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**INTERNAL MIGRATION AND TRADITIONAL AGRICULTURE:
The Case of Puerto Rico**

by

ANDRE ARCHER

A dissertation submitted to the Graduate
Faculty in Economics in partial fulfillment
of the requirements for the degree of Doctor
of Philosophy, The City University of New York.

This manuscript has been read and accepted for the Graduate Faculty in Economics in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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PREFACE

This study establishes the relation between industrialization, internal migration and traditional agriculture in Puerto Rico. It examines particularly the impact of industrialization and internal migration on agricultural production and modernization and measures the magnitude, direction and the principal factors responsible for migration. It shows how agriculture has made fundamental adjustments, following economic development.

The study estimates also an aggregate farm production function and a function for sugar cane in Puerto Rico using data of the 1970 crop. From the results of these function estimations policy recommendations are made. These policies are concerned mainly with the future development of agriculture in particular sugar cane and its capability of providing employment to the population of the rural sector.

I am greatly indebted to Professors Stanley Friedlander, Malcom Galatin and Elliot Zapnick as dissertation advisors. Professor Stanley Friedlander has contributed largely to the actual shaping of the work. Thanks are also due to the Department of Agriculture of Puerto Rico, Office of Agriculture Statistics and Economic Studies for providing me with many of the empirical data

used in this research. Thanks are also extended to the Computer Center of the Université du Québec à Trois-Rivières which contributed extensively in the programming and computation of the statistical results reported in the study.

I bear of course, full responsibility for any errors on shortcomings that may appear.

André Archer

Trois-Rivières, P.Q.

February 1976

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CHAPTER I

INTRODUCTION

General setting

A knowledge of a country's history is often helpful in understanding specific questions relating to its economic development. While this is generally true it applies particularly in the case of Puerto Rico, a country whose economic record during the last three decades has been described as that part of the world par excellence where poor education, bad housing, inadequate facilities, a high mortality rate, unemployment, and low per capita income resulted from a backward and purely agrarian economy. Puerto Rico could have served as a perfect illustration of the concept of the "vicious circle" which is so widely used in the literature of economic development. Within less than thirty years... and despite its small size and scanty natural resources... observers of all disciplines have witnessed in Puerto Rico the characteristic features of a growth process leading to a sound and dynamic economy. There has been expanding output, growing labor productivity, rising wages, increasing urban employment and urbanization, accompanied by a decline in agricultural output, while internal migration reallocated the labor force to meet newly-created job opportunities. This last feature, internal migration along with its concomitant effect on the agricultural sector is the object of this study.

Development plans normally establish not only the targets to be reached but also the necessary capital requirements. And unless the necessary capital comes from elsewhere it has to be mobilized internally

which usually involves a lowering of domestic consumption. Leibenstein notes that in underdeveloped countries, among other characteristics, there exist "Practically zero savings for the large mass of the people" and "Whatever savings do exist are usually achieved by a landholding class whose values are not conducive to investment in industry or commerce."¹ This situation, he contends, prevails because in these countries people are living near the "subsistence" level and have very little capital per head with which to work. This statement is, however, in contradiction with the views of both Hagen and Higgins. Hagen² advances that "It is a matter of common judgment among economists acquainted with the income statistics and the economic structure of the low-income countries that the distribution of income is more unequal in such countries than in high income ones, and especially so if the comparison is made after payment of direct individual taxes has been allowed for. It follows that if the mass of the population in low-income countries have a sufficient level of income to live - which they do, and sufficiently well to increase steadily in number - then the higher income groups a fortiori are able to save if they wish to."² Higgins for his part, advocates the same idea in saying that large disparities exist in the levels of income recipients in most underdeveloped countries. Particular groups do have income high enough to economize. The savings of these income classes could have been channeled toward investment in line to development targets. "Some groups, at least, receive real income high enough for a comfortable, even luxurious standard of living and substantial savings as well."³ Hagen⁴ acknowledges that poor countries do save out of low incomes in the form of "gold or jewelry" or for entertainment, while Higgins⁵ mentions "short term loans to consumers, farmers, traders and specu-

lative gains derived from hoarding goods..." are the principal uses of these savings.

But the question that can immediately be raised is: Why do the low-income countries not use their savings in a way that contributes to future growth? Or as Schultz⁶ puts it, "What are the rewards to them for saving more of their meager income?" The answer to these questions is found in the hypotheses advanced by Schultz himself, "The rate of return on such savings when they are invested in the traditional factors of production is exceedingly low. Should this hypothesis be consistent with the facts, there will be little or no inducement to save."⁷

Indeed in these low-income countries, while income disparities are widespread and savings of the high-income class very substantial, the latter is not nevertheless the sole problem impeding growth. Other issues as burning as the savings question must be solved, in particular, the question of human resources in terms of education, know-how and that of foreign exchange to secure the necessary raw materials and other equipment that are lacking in these countries. Incentives to invest in the types of projects conducive to growth are non-existent, because the marginal productivity of such investments being low, capital formation is practically nil. The problem, thus becomes one of changing the production possibilities existing in these countries by introducing a new "state of the arts" or new factors of production that can lower the cost of capital and other inputs and thereby make more attractive the opportunity to invest for growth.

In our case, given the economic structure of Puerto Rico,

which by 1940 was still typically colonial -- based on the export of a few crops and some raw materials and importing virtually all manufactured consumer goods -- and with the lack of training and skills of its human resources, the necessary impetus to unlock the "vicious circle" could not be realized.

General Characteristics of Puerto Rico

- Historical and Geographical Setting

One of the four major islands of the West Indies group, Puerto Rico is situated between the Atlantic Ocean and the Caribbean. It measures approximately 100 miles by 35 miles. On November 19, 1493 it was discovered by Christopher Columbus during his second voyage to the New World.⁸ From then until December 10, 1898 the island remained a Spanish colony. Under Spanish rule the economy was neglected and showed no signs of organization. Interested only in the natural tropical products of the island, Spain maintained a strong monopolistic policy as far as trade was concerned. The island was not legally allowed to trade with any other country but Spain. This led to widespread smuggling (privateering) between North America and the surrounding islands. By 1815, however, attempts were made to organize the collection of revenues from exports and to make trade with other places possible. These steps brought some improvements to the economic situation. From \$269,000 in 1813 trade reached \$1,000,000 by 1816 and continued to rise thereafter⁸. Coffee was the principal export item. Its production during the 1890's fluctuated around 50,000,000 pounds per year valued at \$12,000,000 or three times the value of sugar.

The first census taken in 1765 reported 44,883 inhabitants. Until 1850 the doors of Puerto Rico were closed to all foreigners other than Spaniards. Only from 1850 was immigration permitted. In 1850 the population was stood at approximately 500,000 and climbed to 900,000 by 1898 due to new arrivals under the liberalized immigration policy of 1850.

Table I.- Selected Vital Statistics, Puerto Rico

	1940	1950	1960	1970	1971
Population (,000)	1,861	2,200	2,340	2,694	2,743
Birth rates per 1,000 population	39.0	39.5	32.5	25.2	27.0
Death rates per 1,000 population	18.2	10.5	6.7	6.6	6.7
Rate of natural increase per 1,000 population	20.8	29.0	25.8	18.6	20.3

Source: Informe Económico al Gobernador, 1971
Junta de Planificación, Puerto Rico

Due mainly to the high rate which has changed only from 39.0 per 1,000 population in 1940 to 27.0 in 1971, i.e. 30.7% compared to the decrease in mortality rate that passed from 18.2 per 1,000 population in 1940 to 6.7 in 1971, i.e. 63% (see Table I) and despite heavy migration to the United States which on the average was 40,000 persons annually during the 1950's and 19,000 in the 1960's¹⁰, the Island had 2.743 million people in 1971 and a rate of natural increase of 20.3 persons per 1,000 population, which incidentally has remained identical to the rate of the 1940, rate of 20.8 as shown by Table I. These figures could

have been higher had it not been for external migration and to a lesser extent the decrease in the birth rate.

- External Migration, Population and the Labor Force

External migration has long been by far the principal deterrent to the high population pressures existing in the Island. Since the 1960's, however, migration to the Mainland had slowed down substantially due to the high level of unemployment experienced by the United States for some years in the 1960's. In one year (1968-1969) the net balance has been positive as shown by Table II.

External migration has been a reliable escape valve in stabilizing the population of Puerto Rico. Unemployment and recessions in the United States can be expected to alter or even interrupt the flow of outmigrants, but fortunately one can anticipate that the outflow will regain its tempo as soon as the economic situation shows some improvement. Moreover, the great number of Puerto Rican families already residing in the United States is likely to continue to attract people from the Island.

External migration is said to be very selective with respect to age, and to the extent that heavy migration is occurring at the same rate, the distributional age of the population is expected to show a shift towards a gradual increase of its median age. Calzada¹¹, in his study of migration of Puerto Rico has shown that during the 1950-1960 period, 70% of migrants to the United States were aged 15-39, only 18% were under 15 years old while 12% were 40 or older. The consequence of such a heavy drain of the young rather than the old is undoubtedly

Table II.- Net Migration (1960-61 to 1970-71)

Fiscal Years	Net Balance
1960-61	- 13,762
1961-62	- 11,363
1962-63	- 4,798
1963-64	- 4,366
1964-65	- 10,758
1965-66	- 30,089
1966-67	- 34,174
1967-68	- 18,681
1968-69	7,047
1969-70	- 44,082
1970-71	- 1,811

Source: Junta de Planificacion, Sección Balamzas de Pagos, in Informe al Gobernador, op. cited, Table I, page 234.

affecting the size and age composition of the labor force. Calzada estimates that in the 1960's, external migration has helped by reducing the relative size of the labor force more than that of the population. Without external migration, the level of the working population would have been 903,000. External migration brought about a reduction of 35% to achieve the current level of the labor force of 586,000, while total population has been reduced to only 28%. Moreover, he notes that for the same period, a higher proportion of the age-group 20-34 forms the labor force in the United States, as compared to the labor force in Puerto Rico, while the proportion of the age-group 45-64 is less in the United States.¹² From this evidence, Calzada underlines the negative aspect of external migration which is selective of the young - ablest and the most talented of the labor force.

In the same vein, he mentions that due to these negative aspects, the labor force participation rate has decreased substantially since 1940. If we interpret this trend as likely to continue, this contention seems in conformity with that argued by Alvin Mayne.¹³ Mayne, writing in 1958, argues that the average age of the population has decreased during the period 1940-47 due to the growth of the population, but that by the next decade, the median age is expected to increase from nineteen years to twenty-eight years, the population to stabilize and a rapid shift to occur in the age of the population, due principally to heavy migration. Consequently, the Puerto Rican labor force will grow substantially during the next twenty years while the total population will remain stable. More specifically, Mayne foresees: "The proportion of persons under twenty may be expected to drop sharply during the 1960's, the population between the ages of twenty and forty-five will remain relatively constant, while the number of persons over forty-five will increase from 17 per cent to 30 per cent of the total"¹⁴.

Data up to 1970 seems to be in the direction foreseen by Mayne as far as age distribution is concerned. Table III shows that from 1960 to 1970, the proportion of persons under 20 drops from 3.4% to 4.7%. Those between 20-45 show some increase from 1960 to 1970, but the level remains fairly stable for 1950. As for the group 45-64, the increase is quite marked between 1950 and 1970, i.e. 10.9 and 14.9 respectively, and to be conform with Mayne if we pool those over 45, this group has passed from 17.9 to 21.5 from 1960 to 1970 respectively. This group has increased but will not likely reach the 30% foreseen by Mayne. Also we note that the median age, while stable between 1950 and 1960 (18.4) has,

Table III.- Median Age and Age Distribution for Specific Group-Age,
Puerto Rico , 1950, 1960, 1970

	1950		1960		1970	
	Total	%	Total	%	Total	%
All Ages	2,210,703	100	2,349,540	100	2,712,033	100
Under 20	1,175,827	53.2	1,254,624	53.4	1,284,852	47.4
Between 20-45	707,608	32.0	672,676	28.6	843,773	31.1
Between 45-64	242,274	10.9	303,824	12.9	405,586	14.9
65 and over	83,994	3.8	118,416	5.0	177,858	6.6
Median Age	18.4		18.4		21.5	

Source: Computed from U.S. Bureau of the Census, Census of Population: 1970, General Social and Economic Characteristics, Final Report, PC (1)-C 53 Puerto Rico, U.S. Government Printing Office, Washington

in conformity with the predictions of Mayne increased by three percentage points (21.5) in 1970. With respect to the stability of the size of the population, it did not materialize, since total population has increased from 2,349,540 in 1960 to 2,712,033 in 1970 or an increase of 15.4%. The continuing growth of the population is in part due to the decrease of the rate of the outflow of migrants during the 1960's.

Concerning the growth of the labor force, it has increased from 1960 to 1970 at an average rate of 1.5%. This increase is quite substantial in urban areas during the last decade, while since 1950, the rural labor force was steadily decreased as shown by Table IV. This last feature of the rural area is due principally to internal migration that has contributed, as we shall see later, to a redistribution of the population from rural to urban areas. As Calzada has noted about the declining participation rates of the labor force, this trend is apparent

Table IV.- Persons in the labor Force, Average Annual Growth Rate and Participation Rates of the Population (14 Years and over) Puerto Rico, Urban and Rural, 1950, 1960 and 1970

	1950	1960	1970
<u>Puerto Rico</u>	597,467	594,124	683,790
% Change (Annual Average)	1950-1960: -0.05		1960-1970: 1.5
Participation Rates	45.9	42.0	38.2
<u>Urban</u>	260,178	301,596	450,007
% Change (Annual Average)	1950-1960: 1.6		1960-1970: 4.9
Participation Rates	45.2	45.1	41.6
<u>Rural</u>	337,289	292,528	233,783
% Change (Annual Average)	1950-1960: -1.3		1960-1970: -2.0
Participation Rates	46.4	39.6	42.7

Source: U.S. Bureau of the Census, op. cited, Table III

in 1950, 1960 and 1970. Indeed even though the labor force has increased absolutely from 1960 to 1970 in Puerto Rico in general, especially in urban areas, their participation rates have decreased. As for the rural areas the absolute number of the labor force has consistently decreased since 1950, while its participation rate though decreasing in 1960 relatively to 1950, shows signs of increase in 1970, (see Table IV). We will have occasion to discuss the behaviour of the labor force when we come to deal with the impact of internal migration on the agricultural sector.

- External Migration and the Quality of the Labor Force

Another effect of external migration no less important than the ones just mentioned is the deterioration of the labor force in terms

of the quality of its human resources drained to the United States. Thus, one of the prime impacts of outmigration has been to decrease the level of education of the remaining peoples in Puerto Rico, since, as mentioned earlier, it is the young, the ablest and most skillful persons that leave first. This observation, however, is not equally shared by some students of economic affairs. Friedlander¹⁵ acknowledges that "while the pre-1945 migrants were more skilled and had higher incomes than the population from which they emerged, the post-war migrants were considerably different, having a greater proportion of unskilled to skilled workers than the remaining population of the island of Puerto Rico". Calzada reports that according to the census of 1960 - thus during the post-war period - the median number of years of school completed by the adult Puerto Rican should have been 5.5 years, had it not been for migration, which brought it to only 4.6, and that difference is even greater within the 25-44 age-group. Moreover the same author reports that, while 55% of the Puerto Ricans residing in the Island had less than 5 years of schooling completed, 50% of Puerto Ricans living in the United States had eight or more years of schooling. If we interpret years of schooling to mean skills, these two reports are contradictory. But neither author makes any mention of the timing of the survey leading to his observations, i.e. were the observations made from a cohort of migrants at the entrance door of the United States for some time? I suspect that the Calzada sample at least is drawn from the Census and does not differentiate between persons just arrived or those already established on the Mainland for some time. This aspect of the question is important, for being in the United States instead in Puerto Rico might give the same individual more motivation to acquire extra skills and supplementary schooling. These contentions

though antithetical do not reject the hypothesis that migration is selective of the young and of the most talented.

- Origin of Migrants

Finally on the outmigration question, we will mention the fact that opinions are conflicting on the question of the origin of migrants, i.e. whether they come from rural or urban environments. According to Mills¹⁷ writing in 1948, 90% of the Puerto Rican migrants originated in urban areas, while Calzada reports that from data collected by the "Junta de Planificacion", 60% of the migrants came from rural areas and the rest, 40% from cities during 1965. These findings have been confirmed also for the period 1950-1960. Again from these contradictory reports, one cannot say whether the migrants come from rural or urban areas.

However strong may be some of the negative effects of external migration on the Island labor force and its peoples, the positive effects outweigh heavily the negative effects. Indeed had it not been for that particular outlet, unemployment which still is high (11.6% in 1971) would certainly have been higher, also income per capita and productivity in industry as well as in agriculture would have suffered. Urban slums with the concomitant problem of city crimes would have been worse than what they are now. Finally, the housing problem, health care, and pollution of the environment would have been harder to cope with, especially in the Metropolitan San Juan.

Returning to our historical setting of today's Puerto Rico, we will say that the steady decline of Spain as a military power towards

the end of the 19th century, and the closeness of Puerto Rico to the United States, made possession of the island more and more attractive to the United States. This desire was quickly and easily realized by landing the marines at Guanica on July 25, 1898. The Treaty of Paris conceded Puerto Rico to the United States on December 10, 1898.

Under the administration of the United States the sugar industry was developed and modernized. Its production rose from \$8,000,000 in 1910 to \$100,000,000 in 1930, while coffee output dwindled and industry remained completely absent except for needlework.

Post-War Development of Puerto Rico

After World War II the need was felt by the United States to bring some improvement to the lot of the people of Puerto Rico. Most of the basic conditions necessary to attract foreign capital were well fulfilled by the Island. The link with the United States helped provide the foreign capital, especially from the United States. And the security of not being subject to nationalization, as is the case in many other countries, helped too. Added to this were many other advantages such as exemption from income taxes for a relatively long period and the low wages existing on the island. "Operation Bootstrap" was initiated in 1947, its main aim being to encourage and stimulate private business investment by creating infrastructures, i.e. roads, power, etc. The operation was greatly facilitated by a law providing, as we have just mentioned, multi-year holidays from income tax for new investment. This law became the Industrial Incentive Act in 1963 and as amended and in effect in 1969, it has afforded a range of 10, 12, 15 and up to 17 years

of tax exemption to businesses depending upon where they located. The higher exemptions are for firms willing to relocate or locate in less attractive regions in order to fight growing disparity among the "municipios" of the Island. In 1950 a new agency was created: Fomento meaning in Spanish promotion or Economic Development Administration (EDA). Its objective was to recruit firms and undertake every promotional effort deemed necessary to encourage industrialization. It also provides information on transport facilities, availability of laborers, taxation, markets and even aid in securing financing for firms in difficulties.

- Industrial Development

By 1950, business had arrived in the Island and the industrial revolution that has changed the Island's economic structure had begun. From 1950 to 1968, the number of firms installed in the Island under the Fomento banner totaled 1684 and of this number 1,404 were still operating in 1968¹⁸. During the fiscal year 1970-1971, these firms provided around 75% of total income in manufacturing, 78% of total exports which go almost entirely to the United States and 76% of all manufacturing employment¹⁹. Furthermore, an estimated 385 new industrial establishments were promoted in 1965 and by 1974, expectations were for a total of 1,910 plants.

As a result of these efforts, tremendous changes have taken place in the economy. Net income from manufacturing rose from \$82 million in 1948 to \$999 million in 1971, an increase of 1,118.3% in current dollars, while agriculture passed from 137 million to 195 million current dollars in 1948 and in 1971 respectively, or an increase of only

42%. Meanwhile, manufacturing employment (except needlework) rose from 56,000 in 1940 to 142,000 in 1971 or an increase of 153%, while agricultural employment dwindled from 239,000 in 1940 to 65,000 in 1971 or a decrease of 71.6%²⁰. Net income per capita in constant 1954 dollars grew from 215 in 1950 to 1,054 in 1971. Industrialization grew steadily in importance and by 1955 income drawn from industry surpassed that of agriculture. Industrial net income in current dollars was valued at five times that of agriculture in 1971, that is 999 million for manufacturing compared to 195 for agriculture. The growth rate of manufacturing income was estimated at 5.3% in 1971 compared to 1970, while in 1968 it was at 14.1% over 1967 one of the highest in the world. Despite these outstanding achievements, unemployment remains high at around 11 to 12% since 1950 as shown in Table V.

Table V.- Unemployment in Puerto Rico (%)

Years	1950	1960	1965	1966	1967	1968	1969	1970	1971
Unemployment (%)	12.9	13.2	11.6	12.1	12.7	12.0	10.6	10.8	11.6

Source: Informe al Gobernador 1971, Junta de Planificacion, Table 25, p. 25-A

From 1950 to 1960, the high rate of unemployment was particularly due to the disappearance of the home-needlework industry whose productivity was unable to compete with the productivity and low wages of the same industries in such countries as Taiwan and Japan. Other industries having contributed to the decline in employment during this period, were tobacco stemming, domestic services and of course the sugar industry.

The rapid development of Puerto Rico following this period has in fact contributed to the elimination of more jobs than it has been able to create. Indeed, industries that were previously attracted by the low wages prevailing in the Island, soon were confronted with particular conditions that forced them to revise their policies. Unit costs have increased, and minimum wages were brought about by the Commonwealth Government and by pressures from unions. These factors together have made necessary the introduction of machines to increase productivity, which in turn creates unemployment. In a developed country whose path to development has been slower and smoother, shrinkage of traditional sources of employment can be more easily offset by expansion in other emerging industries, so that the total effect on employment is compensated for, but in developing countries where jobs are not created as fast as the old ones disappear, unemployment is likely to remain severe. This is indeed the case in Puerto Rico. Moreover, as Reynolds has observed, in new industrialized countries "manufacturing industries embodying modern production methods create relatively little employment, and part even of this employment involves drawing new people into the labor force rather than absorbing previously employed workers."²¹

In the meantime, trade between Puerto Rico and the United States has grown in importance. Puerto Rican exports to the United States passed from \$220 million in 1942 to \$2,520 million in 1971. In return, United States sales to Puerto Rico climbed from 197 millions in 1942 to 4,042 millions in 1971.

- Agricultural Development

Whereas, agriculture provided 31% of the net income in 1940, i.e. \$70 million out of a total income of \$225 million, it accounted for only 4.5% in 1971 on \$196 million out of a total income of \$4,296 million. As for its share of the employed labor force which was 44.7% in 1940, it decreased in 1960 to 22.8% and was only 6.8% in 1971 or 65,000 out of 455,000 gainfully employed in the Island. The shift of population from the country to the city had started. By 1965 more people were gainfully employed in industry than in agriculture, where many marginal farms especially sugar-cane farms have disappeared because of low productivity of labor and rising costs. The principal cause of this tremendous decrease in employed persons in agriculture has been caused by the disappearance of many sugar farms and the resultant decline in sugar-mill production. A report from the United States Department of labor indicates that while during the 1951-52 crop-year, production of sugar cane provided a peak number of 153,000 workers, and a corresponding 10,000 in sugar mills and refineries, these numbers decreased to 26,000 in farms and to less than 5,000 in mills and refineries during the crop-year 1970-71. Along with this decrease in production and employment a substantial drop in the number of farms and acres harvested has been recorded. In 1951-52 there were 18,300 farms harvesting 392,000 acres of land, but these numbers dropped to 4,200 farms and 153,000 acres of land in 1970-71. The reasons advanced to explain these changes are principally the inability of this sector to compete for labor with the newly established industries and the low productivity of labor relative to other sugar-producing regions. For example, in 1970 it took 2.16 man-hours to produce one ton of cane in Louisiana, 1.63 in Florida, 1.06 in Hawaii and 4.93 in Puerto Rico.²² Nor is the situation any brighter in sugar production.

In effect, to produce one ton of sugar in 1970, it took 9.50 man-hours in Hawai, 14.19 in Louisiana, 24.82 in Florida and 63.12 in Puerto Rico.²³

While it takes more man-hours in farming as well as in industry to produce cane and sugar, the yield per acre harvested is quite low as shown by Table VI.

Table VI.- Yield of Cane of Some Producing Regions 1967-1970

	1967	1968	1969	1970
Puerto Rico	30.99	27.79	32.75	31.21
Louisiana	27.61	26.12	24.14	26.07
Florida	34.32	29.48	33.84	33.36
Hawai	98.77	99.36	95.72	91.88

Source: U.S. Department of Agriculture: Agricultural and Conservation Service: Sugar Reports, in an Economic Report on "The Sugar Farming Industry and The Sugar Manufacturing Industry in Puerto Rico", April 1970. U.S. Department of Labor, Employment Standard Administration, Wage and Hour Division, Table 8, p. 24

But why is productivity of labor as well as of land so low especially in sugar cane? Mayne²⁴ reports that during the 1930's, agriculture in Puerto Rico was dominated mainly by a small number of large farms or corporations whose stockholders did not reside in the Island. Following the land reform of the 1940's, a large number of local residents became land owners and as a result a substantial proportion of small and medium sized farms emerged and still continue to exist in 1969. As can be seen from Table VII, 49.4% of all lands were in the hands of full owners in 1940, whereas this proportion increased to 63.6 and 61.0 in 1950 and 1959 respectively. By 1969, even though this percentage declined

Table VII.- All Lands in Farms by Tenure of Operators
Puerto Rico

Year	Number of Cuerdas		Full Owners		Part Owners		Managers		Tenants	
	Total	% Distri- bution	Total (Cuerdas)	% Dist.	Total (Cuerdas)	% Dist.	Total (Cuerdas)	% Dist.	Total (Cuerdas)	% Dist.
1940	1,885,874	100	931,931	49.4	140,213	7.5	573,699	30.4	240,031	12.7
1950	1,884,886	100	1,174,157	63.6	240,469	11.1	340,194	18.4	126,066	6.8
1959	1,682,556	100	1,027,037	61.0	230,097	13.7	327,036	19.4	93,386	5.8
1964	1,641,042	100	936,421	57.0	260,448	15.9	349,589	21.3	94,575	5.8
1969	1,334,800	100	714,779	53.5	359,442	26.9	122,582	9.2	137,997	10.3
% Change 1940-1969	- 29.2		- 23.3		156.4		- 78.6		- 42.6	

Source: Census of Agriculture, 1964 and 1969, U.S. Bureau of the Census Statistics for Puerto Rico and Municipios, U.S. Government Printing Office, Washington D.C.

to 53.5, it was still higher than that of 49.4% in 1940. Generally though, land under cultivation has decreased for all forms of tenure, principally as a result of urban encroachment, public parks, roads etc. At the same time the figures representing acreage held by part owners increased from 7.5% in 1940 to 26.9% in 1969 and the acreage worked by managers decreased absolutely and percentage wise from 30.4 in 1940 to 9.2% in 1969.

Table VIII shows that small farms less than 9 "cuerdas" represented more than 52% of all farms in 1940 but occupied only 7.7 of all lands. This proportion was still the same in 1969, i.e. 52.7% of all farms of less than 9 cuerdas had only 5.8 of all lands. If we take farms of less than 49 cuerdas, they represent 88.6% of all farms and only 29.4% of lands in 1940, but in 1969 they counted for 88.2% of all farms and only 23.7% of all lands. The distribution of farms by size has not shown any change since 1940, but nevertheless all sizes of farms have decreased almost in the same proportion, except for big farms of 260 and more cuerdas, these having increased somewhat from 936 in 1940 to 949 in 1969. Small farms are not only characteristic of traditional crop-raising but are also typical of sugar-cane farming. Out of 5,565 farms harvested in 1970, 2,713 or close to 50% have between 0.01 and 5.00 acres and 1,066 between 5.01 and 10 acres²⁵. These farms exhibit a lower productivity per acre than the big farms.

Table IX establishes consistently a lower tons/acre and raw value sugar/acre for small farms (less than 5 acres) harvested than for the larger ones. The best yields for both cane and sugar are among producer-processors and farms managed by the Land Authority of Puerto

Table VIII.- Number and Area of Farms, by Size of Farms, 1940, 1950, 1959, 1969

Size in Cuerdas	1940		1950		1959		1969	
	Cuerdas	Farms	Cuerdas	Farms	Cuerdas	Farms	Cuerdas	Farms
Total	1,885,874	55,519	1,884,886	53,515	1,682,556	45,792	1,334,800	32,687
%	100	100	100	100	100	100	100	100
Up to 9	145,438	29,370	143,008	27,985	115,287	22,967	77,648	17,238
% of total	7.7	52.9	7.8	52.3	6.9	50.2	5.8	52.7
10-19	151,510	11,288	144,449	10,538	130,077	9,654	89,952	6,579
% of total	8.0	20.3	7.8	19.7	7.7	21.1	6.7	20.1
20-49	258,563	8,575	263,720	8,687	234,010	7,788	150,153	5,045
% of total	13.7	15.4	14.3	16.2	13.9	17.0	11.2	15.4
50-99	215,540	3,200	216,148	3,166	176,636	2,621	114,754	1,683
% of total	11.4	5.8	11.7	5.9	10.5	5.7	8.6	5.1
100-174	191,678	1,504	186,539	1,440	155,767	1,212	99,855	767
% of total	10.2	2.7	10.1	2.7	9.3	2.6	7.5	2.3
175-259	135,568	646	133,055	627	107,650	512	89,918	426
% of total	7.2	1.2	7.2	1.2	6.4	1.1	6.7	1.3
260 and more	787,577	936	757,967	1,072	763,129	1,038	712,521	949
% of total	41.8	1.7	40.2	2.0	45.4	2.3	53.4	2.9

Source: Same as Table VII, op. cited, pages 2 and 3.

Table IX.- Tons of Cane and Tons of Raw Value Sugar per Acre for Specific Growers
And for Specific Size of Farms

	1963		1965		1969		1970	
	Cane	Sugar	Cane	Sugar	Cane	Sugar	Cane	Sugar
1) Independent Growers (Farms of less or equal to 5 acres)	26.0	2.54	24.6	2.46	26.9	2.18	24.3	2.02
2) Independent Growers (Farms of more than 5 acres)	29.5	2.96	26.9	2.79	29.5	2.47	27.0	2.19
3) Land Authority of Puerto Rico	39.0	3.32	38.1	3.52	42.2	3.23	38.3	2.86
4) Producer-Processors	42.3	4.14	37.1	3.79	38.7	3.14	38.4	2.87

Source: Annual Report of 1970, Caribbean Area Office, United States Department of Agriculture, Agriculture Stabilization and Conservation Service, Puerto Rico, San Juan, June 1971

Rico, due perhaps to better farming methods and more rational use of fertilizer which increases yield per acre. Whatever the reasons Table IX demonstrates that the possibility exists for increasing yield per acre by the consolidation of small marginal farms into more profitable ones. The disadvantageous situation of small farms relative to bigger farms is indisputably the result of the severe limitation of capital generally encountered by small farms. Indeed they are not in a position to borrow or simply may not be interested in such risks because of the danger of adverse weather conditions which could affect future yields even though future prices might be guaranteed for sugar cane in Puerto Rico. Moreover, sugar farming in the Island is under a quota system which fixes the amount that can be marketed and thus incentives needed to increase yield per unit of land, are lacking.

Despite these shortcomings in sugar farming, the agricultural sector has experienced some basic changes that are worth mentioning. Land suitable for agriculture per farm worker has increased substantially since 1940 from 8.2 cuerdas to 18 in 1970. Higher incomes have shifted the demand from traditional to more nutritious food. And farm production has taken advantage of these opportunities by diversifying its output of coffee, sugar, tobacco and starchy vegetables to include livestock, milk and eggs, as shown by Table X. Investment expenditures have shifted to particular inputs that promise more income and at the same time better return per unit of inputs invested. For example, while in 1969-70 total expenditures on farms were 2.31 times the total income in 1950-51, expenditures on food for livestock and poultry in 1969-1970 were 5.1 times that of 1950-51. Furthermore, income in current dollars from crops

Table X.- Agricultural Production: Physical Volume Index (1950-51 : 100)

	1951/52	1961/61	1965/66	1969/70 ^a
Traditional Crops	120.4	104.5	94.2	63.8
Starchy Vegetables	111.3	85.4	94.3	89.3
Milk	103.3	197.9	248.6	263.3
Eggs	105.0	160.1	225.3	233.6
Poultry	101.3	165.7	191.7	207.0

A) Preliminary Figures

Source: Facts and Figures on Puerto Rico's Agriculture, Department of Agriculture, 1969-1970, Table 56 Commonwealth of Puerto Rico, P.R.

decreased from 1959 to 1969 by 35%, i.e. from 129,764,342 dollars to 84,397,351 dollars, whereas income from livestock increased for the same period by 113.4%, i.e. from \$41,491,621 to \$88,547,545^{25a}, and the trend has continued since.

Purpose and Methodology of the Study

Such is the general background of the country which will be the subject of our study. Our purpose will be to present a model of internal migration that is likely to fit the Puerto Rican migration pattern. Its magnitude will be evaluated as well as its economic implications. Furthermore, we shall make a detailed analysis of the negative and positive factors affecting it. Attempts will be made to pinpoint the origins and characteristics such as age, sex, education and destination of migrants by indentifying the regions or "municipios" that have gained or lost people during the decade 1960-1970.

- Measurement of Migration

We will follow the method of estimation devised by Jacob S. Siegel and Horace Hamilton²⁶, in which the residual estimate of intercensal migration is taken as the difference between the surviving immigrant to the region in question and the surviving outmigrants, which is the redistribution of the population due to migration. Leroy O. Stone²⁷ applying the same method, gave a clear and concise exposé of the techniques involved in estimating the net migration. Stone used the survival ratio technique. The method is described as follows, "Let $P(x,t)$ refer to the population of a place (a) which is aged (x) at time (t). Let $R(t)$ be the proportion of $P(x,t)$ which survives ten years, that is up to time $t+10$. Then "survival Ratio Method" estimate of net intercensal migration is defined as:

$$P(x+10, t+10) - R(x) \cdot P(x,t)$$

In applying the method in his paper, Stone based the value of $R(x)$ on census data. The estimate is obtained by taking the number of Puerto Rican aged (x+10) in 1960 who were residing either in the Island or the United States. He divided the number by the corresponding population aged (x) in 1950. He assumed for the estimate of " $R(x)$ " that a negligible proportion of Puerto Rican-born persons resided in places other than the Island or the United States, an assumption, which, he thinks, is generally accepted.

But since " $R(x)$ " as estimated by Stone is likely to give inaccurate measures of survivorships, that is, for certain age-groups " $R(x)$ " may be greater than unity, especially when the age-group at later

census is affected by large positive in-migration, we will use instead the survival ratio estimated from model life table adjusted for external in or out migration as explained in Appendix A. Moreover, in applying the method of survival ratio estimated from a model life table, we will be able to draw meaningful comparisons with ours from similar study on internal migration in Puerto Rico carried out by Nerlove and Schultz²⁸ for the decade 1950-1960, in which the same method of survival ratio constructed from a model life table has been applied. Like all methods of estimation, it presents some advantages as well as shortcomings with respect to the accuracy of the results that will be discussed later.

We shall use this technique and express our results as the net migration for a definite period, i.e. the period between censuses. The regions or "municipios" that have gained or lost people along with the effects of the age-sex composition of the population on the labor participation rates, educational level, and especially on agriculture will be gauged after internal migration has occurred. As an example of the trend of the age composition of employed persons in some sectors of the economy, as a result of migration, we note that the median age for male manufacturing workers has decreased between 1960 and 1970 from 36.7 years to 33.1 years respectively, while it has increased for farm laborers and farm foremen from 38.0 to 44.2^{28a} for the same period. The effect of this trend is quite significative for the farming sector, for as the farming population ages, its ability and willingness to make, accept or learn the changes necessary for transforming the input mixes to keep up with the modernization process will naturally decline.

The redistribution of population, its age and sex brackets,

seems the most important factor affecting certain sectors of agriculture, particularly sugar-cane and coffee. The share of agriculture in the total labor force and output in the Puerto Rican economy has steadily grown smaller. Whereas, in 1950 this sector produced 24% (\$149 million of net income out of a total of \$164 million) it accounted for only 4.5% (\$195 million out of total net income of \$4,296 million current dollars) in 1971.²⁹ As for the labor force the decline is more obvious. The labor force involved in agriculture was 36% in 1950, dropped to 23% in 1960, and less than 8% in 1971, without any substantial increase in total output. When coffee, for example, is considered, the importance of the labor force cannot be minimized, especially the labor force at the required age. For coffee growing requires land with a topography averaging a 60% slope which does not easily lend itself to modern mechanization. Only a sufficient and efficient labor force can maintain or increase the output of this sector. With some minor modifications, the same observation can be made for sugar-cane which is the largest crop of the Island. Sugar-cane's share of net farm income declined from over one-half of the total of 1950 to about one-fourth in 1969 and 1970. Moreover, in 1949-52, 34 mills were in operation, averaging 1,287,000 tons a year, while in 1970-71, 15 mills remained in operation producing only 320,506 tons a year, a 30% decline over the fiscal year 1969-70. These implications will be explored and the incidence of the labor force redistribution will be assessed accordingly.

The questions that immediately arise are, what are the economic variables that are associated with the reallocation of the labor force or more precisely with the movement of farm labor to the cities? What

are the effects of migration on the income gap between farm and non-farm occupations? Or its impact on disparity among regions of the Island? Is migration going in the right direction? Is more information necessary to the individual desiring to migrate? The answers to these questions are important for policy decisions aimed at distributing equitably the gains from progress to the total population, farm and non-farm alike. Also, since agriculture is the sector most likely to be affected by growth and progress, the answers to these questions will help in determining whether or not agriculture is adjusting itself to the rest of the economy without incurring great sacrifice of income or welfare.

- Production Function Estimation

One way of answering this question is by a simultaneous estimation of income shares accrued by all factors used in agriculture, and an evaluation of the variations occurring in the income going to land, capital, and particularly to labor.

The estimation of the income going to the factors of production will be made from an explicit production function. Attention will be focussed on the agricultural sector. Analyzing the results of the function will allow us to assess the magnitude of changes in income occurring among the factors of this sector and its implications on the employment level.

Corss-section will be employed, because of the availability of the data and in order to avoid the problems of multicollinearity so often present in time series data. A simple unrestricted function, i.e. whose sum of coefficients is not predetermined, of the Cobb-Douglas

type will be used because of its convenience of application. From the derived function, formal estimation of factor marginal products can be made and then compared to their price to see whether or not the factor is under -or over- used. In this sense the results obtained can be used to make the necessary adjustments in the level of resources, and also for policy formulations regarding availability of credit aimed at increasing or decreasing the usage of certain inputs. As Heady and Dillon³⁰ observe: "The concept is basic to certain theories in the functional distribution of income. The conditions under which a total output can be imputed to the factors from which it is produced with the product just exhausted depends on the nature of the production function."

The following variables will be tested:

Land and Buildings affected in the exploitation of the crop;

Labor, devoted to agriculture

Capital, encompassing all the non-labor costs involved in the production, including machinery and fertilizers, pesticides and others.

Education will be introduced to evaluate its effect on the quality of the labor force. The findings of Grillich³¹ concerning education in United States agriculture, where an increase in education which improves the quality of the labor force has the same effect as a physical increase of the labor force itself, will be tested for Puerto Rico.

The method of least-square regression applied to the logarithm of the variable will be used taking output as the dependent

variable. The form that the variables will take before incorporating them into the function will depend once again on the data.

Once the function is estimated, inferences then can be made as to the changes in labor supply, the ratio of capital to labor, productivity and income accrued to factors of production and their implications can be assessed.

- Regional Inequality Estimation

Concerning regional inequality, we shall attempt to investigate its magnitude during the decades 1950-1960 and 1960-1970 by effecting a cross-sectional analysis of the Island, with regions or groups of "municipios" as defined by the Department of Agriculture of Puerto Rico as units of observation. To do so, we will rely on the method devised by J. G. Williamson³². Williamson, measuring the extent of regional disparities within countries, uses the concept: "Index of Regional Inequality V_w , which he defines as a weighted coefficient of variation which measures the dispersion of the regional income-per-capita levels relative to the national average while each regional deviation is weighted by its share in the national population". In mathematical form, " V_w " is equal to:

$$V_w = \frac{\sqrt{\sum_i (Y_i - \bar{Y})^2 f_i / n}}{\bar{Y}}$$

where,

f_i = population of the i th region

n = national population

Y_i = income per capita of the i th region

$\bar{Y}$ = national income per capita

By a comparison of the regions over the successive decades, we can establish the trend of regional inequality, whether it tends to diminish or increase as a result of internal migration.

Calzada, recognizing the importance and the magnitude of the question of regional inequality, states that "should the government wish to reduce migration, it must first reduce the diversity between semi-rural Puerto Rico and Puerto Rican and U.S. urban areas."³³ In fact, the government has already been engaged in this task. One of the first steps taken in this direction was the extension of the seven years of tax exemption offered new industries willing to locate in the less industrialized regions of the Island. Should industries take advantage of this offer, internal migration will, in fact be substantially reduced. However, since the factors affecting the locations of industries are various, it remains to be seen how successful the proposed program will be.

Should the trends of regional inequality show a widening of the disparities, it will be necessary to formulate policies aimed at counteracting their direction. H. C. Barton, Jr.³⁴ observes that the "loss of rural jobs profoundly and irreversibly upset the earlier geographical balance of employment." Confirming the geographical imbalance, he adds that, "many workers continue to live in rural places but increasing numbers commute to urban jobs. This tendency seems sure to continue and Puerto Rico's future population growth is expected to be entirely urban or suburban."³⁵

The Puerto Rican government is well aware of this problem and

has taken many steps to counteract the growing disparities among regions of the Island. For instance, in addition to allowing the 17 years' tax exemption to encourage firms willing to locate in the least industrialized zones, large cash grants are offered for the establishment or expansion of industries outside the San Juan Metropolitan Area. However, as noted by the International Economic Survey (Chemical Bank/ International Division), "in the near future some zoning to preserve the natural environment in certain areas may well impose limits on industrial decentralization."³⁶

- Concluding Remarks

Today considerations by public officials of questions related to an appropriate regional distribution of economic activity constitute strong issues of public policy. These issues center mainly around the course that distribution of employment, income, population, industry should take in the rural and urban regions of a given country. The difficulties in debating such policies seem to stem from questions of whether and if so, how the natural economic forces pushing the industries and population to concentrate in already crowded cities should be regulated or directed.

There is no doubt that schemes tending to make farming more remunerative by the introduction of scientific methods, agricultural extension, education, and the vulgarization of modern farming practices could improve the moral and material conditions of cultivators. In addition to this should be the promotion of programs to make villages more attractive and enjoyable.

There are many opportunities to work in this direction and

the adoption of these schemes might stop the cityward drift of farmers' sons. But there is wide skepticism regarding these steps and as Weber thinks "so long as the present industrial organization endures, no amount of village improvement will keep ambitious youths at home, for the reason that all opportunities for rising in the world are in the cities."³⁷

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CHAPTER II

Internal Migration Theories

Review of the Literature

Introduction

Students of economic development are unanimous in recognizing the vital role played by internal migration in the process of growth. Lewis¹ asserts that "Economic development involves a reallocation of the labor force from the rural to the industrial sector." Kuznets² states that "The relation between population redistribution and economic development is an important and indispensable link in the process of growth." Lee³ mentions that "The interests of the economy and of the individual are best served by the fluid movement of those who are hardest to replace." And Morrisson⁴ adds that "Migration serves as a mechanism of labor force adjustment and equilibration among different regions. It siphons off surplus labor from areas of stationary or declining opportunities and steers mobile elements of the population to areas of economic expansion."

Internal migration is thus viewed by all these authors as a response to disequilibrium in the regional labor markets. This disequilibrium may arise from various causes, namely different economic opportunities: available jobs, higher wages in given regions; natural causes: better climate, rougher topography typical of specific zones of a country; different fertility rates: death, birth rates that are higher in certain localities than others keeping the supply of labor consistently higher in some areas; and lastly social or family ties that

induce people to move independently of any rational economic calculus.

Evidence establishing the interregional mobility of people throughout the developing areas of the world has been encountered in various dissimilar countries of the world such as Ghana, especially in the study by Beals, Levy and Moses⁵, in Brazil, investigated by Sahota⁶, in Chile by Herrick⁷ and in Colombia by Schultz T.P.⁸

Many theories have been suggested to explain internal migration. Some are framed for a given country with specific conditions, while others more general in character purport to explain the migration phenomenon in such a way as to be applicable for all countries. Until recently these attempts to understand interregional mobility of people have been circumscribed to explain the composition, direction, volume of migrant groups and to detect whether the observed patterns responded to any universal "laws" that can be generalized and extended to other similar phenomenon. Thus, early efforts were concentrated on approaching internal migration either in terms of "streams" or "differentials" migration. "Migration streams" analyzes the volume and direction of migrants and how they are affected by socio-economic conditions at origins and destinations. "Migration differentials" focusses attention on the principal characteristics of migrants and non-migrants and how these distinct groups differ in their age structure, sex composition, income level, marital status, educational attainment etc. These two ways of viewing internal mobility can be conducted separately or jointly, mostly in the form of mathematical model or statistical regression whose ultimate aim is to forecast with a certain degree of precision future movements of people.

While these approaches are operationally fruitful for certain purposes, for example for specific problems of policy tending in encouraging or counteracting flows and composition of groups of migrants on the reallocation of the labor force and its adjustment as economic development takes place, they fail to take explicitly into consideration, on the one hand, the principal element involved in this decision process, i.e. the migrant himself and, on the other hand, the overall impact that these myriad of personal and isolated decisions have on the regions of origins and destinations of migrants. In other words, from the point of view of the individual, the questions that are not asked are: what are the consequences of migrating in terms of costs and returns for him? and from the point of view of society: are the costs incurred and the benefits accrued to individuals compensate for the costs and returns supported and enjoyed by society?

These questions concerning the collective mobility of people on the people themselves and society are of interest to the policy maker and help him direct his decisions to solve key problems such as: reduction of poverty, unemployment, supply of information to avoid wasteful moves of the individual migrants, education reorientation etc, and to society, redistribution of gains to regions and their environment that have suffered as a result of migration as well as the remaining population that has not moved because of lack of skills for urban jobs or lack of means to undertake the costs that such moves entail.

Fortunately, the approach of Sjaastad⁹ and Schultz¹⁰ has offered valuable insights to this way of viewing migration. Both investigators treat the migration process as an investment problem that

man as a capital makes in himself. This approach stipulates that the individual who desires to migrate will do so when discounted returns surpass costs. Despite its strong appeal, this last feature makes it difficult to verify empirically, because data on future costs and returns at different places are at best difficult to estimate and vary according to the intuition and personal perception of each individual concerned.

Recognizing these difficulties impeding any valid empirical verification of the expected rate of return to migration, Nerlove and Schultz¹¹ have proposed the following steps to circumvent these drawbacks:

"Aggregate variables that should affect the rate of return to migration, such as regional differences in earnings, unemployment, and the structure of employment, are first identified. These may in turn be related to migration for different age-sex categories in order to distinguish how the composition of the population influences the responsiveness of individuals to such differences among regions."

These steps blend some of the elements encountered in the approach of "migration differential", and "migration stream", as well as the "human capital" views. For these reasons, we shall review the most important socio-economic theories of migration according to their chronological order of appearance in the literature, before developing and concentrating on the approach that views migration as a human capital activity or better an investment in man involving cost and returns for the interested individual as well as society. This theory as first expounded by Sjaastad¹² and later developed by Schultz¹³ as well as the

techniques suggested by Nerlove and Schultz¹⁴ will be adopted here for the purpose of this study.

Socio-Economic Theories of Migration

- The "Ravenstein Theory"

The first comprehensive explanation of internal migration was that of Ravenstein¹⁵ presented as a result of his statistical study of the British internal migration in the 1880's. His observation known as "laws of migration" mentions the following conclusion:

1. We have already proved that the great body of our migrants only proceed a short distance and that there takes place consequently a universal shifting or displacement of the population, which produces "currents of migration" setting in the direction of the great centres of commerce and industry which absorb the migrants...
2. It is the natural outcome of this movement of migration, limited in range, but universal throughout the country, that the processes of absorption go on in the following manner: The inhabitants of a country immediately surrounding a town of rapid growth, flock into it; the gaps thus left by the rural population are filled up by the migrants from more remote districts, until the attractive force of one of our rapidly growing cities makes its influence felt, step by step, to the most remote corner of the Kingdom. Migrants enumerated in a certain center of absorption will consequently grow less with the distance proportionately to the native population which furnished them.
3. The process of dispersion is the inverse of that of absorption and exhibits similar features.
4. Each main current of migration produces a compensating countercurrent.
5. Migrants proceeding long distance generally go by preference to one of the great centers of commerce and industry.
6. The natives of towns are less migratory than those of rural parts of the country.
7. Females are more migratory than males.

Except perhaps for the second law dealing with the various steps of the migrants, most of these general trends have been shown to be true in studies related to internal migration, especially those related to distance, population size at origin and destination (See Stouffer, foot note 15b)

Although it has not been possible to carry out a rigorous verification of these "laws" with regard to Puerto Rico, because of the ways in which the data are tabulated in the census of the Island, it is nevertheless possible to detect some of them, in particular the female migration rate versus male rate for different age-groups and the effect of distance on migration.

In spite of the fact that "distance" has been mentioned by Ravenstein as having a negative effect on migration rate, these so-called "laws of migration" cannot be considered as a theory of migration, but rather as a type of observed or empirical regularities in the process of migration during the 19th century in England. Alternatively, these "laws" can be viewed as an attempt to determine the "push" and "pull", though these terms were not used as such, that regulate migration and suggest also that the process of migration tends to maintain a position of equilibrium between a main current and a compensating countercurrent. While Ravenstein mentions "great centers of commerce and industry" as natural places to absorb the main currents of migration, he does not spell out the destination of the countercurrent. Certainly the countercurrent must consist of people from the cities who do not move in the direction of the towns where the main current originated, but perhaps towards the suburbs surrounding the cities, a phenomenon similar to

that experienced by most big cities nowadays.

In the context of Ravenstein, migration is not necessarily geared by economic forces, it may occur without any sure or expected remunerative employment in the modern sector. Yet, Ravenstein considers migration as beneficial to the migrants and as a contribution towards enhancing the general welfare of the population. "Migration means life and progress, a sedentary population stagnation."

- The "Push-Pull Theory"

The next theory no less important is the one known as the "push" and "pull". This theory is based on forces, economic as well as social, pertaining to the region of origin and destination of the potential migrants. Applied to the urban-rural migration, the "push" would be the low income prevailing in the rural area, archaic land tenure, and stagnation of agriculture demand for the labor force. The "pull", in contrast, is viewed as higher wages in the cities, shorter working hours, more diversified leisure time, and all the amenities of city life.

The notion of "push" and "pull" includes in itself a relationship, or a comparison between or among areas at a given time. In other words, "push forces" can be said to exist only when somewhere some "pull forces" are present. Otherwise, without any terms of comparison, the notion collapses. Viewed thus, this notion is not too meaningful and can simply be replaced by the differential attractions of various regions. This differential attractiveness comes into play when, as a result of economic growth, economic and social opportunities emerge

for some regions, but fail to materialize in others.

Nevertheless, some people argue that these two forces need not be present concurrently, i.e., in a given situation one of them may be present while the other is not. Bogue^{15a} acknowledges this possibility by stating: "Migration that has a very strong "push" stimulus tends to be much less selective,^(a) with respect to the community of origin than migration which has a very strong "pull" stimulus. Where there is a condition of very strong "push" but no strong "pull" (extreme cases are disasters such as famine, drought, floods, exhaustion of a resource), origin selectivity is at a minimum. In other words, selectivity of out-migrants from any community tends to vary directly with the strength of attractives "pull" from other communities and inversely with expulsive "pushes" from the community itself."

This theory, unlike the preceding one presents no formal "laws" governing migration. It explains migration in terms of existing conditions prevailing in the regions of origin and destination.

- The "Intervening Opportunity Theory" (Stouffer)

Relying on opportunities offered to potential migrants, Stouffer^{15b} proposed in 1940 the theory of intervening opportunities. He relates distance between region of origin and destination and oppor-

(a) in the sense that no specific choice or selection of migrants as far as age, sex, education, marital status for example are concerned.

tunities, where opportunities are not defined as a clear-cut concept. For example, opportunities may be the number of vacant houses in a given tract and intervening opportunities may represent the case in which the vacancies are similar between two different tracts. As it was presented in 1940 his theory asserted that "the number of persons going a given distance is directly proportional to the number of opportunities at that distance and inversely proportional to the number of intervening opportunities."

In 1960, however, Stouffer^{15c} thought that along with factors such as "opportunities and intervening opportunities" influencing the decision of the migrant, other forces must be taken into consideration. Thus he added a new concept -"the competing migrants". His extended hypothesis stated that for a given interval of time and from two places, A & B, the number of migrants from places A and B is influenced not only by the "opportunities" and "intervening opportunities" but also by the number of migrants competing for opportunities existing in the place of destination.

Specific Characteristics of Migrants Around the World

- Age

Generally, from the studies applying these theories, it is noted that migrants tend to show certain specific characteristics. Among them, we mention first age. The young, able, and bold are the first to leave the towns and settle in the cities. These persons have reached a turning point in their life cycle: they have finished their formal

schooling or are making their first steps into the labor market, and more important, even if they are married, they are not yet encumbered with children to raise. In the terminology of the human capital investment theory, they are better off, since by investing in migration when they are still young, they have a longer time-span within which to benefit from the expected returns from their investment. Moreover, being young gives them the extra possibility, if the need arises, of undertaking other profitable investment in themselves, namely in education, on-the-job training etc.

Evidence gathered at different places and times supports strongly the selectivity characteristic of migration as far as the young are concerned.

In the United States, Gladys K. Bowles¹⁶ reports that over one-half of the agricultural population aged 10-19 in 1940 had migrated from the farm by 1950. Around 40 per cent in the age bracket 20-24 in 1940 left farming before 1950. As for the age bracket 30-49 in 1940, less than 20 per cent migrated from agriculture in 1950.

Ira S. Lowry¹⁷ has shown that during 1953-64 young civilian persons from the U.S. (20-24 years of age) have an average annual rate of interstate migration of 88 persons per thousand for the next highest rate group (25-39 years of age).

In an analysis of interregional migration in California (U.S.A.), Rogers¹⁸ indicates that during the 1955-60 period, 43.5 per cent of the population 15-19 years of age moved out of their SEA and this percentage decreased almost to zero for the group aged 65 and over.

These trends regarding age have been proved correct not only for the United States but for other countries as well.

In Ghana (Africa) Caldwell¹⁹ relates that young African males are the most mobile. In 1960, in Acra, there were over 20% more males than females born elsewhere in Ghana. More people 15-34 years old were found in cities than in the country. Surveying persons who plan to undertake long term migration to urban areas, the group aged 18-24 shows the highest percentage (18%) compared to other age groups whose percentage of planning for such moves varies between 0 and 10%. In the same survey, it is noted also that girls are almost as prone to migrate as boys.

In Colombia (South America) Schultz²⁰ observes that in 1958 the highest specific migration rates occurred for men who were between 17 and 25. For women the peak was reached at a younger age, between 12 and 16, declined gradually until 37-41, then rose again.

The behaviour of persons who migrate in early adult-hood is in conformity with the human capital investment theory. By investing in themselves when they are still young, they dispose of a longer time-span for the enjoyment of the expected returns from their investment. In the case of unforeseen events leading to negative or unwanted outcomes, they may have time to redirect their investment or to take any other necessary steps. In a sense, migration of young women from rural to urban places helps indirectly to control population growth, for they are of necessity obliged to control their fertility because of the many problems confronted in city life. In the case of Puerto Rico, should a high rate of migration for young women be the case, this could be beneficial for

the Island, where population growth is a serious deterrent to economic development. We will have occasion to explore this question when we present the empirical findings of Puerto Rican migration in the next chapter.

- Sex

The second important characteristic to consider when studying migrants is sex. On that aspect past researches show no clear pattern favoring one sex to the detriment of the other. Schultz²¹ contends that "among urban immigrants in Latin America, women tend to be more numerous than men." For Colombia, he observes that in a selected group of 17 towns, women are more migratory than men in the metropolitan centers, but in the frontier territories, men surpass women in their rate of mobility. Specifically, in the metropolitan centers, during 1958 and for people age 7 to 51, men migrated at a rate of 1.5 per cent while the rate for women was 2.0 per cent per annum. In the smaller towns of less than 10,000, the annual rate was 1.2% for men and 0.6% for women. He claims that his findings are in conformity with the laws of migration of Ravenstein.

Hutchinson²² investigating mobility in urban Brazil, finds that males show no greater propensity to migrate than females. But when the moves are confined between big cities, men show an annual rate of 15.1% against 13.8% for females. For small and rural places, the female rate dominates in the proportion of 51.4%, while the male rate is only 47.7%.

In a study on Guatemala, Arias²³ shows that except in some

rare cases, males were more migratory than females.

In the United States, Lee²⁴ finds no clear sex selectivity from 1950 statistics in the United States.

In California, Rogers²⁵ finds that males are more migratory than females, i.e. during the period 1961-1963, 12% of the male population of the San Francisco-Oakland SMSA moved outside of their subregion, while the proportion is only 7% for females.

For other parts of the world, Jansen²⁶ reports that:

In Japan, during the period 1950-1955, cities of over 200,000 in habitants attracted more males than females. This preponderance of males over females is less clear in small cities.

In Ceylon, during 1946 and 1963, males showed more inclination to migrate than females for all age groups and this finding is independent of the size of the cities considered.

In the Philippines, in an investigation of eight provinces gaining in-migration during the period 1939 and 1948, the ratio of males to females was 98 to 100 respectively.

Finally, Jansen notes that in England and Wales from April 1960 to April 1961, males migrants represent 1.6% of the total males population, while female migrants constitute only 1.55% of the female population.

From the preceding accounts, the question of males migrating in greater numbers than females or vice versa seems to be specific to the

time of the survey and, the country under study. Among the factors that appear to affect the decision of the male or the female migrant are the size of the cities or towns, the rate of industrialization, customs, family ties, religion and distance of migration.

It is generally conceded, however, that where it is possible for women to enter freely into the labor market as a result of social changes while development proceeds (changes that render them as eligible as men for jobs, given their skill and education) the national output is likely to benefit. In effect, when the economy undergoes changes, the demand for labor is bound to increase and part at least of this increase when fulfilled by women contributes directly to raise the revenues of all households. This generally brings about a rise in demand for goods and services which in turn stimulate production and new employment opportunities. Again, we will see what light the Puerto Rican pattern has to shed on this kind of situation.

- Education

The third characteristic that we will mention is education. Various evidences drawn from many studies tend to support the hypothesis that the migrant tends to be more educated than the average person composing the population he leaves. Education, they contend, by increasing the employability, expectation, and desire to work of the individual, tends to influence positively out-migration. Johnson²⁷ states that "The major effects of more and better quality of primary and secondary education in farm areas as it affects mobility are two. First, the range of opportunities available to the farm migrants would be increased and in some

cases by significant magnitudes. Second, the acceptability of farm migrants in urban communities would be enhanced and the ability of the farm families to adapt to urban conditions would be improved."

However, the role played by education on migration is not as clear-cut as that played by age. In some instances and depending on the period, migration is positively related to education, while in other instances and different periods it is not. For example, Hathaway²⁸ reports two studies showing opposite effects of education on migration over time. In a study of U.S. rural areas, Hamilton²⁹ finds that during the period 1940-50, the least educated among rural farm persons had the highest rate of migration. This rate was approximately similar among those completing more than five years of schooling. Referring to the behaviour of non-whites, Hamilton notes that non-white rural farm persons in the 20-34 age group in 1940 showed a practically similar rate up to the high school grades, but beyond high school the rate of migration was much higher.

In another study by Bogue and Hagood,³⁰ covering a different period, 1935-45, it was found that in general, apart from the Cotton Belt area which contained a mix of low-educated as well as high-educated, rural farm migrants during that period were recruited among the better-educated.

Hathaway attributes these conflicting patterns to two principal causes, namely improved economic opportunities in the non-farm economy and higher levels of educational attainment in the rural areas "at least up to the eighth grade" during and since World War II, i.e. from

1940-50.

For a more recent period, Bogue³¹ states that from the data of the 1960 U.S. Census, the patterns of migration of both whites and non-whites tend to vary directly with the level of educational attainment. The average white college graduate 25-34 of age is two to three times as migratory as do the non-graduate from grammar school. The same pattern is observed but with somewhat less dramatic differences for non-whites.

Caldwell,³² studying rural-urban migration in Ghana reports that in a rural survey relating education and migration for persons 20 years and over, 2/3 of the males and 7/9 of females without education have stayed in the village without participating in any form of migration and without contemplating any plan for migration; the proportion is less than 2/5 of the upper primary, middle school leavers and technically trained for both sexes which also have not migrated or have no plan to do so. Caldwell comments that in Ghana, "schooling turns people towards town life. Indeed in Ghana, it is often thought of as preparing people for urban occupations." He adds that, "what continued education does more than anything else is to promote long-term rural-urban migration. Thus, almost half of those with secondary schooling or university education were reported in towns."

Ralph Beals,³³ and his collaborators support the same view as Caldwell by positing that in Ghana, people "with some education are apt to become dissatisfied and move to cities without regard to job opportunities". However, using a regression analysis, they found that this hypothesis is not verified, since education has a negative sign at

both the origin and destination regions. Yet they acknowledge that in fact a larger percentage of educated than uneducated persons do migrate, especially to the cities. To reconcile these apparent inconsistencies, they relate education to income in the sense that, potential income being affected by education, it follows that regions of high education would be at the same time regions of high income. "If income in a region is high because there are many educated people there earning high incomes, average income for the region may tend to overstate the level of income available to uneducated migrants." They contend that though the data used in their study are not ideal for the purpose of their research, there may exist a separation in the labor market suggested in the concept of "noncompeting groups", so that a single wage or income variable is insufficient for understanding the behaviour of migrants in the Ghanaian context.

In a study of internal migration in Brazil, Sahota³⁴ contends that education can affect migration in different ways and that it is not possible a priori to determine or predict its influence. In the case of Brazil, the results of a regression analysis considering three different age groups showed that education is a deterrent to migration in the origin region and an attraction to migrants in the destination region, but he added as Caldwell did in his study of migration in Ghana, that because of possible collinearity with the wage rate variable, "the direct net effects of education on migration are not likely to be substantial."

For Schultz,³⁵ education has a dual effect on the rate of migration. Commenting on the relation between education and migration

in Colombia, he thinks that education may affect the rate of migration at least in two opposite directions. "A municipality that offers an interesting program of schooling to a high proportion of its child population soon becomes attractive to potential migrants as providing a free and valuable non-wage benefit. But once educated and independent of their parents, the children are likely to try their luck elsewhere, because in his words "they are more able to evaluate their opportunities outside the local market, and they tend to be more adaptable to the demands placed on the migrant."³⁶

In Colombia, education seems to affect migration in a definite positive direction. The same author claims that he has evidences that schooling in Colombia is valued less highly in rural than in urban activities, "so that between rural and urban labor markets, relative and absolute differences in income are higher for the educated than for the non-educated."

From the foregoing evidence, it is clear that education is highly correlated with higher income and since higher income is likely to be gained in non-farm occupations, education thus tends to favor out-migration of the better-educated from rural to urban environments. What then will be the net effect on the quality of the labor force when the educated are driven away from the rural to the urban setting? Are the benefits gained measured in dollars, in one area outweighed by losses in the other? It would be indeed interesting, if it were possible, to ascertain the over-all impact on the long-run welfare of the Puerto Rican population.

As a resource, however, human capital is better developed by education, which helps put the potential of this resource into a better perspective, so that the educated person can identify his values and objectives, and arrive freely at a choice among alternatives. The question remains nevertheless, as to the orientation given to the process of education. If this orientation is geared to urban values and is committed to industrial uses, there is no hope that the farming sector will benefit from education. This a problem of policy which will be considered later when we come to this question.

These reviews of the various trends characterizing internal migration in terms of selectivity and "push" and "pull" are undoubtedly helpful, as we mentioned earlier, in the understanding of mobility, principally the forces behind this process and how they redistribute the population among regions. But this process has other fundamental implications which have side effects affecting not only the human agent, the principal decision maker in the process, but also the environment he leaves and the new milieu in which he elects to stay. These implications deserve consideration.

The Human-Capital Theory of Migration

In this perspective, rather than considering the forces responsible for migration, other investigations consider migration as an investment that man makes in himself in order to increase his productivity, and consequently this investment encompasses costs and returns not only for the individual who undertakes the move but also for society. Indeed, individual moves give rise to externalities that are not

taken into account and cannot even be foreseen by the isolated decision maker. In simple terms, the costs and benefits to the individual are not exactly balanced by the costs and returns incurred and enjoyed by society.

One of the leading proponents of this school is Sjaastad.³⁷ His main point is that migration is an "activity which requires resources", and that it therefore should be viewed within a framework of return to investment instead of relating it to income differentials. As a consequence, when expected returns are less than actual costs, migration may not take place even though differentials in earnings do exist in two different places.

Following the same path, Schultz^{38a} gives this hypothesis: "The central hypothesis is that the act of migrating is an investment and that the life-time expected returns associated with the differences in job opportunities among labor markets or in consumption opportunities among locations as places to live, determine the alternative investment opportunities pertaining to migration."

- Private Returns of Migration

Sjaastad divides the private returns to migration into monetary and non-monetary gains. The monetary gains are the net increase in income that the migrant expects to earn during his life-time, compared to the income he has before moving. Given the level of employment existing at his destination, expected earning differentials are a function of the attributes of the migrant. A positive relation is likely to be found with his level of schooling, skills and previous

on-the-job-training. Age is another factor that affects these differentials. If the migrant is young, subsequent investment, mainly in education, will increase these differentials, while if the migrant is old and with no skills or education, as is the case for most people from farming, investment in education becomes unprofitable because he may not have time to reap the returns. Thus, as Sjaastad³⁸ has pointed out, observed income differentials over space cannot be attributed only to disequilibrium in the labor market. Occupational composition, sex and age affect earnings and thus permanent income differentials may exist even in equilibrium across regions. It follows that income differentials may exist and persist over time among regions and yet no migration take place, because such differentials are not adequate to compensate for the different costs involved in migration.

The non-pecuniary returns of migration involves those subjective or emotional gains accruing to the migrant due to his preferences for a given location. But they can also affect the behaviour of the migrant and may contribute to increase or decrease his effective earnings to the extent that they affect positively or negatively the time devoted to market production. If this amenity contributes to increase productivity, effective earnings will rise and the economy will gain; on the other hand, if it is regarded as a leisure that necessitates expenditure of time and energy, it may decrease efficiency and affect effective earnings. The economy will lose in the sense that this amenity represents a social cost.

- Private Costs of Migration

In addition, he sees private costs of migration in two parts, the money cost and the non-money cost. The money cost comprises basically and for all migrants items such as transportation of the family and their personal belongings, lodging and food, all of which according to estimates performed for the United States, are not generally considered to be too important, (See Maddox)³⁹. When, however, the migrant has to get rid of assets and machinery previously in use, the operation of liquidating them may be very costly, more so when these assets have to be liquidated at a price inferior to their normal replacement cost.

Depending on employment conditions prevailing at the place and moment of the arrival of the migrant, the food and lodging costs when the migrant moves with his whole family added to the cost of his orientation period and search for information will become a real burden, if the waiting period before finding a job is unduly long. In the case of Puerto Rico, the cost of transport incurred by the migrant must be of minor importance due to the smallness of the island and to the relatively cheap and good network of roads and public transportation linking the "municipios". It is not likely that the costs of food and lodging are a very great impediment to the migrant because of the fact that family ties and friendships are usually considered strong among Puerto Ricans.

The non-money costs are identified as two types, the opportunity costs and the psychic costs.

Opportunity costs are real costs embodied in the income forgone from the moment the migrant leaves his home to the time he

finds a new job. This cost is a function of the waiting period and also of the migrant's capacity for adapting himself to his new milieu. While this cost "involves no resources for the economy", it affects their allocation and could result in immobility and waste of resources to the economy. Psychic costs for any individual vary, especially with age. The older the person is, the higher will be his psychic costs. For a small Island like Puerto Rico where cultural differentials are few, psychic costs are not likely to be very important and since most migrants are very young, the time required to resettle and overcome this cost will probably be short.

- Social Costs and Returns of Migration

Social costs and returns arise from the existence of external economies and/or diseconomies which affect differently places of in-migration and out-migration depending on the volume of and the speed with which migration occurs and also of the quality of migrants that have moved. There may result an increase or decrease in the incomes of the people left behind, capital losses or gains of fixed assets, a raising or lowering of per capita public service costs by a decrease or increase of the regions's tax-base, a deterioration or an amelioration of the environment, and of the quality of the public services which may attract or repulse new industries in the area.

As a useful point of departure and in order to visualize how and under what conditions external economies and/or diseconomies can affect places of in-migration and out-migration, let us assume that our country is not subject to external migration and let us divide it

into regions of net potential donors and net potential receivers of persons.

I) Net Potential Donor

A Net potential donor may be a low income region that can show either signs of decline or growth of its per capita income over time. It may be also a high income region whose growth rate is lagging, or even declining.

II) Net Potential Receiver

A net potential receiver is typically a high and growing income region which has shown some dynamism in its rate of investment, creation of employment, diversity and possibly quality of its public services etc.

I) Net Potential Donor Regions

1) A low income declining region is one in which average returns to labor have been persistently below the average for the country as a whole and have not shown any sign of improvement over time. Presumably this region is further characterized by high rates of increase of the population with agriculture in its traditional form as the predominant activity. Moreover, marginal productivity of labor is low due to lack of any modern means of production. Given these conditions, such regions dispose of a reserve of labor which will certainly decide to migrate as soon ways of improving their lots are foreseen. The private costs of moving for these people must be low indeed when compared to potential returns that can be earned elsewhere. In the terminology of

Maddox⁴⁰, most of these regions would correspond to those "in which farming opportunities are so limited that farm abandonment has already occurred on a large scale and will probably continue until most of the land reverts to grass and timber."

In Puerto Rico these regions can be represented by the mountainous regions producing mostly coffee and which occupy a large part of the interior of the Island. A glance at the principal characteristics of the most typical of these regions as shown in Table 1, reveals that the per capita income of persons of these regions is relatively low compared to the Puerto Rican average. Their fertility rate is still relatively high which perhaps explains the high relative ratio of employed persons in agriculture. Moreover, agriculture is still important as a source of income and remains traditional as evidenced by the low percentage of income derived from livestock. The ratio of median income and mean wage or salary income to Puerto Rican average is indeed low, coupled with low median years school completed relative to national average. Finally, these regions have low income and are declining relative to the rest of the island as shown in column 5 of Table 1, in which the ratio of median income to Puerto Rican average has declined from 1960 to 1970. All these characteristics are no guarantee that these regions have any attractiveness to potential migrants.

If out-migration consists mainly of unskilled workers and the least educated, migration will have a beneficial effect on the marginal productivity of the remaining workers at least in the short run since they will have more capital to work with. In the long run, if the rate of migration is higher than the rate of natural increase of population

TABLE I

Type of Relatively Low Income Declining Regions

MUNICIPIOS	Per Capita Income of Persons	Ratio of Fertility Rate to Puerto Rican average	% of Farm Employees in Farm	% of Farm Income made from Livestock	Ratio of Median Income to Puerto Rican average		Ratio of Median School years completed to Puerto Rican average		Ratio of Mean Wage or Salary Income of Family to Puerto Rican average
					1969	1970	Male 1970	Female 1970	
ADJUNTAS	505	1.28	24.2	24.4	0.58	0.45	0.61	0.63	0.61
BARRANQUITAS	444	1.60	18.4	47.8	0.63	0.49	0.75	0.48	0.58
JAYUYA	417	1.64	22.7	31.0	0.54	0.52	0.55	0.57	0.59
LARES	476	1.21	34.7	2.9	0.53	0.53	0.67	0.63	0.53
LAS MARIAS	412	1.33	34.8	8.1	0.55	0.38	0.55	0.60	0.44
UTUADO	416	1.35	26.8	12.0	0.52	0.38	0.60	0.66	0.56

(a) This fertility rate represents the number of children ever born per 1,000 women 35-44 years old ever married.

SOURCE: U.S. Bureau of the Census, U.S. Census of Population: 1960 and 1970, Volumes, I and II, Part 53 Puerto Rico and

Puerto Rico, Census of Agriculture, 1969 U.S. Bureau of the Census

and if the remaining people undertake to recombine existing resource along with new methods of farming, the beneficial effect can continue and income will tend to rise.

There will be no harm done to capital values of existing private assets. Public services can be sustained or even improved with local means, since out-migration is assumed to affect the redundant unskilled workers and the least educated. In such cases, while the social returns are substantial, the costs for the community are only the capital invested in some educated young persons that have decided to leave. These costs will be largely compensated for to the extent that the migrants transfer earnings to their parents left in their hometown.

However, if migration rate is very rapid, and the population is drained of its youngest and best qualified members so that the remaining persons are the uneducated and the overaged without any incentives or motivation, the community will suffer heavily. Under such circumstances, the total production of the region will decline, and the few remaining people will have to pay higher taxes for the maintenance of public services, while losing in the capital value of their fixed assets, because of the abandonment of houses and other economic activities. The region can offer nothing to attract business activities except perhaps marginal firms paying low wages. The social costs for these areas are very important and are represented by their loss of human capital coupled with the subsidies that have to be furnished in order to sustain the public services and the remaining persons who have less potential for migration.

2) Regions of low income but that are growing can be identified by their declining rate of population after an extended period of population increase, due perhaps to more education to be found among its inhabitants. Wages are lower than the most progressive areas of the country but higher than in the previous case and have consistently shown improvements over the years. Furthermore, these regions may have some sort of infrastructure that provide other inducements to business activities. But since employment is not likely to be created at a rate sufficient to absorb population increase, these regions can afford to see some people migrate, who, in the Maddox's terminology can be "represented by maturing farm youths who are not needed to replace the people who die and retire from farming." Even if migration occurs at a higher rate than the birth rate, provided it does not exceed the rate of introduction of modern equipment on new dynamic farms, no great harm will be done, since capital can be substituted for labor and keep economic, public, and private activities going.

These regions are typified by some "municipios" shown in Table II. As can be seen, these regions have relatively higher income per capita than the preceding ones but still show some features that retard their growth and impede a higher level of per capita income of persons. They are mostly coastal regions which produce sugar-cane. Perhaps the introduction of new and better methods of production is lagging; this explains the fact that, except for Rio Grande, more than 9% and in some cases 22% of working people are engaged in agriculture. Some show a high ratio of fertility as compared to the national average, or a substantial percentage of income derived from livestock. The median

TABLE II

Type of Relatively Low Income Growing Regions

MUNICIPIOS	Per Capita Income of Persons	Ratio of Fertility Rate to Puerto Rican average	% of Farm Employees in Farm	% of Farm Income made from Livestock	Ratio of Median Income to Puerto Rican average		Ratio of Median School years completed to Puerto Rican average		Ratio of Mean Wage or Salary Income of Family to Puerto Rican average
	1970	1970 (a)	1970	1969	1960	1970	Male 1970	Female 1970	1970
GUAYAMA	838	1.34	11.0	57.8	0.88	0.95	0.96	0.95	0.88
RIO GRANDE	754	1.01	4.8	67.7	0.89	0.92	0.85	0.88	0.84
VEGA BAJA	755	1.06	9.1	83.2	0.81	0.93	0.84	0.85	0.78
LAJAS	742	0.79	22.9	36.2	0.79	0.82	0.88	0.82	0.74

(a) This fertility rate represents the number of children ever born per 1,000 women 35-44 years old ever married.

SOURCE: U.S. Bureau of the Census, U.S. Census of Population: 1960 and 1970, Volumes, I and II, Part 53 Puerto Rico and

Puerto Rico, Census of Agriculture, 1969, U.S. Bureau of the Census.

income as well as the mean wage or salary income of families relative to the Puerto Rican average is lower than the national average. Finally, the median years of school completed is below or scarcely equal to the national average.

The situations of these areas are very unstable, in the sense that they must keep the rate of income growth relative to the most progressive parts of the country within an acceptable range, for any deceleration of that rate can encourage migration of the higher income earners and cause total and average income to decline. Should this happen, an exodus may follow and the region may revert to the preceding case, that of a low and declining region.

3) A third case that can be classified as a net donor is represented by regions of high but declining income. These areas have ceased to show any growth either in their rate of their income or in the rate of introduction or rejuvenation of their industries. The demand for labor is decelerating and industries are stagnant. Probably these regions have lost their locational advantages or alternatively their principal industries have experienced declining or stagnant prices relative to cost on the national or international market. An example of this situation might be a former agricultural region exporting an important crop, like sugar-cane or tobacco, which has enjoyed peak prices at one time.

In Puerto Rico, these regions can be represented by Mayaguez and Ponce which have high incomes relative to the national average but also have important traditional agricultural sectors in which a very low percentage of their income is derived from livestock.

Table III presents the principal features of these areas. Although their per capita income is higher than the national average, their median income and mean wage or salary income barely equal the total average. Unlike Metropolitan San Juan, these regions have no particular effect on the development and modernization of agriculture of surrounding "municipios" which except for Hormigueros are all of low income.

To the extent that people in these regions foresee no immediate improvement in the lagging economic situation, they may well decide to migrate to regions where the growth rate of income is accelerating. Since the educational and skill level of the people of these regions is likely to be higher than the average, people originating in these areas can be expected to be well informed on opportunities elsewhere. Their private cost of migration is likely to be low as well the social cost for the receiving region. However, if the migration rate is high and draws heavily on the better educated, younger and more skillfull persons, depopulation can ensue. As a result, the region can suffer heavily in term of the tax-base for public services such as schools, hospitals etc. Also, real estate will tend to lose its value as people leave. And finally, depopulation can affect local market-oriented firms which may cease production or move elsewhere. This last effect will create unemployment that can induce more people to move.

II) Net Potential Receiver Regions

A net receiver region is generally an urban area where income is high and growing, and employment opportunities are at their best. The rate of population increase has long since tapered off and educational

TABLE III

MUNICIPIOS	Per Capita Income of Persons	<u>Type of Relatively High Income Declining Regions</u>							
		Ratio of Fertility Rate to Puerto Rican average	% of Farm Employees in Farm	% of Farm Income made from Livestock	Ratio of Median Income to Puerto Rican average		Ratio of Median School years completed to Puerto Rican average		Ratio of Mean Wage or Salary Income of Family to Puerto Rican average
	1970	1970 (a)	1970	1969	1960	1970	Male 1970	Female 1970	1970
MAYAGUEZ	1007	0.83	3.9	13.9	0.98	0.91	1.05	1.00	0.94
PONCE	1011	1.05	3.4	11.2	1.08	1.00	1.08	1.12	1.08

(a) This fertility rate represents the number of children ever born per 1,000 women 35-44 years old ever married.

SOURCE: U.S. Bureau of the Census, U.S. Census of Population: 1960 and 1970, Volumes, I and II, Part 53 Puerto Rico and

Puerto Rico, Census of Agriculture, 1969, U.S. Bureau of the Census

facilities are excellent. The demand for labor cannot in general be met by local supply and industries are expanding.

The principal characteristics of these regions are summarized in Table IV. Their personal per capita income is the highest in the Island. The ratio of their fertility rate to the national average is below unity. They have few people employed in agriculture and derive a high proportion of their farm income from livestock. They are satellite "municipios" surrounding San Juan. Moreover, their median income as well as their mean wage or salary income is well above the national average. Finally mention must be made of their educational level which perhaps has drawn heavily on the educated of low or stagnant regions. We will have to show that in terms of gains in people, these regions are almost the only ones that have a positive in-migration. A purview, however, of their characteristics as net receiver can be had by noting that for most of them the ratio of native persons living there but born elsewhere to the persons born in the "municipios" as reported by the Census is quite high. For example; Carolina: 148.9; Guaynabo: 113.2; Toa Baja: 122.9, while for other regions this ratio revolves around 20% to 50% for the highest. All these regions have benefited greatly from the development of Metropolitan San Juan. Their agriculture has been modernized and they have shown a ratio of median income to Puerto Rican average consistently growing. San Juan, however, though maintaining its high income per capita of persons and mean salary relative to the rest, has shown decline in its ratio of median income to the Puerto Rican average from 1.84 to 1.39 in 1960 and 1970 respectively. Nevertheless we still consider San Juan a very important "pôle de

TABLE IV

Type of Relatively High Growing Regions

MUNICIPIOS	Per Capita Income of Persons	Ratio of Fertility Rate to Puerto Rican average	% of Farm Employees in Farm	% of Farm Income made from Livestock	Ratio of Median Income to Puerto Rican average		Ratio of Median School years completed to Puerto Rican average Male Female		Ratio of Mean Wage or Salary Income of Family to Puerto Rican average
	1970	1970 (a)	1970	1969	1960	1970	1970	1970	1970
CAGUAS	1,033	0.91	4.0	95.6	1.20	1.30	1.13	1.12	1.05
CAROLINA	1,472	0.73	9.0	94.3	1.56	1.91	1.53	1.65	1.33
GUAYNABO	1,803	0.86	1.7	93.1	1.46	1.69	1.48	1.48	1.66
SAN JUAN	1,593	0.79	0.7	92.1	1.84	1.39	1.36	1.40	1.37
TOA BAJA	1,098	0.96	2.3	83.0	0.89	0.98	1.20	1.31	1.54

(a) This fertility rate represents the number of children ever born per 1,000 women 35-44 years old ever married.

SOURCE: U.S. Bureau of the Census, U.S. Census of Population: 1960 and 1970, Volumes, I and II, Part 53 Puerto Rico and

Puerto Rico, Census of Agriculture, 1969, U.S. Bureau of the Census

croissance" and this decline may be due to an influx of low-income people perhaps coupled with an outflux of high-income persons who go to reside in Guaynabo or Toa Baja, but still work in San Juan.

The impact of in-migration into these regions depends upon the quality and speed with which the process takes place. Maddox estimates that "when in-migration from rural areas is slow and amounts to only a relatively small proportion of the existing urban population, its costs in the receiving areas are not of great importance. On the other hand, when it is rapid and relatively large, it is likely to have several undesirable results". If the inflow of migrants is made up of unskilled workers earning low wages, in the short run, average per capita income will decline. Moreover, pressure will be put on the existing housing facilities and public services and to the extent that the increased demand for such facilities is not matched by a corresponding supply, and there will be a development of the slums so characteristic of big cities. The demand for education will rise also, since most migrants are accompanied by their children. This will cause a diversion of resources and increase costs that cannot easily be internalized. Persons already residing in these areas, while enjoying a rise in the capital value of their assets will suffer in their use of public services that cannot be expanded as fast as population increases from migration.

The receiver region, however, will gain in terms of human capital acquired at no cost whatsoever, especially if most of the migrants consist of the best-educated. With an inflow of the latter, average income, even if it decreases, will not take much time to catch up with its former level and even to rise. Furthermore, there will be fewer

"side problems" having to do with existing facilities, such as deterioration of houses or the growth of antisocial behaviour.

The many aspects of social costs and returns are difficult to evaluate and at best impossible to foresee. Migration presents many effects that recommend it high to questions related to development. It remains then to look for ways and means such as education, information, and counseling, in order to ease mobility of persons and minimize the short-run problems of adjustment, all of which can ultimately reduce the social costs for the community.

Commenting on this aspect of the question and considering the farm problem in the United States, where job opportunities have been reduced as a result of technology, schooling, higher education, adult training and so on, Schultz^{38a} thinks that more economic information should be given to the potential migrants in order to reduce not only the private costs entailed by migration but also the social costs whose effects go beyond the "private calculus" of the migrant.

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CHAPTER III

Internal Migration, Puerto Rico's Model

Introduction

There is no denying that during the past three decades of Puerto Rico growth a clear and changing pattern of manpower utilization, from agrarian to industrial occupations, has taken place. This process is apparently a response to the degree of disequilibrium existing among regional labor markets. But, before presenting the details of such a pattern, the methods and restrictions used to arrive at the results presented below, mention will be made of the factors that are believed to be responsible of this internal population movement. It is here argued that there exists sociological and economic characteristics that pertain to the regions of origin and destination and that these differential characteristics form the basis on which the individual migrant makes his choice. Depending on his taste and preferences, these characteristics will be translated in terms of costs and benefits. To the extent that the benefits outweigh the costs, the probability of the individual to undertake the move will greatly increase. These regional characteristics are mainly:

- The differences in unemployment rates,
- The differences in income among region of origin and regions of possible destination.

Other particularities may affect a region's attractiveness and contribute to stimulate migration, such as:

- good educational housing and health facilities existing in the region relative to other regions

- the level of human fertility which by its effects on the supply of labor may contribute to depress local wages relative to wages in other places where the fertility rate is lower. Also, a high fertility rate may have adverse effects on existing regional facilities (benefits) and thereby contribute to decrease its "pull effect".

It will also be argued that there exists characteristics that belong to the individual decision maker proper which affect his decision, for example his

- Education
- Age and
- Sex

In the course of the analysis, Information will be considered as an important factor influencing the calculus of the potential migrant. Information whether available free or at a cost, can contribute to minimize the risk of moving from one place to another without knowing beforehand the facts. But in this respect the level of Education embodied in the individual seems to help greatly in the screening and interpretation of information. Likewise, education is presumed to enhance the person's capabilities of weighing and comparing carefully the true costs and benefits of choosing among regions.

Formally, we will assume a model of migration in which the "migration rate" to be defined later is a function of the following variables:

$$\frac{M}{P} : f (I, U, O, E)$$

where, $\frac{M}{P}$: the regional migration rate

I : Differences in income among "municipios"

U : Differences in unemployment rates among "municipios"

O : A set of differences in regional opportunities, such as
such as health, educational and housing facilities

E : The educational level of the individual

These factors will be discussed in turn along with their impact on the individual's decision to migrate.

Education of the individual

For a person, acquiring education may serve two ends: as a consumption and as an investment good.

As a consumption good, it may provide him services and satisfaction enjoyable over his life time. It contributes in developing his knowledge and understanding of the physical and human environment in which he lives. In this respect, education is presumed to bring to him a certain level of flexibility and tolerance to enhance his cultural background and to make him more apt to live in harmony with his fellow men and the world around him. Although, the utility derived from education as a consumption commodity is not readily measurable, most people are prepared to pay a positive price to have it. Furthermore, education has the characteristics of a superior good. As income rises, the demand for its services increases more than proportionately, and following a general rise in income, the demand for education can be

expected to increase among the young as well as the old.

The second goal served by education, perhaps the most important for economic development is its investment aspect. In this sense, it enables the individual to acquire knowledge and skills in order to raise his productivity and his future stream of earnings. In addition to this, education may provide the individual more potential to make better use of actual possibilities, innovate, conceive and produce goods and services that people need most. The investment purpose of education is clearly not conceivable in a traditional stagnant society but rather in a dynamic setting where technology is changing. In this respect Welch¹ notes that "The incentive for acquiring a college education is based on dynamical considerations of changing technology; and if technology becomes stagnant, this incentive is reduced and may disappear." Indeed, the addition to income that a person can expect from additional investment in education is a direct function of the rate at which technical advances take place in the economy.

Given that an individual has invested in a certain level of education (formal schooling, adult training, or college education), abstracting for the moment from his age and sex and assuming a progressive and dynamic society, how can the amount of education acquired affect his probability of moving relative to those who have not undertaken such investment? Education may affect this probability in at least three different ways:

- 1) By giving the individual a better chance of finding employment or improving "his employability" over those who have less education.

2) By giving him a better chance to have a higher money income over those who have less education.

3) By improving his ability to have access to sources of information and analyze them as compared with those who have less education. Information helps in reducing the risks inherent to any process of decision taking. It can be had only at a cost and the higher the level of education, the lower will be its probable cost.

1) Effect of Education on the "Employability of the Individual"

The first point refers to the effect of education on the "employability of the person". In any modern society the tendency is to recruit persons with more skills rather than those with less. As well, by the very nature of a progressive society in which technology is continuously changing, it ensues that the composition of jobs is likewise varying to include jobs requiring higher education and skills. Thus, workers with a firm and good education base are better equipped to receive training commensurate with new occupations and to be shifted to other places.

That education plays a determinant role in the "employability" of persons in which it is embodied can be gauged by the following Table 1. As the table shows, in 1970, 1971 and 1972, the rate of unemployment among college graduates, i.e. those who have at least thirteen (13) years of schooling completed, was the lowest, not exceeding 4.0%. It was around 9-12% for high school graduates. Among those who have not received a high school diploma the unemployment rate was, with some rare exceptions, consistently higher than the national rate. The higher the

Table I.- Unemployment Rate by Educational Level

Level of Education	1970		1971		1972
	January	December	January	March	March
Total	11.9	11.7	13.2	10.8	10.8
None	10.3	15.9	17.2	9.4	10.7
1 - 3	12.5	14.6	14.8	11.4	11.1
4 - 6	13.8	13.7	16.4	13.8	14.8
7 - 9	16.2	15.4	18.7	14.2	16.7
10 - 11	17.1	14.5	17.0	17.4	15.2
12 (High School)	11.1	9.5	10.3	9.1	11.7
13 and over	2.7	3.2	3.3	3.2	3.8

Source: Employment and Unemployment in Puerto Rico, January 1971 and March 1972, Bureau of Labor Statistics, Department of Labor, Commonwealth of Puerto Rico, Table 10, p. 15

level of education, the lower the risk of unemployment.

More evidence on this score can be obtained by looking at the occupational distribution of unemployed workers. Table II shows that blue collar along with other unskilled workers accounted for more than 65% of all unemployed workers in 1950, more than 80% in 1960 and more than 70% in 1970. Since white collars are more likely to have more education than the rest of all employed persons, it can be inferred that a higher level of schooling leads to a higher probability of employment. The percentage reported here would have been higher were those in the category "occupation not reported" assumed to have held unskilled jobs.

Table II.- Occupational Distribution of the Unemployed Experienced Workers. - 1950, 1960, 1970

	1950		1960		1970	
		%		%		%
Total Unemployment	26,421	100	29,472	100	29,297	100
Professional, Technical and Kindred Workers	432	1.6	638	2.2	789	2.7
Other White Collar (Managers, Sales, Clerical and Kindred Workers)	2,423	9.2	3,666	12.4	3,714	12.7
Blue Collars (Craftsmen Operatives, Transport, Laborers except farms)	11,804	44.7	17,727	60.1	16,132	55.1
Farm	4,014	15.2	2,808	9.5	2,009	6.8
Services	2,068	7.8	3,433	11.6	3,015	10.3
Occupation not reported	5,680	21.5	1,2-0	4.2	3,638	12.4

Source: U.S. Bureau of the Census, Census of Population: 1950, Table 66, 1960, Table 121, 1970, Table 136, Volume I, Characteristics of the Population, Part 53, Puerto Rico, Detailed Characteristics

As the economy grows, the composition of jobs is changing in favor of higher paying professional occupations requiring more training and education. Table III displays the important changes experienced by the Puerto Rican economy. In 1950, the economy was dominated by low-skilled jobs, particularly operatives and farming. Craftsmen, foremen, professional and technical workers were marginal. Since 1960 the reverse has been true. In 1970, more than one third of all employees were white collar, while it was only one fourth in 1950. The proportion of craftsmen and foremen has almost doubled between

Table III.- Changes in the Occupational Composition of Employed Workers.- 1950, 1960, 1970

	1950		1960		1970	
		%		%		%
Total	560,156	100	551,656	100	638,342	100
Professional and Technical	27,183	4.8	42,707	7.7	70,765	11.0
Other White Collar (Managers, Sales, Clerical)	90,260	16.1	118,114	21.4	159,599	25.0
Craftsmen, Foremen and Kindred Workers	41,759	7.4	62,657	11.3	88,654	13.9
Operatives and Transport Laborers, except farm workers	123,923	22.2	130,630	23.7	153,750	24.2
Farmers (Laborers, Foremen and Managers)	209,454	37.4	127,715	23.2	44,262	6.9
All Other Employment	67,577	12.1	69,833	12.7	121,312	19.0

Source: (Same as in Table II)

1950 and 1970, whereas farming employees have declined drastically. The last two features undoubtedly reflect the modernization and mechanization in such sectors like agriculture, construction and transport.

In term of percentage changes, while the total number of jobs has increased from 1950 to 1970 by only 14%, the number of professional and technical positions has increased by 160% from 27,183 to 70,765, other white collar positions by 77% for the same period, from 90,260 to 159,999, craftsmen and foremen by 112%, and transport, operatives,

farming and other jobs have decreased by 25%.

- Incentives to Invest in Education

Incentives for people to invest in education is conditioned to a great extent by availability of educational opportunities, i.e. its supply. If those who demand for the services of education had to pay the full and entire cost of the educational system, inducement to undertake such investment, even under condition of technological advances would be nil. The principal buyers of education, the children and their parents do not have generally enough savings in order to bear these expenses and more so at an early stage of development. Therefore, public expenditures on formal schooling, adult training, higher education and research must be high on the agenda of any government in order to respond to the need of skilled and educated persons as development proceeds.

- Public Expenditures on Education in Puerto Rico

For a society like Puerto Rico which has changed in so short a time from agrarian to industrial this need for qualified workers was and still is very acute to say the least. The Commonwealth Government has realized this and has devoted the largest part of its budget to education. From 1962 to 1971 Puerto Rico allocated about one third of its budget to education surpassing manyfold the funds allocated to health and public welfare, and agriculture and industrial development, as presented in Table IV.

The importance accorded to education in Puerto Rico can

Table IV.- Current Expenditures by some Selected Functions and as Percentage of the Commonwealth Budget (Million dollars): Fiscal Years.

Years	Public Education		Health and Public Welfare		Agricultural and Industrial Development	
	Total	%	Total	%	Total	%
1962	110.2	34	49.1	15	12.9	4
1964	139.3	32	62.4	14	18.0	4
1965	154.1	32	69.5	14	20.0	4
1967	226.3	35	102.2	16	21.7	3
1969	275.0	34	121.9	15	30.9	4
1970	322.1	33	153.0	16	39.9	4
1971	372.8	32	181.4	16	52.7	4

Source: Puerto Rico: Junta de Planificacion, Informe Economico al Gobernador, 1971, Tables A-23

perhaps best appreciated by comparing expenditures on education in the United States and on the Island. The United States Government allocated in 1965, 6.5% of its Gross National product, while in Puerto Rico it was 5.6%. Puerto Rico in 1970 has almost reached the same proportion as the U.S. (Table V), and from that year on, the proportion of the GNP devoted to education in Puerto Rico has been continuously increasing. In 1970, Puerto Rico had almost reached the U.S. proportion as shown by Table V. It can be noted however that Puerto Rico can afford to spend such a large part of its G.N.P. on education because it has no army and no defense expenditures as is the case of other underdeveloped nations. Expenditures for armed forces and defense in Puerto Rico are covered by the mainland United States.

Table V.- Expenditures on Education as a % of Gross National Product, 1965 though 1971.

Year	% of G.N.P.	
	U.S.A. ²	Puerto Rico ¹
1965	6.5	5.6
1966	NA	5.9
1967	NA	6.7
1968	NA	6.5
1969	7.2	6.7
1970	7.5	7.0
1971	8.0	7.2

Source: (1) Puerto Rico, Junta de Planificacion, Informe Economico al Gobernador Tables A-1 and A-23
 (2) Statistical Abstract of United States, 1971 and 1973, Bureau of the Census, Table no 160, p. 107

These efforts in term of large and growing expenditures allocated to education have been accompanied by the population's response to more education in ever increasing numbers. The educational attainment of the population testifies eloquently to this trend. As is depicted in Table VI (A & B), more qualified and educated persons characterize the population, over time, both males and females in both urban and rural areas. While the number of illiterates (those who have no school years completed) has drastically decreased among persons 25 years and over, that with high school and college education has shown the same trend in the opposite direction.

One final point should be noted with respect to the response of the population to the need for better education in order to be qualified for employment. Since 1950 the ratio of high school and

Table VI.- A - Educational Attainment of the population
Persons 25 years and over by Sex: Total, Urban and Rural

MALES

	1950			1960			1970		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Total Males 25 years and over	425,891	181,417	244,474	451,652	213,688	237,964	546,253	347,788	228,465
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
No school years completed	120,340	33,469	86,871	88,816	26,820	61,996	70,746	28,482	42,264
	28.3	18.4	35.5	19.7	12.6	26.1	12.3	8.2	18.5
Up to 8 years (Elementary)	246,834	105,964	140,780	247,964	104,664	143,300	271,922	137,341	134,581
	57.9	58.4	57.6	54.9	48.9	60.2	47.2	39.5	58.9
1 to 4 years (High School)	42,082	28,389	13,688	75,220	50,144	25,076	159,194	116,217	42,977
	9.9	15.6	5.6	16.6	23.4	10.5	27.6	33.4	18.8
1 to 4 years or more (College)	15,405	12,873	2,532	37,456	30,664	6,792	44,391	65,748	8,748
	3.6	7.1	1.0	8.3	14.3	2.8	12.9	13.9	3.8

Source: U.S. Bureau of the Census, U.S. Census of Population: 1960 and 1970, Volumes, I and II, Part 53 Puerto Rico

Table VI. - B - Educational Attainment of the Population
Persons 25 years and over by Sex: Total, Urban and Rural

FEMALES

	1950			1960			1970		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Total Females 25 years and over	416,375	200,696	215,679	473,352	244,112	229,240	620,503	396,503	223,936
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
No School years completed	160,345	59,418	100,927	124,420	47,764	76,656	101,907	47,080	54,827
	38.5	29.6	46.8	26.3	19.6	33.4	16.4	11.9	24.5
Up to 8 years (Elementary)	213,997	107,096	106,901	254,508	121,616	132,892	297,675	168,688	128,987
	51.4	53.3	49.5	53.8	49.8	58.0	48.0	42.5	57.6
1 to 4 years (High School)	27,757	22,391	5,366	60,492	46,432	14,060	150,814	118,444	32,370
	6.7	11.2	2.5	12.8	19.0	6.1	24.3	29.9	14.4
1 to 4 years or more (College)	13,198	11,119	2,079	31,888	27,112	4,776	70,043	62,291	7,752
	3.2	5.5	0.9	6.7	11.1	2.1	11.3	15.7	3.5

Source: U.S. Bureau of the Census, U.S. Census of Population: 1960 and 1970, Volumes I and II, Part 53 Puerto Rico

college graduates to employed workers has not ceased to increase as shown by Table VII.

Table VII.- High School and College Graduates (25 years and over)
in relation to the Number of Employees

	1950	1960	1970
High School and College Graduate	98,442	205,056	454,442
Working Persons	560,156	551,656	638,342
Ratio	0.18	0.37	0.71

2) Effect of Education on the Earnings of the Individual

The second effect of education on the individual manifests itself in the higher earnings that he is likely to gain during his life time over those who are less educated. Becker referring to the influence of education on earnings of persons has pointed out that "Probably the most impressive piece of evidence is that more highly educated and skilled persons always tend to earn more than others".² Schwartz studying the determinants of migration in the U.S. contends that migration is better explained by differentials in life-time earnings than differentials in current earnings and the least educated persons have a lower response to differentials in life-time earnings than do the higher educated. Finally, Schwartz underlines that life time earnings increase monotonically with education.³

As can be seen from Table VIII, as education increases, the income streams of employed persons grow. Another important feature of

Table VIII. - Mean Income of Full-Time Employed Male by Age and Education Puerto Rico, 1970 (Dollar per Year)

Years of School Completed	18-24	25-34	35-44	45-54	55-64
<u>Elementary</u>					
Less than 5 years	1,391	1,859	1,970	1,938	1,595
5-7 Years	1,755	2,327	2,514	2,543	2,280
8 Years	2,054	2,740	3,212	3,480	3,375
<u>High School</u>					
1-3	2,015	2,986	3,452	3,740	3,738
4	2,556	4,085	4,763	5,299	5,422
<u>College</u>					
1-3	2,667	5,557	6,455	7,423	7,255
4	4,137	7,537	9,248	9,924	10,023
5 or more	4,355	9,590	11,661	13,239	12,495

education on the earnings potential of the individual is that the highest level of earnings is reached at an earlier age the lower the education. For example up to the 7th grade the top is attained at age 35-44, it slides to 45-54 for high school, while for college, except college 5 years or more, the increase in earnings continues until retirement or age 64.

- Education, Income and the Probability of Migrating

In order to have an idea of how education could affect the probability of moving, we present in Table IX, the mean incomes of full time employed males by age and education for both urban and rural areas. The expected earnings at all level of education and age show

Table IX.- Mean Income of Full-time Employed Males by Age and Education,
1970, Puerto Rico, Urban and Rural (\$ per year)

Level of School completed	18-24	25-34	35-44	45-54	55-64
<u>Elementary</u>					
<u>Less than 5 years</u>					
Urban	1,579	2,222	2,403	2,398	1,993
Rural	1,183	1,144	1,506	1,520	1,229
<u>5-7 years</u>					
Urban	2,011	2,670	2,901	3,020	2,656
Rural	1,408	1,876	1,859	1,759	1,759
<u>8 years</u>					
Urban	2,281	3,045	3,628	3,883	3,655
Rural	1,438	2,060	2,158	2,417	2,788
<u>High School</u>					
<u>1-3 years</u>					
Urban	2,141	3,278	3,766	4,178	4,084
Rural	1,578	2,250	2,520	2,518	3,275
<u>4 years</u>					
Urban	2,711	4,378	5,148	5,686	5,647
Rural	2,125	3,126	3,076	3,716	5,076
<u>College</u>					
<u>1-3 years</u>					
Urban	2,696	5,881	6,749	7,672	7,772
Rural	2,143	3,874	4,888	5,287	...
<u>4 years</u>					
Urban	4,333	7,815	9,668	10,233	10,324
Rural	...	4,923	5,732	...	...
<u>5 years or more</u>					
Urban	4,210	9,894	11,998	13,417	12,724
Rural	...	5,556	7,999	...	...

Source: U.S. Bureau of the Census, U.S. Census of the Population: 1960 and 1970, Volumes I and II, Part 53, Puerto Rico

sizeable differences between urban and rural. Specifically, if we consider a young rural high school graduate male aged 18 years who is about to enter the labor market, and assuming that the overall growth of the Puerto Rican economy will continue, the differentials in earnings over his life-time between rural and urban areas seem substantial enough to induce him to migrate to an urban place. The mean income differentials between the two places are presented in Table X.

Table X.- Mean Income Differentials (\$) between Rural and Urban Males who completed High School, 1970

	Age Group				
	18-24	25-34	35-44	45-54	55-64
High School (\$)	586	1,247	2,072	1,970	571

If we suppose that the individual can work until retirement at age 65, he will have 47 years of working life. Discounting these extra earnings to the present and assuming an interest rate equal to 10%, amounts to

$$\frac{586}{(1.10)^n} + \frac{1,247}{(1.10)^n} + \frac{2,072}{(1.10)^n} + \frac{1,970}{(1.10)^n} + \frac{571}{(1.10)^n} = 10,071.2$$

Of course, there is the cost of migration which varies according to the individual, his personal appreciation of life in an urban setting, his psychic costs and the risk of unemployment. But, except for these inhibitions, the other monetary costs of migration for a young person who has no family ties are small compared to the present value of these expected returns.

3) Education and Information

Finally we have mentioned a third effect of education on the probability of migration: its influence on the search of information. The search of information about the labor market, wages offered, working conditions and perhaps fringe benefits is one of the obvious steps anyone must take before deciding on any change in occupation with or without a geographical move. Knowledge of the labor market becomes primordial. By improving his ability to have access to and analyze information in these areas, the individual is better equipped to reach a decision as to whether to migrate.

It is true that in many underdeveloped countries, migration sometimes takes place quite randomly without any precise purpose or knowledge of the prevailing labor market situation. But these cases can be classified as "desperate cases" where the person has no alternatives at all other than moving. Becoming landless or too poor to even subsist from the land he or his family used to till, he has no other choice than to emigrate and take a chance in the nearest city. Other cases are found among the risk takers who like adventures and do not hesitate to try their luck, even though they are conscious that they are acting blindly.

For most people, however, some information is necessary before any decision can be taken concerning migration. For them any move has a cost attached to it. The cost is not simply the monetary outlay and expense of the travel and the time lost, but also the psychological cost of departing from their native place, the loss of family and community ties, and the idea of having to readapt themselves to a new environment.

Here again, education comes into play in the sense that, it is likely to permit the individual to make a more rational choice of his sources of information, thereby avoiding a wasteful loss of time.

Puerto Rico's people with respect to receiving information have enjoyed great advantages. As Professors Reynolds and Gregory⁴ put it, "From the outset of the industrialization program, the Commonwealth government worked to publicize the advantages of factory employment and its importance to the island's development. As factory employment grew, an increasing proportion of the population had friends or relatives working in a factory and could get word-of-mouth information. So most people already knew something about manufacturing before considering a factory job for themselves; and what they knew was generally favorable." This is not to say that complete and perfect information about the market was always available at any time. However, the Latin cultural traditions existing in Puerto Rico which establish friend and family ties on a rather basic level help most of the time to minimize to a high degree the cost and the risk involved in moving. These ties usually go beyond simple information; they are translated into concrete facts, such as helping the friend or family looking for a job or sharing food and quarters until he can get settled.

However, the settling time may reveal itself longer when the costs of search are reduced due to help from friends or parents. Indeed by sharing risks of unemployment and by sharing income, the time devoted to search for information by any member of a family unit may be longer than would be necessary by a person constrained by his own resources. To the extent that many individuals enjoy such low opportunity costs

of search, urban unemployment rate is likely to be higher than it would normally be if costs of information had fallen uniquely on the individual concerned. This is perhaps a typical case where individual benefits derived from their isolated actions enter in conflict with social benefits or welfare.

Wage Differentials Between Urban and Rural Regions as a factor of Migration

The second hypothesis refers to the wage differentials between rural and urban occupations. This is a common and familiar fact which is not only true for Puerto Rico but also for other developing countries as well. One of the most important reasons generally advanced to explain differentials is that the cost of living in cities is relatively higher than that in the country. Thus, in order to attract workers to newly established manufacturing facilities in the cities, wages higher than the average encountered in agriculture must be offered. Furthermore, as development progresses, new and scarce skills required to operate efficiently modern capital - intensive oriented industries are not readily available and in order to induce people to invest in these skills, substantial increases in wages must be forthcoming.

If the supply of employed and underemployed in the cities has already vanished, the only remaining source of labor is the agricultural sector. Thus, to secure the necessary number of workers, wages must be increased to levels higher than those actually paid in farms for otherwise the needed workers would not be available. In this case any increase in the prevailing wage level will widen the gap already existing between

rural and the urban areas. Meanwhile as industrial incomes rise the demand for food from the industrial sector increases and in the case of a closed economy even if food production does not decrease. With less labor, use of more efficient methods might keep production unchanged. Food prices will tend to go up since agricultural supply, at least in the short run, is unelastic. The term of trade will turn in favor of farmers and real wages of industrial workers will decrease, thus forcing industry to increase wages anew in order to draw more workers from agriculture. On the other hand, if the economy is opened to external trade, and food can be imported when demand increases and local food prices are rising, the terms of trade will be reversed in favor of industry, since food imports will tend to check the gap between urban and rural wages will remain as before.

- Impact of Unions on Urban Wages

In addition to these general economic causes, wages in industry may tend to pull further away from farm wages because labor prices in industry tend to be influenced by bargaining pressures from organized unions instead of open market forces. Because unions are usually better organized and stronger in industry located in cities than in farm, wages increases granted through this channel are more prevalent in industry. Associated to this is the fact that even when unemployment is high, entrance to industries is not always easy because of artificial barriers imposed by unions, so that the supply of labor that would respond to demand and help level off industrial wages relative to farm is discouraged and thwarted. Finally, wage increases in industry can be obtained through governmental actions usually based on political

Table XI.- Median Weekly Earnings of Male and Salary Laborers (Except Farm) and Farm Laborers and Foremen, Puerto Rico (a)

Year	Laborers (Except Farm) \$	Farm Laborers and Foremen \$	Ratio of farm Laborers and Foremen over Laborers
1954	13.40	8.70	0.65
1955	15.60	8.70	0.55
1956	17.60	10.10	0.57
1957	19.60	10.90	0.56
1958	20.60	11.10	0.54
1959	22.00	11.40	0.52
1960	25.50	11.00	0.43
1961	25.30	12.40	0.49
1962	29.40	12.10	0.41
----	-----	-----	----
----	-----	-----	----
1970 (January)	50.70	25.30	0.50
1970 (October)	51.80	22.60	0.44
1971 (January)	52.70	26.80	0.51

(a) Source: From 1954 to 1962 data are taken from Lloyd Reynolds and Peter Gregory, op. cited p. 65, Table 2-8

From 1970 to 1971, data are taken from "Employment and Unemployment in Puerto Rico, January 1971", Monthly Report Number 71-1 Table 18, p. 25, Bureau of Labor Statistics, The Commonwealth of Puerto Rico

rather than economic reasoning. The picture just described showing the way the gap between farm and industrial wages emerges and persists is found in the Puerto Rican situation. According to Professor Reynolds⁵, "As far back as the early fifties, male agricultural workers in Puerto Rico earned only half as much as men employed in transportation, communication and public utilities." In comparison with wages earned by

other non-farm workers, wages in agriculture were only half as great as shown by the accompanying Table XI.

- Real Puerto Rican Wages are Higher in Urban than in Rural Areas

And Professor Reynolds⁵ concludes, "even allowing for urban living cost, the wage was more than adequate to encourage movement out of agriculture as better alternative opportunities appeared". We do not have a detailed real cost of living measure for urban and rural regions of Puerto Rico, but we do have a consumer price index for wage earners' families in Puerto Rico by areas in 1971. When these indices as shown in Table XII are used to deflate the median weekly earnings of farm and non-farm laborers, the differentials are even more likely to induce people to move from rural to urban areas. Thus, based on Table XII and taking the West Central Area as representative of the rural index for which prices were collected in Utuado, a central mountainous coffee region which practically may be taken as a rural place, and the Coastal Area as representative of the urban index, incidentally an index higher than that of the Metropolitan Area, and weighing the median weekly earnings of farms and non-farm laborers by these indexes respectively, we have the results summarized in Table XIII. Thus taking into consideration, albeit roughly, the urban cost of living relative to the rural, the ratio of earnings of farm laborers to non-farm laborers is even higher than the unweighted ratio.

Reasons for Urban and Rural Wage Differentials

Furthermore with a declining agricultural labor force of about

Table XII.- Consumer Price Index for Wage Earners' Families in Puerto Rico by Areas 1)

Areas	Indexes (1957 - 59 : 100)	
	1970 (January)	1971 (January)
Puerto Rico	136.0	141.8
Metropolitan Area 2)	135.2	140.6
Coastal Area 3)	137.7	143.8
West Central Area 4)	125.4	131.6
East Central Area 5)	134.6	140.0

1) Area indexes do not measure differences in price levels between areas. Comparison of area indexes shows only that prices in one area have changed relatively more or less than in other area, since the base period.

2) Prices are collected in San Juan.

3) Prices are collected in Arecibo, Mayaguez and Ponce.

4) Prices are collected in Utuado

5) Price- are collected in Caguas

Source: Consumer Price Index for Wage Earners' Families in Puerto Rico, January 1971, Department of Labor - Cost of Living Division, The Commonwealth of Puerto Rico

69% from 1950 to 1972, a concomitant decline of about 67% in the number of persons engaged in agriculture during the same period, and a corresponding continuing increase in the non-farm labor force as well as persons engaged in non-farm activities, one would normally expect an improvement in the ratio of wages between agriculture and non-agricultural sectors of the Puerto Rican economy. Instead, farm wages continued to be barely as high as half of those of the lower-paid sectors of the economy.

- Underemployment in Agriculture

The lower levels of returns in Puerto Rican agriculture relative

**Table XIII. - Real Median Weekly Earnings of Male Salary Laborers
(Except Farm) and Farm Laborers and Foremen, Puerto Rico**

Year	Laborers (Except Farm) (weighted by Coastal Area Index)	Farm Laborers and Foremen (weighted by West Central Area Index)	Ratio of farm Laborers over non-farm Laborers
	\$	\$	
1970 (January)	36.82	20.18	0.55
1971 (January)	36.65	20.36	0.56

Source: Computed from Table XI and XII

to the non-farm sector and their persistencesince 1950, despite substantial effort to improve farming techniques and production, can be attributed in the first place to the existence of high underemployment of labor in farming. Table XIV shows the extent of this phenomenon. As can be seen, from 1950 to March 1972, underemployment or people working fewer than 35 hours a week has never been less than 38% of the employed. The supply elasticity of farm labor is not high enough to permit a more substantial transfer of persons engaged in agriculture to the industrial sector. Perhaps the reticence of enough labor to shift to the non-farm sector may be due to lack of information about job openings, lack of funds to cover the cost of transfer or preferences for farm activities. This last feature seems to be very important, for when one considers the average age of farm operators in 1969, it was 56.3 years and 80.2% of all operators were aged 45 years or more,⁶ it becomes evident that these people will not invest in migration, since they are too old to start a new way of life and have time to reap the benefits from their investment.

Table XIV.- Agriculture Employment According to Number of Hours Worked. (Thousand of Workers) Puerto Rico

Years	Total Employed	Working 35 hours or more	Working Less than 35 hours	With Employment but not at work
1950/51	203	88	107	8
1954/55	164	67	87	9
1958/59	137	68	63	6
1963/64	137	76	54	7
1968/69	85	49	33	3
1969/70	74	43	28	3
1970	72	39	29	4
1971	63	32	28	3
March 1972	66	30	32	4

Source: Puerto Rico Department Of Labor, Bureau of Labor Statistics (Various Issues)

- Higher Rural Fertility

That the decrease in farm workers has not been enough to lift returns in farming activities to levels comparable to the non-farm sector can be gauged by comparing the decline in agriculture relative employment to its decline in relative income share. From Table XV, it is clear that there is a greater drop in income than in employment. Thus, labor in agriculture should receive earnings lower than in other sectors.

But why is underemployment still prevailing in Puerto Rican agriculture, despite the substantial outflow of workers from farms to cities? (The labor force declined 69% from 1950 to 1972, see Table XVI). The answer to this question must be found in the presisting high level

Table XV- Agriculture Employment and Net Income as a % of Total Employment and Income

Year	Employment			Net Income		
	Total	Agriculture	%	Total	Agriculture	%
1940	512	229	44.7	225	70	31.1
1950	596	214	35.9	614	149	24.2
1960	543	124	22.8	1353	180	13.3
1965	657	119	18.1	2317	190	8.2
1966	677	105	15.5	2550	185	7.2
1967	684	93	13.5	2799	186	6.6
1968	701	91	12.9	3103	185	5.9
1969	722	84	11.6	3442	173	5.0
1970	738	74	10.0	3848	184	4.7
1971	755	65	8.6	4296	196	4.5

Source: Informe al Gobernador 1971, Tables 8 and Table 26 pp A-8 and A-26

of human fertility in the rural areas compared to the urban areas.

The pattern of human fertility encountered in urban and rural places of Puerto Rico by age is shown in Table XVII. This table discloses an increase in fertility for women aged 15-24 and 25-34 in both rural and urban areas, but this trend is reversed markedly in the following decade 1960-1970. As for women aged 35-44, the decline began earlier, i.e. as of 1950. Despite this decreasing trend, the differential in fertility between urban and rural areas continues to be substantial during the three decades and still remains quite high in 1970.

Table XVI.- Labor Force, Employment in Agriculture and Non-Agriculture Sectors (Thousand of Workers) Puerto Rico. Selected Years

Years	Non Agricultural Sector		Agricultural Sector	
	Labor Force	Total Employed ¹	Labor Force	Total Employed
1950/51	451	380	235	203
58/59	474	409	163	137
59/60	475	417	150	125
60/61	486	430	153	134
64/65	629	564	143	124
65/66	678	571	129	112
66/67	670	589	113	95
67/68	698	609	104	88
1970	759	676	84	72
1971	800	706	74	63
March 72	822	722	73	66
% change				
1950/51				
1972	72%	90%	- 69%	- 67%

1) Data in this column are for calendar years

Source: Puerto Rico Department of Labor, Bureau of Labor Statistics
(Various Issues)

- Why Higher Rural Fertility

The reasons for such differentials can be understood in terms of costs and benefits derived from having children in the two areas. According to Leibenstein⁷, three principal objectives are considered in the production of children. Children can be viewed as,

- a) a consumption good
- b) a capital or productive agent
- c) a means of securing future security

Table XVII. Puerto Rican Human Fertility Characteristics Children Ever Born per 1,000 Women Ever Married, Urban and Rural

Age of women	1950		1960		1970	
	Urban	Rural	Urban	Rural	Urban	Rural
15-24	1,566	1,925	1,707	2,021	1,343	1,643
25 to 34	2,917	4,275	3,012	4,318	2,651	3,874
35 to 44	4,139	6,454	4,016	6,454	3,493	5,730

Source: U.S. Bureau of the Census. - U.S. Census of the Population: 1960 and 1970, Vol. I, Characteristics of the Population, Table 46 (1950, 1960 and 1970)

From this point of view, it can be presumed that urban families derive more benefits from children as a consumption good than do farm families. On the other hand, farm families produce children more as a potential productive agent and as source of security than urban families. Indeed, the returns expected from children in cities by their parents are inferior to that expected by farm parents from their progenies, because, they (the children) "are in general less valuable at early ages, and moreover, the moves in the city are such that they are likely to cease contributing the returns from their productive use to the family at an earlier age."⁸

As a source of future security, rural families enjoy a relative advantage over urban ones, because they are less subject to the influences of urbanization and industrialization which tend to destroy family ties in cities and predispose children to neglect their parents in need.

Table XVIII.- Ratio of Children (less than 5 years of age) to Women
in Childbearing ages (15-49 years old)

	1950		1960		1970 (1)	
	Urban	Rural	Urban	Rural	Urban	Rural
1. Children under 5 years	132,860	233,562	70,840	108,904	171,266	146,839
2. Women (15-49)	444,329	558,652	262,360	274,696	407,209	252,990
Ratio of 1 over 2	29.9	41.8	27.0	39.6	38.1	58.0
% Differences between urban and rural ratios	39.8		47.0		38.1	

(1) For 1970, the figures for rural are computed by adding rural farm and rural non-farm, in order to insure comparability with 1950 and 1960

Source: U.S. Bureau of the Census, Census of the Population: 1950, 1960, 1970, Volume I, Characteristics of the Population, Part 53, Puerto Rico, Tables 12 (1950), 23 (1960), 46 (1970) respectively

In terms of costs, rural families enjoy again some advantages of having children compared to urban ones. Generally direct costs of housing, education and food, are higher in urban than in rural places. Furthermore the indirect cost, consisting mainly of forgone earnings, is higher in cities than in rural areas.

Impacts of Human Fertility of the Population

- Impact on Age

The first impact of the differential fertility is on the age

distribution of the rural and urban population. Table XVIII shows the ratio of young children (less than 5 years of age) to women in childbearing of young ages (15-49 years old) during the years 1950, 1960, 1970. This ratio is consistently higher in rural than in urban areas or more precisely about 40% in 1950, 47% in 1960 and 38% in 1970. This is in accord with the principle that high fertility creates a younger population and a low fertility an older one. This phenomenon cannot go without its consequences on the number of dependents for parents, and particularly on the number of productive workers in the labor force: young people are more consumers than producers. Indeed the higher number of children encountered in rural compared to urban areas helps to a certain extent in understanding the lower rate of participation of the female rural labor force relative to the urban, as depicted in Table XIX.

Table XIX.- Labor Force Participation Rate of Women for Selected Age Groups. Puerto Rico, 1950, 1960, 1970, Urban and Rural

Age	1950		1960		1970	
	Urban	Rural	Urban	Rural	Urban	Rural
Women 25-34	32.6	19.7	38.6	19.8	40.5	24.0
Women 35-44	32.7	17.8	33.7	16.4	38.5	15.8

Source: U.S. Bureau of the Census, op. cited Table XVIII

- Impact on Labor Supply

The second effect of high rural fertility which follows immediately from the first just mentioned is its impact on labor supply. The increase of the labor supply contributes to overcrowding the land,

Table XX.- Demographic Characteristics in the Coffee-producing Municipalities of Puerto Rico, 1960-1970

Municipios	Population	Births	Deaths	Natural Increase
	% change ¹	Number	Number	Number
Adjuntas	- 4.9	6,635	1,347	5,288
Ciales	- 13.9	5,485	1,032	4,453
Jayuya	- 7.1	5,659	1,118	4,541
Lares	- 6.2	8,783	1,939	6,844
Las Marias	- 15.1	2,306	516	1,790
Maricao	- 14.3	1,917	453	1,464
Orocovis	- 0.8	8,022	1,256	6,766
Utuado	- 12.2	11,822	2,823	8,999

1) U.S. Bureau of the Census, op. cited, Table 8, Table 14, 1970

Source: "Natural Increase and Net Migration of Coffee Region Populations in Puerto Rico, 1960-70, by R. Calero, M.I. Hernandez, L. Muler and G. Serra, The Journal of Agriculture of the University of P.R., Vol. LV, No. 4, October 1971

and if technology remains unchanged, the wage rate will be depressed and migration into urban areas will ensue.

That high fertility, because of pressures on existing natural resources when technology remains unchanged, depresses the wage rate and incomes, and leads to migration, can be established by considering a sample of eight mountainous municipios producing mainly a traditional crop: coffee whose technology has not changed markedly while industrialization takes place elsewhere in the rest of the island. These regions are characterized by a relative high fertility ratio, a birth rate superior to the death rate, and consequently a substantial natural increase in their population as shown by Table XX. Yet these regions

Table XXI.- Economic Characteristics of Coffee-Producing Municipios and Some Developed, Dynamic Municipios, Puerto Rico

Municipios	Population change 1960-70 %	Per Capita Income (\$) 1970	% of Males engaged in Agriculture	% of Farm Income derived from Livestock
Adjuntas	- 4.9	505	33	24
Ciales	- 13.9	569	7.8	44
Jayuya	- 7.1	417	30	31
Lares	- 6.2	476	45	3
Las Marias	- 15.1	412	48	8
Maricao	- 14.3	402	55	6
Orocovis	- 0.8	363	37	16
Utuaado	- 12.2	416	35	18.9
Bayamon	116.3	1,289	1.3	94
Caguas	46.9	1,033	5.8	95
Carolina	163.0	1,472	1.3	94
Guaynabo	68.8	1,803	2.2	93
Trujillo Alto	68.0	1,068	3.8	97
San Juan	2.6	1,593	0.9	92

Source: Bureau of the Census, op. cited in Table XVIII and Census of Agriculture, Puerto Rico, Table 39

have shown a negative change of population during the decade 1960-1970. The same source from which Table XX is drawn estimated that the net migration during 1960-1970 from these regions is in the order of 55,019 persons or 35.2% of their population in 1960.

Despite the substantial outmigration experienced by these regions, they still exhibit in 1970 all the characteristics of backward regions relative to the more developed in the island, as shown by Table XXI, that is, low per capita income, a high proportion of people engaged

in agriculture, and an agriculture very traditional as indicated by the proportion of incomes drawn from livestock production relative to more developed and dynamic municipios of the island that have experienced population increases during the decade 1960-1970 as depicted at the bottom of Table XXI. The gap in income per capita and other characteristics is large as between these municipios. Since there is not too much that can be done to improve in a radical way coffee technology in the immediate future, the need for a new approach and the search for new ways of improving the lot of coffee regions is imperative. The solution may be in the control of birth and an encouragement to more outmigration, in order to increase income per capita.

Unemployment as a Factor of Migration

- Employment Opportunities in Urban versus Rural Regions

The third hypothesis states that internal migration from rural to urban areas is greatly influenced by better employment opportunities in cities relative to towns. Rural areas are characterized by a narrow range of economic activities or by a few marginal industries due to the lack of efficient infrastructures and the presence of a high level of unskilled workers. Farming which is basically the principal activity provides jobs or employment only part of the year, during the busy season, where planting and harvesting are taking place and during which most people or even children are working. When the "dead" or off-season arrives, which can extend up to six months, everything is slacking and during that period even the operator of the farm or the head of the family has few things or practically nothing to do.

Table XXII.- Total Employment and Unemployment Rate in Puerto Rico.
1940-1972

	1940	1950	1960	1965	1967	1970	1971	March 1972
Labor Force	602	684	625	769	784	827	854	895
Employment	512	596	543	680	684	738	755	788
Unemployment	90	88	82	89	99	89	99	108
Unemployment Rate	15.0	12.9	13.2	11.6	12.7	10.8	11.6	12.0

Source: Informe al Gobernador, Junta de Planificacion, 1971, Table 25 p. 25-A and Employment and Unemployment in Puerto Rico, March 72, Montly Report Number 72-3 Bureau of Labor Statistics, Table 1, p. 1

Furthermore, as we saw earlier in our discussion of the wage differentials, population growth being faster in rural than in urban areas, due to higher rural fertility rate, contributes to compound the unemployment problem and decrease the opportunities of finding a job for new entrants in the rural labor force.

Puerto Rico, in general, despite its high rate of industrialization and urbanization, has never been able to provide full employment for its human resources. From 1940 to 1972 the rate of unemployment has varied between 11.6% in 1965 and 15% in 1940 as shown in Table XXII.

Reynolds⁹ attributes the low level of employment creation despite this spectacular progress in Puerto Rico to two probable causes. Some traditional sectors, as a result of development, disappear, while the emerging modern sector does not create compensating employment to replace jobs lost from the traditional sectors. Secondly, new industries make more use of capital than labor and when some employment is created,

Table XXIII.- Labor Force and Unemployment Rate in the Farm and Non-Farm Sectors, Puerto Rico. (Thousand of Workers)

Years	Non-Farm Sector			Farm Sector		
	Labor Force	Unem- ployment ¹	% of the Labor Force	Labor Force	Unem- ployment ¹	% of the Labor Force
1950/51	451	56	12.4	235	32	13.6
1958/59	474	65	13.7	163	36	15.9
59/60	475	58	12.2	150	25	16.6
60/61	486	56	11.3	153	19	12.4
61/62	509	63	12.3	161	22	13.6
62/63	529	65	12.2	166	24	14.4
63/64	581	64	11.0	156	19	12.1
64/65	629	65	10.3	143	19	13.2
65/66	678	107	15.7	129	17	13.1
66/67	670	81	12.0	113	18	15.9
67/68	698	89	12.7	104	16	15.3
68/69	710	73	10.2	98	13	13.2
69/70	740	76	10.2	87	13	14.9
1970	759	83	10.9	84	12	14.2
1971	800	94	11.7	74	11	14.8

1) The unemployment figures are for calendar years

Source: Compute from Table XVI of this chapter

this results in an increase of the labor force instead of actually a decrease in unemployment.

- Labor Force and Unemployment

In comparing the unemployment rate in the two principal sectors of the economy, agriculture and non-agriculture, the picture is as shown by Table XXIII. Clearly unemployment as conventionally measured

tends to be higher in rural than in urban places. But the conventional method of measuring the labor force and unemployment, consisting of classifying a person as unemployed if he is looking and ready to work and had done no work or very little during the previous week of a survey, while applicable for a developed country, is very misleading for an underdeveloped country. Indeed, this measure of the labor force and unemployment does not reflect the real extent of unemployment, especially in rural areas. Barton¹⁰ observes that "In the more backward of the underdeveloped countries, even the concept of "looking for work", a key element in conventional labor statistics, is practically meaningless. Most people are self-employed and there are few, if any, jobs within their sight or competence. For many people in Puerto Rico, especially rural women now that the home needlework industry has disappeared, young people who lack adequate education or experience, and unskilled farm laborers during the off-seasons of the various crops, the situation is similar. There is no sense in looking for work when no jobs for which they can qualify are available." As an example of the potential size of the rural labor force or the hidden unemployment, Barton mentions that an average of 70¢ an hour is sufficient to increase male sugar farm workers from 14,000 in December, 1964 to 73,000 in March 1965, the season's peak and 6,000 among the 59,000 increase were seasonal entrants into the labor force, the rest came from other farms and from the unemployed. In 1970, the same phenomenon can be identified. At the peak season in March, the number of employed sugar cane farmers was 33,000 with an average wage rate of 80¢ an hour,¹¹ while in december of the same year it was only 6,000. It can be ascertained that the existence of this kind of hidden unemployment exists also in cities,

but its magnitude is likely to be more important in rural areas than in cities of countries which have reached an advanced stage in their development. In cities of the more advanced countries, the existence of a subsistence sector which usually absorb the hidden unemployment is not important while it may be in rural areas. For this reason, we will infer that in rural areas of Puerto Rico this kind of hidden underemployment is likely to be more important than in cities.

- Agriculture Employment

The incentive to migrate from rural to urban places can be understood more fully by looking at what happened in the rate of employment creation in the two sectors. While employment in agriculture has shrunk drastically, the creation of new employments and jobs has almost been confined in industries located in urban areas. Table XXIV presents data on employment creation in certain selected sectors of the Puerto Rican economy. Except in 1963 where agriculture has shown an increase of 3,000 in employment, over the level of 1962, employment has been consistently disappearing in the farming sector, whereas manufacturing, government and others, mainly services show constant increases in their rate of employment creation, particularly since the 1960's.

- Minimum Wage Laws and Farm Employment

The heavy shrinkage in agricultural employment stems from two principal factors. First, employment has declined heavily in the traditional crops, sugar cane, tobacco and coffee, due particularly to higher costs of labor. Sugar cane farming and industry have been the subject of various minimum wage laws established by the Fair Labor

Table XXIV.- Agriculture and Non-Agriculture Employment and their Absolute Change. Puerto Rico, 1940-1971 (Thousand of Workers)

Years	Agriculture Forestry and Fishing		Manufacturing (except needle work)		Government		Others	
	Level	Change	Level	Change	Level	Change	Level	Change
1940	230		56		19		177	
1950	216	- 14	55	- 1	45	26	190	13
1958	151	- 65	79	24	62	17	166	- 24
1959	137	- 14	78	- 1	65	3	171	5
1960	125	- 12	81	3	62	- 3	177	6
1961	134	- 9	84	3	67	5	185	8
1962	139	- 5	92	8	67	0	187	2
1963	142	3	91	- 1	71	4	194	7
1964	140	- 2	106	15	79	7	217	23
1965	124	- 16	121	15	87	8	232	15
1966	106	- 18	123	2	94	7	230	- 2
1967	95	- 11	128	5	95	1	240	10
1968	92	- 3	136	8	100	5	245	5
1969	85	- 7	143	7	108	8	254	9
1970	74	- 11	141	- 2	113	5	272	18
1971	66	- 8	142	1	119	6	283	11

Source: Socioeconomic Statistics of Puerto Rico, Puerto Rico Planning Board, Bureau of Statistics, March 6, 1972, p. 6

Standards Act as early as in 1940. In addition to the Federal Fair Labor Standards Act, the Commonwealth Government has introduced minimum wages under the 1956 Minimum Wage Act of Puerto Rico which covers employees engaged in interstate commerce and those confined in local activities. As of January 6, 1972, the minimum basic daily wage rates range from \$5.415 to \$9.525 for an 8-hour day corresponding to a range of \$0.68 to \$1.19 an hour.¹² These rates are revised from time to time

with a strong tendency to increase. As a result of these mandatory laws, due perhaps to the government desire to narrow the wage gaps between industry and farm wages, sugar cane employment, as well as that of coffee and tobacco, has decreased dramatically, at the costs of heavy decreases in physical production.

-Farm Employment and Industrialization

The second explanation of the shrinkage in farming employment concerns industrialization, and the fact that agriculture has been modernizing itself at a reasonable pace. Industrialization offering higher wages than in farming, governmental regulations fixing minimum wage laws, better credit facilities to farmers, all render labor more expensive than capital. This situation has led to the introduction of machinery in sugar cane, coffee and tobacco farming, to replace labor. Many new types of farm machinery not reported in previous census of agriculture appeared in the 1969 Census. These include sugar cane harvest machines, sugar cane loaders, coffee pulping machines, in addition to an increase in other types of traditional farm machinery such as tractors, crawlers and wheels. WE note, however, that this substitution seems not to be sufficient or has not yet attained the required level of efficiency, perhaps due to a lack of qualified labor to keep the level of production of these crops from falling. Table XXV presents the situation of employment and physical production in the traditional Puerto Rican crops and others. Agriculture employment has drastically decreased in sugar cane, (63% from 1960 to 1970), coffee (43% for the same period), and tobacco, but less drastically in others (11%). Concomitantly, physical production indices have also decreased for the

Table XXV.- Employment and Agriculture Production (Physical Volume 1950/51 : 100) in Selected Agricultural enterprises.

Years	Employment				Production			
	Sugar Cane	Coffee	Tobacco	Other ¹	Sugar Cane	Coffee	Tobacco	Livestock
1951/52	NA	NA	NA	NA	119.4	174.5	110.2	105.2
1960/61	51	23	11	45	102.4	151.2	107.8	172.1
62/63	45	29	13	54	96.4	167.3	134.5	200.8
63/64	49	23	13	51	93.4	133.4	126.1	202.5
64/65	37	24	16	49	83.9	158.9	148.6	208.5
65/66	35	20	8	47	90.2	127.1	64.9	216.3
66/67	30	19	4	42	77.7	120.3	48.4	219.1
67/68	24	18	3	42	62.8	137.7	43.9	220.6
69/70	19	13	-	40	56.2	95.3	25.5	221.3
% change	-43	-43	-	-11	- 53	-45	-77	105

1) Includes, dairy, pineapples, fishing, forestry and others.

Source: Facts and Figures on Puerto Rico's Agriculture 1968-69, Table 60 p. 89, table 56 p. 69 and 1969-70, table 64 p. 82

three traditional crops; sugar cane decreased by 53% from 1950 to 1970, coffee by 45%, tobacco by 77% while during the same period livestock increases tremendously by 105.3%. Livestock, in the process of modernization of farming represents another interesting feature of Puerto Rican agriculture. Puerto Rican farming has veered away from its traditional crops to specialize in more modern income-elastic foods: mild, eggs, meats etc.

- San Juan as the Principal "Pôle de Croissance"

We mentioned earlier that rural areas are characterized by their narrow range of economic activities and the presence of some

marginal firms paying low wages. This state of affairs is not without its consequences on employment opportunities and the wage level in the rural areas inducing people to emigrate toward urban centers. At the outset of industrialization, the Muñoz government deliberately selected San Juan as the ideal site to start its program for many obvious reasons. The better part of the working force was living in San Juan as well as the educated unemployed that could acquire without great expense the necessary skills for the needs of the expected industries. Moreover, San Juan, being the capital of the island, offered the rudimentary infrastructure that could be readily exploited and eventually improved. Other sites that offered similar advantages were Mayaguez and Ponce. These cities now represent the three metropolitan areas where almost all manufacturing is located. They are coastal cities with facilities for receiving and shipping raw materials. Since Puerto Rico is obliged to import from the outside all of the ingredients for the functioning of its industries, these sites were readily identified as a good starting point. In addition, more than half of the goods produced in Puerto Rico are to exported to the United States or other parts of the world.

- San Juan Compared to Mayaguez and Ponce

From Table XXVI, one sees clearly, beginning in 1954, the pattern of clustering of industrialization around the three SMSA (Standard Metropolitan Statistical Area) has not changed significantly by 1970. These three seem to represent the places where the probability of finding a job is better than anywhere else on the island, excepting of course, certain cities in the mainland United States. The number of

Table XXVI.- Number of Establishments, Average Number of Employees for the three SMSA in Puerto Rico, 1954 and 1970

	Establishment (Numbers)	% of the total	All Em- ployees	% of the total	Pro- duction (Average)	% of the total
1954						
All Industries	1,938	100.0	69,022	100.0	60,336	100.0
Mayaguez	177	9.1	5,740	8.3	6,867	11.4
Ponce	169	8.7	6,197	8.9	5,187	8.6
San Juan	652	33.6	22,410	32.5	18,616	30.8
All Three SMSA	998	51.5	34,347	49.8	30,670	50.8
1970						
All Industries	2,641	100.0	136,737	100.0	114,258	100.0
Mayaguez	168	6.4	9,257	6.8	8,018	7.0
Ponce	143	5.4	9,165	6.7	7,265	6.3
San Juan	1,038	39.3	45,392	33.2	33,776	29.6
All Three SMSA	1,349	51.1	63,814	46.7	49,059	42.9

Source: U.S. Bureau of the Census, Census of the Manufactures: 1954, 1967, Puerto Rico, MC67-PR Tables 2 and 1 respectively and Census of Manufacturing Industries of Puerto Rico, October 1970, Bureau of Labor Statistics, Table 9, The Commonwealth of Puerto Rico

industrial establishments continues to concentrate around the three "póles de croissance" (more than 50% of all industrial establishments on the island). The mean number of employees decreased only three percentage points from 1954 to 1970, though it has increased in absolute number.

As for production workers, it has decreased quite substantially (7.9 percentage points) from 1954 to 1970, more than the number of employees. When they are considered individually, however,

Mayaguez and Ponce have lost some grounds whereas San Juan has slightly departed from its 1954 position in 1970. While the number of industries has increased during the period 1954-70 for the island in general, it has decreased for Mayaguez and Ponce while San Juan has shown a substantial increase of about 59%, i.e. from 652 to 1,038. The same is also true for San Juan as far as the average number of employees and production workers are concerned. In fact, San Juan showed an increase of 102% in the average number of employees (from 22,410 in 1954 to 45,392 in 1970) and 81% in the average number of production workers. In term of number of employees, Mayaguez and Ponce which had 25.6% and 27.6% respectively as many employees as San Juan in 1954 come to have both only 20% as many employees as San Juan. Both Mayaguez and Ponce show increases in their number of employees to the order of 61% and 48% respectively. As for production workers the relative position of Mayaguez and Ponce vis a vis San Juan has also deteriorated. Beginning in 1954 they had 37% and 28% as many production workers as San Juan, and they show by 1970 only 23% and 21% of the number of production workers found in San Juan. The increase in production workers for both SMSA is in the order of 17% and 40% respectively.

Since 1960, San Juan as grown faster than Mayaguez and Ponce. It has over the years positively influenced the development of the surrounding municipios (Caguas, Toa Baja, Toa Alta...), while Mayaguez and Ponce have not seemed to have had any significant effect on their neighbouring municipios, except in the case of Hormigueros, near Mayaguez, which exhibits according to the 1970 Census some interesting features including a 51.4% positive change in population from 1960 to 1970, a

per capita income of \$1,098, although 14.9% of its male employees are in agriculture and derive only 6% of their farm income from livestock. In fact, both Ponce and Mayaguez have as yet a rather relatively high proportion (4.5 and 5.4 respectively) compared to San Juan (only 0.9%) of their male workers engaged in agriculture. Their agriculture is producing mainly traditional crops (Sugar cane, coffee and tobacco) as evidenced by the percentage of farm income drawn from livestock 14% and 11% respectively for Mayaguez and Ponce whereas for San Juan and all its surrounding municipios the % of farm income derived from livestock is in the order of 90% on the average.

The importance of San Juan, the capital and the principal city of the Commonwealth, can be appreciated by the following statistics for January, 1971. Alone, it has more than 39% of the 2,592 manufacturing establishments located on the island. The Economic Development Administration has helped establish a total of 1,737 new plants from which 364 are in the city of San Juan, and 779 in the metropolitan area. It is the site of all Commonwealth Governmental headquarters and of principal offices of all the public corporations. As well, it has concentrated within the city almost all the industry of tourism and the Federal government offices. Finally, of all the commercial volume of goods entering and leaving the island, 66% are handled by the port facilities of San Juan.¹³ Based on these figures, and the preceding pertinent observations, one can conclude that San Juan SMSA remains the principal point of attraction for job hunters and the location of industry on the island.

Urban Employment and Migration

We have so far considered unemployment differentials as a determinant of a person's probability to migrate and have tried to show that migration will take place as long as the unemployment level is higher in rural than in urban areas, and the rate of job creation in cities is growing while that of rural is slackening so that the prospects of finding a city job is better than in rural areas. Some qualifications must be added to this argument, however. The initial level of urban unemployment and underemployment affects the probability of finding a job i.e. even if differential unemployment between urban and rural areas is wide. Todaro,¹⁴ has formulated a behavioral model of labor-migration in less developed countries by taking explicitly into account the role of the initial level urban unemployment upon the individual's decision to migrate. He rejects the current implicit assumption of classical labor transfer models in which any migrant who decides to migrate is automatically assured of a job at the going urban real wage and raises the crucial question. "how long does the average migrant have to wait before finding a job?" Thus he thinks that the most important determinant of the urban labor supplies is not the "prevailing real income differentials as such, but rather the rural-urban expected income differential, i.e. the income differential adjusted, for the probability of finding an urban job." The probability of finding employment is defined in terms of the ratio of new modern sector employment openings in period t relative to the number of accumulated job seekers in the urban traditional sector at time t . The difficulty comes in determining how the average migrant will arrive at a fair estimation of that

probability. Certainly the accuracy of this estimation is a function of the availability of information whose cost varies according to one's education's level. The Todaro approach is certainly in the right direction as can be verified by the variation registered by external migration, i.e. migration towards the mainland according to the unemployment level there. For example, from 1964 to 1968, when the U.S. unemployment level was low, around 4%, net outmigration to the U.S. was positive and reached the high point of 44,000 in 1969-70, while U.S. employment level was at its lowest for some time. It can also be alleged that the internal rate of migration follows the level of urban unemployment and varies according to the rate of creation of new jobs and the absolute level of job seekers. Fortunately in Puerto Rico, due to short distances within the island, and relative low cost distance to the mainland, any miscalculations concerning unemployment level could be corrected, since the migrant has the possibility of returning to his original place if he is not satisfied with the prevailing conditions at destination.

Non-Wage Benefits (Costs) as a Factor of Migration

In addition to these three principal factors, education, wage differentials and unemployment that are assumed to play an important role in the individual's decision to migrate, there exists also other non-wage benefits or costs that are related to migration and which might influence sharply the decision for or against moving. These non-wage benefits or costs may take different forms, for example higher or lower educational standards; superior or inferior health facilities; lower or higher quality housing facilities; lower or higher level of criminality;

acceptable or unacceptable degree of air pollution at destination relative to the migrant's origin. These opportunities encountered at destination will be a benefit to the extent that the individual values them higher at his destination than at his origin.

Among these non-wage benefits (costs) we will consider particularly the housing, medical and education facilities that characterize each "municipio". Of course, these characteristics are not necessarily relevant or of importance for every person who consider migration. For a young person who finished high-school or for a family who has children in school age and who plans to give them a college education, school or educational facilities will weigh heavily in his choice of a locality. Finally, certain persons whatever their age or status might consider the type of housing, the neighborhood as the principal determinant in their decision to migrate.

-Housing Opportunities

A priori, we can safely say that the metropolitan cities enjoy a definitive advantage in the areas of education, housing and medical facilities. Good housing projects are encountered in urban areas whereas low quality inexpensive squatter house are rather located in rural areas. To be sure, cities are the reservoir of slums, but slums were originally good housing that had been put to bad or unwarranted uses.

-Educational Opportunities

In term of educational facilities, cities are likely to have again a lower number of students per teacher or better educational equipment. They are usually the places where most big state sponsored

Table XXVII.- Non-Wage Opportunities for Selected high and low Income municipios of Puerto Rico, 1970

	Health		Education	Housing
	Physicians per 1,000 persons	Nurses per 1,000 persons	Teacher per 1,000 enrolled student	Housing units vacant for sale or rent per 1,000 families
<u>High-Income</u> <u>Municipios</u>				
Bayamon	0.9	1.9	35.2	52.4
Carolina	1.3	3.9	33.5	92.5
Guaynabo	6.2	1.5	26.9	49.4
Mayaguez	1.7	1.2	30.3	52.0
Ponce	1.9	3.0	31.1	59.5
San Juan	0.6	1.4	29.0	43.9
<u>Low-Income</u> <u>Coffee-Producing</u> <u>Municipios</u>				
Adjuntas	0.2	0.3	29.5	18.2
Ciales	0.2	0.1	27.8	21.5
Jayuya	---	1.3	25.7	55.9
Las Marias	0.6	0.6	16.6	32.0
Lares	0.8	0.3	33.8	43.1
Maricao	---	1.3	21.0	9.9
Orocovis	0.2	0.2	23.5	27.6
Utuado	0.7	0.5	32.3	49.9

Source: U.S. Bureau of the Census, Census of the Population 1970, Volume I, Social and Economic Characteristics of the Population, Part 53, P.R. Tables 101, 103 and General Housing Characteristics (1970), Table 17

universities are found.

- Health Opportunities

Finally in the field of medical or health facilities, cities again are in an advantageous position relative to the smaller or rural places. The principal and most important medical facilities, hospitals and other as well the ratio of physician per inhabitants are found in the cities.

We would then expect migrants, *ceteris paribus*, to show strong preference for localities where these services are more abundant.

Table XXVII compares the level of these amenities for two groups of municipios, one called "high-income municipios" surrounding San Juan and the other called "low-income-coffee-producing municipios". Our contention that metropolitan cities are better provided for by these opportunities as measured by the number of physicians, nurses per 1,000 inhabitants (Health column, Table XXVII); number of teachers per 1,000 enrolled students up to high school (Education column, Table XXVII) and number of housing units vacant for rent or sold per 1,000 families, than less developed rural areas, is verified, except for minor exceptions.

FOOTNOTES, CHAPTER III

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- (3) Schwartz, Aba, Migration and Life-Time Earnings in the United States, unpublished doctoral dissertation, University of Chicago, 1968, cited in Schultz, T.W., Human Capital Paper, No 70: 10, Department of Economics, September 9, 1970 (First Draft), Revised January 1971 (Mimeo), p. 60
- (4) Reynolds, Lloyds and Gregory, Peter, Wages, Productivity and Industrialization in Puerto Rico, p. 211
- (5) Ibid, p. 62
- (6) Puerto 1969 Census of Agriculture, U.S. Department of Commerce, Part 52, Volume I, Table 3, p. 4
- (7) Leibeinstein, Harvey, Economic Backwardness and Economic Growth, John Wiley and Sons, pp 159-165
- (8) Friedman, Milton, Price Theory, Provisional Text, Aldine Revides Edition, p. 209
- (9) Reynolds, L.G., "Wage and Employment in a Labor-Surplus Economy", American Economic Review, March 1955, pp. 19-39
- (10) Barton, H.C. Jr., Dependence of the Puerto Rican Economy on the Development of its Human Resources, prepared for the staff of Puerto Rico, April 1966. Reproduced July 1970 by Puerto Rico Development Group (Mimeo). The original title was Distinctive Characteristics of the Puerto Rican Economy, p. 17
- (11) Facts and Figures on Puerto Rico's Agriculture, Department of Agriculture, P.R. 1969-70 and An Economic Report on the Sugar Cane Farming Industry and the Sugar Cane Manufacturing Industry in Puerto Rico, April 1972, U.S. Department of Labor, p. 38
- (12) The Sugar Cane Farming Industry and The Sugar Manufacturing Industry in Puerto Rico, April 1972, p. 37
- (13) "San Juan, Puerto Rico" A Special Report, Commonwealth of Puerto Rico government Development Bank for Puerto Rico, San Juan, January 1971
- (14) Todaro, Michael, "A Model of Labor Migration and Urban Unemployment in Less Developed Countries", American Economic Review, March 1969, pp. 139-149

CHAPTER IV

Measurement and Pattern of Puerto Rican Net Intercensal Migration During the Decade 1960-1970.

Measurement of Migration

The spatial movement of population is a phenomenon which is not easy to evaluate precisely due in part to the impossibility of separating seasonal or temporary moves from permanent moves. As anyone, knows, the former is quite common among agricultural workers looking for jobs during the "dead season", i.e. the period between planting and harvesting operations. Moreover, the current available data makes no mention of the types of moves involved and besides usually gives no indication of the origin and destination of migrants, because movement within the boundaries of a country has no legal restrictions.

Depending on one's objectives and the information available, several indirect methods¹ can be used to estimate net intercensal migration, or migration for a given period. Among these indirect methods, we have those based on vital statistics and those that make use of survival ratios. Vital statistics methods require statistics on births and deaths of the residents of the various regions of the country under study. Net migration is then estimated by subtracting the natural growth from the total population change according to the formula:

$$\text{Net } M = P_{t+n} - P_t - (B-D)$$

M : net migration

P_t : population at the previous census

P_{t+n} : population at the later census

B : number of births that take place to residents of the region during the intercensal period

D : number of deaths that take place among residents of the region during the intercensal period

Unfortunately the unavailability and unreliability of data on births and deaths among the residents of Puerto Rico by age groups and by municipios preclude the use of this method here.

- Survival Ratio Method

For our purpose, which is to determine a sort of "relative" redistributing or migrating of people from rural to urban areas of Puerto Rico and between Puerto Rico and United States, and given the available information consisting of the enumeration of persons classified by age and sex for each "municipio" of Puerto Rico in 1960 and 1970 as reported by the U.S. Census on Puerto Rico, the best approach is the "Survival Ratio Method" defined as:

$$M(x) : P(x+10, t+10) - R(x).P(x,t)$$

where,

$M(x)$ is the net migration of survivors among persons aged x at the first census in a given "municipio". These persons will be aged $x+10$ at the second census, (here the two census-takings are 10 years apart).

$P(x,t)$ is the population aged x in the "municipio" at the first census

$P(x+10, t+10)$ is the corresponding population aged $x+10$ in the same "municipio" at the next census

$R(x)$ is the survival ratio which shows the proportion of persons, among those living in the indicated age groups of the population, who will survive until they are 10 years older. The difference between the enumerated population at the second census and the expected population computed by applying the age-group survival ratio to the enumerated population of the first census gives a fairly good estimate of net intercensal migration for the period between the two censuses. There will be net in-migration if $M(x)$ is higher than zero and net out-migration if $M(x)$ is less than zero.

- Data and Assumptions

The data necessary in the application of this formula is the classification by age and sex of the population by "municipios" at the two censuses and the corresponding survival ratio for each age-group that can be used for regional population of the first census. Regional survival ratio requires age specific death rate for each region and since such statistics are not tabulated by "municipios" in Puerto Rico, we will assume that the available age specific death rate of the country is the same for each "municipio". By using these national death rates by age-group and model life tables as published by the United Nations,² we will compute, as shown in the Appendix, survival rates for Puerto Rico, for the decade 1960-1970.

The measurement of migration using this procedure implies two assumptions. The first stipulates that the ratio of any sex-group to the true population of the nation is unchanged for the cohort in both censuses. In this instance, it is impossible to avoid undercounting or over counting of age groups especially if people tend to "round" their ages thus contributing to "age heaping" about more attractive ages. These counting errors are likely to be severe if the age distribution is misreported due to mis-statement of age, especially if narrow age groups are considered. In the case of broad age groups, errors tend to cancel themselves out. Fortunately, for our objectives, the problem of mis-statement of age seems not to have affected markedly Puerto Rican census data. Schultz and Nerlove³ in their study of Puerto Rican family decision making, observe that for the purpose of estimating migration in Puerto Rico "age heaping does not appear to distort the census data seriously".

The question can be very different, however, when it comes to enumerate in the United States, persons of Puerto Rican birth. On the one hand the enumeration of such persons is likely to be biased downwards because being born in Puerto Rico may be in the words of Schultz and Nerlove⁴ "associated in the minds of many persons with lower-class status in the United States". Hence mis-statement of age is a first source of bias. On the other hand, underenumeration of urban poor and Negro persons in the population is frequent in census. Thus, the largely urban and poor persons of Puerto Rican birth in the United States are likely to be underenumerated in 1960 as well in 1970. For all these reasons, the United States observation is simply deleted in

the equation estimating migration of Puerto Ricans in the study of Nerlove and Schultz. We will also drop the U.S. observation in our estimation of Puerto Rican migration equation. However, because of the importance of P.R. migration to the mainland with regard to the population of the island, we will treat the persons of Puerto Ricans birth residing in the U.S. separately and from the information supplied by the U.S. Census, we will try, taking the above mentioned possible source of bias in mind, to study their principal characteristics, the extent to which these characteristics differ from the residents on the island, and their impact on the island economic structure.

Table I.- Death rates per 1,000 Population, Selected Years

	1940	1950	1960	1965	1968	1969	1970	1971
Death Rates per 1,000 population	18.2	10.5	6.7	7.2	6.5	6.4	6.6	6.7

The second assumption states that the specific mortality rates by age and sex should be geographically uniform. This assumption is likely to be violated in countries with a high rate of mortality, so that geographical units may show wide variations in their respective death rate. Fortunately for Puerto Rico, improvements in health care during the last three decades have generally contributed to a decrease in the general mortality level since 1950 as shown in the accompanying Table I.

- Evaluation of the Survival Ratio Method

Despite this significant decrease in death rate in general, substantial differences in mortality rates among age groups and rural and urban residents may continue to prevail. To the extent that mortality rates are higher in rural than in urban areas, by using a uniform survival ratio, migration from rural to urban areas will be biased upwards. In their 1960 study of Puerto Rican migration, Nerlove and Schultz⁵ think that the magnitude of the bias that could result from regional differences in death rates on migration between rural and urban areas in Puerto Rico appears small relative to the size of net migration rates in this period, i.e. 1950-1960. For the period (1950-1960) considered in their study, death rates are higher in rural than in urban areas. But during the 1960's general mortality tends to be higher in urban than in rural areas in Puerto Rico due to higher risks of crime, pollution and traffic accidents in cities. The figures are from 1970, 52.4% in urban against 47.1% in rural areas.⁶ It can be inferred that this trend tends to eliminate regional death rate disparities and thereby minimize migration bias from rural to urban areas.

Whatever its restrictions and the crudity of the results that it leads to, it remains suitable enough for our needs. Jacob Siegel and C. Horace Hamilton⁷ commenting on it state that "This formula does provide a theoretically accurate estimate of the net change in population attributable to migration, and of net surviving migrants for age cohorts alive at the start of the decade and as such is a valid measure. For some purposes, this is the type of figures desired, not an estimate of the volume of net migration."

Pattern of Puerto Rican Migration during the decade 1960-1970.

In applying the method outlined above to estimate the net spatial change in population due to migration, each of the "municipios" (There are 76 "municipios" in Puerto Rico, but Culebra is omitted due to its small size and the abnormal age profile of its residents) of Puerto Rico is taken as a unit of observation. In order to draw some comparisons with the study of Nerlove and Schultz that analyzed P.R. migration determinants in 1950-1960, ten age groups are formed for each sex, using intervals similar to theirs. Migration rates corresponding to these 10 age-groups are then computed for each "municipio" and used as independent variables in the statistical test of the model discussed in the preceding chapter. These statistical tests will be presented and analyzed in the next chapter.

Likely, survival rates for men and women computed by using average specific death rates occurring during the decade 1960-1970 and model life table as shown in the Appendix, are obtained for the same age intervals identified by Schultz and Nerlove.

The results of our estimates of annual net migration rates expressed in %, means and standard deviations for the 75 municipalities of Puerto Rico in 1960-1970 along with those obtained by Nerlove and Schultz in 1950-1960 are presented in Table II. Similarly, our derivation of survival rates (1960-1970) for men and women in Puerto Rico are compared with those obtained by Schultz and Nerlove (1950-1960) in Table III.

Looking at Table III, we find that survival rates for the

Table II. Annual Net Migration Rates, Means and Standards Deviations
For 75 "municipios" of Puerto Rico, 1950-1960 and 1960-1970

Age of Cohort at the be- ginning of the decade	75 "municipios" of Puerto Rico							
	Decade 1950-1960				Decade 1960-1970			
	Male		Female		Male		Female	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
0-4	-0.91	0.98	-1.07	1.03	-0.18	0.30	-0.47	0.26
5-9	-3.16	1.41	-3.19	1.44	-1.80	0.41	-1.49	0.31
10-14	-7.17	3.06	-5.15	2.20	-5.03	0.80	-3.39	0.55
15-19	-7.28	2.78	-5.16	2.07	-4.84	0.63	-3.21	0.48
20-24	-5.28	1.93	-4.50	1.60	-1.28	0.55	-1.51	0.42
25-34	-2.22	1.34	-1.73	1.03	0.80	0.37	-0.19	0.38
35-44	-1.61	1.04	-2.00	1.00	0.03	0.37	-0.80	0.36
45-54	-0.78	0.84	-1.12	1.06	0.52	0.19	0.37	0.87
55-64	0.02	0.83	-0.62	1.12	0.52	0.33	0.03	0.23
65 and over	0.43	3.48	0.86	2.99	3.43	0.15	3.29	0.11

Source: Decade 1950-1960, Nerlove Marc and Schultz T., Love and Life Between the Censuses: A Model of Family Decision Making in Puerto Rico, 1950-1960, Rand Corporation, September 1970, p. 80, Table A-1;

Decade 1960-1970, See Appendix, Computed from migration rates obtained for all "municipios", applying the survival ratio method to the 10 age-groups for male and female

period 1960-1970 are higher for all age-groups than the earlier decade. This is not too surprising, since health conditions have been improved substantially from 1950 to 1970 as evidenced by the average life expectancy which has passed from 61 years in 1950 to 70 years in 1970 and also probably by more and better care given to the population since the number of persons per physician has decreased from 2,380 in

Table III.- Survival Rates for Puerto Rico, 1950-1960 and 1960-1970

Age of Cohort at beginning and end of decade respectively	Decade 1950-1960		Decade 1960-1970	
	Men	Women	Men	Women
0-4 to 10-14	.9475	.9498	.9582	.9758
5-9 to 15-19	.9839	.9871	.9966	.9977
10-14 to 20-24	.9854	.9910	.9949	.9972
15-19 to 25-29	.9714	.9831	.9931	.9960
20-24 to 30-34	.9551	.9735	.9893	.9950
25-29 to 35-39	.9506	.9686	.9886	.9942
30-34 to 40-44	.9408	.9622	.9861	.9941
35-39 to 45-49	.9339	.9535	.9832	.9909
40-44 to 50-54	.9237	.9472	.9764	.9844
45-49 to 55-59	.8934	.9316	.9625	.9780
50-54 to 60-64	.8632	.9102	.9445	.9672
55-59 to 65-69	.8218	.8781	.9208	.9496
60-64 to 70-74	.7501	.8220	.8890	.9196
65-69 to 75-79	.6599	.7469	.8335	.8668
70-74 to 80-84	.5567	.6292	.7066	.7548
75-79 to 85-89	.4343	.4889	.5306	.5900
80 to 90	.3120	.3810	.3203	.3543

Source: Decade 1950-1960, Nerlove and Schultz, op. cited in Table II, Table A-2, p. 81

Decade 1960-1970, See Appendix, where computations are shown.

1950 to almost half in 1970, i.e. 1,269.⁸

- 1950's and 1960's Rate of Outmigration Compared

From Table II, we notice that the average rate of net out-migration is lower for all age-groups in 1960-1970 relative to 1950-1960. This is due mainly to lower average net migration to the

United States mainland in the 1960's relative to the 1950's. According to estimates done by the Health Department of Puerto Rico and reported by Calzada⁹, the average annual out-migration to the United States amounted during the period 1950-1954 to 47,400 and 1955-1959 to 38,600 while from 1960 to 1967 the highest average was 29,000 reached in 1966. In 1961 and 1963, return migrants to the island outnumbered out-migrants to the U.S. The estimates reported by Calzada cover the years until 1967. From 1968 to 1971 and based on passenger movements between the island and the U.S. the net annual balance of departures over arrivals has been of the order of 14,560. Thus it is clear why out-migration during the 1960's is lower than that of the 1950's.

We notice also that while during the 1950's net average out-migration encompassed age groups from 0-4 to 45-54 at the beginning of the period for male and female, it does so only from 0-4 to 35-44 age groups for females and stops at 20-24 for males during the 1960's. This means that during the 1960's females of age groups 25-34 and 35-44 at the beginning of the period show a mild tendency to outmigrate more than males of the same age groups.

In general, however, the pattern among the age groups during the two decades looks almost identical. Males show on the average a higher propensity to outmigrate than females during the two periods. Likewise, out-migration for both males and females is confined to the youngest, those age brackets from 5-9 to 20-24 of age at the start of the periods.

That out-migration of both males and females is confined

to the youngest, is in conformity with the theory, already explored in the second chapter, that views migration as an investment. Young people are better off in investing in migration than old people since they (the young) will have more time to reap the benefits from their investment.

The propensity shown by males to outmigrate more readily than females is a little surprising, even though Arias¹⁰ arrives at the same conclusion for Guatemala. Indeed, we would expect that women are less tied to farm work or training than men and therefore stand to benefit more by leaving their traditional rural setting. A priori, and assuming that educational level is positively related to the propensity to migrate, one can attribute the higher tendency of men to migrate to their higher level of education. The 1960 Census¹¹ reports that rural men had a median years of school completed of 3.3 years against 2.2 for women, though this difference tends to disappear in 1970 where it is 5.5 in 1970. But having not yet established the effect of education on migration - we will go into this question in the next chapter covering statistical tests of various variables including education on the migration rates of male and female - it would seem more appropriate for the moment to explain the higher rate of migration of men relative to women by the tremendous decline in agricultural employment. The decline is in the order of 87,000 between 1963 and 1973 or from a level of 141,000 to 54,000¹². Sugar-cane farm employment declines from 50,000 to 10,000 during the same period 1963-1973¹³. Employment in agriculture being the lot of men, where for every woman working, 21 to 24 men are working in 1970 and 1971, it is conceivable that men during the 1960's

show a higher propensity to out-migrate than women.

This phenomenon of men's higher tendency to migrate might not always have been so. Calzada¹⁴ mentions that women tend to migrate more than men before the 1950's. This was perhaps due to the disappearance of home needlework employment beginning as early as late 1940.

Finally, we will notice that the standard deviations around the means of migration rate are consistently smaller in the 1960's than the corresponding figures of the 1950's. This might indicate that migration among similar age groups is more uniform among municipios during the 1960's relative to the 1950's.

- Origin and Direction of Migrants

Before considering in more detail particular characteristics of migrants from Puerto Rico to the mainland United States, from rural to urban areas in Puerto Rico and the extent to which these processes have affected the economic structure of the regions that have lost or gained people, it may be useful to determine within the island the geographical origin and direction of migrants. Do the migrants originate mainly from rural areas or urban areas? Do they come from specific "municipios" producing certain types of crops? Do the migrants show any special preference for particular places within the island or the U.S. etc?

According to Table IV, the average rate of natural increase during the 1960's was 23.4%. However, because of out-migration PUerto Rico's population increased to 15.0% from 2,349,544 in 1960 to

Table IV.- Birth and Death Rate per 1,000 Population and Rate of Natural Increase: 1960-1970

Years	Birth rate per 1,000 popu- lation	Death rate per 1,000 popu- lation	Rate of Natural Increase per 1,000 Population
1960	33.5	6.7	26.8
1961	32.7	6.8	25.9
1962	32.6	6.8	25.8
1963	32.3	7.0	25.3
1964	32.3	7.3	25.0
1965	32.1	6.9	25.2
1966	30.2	6.7	23.5
1967	27.9	6.4	21.5
1968	26.5	6.6	19.9
1969	26.5	6.5	20.0
1970	25.8	6.7	19.1
Average	30.2	6.8	23.4

Source: Socioeconomic Statistics of Puerto Rico, Commonwealth of Puerto Rico, Bureau of Statistics, Economic Indices Section, March 1972, p. 3

2,712,033 in 1970. On the basis of these two levels and assuming that the increase in population was on the average the same for all "municipios", we can classify them into three distinct groups:

a) "Municipios" that have shown an increase in their population higher or equal to 23.4%. They are "municipios" of net immigration, "municipios" that have definitely gained people on a net basis. These immigrants may be return migrants from the United States or persons from other "municipios".

b) "Municipios" that have experienced an increase in their population of between 15.0% and 23.4%. Since the growth of their population is less than their natural increase but more than the average growth of the island, we can say that these "municipios" have known some light out-migration in favor of the preceding groups or to the mainland U.S. They may even gain people within certain age-groups.

c) "Municipios" that have experienced population increase of less than 15.4%. These "municipios" are zones of definite out-migration. They include places whose population has decreased or has shown a negative growth rate. These places have lost people both to internal and external migration.

- Municipios Whose Population Growth Rate is Higher than 23.4%

What "municipios" form the first group? Which is the sector of these "municipios" (urban or rural) that has gained most in the case of a zone of immigration or lost most in the case of a zone of out-migration?

Twelve municipios represent the first group. They are Bayamon, Caguas, Carolina, Dorado, Fajardo, Guaynabo, Hormigueros, Loiza, Rio Grande, Toa Baja, Trujillo Alto, Vega Alta. Some of them like Bayamon, Carolina and Toa Baja show an increase of more than 100% in their population. Except for Hormigueros located near Mayaguez, all these "municipios" are clustered in a nucleus around San Juan city and five of them actually form the San Juan Metropolitan Area, as shown by Map I. Table V presents total population change experienced by these "municipios" as well as change in their urban and rural sector. It can be readily noted that the gain in population has been particularly

Table V.- "Municipios" showing Population growth higher than the average natural increase of 23.4% and Change in their Rural and Urban sectors, 1960-1970

Municipios	Population		
	Total % change	Urban % change	Rural % change
Bayamon	116.3	183.0	- 76.0
Caguas	46.9	107.6	- 5.9
Carolina	163.0	320.0	- 40.2
Dorado	29.2	(25%) ^a	- 3.4
Fajardo	25.7	47.1	- 19.1
Guaynabo	68.8	119.6	- 19.2
Hormigueros	51.4	(60.3%) ^a	- 39.9
Loiza	38.9	264.0	11.0
Rio Grande	27.8	153.3	3.9
Toa Baja	135.5	(77.3%) ^a	- 46.6
Trujillo Alto	68.0	(60.2%) ^a	- 33.2
Vega Alta	29.6	173.0	- 2.1

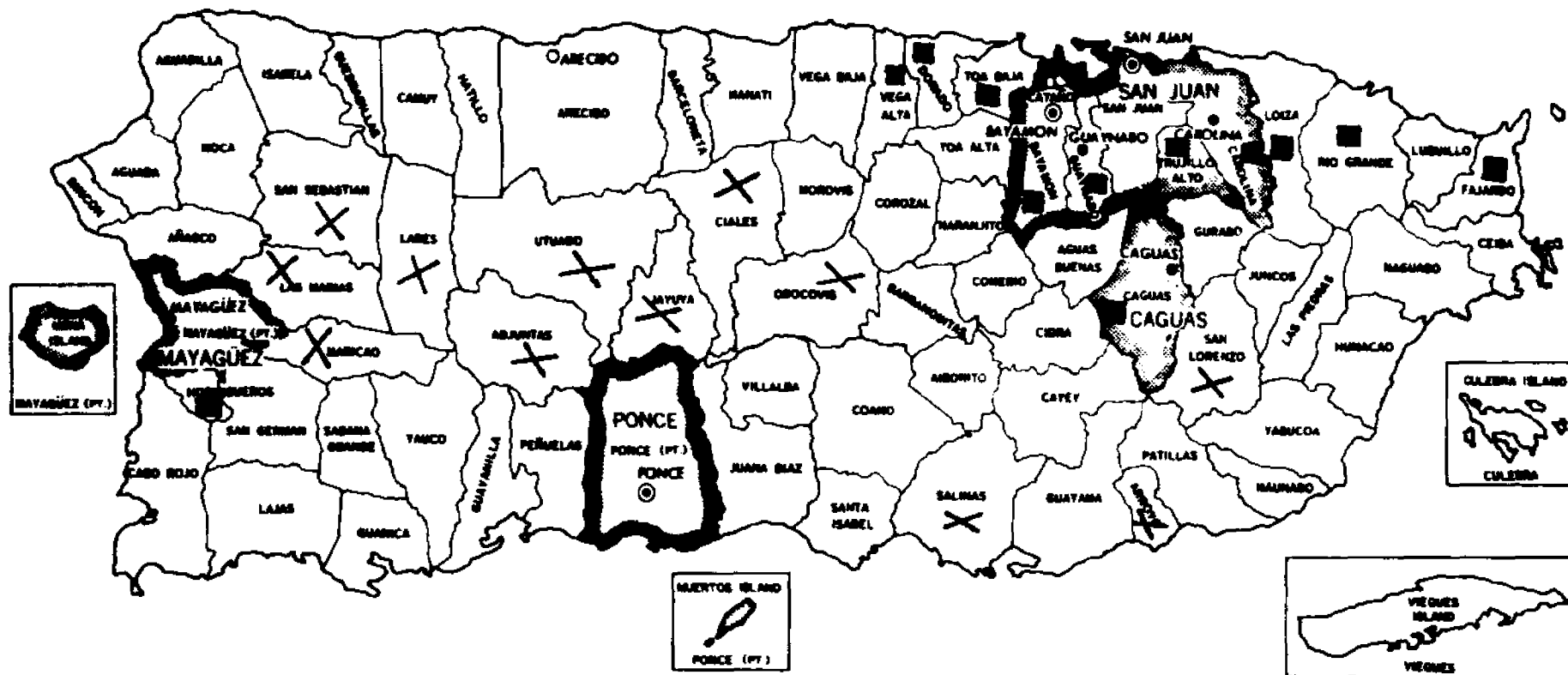
a) These "municipios" had no urban population in 1960, the figures (%) in parentheses represent the urban population in 1970 as a % of total population.

Source: U.S. Bureau of the Census, Census of Population 1970. Vol. I, Characteristics of the Population, Part 53, Puerto Rico, Tables 14,31

concentrated in the urban sector. Four places (Dorado, Hormigueros, Toa Baja, Trujillo Alto) that were entirely rural in 1960 have developed an urban sector equivalent to the percentage of their total population as shown in parentheses in the second column of Table V. The rural sector of these "municipios", except for Loiza and Rio Grande, has shown a substantial, sometimes a heavy decrease in its population

MAP 1-1V

Net "Receiver" and Net "Donor" Regions



LEGEND

- LEGEND
- Places of 100,000 or more inhabitants
 - Places of 50,000 to 100,000 inhabitants
 - Places of 25,000 to 50,000 inhabitants outside SMSA's

 Standard Metropolitan Statistical Areas (SMSA's)

 : Net "Receiver" Region

 : Net "Donor" Region

SCALE
0 5 10 15 20 MILES

relative to its 1960 level. The implications of this change in rural population upon certain characteristics such as family composition, fertility rate, the labor force participation rate of men and women, agricultural crop composition, the agricultural labor force and so on will be explored shortly.

- Municipios Whose Growth Rate is Between 15.0% and 23.4%

The second group is represented by "municipios" that exhibit increase between 15.0% and 23.4%. They are only 7, Luquillo (21.1%), Naranjito (15%), Toa Alto (20.7%), Vega Baja (17%) which are located around San Juan Metropolitan Area; Juana Diaz (20.7%), Villalba (15.4%) near Metropolitan Ponce and finally Quebradillas (19.2%) a coastal town which is not near any of three metropolitan cities (San Juan, Mayaguez or Ponce). There is no detectable pattern among these places. Some like Luquillo and Naranjito have both their rural and urban population increased; other like Vega Baja, Villalba and Juana Diaz have gained heavily in urban and lost in rural population. Table VI presents the picture. It is possible that towns that have gained in rural population have their people commute to work to the nearest metropolitan center. This will be verified later.

- Municipios Whose Growth Rate is Less than 15%

The third group, i.e. those places with a population increase of less than 15.0% can be divided into two sub-groups:

a) The sub-group whose population increase is less than 15% but superior to zero, and

Table VI.- Total, Rural and Urban Population change of "Municipios" whose Population growth was between 15.0 and 23.4%

Municipios	Population change (%)		
	Total	Urban	Rural
Juana Díaz	20.7	185.0	- 9.1
Luquillo	21.1	0	21.1
Naranjito	15.0	20.7	13.9
Quebradillas	19.2	(18.2%) ^a	- 2.5
Toa Alta	20.7	(17.0%) ^a	0
Vega Baja	17.0	359.6	- 31.1
Villalba	15.4	(22.1%) ^a	- 10.1

a) These places had no urban sector in 1960. The % in parentheses represents the proportion of their urban sector relative to their total population

Source: op. cited in Table V.

b) The sub-group whose population has decreased or whose rate of increase was negative.

- First Sub-Group

a) The first sub-group whose population increase is less than 15% but superior to zero represents 44 "municipios" or 58.7% of the total. They are scattered along the south and north coast of the island. In general all towns in this group exhibit increase in their urban and decrease in their rural population. Only three of them, Barceloneta and Santa Isabel two coastal towns, and an inner town called Barranquitas, have shown a decrease in their population (27.2, 4.6 and 3.7% respectively during the decade). The pattern of net population movement has been either from rural to urban within these regions or from rural

Table VI-A.- Total, Urban and Rural Population change experienced by "municipios" whose Population Growth is less than 15% but Superior to zero

Municipios	Population change		
	Total (%)	Urban (%)	Rural (%)
Aguada	10.4	22.1	8.17
Aguadilla	7.3	79.0	-28.5
Aguas Buenas	9.2	(18.4) ^a	-10.9
Aibonito	9.2	38.4	- 3.3
Anasco	12.9	(22.7) ^a	-12.8
Arecibo	5.1	23.1	- 7.5
Barceloneta	7.5	-27.2	24.0
Barranquitas	6.0	- 3.7	9.2
Cabo Rojo	4.8	132.7	-13.3
Catano	5.0	5.0	b
Ceiba	13.6	(28.6) ^a	-18.9
Cidra	9.1	97.6	- 5.9
Corozal	4.1	64.6	- 5.2
Guanica	8.1	22.5	- 8.2
Guayama	7.6	20.1	- 8.8
Guayanilla	4.3	69.2	- 9.6
Gurabo	10.2	92.3	-15.6
Hatillo	8.3	6.9	8.5
Humacao	7.9	55.0	- 6.9
Isabella	5.8	30.3	- 2.5
Lajas	7.6	(20.5) ^a	-14.4
Las Piedras	6.2	47.3	- 3.0
Manatí	4.1	39.2	-13.2
Mayaguez	2.4	18.1	-34.7
Moca	1.7	0	1.7
Morovis	5.3	(15.2) ^a	-10.6
Naguabo	4.7	36.3	- 3.1
Patillas	4.2	(14.3) ^a	-10.6
Penuelas	7.3	(19.8) ^a	-14.4

Table VI-A (Continued)

Municipios	Population Change		
	Total (%)	Urban (%)	Rural (%)
Ponce	9.2	15.2	-12.7
Rincon	4.5	0	4.4
Sabana Grande	2.7	67.6	-14.4
San Juan	2.6	4.7	-45.7
Santa Isabel	10.4	-4.6	17.6
Vieques	7.7	0	7.7
Camuy	0.9	(19.5) ^a	-18.8
Cayey	1.0	9.2	- 7.9
Coamo	1.5	-0.6	3.3
Comerio	1.3	20.3	-6.2
Juncos	1.5	27.8	-9.3
Maunabo	0.1	0.1	0
San German	1.2	49.1	-17.6
Yabucao	1.3	110.2	- 8.0
Yauco	0.9	43.6	-14.0

a) These places had no urban sector in 1960. The % in parenthesis represents the proportion of their urban sector in 1970 relative to their total population in 1970

Source: Ibid Table V.

directly to the U.S. mainland. Table VI-A lists the change in urban, rural and total population experienced by these 44 "municipios" during the 1960's.

- Second Sub-Group

b) The second sub-group is the one that has a negative population increase. They present a common outstanding pattern: They

present a common outstanding pattern: They belong to the inner mountainous coffee region with the highest average annual rate of natural increase which was estimated at 30 per thousand population during the 1960's¹⁵. The same aforementioned source puts at 55,019 the people that left the coffee region during the decade 1960-70. Looking at Table VII, we note that again it is the rural sector of these regions that have supported the Out-migration. Regions like Adjuntas, Las Marias, Maricao have sustained out-migration from their rural population alone without any change in their urban population. These "coffee regions" constitute the principal and most important source of internal and external migration.

Having identified on a net basis the principal "suppliers" and "receivers" of people among the different "municipios" of the island and their location (see Map 1-IV), we will proceed with our analysis of the pattern of migration within and outside the mainland and then migration within the island.

With respect to internal migration, we will conduct our investigation by focussing our attention first, on two broad sectors of Puerto Rico, the urban and the rural, since except for few regions, the change in population following migration during the 1960's has affected particularly the rural sector of the island. Thus, as far as origin of migrant is concerned, we can safely say that migrants originated from the rural and go the urban part of the "municipios" of Puerto Rico or the United States. According to Calzada¹⁶, data published by the Planning Board of Puerto Rico confirms the rural origin of migrants since this data asserts that in 1965, 60% of migrants to the U.S. in particular originated from the rural while 40% come from the urban

Table VII.- Total, Urban and Rural Population Change of "Municipios" whose rate of Population increase is negative, 1960-1970

Municipios ¹	Population change (%)		
	Total	Urban	Rural
Adjuntas	- 4.9	0	- 6.7
Arroyo	- 2.1	45.1	- 20.6
Ciales	- 13.9	23.5	- 22.1
Jayuya	- 7.1	(28.2) ^a	- 33.3
Lares	- 6.2	7.8	- 8.7
Las Marias	- 15.1	0	- 15.1
Maricao	- 14.3	0	- 14.3
Orocovis	- 0.8	22.6	- 4.8
Salinas	- 5.6	173.0	- 39.2
San Lorenzo	- 0.7	38.7	- 10.5
San Sebastian	- 9.8	3.8	- 13.4
Utuaado	- 12.2	17.2	- 21.8

a) Jayuya had no urban sector in 1960. The figure in parenthesis shows the percentage of the urban sector in 1970 relative to its 1970 population

1) Four of these places do not belong to the so called "Coffee Region".

Source: Ibid, Table V.

sector of the island. Because, however, of apparent similarities on the one hand of the first identified group of "municipios" or the "net receiver" with the urban sector and on the other hand of similar features of the second identified sub-group of the third group or the "net supplier" with the rural sector, we will try to conduct the analysis in a paralled way; that is urban and first group or "net receiver", versus rural and second sub-group of the third group, so that meaningful comparisons of their characteristics and salient points can be made.

In the course of our inquiry, we will also consider the cities of San Juan, Ponce and Mayaguez which, although they don't show any substantial increase in their rates of population growth (San Juan has 2.6%; Mayaguez: 2.4% and Ponce: 9.2%) during the decade, contain a sizeable part of the island population (26.1% i.e. 708,080 persons out of 2,712,033 in 1970) and thus deserve some attention. Also, we will touch upon a special group of regions formed by the "municipios" whose rural population has increased during the decade. These regions numbered thirteen and incidentally three of them -Barceloneta, Barranquitas and Santa Isabel - show a decrease in their urban population (See Tables VI and VI-A). Concerning these places we will try to discover, whether or not they exhibit any particular traits, for example, number of farms or farm tenure during the decade, that are not encountered among the other groups of "municipios".

External Migration.

- General Characteristics

From the time the United States took over control of the island from Spain on December 10th 1898 and until 1944 the number of Puerto Ricans migrating to the United States did not exceed 90,000. Annual migration during that period was then relatively low, except for the decade of 1920 when it was estimated to reach 40,000¹⁷. But beginning in 1945, migration toward the U.S. increased at a very fast rate reaching 34,500 in 1949-50 and 75,000 in 1952-53. By 1956, however the rhythm and volume of the migrants was estimated at 20,000. According to data released by the Planning Board of Puerto Rico¹⁸ external net

Table VIII, External Net Migration, 1960-61 to 1970-71

Fiscal Years	Arrivals	Departures	Net Balance
1960-61	667,081	680,843	- 13,762
1961-62	796,186	807,549	- 11,363
1962-63	925,868	930,666	- 4,798
1963-64	1,072,037	1,076,403	- 4,366
1964-65	1,254,338	1,265,096	- 10,758
1965-66	1,445,139	1,475,228	- 30,089
1966-67	1,594,735	1,628,909	- 34,174
1967-68	1,839,470	1,858,151	- 18,681
1968-69	2,112,264	2,105,217	7,047
1969-70	2,032,628	2,076,710	- 44,802
1970-71	2,113,336	2,115,147	- 1,811

Source: Movimiento de Pasajeros -Junta de Planificación, Sección Balanza de Pagos, cited in Informe al Gobernador, 1971, p. 234

migration shows many annual fluctuations during the 1960's depending on the availability of employment in the U.S. as shown by Table VIII. For example, net out-migration was quite high during 1964-65 and 1965-66, low beginning in 1960 to 1965 and 1970-71 and high in 1969-70. Though net migration tends to be lower on the average during the 1960's relative to the preceding decade, gross movement continues to be very substantial. This heavy movement between the U.S. and Puerto Rico is certainly facilitated by low transportation costs and the availability of transport as well as common citizenship that poses no legal restrictions to migration.

These figures (Table VIII) referring to all passengers, including tourists, persons in transit etc, give no indication from their characteristics as to whether they are residents or non residents,

and the real purpose of the trip. Net balance of travellers cannot tell the real volume of new migrants, i.e. Puerto Ricans entering into the United States for the first time, or returning to the island on a permanent basis.

- Estimate of Net Annual External Migration

Because of these shortcomings in the figures on net external Puerto Rican migration, an attempt is made here to estimate the total volume and the average net annual migration from Puerto Rico to the United States during the decade 1960-70. The data used for the estimation is taken from the U.S. Census, Persons of Puerto Rican birth in the United States in 1960 and 1970. Like our estimation of internal migration ten age groups for each sex are considered, to which the method of "survival ratio" is applied. The basic assumption made for our estimate is that the same survival ratio computed for Puerto Ricans residing in the island applies also for Puerto Ricans residing in the mainland. The data used and the results obtained are presented in Tables IX (male) and X (female). Net annual migration rate for each age bracket is obtained by taking the ratio between total migration and the mean value for the corresponding age group in 1960 and the same group ten years later in 1970. By adding net total, we arrive at 62,041 males and 91,006 females during the decade, which gives an annual average of 5,600 men and 8,200 women during the decade, or an average total figure of 13,800 for both sexes. Estimates of the Health Department of Puerto Rico¹⁹ give an annual average figure of net migration of Puerto Ricans to the United States of around 12,000 (males and females), from 1960 to 1967, a figure which is not too far from the one (13,800) obtained here.

Table IX.- Estimation of Total and Annual Net Migration of Persons of Puerto Rican Birth to the United States, 1960-1970

MALE

Age-Group 1960	Counted Popu- lation 1960	Survival Ratio	Expected Popu- lation 1960 in 1970	Age- Group 1970	Counted popu- lation in 1970	Total mi- gration	Annual Net Rate
0-4	10,141	0.9582	9,717	10-14	26,164	16,447	9.1
5-9	20,598	0.9966	20,528	15-19	35,918	15,390	5.4
10-14	29,431	0.9949	29,281	20-24	51,135	21,854	5.4
15-19	29,972	0.9931	29,765	25-29	49,363	19,958	4.9
20-24	39,680	0.9893	39,255	30-34	44,543	5,288	1.3
25-34	78,649	0.9748	76,764	35-44	69,798	- 6,966	-0.9
35-44	51,557	0.9599	49,489	45-54	42,405	- 7,084	-1.5
45-54	27,319	0.9090	24,833	55-64	22,455	- 2,378	-0.9
55-64	13,717	0.8185	11,227	65-74	9,256	- 1,971	-1.7
65 and over	6,334	0.2520	1,596	75 and over	3,459	1,863	3.8

Notes: Column 4 (Expected Population) : Column 2 (Pop. 1960) x
Column 3 (Survival Ratio)

Column 7 (Total Migration) : Column 6 - Column 4

Column 8 (Annual Net Rate) : Column 7 divided by arithmetic
mean of Columns 2 and 6

Source: U.S. Bureau of the Census, Puerto Ricans in the U.S. (1960), p. 2,
(1970), p. 4

- 1950's and 1960's Rate of External Migration Compared

However, in comparing, our annual rates for the various brackets in the 1960's, with those obtained by Schultz and Nerlove²⁰ for the 1950's, as shown in Table XI, we note that during the 1960's, the migration rate has decreased considerably relative to the 1950's, which

Table X.- Estimation of Total and Annual Net Migration Rates of Persons of Persons of Puerto Rican Birth to the United States, 1960-1970

FEMALE

Age-group 1960	Counted Popu- lation in 1960	Survival Ratio	Expected Popu- lation 1960 in 1970	Age-group 1970	Counted Popu- lation in 1970	Total Mi- gration	Annual Net Rate
0-4	10,017	0.9758	9,774	10-14	25,803	16,029	8.9
5-9	20,171	0.9977	20,125	15-19	36,253	26,128	5.7
10-14	30,222	0.9972	30,137	20-24	57,056	26,919	6.2
15-19	32,222	0.9960	32,093	25-29	54,279	22,186	5.1
20-24	39,169	0.9950	38,973	30-34	47,962	8,989	2.1
25-34	75,793	0.9883	74,906	35-44	74,567	- 339	-0.04
35-44	48,568	0.9754	47,373	45-54	46,057	- 1,202	-0.3
45-54	27,486	0.9459	25,999	55-64	26,476	477	1.8
55-64	15,702	0.8732	13,711	65-74	12,509	- 1,202	-0.9
65 and over	10,298	0.3100	3,192	75 and over	6,327	3,135	3.8

Notes: See Notes, Table IX

Source: op. cited, Table IX

confirms the already mentioned tendency for net migration to taper off. During the 1950's all brackets show clear signs of outmigration, while during the 1960's the older groups beginning with the 35-44 bracket at the end of the period, show signs, albeit slight, of returning migration to Puerto Rico. During both periods the pattern is the same, the young show higher rates of outmigration than the old and the highest rates are found among those aged 10-14 to 25-29 at the end of period. With regard to sex, while males tend to show a higher rate than females in internal migration, females tend to dominate men (if only slightly), in external migration, especially among the brackets 20-24 to 30-34 at the

Table XI.- Puerto Rico Net Migration Rates to the United States
1950-1960 and 1960-1970

Group-age at the beginning of the period	Male		Female	
	1960 ¹	1970 ²	1960 ¹	1970 ²
0-4	19.83	9.1	20.13	8.9
5-9	14.34	5.4	14.77	5.7
10-14	15.76	5.4	17.08	6.2
15-19	16.47	4.9	14.36	5.1
20-24	9.32	1.3	7.64	2.1
25-34	6.93	-0.9	5.27	-0.04
35-44	3.70	-1.5	3.12	-0.3
45-54	3.07	-0.9	4.12	1.8
55-64	4.09	-1.7	4.62	-0.9
65 and over	3.61	3.8	2.01	3.8

Source: 1) Schultz and Nerlove, op. cited note 3, p. 80 Table A-1

2) Taken from Tables IX and X

end of the period.

Characteristics of the Puerto Rican Migrants in the United States

What are the principal characteristics of the persons of Puerto Rican birth in the U.S. and what are the consequences of their absence from Puerto Rico on the Puerto Rican economy? To find out about these characteristics, we will conduct the analysis by comparing Puerto Rican migrants in the U.S. and Puerto Ricans living in Puerto Rico.

- Sex and age. In 1970, we found in the U.S. mainland 810,087 persons of Puerto Rican birth of whom 420,378 were females and only 389,709 males. Females thus outnumber males by 30,669. Percentage-wise

Table XII.- Distribution by Age and Sex of Persons of Puerto Rican Birth in the U.S. and in Puerto Rico, 1970

Age-groups	Persons of Puerto Rican Birth in							
	U.S.				Puerto Rico			
	Male	%	Female	%	Male	%	Female	%
0-14	61,377	15.7	58,892	14.0	503,133	37.8	489,331	35.4
15-19	35,918	9.2	36,253	8.6	144,330	10.8	148,058	10.7
20-24	51,135	13.1	57,056	13.6	106,242	8.0	124,247	9.0
25-34	93,906	24.1	102,241	24.3	157,672	11.9	181,721	13.2
35-44	69,798	17.9	74,567	17.7	130,263	9.8	143,232	10.4
45-64	64,860	16.7	72,533	17.2	202,301	15.2	203,285	14.7
65 and over	12,715	3.3	18,836	4.5	86,017	6.5	91,841	6.6
Total	389,709	100	420,378	100	1,329,100	100	1,382,075	100

Source: U.S. Bureau of the Census, Census of Population 1970, General Social and Economic Characteristics, PC (1)-C53, Puerto Rico and Puerto Rican in the U.S., p. 2

these numbers represent 51.0 females against 48.1 males. In 1960, women outnumbered men by only 2,000. The substantial difference in number of females over males prevailed in 1950 as well when it was 9,000 or 51.9% women and 48.1% men.

Why do we find in the U.S. more Puerto Rican women than men? Aside from the well-known fact that females have a definite longevity advantage over males, more so if men are subjected to the fatal diseases and accidents inherent to urban life - we will see later that in fact the male participation rate in the labor force in the U.S is not only higher than that of women but also that they live and work mostly in urban centers in the U.S. (97.8% of Puerto Ricans living in the U.S.

live in urban centers) - there is also the fact that, outmigration being mainly made up of rural persons, women are more prone to migrate from farms since they are not tied to any particular farm training as are their male counterparts. Looking now at the distribution by age and sex of the two populations in Table XII, we observe that among Puerto Ricans living in Puerto Rico as compared with those living in the United States there are more young persons 0-14, 15-19 and old persons 65 and over in the population. This means that there exist in the island more persons dependent on those who work than among the Puerto Ricans in the U.S. The effect of urban environment on Puerto Ricans living in the U.S. with regard to the cost of children is readily apparent. Because of migration, Puerto Rico suffers a clear deficiency relative to the U.S. group in its more productive and active population. The brackets 20-24 to 45-64 are better represented in both sexes in the U.S. than in Puerto Rico. The contention that migration selects among the youngest is well verified in the case of Puerto Rican migration to the United States. The principal effect of this drain on the population must have its effect on the size of the labor force and certainly on its skills and educational level, as we will see later.

- Sex ratio. In 1960, Puerto Ricans in the U.S. had a well balanced sex ratio (men over women) of 99.3 and this balance extended fairly well over all the age-brackets, except for the old age-brackets where women dominate. By 1970, the tendency of the sex ratio in the U.S. is to show some unbalance, especially among the groups 20-24 and 45-64 as shown in Table XIII. Overall, the sex ratio is more balanced in Puerto Rico than in the U.S., 96.2 (Puerto Rico) against 92.7 (U.S.A.).

Table XIII. Sex Ratio of Persons of Puerto Rican Birth in the U.S. and Puerto Ricans in Puerto Rico, by Age-Groups, 1970

Age-Groups	Persons of Puerto Rican birth in	
	United States	Puerto Rico
0-14	104.2	102.8
15-19	99.1	97.5
20-24	89.6	85.5
25-34	91.8	86.8
35-44	93.8	91.6
45-64	89.4	99.5
65 and over	92.7	96.2

Source: Computed from Table XII

We also note (Table XIII) that the balance is more even among the young and the old in Puerto Rico, whereas in the U.S. women dominate in the group 65 and over. This may indicate that old men return to Puerto Rico to retire. Young women leave Puerto Rico in greater numbers than young men and old women stay in the U.S. probably to continue living with or caring for their progeny.

- Education. How do the two populations compare as to their educational level? In trying to answer that question the objective is to ascertain whether or not migration has drained the better educated leaving Puerto Rico with a higher proportion of less educated and skilled persons. However, the data, as presented in the census, do not permit a conclusive answer because the level of education of the Puerto Ricans living in the United States is not gauged upon entry to the U.S. Most of them have been living there for some time and there is no way of knowing whether the level reported has been acquired in Puerto Rico or

in the United States. Perhaps in arriving in the U.S. the Puerto Rican migrant finds that it pays more to continue to increase his level of schooling in order to secure a better job. He then becomes more motivated. For these reasons, in considering the level of education of the population we cannot say positively what the migrant level of education was. With this observation in mind, we note that in 1960, the median years of school completed among Puerto Ricans residing in the United States was 7.5 against only 4.6 for those residing in the island, which is approximately three years more for the U.S. residents. This differential tends to narrow somewhat in 1970, as the 1970 figures were 8.4 for the residents of the U.S. and 6.9 for P.R. residents. Perhaps, one can attribute the differential in level of schooling to the differences in the age structure between the groups. As shown by Table XVI, the age structure tends to have some influence on the overall median. Males in Puerto Rico compare favorably with those in the U.S., except for the group 65 or over, whose level is three times less in Puerto Rico relative to the U.S. Females in Puerto Rico also compare quite favorably with those in the U.S. in younger groups 14-19, 20-24 and 25-34. Over the age of 35 the level decreases quite substantially. Thus we can conclude that in 1970 differential in the overall level of schooling between the two groups is due to the aging of the Puerto Ricans in Puerto Rico whose population has a higher proportion of persons 65 and over (see Table XII of this chapter).

That the level of education of Puerto Ricans born in Puerto Rico residing in the island relative to those residing in the United States has been increasing can be attributed to various factors, in par-

Table XIV. Median (average) School Years completed by Puerto Ricans of Birth Residing in the U.S. and those Residing in Puerto Rico by Age-groups and Sex, 1970

Age-groups	Male in		Female in	
	United States	Puerto Rico	United States	Puerto Rico
14-19	8.9	8.5	9.1	9.0
20-24	10.8	11.3	10.7	12.0
25-34	9.8	10.4	9.4	10.2
35-44	8.6	9.4	8.2	7.8
45-64	7.9	12.0	6.9	4.9
65 and over	6.2	2.7	5.1	2.4

Source: U.S. Bureau of the Census, Puerto Rican in the United States: 1970, Table 5, p. 39 and Characteristics of the Population, Puerto Rico, Table 117, p. 658

ticular to the presence of returning migrants from the United States in Puerto Rico from 1965 through 1970. Out of 123,630 men who returned to Puerto Rico during that period 11% or 13,626 were attending school or college; the percentage for women is higher - 15% or 15,080 out of 99,170 during the same period²¹. Also the percentage of persons of 3-34 years of age enrolled in school in Puerto Rico compared favorably to that of the United States, as shown by Table XV. When the percentage (49.2) enrolled in school in 1970 in Puerto Rico is compared to the percentage in 1960 (45.6)¹, there is substantial progress. If this trend continues, i.e. if education continues to reach all the strata of the population, and jobs requiring education and skills become more

1) In 1960, the school enrollment was given for children 5-34 years old.

Table XV. Percent of School Enrollment of Persons of P.R. birth 3-34 Years old Residing in the United States and in Puerto Rico, 1970

Age	Persons of Puerto Rico Birth in	
	United States	Puerto Rico
3-34	27.7	49.2
3 and 4	11.4	4.6
5 and 6	67.5	51.4
7 to 13	67.5	91.2
14 to 17	77.1	79.9
18 to 24	11.7	28.2
25 to 34	1.9	6.2

Source: U.S. Bureau of the Census, op. cited in Table XIV. Tables 45 and 4.

plentiful, one can expect that migration will be less and less harmful to the level of education of the population.

Labor force. Since external migration, as previously established, has played an important role in the shaping of the various age components of the population, we expect this to be reflected in the age structure of the labor force as well. In other words, even if the total population has increased during the decade, the proportion of the population participating in the labor force may not grow correspondingly due to the effects of migration. Added to this, is also the possible effect of the rising educational opportunities offered both men and women and the clear relation existing between education, income and "employability" which can affect the labor participation rate, mostly of the younger age-groups by inducing them to stay in school. On the side of women, we expect that the combined effect of "emancipation"

Table XVI. Changes in the Labor Force in Puerto Rico by Age-groups
1960-1970

Age-groups	Male (Thousands)			Female (Thousands)		
	1960	1970	% change	1960	1970	% change
14-15	2,924	2,766	- 5.4	1,988	1,279	- 35.7
16-19	32,656	23,454	- 28.2	12,192	13,301	9.1
20-24	59,640	65,621	10.0	29,168	45,130	54.7
25-34	103,732	124,100	19.6	42,068	64,785	54.0
35-44	103,788	102,649	- 1.1	31,488	47,211	49.9
45-64	131,088	135,169	3.1	24,992	38,027	52.1
65 and over	16,012	17,610	1.0	2,364	2,688	13.7
Total	449,840	471,369	4.8	144,260	214,421	48.6

Source: U.S. Census of the Population, Characteristics of the Population, Table 135 (1970) and Table 97 (1960)

as the result of world-wide women's liberation, higher levels of education and the diversification of the structure of employment will give them more opportunities and induce them to enter the labor force. In order to determine the changes that have taken place in the Puerto Rican labor force during the decade, we will compare its profile in 1960 and 1970 and then with that of P.R. residents in the U.S.

Table XVI presents the changes that took place in the Puerto Rican labor force from 1960 to 1970. We observe, on the side of the males, a decrease in the young groups 14 to 19 despite the increase in the total population in that bracket of 14.6% (14-15) and 16.3% (15-19) during the decade. That decrease must be attributed to the increase in school enrollment in these groups, in addition to the impact of migration. School enrollment, according to the 1960 and 1970 Census,

Table XVII.- Labor Force Participation Rate by Age, Puerto Rico 1960-70 and Puerto Rican by Birth in the United States, 1970. Male and Female.

Age	Puerto Rico				United States	
	Male		Female		Male	Female
	1960	1970	1960	1970	1970	
14-15	5.0	4.1	3.3	1.9	8.8	4.2
16-19	33.9	21.0	12.6	11.5	44.3	27.0
20-24	76.0	61.8	31.9	36.3	83.0	36.4
25-34	87.0	78.7	29.6	35.7	87.3	27.4
35-44	89.8	78.8	25.0	32.9	87.9	35.3
45-64	82.5	66.8	17.2	18.7	77.7	32.3
65 and over	27.6	20.5	3.9	2.9	20.7	7.0
Total	65.7	54.7	20.0	22.9	74.7	29.5

Source: Ibid, Table XIV

increases for males from 66.0% to 83.2% for the group 14-15 and from 39.1 65.1% for the group 16-19 during the decade 1960-70.

Apparently, since the groups 20-24 and 25-34 have shown substantial increase in their labor force, one would tend to conclude that migration has not affected them. That this is not so can be verified by looking at the corresponding increase in the population of these brackets. Group 20-24 (male) shows a population growth of 27.7%, yet its labor force increases by only 10% and group 25-34 records a population growth of 31.7% with a corresponding increase of only 19.6% in the labor force. One cannot resist the conclusion that migration has certainly had its impact on the labor force of these groups.

On the side of the females, the decrease in the group 14-15

of age and from 38.4 to 65.6 for those aged 16-19. From persons aged 20 to 64, the labor force has grown more than 50% and even those aged 65 and more have shown some increase (13.7%). In fact, in total, the growth of the women's labor force is in the order of 48.6 which is suggestive of increasing employment opportunities, especially in the office and clerical fields and also in the increase in the educational level of women which makes them more "employable".

-Rate of Participation of the Puerto Rican Migrants in the U.S.

In term of rate of participation in the labor force, there is a clear decline during the decade (see Table XVll) for men of all ages, 65.7% in 1960 to 54.7% in 1970, while the participation rate for women shows an increase from 20.0 to 22.9% during the same period. While the structure of the economy tends to offer more opportunities to women, migration seems to draw heavily on the groups of men who want and look for work. Indeed comparing the behavior of both sexes in 1970 in Purto Rico and in the United States, the U.S. group shows consistently more desire and willingness to work than the Puerto Rican group, which is to say that the migrants are more motivated than the nonmigrants. Despite this low participation observed in Puerto Rico, the unemployment rate is heavy among the younger groups in the islands, heavier than in other groups, as shown by Table XVlll. It is clear that while one can talk about the negative effect of migration in the sense that it drains the ablest and youngest, one cannot help wondering what would be the number of jobs necessary to occupy all these migrants, had they not decided to migrate.

With regard to the participation rate of both men and women

Table XV111.- Unemployment Rate in Puerto Rico, Persons 14 Years Old and Over, March 1972.

Age-group	Men		Women	
	Number(Thousands)	Rate	Number(Thousands)	Rate
14-19	13	30.6	4	27.3
20-24	25	24.3	9	15.3
25-34	22	12.3	8	8.5
35-44	10	8.7	4	7.0
45-54	6	6.9	_1)	_1)
55-64	4	6.2	_1)	_1)
65 and over	_1)	_1)	_1)	_1)
Total	81	13	26	9.6

_1) Not enough cases in the samples for a reliable estimate.

Source: Employment and Unemployment in Puerto Rico, Monthly Report 72-3, March 1972, Bureau of Labor Statistics, Table 2, p. 5

65 and over in Puerto Rico, we observe that they show a decrease. This may be attributable partly to shifts from farm to cities. Older persons are less likely to find employment in cities than on farms, and thus, knowing that they cannot find a city occupation, they simply drop from the labor force.

-U.S. and P.R. Job-Skill Requirements Compared

Are Puerto Rican concentrated in higher-skilled jobs in the United States than they are on the island? In trying to answer this question, we can perhaps add some light to the contention that Puerto Ricans in the U.S. are on the average more skillful or more educated than those in the island, since white-collar jobs require more education and skills and it is generally observed that in industrial societies poor education goes hand in hand with poor employment experience. But even if the U.S.

Table XIX.- Occupational Distribution of Puerto Rican Born Persons in the United States, 16 Years Old and Over by Sex, 1970.

Occupation Group	Male		Female	
	U.S.	P.R.	U.S.	P.R.
Total	100.0	100.0	100.0	100.0
Professional, Technical	3.8	8.9	6.5	18.5
Managers, Administrators except Farms	3.9	8.7	1.5	3.4
Sales Workers	3.8	8.3	3.8	5.4
Clerical and Kindred	9.6	7.2	24.7	23.1
Craftsmen, Foremen	15.6	20.3	2.7	3.0
Operatives and Transport	35.6	16.7	46.2	26.2
Laborers, except Farm	7.9	9.1	1.2	1.1
Farmers and Farm Managers	0.05	2.0	-	0.1
Farm Laborers and Foremen	1.52	8.5	0.35	0.4
Service Workers, except Private Household	18.1	10.1	11.9	13.7
Private Household Workers	0.08	0.1	0.9	4.9

Source: U.S. Census of Population, op. cited in Table XIV, Table 137 (1970) and Table 7 (1970) respectively.

Puerto Rican population shows a lower proportion of persons concentrated in blue-collar jobs than on the island, there remains the question of discrimination based on origin or language that may play an important role in shaping the employment profile of the U.S. group. Nevertheless, Table XIX compares the occupational distribution of employment in Puerto Rico and in the United States of persons of Puerto Rican birth. Males residing in Puerto Rico are more advanced in occupation than those in the United States: Only 21.1% of the U.S. group are in professional,

technical, clerical and sales - level jobs, as compared with 33.1% in Puerto Rico. Women show a much higher proportion: 50.4% of Puerto Rican women in Puerto Rico as compared with 36.5% in the U.S. As for blue-collar (craftsmen, operatives, transport and non-farm workers) Puerto Rican males in the U.S. show a higher proportion: 68.7% to 46.1% in Puerto Rico. The same is true for women, where 50.1% in the U.S. are in blue-collar jobs, as compared to 30.3% in Puerto Rico. Farming occupies 10.5% of Puerto Rican males in Puerto Rico as compared to 1.6% in the U.S. In both the U.S. and on the island women show no interest in agriculture, less than 1%. Finally, workers in services and the private household sector occupy a higher proportion for men in the U.S. than in P.R., while the reverse is true for women. In total, Puerto Rican men and women in the U.S. are more concentrated in blue-collar jobs than in Puerto Rico which, aside from other probable effects (discrimination or language) against Puerto Ricans in the U.S., does not sustain the thesis that net migration to the U.S. during the 1960's has drained the better educated and talented from Puerto Rico.

- Education and Employment of Puerto Rican-born Workers in the United States

That education may have played a more important role than discrimination based on origin in shaping the employment of Puerto Rican-born workers in the U.S. can be ascertained by looking at the profile of employment of U.S.-born persons of Puerto Rican parentage versus a similar profile of persons of native Puerto Ricans working in the U.S. It is evident from Table XX, that these second-generation Puerto Ricans occupy better positions on the employment ladder than those of the first gener-

Table XX.- Occupational Distribution of Puerto Rican born Persons and by Parentage in the U.S., 1970

Occupation Groups	Male		Female	
	Birth	Parentage	Birth	Parentage
Total	100	100	100	100
Professional and Technical	3.8	9.1	6.5	10.4
Managers, Adm. except Farms	3.9	5.4	1.5	1.9
Sales Workers	3.8	6.2	3.8	6.7
Clerical and Kindred	9.6	15.2	24.7	50.3
Craftsmen, Foremen	15.6	15.3	2.7	1.3
Operatives and Transport	35.6	19.4	46.2	13.3
Laborers, Except Farm	7.9	7.9	1.2	0.4
Farmers and Farm Managers	0.05	0.1	-	0.1
Farm Laborers and Foremen	1.52	0.35	0.35	0.1
Service Workers, Except Private Household	18.1	12.4	11.9	14.1
Private Household Workers	0.08	0.08	0.9	1.1

Source: Op. cited in Table 14, Table 3 p. 33

ation. Male Puerto Ricans by parentage are in the proportion of 35.9 in white-collar jobs, as opposed to 21.1 for males in Puerto Rico. The record for women is more impressive, 69.3 of Puerto Rican parentage in white-collar jobs to only 36.5 native Puerto Ricans. Native-born men, like the women, hold down a higher proportion of blue-collar jobs, and except in domestic employment where women of Puerto Rican parentage outnumber women born in Puerto Rico, the picture of better job occupation is more favorable for second generation Puerto Ricans in the U.S. than for migrants born on the island.

Better job occupation is also accompanied by a higher score on the educational level for second-generation Puerto Ricans in the U.S.

Table XXI- Median School Years Completed of Persons of Puerto Rican Birth and Parentage Residing in the United States, 1970

Age-groups	Male		Female	
	Birth	Parentage	Birth	Parentage
14-19	8.9	9.8	9.1	10.0
20-24	10.8	12.2	10.7	12.3
25-34	9.8	12.1	9.4	12.1
35-44	8.6	11.6	8.2	11.7
45-64	7.9	8.9	6.9	8.9
65 and over	6.2	5.8	5.1	5.1

Source: U.S. Bureau of the Census, Puerto Rican in the United States: 1950, Table 5, pp. 39-40

At all ages, except in the group 65 and over, there is at least one more full year of median school completed by male and female Puerto Ricans by parentage as compared to those born in P.R., as shown by Table XXI. In this way, education must have played a role in job occupation. The only question remaining is the one having to do with language. Since Puerto Ricans born in the U.S. have studied in English there, they may have some advantage in employment opportunities over those born on the island who speak mainly Spanish. Whatever the case, Puerto Ricans by parentage 3-34 years old show more attachment to school than native-born Puerto Ricans, all of which militates for their relatively more favorable employment picture. Table XXII presents the comparison. From five years of age and up to 34, the P.R. by parentage show a more impressive score than those native-born P.R.

External Migration and Puerto Rican Family Characteristics in the U.S.

Has migration brought any changes in the size of family

Table XXII.- Percent of Puerto Ricans by Birth and Parentage Enrolled in School, 3-34 Years old, 1970

Age-groups	Birth	Parentage
3 to 34	27.7	67.4
3 and 4	11.4	10.4
5 and 6	67.5	73.7
7 to 13	93.2	95.6
14 to 17	77.1	90.3
18 to 24	11.7	30.0
25 to 34	1.9	6.8

Source: U.S. Bureau of Census, op. cited in Table XIV, Table 4

preferences of persons of Puerto Rican birth residing in the United States? Or are there any differences between Puerto Ricans in the U.S. and those in P.R. in terms of fertility rates? It is a well known fact that Puerto Ricans in Puerto Rico, especially in the rural areas are characterized by their high though declining rate of fertility. It is this high rate of fertility that renders the population problem so acute in the island and migration to the U.S. so welcome as to be called a "safety valve". Without migration, estimates are that the island population would double every twenty years.

During the decade 1960-1970 there has been a substantial decrease in the fertility ratio as shown in columns 2 and 3 of Table XXIII. Aside from other effects, such as urbanization and use of contraceptives, migration, drawing, as we can see, largely on the most productive age among women, must account for the decrease observed.

Since most Puerto Rican migrants in the U.S., as we found

Table XXIII.- Fertility Characteristics, Persons of Puerto Rican Birth and Parentage in the United States and in Puerto Rico

	By Birth in the U.S.	Puerto Rico		Parentage
	1970	1960	1970	1970
Children per 1,000 women ever married				
15-24 years old	1,507	1,884	1,469	1,074
25-34	2,812	3,661	2,975	2,272
35-44	3,563	5,269	4,077	3,007

Source: op. cited, Table XIV

earlier, originate from rural Puerto Rican areas and live in the urban centers of the U.S., they must show differential fertility relative to Puerto Rico, if fertility is not simply a biological question but rather conditioned by prevailing economic conditions. If this is so, i.e. if Puerto Ricans in the U.S. exhibit a lower fertility ratio it can safely be inferred that as Puerto Rico approaches the U.S. in its urban and economic structure, fertility in the island will tend to approach also that of the U.S. Table XXIII compares fertility characteristics of persons of Puerto Rican birth and parentage in the U.S. and in P.R. Young women of P.R. birth in P.R. and in the U.S. 15-24 tend to behave almost the same way in both groups. Perhaps it is a common desire to have children at rather early ages. But from 25 to 44, women residing in Puerto Rico tend to show a higher rate of fertility than those residing in the U.S. The evidence here, though not decisively conclusive indicates that more acquaintance with an urbanized "milieu" has a certain effect on the rate of fertility. In fact, column 3 of Table XXIII adds to this evidence. Persons of Puerto Rican parentage, though subject to a

familial environment of Puerto Rican parents by birth show a clearly lower rate of fertility relative to those originated in Puerto Rico but residing in the U.S. and those still living in Puerto Rico.

Concluding Remarks on External Migration

In conclusion, external migration during the 1960's seems to have affected mostly the age structure of the population and the labor force. The population of Puerto Rico contains a high proportion of young and old. The sex ratio seems not to be affected seriously by migration. The labor force shows a deficit in the younger brackets 20 to 34. On the question of education, external migration seems not to have affected the island labor force very seriously. Perhaps this is due to the changing structure of the Puerto Rican employment profile requiring more white-collar jobs, and thus more education, which in turn induces the population to invest more in education, or to the effects of returning migrants who generally bring skills and education to the island population. Finally, the fertility ratio tends to differ among women in Puerto Rico and in the U.S., and especially so at older ages. Since the Puerto Rican population, when compared to that of Puerto Ricans resident in the U.S. shows a deficiency in the proportion of women of the most productive age, migration seems to have helped decrease the fertility ratio.

Characteristics of the Puerto Rican migrants within the island.

- Age and Sex

The first characteristic that will be investigated refers

Table XXIV. Distribution by Age and Sex of the Puerto Rican Population, Urban and Rural, 1970

Age-groups	Urban				Rural			
	Male		Female		Male		Female	
	Total	%	Total	%	Total	%	Total	%
0-14	267,732	35.3	262,742	32.1	235,401	41.1	226,589	40.1
15-19	79,067	10.4	84,085	10.3	65,263	11.4	63,973	11.3
20-24	63,655	8.4	74,143	9.1	42,587	7.4	50,104	8.9
25-34	98,399	13.0	114,874	14.1	59,273	10.3	66,847	11.8
35-44	83,466	11.0	94,127	11.5	46,797	8.2	49,465	8.8
45-64	119,510	15.8	128,696	15.7	82,791	14.5	75,089	13.3
65 and over	46,413	6.1	59,306	7.2	39,604	7.0	32,535	5.8
Total	758,242	100	817,473	100	571,716	100	564,602	100

Source: U.S. Bureau of the Census, Census of Population: 1970 General Social and Economic Characteristics, Final Report PC (1) - C53, Puerto Rico

to the structure of the population by age and sex. The proportion of the various age groups of a population has an important bearing on its fertility rate, on the composition of the labor force and on the economy in general. A very young population will weigh heavily on the budget allocated to educational facilities. A very old population, because of its low fertility rate, will affect the rate at which different age groups will grow, especially the younger groups. Furthermore the age composition of the labor force will be altered over time depending on the age structure of the population. When, as a result of migration, the working force, those between 18 and 45, have left, leaving a higher proportion of old and young, there will be more dependent persons on

the economy, i.e. more mouths to feed and fewer hands to work.

Table XXIV presents the profile by age and sex of the Puerto Rican urban and rural population. Clearly the rural population is younger than the urban relatively. The groups 0-14 and 20-24 are better represented in urban than rural areas. As already noted, the higher proportion of young persons in rural compared to urban areas can be attributed to the higher fertility ratio prevailing in the rural sector: the benefits of having children in this sector outweigh their costs as compared to the urban. But from the next 20-24 to the 35-44 brackets, the picture is reversed. These groups, constituting the main part of the labor force, are more concentrated in urban areas where jobs are more plentiful. There is however, no sharp difference between the next two older groups. We would normally expect a higher ratio of old people in rural areas, but the decrease in farm jobs, better health opportunities in cities, and the customs in Puerto Rico of older parents to accompany their sons or daughters, may be responsible for the almost even proportion of older groups in both sectors. In fact, women who tend more to migrate with their sons and daughters are absolutely and percentage-wise lower in rural than men, whereas in the younger groups (20-24 to 25-44) they surpass men absolutely as well as percentage-wise.

- Age and Sex in the Receiver and Donor Regions

Tables XXV and XXVI present the distribution by age for both sexes of the population of the regions forming the "receiver" and "donor" groups. In looking at the mean of the distribution, we note the following pattern: The "donor" regions are characterized by a higher

Table XXV.- Distribution by Age and Sex of the Population of the "net Receiver" Regions
1970 (%)

Municipios	0-14		15-19		20-24		25-34		35-44		45-64		65	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Bayamon	31.4	33.8	9.9	10.4	7.6	8.8	13.7	15.6	12.9	13.0	13.9	12.9	4.5	5.1
Caguas	38.2	35.4	10.2	10.2	7.8	9.5	13.8	14.9	10.6	10.8	13.5	13.3	5.8	5.8
Carolina	36.9	33.7	9.0	9.2	7.6	9.6	16.9	18.6	13.2	12.5	12.6	12.1	3.8	4.2
Dorado	38.2	37.1	10.8	11.8	8.8	9.9	13.0	13.6	9.0	9.4	14.3	13.1	5.9	5.0
Fajardo	34.4	32.7	8.1	8.6	8.0	9.1	13.1	14.3	11.0	11.1	16.7	16.4	8.6	7.7
Guaynabo	37.3	35.8	10.2	10.4	7.7	8.3	12.7	14.3	12.7	12.8	14.9	13.3	4.5	4.9
Hormigueros	34.1	32.8	7.8	9.2	7.8	11.5	15.0	19.3	12.1	12.3	16.8	15.9	6.3	6.6
Loiza	41.7	40.7	11.0	10.5	8.2	9.6	12.2	13.2	9.0	9.5	12.6	11.4	5.2	4.9
Rio Grande	36.9	36.1	10.5	10.1	8.7	10.0	13.8	14.6	9.7	9.7	13.7	13.5	6.6	6.0
Toa Baja	39.4	38.2	9.9	9.6	8.9	9.7	14.9	15.9	10.6	10.8	12.3	11.5	4.0	4.2
Trujillo Alto	37.2	36.0	10.3	10.4	8.4	9.8	15.0	16.6	10.9	10.8	13.3	12.0	4.8	4.4
Vega Alta	40.6	38.0	10.8	10.8	7.5	8.1	12.0	14.3	9.3	9.8	14.0	12.7	5.8	5.2
Mean	37.7	35.8	9.9	10.1	8.1	9.6	13.8	15.4	11.0	11.0	14.0	13.2	5.5	5.3

Source: U.S. Bureau of the Census, Census of the Population 1970, Volume I, Characteristics of the Population, Part 53, Puerto Rico

Table XXVI.- Distribution by Age and Sex of the Population of Net "Donor" Regions
1970 (%)

Municipios	0-14		15-19		20-24		25-34		35-44		45-64		65	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adjuntas	42.4	40.2	11.7	11.5	6.2	8.0	8.7	11.4	8.0	8.5	15.5	13.9	7.3	6.5
Arroyo	41.7	39.6	11.7	10.6	7.3	8.1	9.7	10.7	6.9	7.8	14.7	15.3	8.0	7.8
Ciales	43.7	42.3	12.3	11.1	6.8	8.1	8.4	10.0	8.1	9.0	14.0	13.1	6.8	6.2
Jayuya	44.7	43.8	12.5	12.1	6.2	7.8	8.4	10.0	7.1	8.0	14.4	13.0	6.7	5.2
Lares	43.1	38.9	10.6	12.0	6.4	7.9	8.9	11.2	8.3	9.0	15.4	14.1	7.4	6.9
Las Marias	40.1	39.3	11.9	11.7	6.7	9.3	10.1	11.2	8.1	8.3	15.2	14.3	7.9	5.9
Maricao	40.2	40.1	13.0	12.7	7.6	9.2	9.0	11.0	7.6	8.5	14.8	12.9	7.7	5.6
Orocovis	48.6	46.6	12.3	11.5	6.1	7.5	7.7	9.1	6.7	8.0	12.8	12.1	5.8	5.2
Salinas	41.2	39.1	11.1	10.5	7.7	8.6	10.6	11.9	7.6	10.9	16.1	14.6	7.4	6.5
San Lorenzo	44.3	41.5	11.4	12.0	6.2	8.0	9.1	10.3	7.8	8.7	14.2	13.8	7.8	6.8
San Sebastian	39.4	36.2	11.1	11.7	6.5	8.1	9.2	11.0	8.6	10.5	17.3	15.7	7.8	6.8
Utuado	42.8	40.4	11.5	11.4	6.1	8.0	8.3	10.2	7.5	9.0	15.8	14.3	8.0	6.7
Mean	42.7	40.7	11.7	11.6	6.7	8.2	9.1	10.7	7.7	8.8	15.0	13.9	7.3	6.3

Source: Op. cited Table XXV

proportion of young persons (male and female) than the "receiver" regions. This proportion is 37.7 (male), 35.8 (female) and 42.7 (male), 40.7 (female) for the group 0-14 for "receiver" and "donor" respectively. It is equally lower for the "receiver" than "donor" for the next younger group (15-19), i.e. 9.9 (male), 10.1 (female) for "receiver" and 11.7 (male), 11.6 (female) for "donor". Regions of destination are closer to the urban sector in general, whereas regions of origin identify themselves more with rural areas where the fertility ratio is higher. But beginning with the brackets 20-24 to 35-44, the proportion of persons is higher among the "receiver" than the "donor". (See Tables XXV and XXVI). This was to be expected, since this is the group that forms the bulk of the labor force. Persons in the group 20-24 have certainly terminated their formal schooling, or are ready to enter the labor force or to get married, so that a move appears not incompatible with their present status. In the terminology of the human capital theory, the gains to be derived from investment in migration are the highest and the cost the lowest when the decision is taken at an early stage of the life-cycle.

Following with the older brackets, we find that the picture is reversed; "donor" regions tend to have a higher proportion of their population in the brackets 45-64 and 65 and over relative to the "receiver" regions. This is the age when most people are already settled and are reluctant to undertake changes. The process of migration tends, thus, to leave the mainly agricultural or rural "donor" regions with the youngest and the oldest with the result of more dependents on those who work. It is not surprising then that the introduction and implementation of new methods of farming sometimes encounter strong resistance among old

farm operators who in turn tend to keep agriculture in its traditional form.

- Age and Sex in the Rural 'Receiver' and 'Donor' Regions

The rural sectors of these regions exhibit with minor variations the same pattern as their urban counterparts, i.e. for a given region the same age structure is found, as shown by Tables XXVII and XXVIII. The rural sectors of the "receiver" region show a lower representation of the youngest and oldest in their age-structure relative to the rural sector of the "donor" region, while the intermediate groups are more represented in the "receiver" relative to the "donor". This suggests that the workers of the rural sectors of the "receiver" regions, because of their nearness to Metropolitan San Juan where opportunities for employment are high, are abandoning labor-intensive farming in favour of more modern capital-oriented agriculture than in other parts of the island, so that these rural sectors are transformed in suburbs of the metropolis of San Juan, which makes the rural parts of these "municipios" not very different from their urban sector as far as age structure is concerned. This assertion can be verified by looking at Table XXIX and XXX. Income derived from modern agriculture (Livestock) is higher than that derived from traditional crops (coffee, sugar cane, tobacco) in the "receiver" regions, except for Hormigueros near Mayaguez, whereas the reverse is true for the "donor" regions. Likewise, the ratio of farm workers to total workers is lower in "receiver" than in "donor" regions. As a result, workers living in rural areas in the "receiver" zones commute in a higher proportion to go to work outside their "municipios" of residence (see third column of Tables XXIX and XXX)

Table XXVII. Distribution by Age and Sex of the Rural Population of the Net "Receiver" Regions
1970 (%)

Municipios	0-14		15-19		20-24		25-34		35-44		45-64		65	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Bayamon	39.1	41.1	10.2	10.6	9.8	8.9	12.5	12.8	9.2	9.4	13.5	11.3	6.7	5.8
Caguas	41.3	39.9	11.6	12.0	7.8	8.9	11.2	12.2	8.5	8.8	13.4	12.1	6.2	4.8
Carolina	36.6	36.4	10.5	11.4	9.0	11.8	13.9	14.8	10.8	9.8	13.3	11.9	6.0	4.9
Dorado	38.2	37.6	10.7	11.4	9.2	9.9	13.0	14.1	9.1	9.2	13.9	13.0	5.9	4.8
Fajardo	32.4	35.2	9.0	8.7	8.0	9.5	12.1	13.4	10.2	10.3	18.6	15.7	9.8	7.2
Guaynabo	39.2	40.0	11.3	11.5	8.6	10.5	12.2	12.9	9.2	8.8	13.3	12.5	6.2	4.8
Hormigueros	32.2	31.1	8.9	11.3	9.0	10.6	12.7	14.8	10.2	10.3	18.8	15.2	7.6	6.6
Loiza	41.9	41.4	10.8	10.5	8.3	10.0	13.0	13.8	9.3	9.2	11.8	10.8	4.1	4.4
Rio Grande	36.9	37.7	10.6	10.1	8.3	9.4	14.0	14.3	9.6	9.3	13.5	11.5	7.0	6.1
Toa Baja	39.2	40.8	10.2	9.2	11.1	9.1	12.4	14.0	9.4	10.7	13.0	11.5	4.7	4.8
Trujillo														
Alto	36.9	36.0	10.8	11.0	8.9	10.2	13.7	15.2	9.7	10.4	14.1	12.4	5.8	4.7
Vega Alta	41.2	39.6	11.4	11.3	7.6	8.7	10.7	12.6	8.6	9.5	14.3	12.9	6.1	5.3
Mean	37.9	38.1	10.5	10.7	8.7	9.7	12.6	13.7	9.5	9.6	14.3	12.7	6.3	5.3

Source: Op. cited, Table XXV

Table XXVIII. Distribution by Age and Sex of the Rural Population of the "Net Donor" Regions
1970 (%)

Municipios	0-14		15-19		20-24		25-34		35-44		45-64		65	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adjuntas	43.7	42.8	11.5	11.6	6.3	8.0	8.5	11.1	7.4	7.8	15.6	13.1	7.0	5.7
Arroyo	43.7	42.9	12.4	11.6	7.7	7.4	8.1	9.1	6.7	7.8	14.3	14.6	8.1	6.6
Ciales	44.7	44.3	12.7	11.8	6.8	8.3	7.7	9.4	7.4	8.3	14.3	12.6	6.4	5.4
Jayuya	45.3	45.7	12.4	11.2	6.3	8.8	7.8	9.5	6.8	7.5	14.5	12.8	6.8	4.5
Lares	44.3	40.1	10.8	12.4	6.0	8.4	8.5	11.1	8.0	8.7	15.2	13.8	7.1	6.2
Las Marias	40.1	39.3	11.9	11.7	6.7	9.3	10.1	11.2	8.1	8.3	15.2	14.3	7.9	5.9
Maricao	40.2	40.1	13.0	12.7	7.6	9.2	9.1	11.0	7.6	8.5	14.8	12.9	7.7	5.7
Orocovis	49.1	47.4	12.5	11.8	6.1	7.3	7.4	9.2	6.5	7.6	12.8	12.0	5.6	4.8
Salinas	42.4	41.4	10.4	10.2	7.3	9.1	10.4	12.0	7.6	8.8	15.2	13.4	6.6	5.0
San Lorenzo	46.5	44.4	11.6	12.7	6.0	7.7	8.6	9.9	7.4	8.1	13.4	12.5	6.6	4.7
San Sebastian	40.2	37.4	10.9	11.8	6.7	8.2	9.2	11.2	8.2	10.0	17.1	15.2	7.7	6.0
Utua	43.5	42.3	11.8	11.9	6.1	8.0	7.7	9.6	7.1	8.5	16.0	14.0	8.1	5.5
Mean	43.6	42.3	11.8	11.8	6.5	8.3	8.6	10.4	7.4	8.3	14.9	13.4	7.1	5.5

Source: Op. cited, Table XXV

Table XXIX.- Income Derived from Traditional and Modern Farming, Ratio of Farm workers to Total Workers and Percentage of Workers who Work Outside "Municipios" of Residence.

"Receiver" Regions.				
Municipios	Income (%)		% of Persons to Total Workers engaged in Farming 1969	% of Workers working Outside Municipios of Residence 1970
	Modern	Tra- ditional		
Bayamon	93.7	6.1	1.0	46.4
Caguas	95.6	4.1	4.0	29.4
Carolina	94.3	5.4	0.9	54.3
Dorado	65.7	20.2	7.1	42.2
Fajardo	55.3	42.6	5.1	22.8
Guaynabo	93.1	6.1	1.7	56.3
Hormigueros	6.7	93.1	10.4	47.8
Loiza	75.7	23.2	7.8	52.6
Rio Grande	67.7	31.7	4.8	39.2
Toa Baja	83.0	15.7	3.1	55.0
Trujillo Alto	96.6	3.3	2.3	58.1
Vega Alta	83.2	5.4	8.2	47.8

Source: U.S. Bureau of the Census, Part 53 Puerto Rico, Table 104 and U.S. Census of Agriculture for Puerto Rico, 1969, Table 39

relative to "donor" zones. These facts support strongly the view that the labor market works more efficiently near centers of high urban-industrial development by facilitating the movement of excess labor farm and thereby helps increasing farmer income and productivity.

- Age and Sex in the Three Metropolitan Cities of P.R.

With respect to age distribution, how do the three largest cities in Puerto Rico -San Juan, Mayaguez and Ponce - behave with their heavy concentration of people? These three places with a population of

Table XXX.- Income Derived from Traditional and Modern Agriculture, Ratio of Men to Total Workers engaged in Agriculture and Percentage of Workers who work outside "municipios" of Residence

"Donor" Regions				
Municipios	Income (%)		% of Men to Total Workers engaged in Agriculture 1969	% of Workers working outside Municipios of Residence, 1970
	Modern	Traditional		
Adjuntas	24.4	73.2	24.2	17.0
Arroyo	16.9	83.1	15.6	31.6
Ciales	43.8	56.0	19.9	19.8
Jayuya	31.0	69.0	22.7	7.3
Lares	2.9	96.8	34.7	14.0
Las Marias	8.1	91.3	34.8	30.1
Maricao	6.0	92.6	45.4	17.3
Orocovis	15.6	83.4	29.4	9.7
Salinas	29.0	71.0	18.4	22.2
San Lorenzo	84.7	15.0	13.6	31.0
San Sebastian	12.0	87.9	33.1	9.6
Ututo	18.9	80.5	26.9	11.1

Source: Op. cited, Table XXIX

463,242 (San Juan), 85,857 (Mayaguez), 158,981 (Ponce) in 1970 showed a rather mild rate of population growth during the decade 1960's of 2.6%, 2.4% and 9.2% respectively. Table XXXI presents their age distribution by sex. The younger group 0-14 of Ponce is comparable to the ratio of the "receiver" regions but Mayaguez and San Juan exhibit a clear lower percentage of that bracket in its population. The costs of raising children in big urban cities are high relative to the benefits that can be derived from them. Thus, it is a normal economic fact that young children are in lower proportion there. The groups 15-19 and 20-24 are

Table XXXI.- Distribution by Age and Sex of the Population of San Juan City, Mayaguez and Ponce.

	San Juan	Mayaguez	Ponce
<u>0-14</u>			
Male	31.4	32.3	38.4
Female	28.1	30.2	35.4
<u>15-19</u>			
Male	10.5	12.6	11.0
Female	10.3	10.5	10.9
<u>20-24</u>			
Male	9.2	11.6	8.1
Female	9.6	9.7	8.1
<u>25-34</u>			
Male	12.9	11.6	11.5
Female	13.1	13.5	12.4
<u>35-44</u>			
Male	11.4	9.7	9.4
Female	12.4	11.1	9.8
<u>45-64</u>			
Male	18.1	16.4	15.4
Female	18.2	16.6	15.0
<u>65 and over</u>			
Male	6.5	6.9	6.3
Female	8.3	8.2	7.5

Source: Op. cited, Table XXV

also comparable to the "receiver" group. The groups 25-34 tend to be less represented relative to the "receiver" regions, while the older group 45-64 surpasses the percentage shown by the "receiver" group. This group is of the order of 18% for both male and female in San Juan which suggests that many old executives and managers live there, since this is the place where most business headquarters are located. Finally we find that the oldest group 65 and more is well represented with a percentage higher than the "receiver" but lower than the "donor". The presence of such a

high percentage of old people, especially women may be as noted earlier due either to better health opportunities usually found in big cities or simply that women come to live in San Juan to take care of their grandchildren, while their sons or daughters work, as it is the custom here.

Ponce and Mayaguez have since 1960 lagged behind San Juan in terms of dynamic growth and repercussions on the development of their neighbouring municipios. Perhaps it is the combined effect of governmental policies and geographical location that explain their lower rate of growth. Geographically both Ponce and Mayaguez, even though coastal cities, are surrounded on the east by mountainous coffee regions which make their contact with the mainland U.S. less easy than it is for San Juan. As a result, municipios surrounding Mayaguez and Ponce number fewer manufacturing establishments than those clustering around San Juan, and their agriculture shows by Table XXXII. San Juan, including its immediate neighbouring regions, counts for 25% of all manufacturing establishments in Puerto Rico, while Mayaguez and Ponce count for 9.0% and 6.5 respectively. As for physical capital - labor ratio as represented by the items of modern agriculture, (columns 2 to 4, Table XXXII) the farm workers in the immediate regions of San Juan are better equipped and are likely to have better productivity. Thus, regions that lag in the development of their industrial-urban structure also show lower development of their agriculture.

Sex Ratio

Sex ratio defined as the number of males per 100 females is presented for Puerto Rico in general and its urban and rural sectors in

Table XXXII.- Farm Workers, Manufacturing Establishments, Modern Physical Capital - Labor ratio in "Municipios" Neighbouring, Mayaguez, Ponce, San Juan, 1970

	Farm Workers	Fixed Capital per Labor Ratio			Manufacturing Establishments
		Milking Machines	Poultry Buildings	Livestock Barns	
1) <u>Regions of San Juan</u>					
San Juan	325	-	46	4	156
Bayamon and Catano	207	24	12	5	220
Carolina	135	73	3	19	184
Guaynabo	111	24	11	8	80
Trujillo Alto	136	5	14	6	29
Total	914	126	86	42	669
Per Farm Worker (%)		13.8	9.4	4.6	
2) <u>Regions of Mayaguez</u>					
Mayaguez	645	21	25	12	168
Anasco	642	-	6	2	15
Las Marias	336	4	19	3	2
Maricao	504	-	7	5	1
Hormigueros	265	6	4	7	11
San German	1,382	8	31	15	42
Total	3,774	39	92	44	239
Per Farm Worker (%)		1.0	2.4	1.2	
3) <u>Regions of Ponce</u>					
Ponce	944	37	20	26	143
Adjuntas	563	10	6	18	15
Jayuya	372	9	16	16	5
Juana Diaz	868	58	21	16	15
Penuelas	223	15	4	6	10
Total	2,970	129	67	82	173
Per Farm Workers (%)		4.3	2.2	2.8	

Source: Op. cited, Table XXIX and Census of Manufacturing Industries in P.R., 1970, Bureau of Labor Statistics, Table 10, p. 27

Table XXXIII.- Sex Ratio, Puerto Rico, Urban and Rural, 1970

Age group	Puerto Rico	Urban	Rural
0-14	102.7	101.9	103.9
15-19	97.5	94.0	102.0
20-24	85.9	85.9	85.0
25-34	87.4	85.6	88.7
35-44	89.9	88.7	94.6
45-64	99.5	93.2	110.3
65 and over	93.8	78.3	121.7
Total	96.2	92.8	101.3

Source: op. cited, Table XXIV

Table XXXIII. In general the urban sector has more females than males, while in the rural areas, the ratio tends to be in favor of men. Young women are less attached than young men to farm activities. At early ages (0-14) men tend to dominate in both rural, urban and in general.

Bogue²² contends that since at birth male babies tend to show a higher rate, consistently over time and in many parts of the world, the excess of males over females at early ages may be biologically determined.

Bracket 15-19 show a marked difference between urban and rural, the rural being higher. In rural areas boys are more useful on farms than girls. Beginning with age 20 to 44, there is a clear imbalance showing fewer males than females. This imbalance is strongly accentuated within the groups 20-24 and 25-34 in urban as well in rural areas. Differential rates of male out-migration to the U.S., as we saw earlier, must be the principal reason behind this imbalance. In fact these are the brackets where most of the labor force is recruited.

At older ages (from 45 up) the balance is in favor of more men in rural areas and more women in urban areas. While older men are less in demand in urban industries, they can always find routine jobs to perform on farms or in small cities. The presence of more older women than men in urban areas can be explained by the need for domestic servants in cities, and the fact that women are most likely to stay with their progeny when they migrate.

- Sex Ratio in the 'Receiver' and 'Donor' Regions

Before exploring the consequences of such imbalance between the sexes in Puerto Rico, let us look at Table XXXIV where the sex ratio is tabulated for both "donor" and "receiver" areas tends to conform more to the pattern of the urban sector, except that the brackets 45-64 and 65 are on the average well balanced in the "receiver" while they are not in the urban sector. The presence of many "municipios" like Hormigueros, Loiza, Toa Baja, Dorado, Trujillo Alto, though they have gained people, preserves nevertheless a rural structure, which contributes to favor more men than women in these brackets. As for the "donor" regions, they can unhesitatingly be identified with rural sector.

Such disproportion between males and females can be the cause of many social problems: young single girls must go without male companions and men may tend to go with more than one woman. Calzada²³, studying the effects of the imbalance of sex in Puerto Rico following external migration, notes that the proportion of married women, including those consensually married within the 15-24 brackets decrease between 1950 and 1960, while it increases among the married men, which confirms that out-

Table XXXIV Ratio of Men - Women among Net "Receiver" and Net "Donor" Regions, 1970

Receiver							
Municipios	0-14	15-19	20-24	25-34	35-44	45-64	65
Bayamon	106.5	89.6	81.0	82.8	93.5	101.6	83.3
Caguas	101.8	93.4	78.5	87.1	92.6	95.2	93.4
Carolina	103.5	91.9	75.5	85.6	99.9	98.2	84.4
Dorado	103.3	91.7	89.9	95.8	96.2	109.5	116.9
Fajardo	100.2	90.3	82.8	87.9	94.5	97.2	105.6
Guaynabo	91.8	93.7	87.3	84.1	94.3	105.9	87.9
Hormigueros	103.8	79.2	71.5	78.0	98.4	106.1	96.5
Loiza	104.4	106.7	87.0	94.2	96.4	112.8	108.2
Rio Grande	108.1	110.4	92.4	100.2	105.7	106.8	117.2
Toa Baja	103.8	103.7	92.0	94.3	98.5	108.4	96.0
Trujillo Alto	106.4	101.8	88.7	92.8	104.2	113.9	110.9
Vega Alta	103.8	97.3	80.9	81.7	92.7	106.7	108.1
Mean	103.1	95.8	83.9	88.7	97.2	105.2	100.7

Donor							
Adjuntas	101.8	97.0	75.5	73.8	91.1	108.0	109.2
Arroyo	106.7	106.1	85.6	88.3	84.8	92.8	98.4
Ciales	105.7	113.3	85.9	85.6	91.8	109.1	111.4
Jayuya	111.0	102.3	79.1	82.7	70.7	109.7	127.1
Lares	105.5	84.8	76.7	75.6	87.8	103.8	105.5
Las Marias	103.9	103.5	72.7	91.9	99.7	108.1	136.8
Maricao	101.5	103.1	83.3	83.5	90.8	116.1	140.4
Orocovis	102.8	104.8	81.1	83.2	82.4	103.7	110.2
Salinas	104.6	106.7	87.2	88.4	85.1	109.7	113.6
San Lorenzo	103.9	92.8	74.7	86.3	87.7	100.4	117.0
San Sebastian	104.1	90.7	77.5	79.9	79.0	106.0	110.5
Utua	100.2	95.5	72.0	77.2	79.0	106.0	116.0
Mean	104.3	100.0	79.3	83.0	85.8	106.0	116.0

Source: op. cited, Table XXV

Table XXXV- Proportion of Married Women and Men (15-24) and (25-29) in Puerto Rico, 1960, 1970

Age-groups	1960		1970	
	Men	Women	Men	Women
15-24	16.1	34.6	18.4	32.1
25-29	71.0	80.3	71.6	76.6

Source: U.S. Bureau of the Census, Part 53, Puerto Rico, Table 83 (1960) and Table 121 (1970)

migration has reduced marriage opportunities for young women. This trend towards a decreasing proportion of married women and an increasing between 1960 and 1970 as shown in Table XXV. As Calzada puts it, this cannot be attributed to a change in the pattern of marriage or simple postponement of early marriage. This is a clear lack of opportunities offered women and caused by migration since men continue to get married at the same proportion while in both brackets women show a clear decrease in their proportion from 1960 to 1970.

- Sex Ratio in the Three Metropolitan Cities of P.R.

Table XXXVI presents the pattern of sex ratio for the three metropolitan cities, San Juan, Mayaguez and Ponce. While the age pattern tends to conform to the urban profile, except for Mayaguez, which has shown a rather peculiarly high ratio for the group 20-24, a ratio which is not found even in the "donor" regions, the groups 45-64 and 65 and over show a clear dissimilarity, when compared to the corresponding groups of the "donor" and "receiver" regions. This can be attributed to many factors. Since we have found among the "donor" regions a high sex ratio in favor of men 65 and more, and a quite balanced ratio among

Table XXXVI.- Ratio of Men - Women, San Juan City, Mayaguez and Ponce

Municipios	0-14	15-19	20-24	25-34	35-44	45-64	65
San Juan	102.7	94.1	87.5	90.1	84.6	91.6	72.5
Mayaguez	102.1	114.3	104.3	82.0	83.0	94.0	80.3
Ponce	101.8	94.4	84.6	86.9	90.1	96.3	78.7

Source: Op. cited, Table XXV

the "receiver" it may be inferred that men in this bracket 65 and more are retiring in their native towns while old women stay in the cities to live with their children and possibly take care of their grandchildren. We may also take into consideration the fact that in metropolitan cities fewer men than women reach this bracket because they are exposed to more fatal accident and diseases of many kinds than women are. While this last point may contribute in part to account for the high level of women relative to men, the first reason seems more plausible, in view of the fact that more old men (65 and more) are consistently present in both "donor" mainly rural regions and "receiver" regions which can be considered as suburbs of the metropole.

Education among, Urban, Rural and the "Donor" and "Receiver" Regions.

We have already discussed the various ways in which an individual's educational attainment may affect his decision to migrate. In modern industrially oriented society more education becomes a prerequisite if one wants to decrease one's risk of "unemployability". In fact, as the economy grows, blue-collar employment declines while white-collar, requiring more education, increases relatively. More education makes the individual more mobile, because of his better possibility of acquiring new skills

as the composition of jobs or industrial locations change. As Galbraith puts it in discussing employment and education in the present western industrial system: "But the increasing educational requirements of the industrial system add to the mobility of the working force both as between occupations and regions. The skilled craftsman of modest education does not easily learn a new skill and the risks of movement are his own. So if he establishes himself as a tool-and-die-maker in Detroit there is a fair chance that he will remain there. The engineer or sales executive, though he is strongly specialized as to task, can acquire another perhaps less demanding qualification if he must. He is but little tied to his surroundings. If there is greater need for his speciality on the other side of the country he moves in response to a promise of employment, or is moved by his new employer as a matter of routine"²⁴.

Education for a given region may also create countercurrents of migration depending on the interests of various groups. For example, parents with children of school age are attracted by regions with good school opportunities and possibilities for high achievement, while educated persons from such regions migrate because of better employment opportunities offered elsewhere.

In certain circumstances, due to risk aversion, highly educated people may prefer to stay home instead of migrating because competition among educated persons at the destination is tighter, even though financial returns there are substantially higher than at the origin. Such persons, by deciding not to move despite higher wages, may find their compensation in terms of higher prestige at home.

Evidence gathered for the United States from March 1969 through 1970 by Morisson²⁵ tends to establish clearly that migration rates vary directly according to educational attainment. For example, people with some college education have a rate of migrating across a state line nearly four times (4.9) higher than that of persons with only an elementary education (1.3). Between these two groups, migration tends to be higher with increments in education. As for short distance movement or local mobility, Morisson did not find any systematic relation between educational level and mobility.

- Index of Education by Regions

In the case of Puerto Rico, we would expect education to be substantially correlated with internal migration during the 1960's - perhaps less so than external migration. To verify what happened to Puerto Rican "municipios" educational levels as a result of migration, we will construct for both rural and urban, out two different groups "donor", "receiver" and for the three metropolitan cities an aggregate measure of educational attainment in 1950, 1960 and 1970 and we will try to detect how this measure has varied over the two decades. Of course, we expect it to increase, but the rate must vary among "donor" and "receiver" depending on who migrates. When those who are better educated migrate more than the less educated they will tend on a net basis to affect negatively the origin region's measure, while the destination region's will be positively affected.

The construction of our measure of the region educational attainment will follow the method devised by Grilliches²⁶. This method

Table XXXVII.- Index of Education Level of Puerto Rican Males and Females 1950, 1960 and 1970

School Years completed	Male			1960 Median Income of Males 25 years and over by School Years completed, P.R.	Female			1960 Median Income of Females 25 Years and over by School Years completed, P.R.
	1950	1960	1970		1950	1960	1970	
None	28.3	19.7	12.3	\$ 472	38.5	26.3	16.4	\$ 180
<u>Elementary</u>								
1-4	32.9	31.7	23.4	767	30.1	31.3	23.3	327
5-7	17.4	16.2	16.4	1,120	15.1	16.4	17.5	540
8	7.6	6.9	7.4	1,593	6.2	6.1	7.1	846
<u>High School</u>								
1-3	6.0	8.1	11.7	1,813	3.4	6.4	10.2	1,176
4	3.9	8.6	15.9	2,299	3.2	6.4	14.0	1,726
<u>College</u>								
1-3	1.5	4.0	5.8	2,746	1.8	3.9	6.3	2,026
4 and over	2.1	4.3	7.1	5,510	1.4	2.8	5.0	2,763
Median Weight								
Income	1057	1319	1667		472	632	888	
Index	80	100	126		75	100	140	

Source: U.S. Bureau of the Census, Census of Population, 1960 and 1970, Tables 42 p. 120 and 45 p. 198 respectively. Income is taken from the 1960 Census, Table 117.

consists of constructing a distribution of persons 25 years and over among the population that have completed a given level of schooling and weighting each school-year-completed class by the average income that this level of education can earn for a given year. This measure transformed in index represents the average schooling per man for the region considered. As an example, we will derive in Table XXXVII this index for Puerto Rico in 1950, 1960 and 1970, using median income earned by males and females

in Puerto Rico in 1960 as weight. Subsequently we will only give the results of our computation for urban, rural, "receiver", "donor" etc directly.

Table XXXVII shows how the index of education per man has increased over the two decades. Males show an increase of 25% from 1950 to 1960 and 26% from 1960-1970. The increase from 1950 to 1970 is in the order of 58%. As for females the increase is of 34% between 1950-60, 40.5% from 1960-70 and 88% from 1950-70. In this way we observe that the rate of increase in education for females is faster during the period 1950-1970 than for males. But this tells us nothing with respect to regions that have gained or lost people.

Table XXXVIII.- Number of Teachers (Private and Public) per Enrolled Students, Urban and Rural, 1960, 1970

	Urban		Rural	
	1960	1970	1960	1970
Enrolled Students (5-34 years old)	274,304	471,770	332,132	343,100
Teachers (Elementary, Secondary, College)	21,484	36,479	11,036	12,961
Teachers per Students	7.8	7.7	3.3	3.8

Source: U.S. Bureau of the Census General Social and Economic Characteristics of the Population, Puerto Rico, 1960 Tables 54 and 78; 1970, Tables 49 and 115

Since educational opportunities have been offered in all regions in P.R. and the ratio of educational facilities to enrolled

students, as measured by the number of teachers (private and public) per students enrolled in school in 1960 and 1970 has remained roughly the same (see Table XXXVIII) -in the urban sector around 7.8 teachers per students and 3.3 to 3.8 in the rural sector from 1960 to 1970- we would expect our index of education per man to grow by the same rate in absence of migration. If this index shows a higher rate of increase in urban, relative to rural for example, migration of better educated persons from rural to urban must be of some contribution in the observed higher rate of increase.

- Education of Males and Females in Rural and Urban Areas
Compared.-

Table XXXIX presents the derivation and the results of our index. A single weight (1960 median income for Puerto Rican males 25 years and over by educational level) is used for urban and rural males. The same is done for urban and rural females, that is a single weight (1960 median income for Puerto Rican females 25 years and over by educational level) is used to construct the female's index. We observe that, among males, while the urban index has increased by 16% during the period 1960-70, it has increased only by 12% for rural, and we may say that in terms of education rural males have lost in favor of urban. The same cannot be said, however, for females. The index shows a higher rate of increase in rural areas: 35% against 30% in urban. Clearly women who have decided to go the cities have not been among the better educated, otherwise, we could have found a lower index among rural relative to urban.

That rural women of lower educational level have migrated to urban areas in P.R. relative to rural men can be verified by referring the occupational distribution of rural employees presented in Table XL.

Table XXXIX Index of Educational Level of Puerto Rican Males and Females 25 Years and over, Urban and Rural, 1960 and 1970

School Years completed	Male				1960 Median Income, Males 25 years and over by School years completed	Female				1960 Median Income, Females 25 years and over by School years completed
	Urban 1960	Urban 1970	Rural 1960	Rural 1970		Urban 1960	Urban 1970	Rural 1960	Rural 1970	
None	12.6	8.2	26.1	18.5	\$ 472	19.6	11.9	33.4	24.5	\$ 180
<u>Elementary</u>										
1-4	23.4	16.9	39.3	33.4	767	24.5	18.1	38.5	32.5	327
5-7	16.3	14.3	16.1	19.5	1,120	17.1	16.1	15.7	20.1	540
8	9.2	8.3	4.8	5.9	1,593	8.2	8.3	3.7	5.0	846
<u>High School</u>										
1-3	10.7	12.9	5.6	9.8	1,813	9.0	11.8	3.6	7.6	1,176
4	12.7	20.5	4.9	9.0	2,299	10.0	18.1	2.5	6.9	1,726
<u>College</u>										
1-3	6.6	8.2	1.7	2.1	2,746	6.4	8.5	1.3	2.3	2,026
4	7.8	10.7	1.1	1.7	5,510	4.7	7.2	0.8	1.2	2,763
Median Weight										
Income	1785	2064	1218	1364		8151	1060	436	589	
Index	100	116	100	112		100	130	100	135	

Source: Bureau of the Census, op. cited in Table XXXVII

Table XL.- Occupational Distribution of Rural Employees 16 Years Old and Over, Men and Women, 1970.-

Occupation	Men	Women
White-Collar	16.3	29.1
Blue-Collar	50.1	47.4
Farm	24.9	1.7
Service Workers, except Private Household	8.6	16.7
Private Household Workers	0.1	5.1

Source: Bureau of the Census, Detailed Characteristics of the Population, Table 137, p.156

Women in the white-collar field requiring a higher level of education are more tied down at home than men. And in the services except for household professions which contain a great number of white-collar employees such as the medical profession, women also show a higher percentage than men. Also, we note that while women represent only 23.8% of the total number of rural employees, women professional, technical and kindred workers occupy 2.8% against 2.5% for all male employees. The same is true for clerical and kindred workers, women clerical staff make up 2.7% of all employees compared to 2.5% for men. Thus in rural areas women find better occupation than men.

- Education of "Receiver" and "Donor" Regions Compared

Tables XL1 and XL11 present the computed educational index for males and females of the "receiver", San Juan, Mayaguez, Ponce regions (Table XL1) and "donor" regions (Table XL11). It emerges from these tables that women from the "receiver" regions show an average rate of increase higher in their educational level than men, that is 52% (women) against 44% (men). Regarding the "donor" regions, we find the same phenomenon,

Table XL1.- Index of the Educational Level of Males and Females, 25 Years Old and Over, "Receiver" and thr three SMSA regions, 1960-70

"Municipios"	Male				Female			
	Median Weight Income		Index		Median Weight Income		Index	
	1960	1970	1960	1970	1960	1970	1960	1970
Bayamon	1353	1738	100	128	776	1053	100	136
Caguas	1255	1376	100	110	631	718	100	114
Carolina	1535	2074	100	135	831	1213	100	148
Dorado	1084	1450	100	134	527	768	100	146
Fajardo	1151	1625	100	141	654	946	100	145
Guaynabo	1349	2395	100	177	710	1217	100	171
Hormigueros	918	1708	100	186	514	933	100	181
Loiza	992	1376	100	139	554	769	100	139
Rio Grande	952	1394	100	146	528	758	100	144
Toa Baja	992	1725	100	174	493	993	100	201
TrujilloAlto	1184	1760	100	149	574	1017	100	177
Vega Alta	1058	1332	100	126	491	699	100	142
Mean	1152	1663	100	144	607	924	100	152
San Juan	1842	2233	100	121	935	1175	100	126
Mayaguez	1388	1734	100	125	647	879	100	136
Ponce	1389	1759	100	127	615	942	100	153

Source: Bureau of the Census, General Social and Economic Characteristics of the Population, Puerto Rico, 1970 (Table 101), 1960 (Table 68).

the rate for women is higher than for men. While it is clear that rural regions have lost educated males in favor of urban and have retained their educated women, this cannot be said in the case of "donor" and "receiver" regions. "Receiver" regions have shown a higher rate of educational increase both for men and women than "donor". The percentage in favor of men is higher, however, than that of men. The gain in favor of men is 25 percentage points, while for women it is only 12. "Donor" regions, mainly

Table XL11.- Index of the Educational Level of Males and Females 25 Years Old and Over of "Donor" Regions, 1960-70.-

"Municipios"	Male				Female			
	Median Weight		Index		Median Weight		Index	
	Income				Income			
	1960	1970	1960	1970	1960	1970	1960	1970
Adjuntas	1047	1215	100	116	458	606	100	132
Arroyo	1077	1242	100	115	553	771	100	139
Ciales	1005	1158	100	115	420	620	100	148
Jayuya	992	1022	100	103	408	616	100	151
Lares	881	1129	100	128	439	603	100	137
Las Marías	843	1062	100	126	401	510	100	127
Maricao	953	1203	100	126	417	562	100	135
Orocovis	1020	1171	100	115	409	519	100	127
Salinas	1144	1399	100	122	494	732	100	148
San Lorenzo	930	1197	100	129	423	625	100	148
San Sebastian	1058	1274	100	120	453	638	100	141
Utua	994	1194	100	120	438	627	100	143
Mean	995	1189	100	119	443	619	100	140

Source: Op. cited, Table XL1 of this chapter

made of coffee regions, have, unlike rural areas in general, lost both in terms of young people and educated men and women in favor of "receiver" regions.

The higher rate of increase in education experienced by "receiver" regions relative to "donor" may also have been the outcome of the higher percentage of educated return migrants who elect to stay in "receiver" instead of "donor" regions. Data drawn from the 1970 Census establish that among total return migrants who choose to settle in "receiver" regions, 11% of them (males 14-24 years old) were attending college in the U.S. and 13.5 for women of the same type. In contrast we

found only 4.7% (males 14-24) and 8.3% (females 14-24) who attend college in the "donor" regions.

- Education of the Three Metropolitan Cities Compared

In looking at the bottom of table XL1, we find the change occurring during the decade in the index of educational level of the three largest cities in Puerto Rico: San Juan, Mayaguez and Ponce. In general the rate of increase of the index is lower than that of "receiver" regions both for men and women. Mayaguez and Ponce exhibit higher rates of increase than San Juan. Ponce, particularly, shows a higher educational increase among women than both Mayaguez and San Juan and its rate is comparable to that of the "receiver". In general, like the other regions, women in these cities show substantially higher rates of increase than men.

With to return migrants, 10.6 males (14-24) and 14.2% women of all return migrants staying in San Juan were attending college. The percentage were for Ponce and Mayaguez; 8.4% males (14-24 years old), 11.5% females of the same age and 9.9% males, 10.7 females respectively. Despite the higher proportion of return migrants selecting to stay in San Juan relative to Mayaguez and Ponce, San Juan has shown a lower rate of increase in its educational index. This is due perhaps to the "municipios" surrounding San Juan, especially Guaynabo which constitute true suburbs and "dormitory" for many professional working in San Juan which are not counted by the Census as living in San Juan. This type of suburbs is practically inexistent around Mayaguez and Ponce, so that almost everybody working in these "municipios" is counted there.

Labor Force

The migration effect on the age structure of the two populations is expected to be reflected also on the age composition of the labor force. We would expect the rural labor force to show a higher concentration of both the younger and the older, whereas the brackets 20-24 to 35-44 would be more represented in the urban. Such a contention seems not quite verified however. In Table XLIII both rural and urban show a clear deficiency in men aged 20-24. This has sustained the load of external migration. Women in this bracket are better represented than men both in rural and in urban, although it is higher in rural. Youths 14-19 tend to be in a higher proportion in rural than in urban and women outnumber men relatively. Group 35-44 has a higher proportion of men in rural than in urban, likewise the rural shows a higher ratio of old men 65 and more. As for women, from 16 to 34, rural women are in a higher % than in urban. This helps explain our earlier findings concerning educated women who had stayed home. In reverse, women 45-64 are in a higher proportion in urban. This group is likely to be less educated on the average than the younger group.

- Age Distribution of the Labor Force

The contrast in terms of age distribution of the labor force is best seen by comparing urban and rural farms in Table XLIII. It is clear that the rural-farm labor force is younger (14-19 years old) and older (45- 65+) than the urban. In the bracket 20-24, women are well represented on rural farms with a ratio of 30.3 against 19.4 in urban environments but are more concentrated in the urban at the age of 35 to

Table XLIII.- Age Structure of the Labor Force, Urban, Total Rural, Rural non-Farm and Rural Farm, 1970

Age-groups	Urban		Total Rural		Rural non-farm		Rural-Farm	
	Male	Female	Male	Female	Male	Female	Male	Female
14-15	0.5	0.6	0.7	0.6	0.6	0.6	0.8	0.5
16-19	4.3	5.3	6.1	8.7	5.9	8.4	6.8	9.7
20-24	13.2	19.4	15.3	26.3	15.5	25.0	14.8	30.3
25-34	26.8	30.2	25.5	31.4	26.9	31.9	21.5	29.4
35-44	23.2	23.6	19.4	18.5	20.2	19.4	17.3	15.9
45-64	28.7	19.5	28.7	13.6	27.4	13.9	32.2	12.8
65	3.4	1.4	4.3	0.9	3.4	0.8	6.6	1.4

Source: U.S. Bureau of the Census, Detailed Characteristics of the Population, Puerto Rico, Table 131, p. 712

64. Rural farms tend to have a much higher concentration of old men 45-64 and more than the urban, which is in conformity with the population profile described earlier.

- Labor Force Participation Rate, Receiver and Donor Regions Compared

Data for age profiles of the labor force are not disclosed by "municipios". However, we do have the rate of participation of different group-ages in the labor force by age. On this score, we would expect, a much higher rate of participation of men and women of all ages in the "receiver" regions as well as in the three largest cities than in the "donor" regions. In fact, Table XLIV supports this expectation. "Receiver" areas show a higher rate of participation than "donor" for both men and women aged 18 to 64. Because they migrate from "donor" to "receiver", primarily in order to work, it is normal that people in these brackets

Table XLIV.- Labor Force Participation Rate of "Receiver", "Donor", Regions and San Juan, Mayaguez and Ponce, 1970

Age-groups	"Receiver" ¹		"Donor" ¹		San Juan		Mayaguez		Ponce	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
14-17	8.7	3.5	8.1	3.0	9.6	4.3	8.5	3.5	10.0	6.0
18-24	55.3	32.0	43.7	24.3	49.2	34.1	40.7	31.7	48.5	25.6
25-34	80.0	36.8	69.9	28.7	77.5	40.3	80.2	42.6	80.7	34.6
35-44	79.8	32.6	70.6	22.3	81.2	41.0	84.5	38.2	82.8	30.1
45-64	67.6	18.2	56.3	12.8	72.2	28.6	72.6	19.4	71.5	18.1
65	20.1	2.9	20.0	1.8	23.4	4.6	27.6	3.9	17.7	4.0

1) Average for the "municipios" forming the "donor" and "receiver" regions.

Source: Bureau of the Census, op. cited, Tables 102

show a higher attachment to the labor force. The picture for the three largest cities is closer to "receiver" regions than "donor", though in San Juan women show a higher degree of attachment to the labor force, especially in the group 45-64. San Juan offers more jobs to women, particularly in the field of textile and clerical than the other cities. The lack of jobs in the "donor" regions, mainly industrial, coupled with the departure of the people willing to work from these places accounts for the lower participation rate observed there. Finally, we note that in general, women show a lower rate of participation than men in all regions.

- Labor Force Participation Rate of Men and Women in Urban and Rural Areas

Despite this lower rate of participation of women relative to men depicted in 1970, the situation was worse in 1960. Compared with

Table XLV.- Labor Force Participation Rate of Men and Women, by Rural and Urban Places, 1960 and 1970

Age-groups	Men				Women			
	Urban		Rural		Urban		Rural	
	1960	1970	1960	1970	1960	1970	1960	1970
14-17 ¹	9.5	11.5	15.0	12.0	7.8	6.1	3.9	3.2
18-24	60.7	49.4	72.2	51.3	35.4	32.8	20.0	24.6
25-34	86.0	80.5	88.1	72.3	38.6	40.7	19.8	23.4
35-44	90.2	82.1	89.5	68.5	33.7	38.8	16.4	15.9
45-64	82.6	70.8	82.4	59.9	23.6	23.5	10.5	7.2
65 +	26.4	21.6	28.5	23.8	4.9	3.6	2.7	1.8

1) Group 14-17 is for 1960. It is 16-17 in 1970

Source: Bureau of the Census, op. cited, Tables 47 (1970) and 59 (1960)

the 1960's participation, women exhibit substantial improvement in their rate, while men tend to drop from the labor force. We have already noted this point when we were considering external migration. Table XLV presents the level of participation rate for both men and women, urban and rural during 1960 and 1970. As noted earlier, in the case of external migration, the participation rate of men in the labor force shows a decrease in both urban and rural areas, while women show a different pattern in urban and rural during the 1960 and 1970. For example, in the urban, the group 18-24 decrease and increases in the rural. The bracket 25-34 shows increases in the urban and tends to decrease in the rural. Apparently, urban women in the group 18-24 stay longer in school than the same group in a rural setting, while in the group 35 and over because of a higher number of children in the rural milieu, disappears from the labor market. Since the latter group is most represented in the urban

Table XLV1.- Labor Force Participation Rate for Men and Women, 1960-70

Age-group	"Receiver"				"Donor"			
	Men		Women		Men		Women	
	1960	1970	1960	1970	1960	1970	1960	1970
14-17	13.3	8.7	5.9	3.5	14.6	8.6	3.7	3.0
18-24	71.7	55.3	28.4	32.0	65.3	43.7	14.5	24.3
25-34	86.3	80.0	30.0	36.8	83.5	69.9	17.0	28.7
35-44	90.8	79.9	26.1	32.6	88.0	70.6	16.0	22.3
45-64	83.0	67.6	15.0	18.2	87.7	56.3	10.3	12.8
65 +	25.4	20.1	2.7	2.9	32.2	20.0	1.9	1.8

Source: Bureau of the Census, op. cited in Table XLV

areas, it must have shown correspondingly stronger attachment to the urban labor force.

When we look at Table XLV1, we find that the trend of men to drop and women to enter the labor force is much clearer among "donor" and "receiver" regions. Except for the group 14-17 which shows a uniform decrease among men and women in both sectors from 1960 to 1970, due possibly to higher school enrollment in 1970, men drop from the labor market while women increase their rate of participation. The case of men dropping from the labor force is generally attributed to external migration. As for women, higher education and more employment opportunities in urban areas as well as in rural areas are responsible for their higher rate of participation.

The lower rate of participation of men in the labor force observed in Puerto Rico in general since the 1950's is clearly due in great part to the out-migration of its youngest elements. But another cause related to this phenomenon may also be found in the steady transformation of the manufacturing industries in the island from non-durable to durable and the higher competition between men and women in the labor market. Industries manufacturing non-durable goods tend to create more jobs than

durable goods industries. Moreover women nowadays perform many jobs that formerly were reserved for men only. In 1950, non-durable goods industries represented almost 90% of all industries in Puerto Rico. With the heavy shrinkage of the sugar cane industry (which employed mostly men) and the transformation of the economy towards heavier industries, Puerto Rico now numbers 73% of its employees in non-durable industries in 1970. Petrochemical and pharmaceutical industries, while requiring more capital-labor ratio, do not create proportionately more jobs. These are the industries that are emphasized by the economy, now that light industries -being labor-intensive- are less competitive on the international and U.S. market. The dilemma of the Puerto Rican economy is whether to create more jobs by encouraging labor-intensive, light industries or heavy capital-oriented industries in order to become more competitive on the market. The guess is that, as Puerto Rico is linked to the U.S., it will follow the trend towards heavier industries, thereby eliminating more jobs than it can create. As a result, the U.S will remain the normal escape for young Puerto Ricans willing to work.

Internal Migration and Family Characteristics in Puerto Rico

Migration has left its impact on other characteristics of urban, rural in general and on "receiver" and "donor" regions. For example, the Census of 1970 shows that married women with their own children are relatively higher in the labor force in urban than in rural regions. The same is also true for "receiver" and "donor" areas. The proportion of urban married women with their own children under 6 years of age in the labor force is almost that of rural married women of the same status. This proportion is 28.9 in urban versus 15.0 in rural areas.

Table XLVII.- Differences in Fertility Ratio (Children per 1,000 Women Ever Married) for some Selected Age-Groups. Urban, Rural, 1960 and 1970.-

Age of Women	Number of Children Ever Born per 1,000 Women Ever Married in:					
	Urban			Rural		
	1960	1970	Difference	1960	1970	Difference
15-24	1,707	1,343	364	2,021	1,635	386
25-34	3,012	2,651	361	4,318	3,647	671
35-44	4,016	3,493	523	6,454	5,356	1,098

Source: U.S. Bureau of the Census, op. cited, Tables 46 (1970) and 45 (1960).

We must also mention the fact that as more young women of child-bearing age are leaving rural areas, the fertility ratio has dropped substantially there. Table XLVII compares the differences that have occurred from 1960 to 1970 in rural and urban areas. The decline recorded in rural areas is particularly striking. In all age-groups it surpasses the urban drop, especially in the bracket 35-44.

There is no definite answer to the factors affecting the fertility level. Schultz²⁷ thinks that the parents' desire to have a number of children depends on three factors: a) the environment which shapes their preferences for surviving children; b) past or expected child death and c) uncertainty associated with deaths and births they seek. In this approach the problem is how to determine uncertainty related to births and deaths. Whatever the case, it seems that the parents' desire to have children is closely associated with their costs, the income opportunity of the mother, and her educational level which gives them a better understanding of birth control and family planning. Given these factors, it seems that there is a promising avenue for Puerto Rico in the field of population control: women are becoming more educated, opportunities for

employment are increasing, and finally, as urbanization reaches the most remote areas in Puerto Rico the cost of having children will go higher and higher.

Agriculture

One of the sectors of the economy that has been mostly affected by the redistribution of persons as a result of internal and external migration is the agricultural sector. Even though we will consider this sector particularly in the second part of our study, we shall touch for the moment upon certain points that are most likely to undergo changes. for example: the number of farms and acreage of land under cultivation; the change in number of farms of a given size; and the distribution of farms by tenure of operators.

- Number of farms

The latest and most comprehensive available data on Puerto Rican agriculture is that of 1969 published by the U.S. Bureau of Census, Census of Agriculture, P.R. Comparing this data with that of 1950, we observe that, for Puerto Rico in general, the total number of farms of all sizes has decreased by 39% passing from 53,515 in 1950 to 32,687 cuerdas¹ in 1969 while land under cultivation has dropped to 29.2% from 1,888,886 cuerdas in 1950 to 1,334,800 during the same period. The principal reason for the decrease in land under cultivation is attributed to urban encroachment in the form of roads, parks, play-grounds etc. Table XLV111 presents changes in the number of farms, land under cultivation

1) 1 Cuerda 0.9712 acre

Table XLVIII.- Changes in Number of Farms, Land Under Cultivation and Average Land per Farm, 1950 and 1969

Regions	<u>Farm</u>				<u>Land in Farms (Cuerdas)</u>			
	1950	1969	% change	Land per Farm 1950	1950	1969	% change	Land Per Farm 1969
"Donor" ¹	1,156	863	-25.4	29.1	33,656	24,688	-27.5	28.6
"Re-ceiver" ¹	500	220	-56.0	35.2	17,613	10,031	-43.0	45.5
"Inter-mediate"	581.1	319.4	-45.0	36.4	21,130	14,651	-31.7	45.9
Puerto Rico	53,515	32,687	-39.0	35.2	1,884,886	1,334,800	-29.2	41.0

1) The figures are average for the "municipios" forming these groups.

Source: U.S. Bureau of the Census, Census of Agriculture, 1969, Volume I, Area Reports, Part 52, Puerto Rico, Table 1

and acreage per farm in 1950 and 1969, for "donor" and "receiver" areas, and the group of "municipios" whose rural population has increased, hereafter called "Intermediate". We recall that, because these "municipios" had their rural population increased from 1960 to 1970, there might be a certain extension of their agricultural activities leading to an increase in the number of farms or land under cultivation etc... (See Table XLVIII referring to these "municipios").

We note that "receiver" regions show the highest rate of decrease in number of farms and also the highest rate of decrease in land under cultivation. These regions are the most industrialized and tend to have extensive modern livestock breeding, abandoning most of the traditional crops (coffee, sugar and tobacco). In contrast, "donor" areas

Table IL.- Change in Number of Farms by Tenure of Operators
Puerto Rico, 1950-1969

	1950	1969	Change
Full Owners	47,821	27,757	- 42.0%
Part Owners	2,363	2,339	- 1.0%
Managers	421	197	- 53.0%
Tenants	2,910	2,394	- 18.0%

Source: U.S. Bureau of the Census, op. cited, Table XLVII

show the lowest percentage change in number of farms as well as in land. They are the least urbanized and industrialized among the Puerto Rican regions. Average land per farm, while it increases 35 to 45 cuerdas in "receiver" regions, remains practically the same in "donor" areas from 1950 to 1969. As for the "Intermediate" group they show no peculiar signs such as a higher number of farms or land under cultivation. They are very close to "receiver" regions and well above the Puerto Rican average in terms of these items. The increase shown in their rural population might simply due to a census definition rather than to transformation within their agriculture.

- Size of farms. We have already seen that for Puerto Rico in general land per farm tends to remain unchanged, 40.8 cuerdas per farm in 1969 to 38.9 in 1950. How have the different sizes of farms changed during that period? We would expect that, since more and more persons are leaving farming there would be a tendency to consolidate small farms into bigger ones. That more and more persons are giving up farming can be verified by looking at Table IL.

Table L.- Distribution of Farms of Different Size by Regions, 1950, 1969

Regions	Less than 10 cuerdas		10-49 cuerdas		50-179 ¹ cuerdas		179 and more cuerdas	
	1950	1969	1950	1969	1950	1969	1950	1969
Puerto Rico	52.3%	52.7%	35.9%	35.6%	8.7%	7.5%	3.1%	4.2%
"Re- ceiver"	49.6%	55.6%	38.4%	32.8%	8.6%	5.8%	3.4%	5.8%
"Donor"	55.1%	51.7%	34.0%	38.0%	8.2%	7.4%	2.3%	2.8%
"Inter- mediate"	51.9%	52.7%	38.1%	36.1%	8.7%	7.0%	3.0%	4.1%

1) In 1969, the interval was 50 to 174 cuerdas.

Source: U.S. Bureau of the Census, op. cited, Table XLIV

The number of farms exploited by managers, owners, or tenants have decreased substantially, except for the owners' part, which shows only 1% decline during the 19-year period.

Table L shows the distribution of farms by size according to regions. For Puerto Rico as a whole, small farms of less than 10 cuerdas like those between 10-49 cuerdas tend to keep their position of 52% and 36% of all farms. There is a slight tendency for farms of 50-179 to decline by 1 per cent and an increase by the same percentage in farms 179 cuerdas and over. So there is no spectacular change in farm size during that period as a result of migration.

On the side of "receiver" regions, the tendency is for farms of intermediate size to decrease, while small and large farms increase relatively. The increase in small farms in these regions can be

explained by the type of agriculture prevailing there. This is a modern agriculture devoted to the production of eggs, poultry or livestock in general and located near metropolitan centers - which reduces certain costs, like transport, and increases their access to credit, markets etc.

The "donor" regions show a slight decrease in small farms and in farms of 50-179 cuerdas. Farms of between 10 and 49 cuerdas increase by 4% while bigger farms remain proportionately unchanged.

- Concluding Remarks

In total, farm consolidation as a result of migration and industrialization has made no breakthrough in Puerto Rico. The distribution of farms has shown slight changes. It remains to be seen how the agricultural sector as a whole has undergone transformation in term of products and capital-labor ratio since industrialization and migration began in 1950 and earlier. This will be the object of the second part of this work.

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- (7) Siegel, Jacob S. and Hamilton Horace C., "Some considerations in the use of the Residual Method of Estimating Net Migration", Journal of the American Statistical Association, Vol. 47, No 259, September 1952
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CHAPTER V

Statistical Test of the Puerto Rican Migration

Introduction

In order to carry further our analysis of Puerto Rican migration, we will test statistically the model discussed in Chapter III. The dependent variable is the average annual migration rate defined as the ratio of net migration (positive for immigration and negative for emigration) to the arithmetic mean of the original population sustaining or receiving migration during the two decades. Of course we have only one observation for each "municipio", since observation in the two census years are necessary to compute the net migration rate during the decade. Ten age-groups are constructed for each sex which give a total of twenty observations. These age-groups (male and female) are as follows:

Age-group	Age in 1960	Age in 1970
1	0-4	10-14
2	5-9	15-19
3	10-14	20-24
4	15-19	25-29
5	20-24	30-34
6	25-34	35-44
7	35-44	45-54
8	45-54	55-64
9	55-64	65-74
10	65 and over	75 and over

The method of multiple regression analysis is applied.

Variables in the Equations

The following variables are tested.

1) Mean Income Differences: $INC = I_i - I$, where I_i refers to income of "municipio" of observation and is computed by taking the mean value of median income prevailing in the "municipio" in 1960 and 1970 and I , the mean value of median income for the island in 1960 and 1970. This variable is different for male and female.

This measure of median income, instead for example of per capita income, while it gives a good idea of the degree of distribution of income in the "municipio" of observation and the island, and thus approximates the general welfare of the region, does not reflect the true incentive that could be given to the potential migrant by the labor market. Actual wage rates paid to manufacture or other non-farm occupation would be more appropriate. Unfortunately data on wage rates by "municipios" is not available.

2) Differences in Unemployment Rates: $UN : U_i - U$, where U_i represents the mean rate of unemployment existing in the "municipio" of observation in 1960 and 1970 and U the mean rate of unemployment for the island as a whole. The unemployment rate: U is computed in 1960 and 1970 by taking the ratio of reported unemployment over the reported labor force multiplied by 100. This variable is computed separately for males and females.

3) Education Level: $EDLE$, computed by taking the mean percentage between 1960 and 1970 of children aged 14-17 in school over the number of children male and female of the same age in the region. This variable does not differentiate between male and female because of data limitations, but rather, tends to measure the general educational level of the region. It can be said that the educational attainment of

the region, i.e. the proportion of persons in the region having attained or completed a certain level of schooling would be more appropriate in this case. But this variable is likely to reflect the influence of past migration, instead of giving a true educational picture of the region, and therefore cannot fulfill our objective of explaining migration. Beals, Levy, Moses use as an educational variable in their study of migration in Ghana, the percentage of adult males in the region who have attended school¹. Schultz and Nerlove² construct their education variable in the same way, but restrict it to children 14-17 providing the following rationale for its use: "Since the better educated tend to migrate more, there will be fewer of them left in a municipio having a net inflow of population. Large numbers of adolescents in school, however, suggest a high level of educational attainment in the area without itself being directly influenced by the migration it is supposed to explain".

4) An index of demand for female labor services: FELAS constructed in a way similar to that of Schultz and Nerlove³ by forming the following ratio:

$$FELAS = \frac{\sum_{j=1}^{20} \beta(j) E(j)}{\sum_{j=1}^{20} E(j)} \cdot \frac{\sum_{i=1}^{75} \sum_{j=1}^{20} \beta(j) E_i(j)}{\sum_{i=1}^{75} \sum_{j=1}^{20} E_i(j)}$$

where $\beta(j)$ = proportion of total female employment in industry (j) in Puerto Rico as a whole. $\beta(j)$ is computed by taking the mean ratio of 1960 and 1970.

$E_i(j)$ = total employment in industry (j) in municipio i.

The industry groups considered along with their respective B's are the following:

<u>Industry groups (j)</u>	<u>B's 1960</u>	<u>B's 1970</u>	<u>B's Mean</u>
1- Agriculture, Forestry and Fisheries	0.017	0.027	0.022
2- Mining	0.009	0.037	0.023
3- Construction	0.021	0.035	0.028
4- Durable Manufacturing	0.250	0.294	0.272
5- Non-Durable Manufacturing	0.447	0.497	0.472
6- Transportation, communication and Utilities	0.066	0.105	0.085
7- Wholesale Trade	0.117	0.169	0.143
8- Retail Food and Dairy products	0.099	0.143	0.121
9- Eating and Drinking Places	0.208	0.257	0.232
10- Other Retail	0.282	0.284	0.283
11- Banking, Insurance and Finance	0.336	0.362	0.349
12- Business and Repair	0.050	0.093	0.071
13- Private Housing Services	0.873	0.860	0.866
14- Other Personal Services	0.434	0.384	0.409
15- Entertainment and Recreation Services	0.192	0.188	0.190
16- Hospital and other Health Services	0.399	0.622	0.510
17- Public Educational Services	0.711	0.706	0.708
18- Private Educational Services	0.671	0.701	0.686
19- General Public and Professional Services	0.411	0.516	0.463
20- Public Administration	0.268	0.303	0.283

This index of demand for female labor services is thought to

represent the opportunity income of women. Women in underdeveloped countries do not ordinarily show a high participation rate in the labor force because jobs for them are not available. They devote their time to activities inside the home, mainly rearing children. As jobs become easier to find, the opportunity costs of rearing children increases.

When women expect to, or can, find good jobs with relatively attractive income outside their home and within their municipio of residence, they are likely to increase their rate of participation in the labor force in order to bring more income home. Depending on their age bracket, this may lead to a variety of decisions. If the women are already married, they may expect to lower their birth rate, or better, to lengthen the interval between births which in the long run may have appreciable effects on the overall fertility rate or supply of labor. If, on the other hand, the women are still young and not yet engaged in marital life, they may defer in the mean time their education and pursue it later or even postpone their marriage. If the attractive jobs are outside their municipio of residence, women, mainly the young, may decide to migrate, more so if the jobs are expected to be permanent. As for married women, the decision to take advantages of jobs offered can be viewed as an indirect cost (benefit) for men or bread winners of the family, since men's earnings are the principal source of family income.

Young children (male and female) dependent on their parents will tend to show higher rates of migration depending on their parents' decisions. So this index variable, introduced in both equations explaining men and women (various age groups) migration, is expected to have strong positive influence on the rate of male and female migration.

5) An index of relative population: POIN, constructed by taking: the ratio of the difference between the island total population (male or female) for a given age group and the municipio total population (male or female) for the same age group over the island total population for the same age group or:

$$\text{POINF} : \frac{\overline{Pf}(g) - \overline{Pfi}(g)}{\overline{Pf}(g)} \quad \text{or} \quad \text{POINM} : \frac{\overline{Pm}(g) - \overline{Pmi}(g)}{\overline{Pm}(g)}$$

$\overline{Pf}(g)$ or $\overline{Pm}(g)$: total island population male (m) or female (f) in age group (g), average in 1960 and 1970

$\overline{Pfi}(g)$ or $\overline{Pmi}(g)$: total municipio population male (m) or female (f) in age group (g), average in 1960 and 1970.

The relative population of the destination and origin region seems to affect its relative economic opportunities (schooling, jobs, health, housing and other non-wage opportunities). A high population at the destination and origin region tends to be associated with a large and important labor market offering more job opportunities, but rather poor non-wage opportunities (educational, health and housing facilities).

To the extent that higher relative population at the destination region is the result of past migration, the probability that the potential migrant find friends or relatives to help him in the transition to his new surroundings tends to be higher. This help may be provided in the form of shelter, food, information or moral comfort. In his study of migration in Egypt, Greenwood⁴ finds that "migrants are attracted to regions which have large labor markets, and / or that persons tend to migrate to regions to which natives of their home regions previously

migrated".

6) A distance variable: DIST, constructed by computing the road distance in miles of the municipios to San Juan, the capital of the island. This measure is clearly not an ideal measure of the distance covered by migrants, but San Juan is chosen as an average destination point because, as we have seen, the San Juan metropolitan area is the only region which has gained population on a net basis.

The principal costs of moving, transportation and transfer costs, are likely to increase with distance moved. Also, psychic cost is expected to be higher with distance. Moreover, in the process of moving, information related to alternative localities plays a decisive role in the migrant's choice of destination. Distance and flow of information tend to be inversely related as established by previous migration studies, principally those of Beals, R.E., Levy, N.B. and Moses, L.N. ("Rationality and Migration in Ghana", op. cited note 1), and Sohata G.S.⁵ in Brazil.

As distance increases between two points, the flow of information tends to decrease and without pertinent information, uncertainty increases, which is a deterrent to migration. Thus, distance serves a proxy for cost specified or unspecified and is expected to be inversely related to the rate of migration.

Later on, after presenting the equations containing these variables, we will consider and discuss other variables, such as opportunities in education, health, housing, fertility rates, with and without lags in our equations, as well as certain changes in the age groups of

cohorts forming the equations.

Empirical Results

The first relationship is of the following form:

$$M(g) : f(INC, UN, EDLE, FELAS, POIN, DIST)$$

where $M(g)$: migration rate by age-group and by sex. We have ten age-groups giving twenty equations, or ten equations for each sex.

INC, UN, EDLE, FELAS, POIN, DIST represent income, unemployment, education, demand for female labor services, relative population and distance respectively as discussed and constructed previously. In each age-sex equation, the independent variables are identical, except for income, unemployment and relative population, which are different by sex.

Tables I and II present parameter estimates for ten age-groups (male), and ten age-groups (female), respectively, with t-ratios in parenthesis and the corresponding coefficient of multiple determination (R^2), and Table III presents simple correlation coefficients for the independent variables used in the males equations.

We see readily that the model does not exhibit excessive multicollinearity among its variables as shown by Table III.

First Model: Male

Consider Table I depicting the ten equations for males. We note that males who were aged 10-14 in 1960 and 20-24 in 1970 show the highest coefficient of multiple correlation (R^2 : 0.647) followed by

Table I.- Male Migration in Ten Age Groups 1960-1970 (t-ratios in parentheses)

LEGEND: UNMA: Unemployment Male POINM: Population Index									
EDLE: Education Level DIST: Distance									
INM: Income FELAS: Demand for Female Labor Services									
(K) AGE GROUP	R ²	INTERCEPT	F-VALUE	UNMA	EDLE	IN	POINM	DIST	FELAS
0-4	0.348	1.47	6.0	-0.51 (3.5)	0.03 (0.8)	0.04 (0.4)	0.30 (2.2)	-0.03 (2.9)	4.53 (2.8)
5-9	0.473	-4.07	10.2	-0.51 (3.6)	0.09 (2.5)	0.09 (0.8)	0.21 (1.6)	-0.03 (3.2)	4.17 (2.6)
10-14	0.647	-11.43	20.8	-0.55 (2.8)	0.12 (2.4)	0.93 (6.3)	0.15 (0.9)	-0.05 (3.3)	5.79 (2.6)
15-19	0.478	-8.04	10.4	-0.63 (2.7)	0.10 (1.8)	0.44 (2.5)	0.10 (0.5)	-0.05 (3.0)	6.93 (2.6)
20-24	0.348	0.96	6.1	-0.92 (4.1)	0.07 (1.2)	-0.19 (1.1)	0.22 (1.3)	-0.037 (2.2)	6.74 (2.6)
25-34	0.281	0.45	4.4	-0.65 (3.4)	0.084 (1.7)	-0.13 (0.9)	0.21 (1.6)	-0.032 (2.4)	2.97 (1.4)
35-44	0.215	1.002	3.1	-0.45 (2.7)	0.044 (1.1)	-0.15 (1.2)	0.107 (1.0)	-0.03 (2.3)	2.30 (1.2)
45-54	0.235	1.52	3.5	-0.32 (3.0)	0.022 (0.8)	0.013 (0.2)	0.12 (1.5)	-0.02 (2.8)	1.39 (1.1)
55-64	0.333	3.39	5.7	-0.32 (3.3)	-0.017 (0.7)	0.20 (2.8)	0.144 (1.8)	-0.02 (3.3)	2.22 (2.0)
65 or over	0.274	4.22	4.3	-0.16 (2.5)	0.009 (0.6)	0.00006 (0.0)	0.08 (1.3)	-0.01 (3.3)	1.35 (1.8)

Table II - Female Migration in Ten Age Groups 1960-1970 (t-ratios in parentheses)

LEGEND: UNFE: Unemployment Female EDLE: Education Level INF: Income									
POINF: Population Index DIST: Distance FELAS: Demand for Female Labor Services									
Age Group	R ²	INTERCEPT	F-VALUE	UNFE	EDLE	IN	POINF	DIST	FELAS
0-4	0.285	-1.36	4.5	-0.14 (1.8)	0.04 (1.0)	0.06 (0.5)	0.25 (1.8)	-0.018 (1.8)	3.97 (2.3)
5-9	0.341	-3.20	5.9	-0.16 (1.9)	0.05 (1.3)	0.02 (0.2)	0.09 (0.6)	-0.016 (1.5)	4.98 (2.7)
10-14	0.473	-6.35	10.2	-0.14 (1.3)	0.05 (0.9)	0.52 (3.3)	0.04 (0.2)	-0.03 (2.1)	7.11 (3.0)
15-19	0.412	-7.16	7.9	-0.13 (1.0)	0.066 (1.1)	0.51 (2.8)	0.21 (1.1)	-0.03 (1.9)	7.80 (2.8)
20-24	0.323	-7.75	5.4	-0.10 (0.9)	0.10 (1.8)	0.31 (1.8)	0.24 (1.4)	-0.015 (1.0)	5.83 (2.3)
25-34	0.256	-2.19	3.9	-0.15 (1.6)	0.06 (1.3)	0.024 (0.2)	0.14 (1.2)	-0.021 (1.8)	3.77 (1.8)
35-44	0.258	-3.72	3.9	-0.13 (1.5)	0.07 (1.7)	-0.014 (0.1)	0.13 (1.2)	-0.014 (1.3)	3.54 (1.9)
45-54	0.280	-4.12	4.4	-0.17 (2.0)	0.095 (2.3)	0.033 (0.3)	0.15 (1.4)	-0.016 (1.1)	2.37 (1.3)
55-64	0.304	-2.06	4.9	-0.092 (1.4)	0.046 (1.4)	0.086 (0.9)	0.088 (1.0)	-0.01 (1.6)	3.11 (2.1)
65 or over	0.257	3.24	3.9	-0.06 (1.2)	0.0099 (0.4)	0.10 (1.4)	0.05 (0.9)	-0.01 (2.2)	1.81 (1.7)

Table III.- Simple Correlation Coefficients of the Independent Variables Used in Male Equations.

	UNME	EDLE	INCM	POINM	DIST	FELAS
UNMA	---	---	---	---	---	---
EDLE	0.102	---	---	---	---	---
INC	0.074	0.297	---	---	---	---
POINM	0.017	-0.369	-0.086	---	---	---
DIST	-0.377	-0.396	-0.080	0.236	---	---
FELAS	0.088	0.560	0.243	-0.411	-0.356	

UNMA : Unemployment Male

EDLE : Educational Level

INCM : Income Male

POINM : Population Index Male

DIST : Distance

FELAS : Index of Demand for Female Labor Services.

males aged 15-19 (R^2 : 0.478) and 5-9 (R^2 : 0.473) in 1960. Thus, young from 5-9 to 15-19 of age in 1960 are better explained than the other groups. These brackets usually form an important segment of males that are either still in school, or on their way to entering the labor force or to getting married. In other words, they are persons who are likely at a critical point in their life cycle and are the most prone to migrate.

- FELAS

The variable with the highest coefficient in all age-groups is the FELAS (Demand for female labor services). Its value ranges from a low 1.35, for the group 65 and over in age in 1960, a high to 6.93 for the group aged 15-19 in 1960. This coefficient is of positive sign and is significant at 5 percent level of confidence (two-tailed test) except

for the four equations dealing with the groups 25-34, 35-44, 45-54 and 65 and over in 1960, which are significant at more than 5 percent around 10 percent level of confidence.

The demand for female labor services because of its high power of explanation of male migration suggests that for a given region, whenever the demand for female labor services increases, the expectation is such that job opportunities for men will increase too. Or alternately, men tend to migrate where their wives have the highest probability of finding employment, thus increasing the family income or resources. In any case, in a given regional labor market in Puerto Rico, the timing and pattern of male migration seem strongly related to job opportunities offered to women. Perhaps because of the high unemployment rate prevailing in the island, the choice of a destination offering high opportunities for women to work seems to add a certain security to the family's income.

- UNMA

The second variable which exhibits in all equations the right, i.e. negative sign, is unemployment. For all age-group equations its coefficient is significant at the 5 percent level of confidence. Its value tends to be higher among the younger age-groups. Unemployment is clearly a deterrent to the rate of migration, the higher its level, the lower tends to be the rate of male migration, mainly among the younger age-groups. The highest coefficient (-0.92) is found among the group aged 20-24 in 1960.

- POIN

The third variable which shows the highest coefficient is the

population index. Unfortunately its t-ratio, except for the group aged 0-4 in 1960, is not significant at the conventional five per cent level of confidence. Its sign, however, is correct, i.e. positive as expected, which implies that male persons tend to be attracted by regions of high population density where the labor market is large and where friends and relative are likely to be found.

- INC

Income, our fourth variable, appears to best explain migration for the age-groups 10-14, 15-19 and 55-64 in 1960. The coefficients for these three equations are the highest and significant at the five per cent level of confidence. In all other equations the income coefficients show either the wrong sign (negative) or are very low and not statistically significant. We note also that the income coefficient is highest and significant where the explanatory power is high, and for the groups where migration rate is likely to be high (10-14 and 15-19 of age in 1960).

- EDLE

Education level does not appear to explain satisfactorily our migration equations. In all of the equations its coefficient tends to be very low, though with the right sign (positive), except for the group 55-64, where it is negative. Despite its poor showing, the education level coefficient is very significant (five per cent level of confidence) for the groups 5-9 and 10-14 of age in 1960 and (ten per cent level of confidence) for the group 15-19. Also in these groups, its value is the highest, which implies that among the youngest, education

plays a relatively more determinant role in the decision to migrate.

- DIST

Finally Distance, as expected, shows not only the right sign (negative) in explaining migration of all age brackets, but is significant at the five per cent level of confidence. Its low value is perhaps due to the smallness of the island.

In conclusion male migration in Puerto Rico during the 1960-1970 decade is best explained by economic variables such as the demand for labor services, the population index (size of the labor market), unemployment level and distance. Education and income while they seem not to be a valid explanatory variable for old groups, appear to explain better the most active age brackets (5-9, 10-14, 15-19 of age in 1960).

First Model: Female

Turning now to Table II where the equations for female age groups are presented, we notice immediately that the explanatory power (coefficient of multiple determination R^2) is lower in general for female migration than for male of all age-groups. The highest R^2 are found among the young groups: 5-9, 10-14 and 15-19 of age in 1960.

The same independent variables entering the male equations are used, but unemployment, income and population index are constructed with data for females. As for the male equations, the simple coefficients of correlation does not depict any excessive multicollinearity among the independent variables, as shown by Table IV.

Table IV.- Simple Correlation Coefficients of the Independent Variables used in Female Equations

	UNFE	EDLE	INCF	POINF	DIST	FELAS
UNFE	---	---	---	---	---	---
EDLE	-0.146	---	---	---	---	---
INCF	-0.134	0.297	---	---	---	---
POINF	0.235	-0.367	-0.088	---	---	---
DIST	0.090	-0.396	-0.080	0.229	---	---
FELAS	-0.167	0.560	0.243	-0.411	-0.356	---

UNFE : Unemployment Female

EDLE : Educational Level

INCF : Income Female

POINF : Population Index Female

DIST : Distance

FELAS : Demand for Female Labor Services

- FELAS

As expected, of all the variables, the demand for female labor services variable best explains female migration of all ages, with positive coefficients ranging in value from 1.8 for the group 65 and over, to 7.8 for the group 15-19 of age in 1960. But unlike male migration only the younger age-groups (0-4 to 20-24) and the group 45-54 years of age in 1960, show coefficients which are significant at the five per cent level of confidence. The other groups coefficients though quite high relative to the coefficients of the other variables, are significant only at the ten per cent or lower level of confidence. Again the equations of the groups aged 10-14 and 15-19 in 1960 with the highest R^2 , show the highest coefficients 7.11 and 7.8 respectively.

- UNFE

The unemployment variable exhibits the expected sign, (negative) but is not significant for all age-groups at the conventional five per cent level of confidence, except for the equation of the group 45-54.

- EDLE, INC, POIN

The education, income and population index coefficients show the expected sign, but display low coefficients and are not satisfactorily significant using the conventional five per cent t-test, except in some rare cases.

- DIST

As for the distance variable, the sign of its coefficient is correct as expected, i.e negative but not too significant.

In general, female migration is less well explained than male migration, particularly among the older age groups.

Before we continue our analysis by introducing certain modifications in our equations, and new variables, let us try to draw some comparisons between the equations we just discussed, and other similar studies.

Nerlove-Schultz's and this Study Compared

- The variables

The variables as discussed, formulated and used in our equations, are roughly similar to the ones used by Nerlove and Schultz⁶

in their estimation of the determinants of migration in Puerto Rico during the 1950-60 period. All variables used in the Nerlove-Schultz study, except education, are weighted differences between the municipio of observation and all other municipios of Puerto Rico, including the mainland U.S. Puerto Rican-born population, whereas our variables are unweighted and, except for the demand for female labor services, represent differences between the municipio to which the observation refers and the island, without considering the mainland U.S. Puerto Rican-born population. In fact, although the mainland U.S. Puerto Rican-born population is introduced in the computed values of the Nerlove-Schultz independent variables, no separate independent observation for emigration to the mainland United States from Puerto Rico."⁷ . In our estimation the variable: demand for female labor services, is not used as a difference, but simply as a ratio of the demand for labor services in each municipio of observation to the demand for female labor services in the island in general.

Furthermore, Nerlove and Schultz do not consider distance as an explanatory variable but rather use a dummy variable to account for "extra cost and unspecified benefits of moving to the U.S." This dummy variable is constructed separately for males and females by forming for each municipio and each age group, the following ratio:

$$y_{23}(k) : \frac{\overline{Nm1}(k) - \overline{Nm76}(k)}{Nm1(k)} \quad ; \quad y_{24}(k) : \frac{\overline{Nf1}(k) - \overline{Nf76}(k)}{Nf1(k)}$$

where $y_{23}(k)$ and $y_{24}(k)$ are the dummy variables

$Nm1(k)$ and $Nf1(k)$: male (m) or female (f) population in age-group
k in municipio i.

$Nm76(k)$ and $Nf76(k)$: male (m) or female (f) population in age-group

k in the United States.

Since we do not consider any U.S. Puerto Rican-born data in the construction of our variables, and do not introduce any U.S. observation in our equations, our results can simply be termed "internal" migration to the contrary of those of Nerlove-Schultz which contain some elements of "external" combined with "internal" migration. We think that external migration, because of the many extraneous factors that differentiate it from internal migration should be considered separately from internal migration. Taking in mind these observations, we will introduce our results by weighing, in a similar way, our variables and trying to draw some comparisons between our results and those obtained by Nerlove and Schultz.

The ratio used by Nerlove and Schultz to weigh three of the six variables used in their equations, namely Income Differences, Differences in Unemployment Rates and Differences in the Index of Demand for Labor Services, is intended to reflect the size of the relevant population. This is formed as follows:

$$\frac{\sum (\overline{Nm(g)} + \overline{NmI(g)})}{\sum \overline{Nm(g)}} \quad \text{and} \quad \frac{\sum (\overline{Nf(g)} + \overline{NfI(g)})}{\sum \overline{Nf(g)}}$$

where the sum is over all 75 municipios of observation (Culebra omitted) including the mainland U.S. Puerto Rican-born population.

$\overline{Nm(g)}$, $\overline{Nf(g)}$ refer to male (m) or female (f) population in age group (g) in Puerto Rico and the U.S. Puerto Rican-born population as a whole.

$Nm\bar{f}(g)$, $Nf\bar{f}(g)$ refer to male (m) or female (f) population in age group (g) in municipio i.

Bar refers to mean values for age group (g) in 1950 and age group (g+10) in 1960.

We use the same wight formula except that we do not introduce the U.S. Puerto Rican-born population in our computation.

Tables V and VI present the Schultz-Nerlove male and female migration equations and Tables VII and VIII our results weighted as explained above.

Regression Results

A first glance at Tables VII and VIII reveals that our weighted variables (income, unemployment and demand for female labor services) exhibit in a consistent way signs that are antithetical to the ones obtained when they are unweighted (Tables I and II). Clearly we expect these variables to show signs depicted by the equations shown in Tables I and II rather than those of Tables VII and VIII. We note also that the values of their coefficients, their t-ratios and the explanatory power of the equation have not changed significantly. The effect of the weights is confined to the sign of the coefficients. Since we do not use any kind of weight with our dependent variables or the migration rates, we conclude that the introduction of weights to our above mentioned variables is inappropriate and must be deleted.

We will thus use for comparison purpose the results of our

Table V. Male Migration in Ten Age Groups Between 1950 and 1960^a
(t ratios in parentheses)

Age Group K	R ²	y ₁₆	y ₁₈	y ₂₀	y ₂₂	y ₂₄	z ₂
0-4	.085	.305 (.91)	.00229 (.01)	.0249 (.41)	158. (.82)	13.1 (.79)	4.29 (.21)
5-9	.621	2.52 (7.41)	-.247 (.69)	-.00629 (.11)	381. (2.93)	47.7 (3.25)	8.61 (.44)
10-14	.666	6.17 (8.19)	1.13 (1.64)	-.155 (1.43)	422. (2.55)	90.1 (3.13)	-2.02 (.01)
15-19	.519	3.79 (5.21)	1.05 (1.53)	-.0317 (.29)	-396. (2.77)	102. (3.34)	11.8 (.27)
20-24	.359	1.62 (2.76)	-.295 (.61)	.129 (1.65)	-139. (1.40)	43.6 (1.79)	-30.5 (.87)
25-34	.132	.151 (.33)	.0111 (.03)	.0765 (1.14)	-48.6 (.54)	11.3 (.57)	-16.7 (.59)
35-44	.146	.218 (.66)	-.274 (.79)	.0901 (1.60)	-91.2 (1.04)	18.3 (1.16)	-1.62 (0.08)
45-54	.113	.234 (.85)	-.0710 (.23)	.0206 (.43)	-138. (1.58)	21.3 (1.63)	17.2 (.98)
55-64	.093	.251 (.87)	-.294 (.88)	.0511 (.99)	5.80 (.04)	.152 (.01)	2.88 (.17)
65 +	.354	.105 (.10)	-1.18 (.95)	.526 (2.85)	-1309. (1.25)	100. (1.81)	87.4 (1.42)

Note: a) Observations for the 75 municipios in PUerto Rico used in estimation. Migration variable expressed as annual rate per thousand persons.

y₁₆ : Weighted Income Differences

y₁₈ : Weighted Differences in Unemployment Rates

y₂₀ : Weighted Differences in the Index of the Demand for Female Labor Services

y₂₂ : Relative Population Index

y₂₄ : "Dummy" to Account for the Extra Cost and Benefits of Moving to the U.S.

z₂ : Educational Levels

Table VI. Female Migration in Ten Age Groups, Between 1950 and 1960^a
(t ratios in parentheses)

Age Group K	R ²	Y ₁₅	Y ₁₇	Y ₁₉	Y ₂₁	Y ₂₃	z ₂
0-4	.167	.397 (1.18)	-.150 (.39)	.0594 (.98)	-196. (1.07)	17.6 (1.07)	8.30 (.40)
5-9	.405	.875 (2.26)	.140 (.31)	.128 (1.82)	-257. (1.66)	32.1 (1.73)	-5.67 (.23)
10-14	.462	1.90 (3.43)	.298 (.48)	.140 (1.45)	-221. (1.40)	40.2 (1.54)	22.4 (.63)
15-19	.395	1.66 (3.37)	.570 (1.02)	.0606 (.68)	-245. (1.98)	57.2 (2.28)	-6.37 (.18)
20-24	.298	1.36 (3.45)	-.494 (1.16)	.0286 (.41)	-256. (2.79)	63.0 (3.07)	10.3 (.35)
25-34	.192	.669 (2.36)	.209 (.68)	-.0143 (.266)	-76.6 (1.13)	17.6 (1.21)	-1.40 (.07)
35-44	.287	.346 (.133)	-.0671 (.22)	.0547 (1.12)	-241. (3.39)	49.3 (3.65)	29.8 (1.60)
45-54	.240	.178 (.62)	-.00144 (.00)	.0988 (1.84)	-120. (1.82)	23.8 (1.59)	12.9 (.63)
55-64	.261	.222 (.71)	-.570 (1.56)	.0804 (1.36)	-163. (1.33)	20.6 (1.30)	25.7 (1.22)
65 +	.238	.797 (.90)	-1.11 (1.08)	.199 (1.22)	-494. (1.00)	49.0 (1.09)	92.5 (1.62)

Note: a) Observation for the 75 municipios in PUerto Rico used in estimation migration variable expressed as annual rate per thousand persons.

y₁₅ : Weighted Income Differences

y₁₇ : Weighted Differences in Unemployment Rates

y₁₉ : Weighted Differences in the Index of the Demand for Female Labor Services

y₂₁ : Relative Population Index

y₂₃ : "Dummy" to Account for the Extra Cost and Benefits of Moving to the U.S.

z₂ : Educational Level

Table VII.- Male Migration in Ten Age Groups 1960-1970 (t-ratios in parentheses)

LEGEND: UNMAM: Unemployment Male EDLE: Education Level INM: Income POINM: Population Index DIST: Distance FELASM: Demand for Female Labor Services									
AGE GROUP	(K) R ²	INTERCEPT	F-VALUE	RINM	UNMAM	FELAS	POINM	DIST	EDLE
0-4	.345	-1.86	6.0	-0.015 (0.3)	0.31 (4.0)	-2.25 (2.4)	0.87 (3.0)	-0.03 (3.0)	0.039 (1.1)
5-9	.478	-7.35	10.4	-0.012 (0.2)	0.32 (4.1)	-2.44 (2.6)	0.84 (2.9)	-0.03 (3.3)	0.101 (2.9)
10-14	.568	-1.46	14.9	-0.36 (4.4)	0.34 (2.8)	-3.71 (2.6)	1.65 (3.6)	-0.04 (2.9)	0.17 (3.2)
15-19	.436	-13.01	8.8	-0.17 (1.8)	0.40 (3.0)	-3.06 (1.8)	1.11 (2.1)	-0.05 (3.1)	0.15 (2.5)
20-24	.339	-6.16	5.8	0.08 (1.0)	0.58 (4.6)	-2.67 (1.5)	0.78 (1.5)	-0.04 (2.3)	0.09 (1.6)
25-34	.3097	-4.42	5.1	0.06 (0.9)	0.42 (4.1)	-0.49 (0.3)	0.24 (0.6)	-0.03 (2.5)	0.097 (2.2)
35-44	.238	-2.28	3.5	0.07 (1.1)	0.31 (3.4)	-0.63 (0.5)	0.16 (0.5)	-0.03 (2.5)	0.05 (1.3)
45-54	0.251	-0.72	3.8	-0.0067 (0.2)	0.21 (3.5)	-0.40 (0.6)	0.24 (1.1)	-0.02 (3.0)	0.03 (1.2)
55-64	0.306	1.32	5.0	-0.08 (2.1)	0.19 (3.5)	-1.29 (1.9)	0.60 (2.9)	-0.02 (3.1)	-0.003 (0.1)
65 or over	0.259	2.99	4.0	-0.005 (0.2)	0.0997 (2.7)	-0.48 (1.1)	0.199 (1.4)	-0.016 (3.3)	0.015 (0.9)

Table VIII. - Female Migration in Ten Age Groups 1960-1970 (t-ratios in parentheses)

LEGEND: UNFE: Unemployment Female POINF: Population Index									
EDLE: Education level DIST: Distance									
INF: Income FELAS: Demand for Female Labor Services									
(K) AGE GROUP	R ²	INTERCEPT	F-VALUE	UNFE	EDLE	RIN	POINM	DIST	FELAS
0-4	0.253	-3.797	3.8	0.09 (1.9)	0.06 (1.6)	-0.008 (0.1)	0.82 (2.5)	-0.02 (1.8)	-1.46 (1.5)
5-9	0.306	-6.25	5.0	0.106 (2.1)	0.08 (1.9)	0.03 (0.5)	0.81 (2.2)	-0.017 (1.5)	-2.09 (1.9)
10-14	0.389	-9.37	7.2	0.087 (1.2)	0.10 (1.9)	-0.17 (1.9)	1.32 (2.6)	-0.03 (1.9)	-3.36 (2.2)
15-19	0.320	-11.08	5.3	0.083 (1.0)	0.13 (2.1)	-0.18 (1.7)	1.36 (2.2)	-0.03 (1.9)	-2.83 (1.5)
20-24	0.246	-11.72	3.7	0.074 (1.0)	0.17 (2.8)	-0.09 (1.0)	0.76 (1.3)	-0.018 (1.1)	-1.01 (0.6)
25-34	0.222	-5.91	3.2	0.10 (1.7)	0.099 (2.2)	0.029 (0.4)	0.45 (1.0)	-0.023 (1.8)	-0.43 (0.3)
35-44	0.239	-6.55	3.6	0.10 (1.9)	0.09 (2.3)	0.04 (0.6)	0.63 (1.7)	-0.014 (1.2)	-1.22 (1.0)
45-54	0.275	-7.16	4.3	0.12 (2.3)	0.12 (3.0)	0.008 (0.1)	0.60 (1.6)	-0.01 (1.0)	-0.61 (0.5)
55-64	0.268	-4.28	4.1	0.067 (1.6)	0.071 (2.2)	-0.02 (0.4)	0.55 (1.9)	-0.013 (1.4)	-1.09 (1.2)
65 or over	0.234	1.97	3.5	0.044 (1.5)	0.025 (1.1)	-0.03 (0.8)	0.43 (2.0)	-0.01 (1.9)	-0.88 (1.3)

equations shown in Tables I and II with those of Schultz and Nerlove in Tables IV and V.

Clearly the Schultz-Nerlove results for female migration equations are less well explained than the male equations, as evidenced by the values of their R^2 . We have also found better explanatory power in our male equations relative to the female ones. Equally, the younger groups (male and female) in both periods show higher R^2 .

- FELAS

The index of demand for labor services does not explain migration, even for females, during the 1950-60 period, while during the next decade (1960-1970), it becomes the strongest variable in terms of coefficient value. Perhaps this is due to more attractive female employment opportunities, coupled with higher and more generalized woman education in the 1960's relative to the 1950's.

- INC, UNMA and UNFE

Income shows up generally strongly in the Schultz-Nerlove study while it has no effect on migration rates in the 1960's. The reverse is true for the unemployment variable. It works poorly in the 1950's whereas its effect is quite marked in the 1960's. The sharp decline in agricultural employment in the 1960's relative to the 1950's, and the tendency for industrial income (wages) to be more even among municipios, can be thought to account for this reversal influence.

- EDLE

In both periods education appears not to be an influential

explanatory variable. In the 1950's the education coefficient for all age groups is not at all significant, while in the 1960's its value is very low with low significance. Perhaps the measure used to express education (percentage of adolescents 14-17 in school) is not ideal. A measure of educational attainment in the region would be better, but as previously noted such a measure is difficult to isolate from the effect of past migration. Furthermore, education is likely to be correlated either with income or unemployment. Indeed, in each of the periods, income in the 1950's and unemployment in the 1960's behave quite satisfactorily in explaining migration.

- POIN

The relative population variable is very strong and mostly negative in the 1950's, which in the words of Schultz and Nerlove suggests "that migration occurs more than proportionately from rural areas with relatively small populations to urban areas with relatively large populations." In the 1960's, relative population is positive but less strong than it was in the 1950's. It is statistically significant mainly among the young for 0-4 to 15-19 years of age (male and female). We interpret this as meaning that people are rather attracted by large agglomerations likely to offer large labor markets.

- DIST

Finally, distance as expressed in our equations appears to explain migration in the 1960's better than the "dummy" used in the 1950's equation. Distance has the right sign and is very significant in all age groups, while the "dummy", though very high in value, is

hardly significant at all in the 1950's equations.

On the whole, the 1960's equations appear to show more consistency in term of expected sign of the coefficient variables and more significant t-ratios than the 1950's equations. However, the low general R^2 of both set of equations in the two periods suggests that some refinements are necessary in order to try to add some improvements in the explanatory power at least of the 1960's equations. To this end we now turn.

Second Model: Male and Female

Two new variables are introduced in the groups of equations (male and female) in addition to the variables used previously. These variables are: fertility rates (Fert 1) in 1950 and fertility rate (Fert 2) in 1970 representing the number of children ever born per 1,000 women 18-44 years old ever married in these two years. Fertility rate in 1950 (Fert 1) is a sort of lag variable of past fertility compared to actual or present fertility (Fert 2) in 1970. High fertility, mostly prevalent in rural areas, represent pressures upon the rural population and, at best, can be considered as a proxy for low wages or high unemployment in rural areas. Past fertility, having contributed to the actual shaping of the mature age groups of the population, is expected to be positively associated with migration, while present fertility, affecting particularly the actual number of persons of childhood age, is expected to be an impediment to the process of migration.

- Regression Results

Tables IX and X present the results of the estimation. The value of the coefficients of both variables in the two sets of equations are very small and do not appear to influence migration at all. However small, present fertility (Fert 2) and past fertility (Fert 1) exhibit the expected sign. Fert 1 in addition to being small in value is not significant at all, while Fert 2 or actual fertility is very significant at the conventional five per cent level of confidence.

We notice also, that in the two sets of equations (male and female), the principal variables demand for female labor services, unemployment, income for the age-groups (10-14 and 15-19 in 1960), population index and distance remain quite stable, showing the expected sign. The male equation (10-14 of age in 1960) shows substantial improvement in its proportion of explained variance R^2 (0.709). The same age group (10-14) for females fails to exhibit as high an R^2 , but shows nevertheless substantial improvement over the value obtained in Tables I and II. On the whole, the male equations are better explained than those for the female.

Third Model: Male and Female

The decision to migrate involves consideration of costs and benefits related to such a decision. These costs and benefits need not be associated exclusively with wages, unemployment or other wage-related factors. They may take other forms as well, for example, educational facilities affecting the regions which are of interest primarily to parents with children of school age; medical or health facilities offered by a

Table IX.- Male Migration in Ten Age Groups 1960-1970 (t-ratios are in parentheses)

LEGEND:	UNMA: Unemployment Male	POIN: Population Index	FERT1: Fertility rate (1950)
	EDLE: Education Level	DIST: Distance	FERT2: Fertility rate (1970)
	INM: Income	FELAS: Demand for Female Labor Service	

(K) AGE GROUP	R ²	INTERCEPT	F-VALUE	UNMA	EDLE	RIN	POIN	DIST	FELAS	FERT1	FERT2
0-4	0.443	1.31	6.6	-0.45 (3.3)	0.025 (0.7)	0.004 (0.0)	0.26 (1.9)	-0.03 (2.2)	3.81 (2.1)	0.0004 (1.4)	-0.0005 (3.0)
5-9	0.566	-3.40	10.8	-0.45 (3.4)	0.08 (2.4)	0.05 (0.5)	0.20 (1.5)	-0.03 (2.7)	3.14 (1.8)	0.0004 (1.3)	-0.0006 (3.4)
10-14	0.709	-10.68	20.2	-0.46 (2.6)	0.11 (2.3)	0.88 (6.4)	0.14 (0.8)	-0.04 (2.7)	4.47 (1.9)	0.0005 (1.3)	-0.0008 (3.4)
15-19	0.555	-4.62	10.3	-0.54 (2.5)	0.09 (1.5)	0.39 (2.3)	0.14 (0.7)	-0.05 (2.8)	4.74 (1.6)	0.0003 (0.6)	-0.0009 (3.2)
20-24	0.424	2.82	6.1	-0.84 (3.9)	0.06 (1.1)	-0.23 (1.4)	0.24 (1.4)	-0.04 (1.9)	5.18 (1.8)	0.0004 (0.8)	-0.0008 (2.8)
25-34	0.377	0.67	5.0	-0.58 (3.2)	0.08 (1.7)	-0.18 (1.3)	0.20 (1.6)	-0.03 (1.8)	2.03 (0.9)	0.0005 (1.2)	-0.0007 (2.8)
35-44	0.307	2.42	3.7	-0.39 (2.5)	0.036 (0.9)	-0.18 (1.5)	0.11 (1.0)	-0.03 (1.9)	1.13 (0.5)	0.0003 (0.8)	-0.0006 (2.8)
45-54	0.287	1.99	3.3	-0.29 (2.8)	0.02 (0.7)	-0.004 (0.0)	0.12 (1.4)	-0.02 (2.3)	0.87 (0.6)	0.00015 (0.7)	-0.0003 (2.0)
55-64	0.462	2.87	7.1	-0.27 (3.1)	-0.02 (0.8)	0.17 (2.5)	0.12 (1.5)	-0.02 (2.5)	1.81 (1.5)	0.0003 (1.8)	-0.0004 (3.4)
65 or over	0.347	5.47	4.4	-0.14 (2.2)	0.004 (0.2)	-0.009 (0.2)	0.09 (1.5)	-0.02 (3.1)	0.70 (0.8)	0.00002 (0.2)	-0.0002 (2.7)

Table X.- Female Migration in Ten Age Groups 1960-1970 (t-ratios are in parentheses)

LEGEND: UNFE: Unemployment Female POIN: Population Index FERT1: Fertility Rate (1950)											
EDLE: Education Level DIST: Distance FERT2: Fertility Rate (1970)											
IN: Income FELAS: Demand for Female Labor Service											
(K) AGE GROUP	R ²	INTERCEPT	F-VALUE	UNFE	EDLE	RIN	POIN	DIST	FELAS	FERT1	FERT2
0-4	0.390	0.24	5.3	-0.13 (1.7)	0.03 (0.8)	0.03 (0.3)	0.24 (1.7)	-0.02 (1.6)	2.78 (1.5)	0.0003 (0.9)	-0.0006 (3.2)
5-9	0.446	-1.01	6.6	-0.15 (1.9)	0.04 (1.1)	-0.007 (0.1)	0.09 (0.6)	-0.02 (1.5)	3.54 (1.7)	0.0003 (0.8)	-0.0007 (3.4)
10-14	0.556	-2.60	10.3	-0.13 (1.3)	0.03 (0.6)	0.48 (3.2)	0.07 (0.4)	-0.03 (2.1)	5.02 (1.9)	0.0003 (0.6)	-0.0009 (3.4)
15-19	0.475	-3.72	7.5	-0.12 (1.0)	0.05 (0.8)	0.48 (2.7)	0.25 (1.2)	-0.04 (1.8)	5.87 (1.9)	0.0003 (0.5)	-0.0008 (2.7)
20-24	0.416	-3.71	5.9	-0.097 (0.9)	0.08 (1.5)	0.28 (1.7)	0.28 (1.6)	-0.02 (1.2)	3.68 (1.3)	0.0002 (0.5)	-0.0009 (3.1)
25-34	0.365	-0.13	4.7	-0.14 (1.5)	0.05 (1.1)	-0.01 (0.1)	0.15 (1.3)	-0.02 (1.6)	2.37 (1.0)	0.0003 (0.9)	-0.0007 (3.1)
35-44	0.365	-1.73	4.8	-0.12 (1.5)	0.06 (1.5)	-0.04 (0.4)	0.14 (1.2)	-0.016 (1.2)	2.21 (1.3)	0.0003 (0.8)	-0.0006 (3.2)
45-54	0.314	-2.00	3.8	-0.17 (2.0)	0.09 (2.0)	0.02 (0.2)	0.17 (1.4)	-0.01 (1.1)	1.32 (0.6)	0.0006 (0.2)	-0.0004 (1.8)
55-64	0.420	0.44	6.0	-0.09 (1.4)	0.03 (1.1)	0.06 (0.7)	0.10 (1.2)	-0.02 (1.7)	1.74 (1.1)	0.0001 (0.6)	-0.0005 (3.5)
65 or over	0.313	-0.06	3.8	-0.06 (1.3)	-0.0004 (0.0)	0.098 (1.4)	0.08 (1.2)	-0.02 (2.5)	0.68 (0.6)	-0.0001 (0.5)	-0.0003 (2.3)

region, which may be of interest to persons of advanced age or to those whose health is rather frail; housing availability by sale or for rent along with the type of neighborhood etc. which may interest both old and young.

Education, Health and Housing opportunities are quantified as follows:

Educational opportunities : EDOP : Total employees in educational services (elementary, secondary and college both private and public) divided by the number of persons (3-34 years of age) attending school in the municipio, average in 1960 and 1970.

Health opportunities: HEOP : Number of employees in hospitals and other health services divided by total population in each municipio, average in 1960 and 1970.

Housing opportunities: HOOP : Proportion of sound vacant year-round units for sale or for rent divided by the number of adult persons over 18 years of age in each municipio.

In addition to these three variables, we introduce a fourth variable: Migrant stocks or the ratio of persons born outside but residing in the municipio to the native population living in the municipio. Greenwood⁸ in his study of the economic determinants of geographic labor mobility in the United States, uses this concept quantified as "the number of persons born in state i (the origin state) and living in state j (the destination state). He finds that this variable affects migration positively, implying that "persons have a strong tendency to migrate to

states toward which natives of their region previously migrated". Furthermore, the "migrant stock" variable appears to alter in a marked way the parameter estimates of other variables used in his equation, in particular, it reduced the distance elasticity, which in his words "is an indication that distance entered into the determination of past migration."⁹

Regression Results

- EDOP

Tables XI and XII present the combined effects of these variables with the six variables already introduced in Tables I and II. We note that the variables educational opportunities are not at all significant, show very low values and erratic sign at all age-groups and can therefore be disregarded. Perhaps the data used in its construction are not adequate.

- HOOP

Housing opportunities exhibit the expected sign for both male and female at all age-groups but are significant in only one instance (male 55-64 of age in 1960) and (female 15-19 of age in 1960). This might be interpreted as saying that young females (15-19 of age in 1960) are more interested in good housing than young men, while the converse is true for older persons.

- HEOP

Health opportunities shows a coefficient that is quite important relatively to the other parameters at almost all age-groups,

Table XI.- Male Migration in Ten Age Groups 1960-1970 (t-ratios are in parentheses)

LEGEND: HEOP: Health Opportunities EDOP: Educational Opportunities MIS: Migration Stocks													
HOOP: Housing Opportunities EDLE: Educational Levels POIN: Population Index													
UNMA: Unemployment Male IN: Income DIST: Distance													
FELAS: Demand for Female Labor Service													
(K) AGE GROUP	R ²	INTERCEPT	F-VALUE	HEOP	HOOP	UNMA	EDOP	EDLE	RIN	MIS	POIN	DIST	FELAS
0-4	0.493	0.60	6.2	1.49 (1.6)	0.06 (0.6)	-0.36 (2.6)	-0.09 (0.2)	-0.002 (0.0)	-0.13 (1.1)	6.77 (3.5)	0.42 (3.2)	-0.01 (1.2)	2.39 (1.4)
5-9	0.565	-5.14	8.3	1.32 (1.4)	0.08 (0.7)	-0.37 (2.7)	0.13 (0.2)	0.06 (1.7)	-0.06 (0.5)	5.71 (2.9)	0.31 (2.5)	-0.02 (1.8)	2.10 (1.2)
10-14	0.691	-12.52	14.3	2.15 (1.6)	0.12 (0.8)	-0.38 (2.0)	0.07 (0.1)	0.09 (1.7)	0.73 (4.4)	5.36 (1.9)	0.29 (1.7)	-0.03 (2.0)	3.00 (1.3)
15-19	0.639	-10.89	11.3	1.98 (1.4)	0.29 (1.8)	-0.33 (1.6)	-0.41 (0.5)	0.07 (1.3)	0.04 (0.2)	13.13 (4.5)	0.29 (1.6)	-0.01 (0.9)	3.16 (1.2)
20-24	0.481	-0.42	5.9	2.14 (1.4)	0.14 (0.9)	-0.70 (3.2)	-0.54 (0.6)	0.03 (0.6)	-0.47 (2.5)	10.26 (3.4)	0.37 (2.2)	-0.009 (0.5)	3.79 (1.4)
25-34	0.421	-0.21	4.7	2.32 (1.9)	0.03 (0.2)	-0.47 (2.6)	-0.12 (0.2)	0.04 (0.8)	-0.32 (2.1)	7.77 (3.0)	0.34 (2.7)	-0.01 (1.0)	0.24 (0.1)
35-44	0.383	0.10	4.0	2.13 (2.0)	0.08 (0.6)	-0.27 (1.7)	-0.05 (0.1)	0.006 (0.1)	-0.35 (2.6)	6.86 (3.1)	0.22 (2.0)	-0.009 (0.8)	-0.43 (0.2)
45-54	0.340	1.14	3.3	1.54 (2.1)	0.05 (0.6)	-0.23 (2.2)	0.07 (0.2)	-0.0002 (0.0)	-0.09 (1.0)	2.54 (1.7)	0.20 (2.4)	-0.01 (1.7)	-0.35 (0.3)
55-64	0.419	2.35	4.6	0.92 (1.4)	0.16 (2.1)	-0.23 (2.4)	0.02 (0.0)	-0.02 (0.9)	0.07 (0.9)	1.72 (1.3)	0.20 (2.4)	-0.016 (2.1)	0.75 (0.6)
65 or over	0.333	4.27	3.2	0.33 (0.7)	-0.02 (0.3)	-0.13 (1.9)	-0.13 (0.5)	-0.0002 (0.0)	-0.03 (0.6)	1.95 (2.0)	0.09 (1.5)	-0.01 (2.0)	0.98 (1.2)

Table XII.- Female Migration in Ten Age Groups 1960-1970 (t-ratios are in parentheses)

LEGEND: HEOP: Health Opportunities EDOP: Educational Opportunities MIS: Migration Stocks													
HOOP: Housing Opportunities EDLE: Educational Levels POIN: Population Index													
UNFE: Unemployment Female IN: Income DIST: Distance													
FELAS: Demand for Female Labor Service													
(K) Age Group	R ²	INTERCEPT	F-VALUE	HEOP	HOOP	UNFE	EDOP	EDLE	RIN	MIS	POIN	DIST	FELAS
0-4	0.467	-1.61	5.6	1.73 (1.8)	0.11 (1.1)	-0.12 (1.7)	-0.02 (0.0)	0.004 (0.1)	-0.13 (1.1)	6.75 (3.5)	0.39 (3.0)	-0.005 (0.5)	1.43 (0.9)
5-9	0.534	-3.35	7.3	1.89 (1.8)	0.096 (0.8)	-0.15 (1.9)	-0.02 (0.0)	0.01 (0.3)	-0.19 (1.5)	8.39 (4.1)	0.24 (1.8)	-0.0009 (0.1)	2.17 (1.2)
10-14	0.646	-7.36	11.7	2.00 (1.5)	0.25 (1.8)	-0.12 (1.2)	-0.05 (0.1)	0.01 (0.2)	0.19 (1.2)	11.47 (4.5)	0.23 (1.4)	-0.0056 (0.4)	3.38 (1.5)
15-19	0.631	-8.82	10.9	1.67 (1.1)	0.34 (2.1)	-0.12 (1.1)	-0.02 (0.0)	0.02 (0.5)	0.11 (0.6)	15.13 (5.2)	0.44 (2.5)	-0.0009 (0.1)	3.71 (1.5)
20-24	0.526	-8.36	7.1	2.23 (1.5)	0.21 (1.3)	-0.09 (0.8)	-0.32 (0.4)	0.06 (1.1)	-0.016 (0.1)	12.17 (4.3)	0.44 (2.8)	0.009 (0.6)	2.28 (0.9)
25-34	0.473	-2.67	5.8	1.82 (1.6)	0.12 (0.9)	-0.13 (1.6)	0.18 (0.3)	0.02 (0.4)	-0.20 (1.4)	9.61 (4.2)	0.28 (2.6)	-0.004 (0.4)	0.76 (0.4)
35-44	0.453	-4.10	5.3	2.02 (1.9)	0.13 (1.1)	-0.10 (1.3)	0.10 (0.2)	0.03 (0.8)	-0.22 (1.8)	7.36 (3.5)	0.25 (2.4)	0.0002 (0.0)	0.55 (0.3)
45-54	0.459	-4.90	5.4	2.58 (2.4)	0.22 (1.9)	-0.12 (1.6)	0.24 (0.4)	0.06 (1.6)	-0.19 (1.5)	4.77 (2.3)	0.28 (2.6)	-0.0016 (0.1)	-1.09 (0.6)
55-64	0.476	-2.53	5.8	1.27 (1.5)	0.15 (1.7)	-0.07 (1.2)	-0.12 (0.2)	0.02 (0.8)	-0.097 (1.0)	5.63 (3.4)	0.16 (2.0)	-0.00098 (0.1)	0.98 (0.7)
65 or over	0.549	3.03	7.8	1.19 (2.2)	0.04 (0.7)	-0.05 (1.2)	-0.05 (0.9)	-0.02 (1.0)	-0.01 (0.2)	5.42 (5.0)	0.13 (2.4)	-0.005 (0.9)	-0.12 (0.1)

although not always significant at the conventional 5% level of confidence. In fact its coefficient is significant (5%) for two male groups aged 35-44 and 45-54 in 1960, and two female groups (45-54 and 65 and over in 1960). These four groups male and female indicate that old persons are more sensitive to regions offering good health facilities. Mention should be made of the fact that most of the coefficients, especially among young females, are significant at the 10% level of confidence.

- MIS

With respect to the migrant stock parameter, we note that its coefficient is relatively high, particularly among the young males: 13.13 (group 15-19 of age), 10.26 (group 20-24 of age) and young females: 11.47 (group 10-14 of age), 15.13 (group 15-19 of age) and 12.17 (group 20-24 of age) and very significant for all female groups and almost for all male groups. Its presence in the equation also contributes to increase noticeably the coefficient of the population index parameter (see Tables I and II), and decrease the coefficients of the other parameters, even of the FELAS - demand for female labor services. As Greenwood¹⁰ contented, the migrant stock has a strong explanatory power in explaining mobility and the other variables present in the equation have contributed to the process of past migration. Note that the distance coefficient, although still negative, has markedly decreased in value.

Fourth Model: Young and Old Persons

Even though we have subdivided our male and female population into ten age-groups, we did not expect, of course, that the variables

introduced in the equations would explain in a satisfactory manner all the groups concerned. Clearly, young children (0-4 years of age) cannot migrate without their parents and older persons who can no longer work migrate for reasons that are not entirely economic. In view of these considerations an attempt is made to explain migration of children (0-4 years of age in 1960) and old persons (55-65 and over in 1960) by using other variables. For example, we try to explain the migration rate of young children (males and females) by using the following variables:

MRW1 : migration rate of women aged 15-19

MRW2 : migration rate of women aged 20-24

MRW3 : migration rate of women aged 25-34

DIST : Distance in miles from the municipio to the center of San Juan city

HEOP : Health opportunities

HOOP : Housing opportunities

EDOP : Educational opportunities

and for old persons we consider the same variables, along with the migration rate of men of the same age-groups, and exclude the education opportunities variable (EDOP).

Regression Results

The results obtained are presented in Tables XIII and XIV. The variables explain almost 95 percent of the variation in the rate of net migration among the young (0-4 of age in 1960), males and females, 78 percent of old males and practically 90% of old females.

The most important and significant variable explaining the migration rate among the young is the rate of migration of women aged

Table XIII.- Male Migration of the 0-4 Group 1960-1970 (t-ratios are in parentheses)

LEGEND: MRW1: Migration Rate of Women Aged 15-19 DIST: Distance EDOP: Educational Opportunities
 MRW2: Migration Rate of Women Aged 20-24 HEOP: Health Opportunities
 MRW3: Migration Rate of Women Aged 25-34 HOOP: Housing Opportunities

(K) Age Group	R ²	INTERCEPT	F-VALUE	MRW1	MRW2	MRW3	DIST	EDOP	HEOP	HOOP
0-4	0.949	0.366	179.5	0.08 (1.5)	0.07 (0.8)	0.66 (8.3)	0.002 (0.8)	0.09 (0.5)	-0.43 (1.8)	-0.023 (0.7)

Female Migration of the 0-4 Group 1960-1970

Without ponderation

(t-ratios are in parentheses)

LEGEND: Same as Above

(K) Age Group	R ²	INTERCEPT	F-VALUE	MRW1	MRW2	MRW3	DIST	EDOP	HEOP	GOOP
0-4	0.943	0.13	159.9	0.08 (1.5)	0.14 (1.5)	0.52 (6.3)	-0.0006 (0.2)	0.05 (0.3)	-0.10 (0.4)	-0.003 (0.1)

(K) AGE GROUP	R ²	INTERCEPT	F-VALUE	F15	H15	F20	H20	F25	H25	DIST	HEOP	HOOP
55-65	0.780	2.55	25.6	-0.02 (0.3)	0.035 (0.5)	0.12 (1.3)	0.02 (0.5)	0.19 (1.5)	-0.01 (0.1)	-0.004 (1.3)	-0.42 (1.8)	0.06 (1.8)

(t-ratios are in parentheses)

(K) AGE GROUP	R ²	INTERCEPT	F-VALUE	F15	H15	F20	H20	F25	H25	DIST	HEOP	HOOP
55-65	0.899	2.22	64.5	0.01 (0.2)	0.002 (0.0)	0.136 (1.5)	0.106 (2.2)	0.40 (3.4)	-0.20 (2.3)	-0.003 (1.0)	0.28 (1.3)	0.015 (0.5)

25-34. The remaining variables exhibit very low values with low significance or the wrong sign. Educational opportunities is positive but not significant. We can infer then, that the migration rate of mature women aged 25-34 in 1960 and 35-44 in 1970, explains in a significant manner migration of young children.

As for male old persons, while the R^2 is quite high, no one variable is significant or important enough to be mentioned. Nevertheless the migration rates of women aged 20-24 and 25-34 show significance at the ten percent level of confidence. Among the other variables, health opportunities has the wrong sign or low values. Finally, for older women, the migration rates of men aged 20-24 and women 25-34 appear to positively affect their rate migration, whereas that of men aged 25-34 deters migration significantly. Health opportunities has a positive value and affects the annual migration rate of old women by 2.8% wherever health facilities increase by 10%, its coefficient being significant only at less than 10% level of confidence.

Concluding Remarks on the Model's Used in This Study

In conclusion, we can say that the model, as expounded at the beginning of the chapter and later enlarged with the new variables, appears to better explain the migration rate of young persons from 5-9 to 20-24 years of age in 1960, particularly males. The most important variables are the demand for female labor services, the population index and unemployment. Income explains pretty well the groups 10-14 and 15-19 years of age, among both males and females. Distance, with the right sign and significant most of the time, shows rather low values. The variable

fertility rate, exhibiting the expected signs, is significant only in its 1970 form, and has such low values that it cannot be responsible for any variation in the migration rate. Nevertheless, its presence helps a little in increasing the value of the R^2 of the equation.

The educational opportunities variable, housing opportunities variable and sometimes the health opportunities variable behave rather poorly.

Migration stock when introduced in the equation behaves in the expected way by reinforcing the role of the population index, while it contributes to decrease the influence of the other variables.

We will conclude that explicit economic considerations (income, unemployment) loom large in the calculus of the potential Puerto Rican's migration. However, the presence of a large labor market (population index) and friends or parents (migration stock) that can help or facilitate the transition between the old and new environment tend to outweigh all other economic considerations.

Conclusion regarding the overall performance of the Human-Capital approach.

Although our enlarged and modified model shows substantial improvement over the Schultz-Nerlove one, it is clear that neither set of results explains convincingly Puerto Rican migration in the 1950's and 60's. We make this judgment from the low values of the regression statistics - the R^2 's (coefficient of determination) and the F's (Fisher-test) - exhibited by the migration equations. Indeed, except in the equations

explaining male and female children aged 0-4 in 1960 and old persons aged 55-65 in the same year, the equations covering distinct age-groups exhibit R^2 -values barely equal to 0.6, or in one case 0.7, and most of the time values as low as 0.3-0.5 with corresponding F-values slightly over 10. Furthermore, given the few t-values of the explanatory variables particularly among the female groups that are statistically acceptable at the conventional 5% -level of significance, we simply cannot be satisfied with the overall performance of our results.

The approach used in trying to understand the Puerto Rican's migration relies on the human-capital approach which views migration as an investment that man makes in himself.

It implicitly assumes that data such as expected profiles of earning differentials by regions and by occupation, opportunity costs and benefits related to migration, are available to the investigator. In reality, such data are at best difficult to secure even in developed countries and more so in developing regions - to which Puerto Rico belongs - where most routine economic data are lacking.

But aside from data scarcity and inavailability, the human-capital approach presents serious shortcomings that render it quite irrelevant in explaining mobility in a context of developing regions. The human-capital model assumes that the individual who decides to move is capable of searching, collecting and analyzing pertinent information related to occupations in origin and alternative destination locations and finally arriving at decisions that optimize his lifetime income. It is not hard to realize that such high degree of sophistication in the

process of decision-making in developing regions is not yet reached by the average person who envisions migration.

For these reasons, the traditional "push-pull" model focussing on the determinants of migration such as rural versus urban conditions and non agricultural employment opportunities in the cities may be more appropriate in explaining mobility in the less developed regions.

FOOTNOTES, CHAPTER V

- (1) Beals, R.E., Levy H.B. and Moses L.N., "Rationality and Migration in Ghana", The Review of Economics and Statistics, 49(67), p. 480-486.
- (2) Schultz Paul T. and Nerlove Marc, Love and Life Between The Censuses: A Model of Family Decision Making in Puerto Rico, 1950-1960, The Rand Corporation RM-6322-AID, September 1970, p. 73, note 1.
- (3) Schultz and Nerlove, op. cited in note 2
- (4) Greenwood Michael J., "The Determinants of Labor Migration in Egypt", Journal of Regional Science, Volume 9, No 2, 1969, p. 283-290
- (5) Sohata, G.S., "An Economic Analysis of Internal Migration in Brazil", Journal of Political Economy, 76(1968), p. 218-245
- (6) Schultz and Nerlove, op. cited in note 2
- (7) Schultz and Nerlove, op. cited in note 2, p. 61
- (8) Greenwood, "An Analysis of the Determinant of Geographic Labor Mobility in the United States", The Review of Economics and Statistics, 51, (1969), p. 189-194
- (9) Greenwood, op. cited in note 8, p. 191
- (10) Greenwood, op. cited in note 8

CHAPTER VI

The Agricultural Sector in Puerto Rico

Introduction

The purpose of this chapter is to provide a general background for the type of agricultural production existing in Puerto Rico, an overview of the systems of land tenure, size of farms and other features that characterize farming operations in the island before and after the process of industrialization started in the 1950's. This chapter, while largely descriptive, will nevertheless set the stage for a better understanding of the structural changes that have taken place in the Puerto Rican farm sector since that period.

Puerto Rico is a small island (100 miles long by 30 miles wide approximately) of the West Indies group bordered by the Atlantic Ocean on the north and the Caribbean Sea on the south. Its area covers 3,435 square miles characterized by a coastal plain surrounding a central mountain range. According to the Department of Agriculture of Puerto Rico¹, only a little more than half of its area is fit for agriculture. About 580,000 cuerdas^a have slopes of 15 per cent or less and 60,000 cuerdas have slopes between 16 to 45 per cent. The remaining land is not considered suitable for farming because of its steepness or low fertility and must be reserved for forest and brush, or kept under conservation measures. The types of soils vary widely in Puerto Rico,

a) 1 cuerda : 0.9712 acre

but the most fertile are located in the coastal areas and are devoted mainly to sugar cane and - since the 1960's - to dairy products, which latter are now tending to replace the former in terms of proportion of total income derived from agriculture.

Although small in size, Puerto Rico enjoys a wide variety of climate and topographical conditions, enabling it to produce various types of crop, plus tropical fruits and vegetables. Traditionally however, sugar cane, tobacco and coffee were always the three principal crops dominating agricultural production in terms of proportion of gross farm income and total farm employment generated by their exploitation. We will review the principal crops now produced in Puerto Rico, the problems encountered in their modernization, and how their relative importance in the farm economy of Puerto Rico has shifted over the years.

Traditional Crops in Puerto Rico

- Sugar Cane.

Sugar production used to play a prominent role in the economy of Puerto Rico. By the mid-1960's however, its role had gradually decreased. While in the 1951-52 crop year, employment provided by the production of sugar was estimated at 153,000 (peak number) in farms and more than 10,000 in sugar mills and refineries,^a in the 1970-71 crop year the highest level of employment on farms reached only 26,000 and

a) These figures and the following on Sugar cane are taken from : An Economic Report on the Sugar Farming Industry and The Sugar Manufacturing Industry in Puerto Rico, April 1972, U.S. Department of Labor, Wage and Hour Division

that on sugar mills and refineries which were fewer than 5,000. In 1952, sugar cane contributed 120 million to gross farm income or 52 per cent of all gross farm income, while its contribution dropped to \$36 million in 1970-71 or only 13 per cent of gross farm income. The number of farms devoted to sugar cane declined also from 18,300 in 1951-52 to 4,200 in 1970-71 with a corresponding decrease in acreage passing from 392,000 acres in 1951-52 to around 153,000 in 1970-71. As a result the number of tons of sugar produced by Puerto Rican mills dropped from 1.4 million tons in the 1951-52 grinding season to 324,000 tons in 1970-71. Table I presents data on sugar cane from 1950-51 to 1970-71.

- Productivity

What are the factors that account for this drastic decline in the sugar cane production since the mid-1950's? In a report prepared for the United States Congressional Committee on Agriculture by the "United States Sugar Program"² dated December 31, 1970, the principal causes are attributed to the "inability of sugar-cane farming in Puerto Rico to compete for labor with the newer industries". Besides, it is also emphasized that the productivity of labor in the island is well below the productivity of other domestic producing areas such as Louisiana, Florida or Hawai. Indeed, while it takes in 1970 4.93 hours to produce 1 ton of cane in Puerto Rico, it takes 2.16, 1.63 and 1.06 man-hours for Louisiana, Florida and Hawai respectively.³

Labor used to be abundant at low wages in Puerto Rico. The farming of sugar cane has relied since its unciplency mainly on hand labor. A comparison of labor used per acre, harvested in 1970 gives

Table I.- Selected Characteristics of Sugar Cane Farming in Puerto Rico, 1950/51 - 1970/71

Years	Number of Farms (1,000)	Workers ¹ (1,000)	Acres Harvested	Farm Value (\$1,000)		%
				Total Agri- culture	Sugar Cane and molasses	
1950/51	16.5	144	366	199,805	110,273	55.2
1951/52	18.3	153	392	232,605	120,312	51.7
1952/53	19.8	145	385	212,556	103,889	48.9
1953/54	19.5	141	367	220,544	101,671	46.1
1954/55	19.3	127	361	212,958	97,324	45.7
1955/56	18.4	124	353	220,887	99,481	45.0
1956/57	17.6	118	361	213,047	90,636	42.5
1957/58	16.5	113	328	217,078	83,725	38.6
1958/59	16.0	97	345	226,405	96,516	42.6
1959/60	15.0	95	328	238,070	90,090	37.8
1960/61	14.2	97	328	251,183	101,618	40.4
1961/62	13.2	94	309	261,459	94,947	36.3
1962/63	12.3	95	303	297,504	116,816	39.3
1963/64	11.6	91	303	279,930	97,692	34.9
1964/65	10.8	81	288	273,945	86,109	31.4
1965/66	9.8	70	273	269,555	88,163	32.7
1966/67	8.8	60	263	265,939	85,225	33.2
1967/68	7.8	49	237	269,109	69,473	25.8
1968/69	6.5	38	180	260,160	52,547	20.2
1969/70	5.6	34	189	267,355	52,550	19.7
1970/71	4.2	26	153	278,768	36,444	13.1

1) Estimated peak number of persons working on farms during crop year, including working farm operators and unpaid workers.

Source: An Economic Report on the Sugar Cane Farming and Industry, P.R. U.S. Department of Labor, Table I and Facts and Figures on Puerto Rico's Agriculture, various issues, Department of Agriculture of Puerto Rico.

the following results: 6.6 workers per acre in Louisiana, 5.6 in Florida, 5.2 in Hawaii and 18.0 in Puerto Rico.^a The sugar-farming industry has been slow in realizing that the source of cheap labor is finally drying up, and will continue to do so as long as the rhythm of industrialization of the island can be sustained and also, as long as farm workers can migrate to the cities or the mainland to find better-paying employment. Despite many incentives given to sugar-cane farming for the re-seeding of old plantations and to introduce machines into the various operations (planting, harvesting, cutting and loading etc), production has not been boosted.

- Mechanization

Serious efforts to mechanize seem to have begun fairly recently in the late 1960's and have confronted many difficulties. As late as 1971 only 38% of the cane harvested was cut mechanically,⁴ although it is estimated that this method has reduced the cost of cutting and loading operations by \$2.80 per ton of cane. Table II presents the % of cane loaded by machine and by hand. Sugar-cane production decreased by more than 50% from 1954 to 1971 and yet in 1971 19% is still being cut by hand.⁵

Mechanical harvesters are not constructed to respond to the peculiarities prevailing in Puerto Rican farming. More than 90% of all sugar-cane farms on the island measure between 0.01 and 50 acres (5019

a) Computed by dividing number of workers (peak season) through acres harvested in these producing areas. Figures are taken from: An Economic Report on Sugar Cane Farming and Industry, P.R., op. cited, Table I, p. 9

Table II.- Gross Sugar Cane Production and Amount Loaded by Hand and by Machine. Puerto Rico
Crop Years 1954 to 1971

Years	Total Cane Produced	Cane Loaded			
		By Hand		By Machine	
		Thousand Tons	%	Thousand Tons	%
1954 ¹	10,880	10,195	93.70	685	6.30
1955	9,873	9,053	91.70	829	8.30
1956	10,306	9,056	87.86	1,251	12.14
1957	8,711	7,290	83.69	1,421	16.31
1958	9,067	7,272	80.20	1,796	19.80
1959	10,182	7,740	76.02	2,441	23.98
1960	10,001	7,394	73.94	2,607	26.06
1961	10,754	7,245	63.37	3,509	32.63
1962	9,663	5,888	60.93	3,775	39.07
1963	10,122	5,206	51.00	4,916	49.00
1964	9,802	4,565	46.57	5,237	53.43
1965	8,807	3,575	40.59	5,232	59.41
1966	9,523	3,580	37.59	5,943	62.41
1967	8,160	2,532	31.03	5,628	68.97
1968	6,618	2,040	30.83	4,578	69.17
1969	5,927	1,612	27.19	4,315	72.81
1970	6,020	1,286	21.37	4,734	78.63
1971	4,740	894	18.87	3,846	81.13

1) Year in which machine-loading of sugar cane was begun in Puerto Rico

Source: Puerto Rico Sugar Board, cited in Puerto Rico Rural Manpower Service Report, 1971, Department of Labor, Bureau of Employment security, Table 9.

out 5565 farms)^a in the crop-year 1969-1970, thus needing small and relatively light machines whose costs are considered prohibitively high for

a) Agricultural Stabilization and Conservation Service Caribbean Area, 1970 Annual Report, Table 2

small farms. Apparently the market is not yet large enough to induce producers of the machine to offer smaller ones adapted to small farms, as is commonly done in Japanese agriculture. Puerto Rico depends on the U.S. for its supply of machines. The available machines constructed perhaps for larger farms (Hawaii, Florida or Louisiana) must await the day when farms in Puerto Rico are consolidated into bigger units in order to make their use more profitable.

Besides, the Puerto Rican Annual Report on Manpower, in its issue of 1970, reports other shortcomings that markedly affect the yield of sugar cane. "The cane harvested by these machines contains a large amount of extraneous material leaves, soil stones, than the cane cut by hand... and the sugar mills operating in the island lack the facilities to receive and clean this cane with excessive extraneous material". As a result, the yield of 96⁰ Sugar per ton of sugar drop from an average 11.9 in the 1950's to 7.7 in 1970 and 7.0 in 1971 and from 34 sugar mills operating in 1950, only 15 mills were in operation in 1971 with only 40% of their combined rated capacity.⁶

- Sugar Cane Prospects

Sugar-cane farming and the sugar industry in Puerto Rico have been operating under a guaranteed preferential price, a sure market in the mainland and subsidized payments - all of which did not provide incentives for farmers to shift to other commodities as readily as they should have. Besides, Puerto Rican sugar is regulated by a quota that limits the amount that can be marketed. Thus the incentives to increase land productivity are not too strong. Until the time farmers realize

that alternative crops can add more to their incomes than sugar cane, they will keep their land under sugar-cane production. With all the problems they confronted at the end of the 1960's labor prices that are high and mechanization that is not readily adaptable to Puerto Rican conditions, - land has been shifted at a rapid pace to other more profitable undertakings, in particular livestock production as we will see shortly.

Coffee.

Coffee is, after sugar cane, the crop whose production used to add more to gross farm income than any other. It is, like sugar cane, produced mainly for export. The income derived from this crop is very unstable however, due to the biennial cycle inherent to it, giving one year of high harvest followed by a low one. Income derived from that crop, areas harvested and average employment provided by it, are compiled in Table III. The total area devoted to this crop has remained practically unchanged (compared to sugar cane), mainly because of the fact that land suitable for it is very mountainous (this crop is located on the Western uplands of the Central Range whose average slope is around 60%) and does not lend itself too easily to the production of other crops.

- Production and Prospects

Coffee production is, like sugar cane, confronted with problems of labor and mechanization. Mechanization is difficult to implement even during the harvesting operation. Attempts are made to improve or reduce the man-hours of harvesting, but the techniques used require that coffee trees be well aligned, which is not the case in long-established, traditional coffee plantations. Thus to make Puerto Rican coffee competitive

Table III.- Income, Employment and Areas Harvested in Coffee Plantations.
Puerto Rico, 1950/51 - 1970/71

Years	Area Harvested (1,000 cuerdas)	Employment (1,000)	Farm Value (\$1,000)		
			Total Agriculture	Coffee	%
1950/51	159	22	199,805	8,402	4.2
1951/52	159	NA	232,605	14,750	6.3
1952/53	159	NA	212,556	8,709	4.1
1953/54	159	NA	220,544	16,380	7.4
1954/55	160	NA	212,958	11,696	5.5
1955/56	160	NA	220,887	16,930	7.7
1956/57	160	NA	213,047	11,430	5.4
1957/58	160	NA	217,078	19,881	9.2
1958/59	160	NA	226,405	13,974	6.2
1959/60	160	23	238,070	19,867	8.3
1960/61	160	23	251,183	14,876	5.9
1961/62	160	29	261,459	20,279	7.8
1962/63	160	29	297,504	22,807	7.7
1963/64	160	23	279,930	18,205	6.5
1964/65	160	24	273,945	21,698	7.9
1965/66	160	20	269,555	17,278	6.4
1966/67	160	19	265,939	19,062	7.2
1967/68	160	18	269,109	21,745	8.1
1968/69	160	17	260,160	17,386	6.7
1969/70	130	13	267,355	13,393	5.0
1970/71	NA	13	278,768	22,776	8.2

Source: Facts and Figures on Puerto Rico's Agriculture, 1969-70 Tables 38 and 64 and An Economic Report on the Sugar Farming Industry and the Sugar Manufacturing Industry, op. cited, p. 4

on the world market, a Price Support Program is being organized by the Economic Stabilization Office of Puerto Rico to help farmers. This program also provide a subsidy to coffee marketed outside Puerto Rico.

The only alternative for land devoted to coffee is the production of leaf vegetables, and fruit, all of which are in high demand as income increases. But again, these steps might not be very successful, as coffee locations are far from cities where the demand for fruit and vegetables is the highest. This impediment could be alleviated by roads linking coffee areas to urban places. These roads would insure fast transportation as well as low cost and competitive prices to other well-located producing areas.

-Tobacco.

This crop forms, along with the two preceding ones, the three traditional export items of Puerto Rican agriculture. It is exported to the U.S. in the form of tobacco leaves or cigars locally manufactured. Tobacco finds its best habitat in the east -and west- central mountains where medium deep soils are to be found.

Because of the wide price fluctuations registered on the world market, production is regulated by a system of variable quotas which may be increased or decreased depending on the tobacco inventory or prospects on the world market.

Because of a shortage of hand labor, production has shown a consistently decreasing trend since 1966. Indeed, at this stage of knowledge in P.R., without hand labor, there is no way of conducting production on a scale sufficient to insure adequate revenue to farmers. As a consequence, the proportion of total gross farm income provided by tobacco is becoming smaller and smaller. Table IV presents the situation of tobacco from 1950/51 to 1970/71.

Table IV.- Area Harvested, Employment and Farm Value of Tobacco
Production: 1950/51 - 1970/71

Years	Area Harvested (1,000 Cuerdas)	Employment (1,000)	Farm Value (\$1,000)	
			Tobacco	% of total Farm Value
1950/51	37.0	20	6,355	3.2
1951/52	36.0	NA	8,430	3.6
1952/53	36.7	NA	11,147	5.2
1953/54	41.7	NA	10,230	4.6
1954/55	38.0	NA	10,540	4.9
1955/56	36.1	NA	7,545	3.4
1956/57	26.3	NA	7,402	3.5
1957/58	26.5	NA	7,428	3.4
1958/59	24.2	NA	7,875	3.5
1959/60	26.3	9	9,349	3.9
1960/61	28.5	11	9,592	3.8
1961/62	27.0	10	11,598	4.4
1962/63	28.5	13	13,378	4.5
1963/64	30.0	13	13,151	4.7
1964/65	30.0	16	14,088	5.1
1965/66	18.0	8	5,321	2.0
1966/67	9.5	4	3,895	1.5
1967/68	7.8	3	3,753	1.4
1968/69	6.2	3	2,781	1.1
1969/70	5.1	2	2,273	0.9
1970/71	4.0	2	1,980	0.7

Source: Facts and Figures on Puerto Rico's Agriculture, 1969-1970 Tables 40 and 64 and An Economic Report on the Sugar Farming Industry and The Sugar Manufacturing Industry, op. cited p. 4

Because of its particular fame on the world market as one of the best fillers in the production of cigars, efforts are being made to organize producers and dealers into cooperatives for production and marketing, to find better methods of production, and to provide subsidies

to producers, -all with the objective of reducing costs and making the Puerto Rican price more competitive.

-Other Crops.

Besides these three principal crops, Puerto Rico produces a variety of vegetables: starchy, other vegetables and legumes; a variety of fruits; some types of cereals and ornamental plants.

- Starchy Vegetables.

Among the starchy vegetables we might mention sweet potatoes, plantains and bananas. Their natural habitat is found in the mountainous areas of the island. Except for bananas which are produced concurrently with coffee, most starchy vegetables are cultivated in rotation or after the tobacco harvest.

- Legumes and Others

Among the other vegetables and legumes the most important are tomatoes, pumpkins, peppers, cabbages and pigeon peas. Like the preceding they are cultivated in the mountains as well as in the coastal plains. The production of these types of vegetables and legumes is tending to replace some of the imports that used to come from the United States, and there has existed since the mid-sixties, a good prospect for potential exports to the mainland.

Corn is the principal cereal that is cultivated, of which only 40% is marketed and the remaining is consumed on the farm.

Ornamental plants are important mainly for local consumption.

Together legumes, starchy vegetables, yellow, green and leafy vegetables along with other farm products and benefit payments represent 8.1% of total farm income in 1950 and 22.9% in 1971.

Due to their perishable characteristics and a demand that tends to be income elastic, especially for legumes and leafy vegetables, producers of these items are given technical aid in their production and marketing. They are also encouraged to locate around potential markets near San Juan at Naranjito, near Caguas at San Lorenzo, near Ponce at Adjuntas and Utuado and Isabella in the North-eastern coastal plain, whose good network of surrounding roads facilitates delivery at Mayaguez or at the merging coastal towns near San Juan.

Before we pass to livestock and dairy products, we must also mention the production of fruit, with its many possibilities for export. The climate of Puerto Rico is indeed well suited for the cultivation of a variety of tropical as well subtropical fruits.

Oranges are grown in the hilly areas along with coffee and bananas. Avocados, mangoes, lemons and some less well-known fruits are produced from trees scattered throughout the plots and not on a commercial basis.

The most important among the fruits produced is the pineapple, which is grown in commercial farms in the north central plain, mainly for export. At the beginning of the 1960's production began to increase sharply to reach an average of 74,000 tons during the years 1964 to 1967 and decrease thereafter from 1968 to 1970 probably because of the bad weather conditions so frequent in the island. Lack of data does not

Table V.- Pineapple Production, Areas Harvested and Crop Disposition,
Puerto Rico 1950-1970

Years	Areas Harvested (Cuerdas)	Total	Production (Tons)			Gross Farm Value	
			% Shipped Fresh to U.S.	% Processed in P.R.	% Local Market	Total (\$1,000)	% of Total
1951	3,054	27,700	24.8	63.3	11.9	1,290	0.6
1952	2,056	22,300	34.2	51.0	14.8	1,460	0.6
1953	2,176	24,073	40.9	45.4	13.7	1,467	0.7
1954	2,276	26,505	34.2	60.1	5.7	1,400	0.6
1955	2,638	29,046	33.3	61.8	4.9	1,465	0.7
1956	2,521	31,037	31.6	64.4	4.0	1,395	0.6
1957	3,008	29,314	21.6	73.8	4.6	1,338	0.6
1958	3,772	38,261	13.7	83.4	2.9	1,684	0.8
1959	3,322	39,633	23.3	71.6	5.1	1,974	0.9
1960	3,360	46,740	28.7	67.6	3.7	2,311	1.0
1961	4,155	55,474	27.3	70.4	2.3	2,576	1.0
1962	3,699	56,793	29.5	67.9	2.6	2,538	1.0
1963	4,235	64,715	27.6	69.7	2.7	2,854	1.0
1964	4,823	71,884	32.5	65.3	2.2	3,305	1.2
1965	4,980	80,139	28.1	68.1	3.8	3,949	1.4
1966	4,788	72,522	31.0	66.4	2.6	3,587	1.3
1967	4,850	71,972	35.3	61.8	2.9	3,774	1.4
1968	4,301	64,530	39.7	56.1	4.2	3,516	1.3
1969	3,368	53,166	44.3	51.7	4.0	2,860	1.1
1970	3,651	54,036	38.9	56.5	4.6	2,921	1.1

1) From 1952 to 1960, data refers to fiscal or crop years (November 1 to October 31). From 1961 data refers to calendar years.

Source: Facts and Figures on Puerto Rico's Agriculture, Tables 43 and 44

permit a further study of production trends. The proportion of the crop processed in the island varies from year to year and it is not possible, with available information, to determine whether this is due to technical

Table VI.- Beef, Pork, Poultry and Milk Production Physical Index
(1950/51 : 100)

Years	Beef Production	Pork Production	Broiler Production	Milk Production
1950/51	100	100	100	100
1951/52	106	116	101	103
1952/53	85	116	99	112
1953/54	88	118	104	124
1954/55	99	121	103	131
1955/56	119	123	104	142
1956/57	124	122	109	151
1957/58	136	126	121	159
1958/59	144	130	136	171
1959/60	122	133	142	192
1960/61	126	143	166	198
1961/62	129	148	188	213
1962/63	142	156	196	228
1963/64	153	154	206	233
1964/65	174	165	184	245
1965/66	192	166	192	249
1966/67	192	166	197	253
1967/68	182	173	202	261
1968/69	171	189	204	264
1969/70	172	177	223	263

Source: Facts and Figures on Puerto Rico's Agriculture 1969-70, Tables 5, 6, 12 and 19

factors affecting industrial processing or labor conditions on the farm. The most interesting aspect of production, depicted in Table V, is the high gain in tons produced per cuerdas at the beginning of the 1960's. In 1951 the average ton per cuerda harvested was 9.1 tons, which increased to an average of 15 to 16 tons by 1966 to 1970.

Livestock and Dairy products.

- Income and Credit Facilities

The development within the agricultural sector of livestock, dairy and poultry products is the most outstanding transformation to have occurred in this sector. Table VI presents the increase in the physical production index (1950/51 : 100) of beef, pork, poultry and milk during the period 1950/51 - 1969/70. As a result, income derived from the various components of livestock products as a proportion of total farm income has surpassed that of traditional crops. Table VII shows that the proportion derived from livestock products accounts in 1971 for more than 50% of all farm income. For the same year, total income provided by the three traditional crops, sugar cane, coffee and tobacco account for 21.8% (or 61 out of 279 millions) which is less than that derived from milk alone (25.4%).

Among the factors that account for this outcome is increasing demand on the part of the population for high-quality foods. This demand has become possible since people's disposable per capita income in constant 1954 dollars has increased from \$338 in 1950 to \$997 in 1971 or 197%.⁷

Secondly, the rapid expansion of dairy farms is greatly facilitated by the closing down of many sugar farms located in the coastal areas. The former sugar cane farms are well suited for pastures and very convenient for the grazing of livestock.

Thirdly, the Commonwealth Government has greatly contributed with its program for the improvement of pastures by supplying valuable

Table VII.- Proportion of Total Gross Farm Value Derived from Livestock Products, Puerto Rico, 1950-1971

	1950		1960		1968		1971	
	\$ Million	%	\$ Million	%	\$ Million	%	\$ Million	%
Total Farm-Value	185		238		269		279	
Milk	22	11.9	43	18.1	65	24.2	71	25.4
Eggs	4	2.2	8	3.4	12	4.5	13	4.6
Beef	7	3.8	12	5.0	19	7.1	25	8.9
Pork	4	2.2	8	3.4	10	3.7	14	5.0
Poultry	8	4.3	9	3.8	12	4.5	13	4.7
Others	2	1.1	3	1.3	4	1.5	6	2.1
Total Livestock	47	25.5	82	35.0	122	45.5	141	50.7

Source: Informe Al Gobernador, 1972, Puerto Rico, Table 21

technical assistance to farmers. The program, known as Grassland Conservation, jointly sponsored by the Department of Agriculture of Puerto Rico and the Agriculture Stabilization and Conservation Service of the United States Department of Agriculture, has helped to increase pasture area from 5,322 cuerdas in 1954 to 33,000 in 1969 or an average annual increase of 34.7% of acreage under pasture and the area of improved pastures from 4,748 to 17,453 cuerdas or an average annual increase 17.8% of acreage under improved pasture during the same period.⁸

Meanwhile special credit facilities made available both by the Commonwealth and the Federal Government encourage farmers to increase largely their inventory of all cattle, all hogs and poultry chickens to 54%, 61% and 163% respectively from 1951 to 1970.⁹ As a result the

percentage of total expenditures on feed for livestock has increased from 8.2% in 1950/51 to 30.4% in 1970/71 as shown in Table VIII.

Table VIII.- Expenditures on Feeds for Livestock and Poultry as a Percentage of Total Farm Expenditures. Puerto Rico: 1950/51 - 1970/71

Years	Total Farm Expenditures	Expenditures on Feeds for Livestock and Poultry	% of the total
1950/51	117,060	9,620	8.2
1955/56	220,481	13,386	11.1
1960/61	251,744	21,556	15.2
1963/64	281,159	30,801	18.1
1966/67	268,250	34,819	20.9
1970/71	281,261	50,077	30.4

Source: Ingreso Agrícola de Puerto Rico, various issues Departamento de Agricultura, Oficina de Estadísticas Agrícolas, Santurce, Puerto Rico.

Despite these developments, the domestic production of livestock has not been able to satisfy local demand. Imports from the United States and foreign countries balanced with return exports show that there exists plenty of room for further expansion in the development of this sector. As of 1969/70, imports of total animals and animal products from the U.S. and foreign countries amount to more than 222 million while exports to them amount to 94 million, that is around 128 million that could be supplied by local agriculture.¹⁰

Agricultural inputs in Puerto Rico.

Conventionally, inputs in agriculture are divided into three parts: land, labor and capital.

- Land

A satisfactory measure of land as an economic factor is very difficult to specify, because behind the term "land" are hidden a whole array of heterogeneous characteristics such as its physical and chemical composition or its location etc. As a purely physical entity land is without doubt necessary for farming but its productivity (which is what interests the farmer) can be increased by investing in it in the form of protective structures against erosion, good cultivation practices like rotation, irrigation and use of fertilizers to restore to it the nutrients consumed by previous harvests. In a truly economic sense land should be considered not only as a site but also as the amount of investments or disinvestments embodied in it. In our discussion of farmland in Puerto Rico, we shall try, given the available data, to mention changes that have occurred in its quantity (acreage) but also the kinds of investments that are made in it.

-Land In Farms

Table IX presents the total amount of land in farms in Puerto Rico. Up to 1964, the proportion of total land area in farms was 72.8% but as of 1969, the percentage dropped drastically to 59.2%. It is a well-known fact that as development proceeds, land is widely encroached upon to provide urban amenities in the form of parks, playgrounds, and mostly roads. In the period 1965/66 to 1970/71, investment in the construction of roads linking the municipios has more than tripled relative to the period before 1965.¹¹

Despite this substantial decrease in the quantity of land in

Table IX.- Land in Farms (Cuerdas) Puerto Rico, 1930-1969

Years	Land in Farms	Percent of Total Land Area (1)	Percent Change in Land in Farms	Average Size of Farms
1930	1,979,474	87.8		37.4
1935	1,913,047	84.8	- 3.4	36.2
1940	1,885,874	83.6	- 1.4	34.0
1950	1,884,886	81.8	- 2.2	34.5
1959	1,682,556	74.6	- 8.8	36.7
1964	1,641,042	72.8	- 2.5	36.6
1969	1,334,800	59.2	- 18.7	40.8

1) The total land area is 2,254,365 cuerdas in 1959, 1964 and 1969. From 1950 it was 2,255,684 cuerdas.

Source: U.S. Bureau of the Census Of Agriculture, 1969, Statistics for Puerto Rico and Municipios, P.R.

farms, the index of physical volume of production has not varied too much (from 100 in 1950/51 to 103.9 in 1969/70, taking 1950/51 = 100). In fact even though the total amount of tons of fertilizers used in farming has decreased, because of total decrease in land in farms, average tons of fertilizers used per unit of land under cultivation tend to increase, as shown by Table X. Available data covers only one decade: 1950-1969. Even though the time span is not too long, it gives an idea of the process of change. During that decade, it can be seen that the amount of fertilizer used per unit of land harvested has increased in 1969 relative to 1959 and 1964.

- Land Harvested

Another aspect no less interesting is the percentage of

Table X.- Fertilizer Used per United of Land Harvested and under Pastures. (Cuerdas)

	Years		
	1959	1964	1969
Total Land Harvested and under Pastures (Cuerdas)	759,641	633,964	413,094
Tons of Fertilizer ¹	245,214	237,676	140,394
Fertilizer per Cuerda	32.3	37.5	34.0

1) Tons of fertilizer are estimated by dividing the dollar amount spent on fertilizers through the average maximum price for the corresponding year.

Source: U.S. Bureau of the Census of Agriculture, op. cited, Table IX, and Ventas de Abonos en Puerto Rico, 1951/52 - 1970/71, Departamento de Agricultura, Oficina de Estadísticas Agrícolas, September 1971.

harvested land (cuerdas) that is irrigated. Traditional farming relies heavily on rainfall to insure the moisture necessary to crops. With irrigation, the amount of water required can be kept under control, and this development is among the kinds of modernization that contribute most to the process of transforming routine agriculture into modern farming. As in the case of fertilizers, we have data for only one decade as presented in Table XI. The absolute amount of irrigated land has decreased between 1964 and 1969, due perhaps to the tremendous reduction in acreage of sugar cane which occupies most of the irrigated land, but the proportion of irrigated with respect to all land harvested has increased substantially. The reduction in acreage has surely affected non-irrigated land more proportionately than land under irrigation.

- Programs of Land Improvements

While the physical quantity of land under cultivation has

Table XI.- Change in the Proportion of Harvested Irrigated Farm Land,
Puerto Rico 1959-1969

	1959	1964	1969
Harvested Land	724,210	585,444	362,642
Irrigated	78,015	92,127	89,288
%	10.8	15.7	24.6

Source: U.S. Bureau of the Census of Agriculture, 1964, 1969, Statistics for Puerto Rico and Municipios

decreased during the 1960's, the remaining land in farming has benefited from some other types of investment, which are worth mentioning. Under a cost-sharing program financed jointly by the Federal and Commonwealth Governments known as ACP (Agricultural Conservation Program) two conservation programs are conducted, dealing principally with pasture improvements, coffee rehabilitation, construction of watersheds development and construction of pipelines, springs and lagoons for livestock.

Available data on programs and accomplishments on the part of the Federal Government show that 17,386 farms in 1964 or 38% of the 45,792 total farms were covered as reported by the Census. In 1970, 14,941 farms participated in the program or 33% of the 44,859 farms on the island.¹²

On programs realized jointly by the Federal and the Commonwealth governments on newly established and improved pastures under the Grassland Conservation Program, Table XII shows an increasing trend toward putting land into pastures for the development of livestock and livestock products.

Table XII.- Pastures Established and Improved Under the Grassland Conservation Program^a, Puerto Rico. 1954-1969

Year	Areas in Pastures	
	Established	Improved
1954	5,322	4,748
1955	11,978	5,508
1956	14,831	4,899
1957	22,257	5,266
1958	19,196	16,235
1959	32,207	18,625
1960	18,889	6,852
1961	23,492	7,121
1962	27,267	9,656
1963	28,538	7,893
1964	30,953	7,567
1965	29,525	6,413
1966	37,484	11,546
1967	34,671	20,970
1968	33,978	12,967
1969	32,999	17,453

- a) A program under the Department of Agriculture of Puerto Rico and the Agriculture Stabilization and Conservation Service of the U.S. Department of Agriculture.

Source: Puerto Rico Department of Agriculture, Pasture Improvement Program, Annual Reports, cited in Facts and Figures on Puerto Rico's Agriculture 1969-70, Table 4

We shall gauge the effects of these improvements on land in Chapter VIII, when we explore the change in productivity over the years as affected by the factors applied to Puerto Rican farming.

- Labor

One of the principal characteristics of economic development

is the reallocation of the labor force, shifting people engaged in agriculture or living in towns toward the cities where industries and workshops are usually located.

While total and industrial labor forces have increased steadily over the years since 1950, agriculture has experienced a sharp decline in its labor force due to both internal and external migration that drives people from the rural areas to the cities in search of better opportunities. During the two decades 1950/51 - 1969/70, the agricultural labor force shrank from about 235,000 to 87,000 or around 63%, whereas employment fell from 203,000 to 74,000 or 63.5%.¹³

- Size of the Labor Force

Despite the decline in the size of the labor force in agriculture, unemployment is estimated in 1969/70 at around 15%, and yet these figures conceal much disguised and hidden unemployment in agriculture, as evidenced by Table XIII in which we see the proportion of persons working less than 35 hours and those with employment but not at work. A glance at Table XIII shows that during the period covered, unemployment has oscillated within the range of 11-16% on the average. Moreover, those working less than 35 hours and with employment but not at work totalled almost 50% of the employed. There remains thus a great deal of unemployment in the agricultural sector that cannot be absorbed by the industrial sector. Migration (external or internal) has failed to reduce the proportion of the unemployed. Although not sufficient, the decrease in the number of people working in agriculture is a priori a healthy sign, for as we shall show in chapter VIII productivity will

Table XIII.- Labor Force, Employment and Unemployment in Agriculture.
1950/51 - 1969/70 (Thousand of Workers)

Year	Labor Force (1,000)	Total (1,000)	Employed ¹ % working 35 hours or more	% working 35 hours or less	% with em- ployment but not at work	Unem- ployment %
1950/51	235	203	43.3	52.7	3.9	14.5
1951/52	225	192	39.6	55.2	5.2	16.9
1952/53	207	172	44.7	49.4	5.8	20.3
1953/54	204	174	42.5	52.3	4.6	14.7
1954/55	198	164	40.9	53.0	5.5	17.7
1955/56	188	161	55.3	41.0	3.7	14.4
1956/57	178	152	51.3	44.7	3.9	14.6
1957/58	173	151	55.0	40.4	4.0	12.7
1958/59	163	137	49.6	46.0	4.4	15.3
1959/60	150	125	48.8	47.2	4.0	16.0
1960/61	148	131	52.7	44.3	3.8	11.5
1961/62	159	137	46.0	48.9	5.1	15.1
1962/63	166	142	42.9	51.4	5.6	14.5
1963/64	156	137	55.5	39.4	5.1	12.2
1964/65	143	124	53.2	41.9	4.8	14.0
1965/66	129	122	57.1	37.5	4.5	13.2
1966/67	113	95	60.0	37.9	4.2	15.9
1967/68	104	88	54.5	40.9	4.5	15.4
1968/69	98	85	57.6	38.8	3.5	14.3
1969/70	87	74	58.1	37.8	4.1	14.9

1) Hours worked refers to week previous to survey

Source: Puerto Rico Department of Labor, Bureau of Labor Statistics, cited in Facts and Figures on Puerto Rico's Agriculture, 1950-1970
Table 63

increase when each worker has more capital and land to work with.

In 1950/51 labor at factor cost accounted for 55.5% of all

inputs, whereas in 1970/71, it accounts for 32.8%. Thus labor remains an important economic input in Puerto Rican agriculture.

While it is a good sign to have fewer people per unit of capital and land devoted to farming, it is nevertheless important that the quality and skill of the remaining people be maintained. As we have already shown in the previous chapters dealing with the characteristics of migrants, young people from rural areas tend to migrate more than the rest of the farm population. Also we have found a positive relationship between migration rates and education. Thus, the remaining farm population is the oldest and the least skillful.

- Education of the Labor Force

The median years of schooling for males from 1950 to 1970, according the U.S. Census of Population on Puerto Rico in 1950 and 1970 gives the following figures.

	Median Years Schooling (Men)		
	Total	Urban	Rural
1950	4.1	5.7	3.3
1970	7.5	9.5	4.1
Increase %	82.9	66.7	24.2

During the two decades (1950-1970) the schooling of rural people has increased more slowly than education for the urban group, presumably because among the migrants a higher proportion of educated than less educated have left the rural for the urban sector. The types of skills required for rural farm areas are a kind of basic instruction,

coupled with a vocational formation training the farmers' children for agricultural as well as non-agricultural employment. For example, a comment on the skills required in the farming areas by the Puerto Rico Annual Rural Manpower Report, 1970 goes like this: "Mechanization of sugar-cane production requires an increasing number of workers with special skills for the operation, maintenance and repair of the machinery and equipment... When workers who have not had sufficient training are used to operate the harvesting machines, breakage of the machines increases and great damage is incurred to the plantations, noticeably increasing the amount of extraneous material accompanying the sugar cane to the mills".¹⁵

Vocational training given to farm children should definitely include not only the skills needed to operate and maintain machines and equipment, but also comprehensive elements of farming techniques, livestock breeding, and soil conservation, so that the children, if they choose to remain in farming, are prepared to understand and implement modern agricultural technology.

- Age of the Labor Force

An inspection among the operators (Table XIV), of farms in 1969¹⁶ reveals that 80% of all operators are 45 years old and over, 28% are over 65. This state of affairs is very significant, as old farmers tend to be more reluctant to innovate than young ones. The reasons generally advanced to explain this behaviour are based on the fact that old farmers are more likely to be bound by tradition to what they have learned for generations, so that it is more difficult to induce

Table XIV.- Operators by Age and Main Occupations

Age	Main Occupation					
	Operators Reporting		Agricultural		Non-Agricultural	
	Total	%	Total	%	Total	%
Operators reporting	30,567	100.0	21,481	100.0	9,086	100.0
Under 25 years	242	0.8	138	0.6	104	1.1
25 to 34	1,671	5.5	945	4.4	726	7.8
35 to 44	4,153	13.6	2,496	11.6	1,657	18.2
45 to 54	7,250	23.7	4,844	22.5	2,406	26.5
55 to 64	8,674	28.4	6,474	30.2	2,200	24.2
65 and over	8,577	28.0	6,584	30.7	1,993	21.9
Average age	56.3		57.5		53.5	

Source: U.S. Census of Agriculture on Puerto Rico, 1969, Table 3

them to change their ways of doing things. In an economic sense, old farmers show less desire to migrate from farm, as their earnings and potential for employment outside farming are less than for young men. On the farm it is contended that the old farmers run less risk by introducing a new unknown method than in applying the methods they know.

As a matter of fact, even within the farm, Table XIV shows that the operators whose main occupations are not farming tend be younger (average 53.5) than the purely agricultural operators (average age 57.5). As farm operators get older, they become more reluctant to migrate or invest in any modern type of capital, or to innovate and apply new and better methods of production.

Agriculture relative to industry tends also to recruit its

Table XV.- Male Employment by Age in Agriculture and Nonagricultural Industries, Thousand of persons. 14 years old and over

Age-group	Agriculture				Nonagricultural Industries			
	1970		1971		1970		1971	
	Total	%	Total	%	Total	%	Total	%
Total	68	100.0	60	100.0	453	100.0	473	100.0
14-34	21	31.0	28	30.0	233	51.4	246	52.0
35-54	21	31.0	28	30.0	167	36.9	172	36.4
55 and over	26	38.0	24	40.0	53	11.7	55	11.6

Source: Negociado de Estadísticas del Trabajo, Department of Labor, Commonwealth of Puerto Rico, 1970-71, pp 16, 17, 18

employees among the oldest of the total labor force. Table XV clearly depicts that, while around 40% of farm employees were 55 years and older in 1970-71 only 11.7 of those in this age bracket were employed in industry during the same period.

The available data does not lend itself to rigorous verification in Puerto Rico of the effects of age on the rate of learning of persons or the difference in degree of reluctance between young and old farmers in applying new methods. It is however clear, that farm workers are getting older relative to young persons to remain in agriculture, the rate of adoption of modern means of production is likely to be slower than it would be if young and dynamic farmers were willing to take over the task of their parents.

Machinery and Equipment on Farms

As we have seen previously, when we were dealing with im-

provements in land, the ASCS (Agricultural Soil and Conservation Service) has carried out, under a cost-sharing program, various soil conservation projects which restored value to existing lands and therefore brought about an increase in the existing stock of capital. Among the various programs undertaken were the installation of pipelines for supplying water for livestock, and the building springs, lagoons, ponds, and various other improvements for pasture and forestry. Data on machinery other than tractors is not available. However, costs of operating machinery, equipment, and building repairs are tabulated in Table XVI. The costs are transformed into index form, using the costs from 1950-51 : 100. It is believed that the growth of these indices as computed gives an approximation, however rough, of the growth of machinery and capital equipment in these sectors of the agricultural economy. With all the limitations surrounding these figures, it is clear that machinery capital has greatly increased during the twenty-year period. Two main points can be underlined from table XVI. First, during 1968/69 the cost index for all agriculture decreased markedly, then started to increase the following year. No reason can be offered to explain this sudden shift in trend. Other than that exception, the growth of the cost has been increasing steadily. Second, the rest of agriculture showed a higher rate of increase (5.3%) in capital formation than did sugar cane (3.6%). Also, we note how investment in feed and livestock purchases has increased since 1950/51. This is indicative of the trend that took place within the agricultural sector. When farmers are faced with rising demand for specific products and increasing labor costs, they readily adopt means to save labor and to shift toward the crops that have become more profitable.

Table XVI.- Index of Cost of Operating Machinery, Equipment and Building Repairs and Feeds and Livestock Purchases 1950/51 : 100

Year	Cost of Operating Machinery			Index of Feeds and Livestock
	All Agri-culture	Sugar Cane	Other Agri-culture	
1950/51	100	100	100	100
1951/52	111	111	110	117
1952/53	118	119	115	127
1953/54	126	127	124	129
1954/55	129	129	128	137
1955/56	136	137	135	139
1956/57	158	161	147	159
1957/58	227	206	297	193
1958/59	254	229	338	199
1959/60	270	244	356	214
1960/61	284	257	373	224
1961/62	297	270	390	265
1962/63	310	281	407	305
1963/64	326	296	426	320
1964/65	362	329	474	387
1965/66	369	333	490	415
1966/67	388	349	515	362
1967/68	391	353	519	427
1968/69	388	350	516	501
1969/70	398	359	526	513
1970/71	400	361	530	521

Source: Estimados Preliminares del Ingreso Agrícola de Puerto Rico . Boletines de 1951 a 1970/71. Estado Libre de Puerto Rico, Departamento de Agricultura, Oficina de Estadísticas Agrícolas, Santurce, P.R.

Land tenure in Puerto Rico.

-Genral Considerations

The most common pattern of land tenure encountered in less

developed countries is the existence of large-scale farms and small peasant holdings. In these countries, the tenure system is obviously a colonial legacy. In Latin America particularly, the first Spanish colonizers marked out large estates for themselves in the form of "latifundias", "haciendas" and to the native population tiny little plots or "minifundias" whose occupants provided cheap labor for the large plantations. This structure of land tenure has persisted even after the countries became independent, and constitutes one of the many controversial issues (land reform) in questions dealing with the development of these countries.

- Size and Productivity of Farms

Should a country have large, medium or small-sized farms in order to accelerate the modernization of its agriculture? Opinions vary widely on this question. Some people contend that large units are preferable to small ones because on large units machinery can be used more efficiently, modern technology adopted more readily, and access to credit, markets and other services streamlined because of the better education of the larger farmer. On small farms, farmers are likely to have less education and since machines are indivisible, a properly scaled-down economy is difficult to arrive at.

Others support the view that family-size farms are preferable because they make better use of existing labor and scarce land. They contend that services such as education market, and credit availability are better organized on a community basis where family-size farms exist. The family farmer's entrepreneurial ability is more efficient since he has fewer workers to supervise and control.

Proponents of the large-farm system claim that external economies can be made internal to the farm if the units are large enough. For example disease control, spraying against insects, and irrigation structures are better performed on large than on small farms.

The optimum size of farms is difficult to determine. It all depends on the economic conditions, type of farming and crop, and the availability of land relative to labor and capital prevailing in the country at a given time. As development proceeds, very large farm units, which are synonymous of power, will finally be broken down into smaller units. And as credit, market and capital become available to small farmers, they will readjust their input proportion, including land, in response to changing conditions. As Schultz observes: "The size of farms may change as a consequence of the transformation - they may become either larger or smaller - but changes in size are not the source of the economic growth to be had from this modernization process."¹⁷

Interfarm comparisons gathered from around the world seem to support the view that production per unit of land tends to be higher on small units, whereas output per man is higher on larger farms. But a closer look at the facts reveals that where the same type of farming and land tenure prevail, these differences seem to vanish. Other factors such as capital availability, land tenure, incentives, and application of improved methods and techniques of farming seem to play a more important role than the size of the farm per se.

- Ownership and Productivity of Farms

The type of ownership prevailing in a country, the relation-

ships between landlords, tenants, sharecroppers and workers, and the division of the farm product between them seem to have more bearing on the modernization of agriculture than does the sheer size of farm.

In a traditionally backward setting, large estates belong to a class of powerful, wealthy landlords who are usually city dwellers. They inherit the land and are seldom present on the farms. The land is rented to a tenant or to sharecroppers for a definite period of time. The rent is paid in terms of an exorbitant part of the harvested crop. Being absent from the field of operations and lacking first-hand information, the landlord is not in a position to take any meaningful or rational decisions as to what kind of investment should be made to improve or increase production. Most of the time, these estates are specialized in export products (coffee, sugar cane, rubber etc.) and the proceeds or foreign exchange obtained therefrom are used to import consumer goods or luxury articles rather than being turned back into capital investment.

As for the tenant, cultivating the land on a lease term basis, he has no incentive to invest in land improvement or any other type of capital. When rent is fixed and does not depend on the harvest, the tenant is more interested in maximizing his share than in anything else.

- Monopsony and Employment on Farms

Another effect of the existence of large farms in a setting which lacks alternative employment opportunities, is their monopsony power over labor. Laborers, being immobile because of lack of information or industrial employment, are obliged to accept the sole source of income offered, which is work on large farms. Where monopsony exists, even where

there is no absentee ownership, output and employment are lower than what they would be under competitive conditions. In a competitive situation, labor is hired to the point where its marginal product equals its marginal cost or its wage. In the monopsony case, labor is hired to the point where its marginal product equals its marginal cost, which is greater than the wage. This can be seen graphically (fig. 1-VI).

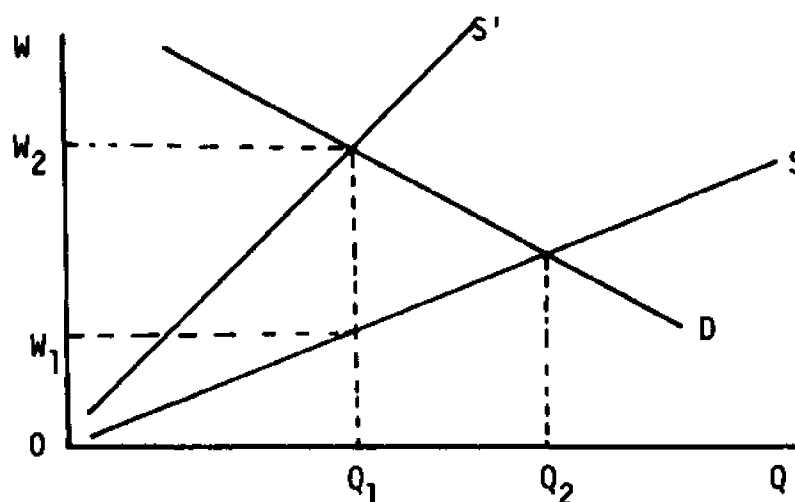


Figure 1-VI

Monopsony Power over Labor

- Monopsony Power over Labor

The monopsonist faces an upward-sloping labor supply curve S or the firm's average resource cost curve since it indicates the wage rate which has to be paid to attract more workers. With this supply curve is associated the marginal cost of labor curve S' or marginal resource cost showing the increase in total cost associated with additional units of labor. It rises more steeply than the supply curve. The demand curve D represents total demand of the large farm as well as the tiny plots. Under competitive conditions, the amount of labor hired would be OQ_2 and wage would be OW_2 . But the monopsonist, equating demand D and the marginal

cost of labor S' , will hire OQ_1 of labor paying OW_1 wages.

Monopsony power on large farms is likely to remain a reality, since the migration that would brake the power of monopsonies entails a cost. The higher the cost of migration, the more powerful will be the monopsony of large garms on labor. When barriers are broken by alternative opportunities offered workers in the village or in the city, information is provided to decrease the cost of migration, and minimum wages are fixed, then the monopsony situation will loosen its grip and will adapt itself to the changing conditions.

Absentee ownerships, and the existence of monopsony are arrangements that impede the modernization of agriculture. The problem of monopsony and its extensive use of existing land can be solved partly by land reform which would redistribute the land to the owner-operators. As economic progress gets under way, pressure is strong to shift the distribution of power and status associated with the ownership of land. There exist strong and valid political reasons for the authorities to act in this way. But economic causes will militate in this direction as well. For example, absentee ownerships characterized by corporations, patnership and managers will have to make way for a more efficient form of tenancy: the owner-operator farmer. Schultz¹⁸ formulates the hypothesis that "under competitive conditions, as farmers adopt and learn how to use modern agricultural factors an increasingly larger part of all farming is taking over by owner-operators". This hypothesis is based on the porposition that the dynamic structure of modern agriculture involves decisions on operations and investments. Absentee ownerships, whatever their form, lack the necessary information that can be had only on the

field.

Data gathered in the United States supports the Schultz's hypothesis. From 1930 to 1959 the percentage of owner-operators increased from a level of 56.7% to 79.0%, that of tenants decreased from 42.4 to 20.5% and finally managers decreased from 0.9 to 0.5%.¹⁹

Farm Size and Farm Ownership in Puerto Rico: Empirical Evidence

What picture does Puerto Rico offer as to farm size and land tenure? Mayne²⁰ reports that "in the 1930's Puerto Rican agriculture was dominated by a small number of large corporations, growers and possessors of sugar cane, many of whose stockholders did not live on the Island. The land reform of the 1940's broke up a number of these corporations, reduced the size and power of those that survived, and brought about a transfer of ownership to local residents". As a result of the reduction of the size of the private corporations, a substantial number of owner-operated farms and public corporations have emerged.

To investigate the transformation in farm size we will use two types of yardstick; the first is the amount of land in cuerdas which, because it takes account of only one element in the production process, gives very little indication of the importance of the enterprise when these farms belong to different sectors of the farming economy. For example, if size is directly related to importance, a given area of cuerdas planted in bananas or flowers is very different from the same number of cuerdas devoted to livestock or dairy production. Thus, another yardstick which is more meaningful in this sense, is to measure

Table XVII.- Number of Farms in Puerto Rico, by Size (Cuerdas)

Years	Size of Farm (Cuerdas)					Total
	Under 10	10-49	50-99	100-259	260	
1930	26,250	19,902	3,351	2,244	948	52,965
%	50.1	37.6	6.3	4.3	1.8	
1940	28,172	19,863	3,200	2,150	936	55,519
%	50.7	35.7	5.8	3.9	1.7	
1950	27,985	19,045	3,166	2,067	1,072	53,515
%	52.3	35.9	5.9	3.9	2.0	
1959	22,967	17,442	2,621	1,724	1,038	45,792
%	50.2	38.1	5.7	3.7	2.3	
1969	17,328	11,624	1,683	1,193	949	32,687
%	52.7	35.5	5.1	3.6	2.9	
% change from 1930 to 1969	-34.0	-41.6	-50.0	-46.8	0.1	-38.3

Source: 1969 and 1964 Census of Agriculture, Part 52, Puerto Rico, Volume I, Area Reports, Tables 2

the size of an enterprise by the amount of sales it commands on the market.

- Farm Size by Cuerdas

When we refer to size in term of number of cuerdas, we find the pattern presented in Table XVII. The number of small-size-farms of less than 10 cuerdas has dominated the Puerto Rican farming sector since 1930. While the total number of farms has declined from 1930 to 1969 by 38.3%, the number of small farms (less than 10 cuerdas) has decreased by less : 34% and the intermediate size (more the total number of farms and the amount of smallest-size farms i.e. between 41 to 50%. As for large-sized farms a slight increase is recorded during the period. Thus,

Table XVIII.- Cuerdas in Farms by Size of Farm

	Size of Farms (Cuerdas)					Total
	Under 10	10-49	50-99	100-259	260	
1930	131,432	412,215	226,464	345,812	861,551	1,979,474
%	6.6	20.9	11.4	17.5	43.6	
1940	145,438	453,073	215,540	327,246	787,577	1,885,874
%	7.7	21.7	11.4	17.4	41.8	
1950	143,008	408,169	216,148	319,594	757,967	1,844,886
%	7.8	22.1	11.7	17.9	41.1	
1959	115,287	364,087	176,636	263,417	763,129	1,641,044
%	6.9	21.6	10.5	15.7	45.4	
1969	77,648	240,105	114,754	189,773	712,521	1,334,800
%	5.8	17.9	8.6	14.2	53.4	
% change from 1930 to 1969	-40.9	-41.8	-49.3	-45.1	-17.5	-32.6

Source: Ibid Table XVII

the pattern of farm size in terms of arable land has been, since 1930, geared toward very small and large-sized farms.

However high the number of small farms (those of less than 10 cuerdas), Table XVIII shows that they accounted for only a minor fraction of the total farmland. In 1930, small (less than 10 cuerdas) farms account for 6.6% of all farmland, in 1969 they occupy only 5.8. In 1930 43.6 of the farmland was in farms of more than 260 cuerdas, in 1969 these large farms account for more than 50% of all arable land. Again in terms of land occupied the same pattern emerges: a tendency to polarize toward small and large farms. In effect, while the total amount of arable land declined by 32.6% from 1930 to 1969, that occupied by small farms (less than 10 cuerdas) declined by 41% and large farms (260 cuerdas and more)

Table XIX.- Farms Classified by Value of Product Sold

	Number of Farms			
	1959	1964	1969	% change 1959-1969
Total	45,799	44,859	32,687	- 28.6
Subsistence ¹	7,342	7,462	5,186	- 29.4
%	16.1	16.6	15.9	
Part-time ²	3,016	3,252	2,819	- 6.5
%	6.6	7.2	8.6	
\$150 to \$ 499	10,599	8,897	9,162	- 13.6
%	23.1	19.8	28.0	
\$500 to 2,499	17,690	16,957	10,979	- 37.9
%	38.6	37.8	33.6	
\$2,500 to 7,499	4,521	5,007	2,318	- 48.7
%	9.9	11.2	7.1	
\$7,500 to 19,999	1,461	1,634	853	- 41.61
%	3.2	3.7	2.6	
\$20,000 and over	1,157	1,650	1,370	18.4
%	2.5	3.7	4.2	

1) Subsistence farms are farms whose operators work off the farm less than 75 days

2) Part-time farms are farms whose operators work of the farm 75 days or more

Source: ibid Table 1, Table 5

17.5%, percentages that are less than those of intermediate farms (10 to 259 cuerdas) which show decreases of between 42 and 49%.

- Farm Size by "Value of Sales"

Using the "value of sales" criterion to assess the pattern of farm size, we find the picture presented in Table XIX. This Table covering

only available data from 1959 to 1969, depicts again the same trend mentioned earlier. Large farms selling for \$20,000 and over show an 18.4% increase during that decade. While the total amount of farms decreases by 28.6%; part time, subsistence and farms with sales ranging from \$150 to \$499 show a slower decrease (6.5 to 29.4%) as compared with intermediate farms with sales between \$500 to \$19,999 whose decrease is in the order of 37.9 to 48.7%.

The trend toward very small and large farm units by Puerto Rico standards is clear whatever the methods of measurement used.

- Trends in Farm Size in Puerto Rico

This development is clearly indicative of two trends. On the one hand the persistence of very small farms (less than 10 cuerda or with products sold between \$150-499) tells us that a lot of family labor exists in the Puerto Rican farming sector, and that they can supplement their incomes by working off their farms as evidenced by the high percentage of part-time, subsistence and farms with income between \$150 and \$499. Together they form 52.5% of all farms in 1969 (Table XIX). Migration toward the cities has not been enough to provide full time employment to that class of labor which is still working small farms.

On the other hand, changes in technology, coupled with the high prices of labor relative to machinery and equipment, favor the large farms (260 cuerdas or more). They are in a better position to obtain credit and organize their marketing than are most of the medium-sized farms (between 10 and less than 260 cuerdas) which rely on hired laborers. The next chapter will explore the change in relative prices of labor and

capital inputs. Most of the medium-sized farms relying on hired labor face high labor costs but also fewer credit facilities for the acquiring of labor substitutes. Unless they are organized into associations or cooperatives or are provided with credit for machinery, feeds, and chemicals (perhaps by the government) they cannot survive for very long. Small farms have no such problems, provided they use their family labor. With the legal minimum wage, hired labor becomes too expensive for medium-sized farms unless they increase in size in order to make the use of machinery and equipment profitable. On a small family farm, a member may agree to work on the farm even though he knows that his share of the family income is below the legal minimum wage. To agree to work outside his farm he must be paid the required minimum wage which is higher than his average product on the family farm. Besides being unable or unwilling to migrate in definite terms to an urban environment, he may keep his small farm in order to provide for the family's consumption of food or as a cushion against seasonal farm jobs outside his farm.

As already pointed out, the question of farm size as related to the modernization of agriculture is difficult to answer. It depends on the relative prices of inputs, economic conditions and the type of farming or crops planted. It must also be clear here that when we talk about size of farms we are referring to conditions existing in Puerto Rico as of the 1960's. A Puerto Rican medium-sized farm (between 10 and 160 cuerdas) would be considered as a small farm in other countries (like the United States or Canada), where the proportion of farms 260 acres or more is higher, 28.8% in the United States¹ against 2.9 in Puerto Rico

1) Statistical Abstract of the United States, 1973

Table XX.- Number of Farms (Thousands) in the United States by Size (Acres).

Years	Under 10	10-49	50-99	100-259	260	Total
1925	379	2,039	1,421	1,887	646	6,372
%	5.9	32.0	22.4	29.6	10.1	
1940	509	1,782	1,291	1,796	724	6,102
%	8.3	29.2	21.2	29.4	11.9	
1950	489	1,480	1,048	1,590	781	5,388
%	9.0	27.5	19.5	29.5	14.5	
1959	244	813	658	1,187	808	3,711
%	6.6	21.9	17.7	32.0	21.8	
1969	162	473	460	849	786	2,730
%	5.9	17.3	16.8	31.1	28.9	
% change from 1925 to 1969	-57.2	-76.8	-67.6	-55.0	21.7	-57.2

Source: Statistical Abstract of the United States, 1961, 1970 and 1973

in 1969. For the same year, the proportion of farms of less than 10 acres in the United States is 5.9% against 52.7% in Puerto Rico. Whatever the case, it may be seen in Table XX that the trend followed by the U.S. in terms of the proportion of total farms tends to be very close to that of Puerto Rico. Large farms (260 acres and more) tend to increase, and intermediate farms (from 10 to 260 acres) tend to disappear faster than do the very small farms (less than 10 acres).

Land Ownership in Puerto Rico

Turning now to the type of ownership prevailing in Puerto Rico, we may recall that we have argued earlier that the type of tenure most

likely to promote modernization in agriculture is the resident ownership type of operator, because other types of tenure, such as absentee-ownership, cannot arrive at good sound decisions due to lack of information and that tenants, sharecroppers or administrators lack the necessary incentives.

As was expected, Table XXI depicts that, aside from some fluctuation shown by tenants whose proportion has increased again in 1969, the tendency is clearly in favor of owner-operators to the detriment of managers. Moreover, it is clear that while the total number of farms declined as a whole from 1930 to 1969 (-38.3%), that of owner-operators has declined at a slower rate (-30.2%) than has the proportion of farms operated by tenants (-63.1%) and managers (-94.2%) during the period 1930-1969.

As a result of having more than 90% of all farms operated by their owners, correct decisions seem to have been easier to take in terms of market demand than if the farms had been in the hands of tenants or absentee owners. Production has been redirected swiftly in order to produce higher quality foods that are more income elastic. These transformations have required a reallocation of the inputs used in agriculture. The next chapter will explore the input readjustment that has taken place in the Puerto Rican agriculture in light of their relative prices.

Table XXI.- Farm (Number) by tenure of Operators

Years	Type of Tenure			
	Owner-Operators ¹	Tenants	Managers	Total
1930	43,101	6,490	3,374	52,965
%	81.4	12.3	6.4	
1940	42,990	11,226	1,303	55,519
%	77.4	20.2	2.3	
1950	50,184	2,910	421	53,515
%	93.8	5.4	0.8	
1959	43,543	1,688	561	45,792
%	95.1	3.4	1.2	
1969	30,096	2,394	197	32,687
%	92.1	7.3	0.6	
% change 1930-69	-30.2	-63.1	-94.2	-38.3

1) Owner-Operators include full owners and part owners.

Source: Ibid Table XVII

FOOTNOTES, CHAPTER VI

- (1) Facts and Figures on Puerto Rico's Agriculture, 1969-1970, Department of Agriculture, Office of Agricultural Statistics
- (2) An Economic Report on the Sugar Cane Farming Industry and the Sugar Manufacturing Industry in Puerto Rico, April 1972, U.S. Department of Agriculture, Wage and Hour Division, pp 3-4
- (3) An Economic Report on the Sugar Cane Farming, op. cited in note 2, p.49
- (4) Puerto Rico Rural Manpower Service Report, 1971, Department of Labor, Bureau of Employment Security, Puerto Rico
- (5) Puerto Rico Rural Manpower, op. cited in note 4, p. 5
- (6) An Economic Report on Sugar Cane Farming, op. cited in note 2, p. 6
- (7) Informe al Gobernador 1972, Puerto Rico, Table 21
- (8) Facts and Figures on Puerto Rico's Agriculture, op. cited in note 1, Table 4
- (9) Facts and Figures on Puerto Rico's Agriculture, op. cited in note 1, Tables 5, 6 and 19
- (10) External Trade Statistics, Puerto Rico Planning Board, cited in Facts and Figures on P.R.'s Agriculture, op. cited, Table 57
- (11) Informe al Gobernador, op. cited in note 7, p. 84
- (12) Agriculture Soil and Conservation Service, Caribbean Area, 1964 and 1970 Annual Report, U.S. Department of Agriculture
- (13) Facts and Figures on Puerto Rico's Agriculture, op. cited in note 1, Tables 58 and 63
- (14) Ingreso Agrícola Department of Agriculture, P.R., various issues
- (15) Puerto Rico Annual Rural Manpower Report, 1970, Department of Labor, Bureau of Employment Security, p. 9 mimeo
- (16) U.S. Census of Agriculture, Puerto Rico, part 52, Table 3
- (17) Schultz T.W., Transforming Traditional Agriculture, New Haven and London, Yale University Press, 1964, p. 111
- (18) Schultz, T.W., op. cited in note 17, p. 119
- (19) Schultz T.W., op. cited in note 17, p. 120
- (20) Mayne Alvin, "Puerto Rico: Progress, Planning, Policy" in Economic Growth, Rationale, Problems, Cases edited by Eastin Nelson, Books for Libraries Press, Freeport, New York

CHAPTER VII

Puerto Rico's Development and its Agriculture

Introduction

In countries or regions of countries with some agricultural potential and having a primitive or stagnant industrial sector, the agricultural sector is generally viewed as a starting point to stimulate industry and generate economic growth. In the process of this development of agriculture its principal role then becomes one of a supplier of labor and capital resources to an emerging industrial sector. This is possible because of the unemployment and underdevelopment that it conceals and at the same time the possibility of increasing farm output with less but more productive labor along with farm innovations and a minimum of working capital.

- Principal Characteristics of Traditional Agriculture

What are the principal characteristics of agriculture in underdeveloped countries?

At early stages of development, agriculture represents the principal economic activity of most underdeveloped countries. It is the main source of employment and income. However, farming operation are usually conducted in a traditional or routine way in the Schultz¹ sense, i.e. operations that are "based wholly upon the kinds of factors of production that have been used by farmers for generations". Labor input with respect to land and capital engaged in agriculture is usually high, although in some cases of traditional agriculture the quantity or stock

of reproducible physical capital may be quite high and important relative to other inputs used. For example, in the irrigated area of Punjab (India), the productive services of reproducible non-human capital, based on farm accounts from 1949-59, are responsible for more than 50% of total inputs.² But these capital goods, because of their origin mainly from labor on the farms in the form of bullock power and implements, traditional seeds, manure and so forth have very low returns because of the backward technology dominating farm practices.

Physical modern non-farm capitals in the form of new crop varieties, inorganic fertilizers, tractors, insecticides, herbicides etc. are scarce in most traditional agriculture, so that returns to labor or wages are low implying a low marginal productivity of labor. Indeed, some students of economic development, in particular Lewis³, Ranis and Fei⁴ contend that the marginal productivity of labor in agriculture in under-developed countries is so low that it is near or even zero. It ensues that a substantial number of workers may be withdrawn from this sector in favour of industry without affecting farm output even if technology remains unchanged. Thus, the real wages paid to industry need only be a little higher than the subsistence wage offered in the traditional sector and it will be constant so long as the surplus labor in agriculture persists. In addition, food production will continue unaltered and development will go forward. Agriculture, in the context of the labor-surplus thesis is viewed as a reservoir of labor available to industry at very low wages. Furthermore, since food may be extracted from agriculture -by using an appropriate system of taxation- to support the new industrial workers, this sector is also an important source of capital for industrial growth.

The labor-surplus model, however, does not mention the possible negative effects of taxing farmers on their incentives to invest in agriculture in order to insure expansion of its production.

The concept of zero or near zero marginal productivity of labor is not universally accepted. Viner⁵ states that:

"As far as agriculture is concerned, I find it impossible to conceive of a farm of any kind on which, other factors of production being held constant in quantity and even in form as well, it would not be possible, by known methods, to obtain some addition to the crop by using additional labor in more careful selection and planting of the seed, more intensive weeding, cultivation, thinning and mulching, more painstaking harvesting, gleaning and cleaning of the crops".

Jorgenson⁶ was also among those who reject the idea of zero marginal productivity of labor in traditional farm. He asserts that it is positive and any decrease in the number of farmers leads to a lowering of total production and a shortage of food. For agricultural production to remain constant or perhaps increase, improvements in the methods of farming, changes in the types and forms of factors used, i.e. technological change within agriculture must come about when its labor force decline. Otherwise, without securing means of improving the productivity of the remaining farm workers, following migration, agriculture will be unable to make any positive contribution to the process of growth.

Evidences accumulated by many subsequent investigators, in particular Mellor⁷, Schultz⁸ and others strongly support Jorgenson's contention. Schultz for example, reports many cases, especially that of India, where the influenza epidemic of 1918-19 reduced the agricultural

labor force and thus led to a drastic reduction of agricultural production. We will espouse the Jorgenson view and argue like Schultz and others that farm production will drop whenever technical change within agriculture does not accompany transfer of labor from farm to city.

- Factors of Production in Traditional Agriculture

What is the relative importance of the three factors of production: Land, labor and capital in the development of agriculture? In other words, on which of these factors can we focus our attention in order to set the impetus for growth within this sector and the rest of the economy? The study of Schultz⁹: Transforming Traditional Agriculture helps dispel all doubts about their potential relative contribution to the process of transforming agriculture from its traditional structure to a modern, dynamic source of growth. Differences in land, he says, explain little of the observable differences in agricultural production among nations. As a physical entity, land is not so important as the past investments that are embodied in it. Moreover, modern factors, such as fertilizers that are a substitute for land are nowadays becoming available in increasing quantity from the non-farm sector.

Quality differences in physical capital are more important in bringing changes than the sheer quantity of conventional capital. It is also an important input as is land but both are less influential than "the differential acquired capabilities of farm people", who by their decision to invest in land or physical capital, to apply modern techniques, to use new and improved seeds etc. can really affect and determine the

rate of development of the agricultural sector.

Mosher¹⁰ reinforce the same idea by observing that, "Farm practices do not change, they are changed by persons. New fertilizers do not occur by spontaneous generation, they are developed by persons. Crop and livestock enterprises do not arrange themselves; they are arranged by persons. So another way to define agricultural development is to say that it is what happens to farms when people grow in understanding of biological, engineering, and economic relationships and when they increasingly concern themselves about, and grow in skills with respect to manipulating biologic growth, on farms, to produce products useful to man."

Peasant's Behaviour in a Traditional Setting: Theoretical Considerations

At this point, it may be helpful to try to understand the behaviour of farmers in a context of traditional agriculture and proceed to see how their transformation can transform an agriculture based on routine into a dynamic source of growth.

The analysis of labor allocation in a "peasant" traditional setting is generally conducted in a framework where the marginal utility of production equals the marginal utility of leisure, Mellor¹¹ or Sen¹². Upon reflection, one readily observes that leisure is far from being the essential activity to absorb the peasant's available time after completion of his share of work on his or the family farm. According to Resnick and Hymer¹³, evidences presented by many scientists (anthropologists, agronomists, and economic historians) support decisively the idea that

peasants devote their time to many diversified occupations other than farming and simple leisure. These activities denoted as "Z" include a composite of non-agricultural, non-leisure pursuits, such as processing of foods, spinning, implement-making, pottery-making for ceremonies, fence repairing, construction and transportation which are carried on either in the household or on a small scale trade basis to serve the needs of the village. Their inclusion and consideration in a peasant behaviour model have an interesting bearing on the idea that policy measures succeeding in replacing them by equivalent goods, quality industrial goods at reasonable prices may induce the peasants to find ways to increase production in order to acquire them. Following Hymer and Resnick, we will assume that the traditional farm sector produces two commodities:

1) Food produced and used by the rural sector either for consumption or in exchange for manufactured goods.

2) The "z-goods", as defined above, used exclusively within and by the agrarian sector.

The farming sector is assumed to have a production possibility between food (F) and the "z-goods" related as follows:

$$F = f(Z) \quad (1)$$

Portion of (F)-good being consumed by the household, the farmer can trade the remaining $(F - \bar{F})$ to obtain manufactured goods from the non-farm sector according to

$$M = P(F - \bar{F}) \quad (2)$$

where

P = term of trade between M and F

M = manufactured goods originated from the non-farm sector

F = total food produced by the rural sector

$\bar{F}$ = Total food consumed by the agrarian sector

The production of "z-goods" being by its nature time-consuming, the alternative required in order to produce more food is to reduce some of the "z-goods" and free more time for agricultural production.

The rural sector has a utility function depicted by the indifference curves:

$$U = U(Z, \bar{F}, M) \quad (3)$$

From these three equations, the equilibrium conditions of the rural sector can be derived. Using the Lagrange multiplier techniques and differentiating with respect to Z , $\bar{F}$ and M , we have:

$$U(Z, \bar{F}, M) + \lambda [M - P.(F - \bar{F})] \quad (4)$$

$$\frac{\partial U}{\partial Z} - \lambda P \frac{\partial F}{\partial Z} = 0 \quad (5)$$

$$\frac{\partial U}{\partial \bar{F}} + \lambda P = 0 \quad (6)$$

$$\frac{\partial U}{\partial M} + \lambda = 0 \quad (7)$$

$$M - P(F - \bar{F}) = 0 \quad (8)$$

The equilibrium equations follow by rewriting equations (5) to (8).

$$\frac{\frac{\partial U}{\partial Z}}{\frac{\partial U}{\partial \bar{F}}} = \frac{-\frac{\partial F}{\partial Z}}{\frac{\partial F}{\partial \bar{F}}} \text{ or } MRS_{ZF} : MRT_{ZF} \quad (9)$$

$$\frac{\frac{\partial U}{\partial F}}{\frac{\partial U}{\partial M}} = P \quad \text{or} \quad MRS_{FM} + MRT_{FM} = P \quad (10)$$

$$\frac{\frac{\partial U}{\partial Z}}{\frac{\partial U}{\partial M}} = -P \frac{\frac{\partial F}{\partial Z}}{\frac{\partial F}{\partial Z}} \quad \text{or} \quad MRS_{ZM} = MRT_{ZF} \cdot MRT_{FM} : MRT_{ZP} \cdot P \quad (11)$$

Condition (9) implies that in consumption the marginal rate of substitution between Z and F must equal its marginal rate of transformation in production.

Equality (10) relates food and manufacturing goods and means that the term of trade between food and manufactured goods dictates to the community the rate at which substitution in consumption and in production must take place. These two rates must be equal.

Finally, equation (11) compares Z and M and establishes the equality of their marginal rate in consumption and in transformation. To obtain more M, Z must be transformed into F which in turn can be exchanged for M.

- The Behavioural Model Evaluated

The question that can immediately be asked is whether or not the rural community has the capability of transforming the classes of goods included in "Z" into food "F", since the z-good are usually considered as a pursuit that can be undertaken during the "dead season" when the opportunity cost of labor is almost nil and consequently the time sequence of the two activities precludes any substitution or transfor-

mation between them. Hymer and Resnick sustain, however, that this argument underestimates the many possibilities at the disposal of the agrarian sector. Specifically both authors argue that over time, methods of cropping and intensity of labor supplied to particular crops can vary and are in fact flexible. Depending on opportunities and incentives, the agrarian sector can change the composition of output, apply more labor to increase output somewhat in order to take advantage of better prices as tastes change and income rises.

The choice of techniques available to the farmer, given that methods used are still traditional, is fundamentally related to the natural characteristics of his environment and the relative scarcity of resources at his disposal. For example, in a setting where land is plentiful and rent low, methods using land extensively will certainly be the choice made. The opposite is true in an environment where land is the limiting factor and labor is plentiful; the latter will be used intensively with the appropriate methods of cultivation. In this case "z-goods" will be given up in order to pay for the use of land.

Flexibility in the choice of techniques by the farmer cannot go too far. Thus, we disagree with Hymer and Resnick when they contend that the farmer can "replace rain-fed agriculture with labor intensive irrigated agriculture."¹⁴ Whatever the desire or willingness of the farmer to replace his rain-fed plantation of coffee located in a steep hill-sided region by a labor intensive irrigated one he could not succeed, because irrigation means flat land and traditional coffee grows in mountainous or escarped regions. The same is true regarding the choice of farming enterprise. In a zone of good climate, soil and

temperature, a large choice of products is feasible. The alert farmer can easily reduce or augment production of certain crops in response to changes in demand or prices. Such is not the case for the traditional coffee farmer who has to continue to grow coffee despite adverse terms of trade, because there is no alternative.

- Diagrammatical Approach of the Behavioral Model

The behaviour of the farmer regarding allocation of his time between agriculture production and "z-goods" can be visualized by using a transformation curve concurrently with a set of indifference curves. Let us take a typical family farm with a given amount of land and a minimum of working capital embodied in some land improvements or rudimentary tools. His production possibility is represented by figure I-VII which shows declining marginal productivity of work for given technology and resources. The horizontal axis OA gives the total time available to be devoted between food production F and Z. Their respective amounts are measured from the origin O. At D for example, Oa of Z measured on the horizontal axis and Ob of food on the vertical axis are produced. A sacrifice of z-goods releases time work (measured from A to the left) for the production of more food. By combining the iso-utility surface (indifference curves) with the production possibility we can determine the equilibrium point of production and consumption.

The equilibrium point is given by the equality between the marginal rates of substitution of the indifference curves and the marginal rate of transformation of the production possibility. Let us say that it is at the point D in figure I-VII. Now, when migration takes

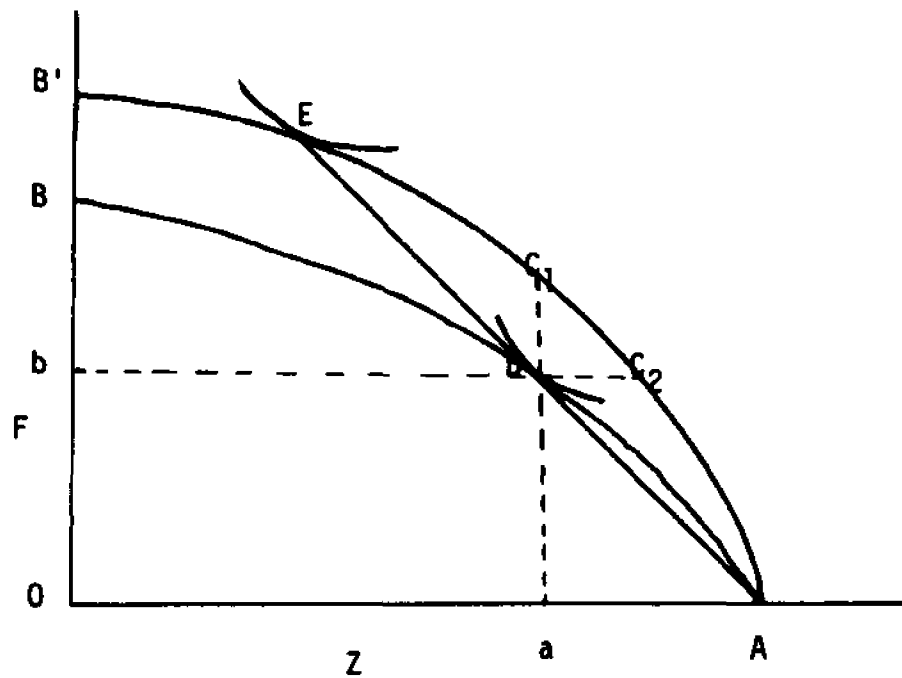


Figure 1-V11
Behavioral Model

place, there will remain fewer people to work with the same amount of land and capital. Therefore the marginal productivity of the remaining workers goes upward to AB' , assuming that land and capital are distributed equally among them. Whether or not the lesser amount of workers will produce the same amount of food depends on where the new higher indifference curve touches the transformation curve AB' . If constant returns to scale are assumed, the new indifference curve should touch AB' at E on the straight line AE for production to remain constant. In other words, at E , the remaining workers would be willing to augment time producing food proportionately to the decrease of the number of workers due to migration. This means that z -goods must be a strongly inferior good.

When the transformation curve shifts upward, many possibilities are offered the farmer. The amount of Z produced may remain constant at Oa , in which case the worker will produce more food (aC_1) than before,

but the total for the community will be less. The worker can still produce more food and at the same time produce more z-goods (any point between C_1 and C_2) or the same amount of food as before (point C_2) and much more Z or finally less food if the new indifference curve touches the transformation curve between A and C_2 . Thus, except in the case of a very strongly inferior z-good (point E on AB') total food production by the whole community will decrease.

Terms of Trade and Traditional Agriculture

Since so far we have assumed that farm technology remains unaltered, while an industrial process is taking shape in the urban sector, departure of some farm workers coupled with more disposable income as industry progresses will put pressure on the agrarian sector supply of food. The pressure will be stronger if the development of the industrial sector has not yet reached a stage where it can trade with the rest of the world to obtain its food and thus secure its growth without improvement in the domestic agricultural sector. This situation will result in a higher price for domestic food that will turn the terms of trade in favour of agriculture. This will result in the views of Lewis, Fei and Ranis in a slowing down of industrial development since cheap food is necessary to keep industrial wage from rising, profit from falling and capital formation in the industrial sector to be inhibited.

Mellor¹⁵ mentions three kinds of inhibiting effects to economic development when the change in the domestic terms of trade turns in favour of agriculture.

1) A redistribution of income toward a sector (agriculture) where saving is generally lower than in other sectors. This is due to lower incomes which will make few positive contributions to non-agricultural capital formation. However, if increases in agricultural prices bring a parallel increase in farm production, the favourable terms of trade will finally be reversed. Thus to redress the favourable terms of agricultural trade, it becomes necessary to tax agricultural development. Mellor recognized that the feasibility of such decision to tax farm income is nevertheless questionable, because of political and economic factors which limit the amount of income that can be withdraw from such taxation.

2) A reduction in the capability of the country to export its agricultural commodities and an augmentation in its imports. Thus once more the contribution of agriculture to development will decrease as taxes levied against export are reduced.

3) Finally a reduction in the transfer of labor from rural to urban because of high food prices in the urban sector. Urban wages have to be increased to induce people to migrate and when this is done, industrial profits will decrease leading to a reduction in the rate of capital formation.

In Mellor's view, taxing the agricultural sector is necessary in order to keep the terms of trade in favour of industry and insure the development process. As already mentioned, a system of taxation that tends to keep the farming sector at a level of subsistence is bound to annihilate all attractive pay-off opportunities from farming and will

kill all incentives to save and invest in agriculture. As Schultz¹⁶ puts it in reviewing Mellor's arguments on the use of taxation of agriculture for development: "Professor Mellor still prefers, so it seems to me, a system of taxation that will neutralize any and all favorable price and income incentives in agriculture, however essential they are to induce farmers to save and invest in the modernization of agriculture. Such a system of taxation would indeed be the death of "Agriculture development ."

It is clear that agriculture being the dominant sector at early stages of development, has to make some net contribution to the rest of the economy. Taxation cannot go only one way. The proceeds of taxation must be used in such a way as to insure an harmonious development of both sectors. Roads for communication must be developed, markets organized to bring non-farm inputs to the farm sector and an efficient system of prices to encourage farmers to invest in these new inputs.

Price Changes and Peasant's Behavior

In the light of the agrarian behavioural model developed above, and assuming that the system of taxation does not tend to erode farm income unilaterally, an increase in food prices will have two types of effect on agricultural income: an income effect and a substitution effect. The income effect depicts the change in the marginal utility of manufactured goods and z-goods. To the extent that z-goods become more desirable than manufactured goods, most of the income earned, following food prices increase, will be spent on Z and as a consequence

less food will be produced to exchange for manufactured goods.

- Substitution and Income Effects

The substitution effect shows the changes in the marginal productivity of labor relative to manufactured and z-goods. As prices of food increase, manufactured goods become less expensive with respect to Z and this effect may bring a higher consumption of manufactured goods relative to z-goods. The outcome of these two effects determine the shape of the food-supply curve of the agrarian sector.

We can see at once the policy implications suggested by Hymer and Resnick¹⁷ regarding the development of the agricultural sector. To the extent that the industrial sector can offer attractive manufactured goods that can replace the z-goods consumed by the agrarian sector, substitution effect will certainly be increased and the substitution effect will outweigh the income effect. On the other hand, the development of the market linking rural and urban will be a stimulus to industry. Otherwise, the agrarian sector will reinforce its consumption of Z and the development of industry, unless it produces for export, will suffer because of lack of domestic demand.

Thus the possibility of a backward-bending supply curve of food by the agrarian sector emerges as a very probable outcome. This, of course, can be counteracted by policies aimed at increasing the availability and diversity of industrial goods bought by farm people at prices favorable with respect to the products they sell. In so doing, the production of Z will decrease in order to devote time and energy to produce more food.

Empirical work conducted by Krishna¹⁸ in the Punjab region (India-Pakistan) and Falcon¹⁹ in West Pakistan suggests positive response from peasant farmers to price changes. Moreover the types of goods included in Z are likely to be inferior, so that food production in terms of either quantity or composition changes as prices increase. Since, as income rises, tastes are likely to change, i.e. people ask for more quality and variety in their diet, aggregate farm output may not change but composition of output is readjusted to satisfy the market. The best example is the intensification and modernization of livestock dairy products in place of starchy vegetables and other less desirable crops as income rises as in the case of Puerto Rico, which we will see in a moment.

-Technological change.

As better communication and better transportation systems to link the rural and urban sector are developed, markets and exchange are widened, educational facilities are expanded to the rural sector, and knowledge and information on better input mix are tested, vulgarized and offered at prices that farmers can afford i.e. that insure returns above and over their purchasing prices their adoption is likely to follow and technological change is said to take place.

In adopting the new technology, income or production rises per unit of labor. Thus, fewer people can be affected to the production of food and the rest released for industry. Following Resnick and Hymer²⁰, the adoption of a new technology on production, like the changes in price, has a twofold effect: an income effect and a substitution effect. The

outcome is similar with the one we discussed when prices increase. By assuming that technological change is more likely to affect the production of food than that of Z, since in their word "learning by doing is more likely to occur in the industry that expands as a result of trade than one that contracts", technological change will contribute to lift the transformation curve from AB to AB' (figure 2-VII) and the new consumption point is likely to pass from C to C_1 insuring a higher marketable surplus of food and consequently a higher consumption of manufactured goods, to the extent that Z is an inferior good. The more inferior is Z, the higher will be the agricultural surplus to be exchanged for manufactured goods.

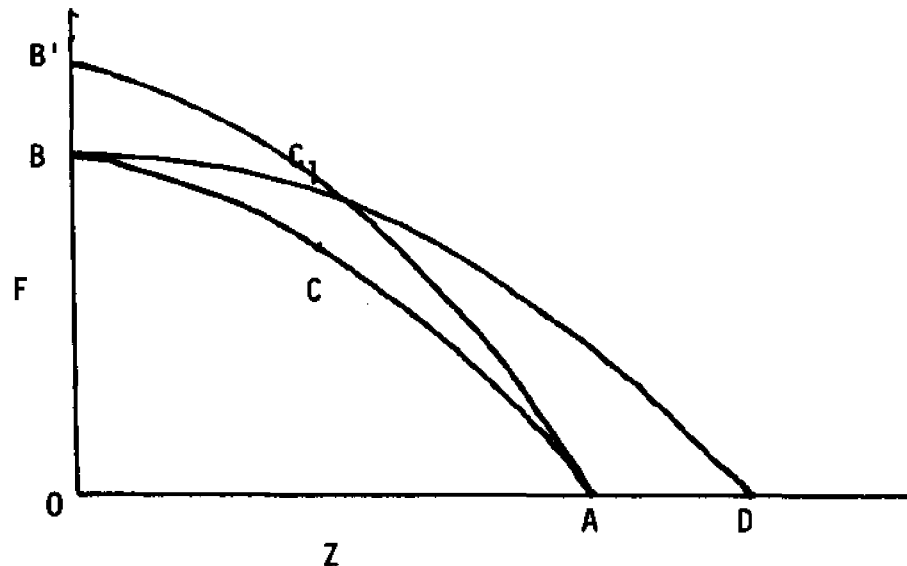


Figure 2-VII

Behavioral Model

Technological change, however, may affect the production of Z. In such case the production possibility will be biased toward Z as shown by BD. Here the possibility of the decrease of food production arises, since as z-goods become relatively cheaper, their consumption is likely to increase to the detriment of food production, unless Z is

Table I.- Variations in Total Labor Force, Agricultural Labor Force and Total Employed in Agriculture Selected Years from 1950/51 to 1969/70

Years	Labor Force		Agricultural Employment			
	Total	Agriculture	Agriculture as a % of total labor force	Total	Percentage change	Annual average % change
1950/51	713	235	32.9	203		
1955/56	643	188	29.2	161	- 20.7	- 4.1
1960/61	639	153	23.9	134	- 16.8	- 3.4
1965/66	807	129	16.0	112	- 16.4	- 3.3
1969/70	827	87	10.5	74	- 33.9	- 8.5

Source: Facts and Figures on Puerto Rico's Agriculture, Table 58, p. 87 (1968-69) and Table 63, p. 81 (1969-70). - Commonwealth of Puerto Rico, Department of Agriculture, Office of Agriculture Statistics, Santurce, P.R.

a strongly inferior good. For example, if the industrial sector offers to the agrarian sector tools or instruments that lower the opportunity cost of Z instead of food this may lead to a decrease of trade, unless again Z is an inferior good.

Application of the Behavioral Model to Puerto Rico

In the light of this model, let us explore what has happened to the Puerto Rican agriculture since the process of industrialization began around 1950.

- Agricultural Labor Force and Employment

Beginning in 1950, the agriculture labor force as well as the total number of all persons employed in agriculture in Puerto Rico have

decreased markedly, as shown by Table I. The Puerto Rican labor force has experienced a dynamic adjustment to the new opportunities offered in the cities that resulted in a consistently lower level of employment in that sector, as already discussed in the chapters dealing with migration. In accordance with the preceding model, total farm output should decline, barring technical change of some sort: biological (uses of fertilizers for example) to increase land productivity or output per unit of land; or mechanical (uses of machine) to increase output per unit of labor more proportionately than the decrease of labor employment in farm. As we argued before, as labor leaves agriculture, wven if land and capital were to be equally distributed among the remaining farmers, it is unlikely that they would increase sufficiently their input of labor time to compensate for the loss of manpower so that total production would remain unchanged. Production per worker may increase, but total production will decline unless traditional methods of cultivation and inputs are replaced by more modern ones. Table II presents the agricultural production picture during the period 1950-1970.

- Shifts from Crops to Livestocks

Aside from year to year fluctuations that are due to the inherent characteristics of tropical agriculture which in general depends heavily on the vagaries of weather, rainfall drought etc, the trend in the index of total physical volume of farm production is on the decrease at an average annual percentage of 0.6% from 1951/52 to 1969/70. Decomposed, however, into its principal components: crops and livestock, one finds that crops (sugar cane, coffee, tobacco, fruits, starchy vegetables, legumes cereals etc.) are mainly responsible for that decline.

Table II.- Agricultural Production: Physical Volume Index 1950/51 : 100

Years	All Products		Crops		Livestock	
	Total	Annual % change	Total	Annual % change	Total	Annual % change
1951/52	116.5		120.4		105.2	
1952/53	100.6	- 13.6	99.0	- 17.8	105.2	0
1953/54	109.5	8.8	108.7	9.8	111.8	6.3
1954/55	103.2	- 5.7	97.9	- 9.9	118.4	5.9
1955/56	110.1	6.7	104.2	6.4	127.0	7.3
1956/57	97.4	- 11.5	84.8	- 18.6	133.5	5.1
1957/58	107.5	10.4	95.4	12.5	142.2	6.5
1958/59	113.4	5.5	99.1	3.9	152.2	7.0
1959/60	117.3	3.4	102.5	3.4	160.1	5.2
1960/61	121.9	3.9	104.5	1.9	172.1	7.5
1961/62	119.6	- 1.9	98.0	- 6.2	186.0	8.1
1962/63	127.9	6.9	104.7	6.8	200.8	7.9
1963/64	126.2	- 1.3	100.3	- 4.2	202.5	0.8
1964/65	124.2	- 1.6	95.5	- 4.8	208.5	2.9
1965/66	124.6	0.3	94.2	- 1.4	216.3	3.7
1966/67	118.1	- 5.2	83.4	- 11.5	219.1	1.3
1967/68	110.4	- 6.5	72.7	- 22.2	220.6	0.7
1968/69	104.8	- 5.1	64.5	- 11.3	222.7	0.9
1969/70	103.9	- 0.9	63.8	- 1.1	221.3	- 0.6
Average Annual % change : 1951-1970: - 0.6						
				- 3.6	4.2	

Source: Facts and Figures on Puerto Rico's Agriculture, op. cited Table I, Table 45, p. 53 (1968-69) and Table 56 p. 69 (1969-70)

In fact, while the index of physical volume of total crop production declines at an average annual rate of 3.6%, that of livestock (milk, eggs, beef, pork, poultry etc.) rises at a substantial annual rate averaging 4.2% during the two decades. Over time farmers have changed the compo-

Table III.- Per Capita Disposable Income and Personal Consumption. Expenditures on Food in Current and 1954 Prices - Puerto Rico (1940-1971)

Year	Per Capita Disposable Income in dollars		Personal Consumption Expenditures in dollars	
	Current Prices	1954 Prices	Current Prices	1954 Prices
1940	117	212	106	208.7 ¹
1950	290	338	239	283.8
1960	582	525	423	390.2
1965	871	724	566	472.5
1966	950	773	609	497.5
1967	1,027	801	637	498.6
1968	1,130	853	703	520.6
1969	1,227	899	736	509.0
1970	1,351	948	797	522.4
1971	1,481	997	901	560.0
% change 1950-71	1,166%	370%	750%	168%

1) Includes alcoholic beverages and tobacco products

Source: Informe Economico al Gobernador, 1971, Junta de Planificacion, P.R. Tables I and II.

sition of their output in response to a demand that has shifted from low-income elastic foods (starchy foods, cereals) to higher-quality-income elastic food.

Reasons Explaining the Shift

- Higher Per Capita Disposable Income

One of the principal reasons explaining this shift in the composition of agricultural production is the increase in the per capita

Table IV.- Farm Value of Traditional Crops (Sugar Cane, Tobacco, Coffee) and Livestock Products (Million Dollars), Puerto Rico, 1940-1970

Years	Total Gross Value of Farm	Traditional Crops		Livestock Products	
		Total	% of Gross Farm Value	Total	% of Gross Farm Value
1940	84	52	61.9	19	22.6
1950	185	118	63.8	47	25.4
1960	238	119	50.0	82	34.4
1965	273	121	44.3	105	38.5
1966	270	111	41.1	112	41.5
1967	266	109	41.0	114	42.9
1968	269	95	35.3	122	45.4
1969	260	73	28.1	130	50.0
1970	267	68	25.5	133	49.8
1971	279	61	21.9	141	50.5

Source: Ibid, Table III, Table 21.

disposable income of the population and concurrent increase in demand for feed as evidenced by Table III. Per capita disposable income in constant 1954 dollars was about 370% higher in 1971 than in 1940. The increase in demand for food excluding alcoholic beverages and tobacco products, though not reflecting the actual demand for food at the farm gates because it includes the demand for non-farm services included in food, gives also a rough idea of the pressure put on food production. As constant 1954 prices, personal consumption expenditures rose from \$208.7 to \$560 in 1971 or an increase of about 168.0% higher in 1971 than in 1940. As a result of this shift in the composition of their output, farmers derive over the years an increasing percentage of their total gross income from livestock products. While in 1940 (Table IV) income derived from the

three traditional crops (coffee, sugar cane and tobacco) represented 61.9% of gross farm value of agricultural commodities, in 1966, they account for only 41.1%. By 1967 the trend has been reversed, and livestock in that year accounts for 42.9% of total gross farm income to reach 50.5% in 1971.

- Higher Demand for Livestock

That the amount of livestock has been becoming more and more important in the diet of Puerto Rican people as income rises can be appreciated by looking at the trend in index of prices received by farmers for crops and livestock. Table V shows that the price index of comestible crops has been rising since 1950/51 at an annual average rate of 5.0% during the period ending in 1969/70, while that of livestock remains fairly stable with an increase of 0.3% per year for the same period. Now if, as shown by Table IV, farmers have been receiving, despite the lower price index of livestock products, an increasing percentage share of their gross income from livestock, it ensues that the production of that item has not only been produced in higher real quantity but also has been bought and consumed in higher real quantity than comestible crops as well.

- Lower Price of Modern Inputs

Another reason explaining the trend of steady and continuous modernization of agriculture is the relatively favorable price of new inputs of non-farm origin and their availability, both of which render them cheaper than the traditional inputs, labor and land. Data on the trend of relative prices of inputs used in Puerto Rican agriculture are scarce

Table V.- Farm Price Index, Crops and Livestock Products for Domestic Consumption: Puerto Rico (1950/51: 100)

Years	Crops	Livestock
1951/52	115.5	107.4
1952/53	115.6	111.9
1953/54	118.3	108.8
1954/55	111.0	105.4
1955/56	113.7	101.5
1956/57	128.4	99.5
1957/58	125.2	99.5
1958/59	118.6	98.4
1959/60	134.0	100.0
1960/61	136.6	99.6
1961/62	151.6	101.8
1962/63	150.7	102.8
1963/64	157.3	100.3
1964/65	174.7	99.9
1965/66	170.9	100.8
1966/67	179.1	101.6
1967/68	216.2	106.2
1968/69	226.1	111.3
1969/70	230.2	114.0
Average annual % change 1951/1969	5.0%	0.3%

Source: Ibid, Table I, pp. 55-57, Table 45 (1968/69) and pp. 67-68, Table 55 (1969/70)

and practically non-existent from Puerto Rican agricultural publications. We will try nevertheless to obtain some estimates of the most important of them and expect to show that the prices of labor inputs in particular have increased over the years, relative to those of fertilizers and machine services, so that farmers profit by substituting cheaper inputs for more expensive ones. We expect also to show that this trend will

be reflected in the distribution of their expenditures or inputs, i.e. as labor becomes more expensive, the % of expenditures on the cheaper inputs relative to total farm expenditures will tend to rise reflecting a wider use of these inputs.

The Agriculture of Crops and Livestocks

Before proceeding to gauge the behaviour of input prices and shifts that occurred on relative expenditures on inputs, some comments on the two types of agriculture (crops and livestock) are in order. For certain purposes, it appears illuminating to divide agriculture into two subsectors, one consisting of what may be called producers of primary products (crops in general) and the other, producers of secondary products (livestock products).

- Crop Characteristics

The primary producer deals mainly with ordinary cheap farm products: cereals, grains, starchy vegetables or crops in general, whereas the secondary producer handles essentially dairy and livestock products.¹

While on some large estates and farms specialized in one operation, these two activities are generally conducted separately, both agriculture are interrelated and produced concurrently on a typical family

1) Harold F. Breimyer, in his paper "The Three Economics of Agriculture", Journal of Farm Economics, Volume XLIV, No 3 (August, 1962) pp 679-99, classifies agriculture activities in three categories, the two mentioned above and a third which he calls: marketing

farm. There are many good reasons of occupation for members of the family who would otherwise be idle in between seasons or during the "dead season". Indeed, the two activities are complementary, in the sense that livestock can be fed on pasture left by previous harvesting of crops, and in return the decomposition of animal excreta provides manure (organic fertilizer) to restore nutritive elements to the soil. Moreover, in the traditional setting, the family farm is exposed to many risks¹, and the combination of crops and livestock on the same farm is a sort of insurance against the animal diseases or bad weather that can wipe out the whole family revenue if only one type of activity is undertaken.

Why divide agriculture into two parts? First, because the inherent structures of the production process are different for the two undertakings, and second because the specific characteristics of supply and demand for these two products are dissimilar according to the level of per-capita income.

On a traditional family farm, primary and secondary production rely on land and labor as their principal inputs. Capital may be present, but it originates from the farm and consists basically of land improvements, manure as fertilizers, seeds from previous harvests and rudimentary tools. Factor inputs are practically fixed in the sense

1) According to the U.S. Department of Agriculture, the family farm is defined as "a risk-taking business in which the operating family takes most of the risks and does most of the work." in Miscellaneous publications No 1023, USDA, Office of Information

that there exists no incentive to change methods of production because of lack of knowledge of better methods or simply because the prevailing input prices preclude such changes.

As development gets underway, the two types of economy experience a true detachment from each other. Primary production tends to remain land-based, although some substitution is possible between land and fertilizers (inorganic) or improved seeds.

- Livestock Characteristics

Secondary production, on the other hand, is no longer land-based. Livestock can be raised by bringing feedstuffs, one of its principal inputs, from outside the farm or even by importing the necessary ingredients at fairly stable prices. Thus, it is no longer necessary to have plenty of land for extensive grazing of livestock. Hence, as many inputs used on the farm can be obtained from outside the farm, the output provision for livestock becomes less of a guess. Livestock and dairy products become more controllable and planned changes take a shorter time to materialize.

Crop production still being land-based remains dependent on the vagaries of weather and uncertainties about future yields, although that consequent adjustments of demand are difficult to secure.

The second reason for dividing agriculture into two parts is that supply and demand are different for crops and livestock. For crop production, and assuming that land is a limiting factor, adjustment of supply in the short run poses many problems because resources tied to

crop production such as capital invested in land improvements, irrigation, erosion-protective structures and simple tools having a low opportunity cost cannot be shifted out of this subsector. Thus, any reduction in demand for crops, because of their low supply elasticity, will be followed by a substantial decrease in revenues.

Supply of livestock, on the other hand, is relatively more elastic, because inputs used in its production can be controlled almost at will according to demand. Thus, with a given reduction in demand, output can be reduced accordingly and with in a short span of time in order to avoid any substantial decrease in revenues.

As knowledge becomes widespread and prices of modern inputs become cheaper relative to costs of land and labor, farmers have no difficulty in understanding the particular characteristics of the two sectors of agriculture, so that the modernization of agriculture tends to put more emphasis on the development of the sector that produces mainly secondary farm products.

Relative Prices of Modern Inputs in Puerto Rican Agriculture

Returning now to our purpose of investigating how relative input prices have changed and how these relative changes have affected the modernization of the Puerto Rican agriculture, we see that indices or prices paid by farmers for labor, fertilizer, machinery and equipment are tabulated in Table VI. Data on prices of other inputs, such as agricultural land (which is very important in farming) are not available.

Table VI.- Indices of Prices of Farm Labor, Fertilizer, Machinery and Equipment, 1950, 1954, and 1971 (1954 : 100)

Year	Wage Rates				Fertilizers				Mach. & Equip. Index
	Total Empl.	Total Exp.	Unit Prices	Index	Tons	Exp.	Unit Prices	Index	
1950/51	203	69,077	340.3	80.9	21,000	353,169	0.059	101.7	85.3
1954/55	164	68,913	420.2	100	14,924	255,257	0.058	100.0	100.0
1970/71	65	59,455	914.7	218.0	9,074	133,660	0.067	115.5	161.4
Change from 1950/1971				169.5%				13.6%	89.4%

- 1) The figures for machinery and equipment are for fiscal years, while those for wage rates and fertilizers are for calendar years.

Sources: Estimados Preliminares del Ingreso Agrícola de Puerto Rico . Boletines de 1951 a 1970/71. Estado Libre de Puerto Rico, Departamento de Agricultura, Oficina de Estadísticas Agrícolas, Santurce, P.R.

Facts and Figures on Puerto Rico's Agriculture, op. cited Table 1
Informe al Gobernador, Table 19

- Labor

The figures on the prices of these three important inputs are computed as follows. Wage rates are estimated by dividing the total amount of money paid to wage and salary farm workers including supplements to salaries by total average farm employment during the year. These numbers are transformed into an index by taking 1954/55 = 100. For example, the total amounts paid to workers (wages and salaries plus supplement to salaries) in 1950/51 and 1970/71 are \$69,077,000 and \$59,455,000, while the total average employment for both years is 203,000 and 65,000 respectively - which by division gives 340.3 and 914.7. The

numbers are then divided into $420.2 \div 100$, the estimated figure for 1954/55, giving 80.9 for 1950/51 and 218.0 for 1970/71.

- Fertilizers

Prices of fertilizers are estimated in the same way, by dividing total expenditures on fertilizers into the total number of short tons of fertilizers used by farms. The numbers are then converted into an index by dividing into the corresponding figure of 1954/55 $\div 100$.

- Capital

As for capital, we have used the implicit price deflator index of machinery and equipment used by private enterprises for Puerto Rico with 1954 $\div 100$, for lack of specific data on farm machinery, on the assumption that the two sets of prices, farm and industrial machinery, and equipment move together in the same direction.

- Prices of Labor and Prices of Capital Compared

Although land prices do not appear in Table V, the inputs included are among the most important. It can readily be seen that labor prices have risen more (169.5%), relative to machinery and equipment (89.4%) and even more than fertilizers (13.6%) during the period 1950-1971. The price of an hour of farm labor for the same type of work varies somewhat according to region, and within the same region, among different cultures. For example, as of July 1971, the minimum hourly wage paid to field workers according to the Minimum Wage Board of Puerto Rico was \$0.50 for coffee, \$0.55 for tobacco, \$0.66 for Pineapples and \$0.65 in Poultry production.²¹ Based, however, on an average hourly wage paid to

Table VII.- Hourly Average Wage Paid to Field Sugar Cane Workers
Puerto Rico, 1950-1971

Year	Dollar/hour	Index 1954 : 100
1950	0.348	79.2
1954	0.439	100.0
1960	0.524	119.3
1964	0.793	157.8
1967	0.550	125.0
1968	0.580	132.0
1969	0.650	148.0
1970	0.800	182.0
1971	0.900	205.0
Change 1950-1971		159.0%

Source: Sugar Reports, Number 160, September 1965, Table 26, p. 33 and 1972, Economic Report on Sugar Cane Farming Industry in Puerto Rico, April 1972, U.S. Dept of Labor Wage and Hour Division, pp. 34-38

sugar-cane workers, it is found that the increase in wages was about the same (159.0%) from 1950 to 1971, taking 1954 : 100, as shown by Table VII. Thus, we have evidence that on the average, the price of farm labor has increased by approximately 2.5 times in 1971 from its level in 1950.

Empirical Evidence on Relative Prices of Inputs

Considering machinery and equipment, the percentage change from 1950 to 1971 is in the order of 89.4% or 1.8 times higher in 1971 than in 1950. Without a doubt, these prices reflect the changes in quality that characterize improvements in 1971 relative to 1950 types of farm machines.

Table VIII.- Farm Production Expenses by Categories of Inputs
1950 and 1971, Puerto Rico (Thousand of \$)

	1950		1971		1971 divided 1950
	Total	%	Total	%	
Gross Farm Income	202,566		281,261		138
Total Farm Production Expenses	117,060	100.0	164,590	100.0	141
Less a) Payments and Purchases to other Sectors	42,248	36.1	82,703	50.2	196
- Feeds for Livestock and Poultry	9,620	8.2	50,077	32.4	520
- Fertilizers	21,000	17.9	9,074	5.5	43
- Cost of operating Mach. and equip.	2,254	1.9	9,017	5.5	400
- Seeds and insecticides	1,177	1.0	2,092	1.3	178
- Property taxes	3,243	2.8	4,497	2.7	139
- Irrigation taxes	395	0.3	527	0.3	133
- Others	4,390	3.7	7,144	4.3	163
- Fisherman expenses	169	0.1	275	0.2	163
Less b) Depreciation	1,758	1.5	7,921	4.8	451
Wages and Salaries	64,991	55.5	54,034	32.8	83
Supplements to Salaries	4,086	3.5	5,421	3.3	133
Interests	3,977	3.4	14,511	8.8	365
Net Profit	85,506		116,671		136

Source: Ingreso Agrícola de Puerto Rico, 1950-1971, various publications, Departamento de Agricultura, Oficina de Estadísticas Agrícolas, Santurce, Puerto Rico

As for fertilizers, the increase in price is only 13.6% over the two decades. This represents a tremendous opportunity for the farmer - as prices of labor increase and thus necessarily that of land, following urban development - to substitute fertilizer for land.

Aside from changes in more modern techniques of production that have surely been available to farmers, the relative change in input prices clearly works to induce farmers to substitute less expensive for more expensive inputs. Indeed, as we have repeatedly mentioned before, labor has, since 1950, become less and less important in Puerto Rican farming and has been replaced by machine fertilizers and other non-farm inputs.

Table VIII presents the development of the trend that has been occurring in the modernization of agriculture from 1950 to 1971. The percentage of labor on total expenditures declined from 55.5 in 1950 to 32.8 in 1971, and the cost of operating machinery and equipment and interests rose from 1.9 to 5.5 and 3.4 to 8.8 respectively during the same period. The lower position of fertilizer input in 1971 relative to 1950 is due to the drastic shrinkage of land devoted to sugar cane, a heavy consumer of fertilizer, (From 392,000 cuerdas in 1950/51 to 153,000 in 1970/61)²² which, because of low yield has been steadily replaced by livestock production as evidenced by the percentage increase recorded by feed for livestock and poultry input from 8.2% of total expenditures in 1950 to 30.4% in 1971. In addition to the changes in the relative proportion of expenditures on new inputs, column 3 of Table VII show also the rise in farm input expenses between the years. Feeds for livestock and poultry, followed by the cost of operating machinery and equipment and interests, all of non-farm origin, combine to form the ingredients on which expenditures increase the most.

Index of Farm Production Inputs in Puerto Rico

In order to have a more complete view of changes in the physical quantities of the inputs that have occurred during the period 1950/1971, an attempt is made to construct a physical index of the principal inputs used in Puerto Rican agriculture and an aggregate index of total inputs. Because of the many difficulties surrounding any problem of aggregation of data and index construction, the results are not intended to show anything precise but rather aim at showing the general direction of the changes.

From data²³ on farm expenditures, gross farm income, net profit and net income originating from agriculture -published by the Department of Agriculture of Puerto Rico- we make an aggregation of the various items in order to obtain tens groups of inputs:

- 1- Livestock on farm and feed for livestock and poultry
- 2- Fertilizer
- 3- Cost of operating machinery and equipment, building repairs and depreciation
- 4- Seeds, insecticides and weed killers
- 5- Taxes (Irrigation)
- 6- Taxes (Property)
- 7- Miscellaneous (Other expenditures and fisherman expenses)
- 8- Total farm labor
- 9- Interests
- 10- Total inputs

Except for the labor index which is constructed from data on the total average of persons engaged in farming operations (employed, self-employed, and family members) and the fertilizer index which is constructed by using the physical amount (tons) of fertilizers used, the

other indices are constructed as follows:

- a) The figures on costs are converted into constant dollars, taking as the base period 1957-1959 = 100. Various price indices are used: cost of operating machinery and equipment is deflated by the index of price deflator for machinery and equipment and the other inputs by the price deflator for gross domestic investment in Puerto Rico. The series of price deflators as published by the "Informe al Gobernador"²⁴ were based on 1954 = 100, but are converted to a new series by shifting them to 1957-59 = 100 by multiplying each of the index numbers (1954 : 100) by $\frac{100}{X}$, where X = average index number of 1957-1959.¹
- b) The figures of constant dollars obtained are transformed into a simple index by dividing them through the average dollar value of 1957-59 = 100.
- c) The results for the eight inputs are then wighted by the average proportion in the total expenditures for each corresponding input during the years 1957-59.

The choice of the three years 1957-59 as relative weights and base-period is purely arbitrary. Other years could have been chosen but the results would vary. The computed relative weights are as follows:

1- Livestock on farm and feed for livestock	
and poultry	0.138
2- Fertilizer	0.114

1) Spurr, William A. and Bonini, Charles P., Statistical Analysis for Business Decisions, 1967, Richard D. Irwin, Inc, Homewood III, Chap. 18, p. 427

3- Cost of operating machinery and equipment and building repairs and depreciation	0.062
4- Seeds, Insecticides and Weed killers	0.022
5- Taxes (Irrigation)	0.0038
6- Taxes (Property)	0.0302
7- Miscellaneous (other and fisherman expenses)	0.044
8- Total farm labor	0.0536
9- Interests	0.050

d) Finally the composite index of total physical inputs are obtained by adding the eight input indeices together. The final results are completely tabulated for the period 1950/51 to 1970/71 in Table IX.

Once again there emerges clearly the picture we have already observed. Labor input has decreased, while cost of operating machinery, maintenance repair and depreciation, a proxy for machine capital, feed for livestock capital, interest and other non-farm items have been used in increasing quantities to replace labor.

It is interesting to note that in the process of these changes the total inputs used in agriculture have decreased more porportionately (from 124 to 85 or 46%) than total agricultural output (from 116.5 to 103.9 or 12%) during the period. The implications are clear; labor and land productivities must have increased substantially in the meantime. the outcome of these developments on labor and land productivity is the purpose of the next chapter.

**Table IX . - Indexes of Farm Production Inputs Puerto Rico
1950/51 - 1970/71 (1956/57 - 1958/59 : 100)**

Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1950/51	72	137	68	59	105	113	109	138	82	112
1951/52	82	101	72	64	118	117	127	131	92	111
1952/53	86	95	76	54	116	143	109	117	96	106
1953/54	84	109	77	64	116	143	116	119	104	108
1954/55	84	99	77	59	113	147	104	112	108	104
1955/56	83	88	79	54	108	140	107	110	118	102
1956/57	90	112	85	68	105	133	93	104	114	102
1957/58	105	90	102	109	97	77	104	103	92	100
1958/59	104	98	111	123	97	93	102	93	94	97
1959/60	111	95	118	114	100	93	114	85	94	95
1960/61	114	93	122	118	100	90	111	91	98	98
1961/62	134	99	127	140	100	93	120	95	100	105
1962/63	154	100	137	173	113	100	127	97	112	111
1963/64	159	103	142	177	113	100	125	93	112	111
1964/65	188	92	155	195	105	103	125	84	120	110
1965/66	196	78	156	177	103	100	118	76	134	106
1966/67	167	74	161	191	142	97	111	65	136	96
1967/68	193	69	161	177	103	93	111	60	126	95
1968/69	221	62	163	114	97	93	104	58	148	96
1969/70	218	54	164	54	181	90	102	50	136	89
1970/71	209	52	158	54	79	87	98	46	166	86

1) Livestock on farm and feeds for livestock

2) Fertilizers

3) Cost of operating machinery

4) Seeds, Insecticide

5) Taxes (Irrigation)

6) Taxes (Property)

7) Miscellaneous

8) Total farm labor

9) Interests

10) Total Inputs

Source: Computed from cost data published by the Department of Agriculture of Puerto Rico, in Ingreso Agrícola 1950/51-1970/71 as explained in the text

FOOTNOTES, CHAPTER VII

- (1) Schultz Theodore W., Transforming Traditional Agriculture, New Haven and London, Yale University Press, 1964, p. 3
- (2) Schultz Theodore W., op. cited, pp. 100-101
- (3) Lewis W. Arthur, "Economic Development with Unlimited Supplies of Labor", The Manchester School, No 22, p. 139-191 and "Unlimited Labour: Further Notes", The Manchester School, no 26, pp 1-32 (1958)
- (4) Fei, John C.H., and Ranis Gustav, Development of the Labor Surplus Economy Theory and Policy (1964), Richard D. Irwin, Inc., Homewood Illinois (1964)
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- (6) Jorgenson, Dale W., "The Development of a Dual Economy", Economic Journal 71: pp. 309-334, June 1961
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- (8) Schultz T.W., op. cited, chapter 4, pp. 55 and following
- (9) Schultz T.W., op. cited, note 1, pp. 16-17
- (10) Mosher, Arthur T., "Agricultural Economics and Agricultural Development" in Economic Development, Readings in Theory and Practice, Morgan and Betz, ed., Wadsworth Publishing Company, Inc. Belmont California, p. 173
- (11) Mellor, John W., "Toward a Theory of Development of Agricultural Development", in: H. M. Southworth and B. F. Johnston, eds., Agricultural Development and Economic Growth (Ithaca: Cornell University Press, 1967), p. 21-60
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- (13) Hymer, Stephen and Resnick, Stephen, "A Model of an Agrarian Economy with Nonagricultural Activities", The American Economic Review, September 1969, pp. 493-506
- (14) Hymer and Resnick, op. cited in note 13, p. 495

- (15) Mellor, John W., op. cited in note 11
- (16) Schultz, T.W., Comment on Mellor's paper: "Toward a Theory of Agriculture Development", op. cited in note 11, p. 65
- (17) Hymer, Stephen and Resnick, Stephen, op. cited in note 12
- (18) Krishna R., "Farm Supply Response in India-Pakistan: A Case Study of the Punjab Region", Economic Journal, 73: 477-87, September 1963
- (19) Falcon, W.P., "Farmer Response to Price in a Subsistence Economy: The Case of West Pakistan", American Economic Review, 54 (Proceedings): 580-591 (May 1964)
- (20) Hymer and Resnick, op. cited in note 13, p. 499
- (21) Boletín Mensual de Estadísticas Agrícolas, Volume XI, Numero 8, August 1971, Santurce Puerto Rico, Table 34, pp. 439-440
- (22) An Economic Report on the Sugar Cane Farming Industry and The Sugar Manufacturing Industry in Puerto Rico, April 1972, U.S. Dept of Labor, p. 3
- (23) Ingreso Agrícola de Puerto Rico, various issues, 1950/51 - 1970/71, Department of Agriculture, Office of Agriculture Statistics, Santurce, Puerto Rico
- (24) Informe al Gobernador, 1971, Junta de Planificación, Puerto Rico, Table 19, p. A-19

CHAPTER VIII

Productivity of Factors in the Puerto Rican Agriculture

Introduction

From the input indexes computed and presented in Table VIII, chapter VII, we are now in a position to consider the two most important partial productivity measures in agriculture: output per unit of labor and output per unit of land and explore how they have changed over time. In the course of our investigation we shall also have occasion to gauge the changes that have occurred in the factor proportions that are responsible for the observed changes in the productivity of these two factors of production.

In a setting where land is plentiful and labor scarce the principal objective of agricultural development will aim at using methods tending to increase land per worker, such as machinery or mechanical devices (tractors) in order to ease the limitation on growth of agriculture set by labor. On the other hand, if land is scarce and labor is in abundant supply, the emphasis will be put on increasing the productivity of land or yield per acre by using more fertilizer per unit of land in order to relax the constraint represented by land. There exist cases, however, where both land and labor are the limiting factors. Today's Puerto Rico is a case in point. Labor, as we have already pointed out, is leaving agriculture to take advantage of better opportunities in the cities of Puerto Rico or on the mainland in the United States. Also, since the 1960's, the amount of land devoted to agriculture has been steadily decreasing.

An important amount of land has been encroached upon by urban development. The 1969 Census of agriculture^a reports that a substantial number of tracts of land are no longer considered as being part of agricultural land because they have been abandoned or left idle for speculative purposes. The principal factors responsible for such widespread land speculation are:

- 1) The airport development in the southwestern part of the island to provide tourist facilities.
- 2) The development of mining concerns around the municipios of Adjuntas, Utuaado, Lares, Jayuya and Ciales located at the west central part of Puerto Rico.
- 3) The urban and industrial development affecting the northern and eastern area near San Juan.

In such a situation the two productivities become equally important, and thus, means to increase them must be secured if growth in agricultural output is to come about.

Labor and Land Productivities in Puerto Rico

Table I presents estimates of labor and land productivities. Agricultural physical output is taken from Facts and Figures on Puerto Rico's Agriculture^b whose base has been shifted from 1950/51 $\approx$ 100 to 1956/57 - 1958/59 $\approx$ 100 to facilitate comparisons with the other indexes

a) U.S. Census of Agriculture on Puerto Rico, 1969, p. A-4

b) Facts and Figures on Puerto Rico's Agriculture, Puerto Rico, Department of Agriculture 1968-69, Table 45 and 1969-70, Table 55.

Table I.- Estimates of Labor and Land Productivities in Agriculture, Puerto Rico, 1951-52/1969-70

Year	Index (1956/57 - 1958/59 : 100) of :			Output	
	Physical Output	Labor Input	Land Input	Per Unit of Labor	Per Unit of Land
1951/52	110	131	NA	84	NA
1958/59	107	93	100	115	107
1964/65	117	84	63	139	186
1969/70	98	50	53	196	185

Source: Column 1 is taken from "Facts and Figures on Puerto Rico's Agriculture: 1968/69, Table 45 and 1969/70, Table 55.

Column 2 is taken from Table VIII, chapter VII

Column 3 is computed as explained in the text

Columns 4 and 5 are obtained by dividing column 1 by 2 and column 1 by 3 respectively.

that are computed relatively to 1956/57 - 1958/59 = 100. Labor input is taken from Table VIII, chapter VII. We do not have an explicit index for land area. For the purpose of measuring land productivity we need the actual quantity of land planted, harvested, and under pasture and not the total quantity of arable land. Land is differently reported by the available census of Puerto Rican agriculture. For example, the 1950 U.S. Census of Agriculture on Puerto Rico gives the quantity of land suitable for crops and pastures but not the actual amount cropped and harvested. The only comparable data on land harvested and under pasture are given by the 1969 census which unfortunately covers only the years 1959, 1964 and 1969. The figures released are as follows:

	1959	1964	1969
Land Harvested (Cuerdas)	724,210	585,444	362,642
Pasture Land (Cuerdas)	601,924	250,444	342,258
Total (Cuerdas)	1,326,134	835,888	704,900
Index 1959 = 100	100	63	53

In using these figures, we form the actual index of land for the three years (1959 = 100) as shown above. The two productivities are then computed by performing the division of column 1 into column 2 for labor and column 1 into column 3 for land (Table I).

We observe (Table I) that both productivities (labor and land) have increased over time. While, however, land productivity has increased from 1958-59/1964-65 to 74%, that of labor has only reached 21% during the same period. Looking now at Table II, we find that during that period fertilizer used per unit of land rose from an index 98 to 146 (1951-52/1969-70 = 100) or 48%, while land per labor declined by 30.5%. Even though machinery per labor increased by 55% (from an index 119 to 185, column 8, Table II), total input used per land rose faster 80% than total input used per labor 26% (rows 9 and 10, Table II). Thus from 1958/59 to 1964/65 land productivity has the lead over labor productivity because total input per unit of land rose faster than total input per worker.

In contrast, from 1964/65 to 1969/70 output per unit of land remained practically stationary while that of labor took the lead with an increase of 41% (from 139 in 1964/65 to 196 in 1969/70). Land per labor rose 41%, machinery per labor rose by 77% and total input per labor

Table II.- Factor Proportion, Index 1956/57-1958/59 : 100¹

	1951/52.	1958/59	1964/65	1969/70
Labor Input	131	93	84	50
Land Input (a)	NA	100	63	53
Fertilizer Input	101	98	92	54
Machinery Input	72	111	155	164
Total Input	111	97	110	89
Land Per Labor	NA	108	75	106
Fertilizer Per Land	NA	98	146	102
Machinery Per Labor	55	119	185	328
Total Input Per Labor	85	104	131	178
Total Input Per Land	NA	97	175	168

1) Line 1, 3, 4 and 5 are taken from Table chapter VII

Line 2 is taken from Table I of this chapter

Line 6 is the division of line 1 into 2

Line 7 is the division of line 3 into 2

Line 8 is the division of line 4 into 1

Line 9 is the division of line 5 into 1

Line 10 is the division of line 5 into 2

a) Land input refers to calendar years 1959, 1964, and 1969

35%, whereas fertilizer per land and total input per land decreased markedly (Table II).

Labor and Land Productivities by Municipios

It would be interesting to be able to assert whether or not these gains in productivity of the two primary factors (labor and land) have been equally shared by all municipios. In other words, we would like to find out whether or not the geographic location of any municipio has any bearing on the development of its agriculture.

To investigate the possible relationship between the agricultural development of the municipios and their geographic location vis à vis the most industrialized ones, we shall use the 1969 U.S. Census of Agriculture on Puerto Rico and its municipios which gives detailed data on agricultural production and inputs used by individual municipios to estimate the corresponding output per unit of labor and output per unit of land.

The following parameters are estimated:

1) Municipio total output is taken to equal the value of all farm products sold plus payments for participation in governmental programs plus inventory change and home consumption. Specific figures are not given for inventory and home consumption by the Census. As estimate is obtained by taking the differences between the physical quantity of crops harvested and those sold, valued at the average local wholesale market price for commercial farming as given by Facts and Figures on Puerto Rico's Agriculture 1969-70, (Office of Agriculture Statistics, Department of Agriculture, Commonwealth of Puerto Rico).

In these computations, no inventory or consumption figures are allowed for sugar cane and tobacco. Sugar cane and tobacco harvested are assumed to equal the quantity sold, because both products are regulated by a quota system which has not been reached for years. As for vegetables, since only the quantity sold is given, an arbitrary value of 1% on the average of the quantity sold per farm is assumed to be consumed on the farm or kept for inventory.

2) Land is taken as the quantity in "cuerdas" of cropland

harvested plus land in cultivated or improved pastures.

3) Labor expressed as man-days per year per municipios is estimated by summing up:

a) total expenditures on hired farm labor divided by the average median daily earnings for wage and salary farm workers and foremen which is \$4.76¹ for Puerto Rico in 1969.

b) Total expenditures on contract labor divided by their average daily earnings which is \$5.25 for Puerto Rico in 1969.¹

c) The number of days for operators working off their farms by subtracting from 300 (the assumed average number of working days during the year)² the average number of days worked off farms multiplied by the number of such operators.

d) the number of days for operators who do not report any work outside their farms by multiplying the number of such operators by 300.

e) the amount of unpaid family labor estimated from the Census of Population, 1970 (Rural Farm Characteristics) by multiplying

1) Employment and Unemployment in Puerto Rico, January 1971, Monthly Report Number 71-1, Department of Labor, The Commonwealth of Puerto Rico.

2) Grilliches, Zvi, in his estimation of the U.S. Agricultural production function made the same assumption (See, Zvi Grilliches, "Research Expenditures, Education, the Aggregate Agricultural Production Function", the American Economic Review, Volume XLIV, December 1964, Number Six.)

Table III.- Estimated Labor and Land Productivities, 74 Municipios, 1969, Puerto Rico

Municipios	Output	
	per worker	per land
Adjuntas	100	100
Aguada	100	191
Aguadilla	118	188
Aguas Buenas	164	254
Aibonito	395	397
Anasco	105	150
Arecibo	180	371
Arroyo	131	168
Barceloneta	115	389
Barranquitas	207	254
Bayamon-Catano	207	491
Cabo Rojo	144	178
Caguas	284	421
Camuy	109	227
Carolina	264	340
Cayey	175	186
Ceiba	304	216
Ciales	127	118
Cidra	176	239
Coamo	264	129
Comerio	138	109
Corozal	182	240
Dorado	167	470
Fajardo	18	203
Guanica	70	247
Guayama	152	128
Guayanilla	107	144
Guaynabo	223	278

Table III (following)

Municipios	Output	
	per worker	per land
Gurabo	193	412
Hatillo	392	873
Hormigueros	177	217
Humacao	156	345
Isabella	177	270
Jayuya	151	134
Juana Díaz	175	164
Juncos	311	373
Lajas	164	131
Lares	77	117
Las Marias	111	90
Las Piedras	246	492
Loiza	192	219
Luquillo	307	560
Manatí	221	388
Maricao	94	94
Maunabo	111	137
Mayaguez	111	185
Moca	95	178
Morovis	167	223
Naguabo	243	303
Naranjito	139	231
Orocovis	98	128
Patillas	108	107
Penuelas	136	209
Ponce	136	234
Quebradillas	168	255
Rincon	124	174

Table III (following)

Municipios	Output	
	per worker	per land
Rio Grande	170	270
Sabana Grande	144	163
Salinas	155	176
San German	111	194
San Juan	156	7,466
San Lorenzo	220	274
San Sebastian	115	178
Santa Isabel	240	479
Toa Alta	207	402
Toa Baja	192	476
Trujillo Alto	344	575
Utuado	80	68
Vega Alta	277	275
Vega Baja	225	298
Vieques	196	29
Villalba	111	111
Yabucoa	125	320
Yauco	124	138

Now, selecting the municipios that exhibit the highest and lowest output per worker and output per cuerda, we have the following list:

<u>Municipios with the highest output per worker</u>		<u>Municipios with the highest output per cuerda</u>	
Aibonito	395	Aibonito	397
Barranquitas	207	Arecibo	371

Bayamon-Catano	207	Barceloneta	390
Caguas	284	Bayamon-Catano	491
Carolina	264	Caguas	421
Ceiba	304	Carolina	340
Coamo	264	Dorado	470
Guaynabo	223	Gurabo	412
Hatillo	392	Hatillo	873
Juncos	311	Humacao	345
Las Piedras	246	Juncos	373
Luquillo	307	Las Piedras	492
Manatí	221	Luquillo	560
Naguabo	243	Manatí	388
San Lorenzo	220	San Juan	7,466
Santa Isabel	241	Santa Isabel	479
Toa Alta	207	Toa Alta	402
Trujillo Alto	344	Toa Baja	476
Vega Alta	277	Trujillo Alto	575
Vega Baja	225	Yabucoa	320

Municipios with the lowest
output per worker

Adjuntas	100
Aguada	100
Anasco	105
Camuy	109
Fajardo	18
Guanica	70
Guayanilla	107
Lares	77
Las Marias	111
Maricao	94
Maunabo	111
Mayaguez	111

Municipios with the lowest
output per cuerda

Adjuntas	100
Ciales	118
Coamo	129
Comerio	109
Guayama	128
Jayuya	134
Lajas	131
Lares	117
Las Marias	90
Maricao	94
Maunabo	137
Orocovis	128

Moca	95	Patillas	107
Orocovis	98	Utuado	68
San German	111	Vieques	29
Utuado	80	Villalba	111
Villalba	111	Yauco	138

by 300 and the result weighted by 0.65, assuming that an unpaid family worker is the equivalent of 0.65 a full worker.

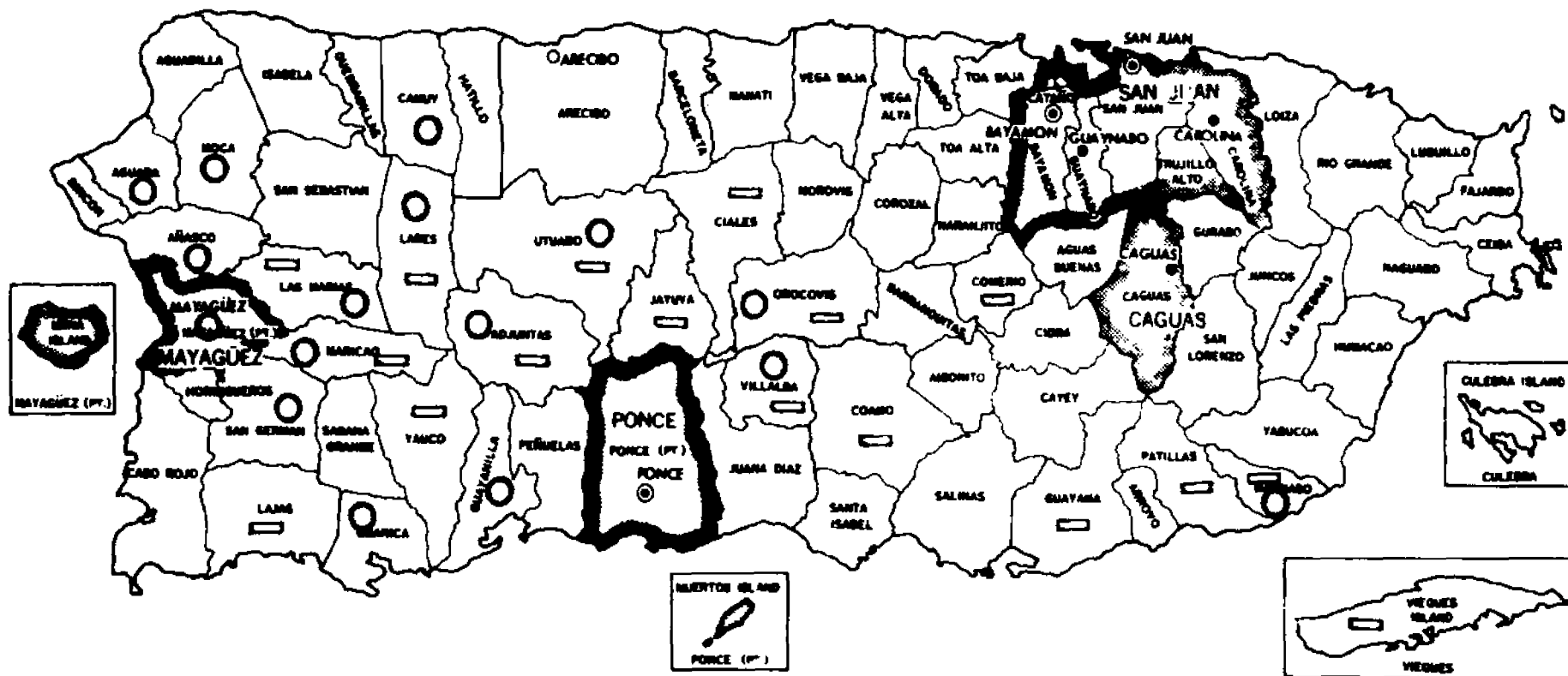
Using these parameters, we obtain output per worker and output per unit of land for each municipio. Selecting Adjuntas' output per worker and output per unit of land as equal to 100 we obtain the results arranged in Table III.

Geographical Location and Municipio Productivities

We observe that the most significant progress in labor productivity (municipios having at least twice the productivity level of Adjuntas : 100) and land productivity (municipios having at least three times the productivity level of Jayuya : 100) has been achieved mainly by the municipios surrounding or within the urban industrial complex represented by the San Juan and Caguas SMSA's (Standard Metropolitan Statistical Area) while the fewest gains (municipios having around the productivity level of Adjuntas : 100) are recorded mainly by the mountainous or coffee regions or municipios located farther away from the principal urban-center San Juan. Maps I-VIII and II-VIII give the location of these municipios with respect to three SMSA: San Juan, Mayaguez and Ponce. Although Ponce and Mayaguez are considered as metropolitan centers, the

○ : Lowest Output per Worker
 □ : Lowest Output per Cuerda

LEGEND :



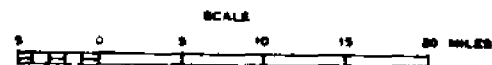
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- ⊙ Places of 100,000 or more inhabitants
- Places of 50,000 to 100,000 inhabitants
- Places of 25,000 to 50,000 inhabitants outside SMSA's



Standard Metropolitan
Statistical Areas (SMSA's)

Map II-VIII



structure of their industrial development coupled perhaps with their own geographical location, as we have argued in preceding chapters, has little impact on the agricultural development of the immediate surrounding regions as evidenced by the low level of output per worker and output per cuerda exhibited by these municipios. Indeed even Mayaguez and Ponce themselves show quite low productivity of labor and land productivity as shown in Table III.

That San Juan and the municipios included in its SMSA's show a higher rate of industrialization -- measured either by the ratio of the number of non-farm workers to total workers (as provided by the 1970 U.S. Census on General Economic and Social Characteristics of the Puerto Rican population) or the per capita taxable payrolls of non-farm employees covered by the Social Security Administration during the first quarter of 1970 divided by the municipio population¹ -- than the municipios in the immediate neighbourhood of either Mayaguez or Ponce, can be easily seen. Looking at the computed ratio of non-farm employees over total employees and the per capita non-agricultural payroll, we find for San Juan, Mayaguez, Ponce and their immediate neighbours the figures presented in Table IV. Clearly San Juan and its immediate neighbours have a higher ratio of non-farm workers to total workers than both Ponce and Mayaguez. In

- 1) Tang, Anthony M. "Industrial-Urban Development and Agricultural Adjustments in the Southern Piedmond, 1940-50", Journal of Farm Economics, Volume XXXIX, August 1957, Number 3, Part I, use the same index: per capita payroll in major nonagricultural industries as a measure of industrial-urban development in his study of the impact of industrialization on the agriculture development in the upper part of Georgia and South Carolina Piedmond.

Table IV.- Ratio of Nonfarm Workers to Total Workers and Per Capita Payroll of San Juan, Mayaguez, Ponce and their Immediate Neighbours.

Municipios	Ratio of Nonfarm Workers to Total Workers	Per Capita Nonfarm Payroll
<u>San Juan</u>	99.2	39.9
Bayamon-Catano	99.0	12.5
Guaynabo	98.3	9.5
Trujillo Alto	97.1	1.4
Carolina	99.0	8.3
Caguas	96.0	10.9
Mean	98.1	13.7
<u>Mayaguez</u>	96.0	23.0
Anasco	83.1	3.9
Las Marias	65.2	0.2
Maricao	54.6	2.3
San German	78.0	8.7
Hormigueros	89.6	5.7
Mean	77.5	6.1
<u>Ponce</u>	96.5	23.0
Penuelas	90.0	1.5
Adjuntas	76.0	1.7
Jayuya	77.3	7.4
Juana Diaz	86.0	2.9
Mean	85.2	7.3

Source: U.S. Bureau of the Census, Characteristics of the Population, Part 53, 1970 and

U.S. Bureau of the Census, County Business Patterns, 1970

addition, the level of per capita payroll generated by San Juan is almost twice that of Ponce or Mayaguez, which is indicative of a greater impact on the market for agricultural products in the area of San Juan.

Urban-industrial development affects both the local product and factor markets. Transfer of surplus labor from agriculture to industry and capital from industry to agriculture is easier to achieve near dynamic growing urban-industrial centers than in regions that lack such characteristics. On the side of product markets, the demand for farm products tends to grow faster and to become more diversified in regions surrounding dynamic industrial centers than in other regions. Finally, there exists also a more favorable factor-product price ratio around an industrial-urban region, thus inducing a higher demand for more inputs of industrial origin.

Estimation of Machinery and Livestock Capital on Farm per Municipio

In view of these considerations we expect that regions which exhibit higher urban industrial development will also enjoy higher capital-labor ratio. To verify this point we estimate two types of capital: Machinery on farm and Livestock or animal capital on farm per municipio and then compute the ratios of both types per labor.

Machinery on the farm is estimated by multiplying the detailed list of machines given by the 1969 Census of Agriculture in Puerto Rico by the average price prevailing in Puerto Rico as of 1969-70. No regional differences in prices, size or age of machines is taken into consideration because of lack of data. The average price of each type of machine supplied by the Department of Agriculture (letter in date of December 26, 1973) is as follows:

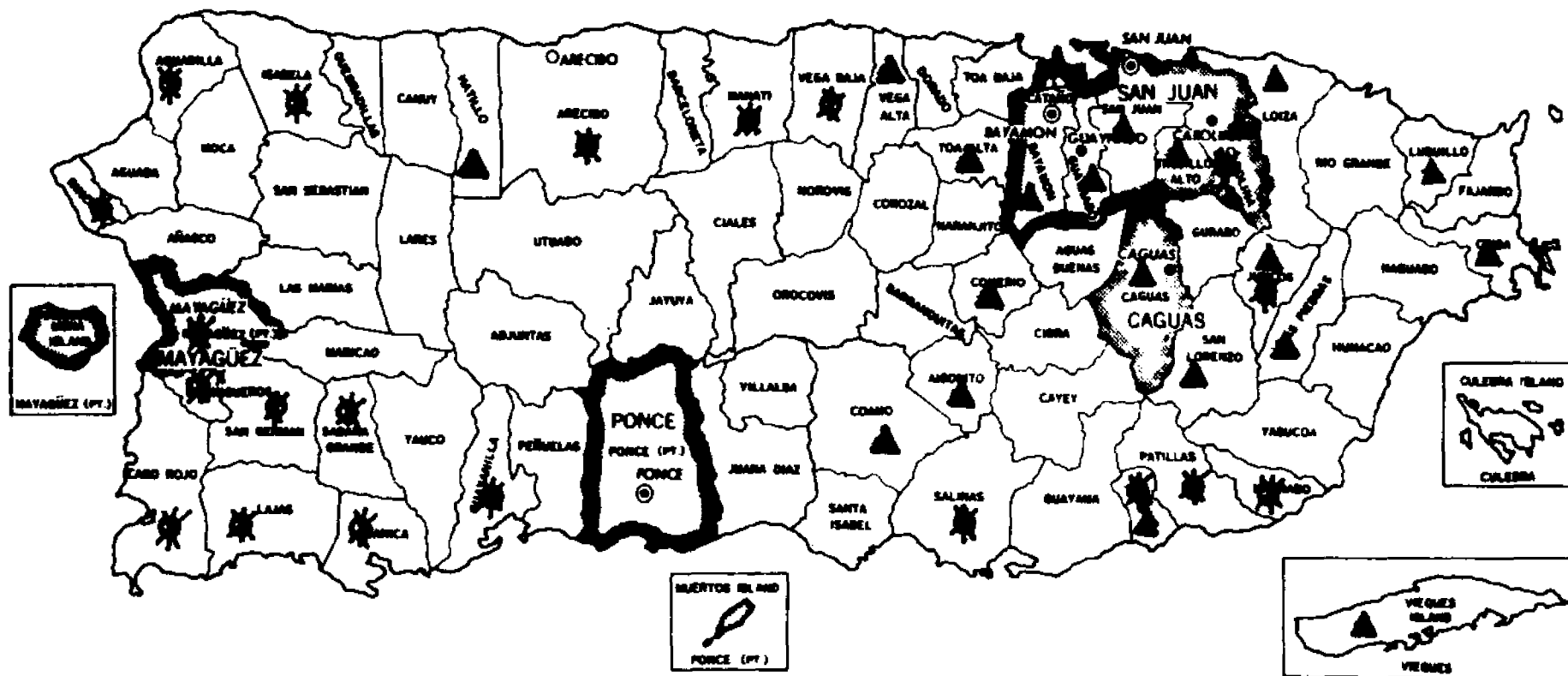
- Jeeps and pick-up trucks	\$ 3,500
- Motor trucks	6,000
- Wheels, tractors	9,800
- Crawler tractors	18,000
- Tractor carts	13,000
- Sugar-cane loaders	22,500
- Sugar-cane harvesting machines	45,000
- Coffee-pulping machines	250
- Milking machines	227
- Milk coolers	7,000

Livestock or capital animal on farm is estimated by multiplying the different types of animal reported on farms (1969 U.S. Census of Agriculture on Puerto) by the average price of these animals in Puerto Rico. The average price of livestock and poultry as of 1969-70 supplied by the same source which supplies us the average price of machinery is as follows:

- Cows	\$ 150.00
- Milk Cows	326.00
- Heifers and heifer calves	165.00
- Hogs	30.60
- Bull calves and steers	165.00
- Sows	63.00
- Horses	60.00
- Mules and donkeys	45.00
- Oxen	45.00
- Goats	30.00
- Chicken hens	1.50
- Started pullets	0.75
- Roosters	2.00
- Broilers	1.75
- Turkeys	5.00
- Pigeon	0.40
- Guinea hens	1.00

LEGEND : ▲ : Livestock-Capital per Worker

✱ : Machine-Capital per Worker



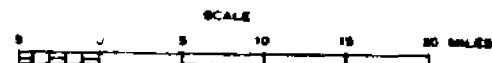
LEGEND

Map III-VIII

- ⊙ Places of 100,000 or more inhabitants
- Places of 50,000 to 100,000 inhabitants
- Places of 25,000 to 50,000 inhabitants outside SMSA's



Standard Metropolitan
Statistical Areas (SMSA's)



livestock capital ≥ 100 and selecting the twenty (20) municipios that have the highest capital-animal ratio (at least eight times the level of Adjuntas ≈ 100) and the twenty (20) municipios that have the highest capital-machine ratio (at least three times the level of Adjuntas ≈ 100) we have the following:

<u>Municipios having the highest capital animal per labor</u>		<u>Municipios having the highest capital machine per labor</u>	
Aibonito	1727	Aguadilla	350
Arroyo	3854	Arecibo	933
Bayamon-Catano	8682	Arroyo	400
Caguas	1200	Cabo Rojo	417
Carolina	1200	Carolina	367
Ceiba	1145	Guanica	653
Coamo	1464	Guayanilla	1142
Comerio	954	Hormigueros	553
Guaynabo	1145	Isabella	347
Hatillo	1527	Juncos	333
Juncos	1218	Lajas	367
Las Piedras	864	Manatí	467
Loiza	845	Maunabo	448
Luquillo	1173	Mayaguez	333
San Juan	882	Patillas	928
San Lorenzo	964	Rincon	533
Toa Alta	854	Sabana Grande	515
Trujillo Alto	1254	Salinas	432
Vega Alta	1318	San German	387
Vieques	5418	Vega Baja	472

When we report municipios with highest animal capital map III-VIII, we discover the same pattern observed earlier regarding the location of

municipios having the highest output per labor or per cuerda, i.e. regions having the highest livestock or animal capital per labor tend to cluster around San Juan and Caguas SMSA's while the municipios showing the highest capital machine per worker are found along the coastal plains where sugar cane is still worked.

Productivity of labor tends more to be associated with livestock or animal per labor than with machine capital per labor. This finding is in conformity with the agricultural transformation depicted earlier, where we note the shift from traditional crops to livestock production. The transformation is more pronounced around the dynamic urban center of San Juan than elsewhere. We note also that high capital machine does not necessarily have any association with labor efficiency or productivity. Again this supports the view expressed before that machines, particularly those introduced into sugar-cane production are not yet fully adapted to local conditions in Puerto Rico since they still require adjustments as to size, and maintenance by trained mechanics.

Puerto Rico's Agricultural Production Function

In order to further our understanding of the factors associated with differences in farm labor productivity among municipios, we will endeavor to estimate two production functions of the Cobb-Douglas type: one encompassing the whole agricultural sector and the other the sugar-cane production. The aggregate production coefficients will be used to explain the observed differences in labor productivity among municipios and both the aggregate and the specific function of sugar cane will serve to determine whether or not increasing, constant or decreasing returns

to scale exist in Puerto Rican farm production.

We have seen that despite the general tendency of labor productivity to increase over the years, there remain substantial labor productivity differences among regions. In terms of policy implications, it is important to pinpoint the factors responsible for these differences and find ways and means capable of narrowing the gaps between advanced and lagging regions. Are the regions poorly endowed with natural resources or located in areas irremediably condemned to low productivity and income, or do there exist specific variables on which the policy makers can play to bring about improvements on the factor productivity of these regions? Or do the human capital and the education embodied therein account substantially for the observed differences? By estimating an aggregate production function encompassing the three main factors -resource endowment (land, livestock, improvement in land etc.), technical inputs (machine, fertilizers, insecticides etc.) and human capital (Education) - generally recognized as responsible for labor productivity differences, we may obtain valuable insights as to the main sources of these differences. For example, Hayami and Ruttan¹ use aggregate international agricultural production elasticity estimates to explain most of the intercountry differences in labor productivity. They express the percentage difference in output per worker as the sum of percentage differences in traditional and non-traditional factor inputs per worker using their respective production coefficient elasticity estimates as weight. In this way they find that human capital in particular explains approximately one-third of the differences in labor productivity between developed and less developed countries². We shall return to this point in due course.

Another interesting aspect of estimating production function lies in the evidence found earlier that farm tenure in Puerto Rico tends to gear towards very small or very large farms. Are there any reasons to reverse this trend by specific policy measures, in other words, are small farm less efficient than large farms? The production function estimates will help us determine the nature of returns to scale. Thus, if there are constant returns to scale in farming production, there is no reason to prefer large to small farms, because one scale of operation can be said to be as efficient as another. On the other hand, if increasing returns to scale prevail, large farms will be preferred.

- Purpose and Techniques of Estimation

Our purpose will be then to estimate an aggregate production function for agriculture in Puerto Rico using municipios as units of observations and a specific function for sugar cane using samples drawn from various sizes of farms across regions of Puerto Rico. Similar estimates of agricultural production function have been carried out by other investigators. For example Grilliches³ has estimated an aggregate production function, using states in the United States as units of observation, with the main purpose of assessing the contribution of research and education on U.S. agricultural output. Hayami and Ruttan⁴ have also estimated an aggregate agricultural production function based on inter-country cross-section data, using countries as units of observation in an attempt to explain differences in labor productivity between developed and less developed countries.

Of course other less aggregate or more refined functions of the

Cobb-Douglas type using cross-sectional farm-firms have been estimated for particular purposes. For instance, Heady and Shaw⁵ have estimated production function designed to conduct resource elasticity coefficients comparisons among four agricultural areas of the United States. The areas covered were: the Piedmont region of Alabama producing mainly cotton and livestock; Southern Iowa, one of the less productive areas of the United States Corn Belt; northern Iowa, one of the most productive regions of the Corn Belt, and the dry area of Montana, producing mainly wheat. The data used for analysis were drawn from commercial farms in each area on a random basis.

Production functions referring to other countries for particular crops have used also the same Cobb-Douglas type of function based on cross-section of random farm samples. Cline⁶ estimates aggregate production functions for various Brazilian crops: coffee, sugar cane, cotton, and cattle -- with the purpose of testing returns to scale in Brazilian farming and of testing production efficiency between tenant and owner-operated farms.

The Cobb-Douglas Production Function: Theoretical Considerations

Before proceeding further, some observations are warranted on the Cobb-Douglas function. Aside from facility of computation and a high number of degrees of freedom provided for statistical testing of the estimated coefficients, our choice is motivated primarily by its ability to provide an adequate fit for the data. Moreover, being a single equation model, it provides the best estimates of production function parameters.

The Cobb-Douglas function has the general form:

$$Q = AX_1 X_2 X_3 \dots\dots\dots X_n$$

where Q : quantity of output

$X_1, X_2, X_3, \dots\dots\dots, X_n$ = factor inputs

A = a constant term

$\beta_1, \beta_2, \beta_3, \dots\dots\dots, \beta_n$: are the production elasticity coefficients with respect to the inputs.

As such, the function is non-linear. But, it can easily be transformed to linear form by taking the logarithms of the variables. Then least squares regression can be applied to estimate the function elasticity coefficients.

The function is such that each input exhibits constant elasticity of output. Each coefficient elasticity is assumed to be less than one. Their sum, however, may be equal to, superior to, or less than one, showing the degree of returns to scale. If the sum is equal to one, constant returns to scale prevail; less than one indicates decreasing returns to scale, and more than one, increasing returns to scale. When constant returns to scale prevail, this simply means that if each input is increased "n" times, the corresponding output will increase "n" times also. Accordingly, decreasing returns to scale mean that output will be increased less than "n" times, and increasing returns to scale mean output increases more than "n" times.

Many criticisms can be made against the use of the Cobb-Douglas function for studies related to production, in particular the fact that it is not defined for an input whose value equals zero. For

all practical purposes this limitation does not encroach too much on reality. It is in effect doubtful that in any production process an important input can be equal to zero. The interest in studying production function is more geared towards assessing marginal productivity of basic important inputs rather than inputs used on a marginal or experimental basis.

The function is also criticized because it implies that given some inputs fixed at a constant level, say, land or labor, capital can be increased without limits and thereby increase production. The function does not put any limit on the combination of factor inputs. Contrary to this criticism, one can resort to real life to find evidence that no inputs can be increased indefinitely while holding the others constant. Actually this is an extreme case that is not likely to reject the use of this function in empirical research.

Other problems encountered in the use of the function are the possibilities of having coefficient estimates that are biased. Errors of measurement give a bias to the size of coefficient estimates, i.e., the numerical values resulting from the regression coefficients are different from the true value that would be obtained had there been no errors of measurement. Bias may also be present when variables are omitted. The omission of variable inputs may be due to various factors, for example, the difficulty of quantifying the concept as such. Management is a case in point. Or it may be the impossibility of gathering information on the quantities of inputs used, for example, the quantity of moisture or sunshine entering production. In cases where the omitted variables are positively correlated with some of the other inputs, the result is likely to over-

estimate one or more of the included variables. For a negative correlation the bias will be towards underestimation of the included variables.⁸ Because we have not been able to include some inputs in our estimation, such as management, and since in general if a correlation exists it is positive, we may have overestimated some inputs.

Along with the problem of omission of inputs we encounter that of aggregation. It is not practically possible to obtain homogeneous inputs even under the strictest scrutiny. Unskilled workers remain non-homogeneous because there exist various degree of skills even among the skilled. This fact can be extended to other inputs as well. Land exhibits various types as far as soil is concerned and cannot be taken as truly homogeneous. Aggregation helps however, in simplifying the problem under study and by all means some sort of aggregation must be made. Unfortunately, when quality differences are ignored within one factor it is equivalent to the omission of a number of variables or the inclusion of additional ones.⁹ This again brings us back to the problem of bias which can overestimate or underestimate the true value of the coefficients. In our study, attempts are made to adjust some inputs for quality differences. For example, an index of education is introduced in the aggregate function. Also attempts are made to adjust land by introducing the ratio of irrigated land to total land area. While the coefficients derived for education alone, and for labor weighted by education are strongly significant, the coefficient for adjusted land turns out to be non-significant and thus has been discarded.

-The data

The data used to estimate the production functions come from

two sources. First, the 1969 United Census on Puerto Rican Agriculture which gives detailed information on output and inputs used in commercial farms (farms with sales over \$1,200 during the period) in Puerto Rico serves to estimate the aggregate production function for the whole agricultural sector. The function is estimated on an average per-farm output and inputs.

Second, data gathered by the United States Department of Agriculture (Agriculture Soil and Conservation Service) operating in Puerto Rico are used to estimate the sugar-cane function. The sample of sugar-cane farms, containing a wide variety of farm sizes (ranging from farms as small as 14 to farms over 5,500 acres) and drawn from municipios producing typically sugar cane, is assumed to be a fairly valid representation of sugar cane farming in the island. Table V gives an indication of the origin, number and size distribution of the sample on sugar-cane farms.

The variables

The two sets of variables defined and discussed below are constructed to be included in the functions. The first set is used in the estimation of the aggregate function for total agriculture and the second set is used for the sugar cane equation.

1. Construction of the variables used in the aggregate function for total agriculture. All the variables are expressed as per-farm municipio average. A total of 74 municipios is taken as unit of observation, the Bayamon and Catano municipios being counted as one observation, and Culebra municipio is being omitted because most of the data are lacking

Table V.- Origin, Number and Size Distribution of Farm Observations in Sample Data (Sugar Cane Production, 1971)

Municipios	Total	Size Interval (acres total farm area)					
		20	20- 100	101- 300	301- 1000	1,001- 3,000	3000
Arroyo	3	-	-	-	1	1	1
Barceloneta	2	1	-	1	-	-	-
Cabo Rojo	4	-	3	1	-	-	-
Camuy	2	1	1	-	-	-	-
Arecibo	2	1	1	-	-	-	-
Mayaguez	6	-	1	2	1	2	-
Moca	9	1	5	3	-	-	-
San Sebastian	12	3	4	3	2	-	-
San German	9	-	3	1	4	1	-
Quebradillas	2	1	1	-	-	-	-
Guayama	2	-	-	-	2	-	-
Sabana Grande	1	-	1	-	-	-	-
Lajas	2	-	1	1	-	-	-
Guanica	1	-	1	-	-	-	-
Isabella	1	-	1	-	-	-	-
Patillas-Lares	1	-	-	-	1	-	-
Penuelas	1	-	-	1	-	-	-
Aguada-Rincon	2	-	-	1	1	-	-
Ponce	1	-	-	-	1	-	-
Humacao	2	-	-	1	-	-	1
Hatillo	2	-	1	1	-	-	-
Santa Isabel	1	-	-	-	1	-	-
Salinas	2	-	1	1	-	-	-
Yauco	1	-	-	-	1	-	-
Total	70	7	25	17	15	4	2

for this municipio.

Output : value of farm products sold in 1969, plus payments for participation in government programs, plus an estimation of inventory change and home consumption. Inventory change and home consumption are estimated as explained earlier where we computed municipio agricultural output per labor.

Labor : man-days per farm constructed as discussed previously in the computation of municipio agricultural output per labor.

Land : a single value is given for land under cultivation and buildings on farms. Figures referring to the number and type of buildings are also given. To get at the value of land under cultivation, the different types of buildings on farms are valued by their average price in 1969-70^a and subtracted from the total value of land and buildings. A rate of interest equal to 11% is applied to land value to express it as a flow concept to which is added the value in dollars of fertilizers used during the period. The interest of this approach is an attempt to take account of quality differences existing in farmland due to the use of fertilizer. The assumption here is that as more fertilizer is used per unit of land, land becomes more productive and of better quality. As for the use of

- a) Average price (1969-70) per different types of buildings on farms is supplied by the Department of Agriculture of Puerto Rico. The different types of buildings on farms and their average price are as follows:

Milking Parlors: \$250.00; Tobacco barns: \$2,500.00; Storage buildings: \$2,000.00; Poultry buildings: \$15,000.00; Livestock barns: \$8,000.00; Agregado houses: \$10,000.00; Other employee houses: \$13,000.00

value instead of acres of land to express the flow of land services entering the function, we assume that the value is likely to reflect, besides location, some inherent characteristics of fertility such as its topography, texture, drainage and other past investments (fences, irrigation structures etc).

In estimating his aggregate production function for the United States, Grilliches¹¹ also uses value instead of acres of land to quantify his land variable. He argues that, in general whenever cross sectional relative price differences are not too excessive, the use of value rather than quantity data imparts no significant bias to the final results. Price differences for land are likely to be large in Puerto Rico, mostly in areas close to urban agglomeration. However, Grilliches justifies his use of value for land measure in contending that price differences in the case of land reflect value that introduces some "pure site rent" into the measure of land, this bias is smaller than the most important error of ignoring "cross-sectional differences in the quality of agricultural land."^{11a}

-Machine and Building Service

The stock of machines on a farm is obtained by valuing at their average 1969-70 price the detailed list of machines on farm by municipios. The types of machines and their prices have already been given above when we estimated machine capital per worker. The stock of machines on farm thus computed is converted into a flow of machine services by multiplying it by 18% (under the assumption the machine will last ten years plus 11% for depreciation and interest). To this measure are added other items such as dollar expenditures on machine hire, customwork and expenditures

on gasoline, fuel and petroleum products.

Livestock on farm capital services: - Animal capital per farm is expressed by using the same approach described above when we discussed the impact of livestock-capital per labor on labor productivity. The stock of animals on a farm is converted into flow measure by assuming a rate of interest of 11% on investment. To this flow we added dollar expenditures for feed for poultry and livestock purchased.

Other. - This item includes seeds, bulbs, plants, chemicals (lime, insecticides, and weed killers) and all expenditures not classified elsewhere.

Education. - This variable is included in the function with the objective of accounting for labor quality differences among municipios or units of observation. Grilliches¹² has found that in the U.S. agricultural production function, an increase in the percentage of the educational level of rural farm labor is equivalent to an increase in the percentage of the amount of labor used in farming production. The coefficients of both variables (labor and education) are practically the same. Thus, labor can be adjusted for quality change by introducing labor into the function in multiplying physical labor by the corresponding index of education.

In order to ascertain whether or not the Grilliches' finding is valid in the Puerto Rican case, we introduce into the function the education variable with labor separately, and labor and education in a multiplicative form - that is labor times education - and then perform an analysis of variance to show whether or not there is any substantial

difference in either coefficient (labor and education separated and labor and education combined). The result of the test follows the results of the estimation of the production function presented below.

The education variable is constructed by using the same approach as Grilliches, consisting of weighing the distribution of school-years completed class. by the rural population 25 years old and over, by the average 1960 income of all Puerto Rican rural males (25 years old and over) belonging to this class. These data are given by the 1960 and 1970 Census on the Characteristics of the Puerto Rican population. The result is equivalent to an index of average education per rural person. An example of the way the computation of education is done is presented for two municipios in Table VI. The computation is conducted in a similar fashion for the 74 municipios entering the equation.

2- Construction of the variables used in the sugar cane production function.- The estimation of the sugar-cane function has the advantage of dealing with a truly homogeneous product. Besides, the problem of aggregation of input is less acute than in the estimation of the aggregate function. The number of farms making the sample amounts to 70. The variables used and the form in which they enter the function are dictated by the availability of the data.

Output or dependent variable : amount of CWT (hundredweight) of cane produced during the period per farm.

Land : area cultivated in acres during the year. This figure exclude all lands devoted to uses other than sugar-cane production.

Table VI.- Derivation of the Index of Education. Two Municipios:
Adjuntas and Aguada

School Years Completed	Rural Farm Population: 25 Years Old and Over, By School Years Completed				1960 Mean Income of Males (25 Years old and over), by School Years Completed Rural, Puerto Rico	
	Adjuntas		Aguada			
	Population	%	Population	%		
None	877	27.6	685	32.7	\$	438
Elementary						
1-4	1158	36.5	877	41.9		612
5-7	692	21.8	289	13.8		864
8	111	3.5	86	4.1		1,262
High School						
1-3	170	5.4	64	3.0		1,484
4	90	2.8	64	3.0		1,861
College						
1-3	43	1.3	9	0.4		2,114
4 and more	34	1.1	19	0.9		4,070
Mean weighted divided by 100	781.3		716.1			

Source: U.S. Census, Characteristics of the Population, Puerto Rico, 1960 and 1970. Table 108 (1970) and Table 117 (1960)

Labor : Dollar value spent in

- planting and cultivation, covering soil preparation, planting, replanting, fertilization, weeding and irrigation
- supervision, administration and inspection
- harvesting, cutting, loading and hauling

Capital or machine services : the current dollar value of all non-labor expenditures incurred by each farm during the year. This variable encompasses

- expenditures for soil preparation, planting, ratooning,

replanting, irrigation, supervision, and hired machines for cutting, loading and hauling.

- expenditures on machine maintenance and repairs
- depreciation and interest paid on machines
- expenses on fuel, petroleum and petroleum products.

As such, this variable can be thought to refer to the flow of services entering production from the stock of existing capital.

Other: this item includes expenditures on fertilizers, pesticides and all expenses not elsewhere classified.

Empirical Results

- The Aggregate Function

The derived aggregate function parameters take the values shown in Table VII. We note readily that except for machine services, all the coefficients are strongly significant at the 5% level of confidence interval (t-test). The adjusted coefficients of determination (R^2) of the three equations are well over 0.90 indicating that more than 90% of the total variation in output among municipios is explained by the inputs used in the equations. We observe also that the coefficients of the conventional coefficients (land, labor, capital and other) do not show any significant change when the education variable is introduced into the equation. Moreover, when the variable labor is multiplied by education, the resulting variable ($L \times E$) in equation 3, Table VII, has practically the same value as the variable labor in equations 1 and 2. To test further whether the two coefficients of labor (L) and education

Table VII.- Estimates of the Aggregate Cross-Section Production Function for Agriculture: 1969, Puerto Rico. - 74 Municipios (All variables are logarithms of original values; the units of observation are average per commercial farm)

Regression Number Sample Size	Production Elasticities		
	1 74	2 74	3 74
Labor (L) ¹	0.255(0.083)	0.274(0.084)	
Land	0.109(0.051)	0.105(0.050)	0.106(0.050)
Machinery	0.035(0.042)	0.035(0.042)	0.039(0.041)
Livestock	0.207(0.034)	0.210(0.034)	0.209(0.034)
Other	0.272(0.0715)	0.256(0.072)	0.263(0.071)
Education (E)		0.188(0.156)	
L x E			0.260(0.079)
Coefficient of det (R ²) adjusted	0.937	0.940	0.937
Sum of conventional coeff.	0.878	0.880	0.877

1) The figures in parentheses are the standard error of the coefficients.

times labor (L x E) variables show any significant differences, we conduct an analysis of variance similar to the one performed by Hayami and Ruttan¹³ on the identical variables they used in their estimates of international production function for agriculture. Basically the test consists in calculating an F-statistic using the squares of residuals and degrees of freedom of the equation where the labor and education variables are introduced separately and the equation where the labor and education variables are combined. The following formula is applied:

$$F: \frac{S_2 - S_1}{S_1} \cdot \frac{P_1}{P_2 - P_1}$$

where S_2 : Sum of squares of residuals (labor and education separate)

S_1 : Sum of squares of residuals (labor and education combined)

P_2 : Degrees of freedom (labor and education separate)

P_1 : Degrees of freedom (labor and education combined)

Using these statistics and equations 2 and 3 the test is present in Table VIII.

Table VIII.- Analysis of Variance to Test the Equality of the Coefficients of Labor and Education

	Sums of Squares of Residuals		Degrees of Freedom		
	S_1	S_2	P_1	P_2	F
Eqs. 2 vs 3	0.67558	0.67848	67	68	0.29

The F-statistic obtained indicates clearly that the two coefficients are practically identical. Thus the findings of Grilliches concerning U.S. agriculture are valid for P.R. agriculture too, i.e. a percentage increase in education per agricultural worker has the same effect as an increase in the farm labor force. Of course an increase in education alone cannot be expected to increase production. Other inputs are necessary too. The role of education in this context is simply that, farmers with higher levels of education tend on the average to make better use of current inputs and tend also to introduce new methods and modern inputs into their production processes (given the relative prices of these inputs) with greater ease than do farmers with less education.

- Test for Returns to Scale

Looking now at the sums of coefficients of inputs excluding education, we find that the sums do not add up to one. To decide whether or not the elasticity sums are significantly different from one, at the 5% probability level, we perform the following test:

We set the null hypothesis,

$$H_0 : C' \beta = 1$$

where C' is a row vector equal to

$$C' = [1 \quad 1 \quad 1 \quad 1 \quad 1] \quad \text{and}$$

$$\beta = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \beta_5 \end{bmatrix}$$

corresponding to the coefficients of the five variables introduced in the aggregate function.

Assuming the β_i have a multivariate normal distribution, $C' \beta$ is a normal variate, i.e. ¹⁾

$$C' \text{ is } N \left[C' \beta, \sigma^2 C' (X'X)^{-1} C \right] \quad \text{and}$$

using the t distribution with $n-k-1$ degrees of freedom, we have:

$$t_{n-k-1} : \frac{C' - 1}{\sqrt{s C' (X'X)^{-1} C}}, \quad \text{where } s : \sqrt{\frac{\sum_1 e^2}{n-k}}$$

1) See Johnston J., Econometric Methods, McGraw-Hill Book Co. pp 132-133.

the corresponding t gives a value of:

$$t : \frac{0.877 - 1}{\sqrt{(0.01015)(0.05237)}} = \frac{0.123}{0.023} = 5.35$$

with 68 degrees of freedom. We have to reject the hypothesis that the sum of the coefficients is in fact equal to 1. In other words, our function exhibits decreasing returns to scale, assuming of course no important inputs are omitted in our estimation.

Comparison with Other Functions

It is perhaps instructive to compare the production coefficients or elasticities estimated in this study with estimates of the same variables obtained for other aggregate production functions.

- The Parameters

The aggregate production elasticities for U.S. agriculture estimated by Grilliches using regions of the U.S. as units of observation and expressing the data as average per commercial farm presents many affinities with this study. In his work, Grilliches found coefficients for labor ranging from 0.4 to 0.5 which is higher than ours (0.25 - 0.27); 0.12 to 0.18 for land which is close to the 0.10 found in this study; the coefficient for education lies between 0.3 to 0.5, while ours is around 0.2, and the coefficient for livestock expenses hovers around 0.15, while ours is higher (0.20). Except for labor and land the values of the other input coefficients depend on the type of aggregation used. For example, his value for "other" which lumps a host of inputs is

around 0.393 in one function while it takes the value of 0.111 to 0.121 in another estimate. In our study the coefficient of "other" takes the value of 0.27. Finally, our coefficient for machine services is very low indeed : 0.04 compared to 0.158 and 0.359 in the Grilliches function, although our coefficient is not significant at the conventional 5% level of confidence.

- Returns to Scale

Concerning returns to scale, Grilliches finds a sum of coefficients tending to be superior to one or slightly increasing returns to scale, while ours is around 0.9 or less than one. Our finding of returns to scale on the decreasing side means that given the types of inputs in usage in 1969-70, the possibility of increasing production by enlarging farms is exhausted. On the average, there is nothing to be gained by increasing the scale of farm operation given the 1969-70 input mix. Perhaps the decreasing returns to scale found in this study is due to the input "management" that is not included in our function. There exist a tendency of large and small farms to dominate the structure of far size in the Puerto Rican agriculture, as we have seen earlier. Intuitively it seems valid to assume that, given that migration has encroached on the best educated persons on rural areas, and as farms become larger, management capabilities of the remaining farmers have not increase to the same proportion as other factors. If this were so, policies should be directed at discouraging enlargement of existing farms until better managers become available to conduct farm operations.

- Other Studies

Other studies reported by Heady and Dillon¹⁴ for mixed farms over the world are compared with ours. We select the functions covering mixed farming because they present more affinities in the way they aggregate their output with our study. However, the studies reported consider only three broad types of inputs: land services, labor services and other services. For purposes of comparison, we aggregate the non-land and non-labor coefficients of our equation into a single elasticity coefficient, assuming that the value obtained represents more or less the coefficient of other services computed in these functions. The comparison is summarized in Table IX.

Table IX.- Farm Production Function of Selected Countries Compared with Puerto Rico.

Countries	Elasticity of Production			
	Land Services	Labor Services	Other Services	Sum of Elasticities
Sweden (1)	0.35	0.05	0.57	0.97
India, Andhra Pradesh (1)	0.14	0.26	0.13	0.53
Austria (1)	0.13	0.26	0.61	1.00
Israel (1)	0.03	0.25	0.80	1.08
Puerto Rico	0.11	0.25	0.52	0.88

1) The functions for these countries were estimated during the period 1950 to 1958

In the functions presented, except for India, "Other Services" shows the highest elasticity. As a consequence, the expansion of the resources included in this aggregate input "other" can be expected to

have more impact on output than the expansion of land and labor inputs. Except also for Sweden which has a very low elasticity for labor, the other countries exhibit a labor elasticity of 0.20 which, compared to the elasticity of 0.4 found by Grilliches for the U.S., is quite low. This means that in these agricultures, particularly in Puerto Rico, labor in farming is still in abundance and its expansion should not be expected to add too much to production. Finally, Puerto Rico shows a land coefficient similar to those of India, Andhra Pradesh and Austria. Since, as we have seen in the preceding chapter, agriculture in Puerto Rico is tending to gear its production towards more livestock production, the expansion of land - an input which is used far more intensively in crop production than in livestock production - should not be expected to have any great impact on future farm production.

Of course, these observations are based on the aggregate production function. Other functions derived for more homogeneous products should be used for better diagnosis related to particular crops or farm products. Nevertheless, we shall use the coefficients estimated to explain, on the aggregate, farm labor productivity differences (output per worker) among municipios in the next chapter.

Accounting for Differences in Output Mix among Regions

It is clear that, despite the general picture obtained for agriculture in Puerto Rico by the aggregate production function, there exist serious problems of aggregation in the input-output mix of different types of farms and thus the application of a unique production function for all the diverse farms specialized in crops, livestock or both might

not seem to warrant valid and useful specific economic conclusions. In his study of the aggregate production of American agriculture, Grilliches¹⁵ raises the question and has taken steps to account for differences in the output-input combinations that exist in farm activities. His approach consists in introducing into his function two "extraneous" variables called "p" and "1 - p" expressing the percentage of livestock, livestock products and crops in the total product. These variables, allowing in each observation for differences in output mix contribute not only to explain "a substantial fraction of the residual variance" but also to change some of the coefficients in the right direction. Thus, he finds that the coefficient of livestock has become larger and more significant, and that of labor has been reduced in the equations containing "p" (% of livestock in the output) and "1 - p" (% of crops in the output) than in the equation where "p" and "1 - p" are deleted. In short, this device tends to impart to the coefficients their relative true value. In other words, in a region deriving most of its farm income from livestock and livestock products, the input coefficient of livestock will be larger than the other coefficients, while that of seeds, bulbs etc. or "other" in our case will take the lead in crop-producing regions.

The introduction of a similar approach in the Puerto Rican agricultural function confirms the Grilliches' finding. Table X summarizes the values taken by our equation when "p" and "1 - p" are introduced in the equation.

Comparing Tables VIII and X, we observe that the coefficients of land and labor have indeed decreased, while the coefficient of livestock has increased markedly. The elasticity of the input

Table X.- Farm Production Function, Allowing for Output Mix Differences, Puerto Rico, 1969

Regressions	Coefficients of (1)		
	3	4	5
Sample Size	74	74	74
Land	0.030(0.062)	0.021(0.041)	0.022(0.041)
Labor (L)	0.160(0.071)	0.196(0.072)	
K-Livestock	0.450(0.053)	0.440(0.052)	0.441(0.052)
K-Machine	0.037(0.039)	0.050(0.039)	0.046(0.038)
Other	0.227(0.059)	0.194(0.060)	0.191(0.059)
L x E			0.207(0.068)
Long P	-0.386(0.062)	-0.384(0.06)	-0.379(0.06)
log (100 - P)	-0.092(0.037)	-0.118(0.038)	-0.113(0.037)
R ² adjusted	0.962	0.97	0.97
Sum of elasticity excluding L and E	0.904	0.901	0.91

1) Standard errors are in parentheses.

"other" tends to decrease while that of capital increased slightly. The behaviour of the variables education (E) and education-times-labor (L x E) are not affected significantly. In addition, the sum of coefficient elasticity is a little higher.

There is however, a more satisfactory way of accounting for differences in output mix and input productivity. If the sample of observations is sufficiently large, we may try to divide the units of observation into two separate groups: 1) regions whose farms derive at least an average of 70% of income from livestock and livestock products

and 2) regions with less than 70% of income from livestock. The figure of 70% is clearly arbitrary, as it is chosen only to allow a better distribution of observations among the two samples. Table XI presents the result of our procedure.

Table XI.- Splicing of the Production Samples into Livestock and Crop Producing Regions

Regressions	Coefficients (1)	
	Livestock (2)	Crop (3)
Sample Size	25	49
Land	0.035(0.031)	0.231(0.071)
Labor	0.109(0.102)	0.252(0.094)
K-Livestock	0.60(0.048)	0.098(0.044)
K-Machine	0.080(0.035)	0.022(0.057)
Other	0.090(0.063)	0.280(0.088)
R ² adjusted	0.984	0.945
Sum of elasticities	0.914 ⁴	0.880 ⁵

1) Values in parentheses are standard errors

2) Regions whose average gross farm income is made of more than 70% of livestock revenue

3) Regions whose average gross farm income is made of more than 70% of crop revenue

4) Different from 1 at 5% probability level, but can be taken equal to 1 at 10% t-test

5) Different from 1 at 5% probability level

It emerges clearly that the input coefficients are different in the two groups. The livestock capital coefficient shows

strongly with a value of 0.6 among the livestock-farms group while it is very low in the crop group. Land, an input used intensively in cropping activities has a larger coefficient in the crop compared to the livestock group, as was expected. It also becomes evident that labor has more impact in crop than in livestock activities. Capital machines, though showing a low coefficient, is nevertheless larger in livestock relative to crop farms. In addition, the input "other" including mainly expenditures for bulbs, pesticides, and weed killers has a coefficient of 0.280 in crop relative to 0.09 in livestock farms. Finally it can be noted that the sum of the elasticity is higher (0.91) in livestock relative to crop farms (0.880). It should be also noted that, by applying the t-test described above to test the divergence between the sum of elasticity coefficients, while the sum of elasticity from crops cannot be accepted to equal to one ($t : 3.8$) at 5%, that of livestock ($t : 1.73$) can be taken to equal to 1 at 10% level of confidence.

- Policy Implications

The implications of these results are of interest for the allocation of resources among sectors. Thus, for example, given the technology existing in Puerto Rico, the costs of resource transfers, natural-factor endowments of particular regions, and fixity of some resources such as land, livestock activities should be encouraged where their elasticity is highest. Not only this, but land uses which play a lesser role in livestock enterprise should be discouraged in nearby urban centers where land is scarce and devoted rather to crops in these areas. As for labor, which has less fixity than most of the resources engaged in agriculture, its use should be encouraged in crop activities

where its impact is stronger than in livestock areas. How to reach such a goal is not too easy. One way would be to facilitate credit for modernization and investment in livestock-capital in regions where its reward is high and to soften minimum-wage regulations in crop areas where the impact of labor on production is strong. Of course resource transfers are not the only way to affect the structure of agricultura production, as encouragement to change existing technology by affecting the ratio of modern input to product prices is perhaps the surest way to increase and modernize agriculture.

Sugar-Cane Production Function

We turn now to a consideration of the results of the estimated sugar-cane function. Our sample of sugar-cane farms is divided into three parts: farms smaller than 100 cuerdas (totalling 31), farms of over 100 cuerdas (totalling 39) and the pooling of all farms in one function. Thus, we present in Table XII three versions for sugar-cane production function in Puerto Rico: the pooled data group: the group of farms of less than 100 cuerdas and the group with farms having more than 100 cuerdas. The purpose of this division, in addition to offering an overview of sugar-cane production in general, is to ascertain whether the inputs used in sugar-cane production have different coefficients for different sizes of farms and also to determine whether there exist any economic reasons to encourage the use of any specific factor of production in higher quantity in one size of farm than in other.

- Empirical Results

In general, when we look at Table XII, we observe that in

Table XII.- Sugar Cane Production Function, Puerto Rico, 1970

Regressions	Coefficients of (1)		
	Pooled Data	Farms having more than 100 cuerdas	Farms with size of more than 100 cuerdas
Sample Size	70	39	31
Labor	0.293(0.087)	0.287(0.135)	0.213(0.141)
Land	0.492(0.089)	0.535(0.171)	0.378(0.139)
Machinery	0.105(0.047)	0.135(0.064)	0.028(0.073)
Other	0.080(0.031)	0.056(0.033)	0.286(0.007)
Adjusted R ²	0.98	0.96	0.83
Sum of Coefficients	0.97 ²	1.01 ³	0.905 ⁴

1) Value if parentheses are standard errors of the coefficients

2) Can be taken to equal to one at 10% level of probability

3) Not different from one at 5% level of probability

4) Different from one at even 10% level of probability

the three versions, the standard errors of the coefficients are quite small compared to the size of the coefficients, except for the coefficient of machinery in small farms, to make the elasticities significant at the 5% conventional level of confidence. We note also that in all the three versions, the coefficient of land is the highest of all and that labor tends, in the pooled data and farms with more than 100 cuerdas, to have a higher value than in small farms, although the difference is not too large. Machinery has clearly a stronger impact in large farms, while "other" inputs are more important in small farms.

Thus, under 1970 technological conditions, an increase

Table XIII.- Sugar Cane Production Functions of Selected Countries
Compared with Puerto Rico

Countries	Elasticity of Production				Sum of Coefficients
	Land Services	Labor Services	Capital Services	Other Services	
Taiwan ¹ (1957)	0.36	0.25	0.34 ²		0.95
Uttar Pradesh ¹ (1955-56)	0.37	0.69	0.30	-0.27	1.09
Alagoas Sugar ⁴ (1962)	0.926	0.081	0.0127	-0.003	1.017
Pernambuco Sugar (4) 1962	0.573	0.264	0.1120	0.054	1.001
Sao Paulo Sugar ⁴ (1963)	0.460	0.622	-0.0726	-0.0057	1.004
Puerto Rico (1970)	0.492	0.293	0.105	0.080	0.97

- 1) Reported in Heady E. O. and Dillon John L.: Agricultural Production Functions (Aimes, Iowa State University Press, 1961), p. 630
- 2) Capital services include "other" inputs
- 3) This coefficient is for "capital assets"
- 4) Regions of Brazil; functions are estimated by William Cline, in Economic Consequences of Land Reform in Brazil, (North-Holland Publishing Company, Amsterdam, London, 1970), p. 64

in land under sugar-cane cultivation is likely to have a stronger impact on large (more than 100 cuerdas) than on small farms. Since, as we have seen earlier, sugar-cane farms have difficulty in adapting machines to local conditions in Puerto Rico, we would say that according to the figures of Table XII, use of machines on small farms should be strongly discouraged. Moreover, since the use of more labor on small farms has a smaller impact on production than that of the use of more land, small farms should be enlarged in order to reach the machine productivity of larger farms.

- Comparisons with Other Functions

In Table XIII, we compare the coefficients of the pooled data version with coefficients of sugar-cane production in other areas of the world. Concerning returns to scale, all countries used for comparison, including Puerto Rico, present practically constant returns to scale. Except for Alogoas (Brazil), the land elasticity reported for Puerto Rico is in the range estimated for Brazil. Taiwan and Uttar Pradesh show lower land elasticity relative to Puerto Rico. The high land elasticity found in Puerto Rico is the result of heavy shrinkage in the land under cultivation observed and discussed in preceding chapters. The labor coefficient for Puerto Rico is close to that of Taiwan and Pernambuco (Brazil) but is lower than that of Sao Paulo or Uttar Pradesh (India). The capital services coefficient compares well with that of Pernambuco but is lower than those of Taiwan and India. "Other" services input is generally low in all areas reported and in most cases is negative, Puerto Rico showing the highest coefficient (0.080). In conclusion we can say that other than in India and Sao Paulo, land is the most important input in the production of sugar cane in the areas included in Table XIII.

Productivity in Small and Large Sugar-Cane Farms

In order to investigate further the efficiencies of resource use in sugar-cane production we shall use the two functions estimated for small and large farms to search out any possible discrepancies among the inputs used in the two sizes of farms. To do so, we will compare the MPP (marginal physical productivity) of the two types of farms.

Table XIV.- Marginal Physical Products among Small and Large Farms
for Puerto Rico's Sugar Cane Farming

Item	Large Farms	Small Farms
<u>Geometric Means</u>		
Output (CWT)	16,229.3	1,479.0
Land (Cuerdas)	410.5	33.2
Labor (\$)	57,942.9	5,859.0
Machinery (\$)	27,580.4	2,009.0
Other (\$)	38,690.1	2,085.0
<u>MPP</u>		
Land (CWT/Cuerda)	21.1	16.8
Labor (CWT/\$)	0.08	0.05
Machinery (CWT/\$)	0.08	0.02
Other (CWT/\$)	0.02	0.20

Table XIV presents the MPP for large and small farms. These quantities are computed at the geometric mean of the inputs and output. The MPP is the quantity by which output would grow and has one more unit of this input used, the other inputs being kept constant. From Table XIV, we notice that the physical returns (CWT) to land, labor and capital are lower in small than in large farms. Only in the use of ther inputs do small farms show a higher physical return. This is thus another reason to support the enlargement of small into large farms.

Using now the pooled data assumed to represent the whole sector, we shall try to investigate the degree of disequilibrium existing in this sector. To do so, we will compute the VMP (value marginal productivity) of the factors as a whole by multiplying the MPP of each factor by the price of the product and form the ratio between the VMP

of each factor and its cost. If this ratio is less than one, it means that too much of the input is used under the market price conditions. If it is greater than one, it means that too little of that input enters production or that more could have been used by increasing the usage of the input in question. At the value of one, equilibrium is reached.

For land, no official yearly cost figures are available for the rental of a cuerda. From information gathered from the "Land Authority" in Puerto Rico and some sugar-cane farmers in various places on the island, we come up with a mean rental price of \$90.00 per acre per year. Obviously, this cost figure is only a rough approximation. The rental price of an acre varies from region to region and even within a region.

The cost of capital borrowing or interest on capital is taken to be on the average 11% in 1970. Again, there exist no official figures on the interest rate paid by farmers. It seems to hover around the figure of 11% according to who the borrower is, his credibility, and the lender if it is a commercial bank or a government agency.

Labor being expressed in dollar value, we will take as the opportunity cost of one dollar spent on labor, one dollar plus the relevant rate of interest (11% or 1.11), assuming that this dollar has been borrowed on the financial market.

The price received by the farmer for a CWT of sugar cane including the various benefits he receives as supplements, such as extra pay for molasses, soil conservation etc., is taken to \$9.16¹⁶ in 1970.

Table XV.- Sample Means, MPP, VMP and Opportunity Costs of Resources used in Sugar Cane (whole Sector)

Item	All Farms
Sample Means	
Output (Cwt)	5,618.2
Land (cuerda)	134.8
Labor (\$)	21,003.9
Machinery (\$)	8,645.7
Other (\$)	10,612.1
MPP	
Land (Cwt/Cuerda)	20.5
Labor (Cwt/\$)	0.08
Machinery (Cwt/\$)	0.07
Other (Cwt/\$)	0.04
VMP	
Land (\$/cuerda)	187.8
Labor (\$/\$)	0.64
Machinery (\$/\$)	0.64
Other (\$/\$)	0.37
Marginal Returns to cost	
Land	2.08
Labor	0.66
Machinery	0.58
Other	0.28

Table XV presents the relevant statistics, and the VMP of the factors is obtained by multiplying the MPP by \$9.16 or the price of a CWT. The marginal return to cost is obtained by dividing, the VMP of each factor through its opportunity cost.

Equilibrium in Sugar-Cane Farms in Puerto Rico

It emerges clearly that, except for land, extensive

disequilibria exist in the use of resources in the sugar-cane sector. The figures of Table XV suggest that under the price conditions prevailing in Puerto Rico, sugar-cane farmers should increase the size of their farms in order to raise the returns to capital and labor investments. The stock of capital including the services of "other" inputs and the quantity of labor is too large for the input land under cultivation.

Evidence that too much labor was used in sugar cane production in 1970 can be had by comparing the number of man-hours necessary to produce one ton of sugar cane with hour required in other producing areas. Table XVI presents the data. Among the producing areas covered, Puerto Rico has the highest man-hours per ton of sugar and the lowest percentage of sugar recovered per ton. These figures confirm the low labor productivity observed in Table XV.

Concluding Remarks

Within the sugar-cane farming sector, there exist inconsistencies that give rise to strong uncertainties about its future development. For one thing, with the maximum guaranteed price for sugar offered by the Federal Government to Puerto Rican producers and the various programs sponsored by both the Federal Government and the Commonwealth, programs that are designed to encourage production of sugar cane, one would think that incentives to organize and modernize processes in order to increase production would naturally follow. But, on the other hand, the declining yield of sugar per ton of cane attributed to various causes, and in particular to the mechanization process of the harvesting phase which introduces extraneous material, so that more cane must be ground to

Table XVI.- Selected Data on Sugar Cane Production for Some Areas (Crop year: 1970)

Area	% of Sugar recovered	Sugar Yield per harvested Acre	Man-hours per ton of sugar
Puerto Rico	7.81	2.44	63.12
Louisiana	8.70	2.27	24.82
Florida	11.49	3.83	14.19
Hawai	11.11	10.21	9.50
Beet area	13.21	2.43	16.43

Source: An Economic Report on The Sugar cane Farming Industry and the Sugar Manufacturing Industry in Puerto Rico, April 1972, U.S. Department of Labor, p. 9.

produce an equal amount of sugar, exogeneous decisions by the Commonwealth Government to increase minimum wages for agricultural labour in order to keep the gap between farm wages and manufacturing wages from widening, the seasonal quality of the sugar-cane occupations, and the traditionalism that considers sugar-enterprise farming as being inherently labor intensive -all these definitely homper incentives to modernize the sector. Puerto Rico enjoys a quota on the United States market that has not been reached for years. There exists room for more production.

Tentative Policy Proposals

Production of sugar cane in the island is still of importance for the farming sector. Mills cannot run without sugar cane, the production of rum and other alcoholic beverages requires sugar cane, and the exportation of refined sugar to the United States helps the balance of payments. Thus, steps to breathe new life into this sector should be

taken and all the more so as the rate of unemployment has been around 11-14% from 1970 to 1975. These steps should be

- 1) Encouragement to increase farm size. A minimum area of 100 cuerdas should be required in order to be eligible for credit from the Commonwealth or the Federal Government at a preferential lower interest rate

- 2) Freeze the minimum wages for a certain period while farms are enlarged and mechanization is adapted to local conditions

- 3) Encourage the ownership of land by credit facilities. This point is based on the assumption that owners will be more secure to make well-considered and necessary investments to increase production.

These points and others will be discussed more fully in the following and concluding chapter

FOOTNOTES, CHAPTER VIII

- (1) Hayami, Yujiro and Ruttan, Vernon W.: Agriculture Development. An International Perspective, The John Hopkins Press, Baltimore Press, p. 86
- (2) Hayami and Ruttan, op. cited pp. 97-98
- (3) Grilliches, Zvi: "Research Expenditures, Education, and the Aggregate Agricultural Production Function". The American Economic Review, Volume LIV, December 1964, Number Six
- (4) Hayami and Ruttan op. cited
- (5) Heady, E.O. and Shaw R. "Resource Returns and Productivity Coefficients in Selected Farming Areas", Journal of Farm Economics, 36:243-57, 1954; and, "Resource Returns and Productivity Coefficients in Selected Farming Areas of Iowa, Montana and Alabama: Iowa Agricultural Experimental Station Research. Beel 425 Aines 1955 cited in Heady, Earl O. and Dillon John L., Agricultural Production Functions, Iowa State University Press, Ames, Iowa 4th Edition p. 593
- (6) Cline, William R. Economic Consequences of a Land Reform in Brazil, North-Holland Publishing Company Amsterdam, pp 64-65
- (7) Heady, Earl O. and Dillon, John E., Agricultural Production Functions, Iowa State University Press, 1969, Iowa (Ames) 4th Edition, p. 138
- (8) Heady, Earl O. and Dillon, John E., op. cited pp. 214-215
- (9) Heady, Earl O. and Dillon, John E., op. cited pp. 215-216
- (10) Grilliches, Zvi, op. cited, note 3
- (11) Grilliches Zvi, op. cited, note 3
- (11a) Grilliches Zvi, op. cited, note 3
- (12) Grilliches Zvi, op. cited, note 3
- (13) Hayami and Ruttan, op. cited, note 1 p. 95
- (14) Heady, Earl O. and Dillon John E., Agricultural Production Functions, Ames, Iowa: Iowa States University Press, 1961, p. 630
- (15) Grilliches Zvi, "Estimates of the Aggregate Agricultural Production Function From Gross-Sectional Data." Journal of Farm Economics (Proceeding issue), Volume XLII, December, 1960, p. 425

- (16) Departamento de Agricultura, Oficina de Ingresos Garantizados
a Trabajadores Agrícolas: Estudio de Ingresos y Costos de
Producción de 831 Fincas de Cane (1971)

CHAPTER 1X

SUMMARY AND CONCLUSION

Introduction

One of the two concerns of this study has been to understand and explain the pattern of migration, particularly internal migration in Puerto Rico, following the impressive record of economic growth the island has experienced since "Operation Bootstrap" was inaugurated in 1948. This program has transformed Puerto Rico from an economy based on traditional export crops (sugar cane, tobacco and coffee) to an industrial center, one of the most important trading partners of the United States. As a result, the population distribution of the island has drastically changed: an exodus of rural workers to urban centers and to the mainland U.S. has taken place. The impact on agriculture has been irreversible. While industrialization has been growing, the agriculture labor force and employment have followed a steadily declining trend. The composition of its output has also changed from mainly crops to modern livestock and livestock products. The development and adaption of P.R. agriculture to its process of industrialization is the second objective of this study.

Before presenting the conclusions and some general policy measures towards agriculture particularly sugar cane a brief summary of the principal findings of the study will be underlined.

Summary of the Study

Migration

- Internal

In trying to understand and explain the determinants of migration we have relied on the human capital theory that views migration as an investment that man decides to make in himself. The decision to migrate entails costs and benefits not only to the migrant (private benefits and costs) but also to society (social costs and benefits). Private costs and benefits may be translated into monetary and non-monetary form. The monetary aspect covers the increase or decrease in income accruing to the migrant during his life-time relative to the income he has before moving. Giving the level of employment prevailing at his destination, expected earning differentials are assumed to be function of the schooling, age, and sex of the migrant.

The non-pecuniary returns and costs to migration involve those objective or emotional gains or losses derived by the migrant due to his preference for a given location. It is argued that these psychic costs (gains) while difficult to evaluate can affect the behavior of the migrant and may contribute to increase or decrease his effective earnings to the extent that they affect positively or negatively the time devoted to market production.

Social costs and returns arise from existence of external economies and/or diseconomies which affect differently places of immigration and out-migration depending on the volume of and the speed with which migration occurs and also of the quality of the migrant who have moved.

A model of migration is constructed in which the "re-

gional migration rate" (M/P), given the sex and age of the individual is a function of:

I = Differences in Income among regions or "municipios"

U = Differences in Unemployment rates among regions or "municipios"

O = A set of differences in regional opportunities, such as health, educational and housing facilities.

E = The educational level of the individual

In using the method of "Survival Ratio" to compute the rate of net migration, we find that in terms of the migration pattern, the average rate of net out-migration is lower for all age-groups in 1960-70 relative to 1950-60.

In 1950-60, net average out-migration particularly affected the age groups 0-4 to 45-54 (Male and Female) at the beginning of the period. In 1960-70 only females of the 0-4 to 35-44 age groups and males 0-4 to 20-24 age groups were affected. This means that during the 1960's, aged 25-34 and 35-44 at the beginning of the period show a relatively greater tendency to out-migrate than males of the same age-groups.

In general, however, during the two decades (1950-60 and 1960-70) males show a higher propensity to outmigrate than females. Likewise, out-migration for both males and females is confined to the youngest, particularly the 5-9 to 20-24 age-brackets at the start of the periods.

Finally, based on standard deviations around the means

of migration rate which is smaller in the 1960's relative to the 1950's, we infer that migration among similar groups of age is more uniform among "municipios" during the 1960's with respect to the 1950's.

In terms of regions that have gained people on a net basis, we find that they are represented mainly by "municipios" clustered around or within the San Juan Metropolitan Area or urban areas.

Regions of out-migration are principally the "municipios" of the coffee-growing mountainous regions considered as "net donors" or rural areas.

Other regions or "municipios" show gains or losses depending on age-bracket or sex. Regarding these regions, no clear pattern emerges.

In general however, rural areas show losses of population relative to urban regions.

- External

With respect to external migration or migration to the mainland United States, we find that in the 1960's, net out-migration is lower relative to the 1950's. During the 1950's all age brackets show a clear pattern of out-migration. In the 1960's there was a mild tendency over the average of older brackets (35-44 of age at the end of the period) to show signs of returning migration.

During the two periods (1950's and 1960's) the young show

higher rates of out-migration than the old and the highest rates are found among those aged 10-14 to 25-29 at the end of the period.

As far as sex is concerned, while males tend to show a higher rate than females in internal migration, females tend to outnumber men (if only slightly), in external migration, especially among the brackets 20-24 to 30-34 at the end of the period.

Regarding the characteristics of persons of Puerto Rican birth in the United States, we find that Puerto Rico has a clear deficiency relative to the U.S., in its more productive and active population. The brackets 20-24 to 45-64 of age are better represented in both sexes in the U.S. than in Puerto Rico.

With respect to education, in 1960 Puerto Ricans residing in the U.S. had 7.5 median years of school completed as compared to only 4.6 for those residing in the island, but by 1970 the figures were 8.4 for the residents of the U.S. and 6.9 for Puerto Rican residents.

In terms of rate of participation in the labor force, we find a clear decline during the decade (1960-70) for men of all ages, 65.7% in 1960 to 54.7% in 1970. As for women, the participation rate shows an increase from 20.0 to 22.9 during the same period. We find also that while the structure of the economy tends to offer more opportunities to women, migration seems to draw heavily on the groups of men who want and look for work. Comparing the behavior of both sexes during 1970 in Puerto Rico and in the United States, the U.S. group shows consistently more desire and willingness to work than the Puerto Rican group.

Also, we find that unemployment among the younger age

group is higher relative to other groups despite their lower participation rate and higher rate of out-migration to the mainland U.S. Out-migration, while it has negative effects on the skills and age structure of the population nevertheless helps in reducing the unemployment rate.

We find that education may have played a more important role than discrimination based on origin in shaping the employment of Puerto Rican workers in the U.S.

In terms of fertility rates, Puerto Ricans in Puerto Rico, especially in rural areas, show a higher rate of fertility than Puerto Ricans in the U.S. Within Puerto Rico, rural areas show a higher though declining rate of fertility relative to urban areas.

On a net basis, external migration during the 1960's seems to have had its greatest effect on the age structure of the population and the labor force of the island.

On the question of education, external migration seems to have a mild effect on the population of the island. The fertility ratio tends to differ among women in Puerto Rico and in the U.S., and especially so at older ages.

Internally, we found that the rural population is younger than the urban relatively. In terms of sex ratio defined as the number of males per 100 females, the urban sector has more females than males, while in rural areas, the ratio tends to be in favor of men. Young women are less attached than young men to farm activities. At early ages (0-14) men tend to predominate in both rural, urban and in general. At older ages (from 45 up) the balance is in favor of more men in rural areas and more women in urban areas.

Using as measure of education an index constructed from the distribution of persons of 25 years and over among the population that have completed a given level of schooling and weighting each school-year completed class by the average income that this level of education can earn for a given year we find that males show an increase of 58% from 1950 to 1970, while for females the increase is in the order of 88% for the same period.

When urban versus rural areas are considered, urban males have registered an increase of 16% relative to 12% for rural males during the period 1960-70. As for females, education has increased faster in rural areas, being 35% compared to 30% in the urban milieu. We thus infer that rural women who have decided to go to the cities have not been among the better educated.

Considering the composition of the labor force, we found that both rural and urban milieus show a clear deficiency of men aged 20-24. This group has fed the wave of external migration. Women in this bracket are better represented than men both in rural and urban areas, although they are more numerous in the rural group.

Youths of 14-19 years of age tend to be in higher proportion in rural than in urban settings and women outnumber men relatively. The group aged 35-44 has a higher proportion of men in rural than in urban areas, and likewise the rural shows a higher ratio of old men 65 and over. As for women, from 16 to 34 women are in a higher % in rural areas than in urban ones. Conversely, women aged 45-64 are in a higher proportion in cities.

In terms of the rate of participation in the labor force women exhibit a higher rate in 1970 relative to 1960, while the reverse is true for men who have dropped out of the labor force in 1970 relative to 1960. It is also to be observed that the trend of men to drop from and women to enter the labor force is much clear among "donor" and "receiver" regions than when we consider urban and rural areas in general. External migration accounts for the drop observed among men, while higher education and more employment opportunities in urban as well as in rural areas are responsible for the higher rate of female participation in the labor force.

The impact of migration on the fertility rate of rural areas is particularly substantial. In all age groups, the fertility ratio has dropped more in rural than in urban areas, especially in the age bracket 35-44.

- Statistical Test of Puerto Rican Migration

A statistical test of our model of Puerto Rican migration has been done. This test shows that the model as formulated in the text appears to explain better the migration rate of young persons from 5-9 to 20-24 years of age in 1960, particularly males. The most important variables are the "Demand for Labor Services", the "Population Index" and "Unemployment". "Income" appears important among the groups 10-14 and 15-19 years of age for both males and females. "Distance", with the right sign and significant most of the time shows rather low values. The variable "Fertility Ratio" is introduced with its actual value in 1970 and with lagged values in 1960 and 1970. However, only on its 1970

form it does show some significance, but with values so low that this variable cannot be taken to be responsible for any variation in the migration rate.

The "Educational Opportunities " variable, the "Housing Opprtunuties" variable and sometimes the "Health Opportunities" variable behave rather poorly.

"Migration Stock" or the ratio of persons born outside but residing in the "municipio" to the native population living in the "municipio", when introduced into the equation behaves in the expected way by reinforcing the role of the "Population Index" variable, while it contributes to decrease the influence of the other variables.

We observe that explicit economic considerations such as income and unemployment are the main variables explaining Puerto Rican migration. Among the other variables, a large labor market (Population Index) and the presence of friends or parents (Migration Stock) appear to affect migration most.

Agriculture

The agricultural sector has been particularly affected by the redistribution of persons as a result of external and internal migration.

It is clearly established that the traditional crops (sugar cane, coffee and tobacco) have been by the late 1960's surpassed by livestock production activities in terms of percentage of gross income derived from agriculture. However, the domestic production of

livestock has not been sufficient to satisfy local demand and there exists ample room for further development of this sector.

The index of physical volume in production of crops has decreased substantially but that the livestock has increased markedly, so that the total physical volume of production index has not varied too much from 1950 to 1970.

With regard to inputs used in agriculture, we found that land devoted to agriculture has decreased markedly, while fertilizer used per unit of land had gone up.

Labor as well has decreased sharply since 1950, due to migration of farm persons to cities. Unemployment in rural areas continues to be high, around 15% in 1970. There is a faster exodus of wage-and-salary workers than of self-employed persons from agricultural employment. The ratio of wage-and-salary workers to self-employed persons has passed from 1.84 in 1953 to 1.38 in 1973 according to the data of the Department of Labor of the Commonwealth of Puerto Rico.

In terms of age and education, the persons remaining on farms are on the average the oldest and the least educated.

Farmers as a whole are now tending to replace labor by machines, principally by capital for livestock production and machinery for sugar-cane plantations.

From 1950 to 1970, prices of modern inputs such as fertilizer and machinery have become cheaper than that of labor. Thus substi-

tution of capital for labor has taken place in Puerto Rican agriculture as labor became more expensive than capital.

In terms of farm size, we find that small farms (less than 10 cuerdas) and large farms (260 cuerdas and more) dominate the farming sector of Puerto Rico. Small farms are still using part-time and family labor while large farms rely on hired labor.

- Behavioral Model

To understand the behavior of the peasant farmer in a context of traditional agriculture we present a model where the farmer produces two commodities: food and "Z" including a composite of non-agricultural non-leisure pursuits. We argue , like Resnick and Hymer (note 13, chapter VII) that policies measures succeeding in replacing these by equivalent quality industrial goods at reasonable prices, and may induce the peasants to find ways to increase production in order to acquire the latter.

We argue also that technological change is a process by which modern inputs are offered the farmer at prices that insure returns above and over their purchasing prices. Also we argue that better communication, markets and information on better input mix are a prerequisite in the modernization of agriculture.

As a result of lower prices of modern inputs, especially inputs used in livestock production, productivity of labor and land have increased over time and more so in areas located near industrial centers

particularly in the San Juan metropolitan area where the ratio of non-farm workers to total employees is the highest in the island.

We found also that productivity of labor tends to be more associated with livestock or animal per labor and this finding is in conformity with the shift of agricultural activities from crops to livestock productions.

-Production Functions

Two production functions of the Cobb-Douglas type are estimated: one for the whole agriculture and the other for sugar cane. The function for the whole agriculture exhibits decreasing returns to scale (0.877) different from 1 at the 5% level of conventional confidence, however, by dividing the sample into regions producing mostly livestock and regions producing mainly crops, we find that returns to scale tend to approach: 1, i.e. the sum of coefficient elasticities equal to 0.9164 which can be taken to equal to : 1 at the 10% level of confidence interval, while the returns to scale of crop-producing regions are 0.883, definitely different from 1 at the 5% level of confidence interval. So there is more to be gained, given the existing technology, to increase livestock than crop production.

Another interesting finding is that Puerto Rican agriculture shows that an increase in the level of education of farmers is equivalent to an increase in the labor force. This point is in conformity with the Grilliches' findings concerning the U.S. agriculture.

The function for sugar cane reveals that land has a stronger coefficient in farms of over 100 cuerdas compared with farms of 100 cuerdas and consequently an increase in land under sugar cane cultivation will add more to production than any other factor.

Regarding returns to scale, small farms (less than 100 cuerdas in size) exhibit decreasing returns to scale, while large farms (farms of more than 100 cuerdas) show increasing returns to scale. This is a reason sufficient to encourage transformation of small farms into larger units. We also found that except for "other" inputs, land, labor and machinery show higher physical marginal productivity in large than in small farms. Nevertheless as a whole, the estimates of the function including small and large farms give, except for land, value marginal product for land, labor and machinery lower than their market price.

Regional Disparities

From the foregoing summary of the principal findings of this study and despite the record of economic growth experienced by Puerto Rico since "Operation Bootstrap" was inaugurated in 1948 and also despite the impressive movement of labor from the fields to the cities of Puerto Rico and in general from Puerto Rico to the mainland, it may be readily detected that large disparities in terms of productivity of labor and income exist across the regions of the island. Farm labor productivities, as already pointed out, is higher in regions near urban centers, where the market for factors used in agriculture works better. The question that immediately arises is: Are these regional spatial

disparities tending to increase or decrease over time? Or has the unprecedented growth known by Puerto Rico since 1948 brought any tendency to equalize the distribution of income across the island?

According to classical economic theory, over time, given that factors can move freely within a country, differentials in income per capita among regions should tend to disappear. The persistence of inequalities in terms of income distribution after modern development has been established for some time in a given country, may be due to insufficient speed and magnitude of internal factor flows to counter-balance any original conditions that have allowed resources to concentrate and develop better in certain regions than in others. Thus, in the long run and allowing for transportation costs, the classical theory predicts that per capita income will tend to equalize and that regional disparities will tend to disappear among regions when all hindrances (imperfect knowledge, lack of information etc...) to free factor mobility cease to exist.

To some writers - in particular Myrdal¹, Hirschman², - migration tending to be rather selective at least at early stages of development by drawing the young and the more educated, will contribute to accentuate the disparities among regions. It is unlikely that over time absolute differentials in the degree of regional development should ever disappear. This is the phenomenon of "pôles de croissance" observed in countries like Italy and Brazil, which are the best examples of countries having persisting disparities among their regions.

It is perhaps too early to arrive at a definite idea of

what will happen to Puerto Rico, as development began only in 1948. At this point in time we can only observe the general trend. Using an index of measurement of regional inequalities devised by Williamson³ consisting of weighing "the dispersion of the regional income per capita levels relative to national average by the share of the region to the national population", according to the formula

$$V_w = \frac{\sqrt{\sum (y_i - \bar{y})^2 \cdot f_i / n}}{\bar{y}}$$

f_i = population of the i th region

n = national population

y_i = income per capita of the i th region

$\bar{y}$ = national income per capita

we may determine whether income differentials among the regions of P.R. tend to widen or narrow by the value taken by V_w over time. The higher the value of the V_w index, the wider the size of income disparities.

The index V_w is computed for Puerto Rico as a whole and for the urban and rural sectors separately. For P.R. as a whole, we use P.R. median income, since income per capita by region or units of observation ("municipios") is not available during the two periods (1950 and 1970) considered. The formula is applied also for urban and rural regions of P.R. using median urban income and urban population for the urban sector and median rural income and rural population for the rural sector. The results are presented in Table 1.

The index shows that from 1950 to 1970, relative income

Table 1.- Indices of Regional Income Disparities in Puerto Rico,
Urban and Rural, 1960 and 1970.-

Sectors	Vw (1950)	Vw (1970)
Puerto Rico	0.620	0.450
Urban	0.224	0.164
Rural	0.544	0.791

differentials among regions for Puerto Rico as a whole have tended to narrow somewhat. However, while the gap among urban regions has tended to decrease, that of the rural sector has tended to widen.

We have already noted that the process of industrialization in P.R. has been concentrated particularly around urban centers. It is not surprising to find more uniformity in the wage differentials in urban relative to rural centers. Borts and Stein⁴ observe for the U.S. "In those regions where manufacturing occupies a small share of the labor force relative to other non-farm activities, the wage in manufacturing markedly exceeds the wage paid in these other occupations. On the other hand, where manufacturing occupies a substantial share of the labor force, the differential is narrow. Such a relation is also observed over time".

- Toward Explaining Regional Disparities

In the case of agriculture in Puerto Rico and during the period 1950-70 of general economic development, regional agriculture development shows wide disparities as evidenced by the analysis of chapter VII. There, we find that farms in the peripheries of industrial

urban centers, especially San Juan, exhibit higher growth and adaptation to the over all growth of the island than regions located in the inner mountain range. This phenomenon suggests that location is a determining factor in setting up the necessary impetus for growth. Factor markets work better near industrial-urban centers. This pattern of Puerto Rican agriculture development is in conformity with the Schultz hypothesis:

"1) Economic development occurs in a specific locational matrix ...

2) These locational matrices are primarily industrial-urban in composition.....

3) The existing economic organization works best at or near the center of a particular matrix of economic development and it also works best in those parts of agriculture which are situated favorably in relation to such a center".

Accounting for Productivity Differences

Further understanding of the factors accounting for farm labor productivity differences in Puerto Rico can be gained by using the coefficient estimates derived from our aggregate production function. Such an approach, consisting of approximating the contribution of the principal factors used in agriculture to explain output per worker differentials on an international basis, using elasticities of a Cobb-Douglas production function, has been applied by Hayami and Ruttan⁵. Both authors state that: "The percentage difference in output per worker can be expressed as the sum of percentage differences in conventional and non-conventional factor inputs per worker, weighted by their respective production elasticities".

Based on the coefficient values derived from the aggregate production function and noting the decreasing characteristics of its returns to scale, we assign the following elasticities to the inputs used: Land: 0.10; Capital-Livestock: 0.21; Capital-Machine: 0.50; Other: 0.27 and Education: 0.25 giving a sum of 0.88 differently significant from 1 at 5% level of confidence interval. We form the equation:

$$\frac{Y_h - Y_l}{Y_h} = \frac{0.10(A_h - A_l)}{A_h} + \frac{0.21(S_h - S_l)}{S_h} + \frac{0.05(M_h - M_l)}{M_h} + \frac{0.27(O_h - O_l)}{O_h} + \frac{0.25(E_h - E_l)}{E_h}, \text{ where}$$

Y, A, S, M, O and E are respectively output, land, K-Livestock, K-Machine, Other and Education per worker for high (h) and low (l) productivity "municipios".

The comparison is based on nine "municipios" having the highest output per worker and then "municipios" having the lowest output per worker. Table II compiles the figures for outputs and inputs per worker from the data used in the aggregate production function.

The percentage contribution of each input in the explanation of the differences in output per worker in the two sets of regions is presented in Table III, column 1. The figures, converted into an index taking the percentage difference in output per worker equal to 100, are presented in column 2.

The variables used in the aggregate production function account for 78% of farm output per worker between the highest productive regions, located near the urban industrial center of San Juan SMSA and

Table II.- Output and Inputs per Agricultural Worker. Nine Highest and Ten Lowest Output per worker Municipios (Puerto Rico, 1970)

<u>Highest Q/L</u>	Q/L	K-mach/L	K-Livest/L	Land/L	Other/L	Education/L
Aibonito	33.2	3.00	1.90	20.9	2.89	23.5
Caguas	23.9	5.00	1.44	11.0	4.76	32.0
Carolina	22.2	2.20	1.32	11.0	5.23	47.5
Ceiba	25.5	1.97	1.26	28.1	5.45	37.0
Hatillo	32.9	0.73	1.68	6.3	4.06	14.8
Juncos	26.1	2.00	1.34	16.3	6.40	15.7
Luquillo	25.8	0.80	1.29	10.8	4.09	19.5
Trujillo Alto	28.9	0.28	1.38	22.1	3.55	30.1
Vega Alta	23.3	0.80	1.45	22.8	6.25	17.2
<u>Mean</u>	26.9	1.10	1.45	16.6	4.74	26.4
<u>Lowest Q/L</u>						
Adjuntas	8.4	0.60	0.110	6.5	1.18	13.6
Aguada	8.4	1.70	0.030	5.6	1.62	13.6
Anasco	8.8	1.70	0.020	7.6	2.53	17.6
Fajardo	1.5	0.31	0.028	0.78	0.62	31.1
Lares	6.5	0.53	0.025	3.8	1.13	13.7
Las Marias	9.3	0.60	0.070	6.9	1.91	8.9
Maricao	7.9	0.31	0.050	5.5	1.79	15.3
Moca	8.0	1.53	0.080	3.6	1.81	11.8
Orocovis	8.2	0.25	0.030	5.4	1.46	11.7
Utua	6.7	0.53	0.060	7.3	1.76	12.8
<u>Mean</u>	7.4	0.84	0.098	5.3	1.59	15.8

the lowest productive regions situated in the inner mountainous regions. It is interesting to note that education embodied in the worker accounts for almost 15%, a higher percentage than that contributed by either land and machinery. Modern inputs: capital-animal and inputs such as seeds, pesticides, weed killers etc. account for more than 50% of the total

Table 111.- Percentage Differences in Labor Productivity as Explained by Percentage Differences in Input Variables Between Highest and Lowest Productivity Regions Weighted by Production Elasticities.-

Difference in Output per Worker (%)	72.2	100.0
Percentage of Difference Explained: Total	56.3	78.0
Land	6.8	9.4
K-Livestock	19.6	27.1
K-Machine	1.2	1.6
Other	17.9	24.8
Education	11.0	14.9

variation in output per worker among the two sets of regions.

While the comparison presented here considers the highest and lowest productive regions, it can be safely inferred that these inputs must account for substantial differences in labor productivity among regions of the rest of the economy.

Policy Recommendations

-Migration

Rapid industrialization and the growth of real output experienced by Puerto Rico since 1950 have clearly not been able to provide enough jobs to keep Puerto Ricans at home. As of 1970, external migration continues to draw heavily on the people of working age, i.e. young Puerto Ricans. It is clear that the policy of the Commonwealth

Government has been so far directed at targets such as high output, high productivity, and low cost, in order to attract manufacturing to the island, rather than in a clear policy to provide jobs for its citizens. Indeed, external migration is encouraged by persons in charge of Puerto Rican affairs, as little has been done to counteract the unfavorable demographic effects of out-migration on the age structure of the population and on its labor force.

- Job Creation

The task of creating enough jobs for a growing population and at the same time insuring wages commensurate with the overall economic progress is not an easy one. Industrial wages have been forced up partly by pressure from mainland unions and partly by deliberate governmental policy instituting minimum wage laws. As a result, firms have been induced to economize on labor and use of more capital. Thus, as unemployment grows, the drive to out-migrate becomes irresistible.

In the short run the possibility for the economy to create jobs in order to ease the demographic impact of out-migration may not seem to be too promising. As the economy grows, new skills and higher education are required and those left behind because of lack of skills can never be absorbed by the economy unless they are provided with welfare assistance or encouraged to emigrate.

But in the long run and for future development Puerto Rico should look with greater caution at external migration as a means of alleviating its unemployment problem. The outflow and inflow of

migrants from the U.S. to P.R. and vice versa depends on the economic conditions existing in the United States, particularly the unemployment level. Since Puerto Rico has no control over what may happen to the economic conditions of the U.S., it cannot rely indefinitely on this "escape valve"

-Population Growth

The answer to this question seems to lie in the control of population growth. Puerto Rico still has in 1971 an unchanged crude rate of natural increase relative to 1940, i.e. 20.8 per 1,000 population. It is true that the crude birth rate has decreased from 1940 to 1971, from 39.0 to 27.0 births per 1,000 population, but the death rate has meanwhile decreased from 18.2 in 1940 to 6.7 in 1971.

Population growth is faster in rural than in urban areas. Jobs in rural areas are more difficult as agriculture is being modernized and sugar cane production is declining. It is therefore to rural areas that the policy of encouraging family limitation should be directed. We have already pointed out that children in rural areas entail less costs than children in urban areas. Moreover, in rural areas children start to be productive at an early age. It pays thus to rural families to enlarge their families. The question should be then to find ways to increase the costs of having children in rural areas. For example, imposing and enforcing laws to make attendance at school obligatory for rural children until a more advanced age than the age at which they have to remain at school now, could be implemented. The possibil-

ity of an educational program dealing with family limitation specially designed for adult rural women in rural remote areas should be conducted with the same determination as the "Operation Bootstrap" was undertaken.

Perhaps one might object that knowledge of birth-control techniques is already widespread in P.R., but it is doubtful this knowledge and the necessary education extend to those remote rural areas which are the most potent source of population growth in Puerto Rico.

-Industrial Location

The second problem facing today's Puerto Rico is wide disparity in the distribution of industries across the island. Industries have a clear preference for locating around San Juan. The policy of the Commonwealth Government has been so far to use incentives provided by tax-exemption to encourage new firms to locate outside the San Juan area and stabilize the exodus of rural population towards San Juan. This does seem to have been enough. Firms are also interested in regions where skilled labor is in ample supply. Therefore, while extra financial incentives should continue to be used as a means to induce firms to locate in rural areas, expansion of vocational training and educational programs to upgrade the skills of rural youths should be extended to those areas where unemployment rates are higher and agricultural employment is falling faster.

Agriculture

Policy measures towards agriculture will consider the

farming sector in general and sugar cane production in particular.

- Aggregate Agriculture

For agriculture in general measures should be geared towards increasing production of livestock and livestock products since a large part of the local market is supplied by imports of these products. Moreover the per capita income level of Puerto Rico has reached a level sufficient to insure continuing demand of high quality and better-diet foods.

This goal could be achieved by providing credit facilities for capital investment to farmers who demonstrate ability and competence in those fields of farming.

Educational services to provide the necessary skills in livestock raising to farmers who are willing to shift from traditional crops to more modern enterprises should be extended.

In mountainous areas where the possibility of livestock raising exists, but location is an impediment, road and communication should be organized to aid farmers who are willing to engage and apply modern techniques in farming production.

Meanwhile the general education system should include incentives or grants to farmer's sons or rural youths to undertake agricultural studies in order to be prepared to become farm managers. At the completion of these studies these youths could be given financial facilities to acquire farms left idle because of the retirement or mi-

gration of their owners.

- Sugar Cane

With respect to sugar cane, policies to re-inviolate this sector are imperative since this sector can provide good relief for the rural unemployment problem.

Measures to improve the use of land and labor resources could include: 1) higher land taxation for land suitable for sugar cane production but left idle; 2) special credit facilities to encourage ownership of land and modernization of farms; 3) changes in the minimum-wage laws affecting this sector; 4) training program in the field of maintenance, repair and operation of machinery and equipment used in the sugar-cane plantations; 5) guidance to farmers to regroup themselves into cooperatives for the acquisition and use of machinery and equipment.

1) Land taxation can be viewed as a stimulus to bring land left idle under cultivation. The tax rate will be based on effective use of land. A higher rate would be charged for land left idle. This measure will coerce owners of unused land to offer their land for rent or sale to farmers who are willing to put the land under cultivation.

The tax incentive could be used also to promote or encourage farmers to enlarge their small farms. As we have seen previously, the elasticity coefficient of land is higher for large farms (farms of more than 100 cuerdas) relative to small farms (farms of less than 100 cuerdas), therefore an increase in farm size into farms of at least more

than 100 cuerdas will add more per cuerda to total production than small farms. A flat tax base could be levied against farms of less than 100 cuerdas or more, up to a given minimum.

2) An alternative to the tax incentive policy to increase land use would be to provide special credit facilities for the acquisition of land and capital investment by new owners. These credits should be accorded to farmers who decide to buy single farms of more than 100 cuerdas or neighboring small farms of less than 100 cuerdas in order to consolidate these with their own holdings. The inconvenience of such a policy is that as more farmers decide to take advantage of credit facilities to acquire land, land prices would tend to go up and this might impair the effectiveness of the measure.

3) Minimum-wage laws tend to deter the full use of labor available on farms. As labor costs rise with respect to cost of capital or product prices, farmers tend to substitute capital for labor or reduce output. There follows, in the short run, a general decrease in production. As minimum-wage laws are eliminated, there exists the possibility for employment on farms to increase. It is true that a responsible government interested in the welfare of farm workers cannot accept that farm wages to fall too drastically relative to industrial wages. If the elimination of minimum wage laws leads to a widening of the gap between industrial and farm workers, the government can find means to increase farm income by providing subsidies to farm workers.

If the elimination of minimum-wage laws lowers labor costs relative to capital, there may follow a slowing of the process of mechanization of sugar-cane farming. In this case it would be necessary to

consider the application of more flexible measures such as lowering of interest rates to keep the ratio of labor cost to capital investment within certain limits so that no losses of incentives to mechanize ensue.

4) The process of mechanization of farms particularly sugar-cane farms requires trained and skilled operators to operate, maintain and repair the new machinery and equipment. It is recognized that one of the most crucial impediments in mechanization of sugar-cane farms in Puerto Rico is the lack of skilled operators. The giving of incentives to rural youths to engage in such a field would be richly rewarding. Their training could include also other tasks in order to insure that the operator could do other jobs in between seasons.

5) The organization of farmers, particularly those who own medium-size farms, to group themselves into cooperatives might increase efficiency in the use of machinery and equipment. The cooperatives would regroup farmers of given regions and would be organized to take care of the purchase and maintenance of heavy equipment. We have already pointed out that current machines used in the harvesting of sugar-cane have a relatively high cost and necessitate modifications to adapt them to the particular conditions of different regions. Local cooperatives could better bear the cost of these machines and proceed to undertake particular modifications that best suit their regions. This formula would reduce the unit cost to farmers of use of the machines.

Conclusion

Implementation of such measures will tend to increase

production and improve the use of farm resources including farm labor towards more efficiency. However, they involve costs and the critical question is whether the government is interested in increasing production and stabilizing the exodus of rural population by providing more jobs in rural areas, or whether prefers to rely on the traditional policy of outmigration to give employment to its citizens. The costs involved in the full implementation of these measures are certainly less than the opportunity cost of wasting human resources in the form of unemployment in cities, lower agricultural production and the emigration of the younger and healthier of the population.

FOOTNOTES, CHAPTER IX

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- (2) Hirssman, A.O.: The Strategy of Economic Development, Yale University Press, New Haven Conn. (1958) chap. 10
- (3) Williamson J.G. "Regional Inequality and the Process of National Development: A Description of the Patterns", Economic Development and Cultural change, volume 13 (1965) pp. 3-45
- (4) Borts G.H., Stein J.L. "Regional Growth and Maturity in the United States: A Study of Regional Structural change". in Regional Analysis, ed by L. Needleman p. 159-197
- (5) Hayami Yuyiro and Ruttan W. Vernon: Agriculture Development: An International Perspective, The Johns Hopkins Press, p. 96-98

APPENDIX

Computation of Survival Ratios using Model Life Table

Migration rates in this study is computed by applying the "method of survival ratios". "Survival ratios", for a given population, is a demographic ratio that expresses for a given age-group the proportion of persons, among those who survive to a given age, who live on and reach the next age level. "Survival ratios" are not available for Puerto Rico during the period 1960-1970. They must therefore be computed.

The statistics necessary to carry out these computations are the specific death rates for the various age groups considered in our study. Death rates are not given by official statistics of Puerto Rico. We do have statistics of deaths by age and sex corresponding to the years 1961 to 1966 and 1970 published by the United Nations Demographic Year Book, 1966 and 1971, Tables 31 and 31 p. 376-377 and 708-709 respectively. The Puerto Rican Department of Health, Division of Demographic Registry and Vital Statistic publishes in Anuario del Estadistico, Junta de Planificacion, 1968 data on death by age and sex for the years 1960, 1967 and 1968 and 1969. Finally, the U.S. Census on Puerto Rico gives statistics on population by age and sex for 1960 and 1970.

Owing to external migration taking place during the decade 1960-1970, average population 1960-70, is adjusted to restrict the results obtained (specific death rates) to persons born in Puerto Rico. An example of the way the computation of the average specific death rate during the period 1960-70 is shown in Table A-1 for male. Similar computations are made for female.

Table A-1 Computation of Average Specific Death rate, Male

Age-Group	1960 Popu-lation	1970 Popu-lation	Mean 1960-1970	Yearly average net mi-gration	Cor-rected mean popu-lation 60-70	Mean death attri-buted to cohort 60-70	Average specific death rate per 1,000
0-4	179,619	161,296	170,457	- 6217	164,240	934	5.7
5-9	165,930	171,035	168,482	- 5297	163,185	110	0.7
10-14	162,244	169,789	166,016	- 4172	161,844	105	0.6
15-19	122,602	143,806	133,204	-18919	114,285	172	1.5
20-24	79,792	108,077	93,934	- 4613	89,321	187	2.1
25-29	61,971	84,729	73,350	3701	77,051	170	2.2
30-34	58,723	73,492	66,107	5995	72,102	175	2.4
35-39	61,592	68,187	64,889	3912	68,801	226	3.3
40-44	53,087	61,530	57,308	8064	65,372	282	3.5
45-49	53,781	59,437	56,609	3238	59,847	367	6.1
50-54	39,832	53,032	46,432	5525	51,957	486	9.3
55-59	34,404	49,156	41,780	- 451	41,329	559	13.5
60-64	29,095	40,673	34,884	69	34,923	680	19.5
65-69	24,525	32,914	28,719	1163	29,882	831	27.8
70-74	16,370	21,845	19,107	231	19,338	850	43.9
75 & over	19,197	30,951	25,074	69	25,143	2579	102.6

From these estimated specific death rates, survival ratios are derived for male and female by age-group according to Tables I and II of the Manuals on Methods of Estimating Population, Manual III, Methods for Population Projections by Sex and Age; United Nations, ST/SOA Series A, Population Studies, No. 25. The derived "survival ratios" are presented in Table A-2. Where a "survival ratio" is needed for a larger age-group (25-34 for example) the "survival ratio" is taken as the weighted

Table A-2.- Estimates of Survival Ratio with the use of Model Life Tables, 1960-1970, Puerto Rico

Age-Group	Male		Female	
	Average Specific death rates per 1,000	Survival ratio	Average Specific death rates per 1,000	Survival ratio
0-4	5.7	0.9582	2.3	0.9758
5-9	0.7	0.9966	0.5	0.9977
10-14	0.6	0.9949	0.4	0.9972
15-19	1.5	0.9931	0.7	0.9960
20-24	2.1	0.9893	0.9	0.9950
25-29	2.2	0.9886	1.0	0.9942
30-34	2.4	0.9861	1.2	0.9941
35-39	3.3	0.9832	1.9	0.9909
40-44	3.5	0.9764	2.7	0.9844
45-49	6.1	0.9625	3.6	0.9780
50-54	9.3	0.9445	5.3	0.9672
55-59	13.5	0.9208	8.1	0.9496
60-64	19.5	0.8890	12.5	0.9196
65-69	27.8	0.8335	19.5	0.8668
70-74	43.9	0.7066	31.9	0.7548
75 & over	102.6	0.4279	85.1	0.4721

arithmetic mean of the smaller age group (25-29 and 30-34), the weight being the corresponding population of the age group considered.

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