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INCOME DISTRIBUTION AND ECONOMIC DEVELOPMENT:

A CASE STUDY OF THE KUZNETS' HYPOTHESIS

APPLIED TO PUERTO RICO

By

FELIX MANUEL CUÉ

Bachelor of Arts
Inter American University of Puerto Rico
San Germán, Puerto Rico
1971

Master of Business Administration
Inter American University of Puerto Rico
San Germán, Puerto Rico
1972

Master of Arts
Inter American University of Puerto Rico
San Juan, Puerto Rico
1974

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
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Thesis Approved:

Thesis Adviser

Dean of Graduate College

1233541

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CHAPTER I

INTRODUCTION

Statement of the Problem

Simon Kuznets' well-known hypothesis (1955) relating economic growth and income distribution hypothesized that, income would become less-equally distributed during the early stages of economic growth when the transition from a preindustrial to an industrial society was just beginning, but that income would eventually become more equally distributed in the later stages of growth. Puerto Rico has moved through the various growth stages assumed by Kuznets during the post WWII era, thus making it an ideal subject for a case study of Kuznets' view. However, as will be argued in the next chapter, previous studies of the relationship between economic growth and the income distribution in Puerto Rico have failed to include many of the elements necessary for a valid examination of Kuznets' hypothesis. To the extent that the present study is successful in overcoming these problems it should fill an important gap in the literature on Puerto Rico economic development.

Although the Kuznets' hypothesis is normally stated as a simple relationship between economic growth and income inequality, Kuznets formulated this relationship on the basis of a fairly complex theory of structural and demographic changes in a developing economy. As an economy developed he expected broad changes to occur in the industrial structure, the location of population and the role of government, that

would produce the postulated relationship between development and distribution. Moreover, Kuznets appeared to have a relatively long time frame in mind, surely, one sufficient to move a country a considerable distance through the development process.

The changes envisioned by Kuznets were, briefly, as follows. Initially, there are two forces at work in the developing countries that contribute to increasing inequality in the distribution of income before taxes and fiscal policies: the concentration of savings in the upper income levels, and the change in the industrial structure from agriculture to manufacturing. However, as growth continues there are factors that counteract the cumulative effects of concentration of savings in the upper-income classes, like legislative interference and political decisions to limit the accumulation, the migration of lower-income groups, population control in the upper-income classes, technological change, and the growing importance of the services and professional incomes.

In summary, Kuznets hypothesized a long swing in income inequality: increasing in the early phases of economic growth, becoming stabilized for a while, and, then decreasing in the later phases.[1]

Nature of the Study

The economic history of Puerto Rico appears to reflect many of the changes mentioned by Kuznets. Until WWII Puerto Rico was a typical underdeveloped country with the majority of population living in and earning its income from the agricultural sector. The share of agriculture in the national income was 31.0 percent in 1940 and declined to 17.5 percent in 1955. In turn, the share of income from manufacturing

increased in the period from 12.7 percent to 21.2 percent. The share of government-Insular plus Federal-increased from 18.5 percent to 19.7 percent.[2] Employment in agriculture declined from 212,000 in 1940 to 151,000 in 1957; in manufacturing it increased during the same period from 111,000 to 141,000; in services from 155,000 to 202,000; and in government from 23,000 to 57,000.[3] These changes followed the decision of the government of Puerto Rico in 1947 to change its development program (code name "Operation Bootstrap") from government operated factories to the promotion of private industry. Thus, started the gradual industrialization and urbanization process of Puerto Rico, with the labor force shifting first from agriculture to light industries (textiles, apparels), and since the late sixties to heavier and high tech industries (pharmaceuticals, electronics, oil refineries).[4] The share of agriculture in the net domestic income fell from 25.6 percent in 1950 to an average of 2.8 percent in the 1975-1980 period; whereas the share of manufacturing and services increased from 19.2 to 30.2 percent, and from 55.2 to 67.0 percent, respectively. The share of agriculture in total employment fell from 36.5 percent in 1950 to an average of 5.4 percent in the 1975-1980 period; whereas the shares of manufacturing and services increased from 22.5 to 25.2 percent, and from 41.0 to 69.1 percent, respectively.[5]

These structural changes have been accompanied since the early seventies by massive government transfer payments.[6] From 1950 to 1980, while the disposable personal income increased from $638 million to $10,494 million, net transfers increased from $63.4 million to $1,750 million, and food stamp payments, alone, increased from zero to $810.6 million. The percentage of transfer payments in the personal income of

Puerto Rico increased from around 10 percent in 1970 to a sizeable 16.7 percent in 1980.[7] Meanwhile, the migration of Puerto Ricans to the U.S. mainland greatly increased; between 1945 and 1953, 250,000 Puerto Ricans left the island, and between 1954 and 1964 approximately 500,000 left.[8] However, during the seventies, coinciding with the recession in the U.S., this trend was reversed.

The appearance in Puerto Rico of the structural changes Kuznets expected suggests that he may be right about the relationship between economic development and the income distribution in this country. However, actual structural changes may not have had the effect postulated by Kuznets. Moreover, other changes may have occurred in Puerto Rico that either strengthened or weakened the influence of the Kuznets variables. Therefore, whether Kuznets was right can be determined only by an empirical analysis of the historical record in which variations in income distribution can be compared with variations in both the independent variables identified by Kuznets, and those not so identified.

Up to now, it is safe to say that the Kuznets hypothesis has been only partially tested for Puerto Rico. First, no study exists which uses data from a long enough time period to capture the whole sweep of development envisioned by Kuznets. Most of the existing studies provide results relevant to only the initial stages of development. Second, the empirical models that have been used have been poorly specified, for example missing relevant independent variables. Finally, the results of the existing empirical tests of Puerto Rican development and distribution have also produced mixed results, as the Review of Literature of Empirical Studies on Income Distribution in Puerto Rico indicates.

Objective of the Dissertation

The objectives of this dissertation are to estimate empirically and compare various indexes of income concentration in Puerto Rico for 1949, 1959, 1969 and 1979, and to determine the causes of changes in the distribution of income over these years, as a means of determining whether the Kuznets' hypothesis fits the Puerto Rican experience.

This should produce an evaluation of the Kuznets' hypothesis in the Puerto Rican context that remedies one of the principal weaknesses of previous attempts: a relatively short time frame. To attain such an aim this study is the first which incorporates 1980 Census data, allowing the capture more fully of the long term nature of the development process and the incorporation of some structural relationships only beginning to appear in 1970. Second, it introduces a wider variety of probable causes of changes in income distribution than previous studies. Third, it is based on econometric procedures that produce a fuller determination of the role played by different influences during the development process.

Areas of Investigation

The first area of investigation examines changes in the income concentration among Puerto Rican municipalities due to variations in determinants of income concentration for the years 1949, 1959, 1969, and 1979. For this purpose a regression analysis of variations in GINI coefficient indexes will be used.

The second area of analysis will employ an ordinary least square (OLS) estimation of GINI coefficient indexes for Puerto Rico, and a test to determine whether changes in these coefficients are statistically

significant. The results of this analysis will be helpful in determining whether the economy of Puerto Rico has had significant structural changes during the period 1949-1979.

The third area of investigation will use three additional aggregate income concentration indexes--the Williamson index, the coefficient of variation, and the standard deviation of logs of income--in order to determine if there is a trend toward lesser regional inequalities between rural and urban municipalities in Puerto Rico, and a growing income concentration in the upper-income brackets as the economy matures.

Organization of Dissertation

Chapter II reviews the literature of empirical studies on income distribution in Puerto Rico, with emphasis on each as a means of testing the Kuznets hypothesis. Special attention is devoted to the time span of data used, the statistical techniques used, and the underlying theoretical structure.

Chapter III discusses the theoretical relationship between income distribution and economic development in terms of Kuznets' hypothesis. It focuses on eleven theoretical relationships suggested by past studies in the United States and Puerto Rico. The chapter also presents the specification of an empirical model in terms of three multiple variable regression equations, using the GINI coefficient index (determined as trapezoidal approximations) as the dependent variable.

Chpater IV develops four other income concentration indexes useful in examining the relationship between economic growth and income distribution: the GINI index determined via ordinary least square, the

Williamson index, the coefficient of variation, and the standard deviation of logs of income. These indexes are aggregate measures for all of Puerto Rico, unlike the GINI index via trapezoidal approximations on a municipality basis. Chapter IV explains also other measures used in order to determine the concentration index ratios, such as per capita income, the Pareto equation, and the Leibenberg and Kaitz equations[9] for computing the mid point of the open-end interval of the income distribution.

Chapter V presents the empirical results obtained for the multiple variable log-linear regression model plus its adjusted variant. Also presented is a comparison of these results with those obtained by Mann and Ocasio, (1977). Finally, because this model is based on cross-section data the results of a test for serial correlation using the Durbin-Watson test are summarized.

Chapter VI presents the estimates of the income concentration indexes summarized in Chapter IV, along with tests of statistical significance for each of these indexes.

Chapter VII summarizes the findings of the study in terms of the trend in the income distribution in Puerto Rico during the period 1949-1979. It also outlines the policy implications for future Puerto Rican administrations of those findings.

Chapter VIII, finally, discusses the main limitations of the present study and provides several recommendations for futher research on income distribution in Puerto Rico.

FOOTNOTES

[1]Simon Kuznets, "Economic Growth and Income Inequality," American Economic Review, Vol. 45, No. 1, (March 1955), pp. 1-18.

[2]Puerto Rico Planning Board, Net Income and Gross Product of Puerto Rico 1940, and 1947-1955, San Juan, Puerto Rico, 1956.

[3]Net Income, (1947-1955), op. cit., p. 202.

[4]Jose Joaquin Villamil, "Puerto Rico 1948-1979: The Limits of Dependent Growth" in Time For Decision: The U.S. and Puerto Rico, The North South Publ. Co. 1983, Lanham, Maryland, pp. 95-111.

[5]Puerto Rico Planning Board, Informe Económico Al Gobernador 1979-1980, San Juan, Puerto Rico, 1980, 1981.

[6]Richard Weisskoff, "Crops and Coupons: Agricultural Development and Food Stamps in Puerto Rico," in Time For Decision, op. cit., pp. 148-149.

[7]Informe Económico, 1980, 1981, op. cit.

[8]Villamil, 1983, op. cit., p. 99.

[9]Maurice Leibenberg and Hyman Kaitz, "An Income Size Distribution from Income Tax and Survey Data," Studies on Income and Wealth, Vol. 13, 1951, pp. 380-462, National Bureau of Economic Research.

CHAPTER II

REVIEW OF LITERATURE OF EMPIRICAL STUDIES ON INCOME DISTRIBUTION IN PUERTO RICO

Few economic problems in Puerto Rico have been the object of as many studies and controversies as the income distribution. The pioneering works on income distribution are the 1960 study by M. Bathia[1] and the well known 1964 study by F. Andic.[2] Bathia's work, as the title suggests, is not a general study of the determinants of the income distribution in Puerto Rico, but rather a compendia of fiscal policy recommendations to make the income of Puerto Rico more equally distributed. The study by Andic is thus the first deep analysis made of the island's income distribution and is the logical point of reference for new investigations on the topic.

For Andic, Puerto Rico did not exhibit the tendency of income to become more unequally distributed in the first stages of economic development as hypothesized by Kuznets. Rather there were several factors that produced a more equal distribution.

Among the factors responsible were:

> The growing share of wages in the functional distribution of income and the declining importance of rent and interest; the growing share of industry in the total product; the decline in importance of unskilled workers in the labor force; the movement of low income rural families to urban areas where better paid jobs and higher average wages are to found; the expansion of the government sector and its services, such as education, health services and aid to low income groups.[3]

There are two other factors, the unemployment rate and the number of women in the labor force, which Andic is not sure would accomplish a more equal income distribution. The former has been persistently high in spite of development, and the effect on income distribution of a larger share of women age 20-44 years old in the labor force still is the object of debate. However, other empirical studies made in the U.S. show that a growing number of women working or in the labor force implies less income equality.[4] According to Andic the redistribution of income is the logical result of certain factors or conditions that accompany economic development, like the rise in per capita income and the decline in importance of the agricultural sector, and their effect on demographic variables. In the latter category are items such as the increase in the number of married women working, the lengthening of the education period, the strengthening of the prohibition of children's employment, and the provision of the means for old-age benefits that encourage early retirement. The latter is part of the increasing role played by the government in Puerto Rico through its fiscal policy mechanisms, for example, progressive tax rates on incomes and property, pro-poor income transfer payments, and free goods and services.

Economic growth by itself, maintains Andic, does not change the income distribution, but instead such changes are the net result of a process which economic growth makes possible.

Andic differs from Kuznets on structural shifts of the society since for the latter full industrialization takes place when the shift of population from the agricultural sector to the non-agricultural sector brings the proportion of the agricultural sector from the range of 60-50 percent to about 20 percent. In that range agricultural income

inequalities will decrease, and since the urban income per capita is higher than the rural, the overall results is to reduce income inequality. For Andic there is a steady rise in the relative income in agriculture since the shift from the agricultural to the nonagricultural sector would be, basically, of marginal workers, who would help to increase productivity and incomes of those remaining in the agricultural sector.[5]

Another factor receiving consideration by Andic is the change in the functional distribution of income. Andic believes that a relative decline in property incomes such as dividends, interests, and rents, will bring a more equal distribution.[6]

Other important factors in Andic's study are the expansion in the proportion of workers in the middle-level occupations (white collar, professional, and technical workers) that tends to narrow incomes inequalities,[7] as per Kuznets' hypothesis; and the changes in the distribution of wealth. In the latter case, Andic agrees with Kuznets that government intervention, in the form of highly progressive inheritance taxation, induced inflation, and artificially low interest rates will achieve a diminishing share for wealth as a source of income and an increasing weight for wages and salaries which, in turn, will produce a more equal distribution.[8]

Andic's first two chapters present a clear-cut discussion of the relationship between economic development and income distribution. However, he has overemphasized the factors and conditions that could make that distribution more equal. There is only slight attention to divergent opinions and hypothesis like that of Kuznets' (1955). Thus, for Andic, if the conditions for growth are met the income distribution

in a developing country would automatically show a tendency toward reduced inequality.

In addition to this general bias, Andic's study has several major drawbacks for which it has been severely criticized by Castaneda and Herrero (1965, 1966).

Andic based part of his study on data of the 1946-1947 income tax returns taken from the book of Harvey Perloff,[9] who warned potential users of its limitations. In addition, Andic compared Perloff's data with data from the Departments of Labor and Treasury although they aren't comparable. Also the period covered, 1940-1957, is not long enough to thoroughly test Kuznets' hypothesis.

In Andic's study the families included were only 50, 53, and 52 percent of all families for the years 1941, 1952, and 1953, respectively. Thus, the income included in his distributions failed to include a large part of total income. Since some of the surveys were conducted by the Departments of Labor and Treasury, there are inconsistencies in the answers because people in general are reluctant to answer the Departments of Treasury's questionnaires. Finally, Andic's study is largely descriptive. It does not establish empirically the link between the economic development of Puerto Rico and the changes in the income distribution during the period 1940-1957.

In 1965 Andic published his second work about income distribution in Puerto Rico.[10] In this study on the distribution of labor income, Andic, using Census data of 1950 and 1960, concluded that between 1949 and 1959 the distribution of income among Puerto Rican workers became more equal in the face of rapid growth of the Puerto Rican economy.

According to Andic, Puerto Rico did not exhibit widening inequalities in the first stage of economic development, as hypothesized by Kuznets, because the pattern of development was not the same as that of older developed countries.[11]

Among the factors that Andic considered important in decreasing income inequalities among workers in Puerto Rico are: first, the decline in the number of men and women employed in lesser-paying occupations (domestic service, agricultural workers, and nonagricultural laborers),[12] and second, the geographical shifts of workers from rural to urban locations.[13] In the former instance, there was a decline in the proportion of nonskilled workers within the male work force from 46 percent in 1946 to 33 percent in 1959, accompanied by an increase in the semiskilled male workers proportion from 14 to 22 percent, and in skilled male workers from 15 to 26 percent. A similar pattern occurred in the female labor force.[14]

Andic has been consistent in his studies in assigning to economic development and the resultant shifts of population this narrowing of inequalities, but without the different stages that characterize Kuznets' hypothesis. Unfortunately, the period covered by Andic in his second work (1965), is still too short to adequately verify the Kuznets' hypothesis for the Puerto Rican development process. Moreover, although the data used in this study were better than those used in his 1964 study, he still analyzed them using largely descriptive statistics.

In December 1965 Castaneda and Herrero published an article in which they refuted Andic's (1964) contention about declining inequality in the family income distribution in Puerto Rico.[15] Castaneda and Herrero used data from the Department of Labor of Puerto Rico for the

years 1953 and 1963 and reached the conclusion that they were totally in agreement with Kuznets' (1955) hypothesis on income distribution. They emphasized that the Puerto Rican fiscal system depended in great measure on indirect taxes, that are highly regressive, rather than on more progressive direct taxes. They observed also that the direct taxation system tended to be regressive since taxes are levied basically on labor rather than on capital income. They also mentioned that capital income enjoyed numerous tax advantages which tended to accentuate the income concentration at higher levels. Finally, they noted that the value of land had grown enormously during the period, leading them to speculate that wealth had become even more concentrated than income in Puerto Rico.[16]

Although Castaneda and Herrero's (1965) study made interesting observations and analyses, it has some shortcomings and theoretical weaknesses. For instance, the authors state that

> . . . the distribution has gotten worse in the agricultural sector not only in the salaries and wages but also with the employment level (p. 359)

and observe that if this were due to the shift of the island's main economic activity from agriculture to industry, then:

> the increase in the agricultural sector salaries would be higher than in the industrial sector (p. 359).

The above quotation is true only if both sectors were operating in a purely competitive market, in which each factor of production would be paid according to its marginal product, and that is probably not the case. Castaneda and Herrero's study also didn't account for the effect of the decrease in the agricultural sector's employment due to the aforementioned shift from agriculture to industry. In addition, their study shows that between 1947 and 1961 employee compensation decreased

considerably only in publicly-owned corporations, while it grew substantially in private corporations.

Finally, the time span encompassed by Castañeda and Herrero's study was too short to test the full sweep of Kuznets' hypothesis.

In the same issue, Andic published his answer to the criticisms of Castañeda and Herrero.[17] Andic restated his arguments and exposed some errors and logical flaws of Castañeda and Herrero's study. Andic refuted Castañeda and Herrero's contention on the total regressivity of indirect taxes on the grounds that they did not correctly analyze the incidence of indirect taxes. According to Andic the income distribution is more equal after indirect taxes than before.[18] With respect to direct taxes, Andic argued that income tax evasion has been greatly reduced because of tighter control by the government and that most larger firms are corporations that are closely scrutinized and audited by accounting firms.[19]

Another aspect taken into consideration by Andic that was missed by Castañeda and Herrero is the redistribution impact of goverment expenditures.[20] Andic also asigned a fundamental role in the narrowing of income inequalities to the shift of the island's main economic activity from agriculture to industry, and refuted Castañeda and Herrero's arguments regarding the effect of increased agricultural productivity. Andic argued that Castañeda and Herrero's reasoning was fallacious because they excluded sugar cane production from their computations of total agricultural product (which increased 65 percent between 1953 and 1963), whereas they included sugar cane employment figures which decreased 44 percent during the same period. Also, they did not take into account the value added by the agricultural sector with respect to wages and salaries in order to estimate the actual direction of increase in the productivity of the agricultural sector.[21]

Andic also criticized Castaneda and Herrero's use of salaries and wages paid in 1947 to estimate labor's share of business in 1961. He argued that up-to-date figures would show a larger share of business income for labor in 1961.

Finally, Andic estimated that the GINI coefficient for 1947 was 0.47 and for 1963, 0.42, with the 1963's GINI coefficient similar to the 1953's GINI. Therefore, the Lorenz curves for the years 1953 and 1963 were probabaly very close to each other. Andic did find a slight change in favor of the richest 25 percent vis-à-vis the poorest 75 percent, but a smaller effect than the change shown by Castaneda and Herrero.[22]

In June 1966, Castaneda and Herrero published their second article in their argument with Andic.[23] Here the authors based their argument on the Department of Labor's statistics, which showed that the lower 40 percent of families reduced their share in the income distribution from 16.5 percent in 1953 to 13.0 percent in 1963. According to Castaneda and Herrero, Andic's GINI coefficients and Lorenz curves did not record those changes because of the insensitivities of that measure to changes occurring outside the middle range of the disbribution.[24]

Nevertheless, if the figures of the Department of Labor are correct, they imply some social mobility in those years, because the middle 30 percent of families increased their income share between 1953 and 1963 from 22 percent to 25.5 percent. It could also happen that, due to lower fertility rates in higher income families, a lot of them were able to move from middle incomes in 1953.

In general, Castaneda and Herrero did not conclusively refute Andic's contentions about the trend toward lesser inequality. For one thing Castaneda and Herrero included only Samuelsonian social goods when

considering government expenditures and they ignored the more pro-poor social welfare expenditures.[25] Also, they ignored the mobility factors stressed by Kuznets. However, like Andic's, their studies encompassed a time frame too short for adequate testing of the Kuznets' hypothesis, and relied upon relatively crude empirical techniques.

In 1966 the Puerto Rico Planning Board,[26] using data of the Department of Labor, reached the same conclusions as Castaneda and Herrero, but here too, the period covered was too short to assess Kuznets'-like changes in the income distribution in Puerto Rico. Moreover, like its predecessors (Andic 1964; Castaneda and Herrero, 1965, 1966) this study was not based on a rigorously formulated econometric model, but was based on descriptive statistics with which the authors attempted to give an intituive understanding of the relationship among the variables without actually quantifying these relationships.

In 1970 Richard Weisskoff published one of the most useful studies on income distribution of Puerto Rico, along with comparison with Argentina and Mexico.[27] According to Weisskoff the theory that income becomes more equally distributed in the later stages of economic development as surplus labor disappears, has been widely tested in international comparisons and time series of different countries with the results of the cross-sectional studies generally leading to empirical support of the hypothesis.[28]

However, there is no consensus on the analysis based on time series. Kuznets' 1963 study sustains the narrowing of income inequalities in the developed industrial countries after WWII. Other studies focused on India have had mixed resutls, such as those of Ojha and Bhatta,[29] and Swamy.[30]

Weisskoff's study, based on data of the Department of Labor, showed a trend toward greater income inequality in Puerto Rico between 1953 and 1963. The main characteristic of Weissoff's study is that his conclusions are based on several measures of income concentration. Use of the GINI coefficient and the standard deviation of logs of income showed greater inequality in the income distribution between 1953 and 1963, but the coefficient of variation and the skewness of logs indicated the opposite.[31]

In 1974 Rita M. Maldonado published her study[32] in which she concluded, based on Census data, that between 1959 and 1969 the income disbribution became more equal in Puerto Rico. According to Maldonado, Puerto Rico, due to its special relationship with the United States, is an exception to the Kuznets' (1955) hypothesis.

The interpretation given by Maldonado to her findings, is, in the first place, that the government policies of educating the population and the consequent formation of human capital, is the main factor in explaining this trend. Secondly, she emphasizes the shift in economic activity from the agricultural to the manufacturing and service sectors. Third, she notes the migration of Puerto Rican workers and families to the mainland U.S., arguing that this tended to amelioriate the unemployment problem in the island.[33]

Unfortunately, although Maldonado has used more reliable data than previous studies, the period covered, one decade, is too short to determine the secular trend in income concentration in Puerto Rico. Also, she used a rather small number of independent variables to explain her findings and she did not sort out the extent of each influence empirically.

In 1975 Arthur Mann and William Ocasio published a study,[34] in which they concluded, based on Census data for 1949, 1959, and 1969, that there had been a significant trend toward greater income equality in Puerto Rico. According to their findings, the trend toward greater income equality, although important, was less than the one found by Maldonado (1974).

The authors also developed a simplified model of fiscal incidence with pre-fisc and post-fisc distributions of family income. According to the authors, the tax system of Puerto Rico, although highly progressive, was not as effective as government expenditures in reducing inequalities.[35]

In general, the Mann and Ocasio's study is one of the most original studies of Puerto Rican income distribution. However, the study is relatively short, and dependent upon descriptive statistics and casual comparisons. The authors also concluded that the Kuznets' (1955) hypothesis does not conform to Puerto Rico for the period 1949-1969. Although the period covered in this study is the longest of the periods already analyzed it did not include the critical 1970's.

In 1976 Fuat Andic and Arthur Mann published an interesting study[36] in which they analyzed two decades of change in the distribution of earnings of the experienced civilian labor force in Puerto Rico. For Andic and Mann the economic growth of Puerto Rico during the 1949-1969 years was inpressive.

The authors attempted to measure earnings inequalities rather than income inequalities. Here, there is the problem that 1950 Census data provides total personal monetary income as the base, whereas the 1960 and 1970 Census provide earnings as the base. Andic and Mann found that

income was more unevenly distributed in Puerto Rico during those years than earnings.

For Andic and Mann the changes in occupational structure, due to investments in education and human capital, were responsible for the continuous decline in inequalities in the earnings distribution.

Although, the Andic and Mann's (1976) study was wellconceived, the results are not conclusive, since it is quite risky to argue a cause-effect relationship between income distribution and a roster of social and economic variables without linking them in a mathematical fashion, no matter how impeccable the underlying reasoning.

On the other hand, the Andic and Mann's (1976) study provided valuable information on concentration ratios computed for different occupations, sexes, sectors, etc., that have broadened the knowledge of income distribution in Puerto Rico.

The last important paper on income distribution in Puerto Rico was published in 1977 by Arthur Mann and William Ocasio.[37] These authors also found, based on Census data, a trend toward narrowing of income inequalities in Puerto Rican municipalities during the 1949-1969 period, although inequality increased from 1949 to 1959.

This study was based on a multiple regression analysis in which the authors regressed nine independent variables for each of the 76 municipalities in 1949, 1959, and 1969 against GINI coefficients for each municipality. This technique represented a major advance. However, it was done before data were available for the 1970's decade, and it excluded some key independent variables, like welfare payments, age, and property income.

FOOTNOTES

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CHAPTER III

THEORETICAL FRAMEWORK

Income Distribution and Economic Development

The relationship between economic development and income distribution has long been studied. Simon Kuznets[1] argued that since the savings ratio is higher in the upper-income brackets those recipients will accumulate assets proportionally more rapidly than lower-income recipients, and total income will grow more rapidly for the former than for the latter. Therefore, there is, according to Kuznets, a secular trend in income distribution toward greater inequality as a result of this factor.

Another reason for growing inequalities, suggested Kuznets, applied more strictly to countries in the early stages of development: as growth occurs labor shifts from the rural to the urban sector and the distribution of income is more skewed to the right (i.e., more unequal) in the urban than in the rural sector. Thus, a shift of labor from the rural sector to the urban sector implies an increase in the inequality of income distribution.

Finally, Kuznets maintained that the growing political influence of lower income groups would be the main influence that neutralizes, to a certain extent, the other two forces and gives a net result of increasing equality in the income distribution after the economy matures-after a phase of increasing inequality in the early stages of growth.

Empirical studies in the advanced industrial countries seem to show that those countries experienced increasing equality of income distribution as their per capita income grew.[2] It is still not clear if this equalization is a result of increased capital and, henceforth, output per worker, or is the effect of deliberate social policies.

There are two major elements in the relationship between income equality and growth. One is the effect of income equalization on savings and capital formation. The most common notion is that attempts to equalize personal income in less developed countries will thwart economic growth by transferring income from the rich who save to the poor who do not. However, according to V.K.R.V. Rao,[3] the rich in LDC's indulge in conspicious consumption and have low savings rates, therefore, a loss in the personal income share of the rich would not reduce total savings. The reason for this pattern is that the upper income groups in LDC's really have relatively low incomes compared to those classes in the advanced industrial countries of Europe and North America whose consumption pattern they try to imitate.[4]

The second important element in the relationship between income equality and growth runs in the opposite direction. This is the notion that income redistribution would stimulate long-run growth because consumption would increase and encourage investment in an otherwise stagnant economy. This notion is particularly popular among LDC's economists, mainly from Latin America, such as Celso Furtado[5] who maintained that the lack of consumer demand is causing stagnation in Latin American economies. However, this hypothesis has had great opposition, primarily because it implies that negative savings would stimulate economic growth forever.

Structure of the Model

In order to build a model with the purpose of studying the income distribution in Puerto Rico, it is necessary to take into consideration the main factors that affect the income distribution. The model in this chapter is a cross-sectional analysis using data from the Censuses of 1950, 1960, 1970, and 1980. This model has two main advantages: first, it is general enough to incorpo-ate the principal determinants of variations in the income distribution at a point in time, second, it encompasses a long enough period of time that major structural changes can be identified.

Regression Equations

The model is composed of three multiple variable log-linear regression equations with one dependent variable, the GINI coefficient of concentration (computed via trapezoidal approximation), and nine, ten or eleven independent variables in each equation. Multiple regression has been widely employed to test the relationship between economic growth and income inequality in the U.S. [Conlisk (1967); Sale (1974); Rice and Sale (1975); Foley (1977); Grasso and Sharkansky (1980)] and elsewhere [Adelman and Morris (1973); Chenery and Ahluwalie (1973); Cromwell (1977)]. Its use will help us to compare the results of this study with those from other studies, especially the study for Puerto Rico by Mann and Ocasio.

The regression analysis will employ the following independent variables:

1. Economic Developement (ECODE)
2. Agriculture (AGRI)
3. Manufacturing (MGF)

4. Urbanization (URB)

5. Occupational Structure (OCSTR)

6. Migration (MIG)

7. Education (EDUC)

8. Female Labor Force (FEMLF)

9. Welfare Program (WELPR)

10. Age (AGE)

11. Property Income (in 1979 only) (PROPY)

The basic multiple regression equation used for the Censuses of 1950 and 1960 is:

$$(1)\quad \ln G = b_0 + b_1\ \ln ECODE + b_2\ \ln AGRI + b_3\ \ln MFG + b_4\ \ln URB + b_5\ \ln OCSTR + b_6\ \ln MIG + b_7\ \ln EDUC + b_8\ \ln FEMLF + b_{10}\ \ln AGE + e.$$

For the Census of 1970 we add lnWELPR, and for the Census of 1980, we add both lnWELPR and lnPROPY. G in each equation is the GINI coefficient of personal income concentration (calculated via trapezoidal approximations) in each of the 76 municipalities of Puerto Rico in 1949 and 1959; and the GINI coefficient of family income concentration in each of the 76 municipalities in 1959 and 1969, and 78 municipalities in 1979. Of course b_0 is the intercept, b_1, b_2, ..., b_{11}, are the regression coefficients for each variable, and e is the disturbance of error term.

Rationale for the Independent Variables

Economic Development (ECODE)

A variable such as our economic development variable is used by many authors to represent Kuznets' general postulated relationship between economic growth and income inequality. Kuznets established the

association between economic growth and income inequality as:

> . . . a long swing in the inequality characterizing the secular income structure widening in the early phases of economic growth when the transition from the pre-industrial to the industrial civilization was most rapid; becoming stabilized for a while; and then narrowing in the later phases.[6]

Kuznets also postulated that economic growth tends to render obsolete established wealth as a source of income because of new technologies introduced, thus, reducing, income inequalities. The findings of earlier studies show that economic growth makes the distribution of income more equal as the economy matures (Garvy, 1954, pp. 252-253).

The level of economic development is treated initially as a main determinant of distribution although at a later point (see chapter 5) we discover that it is really a proxy for several, underlying, structural changes in this study. Its treatment in this fashion is consistent with empirical studies in the U.S. which show consistently negative regression coefficient values for an economic development variable (Foley, 1977; Rice and Sale, 1975) for the mature stage of growth as expected by Kuznets (1955). It is also consistent with Puerto Rican studies by Andic (1964), Andic and Mann (1976), and Mann and Ocasio (1977), which assign a great weight to this variable in reducing inequality. The Mann and Ocasio's study (1977) of seventy-six Puerto Rican municipalities produced mixed results in terms of this variable. Between 1949 and 1959 the regression coefficient relating the level of income to the distribution of personal income increased, suggesting greater inequality. However, between 1959 and 1969 the regression coefficient relating income and the distribution of family income fell sharply, suggesting declining inequality.

In this study, each of the eleven variables is represented by a proxy that closely resembles the characteristics of each variable. The

proxy used for the ECODE variable is the median personal income in each Puerto Rican municipality for the years 1949 and 1959, and the median family income for the years 1949, 1969, and 1979.

Agriculture (AGRI)

According to Kuznets, the agricultural sector in underdeveloped countries is characterized by a lower average income, but less income inequality, in the initial periods of development than is the non agricultural sector.

In the early stages of industrialization a shift from agriculture to manufacturing should produce greater inequality in agriculture as the more able agricultural workers move into more productive, higher paid manufacturing jobs. Eventually, though, the reduction of surplus labor in agriculture and the rise in the income shares of the lower group in agriculture will produce less inequality in the agricultural sector. Empirical studies for the U.S. have shown that a smaller share of employment for agriculture is associated with less inequality [e.g. Rice and Sale (1975)]. In Puerto Rico, the AGRI variable has been studied by Andic (1964), Andic and Mann (1976), and Mann and Ocasio (1976; 1977). In this last study, the values for the regression coefficients of the agricultural variable indicate positive relationship between a declining agriculture and equality among persons between 1949 and 1959, and a similar relationship among families between 1959 and 1969, as the economic development process matures, thus confirming Kuznets' hypothesis.

The proxy used here for the AGRI variable is the proportion of employed persons working in agriculture in each Puerto Rican municipality.[7]

Manufacturing (MFG)

Kuznets assigned great importance to this variable in reducing income inequality in the more mature stages of economic growth. Kuznets argument runs as follows:

> . . . the narrowing in inequality, the offsetting rise in the shares of the lower brackets most likely occurred in the income distribution for the urban groups, in the non agriculture sector. While it may also have been in the agriculture sector, it would have had a more limited effect on the inequality in the country wide income distribution because of the rapidly diminishing weight of the agriculture sector.[8]

Empirical studies show that income inequalities tend to decline as manufacturing becomes more important. In the U.S. the Rice and Sale study (1975) showed negative values for the MFG regression coefficient in 1950 and 1960, and a low positive value in 1970. Sale (1974) showed robustly negative values for 300 counties of 12 Eastern states, as well as SMSAs, and for suburban, independent, and rural counties-confirming in all of them the Kuznets hypothesis.

The effect of the industrialization process on income distribution in Puerto Rico has been studied by Andic (1964), Andic and Mann (1975), and Mann and Ocasio (1977). In this last study, the MFG regression coefficient had a negative value in 1949, 1959, and 1969, confirming the Kuznets hypothesis. The proxy used here for the MFG variable is the proportion of the employed persons working in manufacturing in each Puerto Rican municipality.

Urbanization (URB)

Kuznets postulated that:

> . . . all other conditions being equal, the increasing weight of the urban population means an increasing share for the more unequal of the two components distribution. The relative difference in per capita income between the rural and the

> urban populations does not necessarily drift downward in the process of economic growth: indeed, there is some evidence to suggest that it is stable at best, and tends to widen because per capita productivity in urban pursuits increases more rapidly than in agriculture.[9]

Thus, as urbanization is accompanied by industrialization, this tends, Ceteris Paribus, to make the income distribution less equal in earlier stages of development. Urban areas have greater employment opportunities, but the income of rural residents is more irregular than that of urban residents due to the seasonal character of agriculture employment.

Empirical studies in the U.S. have shown mixed results for the URB variable. Foley (1977) found the highest value for an "urbanization" regression coefficient in the SMSA counties, indirectly confirming Kuznets' hypothesis of higher inequality in urban areas. Aigner and Heins (1967) found diminishing negative values between their first and second regressions, thus partially confirming Kuznets' hypothesis. In Puerto Rico an urbanization variable has been studied by Andic and Mann (1976), and Mann and Ocasio (1975; 1977). In the latter of these studies, this variable's regression coefficients were negative in 1949 and 1959, but positive in 1969. The proxy used here for the URB variable is the number of people per square mile in each Puerto Rican municipality.

Occupational Structure (OCSTR)

Kuznets also assigns some importance to the OCSTR variable in reducing income inequality. Basically, the argument is that improved training, coupled with equal access to middle level occupations, will reduce disparities of income.

Empirical studies of the U.S. show the regression coefficient of an occupational structure variable to be highly negative in 1960 (Rice and Sale, 1975) and 1970 (Rice and Sale, 1975; Sale, 1974), confirming the Kuznets' hypothesis. In Puerto Rico such a variable has been studied by Andic (1964), Maldonado (1974), Andic and Mann (1976), and Mann and Ocasio (1977). This last study yielded a regression coefficient with a positive value in 1949, but strongly negative values in 1959 and 1969, confirming the Kuznets' hypothesis. In this study we used the proportion of the labor force in middle and upper level occupations (i.e., professional, technical, craftsmen, clerical, and operatives) in each Puerto Rican municipality as the proxy for the OCSTR variable.

Migration (MIG)

For Kuznets, migration tends to reduce inequality because of its

> . . . countervailing power upon the cumulative effects of savings concentration.[10]

People who migrate in less-developed countries are normally from lower income levels. Therefore, large migrations tend to reduce the relative share of higher income groups.

The effect of migration on income inequality has been studied for Puerto Rico by Maldonado (1974), Andic and Mann (1976), and Mann and Ocasio (1977). This last study produced positive regression coefficients for 1949, 1959, and 1969. Mann and Ocasio used the fraction of population born in the municipality of residence as a proxy for migration. Thus, positive values imply increased income inequality. This study will use the same proxy for the MIG variable.

Education (EDUC)

Kuznets (1955) mentions that the concentration of savings in the upper classed during economic growth can be offset by increased service incomes (from professional and entrepreneurial pursuits), since such incomes depend largely on individual excellence, and they cannot be inherited like material assets. Education plays an important role in forming the professional and entrepreneurial ranks. Therefore, the higher the educational level of the population, the more equal the income distribution.

Empirical studies of the U.S. confirm the above hypothesis. Sale (1974) produced regression coefficient values for education that were highly negative for the fifty states in 1950, 1960, and 1970. Al-Samarrie and Miller's (1967) study of the fifty states for 1959 also produced a negative value. In Puerto Rico, the education variable has been studied by Maldonado (1974), Andic and Mann (1975), and Mann and Ocasio (1977). In the last of these studies the values for the education variable are highly negative in all years, 1949, 1959, and 1969. The proxy used here for the EDUC variable is the median number of years completed by persons 25 years and older in each Puerto Rican municipality.

Female Labor Force (FEMLF)

Changes in the sex composition of the labor force may affect income distribution in different ways. First, a larger female labor force may mean higher household income in intact families. Second, a larger female labor force may mean more families headed by females, which, generally, are at the bottom of the income scale. Third, female labor

force participation may be confined to certain occupations with traditionally lower wages (Miller 1971, p. 173). The first of these possibilities suggests a negative coefficient for the female labor force; the latter two suggest a positive coefficient. For the U.S., Miller (1971) expected the latter two effects to dominate. However, for Puerto Rico, we expect the first effect to dominate in the mature stage of development.

Empirical studies for the U.S. show mixed results for this variable. Sale (1974) found a positive regression coefficient value in 1950, but a highly significant negative value in 1960 and 1970. Rice and Sale (1975) found highly significant positive value for the 50 states in 1950, 1960, and 1970, confirming Miller's contentions, as well as the results of an earlier study by Al-Samarrie and Miller (1967). In Puerto Rico the role of the female labor force variable has been studied by Andic and Mann (1976), and Mann and Ocasio (1977). In the latter study the regression coefficient was positive in 1949, 1959, and 1969, confirming Miller's hypothesis. The proxy used here for the FEMLF variable is the proportion of employed persons who are female in each Puerto Rican municipality.

Welfare Program (WELPR)

Kuznets postulated the importance of the government budget in reducing income inequality as follows:

> . . . the distribution of income after direct taxes and including free contributions by government would show an even greater narrowing of inequality in developed countries . . .[11]

> . . . in democratic societies the growing political parties of the urban-lower income groups lead to a variety of protective and supporting legislation much of it aimed to counteract the worst effects of rapid industrialization and urbanization . . .[12]

To the best of my knowledge, there is only one empirical study for the U.S. that included a welfare program variable. Grasso and Sharkansky (1980) found negative values for the regression coefficient for this variable in the South for the years 1959-1969 - results which they explained on the grounds that such payments encourage some nonearners to maintain separate households. In Puerto Rico, Andic (1964) assigned an important role to budgetary actions by Federal and State governments in reducing income inequality. Recently, Weisskoff (1983) argued that federal funds have kept the island's economy growing or, at least, prevented it from stagnation. The welfare program payments of the Federal government to Puerto Rico have been estimated at $1,750 million in 1979 or 16.7 percent of Puerto Rico personal income (Informe Económico al Gobernador 1980), confirming Kuznets' contentions about the growing role of the government budget.

The proxy used here for the WELPR variable is the proportion of families receiving welfare program payments in each Puerto Rican municipality.

Age (AGE)

According to Herman Miller (1955: Ch. 6) income dispersion increases with age except among the younger generation (less than 24 years). Thus, inequality can be expected to increase with age, as well. Empirical studies like the Long, Rasmussen and Haworth (1977) study for the U.S. showed a negative regression coefficient value for the 18-24 year old cohort, confirming Miller's (1955) hypothesis. The Rice and Sale (1975) study found the regression coefficient values for the population 65 years and older to be highly positive in 1950 and 1960 and

slightly negative in 1970. Sale's (1974) study of the fifty states found a negative regression coefficient value for the population 65 years and older in 1950, but a highly positive value in 1960 and 1970, confirming once again Miller's (1955) hypothesis.

Kuznets (1955) considered the falling death rate, or rising average age of the population, to be one of the factors in the secular swing in income inequality. He expected that in the early phases of economic growth it would tend to aggravate existing income inequalities (Kuznets 1955, p. 19) in LDC's, like Puerto Rico, in which the older generation would not yet have benefited from economic development.

The proxy used here for the AGE variable is the fraction of the population 65 years and older in each Puerto Rican municipality.

Property Income (PROPY)

Kuznets assigns to income from property a relevant role in explaining income inequalities:

> The long swing in income inequalities is also probably closely associated with the swing in capital formation proportions-in so far as wider inequality makes for higher and narrower inequality for lower country wide savings proportions.[13]

The savings accumulated through generations by the top income classes yield the incomes that permit those classes to perpetuate inequality. There is no previous empirical study for Puerto Rico which links this variable to income inequality. Data are availabe in the 1980 Census, however, for each Puerto Rican municipality. In this study the proxy used for the property income variable is the fraction that property income (e.g. interest, dividend, and/or net rental income) is of total income for households in each Puerto Rican municipality.

Dependent Variable. To measure the degree of inequality of personal and family income distribution there are a large number of statistics, for example, the standard deviation, the coefficient of variation (the standard deviation divided by the arithmetic mean), the standard deviation of logs of income, the skewness of the logs, etc., but the most commonly used are the Lorenz curve and the GINI coefficient of concentration, computed via trapezoidal approximations (Bronfenbrenner, 1971: p. 43.)

The widespread use of the GINI coefficient as the dependent variable is due to its simplicity and relative reliability (J. Morgan, 1962: p. 281). It was used here also, to allow us to compare the results of this study with those from past empirical studies in Puerto Rico, U.S., and the rest of the world.

Expected Results. According to our interpretation of Kuznets (1955) and the work of other individuals, the expected signs of the regression coefficients can be summarized as indicated in Table I. It is not possible to be more exact in terms of dates. However, the time frame for which data were available corresponds to a period during which Puerto Rico has grown from a relatively underdeveloped to a relatively mature economy. Thus, it is reasonable to expect to pattern displayed in Table I in the regression coefficients estimated for the initial and final years of this time frame.

Given the data available for proxies it is also reasonable to expect some strong interrelationships between several of the independent variables. In particular, in the early portion of our time frame, most of the labor leaving agriculture was absorbed by the manufacturing sector. Much of the growth in the latter occurred in urban areas, and

was concentrated in the occupations represented by the OCSTR variable. Thus, we would expect, for example, to encounter relatively high correlations between AGRI, MFG, URB, and OCSTR in the early stages of growth. These relationships should be weakened, however, as the economy matures, and, along with it, then is an expansion in the service and government sectors. This topic is treated in greater detail in Chapter V.

TABLE I

EXPECTED SIGNS OF REGRESSION COEFFICIENTS

	Early Stage of Development	Mature Stage of Development
(1) $\frac{\partial \ln G}{\partial \ln ECODE}$, b_1 =	+	-
(2) $\frac{\partial \ln G}{\partial \ln AGRI}$, b_2 =	+	-
(3) $\frac{\partial \ln G}{\partial \ln MFG}$, b_3 =	-	-
(4) $\frac{\partial \ln G}{\partial \ln URB}$, b_4 =	+	-
(5) $\frac{\partial \ln G}{\partial \ln OCSTR}$, b_5 =	+	-
(6) $\frac{\partial \ln G}{\partial \ln MIG}$, b_6 =	+	+
(7) $\frac{\partial \ln G}{\partial \ln EDUC}$, b_7 =	-	-
(8) $\frac{\partial \ln G}{\partial \ln FEMLF}$, b_8 =	+	-
(9) $\frac{\partial \ln G}{\partial \ln WELPR}$, b_9 =		-
(10) $\frac{\partial \ln G}{\partial \ln AGE}$, b_{10} =	+	+
(11) $\frac{\partial \ln G}{\partial \ln PROPY}$, b_{11} =		+

FOOTNOTES

[1]Simon Kuznets, 1955, op. cit., pp. 1-28.

[2]Ibid, p. 4.

[3]V.K.R.V. Rao, "Redistribution of Income and Economic Growth in Underdeveloped Countries" in Colin Clark and Geer Stovel eds. Income Redistribution and the Statistical Foundations of Economic Policy, "Income and Wealth," Vol. 10, London, 1964, Bowes & Bowes, p. 309.

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[5]Celso Furtado, "Development and Stagnation in Latin America: A Structural Approach," Studies in Comparative International Development, Vol. I, 1965, pp. 159-175.

[6]Kuznets, 1955, op. cit., p. 18.

[7]In cross sectional analysis multicollinearity among the explanatory variables can be avoided by introducing a priori ratios or ratios of values, i.e., supply of labor expressed in percentage of labor force. Jan Tinbergen, Income Distribution, The North-Holland Pub. Co. 1975, pp. 31-32.

[8]Kuznets, 1955, op. cit., p. 17.

[9]Kuznets, 1955, op. cit., p. 8.

[10]Kuznets, 1955, op. cit., p. 9.

[11]Kuznets, 1955, op. cit., p. 5.

[12]Kuznets, 1955, op. cit., p. 17.

[13]Kuznets, 1955, op. cit., p. 20.

CHAPTER IV

AGGREGATE INCOME CONCENTRATION AND OTHER INCOME MEASURES

Introduction

In this chapter we explain other indexes of income concentration, besides the GINI ratio computed via trapezoidal approximations on a municipality basis, and other measures of income required to compute them.

The other income concentration indexes used in this study are the aggregate GINI ratio computed via both trapezoidal approximation and by ordinary least squares (OLS), the Williamson index, the coefficient of variation, and the standard deviation of logs of income.

These indexes have their own characteristics and advantages, and their use helps to make this study the most comprehensive analysis of the real trend in the distribution of income in Puerto Rico in the last three decades.

The characteristics and advantages of the different concentration indexes used are explained in the following section.

Aggregate Income Concentration Measures

The first index to be discussed is the GINI coefficient via trapezoidal approximations[1] for Puerto Rico as a whole, rather than on a municipality basis, based on the Censuses of 1950 and 1960, for persons

14 years older and over with income in 1949 and 1959 respectively, and on the Censuses of 1960, 1970, and 1980 for family income in 1959, 1969, and 1979, respectively.

The GINI index is derived from the Lorenz curve which is obtained by plotting the cumulative percent of units (persons or families) on the X axis against the cumulative percent of the aggregate income accounted for by these units on the Y axis. If all units have exactly the same incomes, the Lorenz curve would be represented by a diagonal that bisects the angle made by the X and Y axis. The Lorenz curves drawn from actual data invariably fall below the diagonal, as in the example in Figure 1. Generally, the greater the inequality in the distribution of income the greater the area between the diagonal and the Lorenz curve.[2] The GINI index, per se., is the proportion of the total area under the diagonal that is between the diagonal and the Lorenz curve.[3] With reference to Figure 1, this relationship can be expressed as follows:[4]

$$R = \frac{A}{A + B} = \frac{\text{Area between curve and diagonal}}{\text{Area under diagonal}} \qquad (1)$$

Since the cumulative percents of each axis add to 100, the area in the entire square is 1 and the area under the diagonal is 1/2 the area of the square. Therefore, the above equation can be written as follows:

$$R = \frac{1/2 - \text{Area under curve}}{1/2} = 1 - 2\ (\text{Area under curve}) \qquad (2)$$

If it is assumed that the Lorenz curve between any two points is approximated by a straight line, the area for any segment under the Lorenz curve can be expressed as follows:

$$(fi+1 - fi)\ \frac{(Yi + Yi+1)}{2} \qquad (3)$$

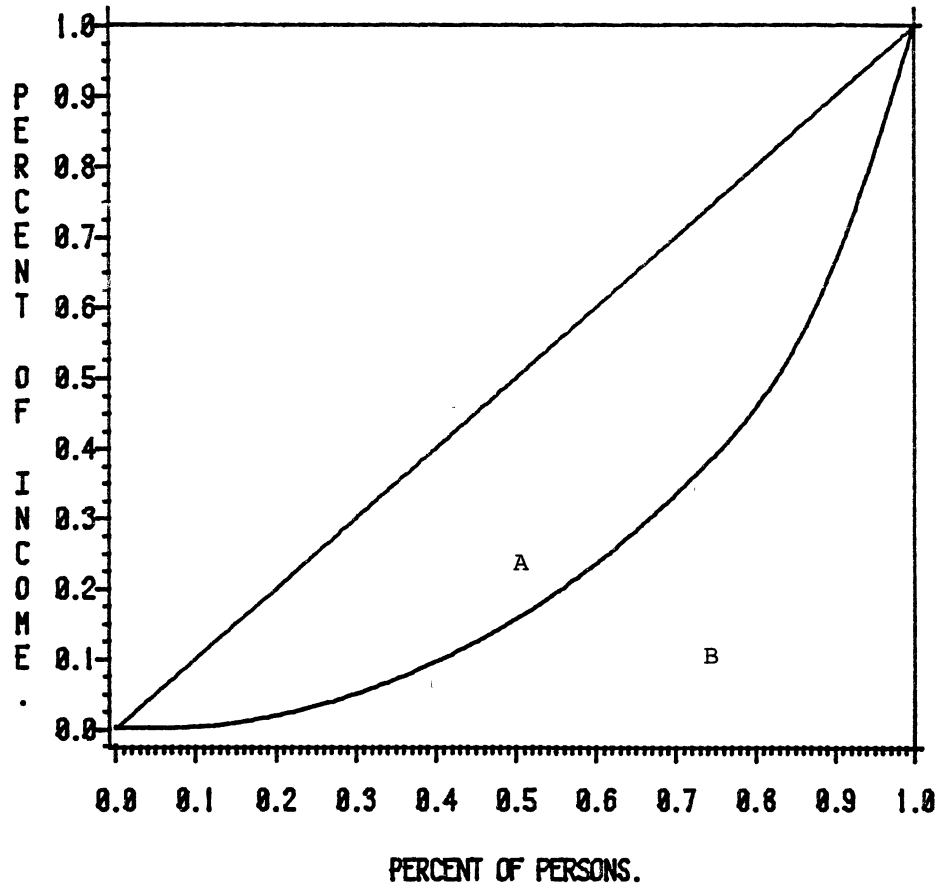

Figure 1. The Lorenz Curve for Personal or Family Income

If all intervals are summed, the area under the curve is:

$$\sum_{i=1}^{K} (fi+1 - fi) \frac{(Yi + Yi+1)}{2} \qquad (4)$$

Substituting equations (3) and (4) into equation (2) produces the formula used in computing the GINI index:

$$L = 1 - \sum_{i=1}^{K} (fi+1 - fi) (Yi + Yi+1) \qquad (5)$$

where L stands for the Lorenz curve, fi is the number of families at point i, and Yi its aggregate income.

The Pareto equation was employed in the estimation of the GINI index via trapezoidal approximations to compute the mid point of the last open-end income interval in which the number of frequencies (e.g. persons or families) were smaller than in the interval preceding it, as follows:[5]

$$\bar{X} = X \left(\frac{V}{V-1}\right), \qquad (6)$$

where $\bar{X}$ is the mid point to compute, X is the lower limit of the open-end income interval, and

$$V = \frac{c - d}{b - a} \qquad (7)$$

where a is the natural logarithm of the lower limit of the interval preceding the open-end interval, b is the natural logarithm of the lower limit of the open-end interval, c is the natural logarithm of the sum of the frequencies in the open-end interval and the one preceding it, and d is the natural logarithm of the frequencies in the open-end interval.

For the few cases in which the number of frequencies in the last open-end interval is greater than in the interval preceding it, equation (6) does not work. In these cases, we used $20,000 for the 1949 and

1959 distribution of personal income in the open-end interval.[6] For 1959, 1969, and 1979 family income the following equation was used:[7]

$$\bar{X} = \left[\frac{fn}{fn-1} \cdot \quad Wn - 1 \cdot \quad K \right] + X_1 \qquad (8)$$

where $\bar{X}$ is the mean income, fn is the number of frequencies in the open-end interval, fn-1 is the number of frequencies in the interval preceding it, Wn - 1 is the width of that interval, K is a constant that is a function of W and of the year to which the distribution belongs, and X_1 is the lower limit of the open-end interval.

The GINI ratio computed via trapezoidal approximations has some limitations. It is relatively insensitive to small percentage changes which may represent large income shifts to the lower income classes. It is also possible for the two different Lorenz curves to intersect, and although representing two different distributions, to yield identical GINI ratios.[8] Finally, it is difficult to determine if differences in GINI ratios calculated this way are statistically significant. It is because of these drawbacks of the GINI ratio computed via trapezoidal approximations, that we have used other indexes in this study.

The GINI coefficient computed via ordinary least squares (OLS), allows us to use a Chow test (1960) in order to determine if the changes in the GINI coefficient over time are statistically significant.

In this formulation, the GINI coefficient is computed using an equation developed by Kakwani and Podder.[9]

$$\eta = \pi e^{-\beta (1 - \pi)}, \qquad (9)$$

where η is the comulative proportion of income, π is the cumulative proportion of families and β is the parameter or slope. The purposes of equation (9) are first, to facilitate the estimation of the share of

income received by various proportions of families, and second to estimate a parameter that can be tested for significant differences among distributions.

In equation (9), if the computed $\hat{\beta}$ is equal to 0, the Lorenz curve coincides with the income equality line (the diagonal), and if $\hat{\beta}$ is greater than 0, the Lorenz curve lies below the income equality line. If $\hat{\beta} > 0$ the first and second derivatives of equation (9) are positive for all values of π in the interval between 0 and 1. This implies that the curve for equation (9) is sloping upward and that its slope increases monotonically. Therefore, the GINI coefficient derived from this function is:

$$G = 1 - \frac{2\ (\beta - 1)}{\beta^2} - \frac{2e - \beta}{\beta^2}, \tag{10}$$

for β greater than 0.

The Williamson index of income concentration is a measure of regional (or in this study municipality) inequality, which permits the estimation and evaluation of changes in income distribution on an intermunicipality and intramunicipality basis over a period of time. The analysis using this index is a complement, therefore, to the regression analysis for municipalities in which trapezoidal approximations of the GINI were used as the dependent variable.

The formula for the Williamson index is as follows:[10]

$$V_W = \frac{\sqrt{\sum_i (Yi - \bar{Y})\frac{f_i}{n}}}{\bar{Y}}, \tag{11}$$

where fi is the population of the ith municipality, n is the national population, Yi is the income per capita of the ith municipality, and $\bar{Y}$ is the national income per capita.

According to equation (11), the Williamson index, V_W, is a weighted coefficient of variation which measures the dispersion in municipal incomes per capita relative to the national mean, where each municipality's deviation is weighted by its share in the national population. The Williamson index is greater the more unequally income is distributed across municipalities. The value for $\hat{V}_W$ should grow in the early stages of development for an economy which conforms to the Kuznets' hypothesis (1955), and fall in the later stages of development.

The coefficient of variation is computed using the following equation:[11]

$$C.\ V._{(X)} = \frac{S_X}{\bar{X}}, \tag{12}$$

where S_X is the standard deviation in incomes, computed as follows:

$$S_X = \sqrt{\frac{\sum f\ (X - \bar{X})^2}{n}}, \tag{13}$$

where f is the frequency in the income interval, X is the midpoint of the income interval, $\bar{X}$ is the arithmetic mean of the income distribution, n is the number of items (e.g. persons or families in the distribution) and is equal to $\sum f$.

The coefficient of variation is an index of the relative variability in a frequency distribution, which, unlike the standard deviation, is not dependent on the units of measurement. Thus, it is similar to the GINI coefficient in the sense that both measures are "scale free;" that is, they imply less inequality in the income distribution if income is transferred from higher income levels to lower income levels. The GINI ratio, however, is more sensitive to changes in the middle ranges of the income distribution than among the very poor

or the very rich, while the coefficient of variation is more sensitive to changes in the upper income ranges.[12]

The standard deviation of logs of income is computed by using the equation:[13]

$$\text{Std Dev (log Y)} = \left(\frac{1}{n}\right) \sqrt{\text{log Yi - log Y}^*} \qquad (14)$$

where n is the number of income intervals for each income distribution, Yi is the mid-point of each income interval and Y^* is the geometric mean of the distribution.

The standard deviation of the logs of income is useful because it is particularly sensitive to changes in relative income and it is little influenced by absolute values of income. An income distribution may have a relatively low standard deviation of the logs of income due to a narrow percentage differential and yield a relatively high GINI ratio due to the larger shares belonging to the upper income groups.[14]

Other Income Measures Used

Other measures of income used in this study besides the indexes of income concentration are the per capita incomes based on personal income and on family income computed for every Puerto Rican municipality, the unweighted average of these values for all Puerto Rican municipalities, and per capita family and personal incomes for Puerto Rico as a whole.

The per capital income for each Puerto Rican municipality in 1949 and 1959 was obtained by the equation:

$$\bar{X} = \frac{fX}{n} \qquad (15)$$

where $\bar{X}$ is the mean income, f is the number of persons 14 years old and older with income in each Puerto Rican municipality in 1949 and 1959, X

is the mid-point of each income interval, and n is the number of inhabitants in each municipality. Equation (15) was used, as well, to compute the per capita income based on family income distributions for 1959 and 1969. The values for 1979 were provided by the Census of 1980.

FOOTNOTES

[1]Martin Bronfenbrenner, Income Distribution Theory, Aldine-Atherson, Chicago, 1971, pp. 49-51.

[2]Herman P. Miller, Income Distribution in the United States, U. S. Department of Commerce, Bureau of the Census, Washington, 1966, Appendix B, p. 220.

[3]James Morgan, "The Anatomy of Income Distribution," The Review of Economics and Statistics, (August 1962), p. 281.

[4]Miller, 1966, op. cit., p. 221.

[5]Ibid, pp. 215-216.

[6]Ibid.

[7]Arthur J. Mann and William C. Ocasio, "La distribución del ingreso personal en Puerto Rico: una nueva dimensión," Revista De Ciencias Sociales, Vol. 19, No. 1 (March 1975), p. 13, taken from Leinberg and Kaitz's, "An Income Size Distribution From Income Tax and Survey Data" on Studies in Income and Wealth, Vol. 13, NBER, 1951.

[8]Richard Weisskoff, "Income Distribution and Economic Growth in Puerto Rico, Argentina, and Mexico," Review of Income and Wealth, Vol. 16, No. 4, (December 1970), p. 307.

[9]N. C. Kakwani and N. Podder, "On the Estimation of Lorenz Curves From Grouped Observations," International Economic Review, Vol. 14, No. 2, (June 1973), pp. 278-292 in M. Reynolds and E. Smolensky, Public Expenditures, Taxes and the Distribution of Income, The United States, 1950, 1961, 1970. Academic Press, New York, 1977, pp. 72-73.

[10]Jeffrey G. Williamson, "Regional Inequality and the Process of National Development," Economic Development and Cultural Change, Vol. 13, No. 4, Part 2, (July 1965), p. 11.

[11]John Neter and William Wasserman, Fundamental Statistics For Business and Economics, 2nd Ed. Allyn and Bacon, Inc., 1961, Boston, pp. 262-264.

[12]Lars Osberg, Economic Inequaltiy in the United States, M. E. Sharpe, Inc., New York, 1984, pp. 20-21.

[13]J. Aitchison and J. A. C. Brown, The Lognormal Distribution, Cambridge University Press, Cambridge, Mass., 1957.

[14]Weisskoff, 1970, op. cit., p. 308.

CHAPTER V

THE MULTIPLE REGRESSION MODEL: EMPIRICAL RESULTS

Introduction

The purpose of Chapter V is to present the regression coefficients and related statistics estimated for the log-linear regression model specified in Chapter IV, and for an adjusted variation of this model.

The original model performed largely as expected, and similar to other studies for the United States and Puerto Rico (such as: J. Conlisk (1967), T. S. Sale III (1974), G. Randolph Rice and T. S. Sale III (1975), W. D. Gunther and C. S. Leathers (1975), J. W. Foley (1977), J. E. Long, D. W. Rasmussen and C. T. Haworth (1977), P. G. Grasso and I. Sharkansky (1980), and A. Mann and W. Ocasio (1977)).

In the original model, however, we found a high correlation between the variable X, ECODE and several of the remaining explanatory variables. To test for multicollinearity between ECODE and the rest of the explanatory variables, the latter variables were regressed on the former, showing in all cases a high R^2; thus, suggesting multicollinearity.

In order to rectify this bias, an adjusted model was built in which all the remaining variables but ECODE were regressed on the dependent variable, the GINI coefficient of income distribution.

Unadjusted Model

As indicated in Table II, we estimated a total of seven regression equations.

For 1949 there were two regressions: one with the variabel X_1, ECODE, defined as the median income for persons 14 years old and older in each Puerto Rican municipality, regardless of whether they have earned income or not; and the other with the variable ECODE defined as the median income for persons 14 years old and older with income. In 1959 there were also two regressions: one with the variable ECODE measured by the median income for persons 14 years old and older with income, and the other with this variable defined as the median family income.

For 1969 and 1979, the proxy used for ECODE was also median family income (the 1970 and 1980 Census did not provide personal income figures). For 1979 there were also two regressions: one in which the variable X_{11}, PROPY was used, and one without that variable.

Table II contains estimates of the values for the partial regression coefficients, the t-ratios[1] (in partentheses), and the levels of significance (indicated alongside each t-ratio). The table also presents the coefficients of determination, R^2, and the F-ratio[2], all of which are significant at the 1 percent level.

Levels of Significance of Unadjusted Model

According to the first two columns for 1949 the only insignificant coefficients were for the variables X_6 MIG, and X_8 FEMLF. The latter is not too surprising, given the generally low level of female labor force participation.[3] The insignificance of MIG suggests that out-migration

TABLE II

SUMMARY OF UNADJUSTED MODEL'S REGRESSION COEFFICIENTS AND RELATED STATISTICS

	(1) 1949 Persons 14 Yrs. & Older	(2) 1949 Persons 14 Yrs. & Older With Income	(3) 1959 Persons	(4) 1959 Families	(5) 1969 Families	(6) 1979 Families (Including X_{11})	(7) 1979 Families (without X_{11})
R^2	.4812	.4699	.3958	.4453	.7075	.3462	.3381
Intercept	-.3285 (-1.03)	-.0982 (-.25)	.3510 (1.07)	.5102 (1.71)**	.8225 (2.18)**	.3701 (.53)	.5382 (.81)
β_1 ECODE	-.0671 (-2.36)**	-.1099 (-2.01)**	-.1721 (-.3.86)***	-.1703 (-4.77)***	-.2093 (-4.34)***	-.1464 (-1.94)**	-.1663 (-2.30)**
β_2 AGRI	.0966 (2.49)***	.0793 (1.94)**	-.0045 (-.15)	.0557 (2.17)**	-.0235 (-1.63)*	-.0157 (-1.12)	-.0126 (-.93)
β_3 MFG	-.0336 (-2.19)**	-.0340 (-2.19)**	-.0488 (-2.85)***	-.0488 (-3.26)***	-.0830 (-5.05)***	-.0507 (-1.90)**	-.0531 (-2.00)**
β_4 URB	.0938 (5.06)***	.0914 (4.86)***	.0074 (.35)	.0330 (1.84)**	.0043 (.37)	-.0151 (-.89)	-.0133 (-.80)
β_5 OCSTR	.1344 (2.62)***	.1222 (2.41)***	.1422 (2.35)**	.1794 (3.37)***	.2181 (2.60)***	.1441 (.93)	.1660 (1.09)
β_6 MIG	.0558 (.85)	.0599 (.89)	.0084 (.13)	-.0672 (-1.23)	.1683 (3.32)***	.0246 (.74)	.0232 (.70)
β_7 EDUC	.0435 (1.40)*	.0469 (1.45)*	.0294 (.84)	.0310 (1.07)	.0161 (.26)	.1255 (1.48)*	.1356 (1.61)*
β_8 FEMLF	.0271 (1.20)	.0229 (.95)	-.0025 (-.07)	.0482 (1.55)*	-.0431 (-1.18)	.-0069 (.-11)	.0029 (.05)
β_9 WELPR					-.0270 (-1.24)	-.0442 (-2.10)***	-.0448 (-2.14)**
β_{10} AGE	.1101 (1.33)*	.1089 (1.30)*	-.0239 (-.48)	.0168 (.39)	.0308 (.76)	.0660 (1.12)	.0713 (1.22)
β_{11} PROPY						.0094 (.91)	
Fratio	6.80***	6.50***	4.73***	5.80***	15.72***	3.18***	3.42***
DEGREES OF FREEDOM	9,66	9,66	9,65	9,65	10,65	11,66	10,67

(t - ratios in parenthesis)
* significant at 10 percent level
** significant at 5 percent level
*** significant at 1 percent level

to the U.S. did not yet play an important role in equalizing income. Moreover, the smallness of the island, itself, may severely limit the significance of internal migration.

In the third regression (third column) the variable ECODE is the weighted average for 1959 income of persons, males and females, 14 years old and older with income in each Puerto Rican municipality. It was necessary to calculate this average because the 1960 Census data were divided into median incomes for males and for females. The average was calculated as follows:

$$\left[\frac{\text{Total Males 14 Yrs. Old \& Older With Income In Each Municipality}}{\text{Total (Males + Females With Income)}}\right]$$

X Median Income For Males

$$+\left[\frac{\text{Total Females 14 Yrs. Old \& Older With Income In Each Municipality}}{\text{Total (Males + Females With Income)}}\right]$$

X Median Income For Females

The model performed much more poorly in this case than it did in 1949, or in the other version for 1959. The variables X_2, AGRI; X_4, URB; X_6, MIG; X_7, EDUC; X_8, FEMLF; and X_{10}, AGE, all had insignificant regressor coefficients.

The generally good performance of the second 1959 equation suggests that the division of median personal income data into income for males and females may have been responsible for these results.

As shown in column (4) only the coefficients for the variables MIG, EDUC, and AGE were not significant in the second 1959 equation. The MIG variable also was insignificant in 1949, while EDUC and AGE were only

weakly significant. EDUC may have played such a small role because of the relatively low general level of schooling for persons 25 years old and older. The AGE variable may not explain much about family income differentials because in Puerto Rico most families take care of their own elderly.

In the fifth column are presented the results of 1969. Here, the insignificant coefficients are for URB, EDUC, FEMLF, WELPR, and AGE. EDUC, FEMLF, and AGE still failed to play the role expected in equalizing income. Apparently, the urbanization process had leveled off in terms of its effect on the income distribution. For the WELPR variable, the low level of significance is due, certainly, to the relatively small welfare program payments received by Puerto Rico in the early years of the Great Society (1967 and 1968 were the first years).[4]

In the sixth and seventh columns are presented the results for 1979. The poor explanatory power for AGRI is probably explained by the fact that much of the out-migration from this sector was accomplished by this time. Results first appearing in 1969 for URB and FEMLF continued in 1979, suggesting the completion of other structural changes. EDUC began to show weak explanatory power again, and the OCSTR variable became insignificant for the first time. The latter probably also implies the end of a trend in a developing economy. Finally, the insignificance of the regressor coefficient of the variable PROPY--used for the first time due to data unavailability in earlier years--implies either that income from assets is not important in explaining income concentration in most Puerto Rican municipalities, or that its importance had passed by 1979. It is not possible to determine which.

Estimated Signs of Unadjusted Model

In table III, we compare the estimated signs with the expected signs of the regression coefficients. As in table I of Chapter 3 we concentrate on the beginning and the ending of the study.

TABLE III

ESTIMATED VS. EXPECTED SIGNS OF UNADJUSTED MODEL'S REGRESSION COEFFICIENTS

	1949		1979	
Independent Variable	Expected Sign	Estimated Sign	Expected Sign	Estimated Sign
X_1 ECODE	+	-*	-	-*
X_2 AGRI	+	+*	-	-
X_3 MFG	-	-*	-	-*
X_4 URB	+	+*	-	-
X_5 OCSTR	+	+*	-	+
X_6 MIG	+	+	+	+
X_7 EDUC	-	+*	-	+*
X_8 FEMLF	+	+	-	-, +
X_9 WELPR			-	-*
X_{10} AGE	+	+*	+	+
X_{11} PROPY			+	+

*Significant at 10 percent or less.

Table III indicates that variations in the level of income did equalize income in 1949, contrary to the Kuznets' (1955) expectations for a country in the early stages of growth. Also, education did not appear to be the leveling force expected by many economists.

Table III also indicates that education continued to create greater inequality, contrary to expectations. Finally, the expected equalizing effect of changes in occupational structure never occurred for Puerto Rico.

The fact that ECODE has the expected sign as the economy grows may indicate that the level of income in Puerto Rico was already too high in 1949 to conform to the low level required for Kuznets' (1955) early stage of development. The unexpected signs of both EDUC and OCSTR may imply the training of inadequate number of individuals for middle and upper-level occupations to reduce the relative income advantages of these occupations. That is, education may simply have produced a sort of "labor aristocracy," tending to make the income distribution less equal.[5]

Comparison With Mann and Ocasio's Model

In Table IV we present the estimated regression coefficents of Mann and Ocasios's model.

The A. Mann and W. Ocasio's (1977) model[6] for Puerto Rico, notwithstanding its similarities, has some difference from our original model. First, their model was in a linear form and our model is log-linear. Second, there are some differences in model specifications. Third, there are differences in signs and significance of some of the coefficients.

TABLE IV

THE A. MANN AND W. OCASIO'S MODEL CROSS-MUNICIPALITY REGRESSION RESULTS, PUERTO RICO, 1949, 1959, AND 1969

Explanatory Variables	1949 Persons	1959 Persons	1959 Families	1969 Families
Constant	571	712	668	480
X_1	-.0028	-.0066*	-.0072**	-.0036
	(.0056)	(.0038)	(.0032)	(.0031)
X_2	.1163	.3712***	.2331***	.0552)
	(.1025)	(.0743)	(.0638)	(.0411)
X_3	-.7031	-.6180	.2145	-1.5088**
	(1.1177)	(.8329)	(.7156)	(.7329)
X_4	-112.6999*	-15.8171**	-8.4836	-4.4002
	(6.5419)	(6.0484)	(5.1969)	(5.6053)
X_5	2.1685	1.6648	1.9467*	1.8526
	(1.3666)	(1.1487)	(.9870)	(1.1740)
X_6	1.2502	-1.8667**	-2.3574***	-1.4920**
	(1.5239)	(.7621)	(.6548)	(.6231)
X_7	.9116	.7208	.0308	1.7101***
	(.5609)	(.4935)	(.4240)	(.4403)
X_8	-3.8365***	-5.9317***	-3.9424***	-.8333
	(1.3739)	(1.4852)	(1.2761)	(.6003)
X_9	.0079***	.0035	.0081**	-.0113
	(.0029)	(.0042)	(.0036)	(.0085)
R^2	.3450	.4480	.4369	.6569
F-Ratio	3.8627***	5.9523***	5.6900***	14.0401***
Degrees of Freedom	9,66	9,66	9,66	9,66

(Standard Errors in Parenthesis)

*Significant at 10 percent level.
**Significant at 5 percent level.
***Significant at 1 percent level.
X_1=Population Density
X_2=Real Per Capita Income
X_3=Proportion Labor Force Employed in Manufacturing
X_4=Median School Years Completed, Persons 25 Years and Older
X_5=Female Proportion of Labor Force
X_6=Proportion Labor Force Employed in Middle-Level Occupations
X_7=Proportion Population Born in Municipality of Residence
X_8=Activity Rate
X_9=Proportion Labor Force Employed in Agriculture

Their Per-Capita Income variable showed positive signs and it was significant only for 1959, unlike ours where the sign was negative and the coefficient significant for each year.

Their variable for the Proportion of Labor Force Employed in Agriculture showed positive signs in all years, except 1969, and significant values for the coefficients only in 1949 and 1959 (for families). The equivalent variable for our model, proportion of employed persons working in agriculture, showed, as expected, positive signs in the early years of economic development, and negative signs in later years, with significant values for 1949, 1959 family income, and 1969.

Their variable, Proportion of Labor Force Employed in Manufacturing showed for its regression coefficients negative signs in all years, except for 1959 family income. Its t-ratio values were significant at 5 percent level only in 1969. The equivalent variable in our model, proportion of employed persons working in manufacturing, showed, as expected, negative signs in all years, and highly significant t-values in all years.

The regression coefficient of their variable, Population Density, had negative signs in all years except in 1969, and its t-ratio was significant only for 1959 personal income and 1959 family income. The equivalent variable in our model, number of inhabitants per square mile, (URB), showed, as expected, positive signs in the early stage of economic development, and negative signs in the mature stage. Its t-ratio values were significant, however, only for 1949 income and 1959 family income.

Their variable, Proprotion of Labor Force Employed in Middle Level Occupations, had regression coefficients with negative signs in all

years except in 1949. Its t-ratio values were significant at 5 percent in 1959 persons and 1969, and at 1 percent in 1959 families. The equivalent variable for our model, proportion of employed persons working in upper and middle-level occupations, showed positive signs in all years and its t-ratio values were significant at 1 percent in 1949, 1959 (family income), and 1969, and at 5 percent for 1959 personal income.

Their variable, Proportion of Population Born in Municipality of Residence had regression coefficients with positive signs in all years which were significant at the 1 percent level, only, in 1969. The equivalent variable of our model, the proportion of population born in the municipality of residence, (MIG), behaved in identical fashion except for 1959 family income.

Their variable for education, Median School Years Completed by Persons 25 Years and Older showed negative signs for the regression coefficient in all years, and its t-ratio values were significant at the 10 percent and 5 percent levels in 1949 and for 1959 personal income, respectively. The proxy used for education in our model was the same as in the Mann and Ocasio's model, but our regression coefficient's signs were positive in all years, and its t-ratio values were significant at 10 percent, only, in 1949 and 1979.

The regression coefficient for their variable Female Proportion of Labor Force showed positive signs in all years and was significant at 10 percent, only, for 1959 family income. The equivalent variable in our model, proportion of employed persons who where female in each Puerto Rican municipality, showed positive signs for its regression coefficients for 1949, for 1959 family income, and for 1979 (without the variable PROPY) and negative signs for 1959 personal income, 1969, and

1979 (including the variable PROPY). The t-ratio value was significant at 10 percent, only, for 1959 family income as in the Mann and Ocasio's model.

The Mann and Ocasio's model has a variable, Activity Rate, whose proxy is the proportion of the total population that is economically active, that has no equivalent in our model. In turn, our model has three variables: Welfare Program, Age, and Property Income that were not used in the Mann and Ocasio's model.

Correlation Matrix of Unadjusted Model

Table V presents the correlation coefficients of $\pm$ .70 or larger for the unadjusted model.

According to table V we found a high correlation between the variable X_1, ECODE and the variable X_2, AGRI; X_5 OCSTR; X_6, MIG; X_7 EDUC; X_8, FEMLF; and X_9 WELPR, suggesting the presence of multicollinearity between X_1 and those explanatory variables. The standard practice in such a case is to delete the variable causing multicollicollinearity provided there are no serious theoretical objections to its exclusion.

The variable ECODE, or rather the proxy used for it, the median personal or family income, allows us to determine whether there is a so-called inverted "U" shape curve,[7] conforming to the Kuznets' (1955) hypothesis, based on the interrelationship between economic growth and income distribution. However, the ECODE variable tell us little about structural changes occurring in the economy that account for the changes in income distribution year by year.

TABLE V

CORRELATION COEFFICIENTS MATRIX OF THE EXPLANATORY VARIABLES IN THE UNADJUSTED MODEL

($\pm$ .70 or Larger)

1949	X_1X_2	X_1X_5	X_1X_6	X_1X_7	X_1X_8	X_1X_9	X_2X_4	X_2X_5	X_2X_6	X_2X_7	X_3X_5	X_3X_8	X_5X_7	X_5X_8	X_7X_9
Persons I	-.74		-.74					-.80				.79			
Persons II	-.74		-.78					-.80				.79			
1959															
Persons	-.83	.79	-.79				-.84	-.78	.79		.78			.80	
Families	-.81	.82	-.75				-.84	-.78	.79		.78			.80	
1969															
Families	-.80	.79	-.74	.87	.72	-.80	-.74	-.74	.75	-.79					-.84
1979															
Families I		.71		.80	.76			-.70		-.77			.71		
Families II		.71		.80	.76			-.70		-.77			.71		

The interrelationship between the variable X_2, AGRI, and the variables X_4, URB; X_5, OCSTR; and X_6, MIG can probably be explained on theoretical grounds. At the same time that the economic development of Puerto Rico took place, the shift away from the agricultural sector was mainly to urban areas and also to middle and upper level occupations. Thus, any one of the three variables serves to some extent as a proxy for the other two.

The interrelationship between X_3 and X_5 is also expected during early stages of growth when middle-level jobs are being created largely in manufacturing.

Test For Multicollinearity

A test for multicollinearity was realized by regressing, for each of the unadjusted model's seven regressions, the remaining eight, nine, or ten explanatory variables on the variable X_1, ECODE. The results confirmed the presence of multicollinearity, in as much as the seven regressions produced very high coefficient of determination, R^2 and of multiple correlation, R. For example, in 1949 for the Persons I equation, R^2: .76 and R: .87. This result means that for this equation, the eight remaining explanatory variables account for 76 percent of the intermunicipality variation in the median personal income in 1949. Equivalent results were found for the rest of the years:

1949 Persons II: R^2: .85; R: .92

1959 Persons: R^2: .85; R: .92

1959 Families: R^2: .84; R: .92

1969 Families: R^2: .89; R: .94

1979 Families I: R^2: .85; R: .92

1979 Families II: R^2: .83; R: .91

In order to correct for the presence of multicollinearity among X_1 and the other explanatory variables, the variable ECODE was deleted from the adjusted model. To further test for the soundness of such deletion, a joint-F statistics test[8] was made which produced for 1949 Persons I, 1949 Persons II, 1979 Families I, and 1979 Families II values of joint F-statistics clearly below the critical values of F-statistics, which indicated that in those years the variable ECODE had a value not significantly different from zero. For the equations, 1959 Persons, 1959 Families, and 1969 Families, the values of joint F-statistics were above the critical values of the F-statistic.

Adjusted Model

The principal elements of the adjusted model are presented in Table VI: the values of the partial regression coefficients, the t-ratio statistics (in parenthesis), the level of significance of the t-statistics, R^2, and the F-ratio statistics.

In general, the adjusted model produced lower values for R^2 for each of the six equations estimated. However, as expected, there was a general improvement in the level of significance of the coefficients for several independent "structural" variables--AGRI, URB, MIG, and FEMLF--and for AGE and PROPY, as well. There was, at the same time, a reduction in significance of the coefficients for three other structural variables: MFG, OCSTR and EDUC.[9] The adjusted model had little effect on WELPR.

The principal gain in understanding from the adjusted model lies in the sharper distinctions it makes between several of the variables highly correlated with ECODE. Close inspection also shows that the

TABLE VI

SUMMARY OF ADJUSTED MODEL'S REGRESSION COEFFICIENTS AND RELATED STATISTICS

	(1) 1949 Persons	(2) 1959 Persons	(3) 1959 Families	(4) 1969 Families	(5) 1979 Families (Including X_{11})	(6) 1979 Families (Without X_{11})
R^2	.4374	.2575	.2512	.6226	.3090	.2857
Intercept	-.6397 (-2.14)**	-.7571 (-4.42)***	.7591 (-4.87)***	-.6746 (-3.87)***	-.8803 (-3.38)***	.8832 (-3.36)***
β_2 AGRI	.1028 (2.57)***	.0158 (.49)	.0700 (2.38)***	-.0162 (-1.15)	-.0210 (-1.50)*	-.0168 (-1.21)
β_3 MFG	-.0302 (-1.91)**	-.0419 (-2.23)**	-.0378 (-2.21)***	-.0813 (-4.39)***	-.0491 (-1.81)**	-.0530 (-1.94)**
β_4 URB	.0948 (4.95)***	.0290 (1.30)*	.0503 (2.49)***	.0074 (.56)	-.0122 (-.71)	-.0085 (-.50)
β_5 OCSTR	.0876 (1.79)**	.0531 (.86)	.0768 (1.37)*	.0956 (1.07)	.0246 (.17)	.0346 (.24)
β_6 MIG	.1135 (1.81)**	.1178 (1.85)**	.0370 (.64)	-.1915 (3.37)***	.0453 (1.42)*	.0478 (1.48)*
β_7 EDUC	.0266 (.85)	-.0110 (-.30)	.0174 (.52)	-.0625 (-.93)	.0562 (.71)	.0575 (.72)
β_8 FEMLF	.0460 (2.12)**	.0257 (-.70)	-.0046 (-.14)	-.1089 (-2.91)***	-.0719 (-1.29)*	.-0704 (-1.25)
β_9 WELPR				-.0018 (-.08)	-.0465 (-2.18)**	-.0483 (-2.24)**
β_{10} AGE	.1202 (1.41)*	.0219 (.41)	-.0561 (1.16)	.0689 (1.55)*	.0695 (1.16)	.0799 (1.32)*
β_{11} PROPY					.0152 (1.50)*	
Fratio	6.51***	2.86***	2.77**	12.10***	3.00***	3.02***
DEGREES OF FREEDOM	8,67	8,66	8,66	9,66	10,67	9,68

(t - ratios in parenthesis)
* significant at 10 percent level
** significant at 5 percent level
*** significant at 1 percent level

signs of the coefficients in the adjusted model conform to expectations about as well as did the unadjusted model. In fact, the signs of the two models are identical in 1949 and 1979.

Test For Serial Correlation

Serial correlation was tested for using the Durbin-Watson technique. Serial correlation occurs more frequently in time-series studies but could also happen in cross-section studies.[10]

The DW statistic test showed the following results. For 1949, with the variable X_1, ECODE, represented by the median income for persons 14 years old and older, the DW statistic was 1.98. Thus, we accepted the null hypothesis that no serial correlation was present ($\rho = 0$), since when DW is close to 2, there is no serial correlation.[11]

For 1949, with the variable X_1, ECODE, represented by the median income for persons 14 years old and older with income, the DW statistic was 2.009. As in the first case, the null hypothesis of no serial correlation was accepted. For 1959, with the variable X_1, ECODE represented by the weighted average of the median income for male and female, the DW statistic was 1.97. Here, also, the null hypothesis of no serial correlation was not rejected.

For 1959, with ECODE represented by family income, the DW statistic was 1.85. Here the DW test was applied as follows. At a 1 percent level of significance, with n = 76 and k = 10, the limits are: d_ℓ: 1.23 and $d_\mu = 1.75$.[12] The rule that fits here is $d_\ell < DW < 2$,[13] hence, $1.75 < 1.85 < 2$. Therefore, for the fourth regression, the null hypothesis of no serial correlation was not rejected.

For 1969, with ECODE represented by family income, the DW statistic was 2.22. At 1 percent level of significance, with n = 76, and k = 11, the limits are $d\ell = 1.21$ and $du = 1.77$.[14] The rule that fits here is $2 < DW < (4 - du)$,[15] hence, $2.00 < 2.22 < 2.23$. Therefore, for the fifth regression also the null bypothesis of no serial correlation was not rejected. For 1979, when the variable X_{11}, PROPY, is included the DW statistic is 1.88. At a 1 percent level of significance, with n = 78 and k = 12, the limits are: $d\ell = 1.19$ and $du = 1.81$.[16] The rule that fits in this case is $du < DW < 2$,[17] or $1.81 < 1.88 < 2$. Therefore, for the sixth regression, as well, the null hypothesis of no serial correlation was not rejected.

Finally, for 1979, without the variable X_{11}, PROPY; the DW statistics is 1.89. At 1 percent level of significance, with n = 78 and k = 11, the limits are $d\ell = 1.22$ and $du = 1.78$.[18] The rule that fits in this case is also $du < DW < 2$, hence, $1.78 < 1.89 < 2$. Therefore, for the seventh regression, as for the first six, the null hypothesis of no serial correlation was not rejected.

FOOTNOTES

[1]In the present study the rule for testing the "null" hypothesis, Ho, against the "alternative" hypothesis, Ha is based on a statistic called 't' ratio, which may be defined as follows:

$$t = \hat{\beta}/\text{Standard Error of } \beta$$

Since the estimate of β and its standard error is obtained from the least square procedure, the t-ratio has a theoretical distribution. When the null hypothesis, Ho is true and the error terms are generated by normal distribution the t-ratio follows the 'student t' distribution with n - k degrees of freedom. The rule is: whenever the computed t-ratio exceeds the critical value, t_c, the null hypothesis is rejected and not otherwise. Testing a null nypothesis against an alternative hypothesis that assigns value to the parameter which are greater than the value implied by the null hypothesis is called the 'right-tail' test.

[2]The F-statistic test was made using the equation:

$$F = \frac{SSR/(k)}{SSE/(n-k-1)}$$

where k is the number of regressors, and n is the number of observations. Henry J. Cassidy, Using Econometrics: A Beginner's Guide, Reston Publishing Co., Reston, Va., 1981, p. 16.

[3]Fuat M. Andic and Arthur J. Mann, "Secular Tendencies in the Inequality of Earnings in Puerto Rico," Review of Social Economy, Vol. 34, No. 1, (April 1976), pp. 17-22.

[4]In 1970 transfer payments constituted only 2.2 percent of personal income, Junta de Planificación, Informe Económico Al Gobernador 1979, 1980 quoted from Richard Weisskoff, 1980, op. cit., p. 149.

[5]Among the studies that have produced the same results for the variables education and occupational structure are Irving B. Kravis's "International Differences in the Distribution of Income," Review of Economics and Statistics, Vol. 42, (Nov. 1960), p. 413, and M. J. Carvajal and David T. Geithman's "Income Distribution and Economic Development.

Some Intra-Country Evidence," Southern Economic Journal, Vol. 44, Communication, (April 1978), p. 926.

[6]Arthur J. Mann and William C. Ocasio, "The Determinants of Income Concentration in Puerto Rican Municipalities," Review Interamericana, Vol. 7, No. 2, 1977, pp. 309-319.

[7]Kuznets, 1955, op. cit., pp. 20-26.

[8]The equation employed for the joint F-statistics was:

$$F = \frac{(R_{UR}^2 - R_R^2)/K_R}{(1 - R^2_{UR})/(n - K_{UR})}$$

where R^2_{UR} and R_R^2 are the coefficients of determination of the unrestricted (unadjusted) and the restricted (adjusted) models, respectively, K_R is the number of restrictions imposed on the model, 'n' is the number of observations, and K_{UR} is the number of regressors, including the intercept, in the unrestricted model.

[9]An interesting and provocative analysis of the changes that have occurred in the Puerto Rican economy in the last two decades is Elias Gutierrez's "The Transfer Economy of Puerto Rico: Toward an Urban Ghetto?" in Time for Decision, 1980, op. cit., pp. 117-134.

[10]R. S. Pindyck and D. L. Rubinfeld, Econometric Models and Economic Forecasts, McGraw-Hill, Inc., 1976, p. 106.

[11]Cassidy, 1981, op. cit., p. 259.

[12]N. E. Savin and Kenneth J. White, "The Durbin-Watson Test for Serial Correlation with Extreme Sample Sizes or Many Regressors," Econometrica, Vol. 45, No. 8, (November 1977), pp. 1989-1976, Table II, pp. 1992-1993.

[13]Pindyck and Rubinfeld, 1976, op, cit., p. 114.

[14]Savin and White, 1977, op. cit. pp. 1992-1993.

[15]Pindyck and Rubinfeld, 1976, op. cit., p. 114.

[16]Savin and White, 1977, op. cit., pp. 1992-1993.

[17]Pindyck and Rubinfeld, 1976, op. cit., p. 114.

[18]Savin and White, 1977, op. cit., pp. 1992-1993.

CHAPTER VI

ADDITIONAL MEASURES OF INCOME DISTRIBUTION

Introduction

In this chapter we present the aggregate money income distributions for persons in 1949 and 1959, and for families in 1959, 1969, and 1979. Also presented are the values produced in those years for the GINI coefficient, computed via both trapezoidal approximations and ordinary least squares, (OLS), the coefficient of variation, the standard deviation of logs of income, the Williamson index, and our interpretation of these results. There is also an assessment of these results in the light of our findings from the multiple regression model.

Descriptions of the Aggregate Income Distribution

The results showed in the following tables of income distribution seem to indicate that the Kuznets' (1955) hypothesis only partially conformed to the Puerto Rican data during the period 1949-1979.

One possible reason for that pattern is that during the decade 1949-1959 Puerto Rico was in the transition period of her economic development, as per Kuznets' (1955) hypothesis, in which the income distribution starts to become more equal, that is, in the mature stage of development. From 1969 to 1979, however, some signs suggest a reversal of this equalization trend.

Table VII shows that a relative improvement in the income distribution among persons 14 years old and older with income occurred during the decade 1949-1959. The general trend is quite evident in the change which occurred in the Lorenz curve between these years (see Figure 2). In 1949, persons with earnings of less that $100 received 0.8 percent of total income and in 1959 their share was only 0.3 percent of total income. However, while in 1949 this group included 12.9 percent of the total number of persons with income, in 1959 it declined to only 9.7 percent. In 1949 the number of people with the highest income, $10,000 and over, were 0.3 percent of the total and their share was 8.5 percent of total income received by persons 14 years old and older with income. But in 1959 the corresponding figures were 0.9 for the former and 11.8 for the latter.

These figures also agree with Kuznets' (1955) expectations about the movement over time of people across the income brackets as economic development takes place; for example, in the middle income brackets, those earning between $3,000 and $9,999, received 18.8 and 29.4 percent of total income in 1949 and 1959, respectively.

The pattern of the change in money income distribution of families for the period 1959-1979 is shown in both Table VIII and Figure 3. In 1959 the largest group of families, 25 percent of the total, was in the bracket of less than $500. This group received only 2.9 percent of total income. By 1969 the largest group of families, 14.5 percent, was in the $6,000 to $9,999 bracket. This group also received the largest share of family income, 25.1 percent. By 1979, however, the $6,000 to $9,999 bracket is still the family income mode with 21.3 percent of total families, but that group in 1979 received only 19.4 percent of

TABLE VII

DISTRIBUTION OF MONEY INCOME IN 1949 AND 1959,
BY PERCENT OF PERSONS 14 YRS. OLD AND OLDER WITH INCOME,
AND PERCENT OF INCOME[1]

	Percent Persons		Percent Income	
Income Range	1949	1959	1949	1959
Less than $100	12.9	9.7	.8	.3
$100 to $299	30.5	15.1	8.1	2.1
$300 to $499	17.0	12.5	9.0	3.6
$500 to $699	9.4	8.7	7.4	3.7
$700 to $999	9.1	10.2	10.2	6.2
$1,000 to $1,499	10.5	14.1	17.4	12.8
$1,500 to $1,999	4.3	9.8	10.1	12.2
$2,000 to $2,499	2.1	7.3	6.2	11.6
$2,500 to $2,999	1.0	3.2	3.5	6.3
$3,000 to $3,499	.9	2.4	3.9	5.6
$3,500 to $3,999	.5	1.5	2.6	4.1
$4,000 to $4,499	.4	1.9	2.1	6.1
$4,500 to $4,999	.2	1.0	1.5	3.8
$5,000 to $9,999	.9	1.7	8.7	9.8
$10,000 and over	.3	.9	8.5	11.8
	100.0	100.0	100.0	100.0

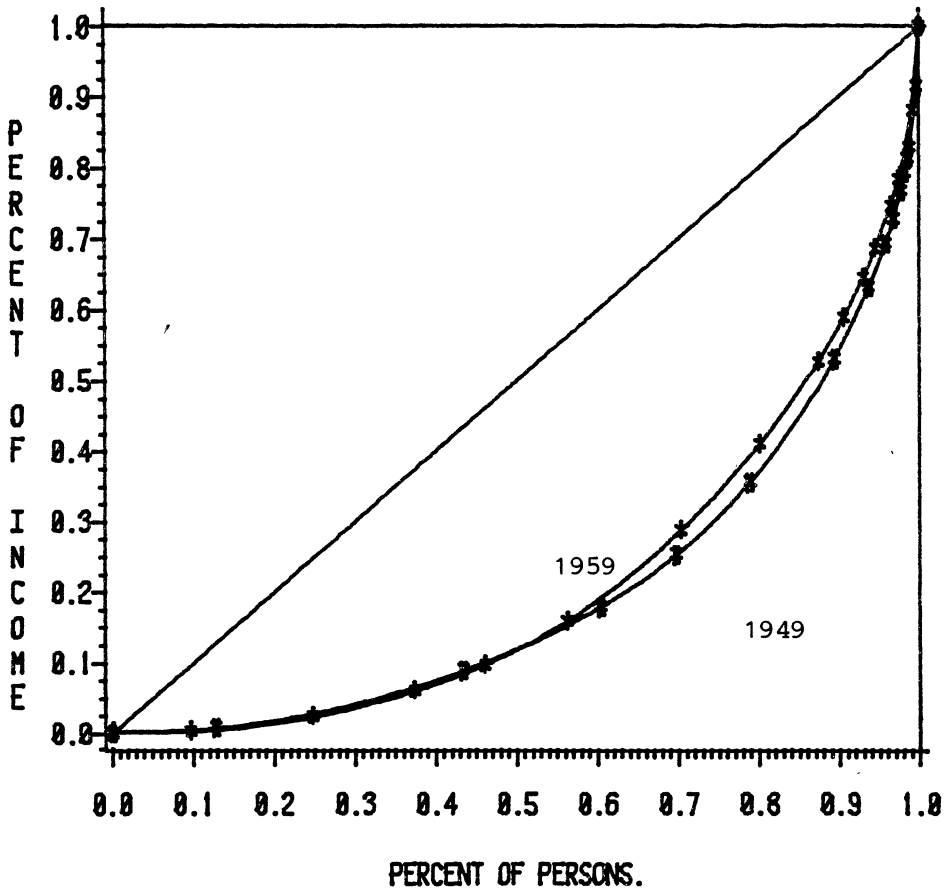

Figure 2. The Lorenz Curves for Personal Incomes for the Years of 1949 and 1959

1949 —|—|— 1959 —•—•—

(Source: Plotted From Data in Table VII)

TABLE VIII

DISTRIBUTION OF MONEY INCOME, 1959, 1969, AND 1979,
BY PERCENT OF FAMILIES AND PERCENT OF INCOME[2]

	Percent Persons			Percent Income		
Income Range	1959	1969	1979	1959	1969	1979
Less than $500	25.0	12.8	8.7	2.9	.7	.3
$500 to $999	17.6	8.6	2.6	6.2	1.4	.2
$1,000 to $1,999	23.7	13.8	7.7	16.5	4.5	1.3
$2,000 to $2,499	12.9	14.1	8.5	15.0	7.6	2.4
$3,000 to $3,999	7.1	11.4	7.9	11.4	8.6	3.2
$4,000 to $4,999	4.4	8.3	8.0	9.2	8.1	4.1
$5,000 to $5,999	2.6	6.2	7.1	6.7	7.4	4.5
$6,000 to $9,999	4.6	14.5	21.3	17.1	25.1	19.4
$10,000 to $14,999	1.4	6.3	13.3	8.2	17.1	19.0
$15,000 and Over	.7	4.0	14.9	6.8	19.5	45.6
	100.0	100.0	100.0	100.0	100.0	100.0

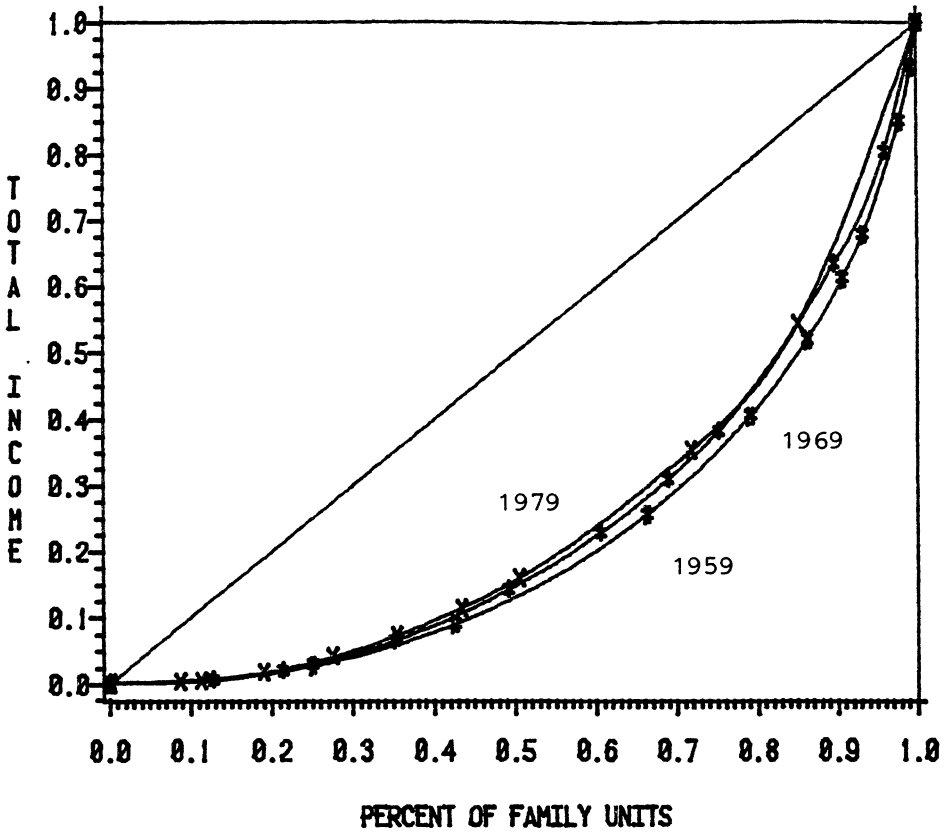

Figure 3. The Lorenz Curves for the Family Incomes for the Years of 1959, 1969, and 1979

1959 —‡—‡— 1969 —•—•— 1979 —X—X—

(Source: Plotted From Data Based in Table VIII)

total income and the largest share of income was received by those in the highest income bracket, $15,000 and over, with 45.6 percent of total income.

The above figures indicate a recent trend-toward higher income concentration in the upper brackets during the 1970's; certainly, a reversal of the initial trend toward income equalization during the 1950's and 1960's.

Summary Statistics of the Aggregate Income Distribution

Aggregate GINI Coefficient

We have calculated the GINI coefficient for Puerto Rico via trapezoidal approximations (see Chapter IV for further details), the unweighted average of the GINI for all Puerto Rican municipalities, and via ordinary least squars (OLS) (also see Chapter IV for further details). The GINI coefficients are presented for both: the 10 income bracket intervals of Table VIII, and for the intervals contained in the Census data.

According to Table IX, there was a general trend toward equality in income distribution in the Puerto Rican municipalities, which appeared to accelerate from 1959 to 1979. Between 1959 and 1969 the GINI for family income declined 21 points, and between 1969 and 1979 it declined 28 points. The GINI coefficient for family income for Puerto Rico as a whole declined between 1959 and 1969 by 45 points, and between 1969 and 1979 by 19 points.

This pattern suggests that the income distribution, at least as measured by the GINI coefficient computed via trapezoidal approximations, has tended toward greater equality, whether the emphasis is on

TABLE IX

AGGREGATE GINI COEFFICIENTS

Year	Trapezoidal		
Census Intervals	Unweighted Municipal Average	Puerto Rico as a Whole	OLS
1949 Persons	.536	.591	--
1959 Persons	.539	.573	--
1959 Families	.519	.560	.545
1969 Families	.498	.525	.570
1979 Families	.470	.506	.530
10 Intervals			
1959 Families	--	.546	.531
1969 Families	--	.515	.535
1979 Families	--	.490	.546

municipalities or on the island taken as a whole. In fact, almost all municipalities showed declining GINI coefficients with the notable exception of the large urban areas, San Juan, Carolina, Bayamón, Caguas, and Mayaguez. These exceptions are probably due to a higher concentration of income in the upper brackets in larger cities. There was rapid mobility upward among the cities' families during the 1949-1979 period; however, this was coupled with the movement of higher income people from inner cities to suburbia and lower income people from rural to urban areas, and a greater number of families headed by women and people of 65 years old and older in urban than in rural areas. This same explanation

may apply to the OLS GINI coefficient which shows, using 10 income intervals, an increase of 15 points between 1959 and 1979 for family income.

The GINI coefficient computed via ordinary least square is based on the equations of Kakwani and Podder's (1973) model (see Chapter IV for futher details).

$$\eta = \pi e - \beta(1 - \pi) \qquad (1)$$

where η is the cumulative proportion of income, and π the cumulative proportion of families. The GINI coefficient obtained by this function is,

$$G = 1 - \frac{2(\beta - 1)}{\beta^2} - \frac{2e - \beta}{\beta^2}, \qquad (2)$$

where if the computed $\hat{\beta} = 0$, the Lorenz curve coincides with the income equality line, and if $\hat{\beta} > 0$, the Lorenz curve lies below the income equality.

The estimates of (2) are shown in Table X.

A Chow (1960) test was applied to determine the statistical significance of the changes over time in the OLS GINI coefficients. This test allows us to determine if the variations of the GINI coefficient are large enough to indicate significant shifts in the income distribution from 1959 to 1979.

For such a purpose we hypothesize that:

$$Ho = \hat{\beta}_{59} = \hat{\beta}_{69} = \hat{\beta}_{79} = \bar{\beta},$$

or

Ha = Ho is not true.

If the calculated value of the F-statistic is less than the critical value according to the Chow test, the differences between the

TABLE X

AGGREGATE GINI COEFFICIENTS BY OLS

Year Census Intervals	$\hat{\beta}$	t-ratio	R^2	OLS	Trapezoidal GINI
1959	2.87	40.90	.99	.545	.560
1969	3.29	20.38	.97	.570	.525
1979	2.85	18.70	.98	.530	.506
10 Intervals					
1959	2.86	32.01	.99	.531	.546
1969	2.90	23.67	.99	.535	.515
1979	3.01	15.99	.97	.546	.490

estimated OLS GINI coefficients are not significant, and one accepts the null hypothesis, (Ho), that the distributions in 1959, 1969, and 1979 are basically the same. Conversely, if the calculated value of F ratio is greater than the critical value the null hypothesis, (Ho), is rejected, and the alternative hypothesis, (Ha), is accepted.

The equation used to compute the F ratio by the Chow test was:

$$F(2, T_{59} + T_{69} + T_{79} - 3) = \frac{[SSE(Ho) - SSE(Ha)]/2}{SSE(Ha)/(T_{59} + T_{69} + T_{79} - 3)} \quad (3)$$

where SSE(Ho) is the error sum of squares of the restricted model, 1959-1979, SEE(Ha) is the error sum of squares of the unrestricted model, that is, the summation of SSE_{59} plus SSE_{69} plus SSE_{79} divided by the number of restrictions, 2, and $T_{59} + T_{69} + T_{79} - 3$ are the number of observations in each year minus three (for the three sets of data).

The results of this test are displayed in Table XI.

The results that emerged from the Chow test indicate that for the whole period, 1959-1979, the changes in the regression coefficients and

TABLE XI

CHOW TESTS FOR SIGNIFICANT DIFFERENCES IN β COEFFICIENTS 1959-1979

Census Intervals	F-ratio
1959	1672.62*
1969	415.38*
1979	349.49*
Period 1959-1979	.24
10 Intervals	
1959	1024.71*
1969	560.11*
1979	255.74*
Period 1959-1979	3.17

*Significant at a 1 percent level

henceforth, in the OLS GINI coefficients are not statistically significant. This implies that the economic structures of 1959, 1969, and 1979 are, basically, the same.[3]

In the following table we present a table of incomes shares of the higher and the lower 20 percent of the population, and the GINI

coefficients, computed via trapezoidal approximations, for several developed and developing countries.

The above results indicate that in Puerto Rico the GINI coefficient values computed both ways (OLS and trapezoidal approximations) are still higher, according to international comparisons (see Tables IX and X), and that, in spite of a trend toward more equal income distribution in the

TABLE XII

INEQUALITY MEASURES FOR SEVERAL DEVELOPED AND DEVELOPING COUNTRIES[4]

		Income Share of Population		Trapezoidal GINI
Developing Countries	Year	Lower 20%	Higher 20%	Coefficient
Argentina	1961	.069	.509	.393
	1970	.044	.503	.414
Brazil	1960	.035	.621	.509
	1970	.028	.673	.557
Korea	1966	.094	.358	.249
	1976	.057	.453	.362
Malaysia	1970	.033	.565	.479
	1973	.035	.561	.471
Developed Countries				
Canada	1969	.050	.410	.338
	1977	.038	.420	.365
France	1962	.023	.547	.476
	1975	.053	.458	.367
Japan	1962	.056	.445	.356
	1971	.038	.463	.387
U.S.A.	1960	.046	.430	.357
	1972	.045	.428	.362

island's municipalities, there are signs of a reverse, or at least a slow down, of that trend for the island taken as a whole.

Coefficient of Variation

The coefficient of variation C.V. was computed by using the equation:

$$C.V. = \frac{Sx}{\bar{X}} \qquad (4)$$

that is, the standard deviation of the distribution of income, Sx, divided by its arithmetic mean, $\bar{X}$ (see Chapter IV for further details).

The results for the C.V. estimates are given in Table XIII.

The C.V. (using Census intervals) shows a decline of 21 percent between 1949 and 1959 for income by persons, a decline of 20 percent

TABLE XIII

ESTIMATES OF THE COEFFICIENT OF VARIATION

Year	Value	
	Census Intervals	10 Intervals
1949 Persons	1.947	--
1959 Persons	1.544	--
1959 Families	1.351	1.149
1969 Families	1.076	1.069
1979 Families	1.091	.958

between 1959 and 1969 for income by families, and an increase of barely 1 percent between 1969 and 1979 for income by families. There was a similar pattern during the 1970's for the GINI coefficient computed via trapezoidal approximations. Also, for both the GINI coefficient computed via trapezoidal approximations and the C.V. fewer intervals tend to reduce the computed value.[5] For the C.V., with higher income concentration in the upper brackets, fewer number of intervals tends to reduce the computed value.[6] This is due to the very nature of equation (4). Where it is necessary to put a greater number of items (e.g., families) in each interval, the standard deviation--the numerator of the C.V.--tends to be magnified. Therefore, it is reasonable to assume that such a small increase as 1 percent in the C.V. does not necessarily indicate a reversal of the long-run trend toward a lower variance in the income distribution of Puerto Rico. However, for reasons already explained, during the 1970's the trend toward equality has not been as marked as in the 1950's and 1960's.

Finally a statistical test was made for the C.V. by regressing the income base of the C.V. measure against the values for the C.V.'s statistic. Thus, the independent variable is the mean personal or the mean family income, as the case may be. The resulting regression equation, corresponding to the Census intervals, was:

$$\text{C.V.} = \underset{(6.59)}{2.2390} - \underset{(-5.71)}{.2466}\,\bar{Y}, \text{ with } R^2 = .9157, \qquad (5)$$

and F-ratio = 32.58 (significant at a 5 percent level). The t-ratio values of both the intercept and the independent variable are significant at a 1 percent level.

The regressed equation produced using 10 intervals was:

$$C.V. = \underset{(5.74)}{2.4846} - \underset{(-5.19)}{.2857}\ \bar{Y}, \text{ with } R^2 = .8998, \qquad (6)$$

and F-ratio = 26.94 (also significant at a 5 percent level). Here too, the t-ratio values of the intercept and the independent variable are significant at a 1 percent level.

Standard Deviation of Logs of Income

The standard deviation of logs of income is computed using the equation:

$$\text{Std. Dev. } (\log Y) = \left(\frac{1}{n}\right) \sqrt{\log Yi - \log Y^*}, \qquad (7)$$

where n is the number of income intervals for each income distribution, Y is the mid-point of each income interval and Y* is the geometric mean of the income distribution.

The estimates based on (7) are given in Table XIV.

There is a clear downward trend for its value until 1969. Between 1949 and 1959 its value declined by 17 percent for income by persons. Between 1959 and 1969 it declined by 22 percent for income by families. However, the trend was reversed from 1969 to 1979, when it increased 5 percent.

As was explained in Chapter IV, this measure is particularly sensitive to changes in the upper end of the distribution. We noted earlier a clear trend toward more families in the upper than in the lower income brackets. Second, according to Table VIII, there was a trend toward greater income concentration in the highest income bracket.

A statistical test was also made for the Std. Dev. (log Y). Here we used as the independent variable the arithmetic and geometric means of personal or family income, as the case may be. With the arithmetic mean income the resulting regressed equation was:

TABLE XIV

ESTIMATES OF STANDARD DEVIATION OF LOGS OF INCOME

Year	Value: Census Intervals	Value: 10 Intervals
1949 Persons	.892	--
1959 Persons	.740	--
1959 Families	--	.720
1969 Families	--	.562
1979 Families	--	.589

$$\text{Std. Dev. (log Y)} = \underset{(3.47)}{1.0484} - \underset{(-4.72)}{.1816}\,\bar{Y}, \text{ with } R^2 = .8812. \qquad (8)$$

The F-ratio of 22. 25 is significant at a 5 percent level. The t-ratio values for the intercept and independent variable are significant at a 1 percent level.

With the geometric mean, the equation produced was:

$$\text{Std Dev. (log Y)} = \underset{(3.24)}{.8642} - \underset{(-4.66)}{.1719}\,Y^*, \text{ with } R^2 = .8786. \qquad (9)$$

Here, the F-ratio of 21.71 is significant at a 5 percent level, and the t-ratio values for the intercept and for the independent variable are also significant at a 1 percent level.

Therefore, for the Std. Dev. (log Y), as for the C.V., the inverse relationship between their income concentration values and its respective income base measures have proved to be significant for each of the five Census years.

Descriptions of the Distribution Statistics, by Municipality

The pattern of the equity-growth trade off, expressed on a municipality basis, is represented in Table XV.

TABLE XV

SUMMARY OF INCOME PER CAPITA
IN PUERTO RICAN MUNICIPALITIES

Year	Income Per Capita For Puerto Rico	Percent of Municipalities With Less Than National Income Per Capita
1949 Persons	218	88
1959 Persons	440	84
1959 Families	408	84
1969 Families	981	82
1979 Families	2,126	86

Table XV shows a small decrease of the percentage of municipalities with per capita income lower than the per capita income of Puerto Rico, from 1949 to 1969. However, the trend reversed from 1969 to 1979. This latter pattern reaffirms the findings based on the OLS GINI coefficient, the C.V., and the Std. Dev. (log Y), of a slow down in the long run trend toward equalization in the income distribution during the last Census decade. In the municipalities case, the reason is probably that as the economy developed and the national per capita income increased,

the per capita income of highly urbanized municipalities tended to increase faster than the per capita income of less urbanized and less developed municipalities. This occurred in spite of the fact that, in general, the income distribution across municipalities became more equal during the period 1949-1979, as shown in Table XVI.

TABLE XVI

CHANGES IN GINI COEFFICIENTS, BY DECADE AND MUNICIPALITY

Decade	Percent Municipalities with Lower GINIS
1949-1959	55
1959-1969	71
1969-1979	74

This table clearly shows a pattern of greater equality in this measure of the income distribution in the Puerto Rican municipalities. From 1949 to 1959 there were 42 municipalities out of 76 in which the GINI coefficient of income by persons declined. From 1959 to 1969 and from 1969 to 1979 there were 54 and 56 municipalities, respectively, out of 76 in which the GINI coefficient of income by families declined. Again, however, it is worth noting that for the most urbanized municipalities this has not been always the pattern.

The Williamson Index

The Williamson index of income concentration, Vw, is a measure of interregional (i.e., intermunicipality) inequality and is computed using the equation:

$$Vw = \sqrt{\frac{\sum_{i} (Yi - \bar{Y}) \frac{fi}{n}}{\bar{Y}}}, \qquad (10)$$

where fi is the population of the ith municipality, n is the national population, Yi is the income per capita of the ith municipality, and $\bar{Y}$ is the national income per capita (see Chapter IV for further details).

The estimates of Vw are presented in Tabel XVII.

TABLE XVII

ESTIMATED VALUES FOR THE WILLIAMSON INDEX

Year	Value
1949 Person	.521
1959 Persons	.511
1959 Families	.485
1969 Families	.411
1979 Families	.355

The Vw, being a measure of intermunicipality inequality, is related to the data summarized in Tables XV and XVI. While the Vw declined only

2 percent between 1949 and 1959 for income by persons, it declined by 15 percent between 1959 and 1969 families for income by families, and by 14 percent between 1969 and 1979 for income by families. If we take the whole period 1959-1979, the Vw declined almost 27 percent. The trend in this index indicates that Puerto Rico was in a mature stage throughout the latter part of the study period (in terms of Kuznets' schema) because the differences in the income distribution among municipalities have significantly narrowed over the last two decades.

The Vw was, like the C.V. and the Std. Dev. (log Y), tested statistically by regressing its income base on the coefficient value with five years as the number of observations. For the Vw the independent variable is the national income per capita.[7] The resulting equation was:

$$Vw = \underset{(2.15)}{.3615} - \underset{(-6.94)}{.1804}\, Y_{PC}, \text{ with } R^2 = .9414. \qquad (11)$$

The F-ratio of 48.16 is significant at a 1 percent level. The t-ratio values for the intercept and the independent variable are significant at a 5 percent and a 1 percent level, respectively.

Summary

The descriptive and summary statistics in this chapter indicate a clear trend toward greater income equality during the 1960's, when the economic development of Puerto Rico started to gain momentum. The trend that was apparent in the 1950's, and was confirmed in the 1960's, accelerated during the 1970's. That is, there was a progressive movement upward of persons and families in the income scale in Puerto Rico. Notwithstanding the fact that the second half of the 1970's was characterized by inflation (for the average family, 181 percent)[8] the

trend toward greater income concentration in the upper brackets during the 1970's was rather significant. Although the summary data do not show it, this trend toward greater income concentration in the upper brackets was in the highly urbanized municipalities. There, the GINI coefficient computed via trapezoidal approximations increased in 5 of the 8 largest urban areas from 1969 to 1979. For the rest of the municipalities, however, the pattern clearly indicated income equalization, according to the best estimates of the GINI and the Williamson coefficient indexes and the findings shown in Tables XV and XVI.

In Table XVIII we present a summary of the estimates of the aggregate indexes developed and dicussed in this chapter.

In general, we can claim that the values produced by the estimated coefficient indexes of income concentration reinforce our findings from the multiple regression model. From 1949 to 1959 all the coefficient indexes for income by persons, except the unweighted average of Puerto Rican municipalities that remains more or less constant, decline appreciably. During that decade the large push for economic development in Puerto Rico produced changes in the income distribution, contrary to Kuznets' expectations (and the findings of others). Moreover, the regression coefficient values of the ECONOMIC DEVELOPMENT variable in the multiple regression analysis were increasingly negative for the same decade: from -.0671 for 1949 person to -.1721 for 1959, for income by persons (according to Table II of Chapter V).

Nevertheless, the results of this study indicate as development slowed down in the 1970's a new wave of income inequality occurred, as demonstrated by the most sensitive summary indexes, (see Table XVIII,

TABLE XVIII

SUMMARY STATISTICS

	Census Intervals				
	Persons		Families		
Type of Statistic	1949	1959	1959	1969	1979
Trapezoidal GINI (Puerto Rico)	.591	.573	.560	.525	.506
Trapezoidal GINI (Municipalities)	.536	.539	.519	.498	.470
OLS GINI	--	--	.545	.570	.530
Coefficient of Variation	1.947	1.544	1.351	1.076	1.091
Standard Deviation of Logs of Income	.892	.740	--	--	--
Williamson Index	.521	.511	.485	.411	.355
			10 Intervals		
Trapezoidal GINI (Puerto Rico)	--	--	.546	.515	.490
OLS GINI	--	--	.531	.535	.546
Coefficient of Variation	--	--	1.149	1.069	.958
Standard Deviation of Logs of Income	--	--	.720	.562	.589

Std. Dev. (logs Y), and OLS GINI with 10 intervals and C.V. with Census intervals). This result was also evident in the estimate of our multiple regression model, for example, the ECODE variable's regression coefficient values became significantly less negative during the 1970's, going from -.1703 for 1959 (for income by family) to -.2093 for 1969 and back to -.1464 for 1979 (without the PROPY variable), as per Table II of Chapter V. In this instance, the Kuznets' (1955) hypothesis may have been confirmed in an opposite direction; that is, as economic

development slackened, the income distribution tended to become less equal.

FOOTNOTES

[1]1980 Census, U.S. Bureau of Census, Table 29, p. 41.

[2]The number of families in each of the ten intervals were provided directly by the Office of Census in Puerto Rico. To compute the income received by families in each interval the mid point for each interval was assumed, except the open-end interval. The income received by families in the open-end interval was computing subtracting the summation of income received up to the penultimate interval from the previous computed total income. The Pareto Equation (Chapter IV) was not used in the open-end interval for 10 intervals' income distributions.

[3]M. Dutta, Econometric Methods, South-Western Publishing Co. 1975, pp. 173-175.

[4]Gir S. Gupta and Ram D. Singh, "Income Inequality Across Nations Over Time: How Much and Why," Southern Economic Journal, Vol. 51, No. 1, (July 1984), Table I, pp. 252-253.

[5]Martin Bronfenbrenner, Income Distribution Theory, Alpine-Atherton, Chicago, 1971, pp. 49-51.

[6]John Neter and William Wasserman, Fundamentals Statistics for Business and Economics, 2nd Ed., Allyn and Bacon, Inc., Boston, 1971, pp. 263-264.

[7]Jeffrey G. Williamson, "Regional Inequality and the Process of National Development: A Description of the Patterns," Economic Development and Cultural Change, Vol. 13, No. 4, Pt. 2, (July 1965), p. 19.

[8]Income and Product 1981, Puerto Rico Planning Board, San Juan, (May 1982). At current dollars the average family income in 1969 was $5,319 and at constant (1954) dollars was $3,926. $5,319 ÷ $3,926 = 1.35. The average family income for 1979 was, at current dollars, $12,000 and at constant (1954) dollars $4,921. $12,000 ÷ $4,921 = 2.44. 2.44 ÷ 1.35 = 1.81 x 100 = 181 percent.

CHAPTER VII

CONCLUSIONS AND POLICY IMPLICATIONS

Introduction

The purpose of this chapter is to present a brief overview of the major findings of the regression analysis and of the six aggregate indexes of income concentration, and some general policy implications for economic development and income distribution in Puerto Rico.

The findings obtained from this study suggest that the Kuznets' (1955) hypothesis, only, partially conforms to the Puerto Rican economic development income distribution experience during the last three decades. The implications of our findings for the island's policy makers are mainly related to the growing role that the Puerto Rican government has played in the last two decades, and its policy options on economic development vis-à-vis income distribution in the near future.

Summary of Findings

1949-1959 Decade

Virtually all measures of income concentration used in this study indicate that this was a decade of rising equality in the income distribution of Puerto Rico. It was also a decade of rapid growth (5.3 percent annual rate of growth in Gross Product).[1]

The inverse relationship between economic development (as measured by the median or per capita personal income) and the various indexes of

income concentration does not conform to Kuznets' (1955) hypothesis for an early stage of economic development or to the results of other studies for Puerto Rico (i.e., Castañeda and Herrero (1965; 1966), Mann and Ocasio (1977)).

The difference between the regression model of this study and Mann and Ocasio's (1977) model basically lies in differences in the specification of variables. However, our multivariable regression model results were confirmed by several additional tests.

As for the conflict with Kuznets' (1955) hypothesis, the explanation could be an inappropriate specification of the model or in other errors. Nevertheless the findings based on variety of tests strongly indicate the unequalizing conditions Kuznets thought were absent in Puerto Rico.

Kuznets' (1955) thought that the concentration of wealth and income were necessary to generate savings essential to private capital formation. However, in Puerto Rico private capital formation may have been facilitated more by government policy than by purely private decisions to save and invest.

1959-1969 Decade

This was also a decade of growing equality and very rapid growth, indeed the highest growth rate ever (7.0 percent annual rate of growth in Gross Product).[2] This growth was accompanied by a variety of changes in the economy that, according to our multiple regression analysis, promoted equality such as industrialization, outmigration from agriculture, increases in the number of working women, and the growing importance of welfare program payments. In addition, the changes which occurred in each of the aggregate indexes are consistent with Kuznets' (1955)

hypothesis that in an intermediate stage of economic development income would become more equally distributed.

1969-1979 Decade

The relationship between equality and growth in this decade is somewhat unclear. Although several of the indexes continue to indicate greater equality, the ones more sensitive to changes outside the middle income range (such as the coefficient of variation and the standard deviation of logs of income) indicate greater inequality in this decade. There appears, in particular, to be a growing concentration in the upper income ranges (the highest income bracket, $15,000 and over, received 19.5 percent and 45.6 percent of total income in 1969 and 1979, respectively--see Table VIII).

This was also a decade marked by slower growth (a 3.7 percent average annual growth rate),[3] a rising unemployment rate (15.55 percent average for the period 1970-1980, 17.5 percent in 1979),[4] and a reduced labor force participation rate (from 44.5 percent in 1970 to 43.0 percent in 1979).[5] This decade was marked also by the increased importance of food stamps and other government transfer payments (in 1979 58.4 percent of the population received food stamps and government transfer payments were 16.7 percent of personal income)[6]--which did tend to equalize income. But some other factors did not equalize income as many people had expected, they were, in particular, education and the increasing share of people working in upper and middle-level occupations (see Table III). This decade also does not conform clearly to Kuznets' (1955) hypothesis that a country in a maturer stage of economic development will experience greater income equality.

Conclusions

The findings of this study seems to suggest some broad generalizations:

1. Rapid growth promotes greater income equality in Puerto Rico but also produces groups better able than others to withstand cyclical downturns, such as those occurring in the 1970's.

2. Growth (if not rapid) does not necessarily ensure continuously increasing equality.

3. Significant downturns (or deviations from the growth path) may be accompanied by growing inequality.

4. Government transfer payments such as food stamps may help to equalize income, but they are not, in Puerto Rico, a sufficient basis for doing so.

5. The role played by education has been particularly disappointing since it seems to have generated greater inequality in the income distribution, rather than the opposite.

6. The role assigned by Kuznets' (1955) to industrialization, urbanization, and migration in the equalization process seems correct for Puerto Rico.

7. The increase in female labor participation has tended to equalize the income distribution.

8. The effect of property income on the income distribution is negligible, at least on a municipality basis for the last decade.

Policy Implications

Puerto Rico was, until the end of the 19th century, a Spanish colony, and became a possession of the United States as a result of the Spanish-American War of 1898.

A special relationship subsequently arose between Puerto Rico and the United States. First, it produced a free movement of goods and resources between the two countries. Second, there was free access for Puerto Ricans to the financial markets of the United States. Third, Puerto Rico was afforded the protection of the tariff system of the United States.

These factors facilitated a change in the pattern of land possession with the ascendancy of the sugar industry and the decline of the coffee and tobacco industries.

In the 1940's Roosevelt's New Deal policies, concomitantly with new local policies, changed the emphasis from the sugar industry in order to amelioriate the "vicious circle of poverty" in Puerto Rico. The Puerto Rican government started a modest industrialization program (e.g., cement, shoes, glass, carton, etc.). Then, beginning in 1947, the Puerto Rican government assumed the role of encouraging investments from the continental United States on the island through an Industrial Incentives Law that provided tax exemptions for periods of 10 years or more.

This policy was highly successful during the next two decades, contributing to a growth in real GNP of 7.9 percent during the 1960-1970 decade, one of the highest of the world.[7] Unemployment which always has been a problem in Puerto Rico did not exceed 13 percent of the labor force.[8]

However, starting from the energy crisis and the recession of 1974-1975, the above scenario began to change. The GNP grew during the 1970-1980 decade at a yearly rate of only 3.7 percent,[9] and the unemployment rate increased to 19.4 percent and 20.0 percent of the

labor force in 1975 and 1976, respectively,[10] and was still at 17.5 percent in 1979.[11]

A change seems to have occurred in the development process of Puerto Rico, and the development policy of the Puerto Rican government may have reached a standstill from which it has to reorient its course.

The big policy question related to this study is whether government needs a specific set of policies to increase income equality (if it is decided that greater equality is a good thing to pursue), or whether it can simply leave this up to market forces.

In general, our results seem to indicate that growth of the standard type [outmigration from agriculture, increased female labor force participation, increased education, increased industrialization, increased urbanization, etc.] is, on balance, equalizing as long as the Puerto Rican economy continues to grow rapidly. This suggests that government policy to equalize income should be policy actually aimed at keeping the economy growing, or at avoiding cyclical downturns, rather than at explicitly redistributing income.

In the last resort, what appears to count most is the creation of jobs, not the provision of transfer payments. In fact, the close association between high transfers payments, high unemployment, and low labor force participation in the last decade raises the question of whether, in the Puerto Rican case, transfers payments have, on balance, been equalizing.

FOOTNOTES

[1]Richard Weisskoff, "Crops Vs. Coupons: Agricultural Development and Food Stamps in Puerto Rico" in Time For Decision, 1983, op. cit., p. 148.

[2]Ibid.

[3]Ibid.

[4]Ibid, p. 150.

[5]Jose' J. Villamil, "Puerto Rico 1948-1979: The Limits of Dependent Growth" in Time For Decision, 1983, op. cit., p. 103.

[6]Weisskoff, Time For Decision, 1983, op. cit., p. 149.

[7]Puerto Rico Planning Board, Informe Económico Al Gobernador 1979, San Juan, Puerto Rico, 1980.

[8]Ibid.

[9]Puerto Rico Planning Board, Informe Económico Al Gobernador 1980, San Juan, Puerto Rico, 1981.

[10]Puerto Rico Planning Board, Informe Económico Al Gobernador 1976, San Juan, Puerto Rico, 1977.

[11]Puerto Rico Planning Board, Informe Económico Al Gobernador 1979, San Juan, Puerto Rico, 1980.

CHAPTER VIII

LIMITATIONS OF THE PRESENT STUDY AND FURTHER RESEARCH

Limitations of the Present Study

The first limitation that confronts someone doing empirical studies is concerned with the quality and quantity of the data available. This study used as the main source of data, information from the last four Censuses. The strength of this source of data is that it is consistent in the criteria used for measurement--an extremely important requirement for such a long time span.

One problem with certain Census data is that they are based on previous years recollections. This is true, for example, of income. In addition, the self-reported information about income tends to be underestimated. Poor people, in particular, tend to declare less income than they actually receive for fear of losing welfare program benefits. Rich people also declare less income to avoid the high marginal tax rates of Puerto Rico.

Whether this underestimation biases estimates of concentration indexes for Puerto Rico is unknown.

Another problem with Census data is that they do not measure all the elements of real income that it would be desirable to include in income distribution studies. Most importantly, the data are for incomes before taxes, and for money income, for example, in-kind transfers are excluded.

One strength of this study is that it is based on the use of a variety of indexes of income concentration.[1] However, it is recognized that there are other indexes that would possibly be used to study the Puerto Rican case.[2] Additionally, all of the analysis of the municipality data in the regression analysis was related solely to the GINI coefficient as a dependent variable, while there may be other dependent variables that would work on a municipality basis.

Finally, we have tried to be as objective and unbiased as possible, notwithstanding, that the income distribution-economic development linkage has high normative connotations. In particular, it has been rather difficult to insulate this study from the implications for society as a whole, of a distribution that seems to have started to show greater income disparaties.

Further Research

The agenda for future research can be derived largely from the critique just made.

The omission of income in-kind will be particularly difficult to correct, although studies done in the U.S. indicate that this can be done, especially for government in-kind transfers.[3] The fact that the Congressional Budget Office currently includes some of these transfers in estimating poverty income may mean that some data on them will be collected in the 1990 Census. Even if it is, however, it would still be necessary to construct the necessary data for the decades covered by this study.

The problem of measuring the effect of taxes and other government expenditures on the income distribution would also be difficult, but it

could be handled using methods developed by Reynolds and Smolensky for the United States.[4]

Another aspect that deserves attention in further studies is the increasing share of property incomes (e.g., profits, interests, dividends, etc.) that are paid to residents abroad.

With respect to the dependent variable in distribution studies further empirical studies should try other types of coefficients and ratios (e.g., coefficient of skewness, coefficient of kurtosis, etc.) in order to further evaluate the empirical results obtained by this study during the period 1949-1979.

Future empirical studies should also include important independent variables like agriculture, urbanization, occupational structure, migration, welfare payments, and property income, and test the effect of each of them on the concentration index during the 1980's, in order to evaluate whether the signs that started to appear during the 1970's were just a cyclical phenomenon due to the recession and shocks of the middle seventies, or were due to a more lasting, long range, structural change of the economies of Puerto Rico and the United States.

FOOTNOTES

[1]Lars Osberg, 1984, op. cit. pp. 9-31.
Weisskoff, 1970, op. cit., pp. 305-309.

[2]Lars Osberg, 1984, op. cit., pp. 9-31.

[3]Edgar K. Browing, "Donor Optimization and the Food Stamp Program: Comment," Public Choice, Vol. 33, No. 3, 1978, pp. 107-111.
J. Fred Giertz and Dennis H. Sullivan, "On the Political Economy of Food Stamps," Public Choice, Vol. 33, No. 3, 1978, pp. 114-117.

[4]Morgan Reynolds and Eugene Smolensky, 1977, op. cit., pp. 45-96.
For studies about post-fiscal income distribution in Puerto Rico see Arthur J. Mann, "Net Fiscal Incidence in Puerto Rico," in Caribbean Studies, Vol. 13 (April 1973), pp. 5-35 and "The Fiscal System and Income Distribution: The Case of Puerto Rico," Public Finance Quarterly, Vol. 4, No. 3, (July 1976), pp. 339-366.

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TABLE XIX

INCOME PER CAPITA IN EACH PUERTO RICAN MUNICIPALITY[1]

	Based on Personal Income Distribution		Based on Family Income Distribution	Provided by Census Data	
	1949	1959	1959	1969	1979
Adjuntas	$145	$218	$204	$505	$1,288
Aguada	133	210	208	524	1,378
Aguadilla	228	435	456	992	1,803
Aguas Buenas	202	289	272	684	1,429
Aibonito	133	297	279	670	1,980
Añasco	137	213	212	641	1,711
Arecibo	208	395	387	840	1,860
Arroyo	162	250	239	588	1,406
Barceloneta	121	251	242	648	1,665
Barranquitas	121	240	218	444	1,110
Bayamón	249	622	589	1,289	2,608
Cabo Rojo	180	334	307	788	1,856
Caguas	223	454	429	1,033	2,258
Camuy	129	257	250	620	1,568
Canóvanas			Only in the Year 1979		1,650
Carolina	184	568	537	1,472	2,916
Cataño	284	447	431	740	1,664
Cayey	187	332	300	719	1,568
Ceiba	318	815	505	1,233	2,817
Ciales	119	212	195	569	1,472
Cidra	120	209	200	566	1,322
Coamo	126	240	214	537	1,472
Comerío	127	241	221	495	1,013
Corozal	127	247	237	613	1,321
Culebra	235	559	419	1,237	3,670
Dorado	138	326	306	781	1,938
Fajardo	214	463	423	1,160	1,925
Florida			Only in the Year 1979		1,620
Guánica	210	316	301	745	1,293
Guayama	211	374	322	838	1,685
Guayanilla	155	264	245	731	1,548
Guaynabo	520	696	631	1,803	3.976
Gurabo	131	351	339	841	1,586
Hatillo	122	284	289	616	1,490
Hormigueros	191	359	336	1,078	2,497
Humacao	179	329	297	832	1,849
Isabela	124	248	242	630	1,475
Jayuya	115	208	201	417	1,112
Juana Díaz	143	275	261	648	1,461
Juncos	189	375	346	801	1,623
Lajas	175	282	270	742	1,832

TABLE XIX (Continued)

	1949	1959	1959	1969	1979
Lares	$107	$211	$199	$476	$1,148
Las Marías	110	204	186	412	1,240
Las Piedras	101	207	197	714	1,627
Loíza	126	279	268	715	1,367
Luquillo	119	377	348	861	1,633
Manatí	162	323	318	748	1,864
Maricao	103	192	161	402	1,513
Maunabo	110	184	148	506	1,154
Mayaguez	279	490	442	1,007	2,313
Moca	87	169	157	465	1,280
Morovis	93	179	177	475	1,223
Naguabo	131	290	262	768	1,581
Naranjito	130	270	241	556	1,562
Orocovis	98	159	142	363	1,116
Patillas	137	169	166	544	1,136
Peñuelas	119	268	276	534	1,255
Ponce	244	496	434	1,011	2,082
Quebradillas	163	271	267	664	1,600
Rincón	124	234	232	570	1,323
Río Grande	124	316	304	754	1,772
Río Piedras	405		Only in the Year 1949		
Sabana Grande	151	328	324	732	1,775
Salinas	198	300	271	628	1,391
San Germán	214	322	313	785	2,015
San Juan	487	830	749	1,593	3,383
San Lorenzo	99	212	214	537	1,263
San Sebastián	151	246	240	519	1,506
Santa Isabel	154	278	254	674	1,357
Toa Alta	151	283	257	678	1,650
Toa Baja	171	401	400	1,098	2,273
Trujillo Alto	169	437	392	1,068	2,577
Utuado	137	208	201	416	1,253
Vega Alta	121	324	320	705	1,680
Vega Baja	137	280	288	755	1,898
Vieques	139	292	277	812	1,480
Villalba	131	198	208	431	1,089
Yabucoa	132	179	170	496	1,420
Yauco	171	284	266	614	1,452
Unweighted Average of All Puerto Rican Municipalities	169	319	295	739	1,705
Puerto Rico	218	440	408	981	2,126

TABLE XX

GINI COEFFICIENTS FOR PUERTO RICAN MUNICIPALITIES[2]

	Persons		Families		
	1949	1959	1959	1969	1979
Adjuntas	.531	.541	.508	.584	.466
Aguada	.532	.577	.550	.522	.471
Aguadilla	.567	.556	.547	.521	.485
Aguas Buenas	.560	.498	.506	.456	.457
Aibonito	.556	.556	.532	.473	.439
Anasco	.540	.534	.513	.480	.419
Arecibo	.599	.566	.568	.528	.437
Arroyo	.523	.526	.539	.472	.442
Barceloneta	.540	.546	.520	.488	.442
Barranquitas	.525	.605	.564	.519	.507
Bayamon	.535	.474	.455	.409	.437
Cabo Rojo	.548	.535	.508	.490	.478
Caguas	.548	.513	.516	.446	.453
Camuy	.551	.514	.522	.523	.476
Canovanas			Only in the Year 1979		.446
Carolina	.529	.515	.484	.404	.457
Catano	.462	.459	.460	.483	.513
Cayey	.545	.508	.487	.492	.459
Ceiba	.539	.504	.515	.427	.452
Ciales	.552	.566	.538	.523	.456
Cidra	.531	.514	.517	.483	.470
Coamo	.517	.528	.531	.514	.473
Comerio	.512	.542	.483	.511	.523
Corozal	.528	.524	.497	.508	.466
Culebra	.416	.624	.592	.581	.566
Dorado	.529	.470	.433	.433	.491
Fajardo	.537	.522	.504	.483	.475
Florida			Only in the Year 1979		.447
Guanica	.505	.534	.499	.476	.516
Guayama	.559	.520	.516	.486	.507
Guayanilla	.547	.544	.548	.471	.510
Guaynabo	.625	.699	.569	.537	.512
Gurabo	.565	.537	.507	.472	.503
Hatillo	.530	.533	.532	.498	.472
Hormigueros	.547	.508	.471	.446	.388
Humacao	.544	.560	.541	.524	.507
Isabela	.595	.602	.581	.515	.457
Jayuya	.544	.584	.557	.512	.481
Juana Diaz	.495	.511	.501	.500	.443
Juncos	.583	.543	.531	.445	.448
Lajas	.474	.492	.475	.471	.443

TABLE XXI

INCOME AND PRODUCT FOR SELECTED YEARS IN CURRENT PRICES
($MILLION)

Item	1950	1960	1970	1979
Gross National Product	755	1,676	4,688	9,998
Personal Income	653	1,374	3,753	9,914
Net Income:				
Agriculture	149	180	178	371
Manufacturing	89	289	955	3,805
Government	70	175	611	1,694
Others*	275	721	2,373	4,811
Rest of the World	31	-16	-368	-2,450
		Per Capita $		
Gross National Product	343	716	1,729	2,959
Personal Income	297	537	1,384	2,934

*Commerce, Services, Construction, and Finance
(Source: Puerto Rico Planning Board, Government of Puerto Rico, Informe Económico Al Gobernador 1976 and 1979.)

TABLE XX (Continued)

	Persons		Families		
	1949	1959	1959	1969	1979
Lares	.531	.589	.541	.529	.458
Las Marías	.466	.532	.536	.551	.392
Las Piedras	.501	.556	.514	.487	.456
Loíza	.544	.502	.498	.472	.461
Luquillo	.529	.537	.512	.458	.466
Manatí	.576	.563	.558	.495	.454
Maricao	.490	.548	.530	.540	.454
Maunabo	.509	.590	.530	.556	.515
Mayaguez	.569	.546	.536	.485	.505
Moca	.502	.540	.524	.515	.436
Morovis	.579	.557	.545	.495	.495
Naguabo	.502	.567	.510	.499	.442
Naranjito	.533	.521	.474	.484	.460
Orocovis	.524	.576	.523	.537	.440
Patillas	.531	.562	.519	.563	.474
Penuelas	.510	.551	.523	.578	.467
Ponce	.563	.550	.537	.524	.508
Quebradillas	.617	.523	.510	.503	.428
Rincón	.560	.568	.539	.505	.487
Río Grande	.530	.511	.520	.462	.443
Sabana Grande	.533	.521	.515	.525	.491
Salinas	.522	.525	.504	.509	.497
San Germán	.582	.542	.546	.519	.476
San Juan	.529	.511	.487	.501	.570
San Lorenzo	.545	.543	.552	.520	.484
San Sebastián	.555	.541	.514	.540	.447
Santa Isabel	.419	.519	.517	.460	.427
Toa Alta	.563	.520	.477	.447	.417
Toa Baja	.505	.471	.469	.432	.443
Trujillo Alto	.523	.505	.487	.460	.503
Utuado	.541	.583	.564	.568	.480
Vega Alta	.545	.528	.533	.451	.434
Vega Baja	.555	.518	.527	.474	.442
Vieques	.538	.536	.486	.492	.483
Villalba	.543	.561	.535	.557	.449
Yabucoa	.528	.461	.533	.546	.473
Yauco	.564	.563	.521	.503	.538
Unweighted Average of All Municipalities	.536	.539	.519	.498	.470

TABLE XXII

POPULATION AND EMPLOYMENT FOR SELECTED YEARS
(THOUSANDS)

Item	1950	1960	1970	1979	Rate of Increase 1950-1979 (%)
Population	2,200	2,340	2,710	3,389	54.0
Population					
14 Yrs. old & over	1,284	1,383	1,718	2,239	74.3
Labor Force	684	625	765	978	43.0
Employed:	596	543	686	807	35.4
Agriculture	214	124	68	38	-82.2
Manufacturing	106	91	132	160	51.0
Government	15	70	118	189	1,160.0
Other	261	258	368	420	61.0
Unemployed	88	82	79	171	94.0
% Unemployed	12.9	13.2	10.3	17.5	35.6
Participitation Rate (%)	53.0	45.2	44.5	43.0	-18.9

(Source: Puerto Rico Planning Board Government of Puerto Rico. Informe Económico Al Gobernador 1976 and 1979.)

TABLE XXIII

PUERTO RICAN GROSS PRODUCT, PERSONAL INCOME, AND TRANSFER PAYMENTS FOR 1950, 1960, 1970, 1979, AND 1980.

Year	Gross Product ($Million, 1954 Constant)	Disposable Personal Income ($Million, Current)	Net Transfer to Puerto Rico ($Million)*	Transfers as a Component of Personal Income (%)
1950	879	638	63.4	9.9
1960	1,473	1,334	46.6	3.5
1970	2,901	3,565	80.1	2.2
1979	4,051	9,367	1,482.7	15.8
1980	4,166	10,494	1,750.0	16.7

*Total net balance of transfer payments between Puerto Rico and federal and state governments and other non-residents.

Year	Food Stamps to Puerto Rico ($Millions)	Food Stamps as a Component of Net Transfers (%)	Percentage of Population Receiving Food Stamps
1950	--	--	--
1960	--	--	--
1970	--	--	--
1979	821.8	55.4	54.2
1980	810.6	46.3	58.4

(Sources: Puerto Rico Planning Board, Government of Puerto Rico. Informe Económico Al Gobernador 1979 and 1980. U.S. Department of Agriculture, Food and Nutrition Service. Monthly Reports. Quoted from Richard Weiskoff, "Crops Vs. Coupons: Agricultural Development and Food Stamps in Puerto Rico," Time for Decision, 1983, op. cit., p. 154.)

FOOTNOTES

[1]The per capita income for 1949 and 1959 were computed from the income distributions provided by the Census of 1950 and 1960, respectively. The per capita income for 1969 and 1979 were obtained directly from Census data of 1970 and 1980 respectively. The methodology to compute the per capita income for 1949 and 1959 is explained in Chapter IV.

[2]The GINI coefficents of Puerto Rican municipalities for the years 1949, 1959 and 1969 were taken from Mann and Ocasio's "The Determinants of Income Concentration in Puerto Rican Municipalities," op. cit., Vol. 7, No. 2, 1977, Table 2, p. 312.

VITA 2

Félix Manuel Cué

Candidate for the Degree of

Doctor of Philosophy

Thesis: INCOME DISTRIBUTION AND ECONOMIC DEVELOPMENT: A CASE STUDY OF THE KUZNETS' HYPOTHESIS APPLIED TO PUERTO RICO.

Major Field: Economics

Biographical:

Personal Data: Born in Havana, Cuba, January 7, 1939, the son of Ing. and Mrs. Félix Cué - Gómez.

Educations: Graduated from Instituto del Vedado, Havana, Cuba in September 1956; received the Bachelor of Arts degree in Economics from the Inter American University of Puerto Rico in May 1971; received the Master of Business Administration degree in Finance from the Inter American University of Puerto Rico in December 1972; received Master of Arts degree in Economics from the Inter American University of Puerto Rico in June 1974; completed the requirements for the Doctor of Philosophy degree in Economics at Oklahoma State University in May 1985.

Professional Experience: Financial Analyst for the Puerto Rican Cement Co. Inc., September 1972 through July 1976; Instructor in the Department of Economics and Finance, Inter American University of Puerto Rico, August 1976 through May 1979; received scholarship of Summer-Program for Minority Students of American Economic Association at Northwestern University, June and July 1979; Graduate Assistant in the Department of Economics, Oklahoma State University, August 1979 through May 1982; Assistant Professor and Director of Department of Business Administration in the Inter American University of Puerto Rico, August 1982 through December 1983; Assistant Professor of the Graduate Program in the Inter American University of Puerto Rico, June 1984.

Professional Organizations: American Economic Association, Asociación de Economistas de Puerto Rico.