwester (2000)- regarding a positive relationship between income inequality and economic growth. Evidence from the income inequality estimates gives support to the argument that (initial contemporaneous) income inequality is a precondition to contemporaneous economic growth in both the medium and the short run estimations; and that last period's economic growth is positively related to contemporaneous income inequality, especially in the medium run.

The estimates obtained in the present study are based on panel high quality income inequality data, whereas previous studies used cross-country estimations based on low quality income inequality data. This key difference results in improved estimates when high quality data are used. The results of the present study shed light on new research ground for an old research topic. Thus, the policy implications of the herein obtained results provide statistical evidence that the negative relationship between income inequality and economic growth found in previous research is not final, neither in economic nor in statistical terms.

Although empirical estimations of the recursive system were performed separately, given that the statistical evidence from the cross model correlations rejected the existence of contemporaneous correlation between the error terms of the income inequality and the economic growth equations, the proposed recursive equation system is an innovative form of estimating the interrelation between income inequality and economic growth. The underlined assumption indicates that both income inequality and economic growth are sequentially related; this is to say that there is no direct feedback from growth of per capita income into inequality. The effect of growth of per capita income on income inequality is presented in a lag form whereas inequality contemporaneously affects income per capita as the initial level of income inequality.

A step forward has been taken in the present research to consider random effects to account for country variability as suggested by Li, Squire and Zou (1998). A *mixed* linear model using the Statistical Analisis System/Iterative Matrix Language was implemented to consider, thus, country random effects after testing for the appropriate model specification.

Estimations perfomed using both five and ten year period data sets support the idea that some basic results are consistent regardless of time spans. Moreover, interaction variables such as *REGINEQ* and *REGGR*, to account for region varying effects, allowed to take into consideration the effect of income inequality and economic growth on each other when interacting with regions. These interaction terms threw evidence in support of a positive effect of economic growth on income inequality that varies across regions.

Thus, increments in income inequality due to past economic growth become greater as one moves throughout regions, starting from the High Income Country Region Classification to Asia, Latin America, Sub-Saharan Africa, and finally Middle East and North Africa.

Performing a panel estimation addressed what most studies in the past did not: how a change in a country's level of income inequality affects economic growth *within* a country and viceversa. This estimation method added to using the high quality data on income inequality from the Deininger and Squire Data Set implied improved statistical results for minimizing measurement error and removing coefficient bias as discussed in Forbes (2000).

Finally, still lack of data, uncompleteness and unbalancedness have to be kept in mind for the above conclusions. Moreover, endogeneity and omitted variables that vary across time may still be a problem. There are three considerations for further research. First, to use the overlapping data set after correcting for the additional problem imposed by not having all explanatory variables of the growth equation as averages. Second, to use income growth per quintile as the dependent variable for the growth equation. Third, to increase the period length of the year periods to determine whether the parameter estimates are robust in a longer run setup.

REFERENCES

Adelman, Irna and S. Robinson. "Income Distribution and Development," in H. Chenery, T. N. Srinivasan, eds. *Handbook of Development Economics*. New York, 1989.

Adelman, I. and C.T. Morris *Economic Growth and Social Equity in Developing Countries*, Stanford, California: Stanford University Press,1973.

Adelman, Irma. *Theories of Economic Growth and Development*. California: Stanford University Press, 1961.

Ahluwalia, Montek, and H. Chenery. "The Economic Framework." In *Redistribution with Growth*. Washington: Oxford University Press, 1974: 38-51.

Ahluwalia, Montek, N. Carter, and H. Chenery. "Growth and Poverty in Developing Countries." *Journal of Development Economics* 6 (September 1979) : 299-341.

Ahluwalia, Montek. "Income Distribution and Development: Some Stylized Facts." *American Economic Review*. 66-2 (1976b):128-35.

Ahluwalia, Montek. "Income Inequality: Some Dimensions of the Problem", in *Redistribution with Growth* by Chenery et al.. London: Oxford University Press, 1974.

Ahluwalia, Montek. "Inequality, Poverty and Development." *Journal of Development Economics* 3 (March 1976) : 307-342.

Ahluwalia, Montek. "Inequality, Poverty and Development." *Journal of Development Economics*. 3 (1976a):307-342.

Alesina, Alberto and D. Rodrik. "Distributive Politics and Economic Growth," *Working Paper Series No. 3668. National Bureau of Economic Research*, Inc.,1991.

Alesina, Alberto and D. Rodrik. "Distributive Politics and Economic Growth," *Quarterly Journal of Economics*. 109-2 (1994):465-490.

Alesina, Alberto and R. Perotti. "Income Distribution, Political Instability, and Investment." *European Economic Review*. 40-6 (1993):1203-1228.

Alesina, Alberto, and R. Perotti. "Income Distribution, Political Instability, and Investment." Working Paper Series No. 4486. National Bureau of Economic Research, Inc. 1993

Alesina, Alberto., S. Özler, N. Roubini, and P. Swagel. "Political Instability and Economic Growth." *Journal of Economic Growth*. 1.(June 1996):189-211.

Alonso, William, (1980), "Five Bell Shapes in Development," *The Regional Science Association Papers*, 45. (1980):5-16.

Altimir, Oscar,. "The Extent of Poverty in Latin America," *World Bank Staff Working Papers*, 522 , 1982.

Anand, Sudhir and S. M. Kanbur. "Inequality and Development." *Journal of Development Economics*. 41. (1993a):19-43.

Anand, Sudhir, and S. M. Kanbur. "The Kuznets Process and the Inequality-Development Relationship." *Journal of Development Economics*. 40. (1993b):25-52.

Bardhan, Pranab. "Research on Poverty and development Twenty Years after Redistribution with Growth" in *Annual World Bank Conference on Development Economics* by Michael Bruno and Boris Pleskovic. Washington: The World Bank, 1996.

Barro, Robert. "Inequality and Groth in a Panel of Countries." *Journal of Economic Growth*. 5 (March 2000):5-32.

Barro, Robert. "Democracy and Growth." NBER Working Paper 4909, October 1994.

Barro, Robert. "Economic Growth in a Cross Section of Countries." *Quarterly Journal of Economics*. 106. (May 1991):407-443.

Barros, Ricardo, L. Fox and R. Mendonca. "Female-Headed Households, Poverty, and the Welfare of Children in Urban Brazil." *Economic Development and Cultural Change*. 45,2.(January 1997):231-257.

Bénabou, Ronald. "Inequality and Growth." in NBER Macroeconomics Annual 1996. The MIT Press, Cambridge Massachusetts, London, England, (1996):11-92.

Benhabib, Jess and M. Spiegel. "The Role of Human Capital in Economic Development. Evidence from Aggregate Cross-Country Data." *Journal of Monetary Economics*. 34-2.(October 1994):143-173.

Bladen, Vincent, (1974), *From Adam Smith to Maynard Keynes; the heritage of political economy*," Toronto: University of Toronto Press.

Bourguignon, Francois and C. Morrison. "Income Distribution, Development and Foreign Trade." *European Economic Review*. 34-6. (September 1990): 1113-1132.

Bourguignon, Francois. "Growth, Distribution and Human Resources" in *En Route to Modern Growth: Latina America in the 1990s* by Gustav Ranis. Washington: The Johns Hopkins University Press.

Budd, Edward (editor) *Inequality and Poverty*. New York WW Norton & Company Inc. 1967.

Buvinic, Mayra and G. R. Gupta. "Female-Headed Households and Female-Maintained Families: Are They Worth Targeting to Reduce Poverty in Developing Countries." *Economic Development and Cultural Change*. 45,2(January 1997):259-280.

Cardoso, Eliana and A. Helwege. *Latin America's Economy. Diversity, Trends and Conflicts*. The MIT Press Cambridge Massachusetts, 1995.

Chenery, Hollis., M. Ahluwalia, C. Bell, J. Duloy, and R. Jolly. *Redistribution with Growth*, New York: Oxford University Press, 1975.

Chu, Yun-Peng. "The Effects of Off-farm Employment on Inequality: Theories and an Empirical Application to the Taiwan Case." *Journal of Economic Development.* 21.2. (December 1996):221-56.

Clarke, George. "More Evidence on Income Distribution and Growth." *Journal of Development Economics.* 47,2(August 1995):403-427.

Cué, Felix. "Income Distribution and Economic Development : A Case Study of the Kuznets' Hypothesis Applied to Puerto Rico." Oklahoma State University, Department of Economics. Unpub. Ph.D. Diss., May 1985.

Dasgupta, A. *Epochs of Economic Theory*, New York: Basil Blackwell Inc., 1985.

De Haan, Jacob and C. Siermann. "Political Instability, Freedom, and Economic Growth: Some Further Evidence." *Economic Development and Cultural Change.* 44,2(January 1996):339-350.

Deininger, Klaus and L. Squire. "New ways of looking at old issues: inequality and growth." *Journal of Development Economics.* 57 (1998):259-287.

Deininger, Klaus and L. Squire. "A New Data Set Measuring Income Inequality." *The World Bank Economic Review.* 10-3 (September 1996):565-91.

Deininger, Klaus and L. Squire. 1996. *Measuring Income Inequality: a New Database.* The World Bank, Policy Research Department, June. Manuscript.

Duffy-Deno K. and R. Eberts. "Public Infrastructure and Regional Economic Development : A Simultaneous Equations Approach." *Journal of Urban Economics.*30 (1991):329-343.

Edwards, Sebastian. "Trade Orientation, Distortions and Growth in Developing Countries." *Journal of Development Economics.* 39 (1992):31-57.

Fields, Gary. "Higher Education and Income Distribution in a Less Developed Country." *American Economic Review.* 27-2.(July 1975): 357-374.

Fields, Gary. "Measuring Inequality Change in an Economy with Income Growth." *Journal of Development Economics.* 26 (1987):357-374.

Fields, Gary. 1989. "A Compendium of data on Inequality and Poverty for the Developing World." Cornell University, Department of Economics, Ithaca, N.Y. Processed.

Forbes, Kristin. "A Reassessment of the Relationship Between Inequality and Growth." *American Economic Review* (Forthcoming 2000).

Foxley, Alejandro, ed. *Income Distribution in Latin America.* New York: Cambridge University Press, 1976.

Galor, Oded. "Income distribution and the process of development." *European Economic Review.* 44 (2000):706-712

Gastil, Raymond. *Freedom in the World.* Various vols. Oxford: Clio.

Grier, Kevin, and G. Tullock. "An Empirical Analysis of Cross-National Economic Growth, 1951-80." *Journal of Monetary Economics*. 24-2 (September 1989):259-276.

Griffin, Keith. *Alternative Strategies for Economic Development*, New York: St. Martin's Press, 1989.

Harvey, A.C.. "Estimating Regression Models with Multiplicative Heteroscedasticity." *Econometrica* 44 (1976): 461-465.

Jain, Shail. 1975. *Size Distribution of Income: A Compilation of Data*. Washington, D.C.: World Bank.

Judge, George., R. Hill., W. Griffiths., H. Lütkepohl, and T. Lee. *Introduction to the Theory and Practice of Econometrics*. Second Edition. Wiley and Sons, 1988.

Kaldor, Nicholas. "Capital Accumulation and Economic Growth." In Nicholas Kaldor, ed., *Further Essays on Economic Theory*, New York: Holmes and Meier Publishers, Inc., 1978.

Knight, J.B. and R.H. Sabot. "Educational Expansion, Government Policy and Wage Compression." *Journal of Development Economics*. 26-2 (August 1987): 201-221.

Knight, Malcom, N. Loayza and D. Villanueva. "Testing the Neoclassical Theory of Economic Growth: A Panel Data Approach." *IMF Staff Papers*. 40 (September 1993):512-541.

Kormendi, Roger and P. Meguire. "Macroeconomic Determinants of Growth." *Journal of Monetary Economics*. 16 (July-November 1985):141-163.

Kravis, I.G. "International Differences in the Distribution of Income." *Review of Economics and Statistics*. 42 (1960): 408-416.

Kuznets, Simon. "Economic Growth and Income Inequality." *The American Economic Review*. 45 (March 1955):1-28.

Kuznets, Simon. "Quantitative Aspects of the Economic Growth of Nations, VII: Distribution of Income by Size." *Economic Development and Cultural Change*. 11.(January 1963):1-80.

Kwabena, "Non Elite Political Instability and Economic Growth: Evidence from Sub-Saharan AfricaTitle" *Journal of Economic Development*. 21-1. (June 1996).

Lam, David and Deborah Levison. "Declining Inequality in Schooling in Brazil and its Effects on Inequality in Earnings." *Journal of Economic Development*. 37. (1992):199-225.

Lee, Woojin and J. Roemer. "Inequality and redistribution revisited." *Economic Le*tters. 65 (1999):339-346.

Leibenstein, Harvey, (1957), *Economic Backwardness and Economic Growth*, New York: John Wiley & Sons, Inc., 1957.

Li, Hongyi, Lyn Squire and Hen-fu Zou. "Explaining International and Intertemporal Variations in Income Inequality." *The Economic Journal* 108. (January, 1998):26-43.

Li, Hongyi and H. Zou. "Income Inequality is not Harmful for Growth: Theory and Evidence." *Review of Development Economics 2.3.* (1998):318-334.

Littell, Ramon C., Milliken, George A., Stroup, Walter W., and Wolfinger, Russell D., *SAS System for Mixed Models*

Loehr, William. "Economic Growth, Distribution and Income of the Poor." *Journal of Economic Studies*. 7. (1980):127-139.

Londregan, John and K. Poole. "Poverty, the Coup Trap, and the Seizure of Executive Power." *World Politics*. XLII-2.(January 1990):151-183.

Mankiw, Gregory., D. Romer and D. Weil. "A Contribution to the Empirics of Economic Growth." *The Quarterly Journal of Economics*. 107-2.(May 1992):407-437.

Meade, James. "Combating Inequality." In *Inequality and Poverty* by Edward Budd. New York, Pennsylvania State University. 1967.

Meier, Gerald. *Emerging from Poverty. The Economics that Really Matters*. New York: Oxford University Press, 1984.

Meier, Gerald. *Leading Issues in Economic Development.* Fifth edition. New York, Oxford University Press, 1989.

Morgan, T. "Distribution of Income in Ceylon, Puerto Rico, the United States and the United Kingdom." *Economic Journal*. 63 (1953):821-834.

Morley, Samuel. *Poverty and Inequality in Latin America. The Impact of Adjustment and Recovery in the 1980s*. The John Hopkins University Press. Baltimore. 1995.

Murphy, Kevin, A. Shleifer and R. Vishny. "Income Distribution, Market Size, and Industrialization." *Quarterly Journal of Economics*. 104,3. (August 1989):537-564.

Nehru, Vikram, E. Swanson and A. Dubey. "A New Database on Human Capital Stock In Developing and Industrial Countries: Sources, Methodology and Results." *Journal of Development Economics*. 46. (1995):379-401.

Papanek, Gustav and O. Kyn. "The Effect on Income Distribution of Development, the Growth Rate and Economic Strategy." *Journal of Development Economics* 23 (1986) : 55-65.

Paukert, Felix. 1973. "Income Distribution at Different Levels of Development: A Survey of Evidence." *International Labour Review* 108 (2, August-September):97-125.

Perotti, Roberto. "Growth, Income Distribution and Democracy: What the data say." *Journal of Economic Growth*. 1,2 (1996):149-187.

Perotti, Roberto. "Income Distribution and Investment." *European Economic Review*. 38 (April, 1994):827-835.

Persson, Torsten and G. Tabellini. "Is Inequality Harmful for Growth." *American Economic Review*. 84-3. (June 1994):600-621.

Quah, Danny. "Twin Peaks: Growth and Convergence in Models of Distribution Dynamics." *Economic Journal*. 106.(1996):1045-1055.

Quah, Danny and James E. Rauch. "Openness and the Rate of Economic Growth. Preliminary Draft," (Economics Department, Massachusetts Institute of technology, Cambridge, MA, and Economics Department, University of California, San Diego, CA) October 1990.

Rauch, James. "Economic Development, Urban Underemployment, and Income Inequality." *Canadian Journal of Economics*. 26,4(November 1993):901-918.

Robinson, Sherman. "A Note on the U Hypothesis Relating Income Inequality and Economic Development." *The American Economic Review* 66 (June 1976) : 437-440.

Sachs, Jeffrey and Andrew Warner. "Economic Convergence and Economic Policies" National Bureau of Economic Research, Inc. Working Paper 5039. (February 1995b).

Sachs, Jeffrey and Andrew Warner. "Natural Resource Abundance and Economic Growth." National Bureau of Economic Research, Inc. Working Paper 5398. (December 1995a).

Saint-Paul, Gilles and T. Verdier. "Education, Democracy and Growth." *Journal of Development Economics*. 42-2.(December 1993):399-407.

Sarel, Michael. "How Macroeconomic Factors Affect Income Distribution: The Cross-Country Evidence". Working Paper 152. International Monetary Fund, 1997.

SAS Institute Inc., *SAS/STAT Software: Changes and Enhancements through Release 6.12*, Cary, NC:SAS Institute Inc., 1997.1167pp.

Scully, Gerald. "The Institutional Framework and Economic Development." *Journal of Political Economy*. 96,3.(1988):652-662.

Seers, Dudley. "The Meaning of Development." *International Development Review* 11 (December 1969): 2-6

Slesnick, Daniel. "Consumption and Poverty: How Effective are In-Kind Transfers." *The Economic Journal*. 106(November 1996):1527-1545.

Solow, Robert. "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics,* 39 (August 1957):312-20.

Sylwester, Kevin. "Income Inequality, education expenditures and growth." *Journal of Development Economics*. 63 (2000):379-398.

Tilak, Jandhyala. "Education and Its Relation to Economic Growth, Poverty, and Income Distribution." *World Bank Discussion Papers. No. 46. The World Bank.* 1990.

World Bank. *Social Indicators of Development, 1995*. Baltimore: The John Hopkins University Press, 1995a.

World Bank. *Trends in Developing Countries*. Baltimore: The John Hopkins University Press, 1995b.

World Bank. *World Development Report 1992. Development and the Environment*. New York: Oxford University Press, 1992.

World Bank. *World Tables*. Baltimore: The John Hopkins University Press, 1995c.

Appendixes

Appendix A – Note on the Overlapping Problem

Note on the overlapping problem

The overlapping of observations creates a moving average error term problem and the OLS parameter estimates would be inefficient and hypothesis tests would be biased (Harri and Brorsen). The correction for overlapping data would require the use of an analytically derived Ω matrix to transform the x's and y's. If $H'H = \Omega^{-1}$, the transformed x's and y's are $X^* = H'HX$ and $Y^* = H'HY$

Following Harri and Brorsen[32], this transformation of the data creates a moving average (MA) process in the error terms of memory *k-1*, where k is the number of periods within which the changes are estimated. That is, k is 10. Each error term is the sum of k original error terms:

(13) $$e_i = \sum_{j=i}^{i+k-1} u_j ,$$

where u_j are the original error terms, e_i are the new error terms. The model further assumes that $E[u_j] = 0$, $E[u_j^2] = \sigma_u^2$, $Cov[u_t, u_s] = 0$ if $t \neq s$.

From the above conditions:

(14) $$E[e_i] = E\left[\sum_{j=i}^{i+k-1} u_j\right] = \sum_{j=i}^{i+k-1} E[u_j] = 0.$$

The unconditional variance of e_i is:

(15) $$Var[e_i] = \sigma_e^2 = E[e_i^2] = k\sigma_u^2$$

given that the u_j's are uncorrelated.

Also since e_i, e_{i+s} have k-s common original error terms, u, for any $k\text{-}s \geq 0$ only, the covariance between the error terms is:

$$Cov\left[e_i, e_{i+s}\right] = E\left[e_i e_{i+s}\right] = (k-s)\sigma_u^2 \tag{16}$$

When dividing the covariances between the error terms by their variance, $k\sigma^2$, the correlations are:

$$Corr\left[e_i, e_{i+s}\right] = \frac{k-s}{k} \tag{17}$$

The correlation matrix Ω is:

$$\Omega = \begin{bmatrix} 1 & \frac{k-1}{k} & \cdots & \frac{k-s}{k} & \cdots & \frac{1}{k} & 0 & 0 \\ \frac{k-1}{k} & 1 & \frac{k-1}{k} & \cdots & \frac{k-s}{k} & \cdots & \frac{1}{k} & 0 \\ \cdots & \frac{k-1}{k} & 1 & \frac{k-1}{k} & \cdots & \frac{k-s}{k} & \cdots & \frac{1}{k} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{1}{k} & \cdots & \frac{k-s}{k} & \cdots & \frac{k-1}{k} & 1 & \frac{k-1}{k} & \cdots \\ 0 & \frac{1}{k} & \cdots & \frac{k-s}{k} & \cdots & \frac{k-1}{k} & 1 & \frac{k-1}{k} \\ 0 & 0 & \frac{1}{k} & \cdots & \frac{k-s}{k} & \cdots & \frac{k-1}{k} & 1 \end{bmatrix} \tag{18}$$

Initially, the size of the Ω matrix would be the number of countries (J) in the sample times total number of years in the sample, if the data set was balanced. That is, J block diagonal matrices like Ω, one per country and each country having the same years. However, for an unbalanced data set like the overlapping data there are years for some

[32] The statistical theory behind the overlapping problem is presented as in Harri's paper. For a more detailed explanation see Harri.

countries for which income inequality data as specified above are not available. Rows and columns for the unavailable observations would be taken out and the resulting size of the Ω matrix is reduced leaving only those columns and rows for which information is available. Thus, the size of Ω may vary according to data availability for the different models.

Appendix B – List of Countries and Regions and corresponding codes

Table 1. List of Countries and Corresponding Country and Region Codes

Code/Region	Country
1/1	Australia
2/2	Bangladesh
3/1	Belgium
4/3	Brazil
5/1	Canada
6/3	Chile
7/2	China
8/3	Colombia
9/3	Costa Rica
10/4	Cote d'Ivoire
11/1	Denmark
12/5	Egypt
13/1	Finland
14/1	France
15/1	Greece
16/2	India
17/2	Indonesia
18/2	Iran
19/1	Ireland
20/1	Italy
21/3	Jamaica
22/1	Japan
23/5	Jordan
24/2	Korea
25/2	Malaysia
26/4	Mauritius
27/3	Mexico
28/5	Morocco
29/1	Netherlands
30/1	Norway
31/2	Pakistan
32/3	Panama
33/3	Peru
34/2	Philippines
35/1	Portugal
36/4	Rwanda
37/2	Singapore
38/1	Spain
39/2	Sri Lanka
40/1	Sweden
41/4	Tanzania
42/2	Thailand
43/5	Tunisia
44/1	Turkey
45/1	UK
46/1	US
47/3	Venezuela
48/4	Zambia

Table 2. List of Regions and Corresponding CODE

Code	Region
1	High Income
2	Asia
3	Latin America
4	Sub Saharan Africa
5	Middle East and North Africa

Appendix C - Institutional Review Board Approval (IRB)

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 11-18-97 **IRB#:** BU-98-011

Proposal Title: INCOME INEQUALITY AND ECONOMIC DEVELOPMENT

Principal Investigator(s): Ron Moomaw, Sandra Trejos

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING, AS WELL AS ARE SUBJECT TO MONITORING AT ANY TIME DURING THE APPROVAL PERIOD.
APPROVAL STATUS PERIOD VALID FOR DATA COLLECTION FOR A ONE CALENDAR YEAR PERIOD AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Disapproval are as follows:

Signature:
Chair of Institutional Review Board

Date: November 19, 1997

cc: Sandra Trejos

VITA

Sandra Roxana Trejos

Candidate for the Degree of

Doctor of Philosophy

Thesis: INCOME INEQUALITY AND ECONOMIC DEVELOPMENT

Major Field: Economics

Biographical:

Personal Data: Born in San José, Costa Rica, October 11,1968, the daughter of Fernando Trejos and Lidieth Rojas de Trejos.

Education: Graduated from Maria Auxiliadora High School, San José, Costa Rica in December 1985; Theology Studies at Insituto Cor Mariae (1986-1990). Received Bachelor of Science Degree in Economics from University of Costa Rica at San José in October 1990; Master's Degree in Business Administration sought (1991-1992). Received Masters of Science Degree at Oklahoma State University in December, 1994; completed requirements for the Doctor of Philosophy Degree at Oklahoma State University in December 2000.

Experience: Researcher at the Economics Research Institute, University of Costa Rica (1998-2000). Taught Research Methodology and Theory of Social Choice at the Graduate Program, Department of Economics, University of Costa Rica (1999-200). Teaching Associate, Introduction to Macroeconomics, Oklahoma State University (1995-96). Teaching Assistant, Oklahoma State University (1995-1996). Economist , General Comptrollership of the Republic of Costa Rica.(1992). Budget Analyst, General Comptrollership of the Republic of Costa Rica (1991).