1. SUBJECT CLASSI- FICATION	A. PRIMARY	
	Development and economics	DA00-0000-G339
	B. SECONDARY	
	General--Puerto Rico	

2. TITLE AND SUBTITLE
Employment, growth, and income distribution in Puerto Rico; a re-evaluation

3. AUTHOR(S)
Weisskoff,Richard

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1972	55p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Yale

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT
(EMPLOYMENT R&D)
(ECONOMICS R&D)

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAE-591	

12. DESCRIPTORS	13. PROJECT NUMBER
Puerto Rico	
Employment	14. CONTRACT NUMBER
Growth	CSD-2492 Res.
Income distribution	15. TYPE OF DOCUMENT

NOT FOR QUOTATION

EMPLOYMENT, GROWTH, AND INCOME DISTRIBUTION IN PUERTO RICO:

A RE-EVALUATION

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PUERTO RICO: THE PATH OF EXPORT DEVELOPMENT

I. Introduction - Background Discussion and Speculation

Puerto Rico's development scheme, generally known as Operation
Bootstrap, represents the prototypical case of export promotion as the
path to development. After an initial attempt at building and operating
its own factories had proved a failure in the late 1940's, the Puerto Rican
government opted for a strategy of attracting branches of American com-
panies in order to overcome the Island's poverty. Rising incomes of the
Wartime period were then to be sustained in a two stage program. First,
Puerto Rico would provide social capital and infrastructure; secondly,
"guest companies" would be lured into locating in the industrial sites.
The set of incentives which were developed in the industrial promotion
efforts have since become the "standard" devices for other low-income regions
of the U.S. and for other countries which seek industrialization as the
path to development. The specific incentives offered to American industry
include a series of promotional devices such as tax exemptions, training
grants, and favorable land rental and utility rates, not to mention the
island's "natural" advantage of lower wage rates relative to the mainland
labor force.

By one set of standards, the efforts to industrialize have been
remarkably successful: capital has flowed into Puerto Rico; over 1,700
factories have been built under the promotion schemes, and a stable, produc-
tive working force has been created. (See Reynolds and Gregory, 1964;
Waggenheim, 1970.) All forms of public services have expanded; port and

transportation facilities have improved; the retail network modernized relative to the inefficient marketing system of the early 1950's. (See Galbraith and Holton, 1955.) The tourist industry has been sucessfully developed, giving an impulse both to large-scale construction and to a permanent service sector. Despite these efforts to keep incomes rising and to develop through export-oriented industrialization, the total number of positions created as a result of the rising incomes has been disappointing. The neglect of the agricultural sector, especially in sugar cane, tobacco, and coffee, has led to the outmigration of large numbers of people who could not be absorbed into the expanding industrial sector. At the same time the industrial promoters were actively devising methods for attracting new industrial capital and increased industrial employment by 90,000 between 1950 and 1970, the agricultural sector -- which accounted for nearly half the labor force in 1950 -- was releasing over 140,000 workers.

In this endeavor, we contradict some elements in conventional wisdom on the subject on the "recomposition" of the Puerto Rican labor force. Reynolds and Gregory (1964) suggest that workers engaged in home needlework merely "left" the labor force when the industry departed from Puerto Rico. This is the explanation given for the leveling off of the female participation rate with the introduction of factories. Reynolds and Gregory furthermore suggest that with the rising male wages, women worked less, job expectations of males increased as factory work was provided, and rural workers merely withdrew their labor at low agricultural rates for seasonal migration in the U.S.

We are suggesting that these explanations underestimate the importance of multiple sources of family income. In the pre-war economy, low agricultural wages had been supplemented with household earnings from needlework.

With the demise of the needlework industry and the slow decline of agriculture, the delicate balance of family income was replaced partially by limited, high wage factory employment in other parts of the country. Families of advanced age and non-transferable skills suffered declines in employment, forcing further migration of mobile members. Thus the success of "promoted" industry and of government construction programs gave rise to the illusion of rising real incomes for the employed as the declining rural sectors vented their manpower. The growing standard of living of those employed in the industrial sector of Puerto Rico contrasts with the relative impoverishment of those for whom the employment in "growing" island economy was withdrawn.

Reynolds and Gregory hypothesize that "The main reason for the labor force decline was emigration, with its effects on age and sex distribution of the island." (p. 32) Yet such statements beg the entire question of the mechanism which propelled the emigration, and at the same time, brought about the absolute decline in earnings due to the stifling of certain types of domestic opportunities. The hypothesis that fewer workers would accept a minimal wage for service or agricultural activities may have been true as long as channels to mainland opportunities were opened as alternatives and as urban wages rose. However, the withdrawal of agricultural units from production then released increasing numbers of workers, who were unwilling or unable to accept lower wage rates and who found no alternative jobs created for them in the island economy.

The point here is an historical one. The sugar and tobacco plantations had been developed on the basis of low wages relative to the mainland, and a set of institutional arrangements by which the crop was profitable, the land intensively farmed, and labor extensively used. When, within a decade,

these activities no longer proved profitable, one is impelled to ask what were the specific policies which brought about the change and how they could have been altered in order to preserve domestic employment.

I suspect the answer to this line of inquiry lies in the adoption of what then was the prevailing strategy of development. Industry was brought in on a laissez-faire basis with the state having minimal interference. At the same time, the decision had apparently been made to forego an intensive program for tropical agriculture, the basic economic activity which had been responsible for the generation of wealth and poverty in the past, and which had supported the dense population of the island.

A major political decision had actually been taken: rather than face a reform of the sugar plantations head-on by changing tenure arrangements or by substituting cane with vegetables or citrus fruits, new industry was sought which would not disturb the traditional sectors. Thus the political impasse was sustained, the U.S.-owned sugar companies were not antagonized, and the industry faced a "natural" decline in the absence of more active intervention.

This course of development -- the seeking of industrialization rather than agricultural reform -- amounts to backing away from a revolution rather than the "administration of the revolution," (Goodsell, 1969). The decision, then, resulted in a shift in the mode of production from a rural to an urban proletariat (see Mintz, 1966) while retaining the similar objective of production for export to mainland markets. With this change from land extensive to mechanical factories, the scale of productive units was reduced, altering the competitive position for collective bargaining under the tripartite arrangement, and left the government and public more influential forces for sustaining wage increases.

We thus encounter a major contradiction between income maintenance and job maintenance. In a society in which work itself is taken as the most important factor in the determination of each individual's position in society, it is not enough to say that "per capita income" has risen substantially while employment has barely advanced with population increases. The ability of the unemployed and of those outside the labor force to support themselves through extended family ties or transfers from other regions of the U.S. may be indicative of the divergence between the success of the industrialization and the actual historical process of employment displacement. Since the inability of the economy to provide employment opportunities undoubtedly affects intergeneration mobility and access to public services, it is crucial for us to investigate the sources and causes of job destruction during the process of income creation. It is this task to which we now turn.

II. Activities

A. Overall View -- Summary

The overall set of activities comprehended three major fields of endeavor in this study of Puerto Rican industrialization. The first involved the design and specification of a multi-sectoral model of the Puerto Rican economy. The design of the model required that bodies of data from the pre and post industrialization process be examined in order to capture the fullest detail in the growth model. While annual time series data are available for a large number of aggregate variables, it was decided to emphasize a model in which employment creation at the level of specific skills and occupations could be included for various points during the development process. Thus, the overall goal of the multi-sectoral model was to trace out the sources of job displacement and creation specifically by sector, occupation, and sex, during the process of rapid economic growth. [See Appendix I for a detailed methodology.]

The second field of endeavor was the empirical study of economic change in the fields of manpower and technology in Puerto Rico. These studies included first, the measurement of the comparative job needs a decade apart and the application of a methodology for evaluating job creation; and second, was the comparative study of two inter-industry tables which reveal the full growth and complexity of the industrializing economy. In these inter-industry comparisons, several hypotheses which had been suggested from similar studies of European countries can be examined in light of this particular process. We are seeking to identify the "webs" of specific industries relying on each other and testing the hypothesis that export-led growth may be inhibited in an open economy in which the key industries are

maintained by intermediate imports to the neglect of a strong domestic foundation. (See chapter II of the Progress Report for triangulation and evaluation of input-output tables for 1948 and 1963.)

The third major activity involved in this research endeavor involved the testing of alternative paths and variations on the growth of the Puerto Rican economy. Based on the structure of the Puerto Rican economy in 1963, we proceed to ask a number of counter-historical and projective questions which embody alternative approaches to development. The first path is the continued growth of the export-oriented economy through 1980, altering the gains of productivity. A second major path involves the imposition, by fiat of a strategy of import substitution of several magnitudes. One plan requires that direct consumer goods be produced at home. The second plan requires that intermediate goods used as raw materials for other industries also be produced locally, leaving only basic materials to be imported as inputs. Since Puerto Rico is within the U.S. tariff area, such import substituting industrialization (ISI) schemes could be implemented through a policy of excise taxes and subsidies. The major output of the model through these development strategies emphasizes employment by specific occupational groups generated by the alternative paths. By how much can national income grow when a greater restrictiveness is placed on the openness of the economy?

The third set of counter-factual propositions deals with a number of hypotheses concerning the effect of the redistribution of personal income on economic growth. Both conventional wisdom and a number of economic studies of Latin American countries (Cline on Mexico, Argentina and Venezuela, 1971; Morley and Smith on Brazil, 1971) have suggested that the redistribution of

income of the lower classes might retard growth or at best, have a neutral effect on the economy. The major experiment performed here includes three variations. First, the entire national income is allocated to a certain "standard" consumption characteristic of the middle or average income class. Then two extremes are attempted: the "poorest" consumption pattern is imposed on the nation, then the particular income expenditure pattern of the upper most class is "imposed" as the national norm. In this way, the domestic multiplier effect of particular patterns of demand are evaluated in terms of the national economy.

B. The Characteristics of the Model

The model developed in this research is a variation on conventional comparative static framework typical of input-output analysis. The basic methodology involved the comparison of two thirty-three-order input-output tables, developed for 1948 and 1963 independently. These tables have been extended in such a way as the income flowing to families is distributed by the size of income, attributing family income to the sector of employment of the head of the household. That row which normally appears as a single entry entitled "value added" in conventional input-output analysis has here been extended to include 15 different income classes.

The second major innovation of the model is to incorporate the consumption pattern of each income class specifically in the model. Thus, the result of redistributing income could be fully reflected in alteration in the national composition of demand by these different income weights.

Other models of this type have either incompletely specified the breakdown of consumption for each income class or have tended to apportion

the industrial composition of broad groups of consumer purchases. It is
the uniqueness of this model and of the basic detail of the Puerto Rican
data which has allowed us to convert budget studies of individual family
expenditures into commodity and industrial breakdowns which correspond
directly to the inter-industry structure. It is hoped that with the degree
of accuracy and precision in the estimating procedure and in the inicial
data that this model could capture the full effects of changes in consumption
patterns and in the standard of living on the domestic economy. A major
effort was devoted to the processing of the household expenditure survey
in pursuit of this accuracy.

III. Results

A. Historical Model of the Limits of Job Creation

A brief glance at the magnitude of change between 1953 and 1963 in the economy gives us some idea of the limits of the industrialization as a path of development. In this analysis we shall attempt to attribute the weakness of job creation to several distinct sources in order to trace the influence of each. A technique is employed in which the two complete economies for 1953 and 1963 are constructed in constant prices. For each year, the manpower structure, size distribution of income, input-output flows, and vectors of final demands are brought together in a static accounting framework. Each of these "elements" for the later year will be substituted into the model for the earlier, pre-industrial economy, and the change in employment and income "accounted" by the hypothesized substitutions will be estimated.[1] (See Appendix III for detailed methodology.) In comparing the two economies for 1953 and 1963 in Table 1, we note that total employment (line 19) has increased by only 10% during the decade, although considerable change has been experienced in the composition of that labor force. Most striking is the decline of male farm managers and laborers (lines 2 and 8) included within the broader classes, the rise of clerical, sales and craftswomen, as well as the decline in female operatives, service, and laborers. Points of cumulated percentages of families (lines 21-35) and their corresponding income (lines 36-50) are summarized by the Kuznets and Gini ratios (lines 51 and 52), which both indicate increasing concentration of

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[1]This is an exercise popularized in the economic history literature, for example, in an evaluation of the impact of the decline of British exports at the turn of the 19th century on the industrial structure (see Conrad and Meyer, 1964). Also, these techniques are used in study of U.S. technological change (see A. Carter, 1970) in evaluating the hypothetical material input requirements under changing levels of final demand.

family income.

How much more employment could have been generated had the economic structure been "frozen" at its 1953 levels of efficiency and inter-industry structures, but produced enough to meet the 1963 level of final demand? In effect, we are asking that the "old" pre-industrialized economy deliver the level and mix of output demanded in a later decade, as if technological change and productivity had been prohibited. We find (col. 3) that total employment would have risen from 548,499 to 1,006,440 due to a straight forward increase due to changed in level and composition characteristic of the 1963 demand. Female employment would have increased due especially to the operative category. It is interesting to note that with the 1953 productivity levels far fewer female clerical and saleswomen would have been employed in order to produce the 1963 basket of goods. (lines 12 and 13, col. 1 and 3).

The second experiment (col. 4) assumes that the manpower efficiency of 1953 is still frozen, say, by a rigid work rules, but that inter-industry structure advances to 1963 levels. This is a situation of partial technological transformation and growth to meet the 1963 basket of final demands. Total employment is reduced, suggesting that changes in the input-output structure account for a 10% reduction in "potential" employment from the "straight growth" solution. The fourth step in which 1963 technology, productivity and final demand is represented at the 1963 levels is the actual economy. In summary, the step-wise substitution of "pieces" of the 1963 economy allow us to separate the differential impact of "modernization" in the three segments of the economy. The higher overall employment under the "straight growth" case highlights the "potential" employability which,

in some sense, could have sustained a larger island population.

How much reduction in employment was due to changes in productivity alone? At 1953 levels and mix of output (col. 5) 1963 levels of productivity would have resulted in a 20% decline of employment and a further increase in male over female opportunity. This last experiment is a mirror of column 4, the previous experiment which applied 1963 input-output technology and growth to 1953 productivity. These two simulations give us the full range of the impact on employment of the changing productivity. They give us a precise accounting of the cost of modernizing: that new factories without growth would have cut employment by half over levels of growth without productivity increases. Yet it is through growth that the new technology became injected into the labor intensive economy.

In the next section, we shall examine the impact of productivity change specifically by sector and occupation.

COLUMN	1	2	3	4	5
	(63 ACT)	(53 ACT)	(53TYM(3D)	(53YM53TD)	(53TC63YM)
ROW					
1-PROFLMEN	24782.992	15226.094	30743.954	28780.434	14655.215
2-MANGEMEN	64016.723	67219.000	99139.562	93232.312	46647.828
3-CLERCMEN	29631.297	13823.500	35502.655	29643.129	19347.367
4-SALESMEN	42560.910	34321.406	42710.344	53972.914	27405.501
5-CRAFTMEN	80925.746	47110.969	125032.437	85133.250	35527.152
6-OPERVMEN	63267.453	48250.445	97691.062	81426.812	39049.004
7-SERVCMEN	31116.684	22711.328	46803.598	44698.367	19034.414
8-LABORMEN	145214.937	155597.437	252465.125	183648.937	126985.437
9-NRPTCMEN	4210.664	3402.233	6243.332	5292.477	2853.217
10-PROFLWOM	17245.574	10424.980	22307.324	26150.937	7859.914
11-MANGEWOM	6795.914	4688.117	7340.973	7717.609	4249.117
12-CLERCWOM	30790.016	16097.746	29872.652	25918.715	20128.730
13-SALESWOM	8991.855	4945.316	6039.887	7866.992	5630.969
14-CRAFTWOM	2205.150	673.417	1559.612	1155.326	1373.717
15-OPERVWOM	42097.836	58774.680	125792.250	93182.875	26070.586
16-SERVCWOM	25880.438	30894.180	68081.187	82241.875	10333.844
17-LABORWOM	2464.651	3307.032	5317.234	4084.612	2149.157
18-NRPTCWOM	3964.456	2002.001	3678.510	3136.926	2673.629
19-TOTAL	606159.562	548490.375	1006440.875	856284.562	411976.625
20-MEN/WOMN	3.316	3.161	2.727	2.405	4.119
21-PERS-1	0.108	0.060	0.062	0.075	0.134
22-PERS-2	0.373	0.200	0.195	0.285	0.405
23-PERS-3	0.556	0.348	0.338	0.494	0.581
24-PERS-4	0.664	0.742	0.736	0.879	0.685
25-PERS-5	0.749	0.939	0.938	0.978	0.769
26-PERS-6	0.803	0.973	0.972	0.990	0.822
27-PERS-7	0.876	0.984	0.984	0.993	0.886
28-PERS-8	0.919	0.995	0.995	0.999	0.925
29-PERS-9	0.948	1.000	1.000	1.000	0.951
30-PERS-10	0.962	1.000	1.000	1.000	0.965
31-PERS-11	0.974	1.000	1.000	1.000	0.976
32-PERS-12	0.981	1.000	1.000	1.000	0.983
33-PERS-13	0.985	1.000	1.000	1.000	0.987
34-PERS-14	0.991	1.000	1.000	1.000	0.991
35-PERS-15	1.000	1.000	1.000	1.000	1.000
36-INC-1	0.020	0.011	0.011	0.019	0.027
37-INC-2	0.115	0.057	0.054	0.115	0.128
38-INC-3	0.220	0.123	0.117	0.246	0.234
39-INC-4	0.307	0.413	0.405	0.644	0.324
40-INC-5	0.397	0.718	0.714	0.859	0.416
41-INC-6	0.466	0.825	0.817	0.910	0.487
42-INC-7	0.584	0.871	0.869	0.928	0.597
43-INC-8	0.672	0.942	0.938	0.974	0.683
44-INC-9	0.746	1.000	1.000	1.000	0.752
45-INC-10	0.790	1.000	1.000	1.000	0.796
46-INC-11	0.831	1.000	1.000	1.000	0.836
47-INC-12	0.858	1.000	1.000	1.000	0.863
48-INC-13	0.876	1.000	1.000	1.000	0.882
49-INC-14	0.904	1.000	1.000	1.000	0.908
50-INC-15	1.000	1.000	1.000	1.000	1.000
51-KUZNETS	71.292	65.791	66.028	49.455	72.284
52-GINI	0.466	0.429	0.430	0.363	0.471

Guide to Matrix E, "Manpower & Income Distribution Comparison for 1953 and 1963"

rows 1-18:   Occupational types for men and women: professionals, managerial,
              clerical, sales, crafts, operatives, service, laborers, & "not reporte

row 19:   Total employment.

row 20:   Ratio of male/female employment.

rows 21-35:   The share of persons in each of the income classes.

rows 36-50:   The share of income received by each of the income classes, cumulated.

              Thus, rows 21-50 give the information for plotting the Lorenz curve
              for income distributions. The Lorenz curve is summarized in the
              following summary measures:

row 51:   Kuznets coefficient is the sum of the absolute differences of the
              shares of income and the shares of families receiving the corresponding
              income share. The coefficient ranges from 0 for perfect equality to 2.0(

row 52:   Gini ratio, ranging from "0" for perfect equality to "1" for maximum
              inequality

COLUMNS:

1:            Indicates the employment and income distribution for the economy in 1963.

2:            Indicates results for the 1953 economy.

3:            Indicates results for (T)   1953 Technology (input-output table)
                                   (M)   1953 Manpower (labor coefficients)
                                   (Y)   1953 Income Distribution
                                   (D)   given 1963 level and composition of Final
                                         Demand.

4:            Indicates results for 1953 Income Distribution   (Y)
                                    1953 Manpower   (M)
                                    given technology   (T) in the input-output
                                                                    table
                                    1963 Demand   (D)

5:            Indicates results for 1953 Technology   (T)
                                    1953 Demand   (D)
                                    given 1963 Income Distribution (Y)
                                    1963 Manpower   (M)

Column codes: T   inter-industry technology.
                Y   income distribution to families by sector.
                M   manpower coefficients: full-time employees per output by sector
                    and occupation
                D   demand by sector for consumption, investment, government, etc.

B. Productivity Changes During Industrialization

1953-1963 Manpower Comparisons:

The impact of industrialization is distinctly demonstrated
in changes in manpower utilization. We hypothesize increasing productivity
of the labor force, as demonstrated by a change in the occupation distri-
bution of the labor force as a shift toward higher skill levels.

To evaluate the impact of macro economic variables on the develop-
ment and composition of the labor force, we have relied on two rather basic
measures for sectoral a d occupational distribution of the labor force.
The first is a measure of productivity, defined as manpower per dollar of
output, and measured by the relative difference of production between 1953
and 1963 weighted by the sector's (or occupation's) share of total man-
power. The second measure is the relative difference of manpower flows be-
tween 1953 and 1963 weighted by total employment of the sector's or
occupation's share. What is important is the comparison of the two, which
yield the following possibilities: 1) an increase in productivity accompanied
by an increase in employment, indicative of a newly developing sector;
2) increasing productivity and declining employment indicative of a maturing
industry; 3) decreasing productivity and increasing employment which might
indicate sectors absorbing unemployment or engaged in producing social
overhead capital; 4) finally, declining productivity and declining employ-
ment.

We find that trade, construction and personal services fall into
our first category of newly developing sectors. The trade sector displays
the most demonstrative change in both productivity and employment, resulting

from the expansion of the monetized sector of the economy, or in other terms, the organized expansion of the commercial sector. The construction sector shows signs of significant, though less dramatic changes, which may be attributed to the construction of new hotels and homes as well as the more obvious construction of manufacturing and distributive facilities. The increasing productivity of the personal service sector is more difficult to interpret, though the increasing employment can easily be attached to repercussions of a developing middle income class.

The second category of maturing or transformed sectors is deliniated by and confined to the agricultural and textile and apparel sectors. The agricultural sector's dramatic increase in productivity and equally dramatic decrease in employment illustrates the sharp transformation of the agricultural sector, which reflects the destruction of the low-productivity sugar economy and the moderate shift to higher productivity dairy enterprises. The textile and apparel sector, which in the early 1950's was still largely a "putting out" system, also went through an intense transformation as it moved into the modern factory system.

Lastly, the government sector has transformed into employing more people at lower levels of productivity. This is part may be explained by the growing provision for educational, medical and welfare services. But it is also accounted for by the fact that the government was trying to absorb some of the unemployment, and some difference may be due to accounting conventions as well.

The picture that this data conveys is that of a small country experiencing a modicum of industrial development, with the greatest impact being on which might broadly be called the distributive and service sectors.

The low profile of traditional industrial development in the overall, picture begins to indicate the limitations of Fomento's industrialization schema. But before beginning to draw any firm conclusions, it might be useful to look at the other side of this picture, i.e., industrializations impact on the occupational distribution of changes in productivity and employment.

Looking at Table   , which provides us with an occupational breakdown of relative changes in employment weighted by total flows, we find a significant shift away from male laborers and managers and female operatives toward male operatives, craftsmen, salesmen, clerical men and professionals, and toward clerical and professional women. The shift in men results from the move out of agriculture and into the trade, construction and government sectors. Women, on the other hand, are moving out of the non-factory textile and apparel sector and into government (teachers and welfare workers), commerce and other service sectors.

The changing occupational composition of the Puerto Rican labor force suggests a slight upward movement, in the skill component, though heavily weighted toward service rather than industrial skills. This confirms our earlier notions of a rapidly transforming economy initiated by some industrialization, but primarily organized around service rather than production industries.

MANPOWER: 53-63 COMPARISONS

RELATIVE DIFFERENCES WEIGHTED BY LABOR FLOWS

	Men	Flows by Occup	Coef by Occup
1.	Professional	-.165	.0012
2.	Managerial	.045	.130
3.	Clerical	-.170	.017
4.	Sales	-.149	.044
5.	Craft	-.239	.087
6.	Operative	-.259	.093
7.	Service	-.145	.022
8.	Laboring	.249	.696
9.	Not Reported	-.014	.0004
	Women		
10.	Professional	-.118	.006
11.	Managerial	-.036	.001
12.	Clerical	-.254	.016
13.	Sales	-.070	.0014
14.	Craft	-.026	-.00005
15.	Operative	.288	.0762
16.	Service	.086	.0241
17.	Laboring	.014	.0002
18.	Not Reported	-.033	-.0003

NOTE: Negative number denotes an increase in employment (Flows) from 53 to 63 and a decline in productivity (Coef)
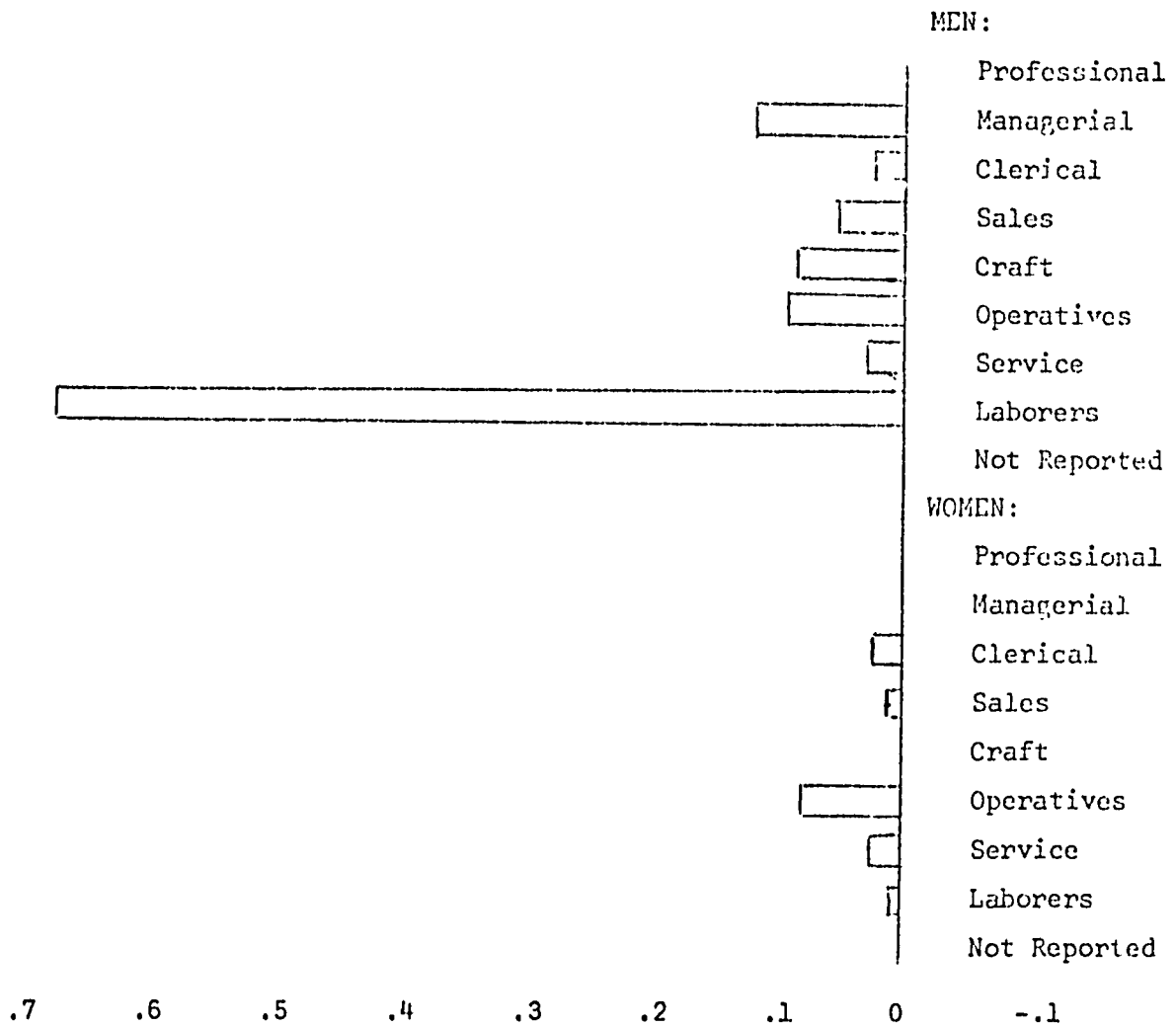
MANPOWER: 53-63 COMPARISONS

RELATIVE DIFFERENCES WEIGHTED BY LABOR FLOWS

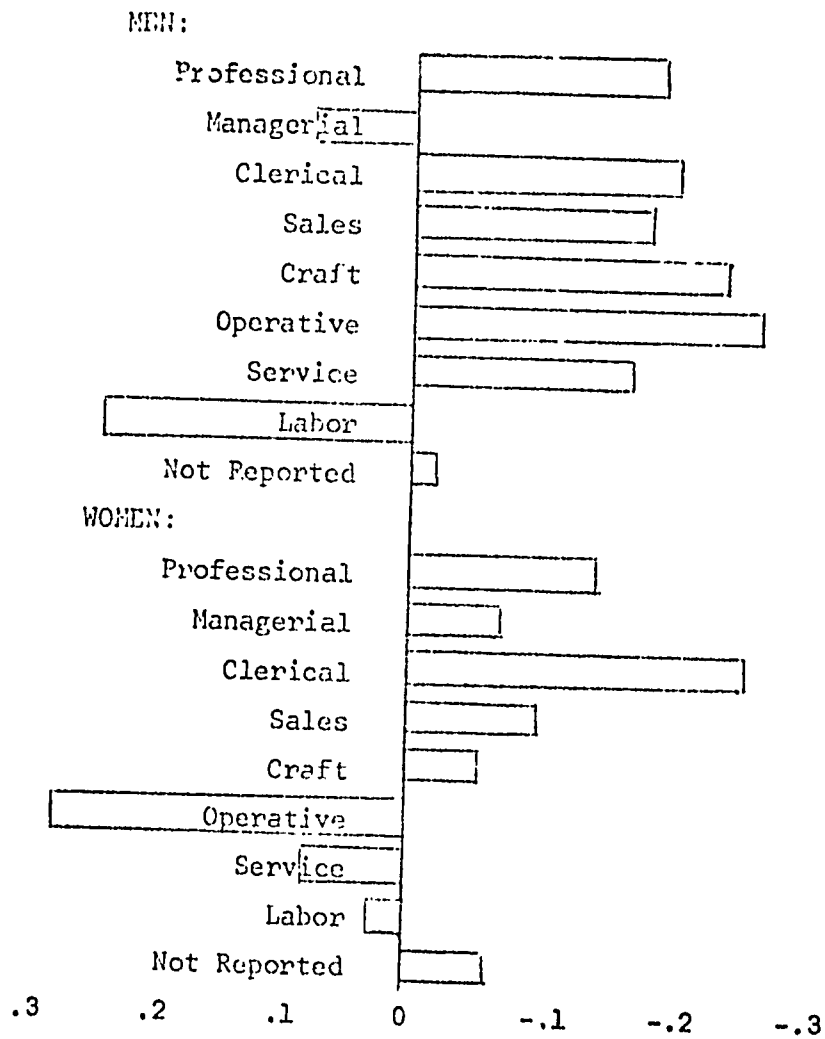|		Flows by Sector	Coef by Sector
1.	Agriculture	.520	.720
2.	Sugar Mill	-.036	-.003
3.	Other Food	.031	.006
4.	Textiles & App.	.270	.068
5.	Wood Furn.	-.017	.0004
6.	Printing	.008	.0006
7.	Chemical	-.006	.0007
8.	Non-Metal	-.020	.0004
9.	Metal & Mach.	-.148	.0014
10.	Other Manufac.	-.102	.0033
11.	Mining	-.020	.0001
12.	Construction	-.216	.060
13.	Trade	-.420	.276
14.	Transport	-.076	.0184
15.	Commun.	-.057	.0003
16.	Fin. Reals	-.090	-.0009
17.	Personal Serv.	-.057	.102
18.	Business Serv.	-.096	.0015
19.	Hotel	-.098	.0051
20.	Utilities & San.	-.036	.0014
21.	Public Admin.	-.368	-.109

NOTE: Negative number denotes an increase in employment (Flows)
from 53 to 63 and a decline in productivity (Coef)

RELATIVE DIFFERENCE IN MANPOWER/$ OF OUTPUT COEFFICIENTS
BY OCCUPATION WEIGHTED BY TOTAL MANPOWER FLOWS
1953-1963

MEN:

Professional

Managerial

Clerical

Sales

Craft

Operatives

Service

Laborers

Not Reported

WOMEN:

Professional

Managerial

Clerical

Sales

Craft

Operatives

Service

Laborers

Not Reported

.7   .6   .5   .4   .3   .2   .1   0   -.1

RELATIVE DIFFERENCE IN MANPOWER BY OCCUPATION

WEIGHTED BY TOTAL MANPOWER FLOWS

1953-1963

MEN:

| Professional |
| Managerial |
| Clerical |
| Sales |
| Craft |
| Operative |
| Service |
| Labor |
| Not Reported |

WOMEN:

| Professional |
| Managerial |
| Clerical |
| Sales |
| Craft |
| Operative |
| Service |
| Labor |
| Not Reported |

.3   .2   .1   0   -.1   -.2   -.3

RELATIVE DIFFERENCE IN MANPOWER BY SECTOR

WEIGHTED BY TOTAL MANPOWER FLOWS

1953-1963

Sector	
Agriculture	
Sugar Mill	
Other Food	
Textile & Apparel	
Wood Furniture	
Printing	
Chemical	
Non Metal	
Metal & Machinery	
Other Manufacture	
Mining	
Construction	
Trade	
Transport	
Communication	
Fin. Real Estate	
Personal Service	
Business Service	
Hotel	
Utility & Sanitation	
Public Administration	

.5   .4   .3   .2   .1   0   -.1   -.2   -.3   -.4
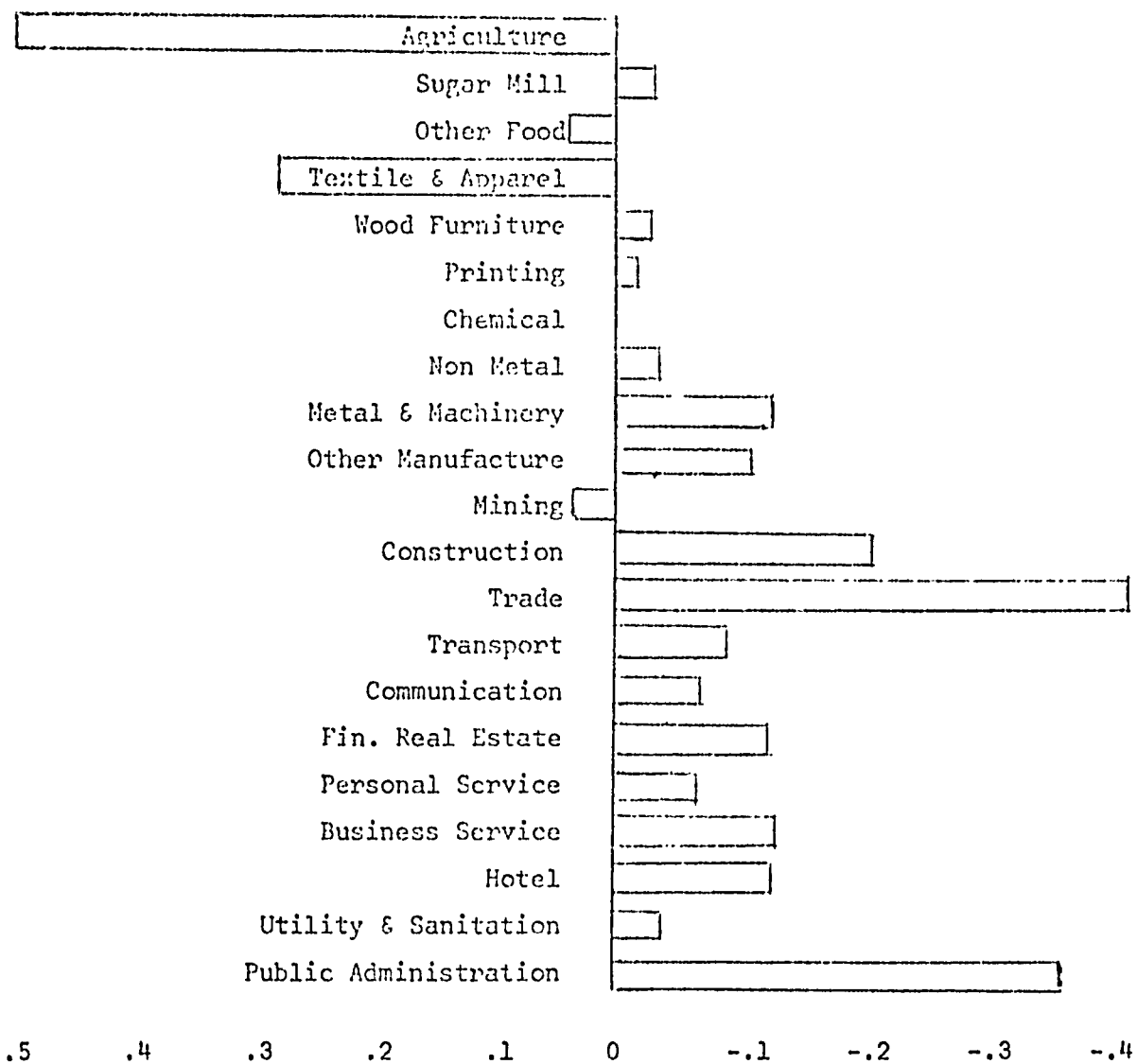
RELATIVE DIFFERENCE OF MANPOWER/$ OF GROSS DOMESTIC OUTPUT

BY SECTOR WEIGHTED BY TOTAL MANPOWER FLOWS

1953-1963

	Agriculture
	Sugar Mill
	Other Food
	Textiles & Apparel
	Wood Furniture
	Printing
	Chemical
	Non Metal
	Metal & Machinery
	Other Machinery
	Mining
	Construction
	Trade
	Transport
	Communication
	Fin. Real Estate
	Personal Service
	Business Service
	Hotels
	Utility & Sanitation
	Public Administration

.7   .6   .5   .4   .3   .2   .1   0   -.1   -.2
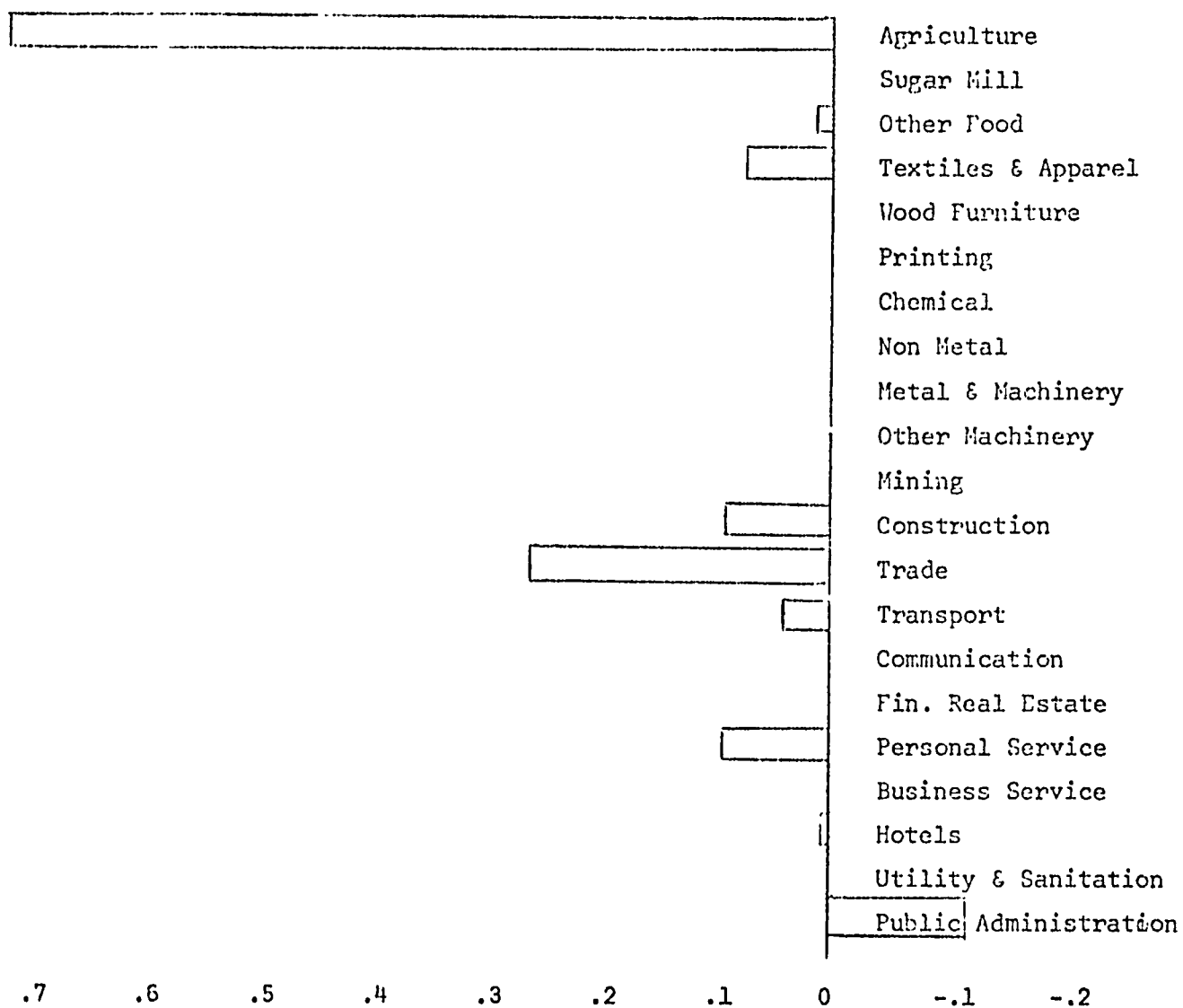
Weighted Relative Differences: Coefficients

purpose: to devise a measure that will demonstrate the impact of
technological change on the labor force of Puerto Rico.
First, accepting the manpower/$m output as a crude measure
of productivity, the relative difference between 1953 and 1963
will give us a measure of the change in productivity between
the two years without overstating the development of new
sectors. To determine the impact that this change in producti-
vity had on the labor force we weight the productivity change
by the sector's average share of the labor force for 1953 and
1963. The same was done for manpower/$m output by occupation.

$$\frac{n_{i63} - n_{i53}}{\dfrac{n_{i63} + n_{i53}}{2}} \quad X \quad \frac{n^{*}_{i53} + n^{*}_{i63}}{N^{*}_{53} + N^{*}_{63}} \quad = \quad n_{iw}$$

reduces to

$$\frac{2(n_{i63} - n_{i53}}{n_{i63} + n_{i53}} \quad X \quad \frac{n^{*}_{i53} + n^{*}_{i63}}{N^{*}_{i53} + N^{*}_{i63}}$$

where n equals the 'manpower/output' coefficient for the
ith sector (or jth occupation) for given year

n^{*} equals the manpower flow for the ith sector
(or jth occupation) for the given year

N^{*} equals the total manpower flow for all i
sectors (or j occupations)

n_{iw} equals the weighted relative difference for the
ith sector (or jth industry).

Technical Note: Definitions of Relative Differences

Weighted relative differences: flows of manpower

purpose: to demonstrate each sector's (or occupation's) contribution
(positive or negative) to the change in employment between 1953
and 1963. This in turn can be computed with the weighted relative
difference of coefficients to pinpoint the sources of employment
creation and labor displacement over the ten year period.

The relative difference of the manpower flow by sector
(occupation) is weighted by that sector's (occupation's) share of
the mean total labor force. This may be stated algebraically as:

$$\frac{n_{i63}^{*} - n_{i53}^{*}}{\dfrac{n_{i53}^{*} + n_{i63}^{*}}{2}} \quad X \quad \frac{\dfrac{n_{i53}^{*} + n_{i63}^{*}}{2}}{\dfrac{N_{53}^{*} + N_{63}^{*}}{2}}$$

which reduces to:

$$\frac{2(n_{i63}^{*} - n_{i53}^{*})}{N_{i53}^{*} + N_{i63}^{*}}$$

III. Policy Implications

A. Alternatives Paths: Export Development Versus Import Substitution

The "success" of the export-promoting industrialization has resulted in a significant change in the composition of the Puerto Rican labor force and the economy's output. Furthermore, the potential for the flexible adoption of growth policies of other than export development may have been reduced by virtue of the chosen strategy. The goal of this section is to examine the consequences of the export-led industrialization as a path to development and compare its successes to some alternative strategies which might in the future be selected by Puerto Rican policy makers.

Our objective first is to evaluate the employment accomplishments by comparing the actual trajectory of growth to some alternatives. In this way, we are posing the counterfactual question" "what would have resulted if a different set of paths had been followed?" Since the actual set of policies are embedded in the input-output relationships and in the occupational distribution of our simulation model, we shall alter some of the historical "choices" and test out the consequences of those choices in terms of employment and income. (The mechanical operations involved in these adaptations are described in the technical appendices.)

1. Counterfactual Results:

We proceed by asking two counterfactual questions in detail: first, how would the economy have developed if, while pursuing export promotion, an attempt had been made to constrain the growth of imports? Secondly what would have been the further implication on economic growth of a more aggresive policy of income redistribution.

The first type of policy could have been carried out by imposing

varying degrees of excise taxes on selected commodities, as has customarily
been applied on luxury goods and consumer durables for the purpose of
raising revenue. These duties, however, could be applied in order to encour-
age the domestic production of a number of traditionally imported goods.
While these policies might result in some short term rise in relative prices
of domestically produced goods, the model will test only for the net income-
generating effect of import substitution at competitive equilibrium prices.

2. Import Substitution:

In developing a set of import substitutes, we assumed first that the
government was able to develop a program to reduce the household sector's
consumption of imports by 20% while imposing no restrictions on interindustry
procurement. This resulted in an 8% increase in national income. On the
other hand when we impose the same restrictions on inter-industry procure-
ment as on household consumption (i.e., 20% overall import reduction) we
found a more dramatic increase in national income and a corresponding increase
in employment and value added to families between 26% and 27% greater than
the 'actual' program. The comparison of the two schemes in some sense
demonstrated the high dependence of Puerto Rican industry on imported inputs
from the mainland, and the full multiplier effects of more complex domestic
production.

Next, we posited a more traditional concept of import substitution,
that of the conscious development of domestic industries capable of competing
with inputs from the mainland. In this experiment attention is focussed on
the agricultural, foodstuff and textile-apparel sectors. In so doing, we
assumed that the household sector had no option other than to consume domestic
products from these sectors (i.e., 100% import substitution of household con-
sumption for sectors 1 through 13). We further assumed that inter-industry

procurement of goods from these same sectors could be no more than 10% of what it had been (i.e., a 90% import substitution of intermediate demand for sectors 1 through 13). There was no alteration of the import-domestic mix in the remaining sectors. This experiment resulted in a base year growth of national income almost identical to that generated by 20% overall import reduction scheme, again between 26% and 27% spurt of growth.

Input-output simulation imposes a static quality which inhib. · the demonstration of the full negative and positive impact of the above experiments over time. Thus the impact that the import substitution schemes had on the base year 1963 is identically mirrored in the annual calibrations. Nevertheless, the dramatic results of both the 20% overall and select-import substitution schemes on national income in the base year is highly suggestive of the additional dynamic gains which might result from a more rationally-selected mix of export promotion and import substitution.

3. Income Redistribution: The Egalitarian Society with Different
   Consumption Patterns

On the 20% import substitution model was further imposed the assumption of an egalitarian society. Income was redistributed such that families received the mean income and spent their income in a pattern similar to the mean income class. The several changes in the economic performance were not as dramatic as might have been thought, since the new equilibrium yields little more than a 1% reduction in national income over the straight import substitution scheme with different income classes intact. These results could be explained by the high degree to which the mean income class characterized the overall consumption behavior of the Puerto Rican population.

In separate experiments, the expenditure patterns of lowest (class 1) and the highest income classes (class 15) were imposed on the population while maintaining an egalitarian of mean income level for all families. This experiment was performed in order to test the sensitivity of the economy to the allocation of family expenditures between different sectors while maintaining the same level of family spending. By adopting the consumption pattern of the lowest income class as the norm, national income rose by 26% over 'actual' program which was only 1% higher than the "class 5" experiment and a slightly lower increment than the program of 20% overall import substitution without altering the income distribution. When the consumption pattern of the highest income class (15) was imposed on the egalitarian society, national income fell but only by five-tenths of a percent from the 'actual' level. These results suggest that the level of economic activity is not significantly affected by income redistribution, at least as a consequence of the static effects on domestic consumer demand.

Results of Import Substitution and Income
Redistribution Schemes

EMPLOYMENT

Scheme:	total emp. ('000)	absolute inc. ('000)	percentage inc. ('000)
actual	715.5	----	----
20% i/s HHCon only	774.2	58.7	8.2
20% i/s HHCon & Interm	900.1	184.6	25.8
Select	919.3	203.7	28.5
20% i/s overall:			
i/rd #5 cp 1	881.1	165.6	23.2
i/rd #5 cp 5	892.5	177.0	24.7
i/rd #5 cp 15	896.5	181.0	25.3

PER CAPITA INCOME

Scheme:	p/c income ($)	absolute inc. ($)	percentage inc. ($)
actual	1,357	----	----
20% i/s HHCon only	1,467	111	8.1
20% i/s HHCon & Interm	1,720	364	26.8
Select	1,710	354	26.1
20% i/s overall, with:			
i/rd #5 cp 1	1,727	371	27.3
i/rd #5 cp 5	1,703	346	25.5
i/rd #5 cp 15	1,687	330	24.3

Various Results Generated by Alternative Development Paths

	1970 Calibrated	20% i/s	+ INTERM	SELECT	i/rd #1	i/rd #5	i/rd #15
Value Added to Families	3,347,782	3,620,516	4,245,000	4,220,347	4,282,472	4,201,093	4,162,326
National Income	4,349,773	4,695,376	5,497,695	5,452,236	5,486,441	5,438,623	5,420,883
Number of Persons Supported	3,924,125	4,239,226	4,952,625	5,008,710	4,709,761	4,651,125	4,608,593
Per Capita Income	1,356	1,467	1,720	1,710	1,727	1,702	1,688
Household Consumption	3,224,168	3,485,475	4,082,733	4,075,251	4,060,727	4,002,253	3,965,322
Imports	2,131,029	2,077,751	2,458,329	2,126,150	2,507,474	2,446,798	2,378,187
Kuznets Coefficient	70.613	70.687	70.665	71.116	0.0	0.0	0.0
Gini Coefficient	0.466	0.466	0.466	0.470	0.0	0.0	0.0

Employment Generated by Alternative Development Paths

	1970 Calibrated	20% i/s	+ INTERM	SELECT	i/rd #1	i/rd #5	i/rd #15	1970 Adjusted
Men:								
Professional	44,961	47,768	53,985	53,059	45,883	52,798	60,195	36,720
Managerial	111,378	122,713	147,405	150,840	152,575	147,041	138,664	67,930
Clerical	51,111	54,610	61,908	60,880	60,282	61,429	61,983	40,575
Sales	73,994	82,694	103,046	100,749	104,167	102,658	98,917	52,921
Crafts	118,468	124,088	138,325	137,106	139,527	137,886	134,847	88,179
Operative	111,395	120,917	146,033	144,687	133,128	146,912	144,300	81,407
Service	55,591	59,136	66,050	65,424	57,874	64,771	73,494	45,728
Laboring	249,004	270,674	311,481	347,583	345,739	312,519	272,216	97,828
Not Reported	7,449	8,043	9,318	9,436	9,074	9,235	9,329	5,143
Women:								
Professional	30,887	33,078	38,409	37,455	24,176	36,018	51,886	26,528
Managerial	11,802	12,949	15,492	15,269	14,831	15,296	15,770	8,582
Clerical	54,898	58,984	67,213	65,783	63,590	66,409	68,956	44,305
Sales	15,449	17,369	21,925	21,345	21,752	21,832	21,172	10,795
Crafts	3,844	4,227	4,926	4,911	5,001	4,927	4,759	3,069
Operative	72,521	79,099	88,114	88,819	91,630	87,781	85,910	59,276
Service	46,251	49,630	58,334	56,760	34,272	53,436	83,983	39,733
Laboring	4,139	4,533	5,229	5,847	5,850	5,239	4,586	1,698
Not Reported	6,998	7,568	8,790	8,965	8,533	8,702	8,832	4,739
Total	1,070,144	1,157,986	1,346,287	1,374,922	1,317,690	1,334,941	1,340,862	715,496
Men/Women	3.3	3.3	3.4	3.5	3.9	3.5	2.9	2.6

Note: The number of people employed were generated prior to the adjustment of the model for changes in labor productivity. Thus the development schemes represented in columns 1 through 7 overstate employment generated. The magnitude of overstatement can be seen by comparing column 1 "1970 calibrated" with column 8 "1970 adjusted." Until new employment data is generated this table provides the reader with a picture of the relative changes in employment resulting from the alternative development paths.

KEY TO CODES:

Column 1: "1970 calibrated" indicates 1970 economy as results from the calibration of exogenous demands.

Column 2: "20% i/s" indicates 20% import substitution of household demand; that is, a reduction in the import content of consumption by 20%.

Column 3: "+ INTERM" indicates a 20% overall import substitution; that is, a 20% reduction in the import content of industry inputs as well as a 20% import substitution of household demand.

Column 4: "SELECT" indicates a program of select import substitution in the agricultural foodstuffs and clothing sectors (sectors 1-13): 100% import substitution of household demand for all foodstuffs, beverages and clothing as well as a 80% import substitution of industrial demand for imported inputs of agricultural goods, textiles and clothing, with no income redistribution. Column 4 should be compared with columns 2 and 3.

Column 5: "i/rd #1" indicates a 20% overall import substitution as in column 3 plus income redistribution: the assumption of an egalitarian society where all families are given the 'mean' income (income class 5) and the consumption pattern of the lowest income class (class 1).

Column 6: "i/rd #5" indicates the same as column 5 except that the consumption pattern of the mean income class (class 5) is imposed.

Column 7: "i/rd #15" indicates the same as column 5 except that the consumption pattern of the highest income class (class 15) is imposed.

Column 8: "1970 adjusted" results of calibration from 1963 to 1970, where the employment coefficients were adjusted for changes in productivity.

III. The Testing of Industrialization Policy

B. Employment Projections for 1980

If Puerto Rico continues growing over the coming decade as it did in the past decade, what will be the level of employment by 1980? Furthermore, what effect will continued growth have on the occupational distribution of the labor force?

These series of experiments was devised to assist in the prediction of the continuation of current growth policies on the society. The model here is essentially an extension of a final demand model, in which the levels of exports and exogenous investment are predicted into the future on the basis of current trends, and their effects on inter-industry flows, employment, consumption, and the consumption feedbacks which are captured within the economy.

How sensitive are the levels and types of employment to the particular mix of exogenous demands? Does the society have much of a choice in its ability to create jobs for an increase in population?

The calibration procedure of the model was undertaken at first by a simple projection of total annual employment by separate industries from 1963 to 1970 by means of applying those segments of final demand which are

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2 The key assumption of the model built into the fixed coefficients is the infinite elasticity of supply of labor for different skill classes. This may not be too unrealistic, given the availability of a mainland managers and the return migration. No attempt in this study has been made to evaluate the impact of wage differentials between mainland in attracting or severing jobs. Thus the model is for all purposes demand-run which assumes that labor is trained and appears instantaneously in order to fill the positions that have been created by the alternative "paths." Thus the overall view taken in the model is that the particular set of promoted industries generate jobs directly and indirectly, and the full impact of predictions along this line must be estimated to give a realistic view of the structure of jobs in the next ten years.

considered to be exogenous to the economy. The discrepancies between a simple straight line projection of employment and actual employment in those years, were ascribed to changes in productivity between 1963 and 1970. The properly calibrated employment for 1970, which accounts for increasing productivity, came within 2 percent of actual employment by sector during the eight year period. Using these averages of increasing productivity and finding that during this period exogenous final demand grew at the rate of 12.7% a year, we chose three alternatives for the overall growth of final demand, 1980-I: less than the historic rate of growth (10% a year) which generated an employment level of 829,000, 1980-II: the historic rate of growth (12.7% a year) employing 1,094,000, and 1980-III: greater than the historic rate (15% a year) with 1,351,000 employed. The employment generated by these assumptions can be seen in Table   columns 9-11. The annual rate of growth of total employment resulting from the three alternatives are 1.6%, 5.3% and 9.0% respectively.

We then chose to alter the major components of exogenous final demand in order to judge the sensitivity of the economy to different levels which may be effected by policy, namely, construction investment and non-government exports which together account for almost 70% of exogenous final demand. In these projections we let all other components of final exogenous demand grow at the overall historic rate (12.7%) while permitting either construction investment or non-government export to grow at a rate of growth different from the overall historic rate. In the first case we assumed that the construction boom which highlighted Puerto Rican development in the 1960's continued at its same pace (16.7% a year) and then we projected an intensification so that the sector reflected an average annual rate of

growth of 20%. The results are recorded respectively in 1980-IV and -V
in the same table, and demonstrate an average per annum employment growth
rate of 6.6% and 7.8% respectively.

Finally, we assume that accelerated export promotion is pursued in
addition to the historically growing construction boom. When the demand
for exports is projected at its historic rate (11.6% per annum) it generates
annual average rate of increase in employment of 4.5%. On the other hand
when we permit export demand to grow at 14% per annum over the decade of
the seventies, an average annual rate of growth of employment of 6.2% is
generated.

What do these alternatives demonstrate? First, they provide us with
a measure of variability of the level of employment that might be expected
to prevail in Puerto Rico by 1980. Predicted employments ranges from 829
thousand to 1358 thousand people, which is encompassed by the high and low
historical paths. Less obvious, but more interesting is the fact that while
construction investment has historically (i.e., between 1963 and 1970)
grown faster than exports, and has been responsible for the generation of
greater absolute employment, there is another side to the picture. If we
compare the additional dollars of final demand with the employment generated
for construction investment and non-government exports, while holding all
other variables constant, we find that over the period from 1970 to 1980
one million dollars of additional construction investment generates 68
jobs while an additional million dollard of non-government exports generates
74 additionally employed people.

From our results no attempt has been made to evaluate the annual
salaries of these different number of jobs. However, if the job creation is

stated as a social goal, then it is suggested that export promotion offer a higher initial employment multiplier than does construction investment, and the reader is urged to regard the aprticular composition of skills and occupations as suggestive of what the alternative societies will look like in terms of equality and range of incomes.

While development strategy must necessarily be oriented at least in part toward employment creation, at the same time policy makers cannot ignore the need to increase the skill component of the labor force. On this basis it is useful to consider the impact that the alternative growth paths are projected to have on the occupational distribution of the labor force. This is demonstrated in Table   .

First we find that the historical overall rate of growth and the two variants (less than, and greater than the historical rate) generate almost identical occupational distributions of employment. However, compared to the 'calibrated' 1970 distribution, the changes are striking. The most significant change is the sharp fall in laboring men and somewhat smaller decline in managerial men, which is associated with a further deterioration of the agricultural sector. The slack is taken up by service men and women, and by women operatives with some additional increase registered by the more skilled clerical and professional women and professional men. The net effect is a relative increase in female employment as shown by a continuing decline in the men/women employment ratio from 2.6 to 2.2. In all, the pattern emerging from the balanced growth path implicit in historic 1980 is one of a slight increase in the skill level of the labor force. But most important is the continuing growth of service sector employment

relative to other occupations.

The construction boom, as might be expected, generates slightly less favorable employment opportunities for women, assuming no major change in the structure of jobs. Compared to the 1980 'historic' projection of the occupation distribution of employment (see Table   ) the men/women ratio rises from 2.2 to 2.4 thereby reversing the equating trent of balanced historic growth. This rise is largely accounted for by the fall in women operatives and the concomitant rise in laboring men and craftsmen.

Alternatively, export oriented growth, as depicted in 1980-VII indicated a slight improvement in the men/women ratio when compared with 'historic' exports 1980-VI and the true 'historic' 1980-II paths. This tendency can be traced to the increase in female operative and reflects the importance of women in the export-oriented manufacturing sectors.

Two tentative conclusions may be drawn from these findings. First, the impact of export promotion relative to a continuing and intensified construction boom, facilitates a movement toward equality between male and female employment opportunities. At the same time, export promotion induces no dramatic changes on the occupational distribution of the labor force, thereby implying no significant changes in the labor forces's skill composition.

Second, the data suggests that a construction boom, as implied by this limited experiment, would have a greater employment multiplier (employment generated per dollar of final demand) than either the historic growth or export promotion paths. The corresponding impact of a construction boom on occupational distribution is only slightly more evident than with export promotion. Most discernable is a small movement away from more highly skilled occupation, from professionals to sales people, and a

corresponding increase at lower skill levels especially among craftsmen

and laboring men.

ASSUMPTIONS UNDERLYING THE ALTERNATIVE EMPLOYMENT PROJECTIONS
BY OCCUPATION FOR 1980[+]

Projection Scheme	Annual Growth Rate of Overall Exogenous Demand 1971-80	Annual Growth Rate of Specific Components of Exogenous Demand	
		Construction Investment	Exports
1980-I	10.0%		
1980-II	12.7%[*]		
1980-III	15.0%		
1980-IV	12.7%	16.7%[*]	
1980-V	12.7%	20.0%	
1980-VI	12.7%		11.6%[*]
1980-VII	12.7%		14.0%

NOTES: [+] a procedural description may be found in the technical appendices. See

[*] denotes the historic annual rate of growth from 1963 to 1970.

PERCENTAGE DISTRIBUTION OF EMPLOYMENT BY OCCUPATION
FOR 1980 PROJECTIONS

	Actual 1970	Balanced Growth			Construction Boom		Export Promotion	
		1980-I	1980-II	1980-III	1980-IV	1980-V	1980-VI	1980-VII
Men:								
Professional	5.1	5.9	5.9	5.8	5.8	5.7	6.0	5.8
Managerial	9.5	8.5	8.6	8.6	8.4	8.3	8.5	8.6
Clerical	5.7	6.4	6.3	6.3	6.1	5.8	6.4	6.2
Sales	7.4	6.9	7.0	7.1	6.8	6.6	6.9	7.1
Crafts	12.3	12.6	12.5	12.5	13.7	14.8	12.7	12.3
Operative	11.4	11.4	11.6	11.6	11.6	11.7	11.4	11.8
Service	6.4	7.5	7.4	7.3	7.1	6.8	7.5	7.2
Laboring	13.7	8.6	8.5	8.5	9.1	9.7	8.6	8.4
Not Reported	.7	.7	.7	.7	.7	.7	.7	.7
Women:								
Professional	3.7	4.5	4.5	4.5	4.4	4.4	4.5	4.5
Managerial	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Clerical	6.2	7.1	7.0	7.0	6.7	6.5	7.1	6.9
Sales	1.5	1.3	1.4	1.4	1.3	1.3	1.3	1.4
Crafts	.4	.5	.5	.5	.5	.4	.5	.5
Operative	8.3	9.3	9.4	9.4	8.9	8.4	9.0	9.8
Service	5.6	6.8	6.8	6.8	6.7	6.7	6.8	6.7
Laboring	.2	.2	.2	.2	.2	.2	.2	.2
Not Reported	.7	.7	.7	.7	.7	.7	.7	.7
TOTALS	100.0	100.1	100.2	100.1	99.9	99.9	100.1	100.0
Percentage Increase in Employment over 1970	--	15.9	52.8	89.9	65.7	77.9	45.5	61.8
Men/Women	2.6	2.2	2.2	2.2	2.3	24.	2.2	2.1
Kuznets	70.613	70.618	70.617	70.616	70.528	70.420	70.612	70.622

CALIBRATED EMPLOYMENT BY OCCUPATION: ALTERNATIVE PROJECTIONS FOR 1980
adjusted for productivity changes

COLUMN	8 (1970)	9 (1980-I)	10 (1980-II)	11 (1980-III)	12 (1980-IV)	13 (1980-V)	14 (1980-VI)	15 (1980-VII)
ROW								
1-PROFLMEN	34720.5	49200.5	64323.1	79458.2	64864.1	73871.4	62179.1	64907.3
2-MANAGMEN	67930.4	79596.5	93323.0	117174.7	91912.1	106632.2	84922.7	94722.8
3-CLERCMEN	46516.4	52708.4	68793.8	84940.2	71793.6	75168.7	66541.8	71490.9
4-SALESMEN	52921.2	57166.2	76702.1	96279.6	83780.7	85279.9	72070.2	82345.2
5-CRAFTMEN	99179.5	104225.3	136392.2	149913.6	162358.9	190455.9	132288.4	142441.4
6-OPERVMEN	91447.5	94825.4	125493.9	158051.2	137615.6	159091.6	118145.9	136315.2
7-SERVCMEN	45729.7	61978.0	80626.4	99464.6	84271.2	86571.2	78391.1	83570.3
8-LABORMEN	97328.7	70950.7	92659.9	114798.5	108387.7	125519.6	89148.5	97326.6
9-FARMELMEN	5143.3	6104.5	8052.5	9999.1	8675.6	9363.5	7660.9	8560.3
10-PROFILWM	26528.6	37374.6	49143.7	60921.0	52732.2	56693.8	47107.5	51591.4
11-MANAGWM	8407.0	10267.8	13603.7	16948.7	14237.8	14933.0	12895.5	14461.7
12-CLERCWM	44306.6	56650.7	76693.4	94450.4	79678.8	83235.6	74027.7	79179.4
13-SALESWM	10756.3	11175.3	15327.7	18960.7	15597.6	16573.2	14291.3	16264.9
14-CRAFTWM	3070.8	4062.6	5172.3	6404.9	5415.0	5662.6	4779.4	5645.9
15-OPERVWM	58216.4	77617.2	102347.9	127528.2	105247.2	104333.0	93414.9	113549.7
16-SERVCWM	39793.1	56645.4	73405.7	51608.5	80015.8	86752.6	70417.4	76116.9
17-LABORWM	1648.3	1370.2	1800.5	2247.7	1741.2	2007.6	1657.5	1954.4
18-FARMLWM	4739.2	5553.4	7324.3	9099.8	7923.1	8582.6	6966.4	7755.5
19-TOTAL	715496.0	829144.4	1093569.0	1358385.0	1185769.0	1287473.0	1040663.1	1157337.0
20-MEN/WOMN	2.6	2.2	2.2	2.2	2.3	2.4	2.2	2.1

The model as a whole may be summarized in the following set of equations.

We let:

(i) capital letters represent coefficient matrices and vectors of ratios

(ii) capital letter superscripted with stars (A^*, for example) represent flow matrices

(iii) capital letters superscripted with bars ($\bar{B}$, for example) represent matrices of means

(iv) a circumflex ($\wedge$) over a vector name represent a diagonal matrix whose diagonal equals the vector

(v) a tilda ($\sim$) over a matrix (or vector) name indicate an augmented matrix (or vector)

The model was run at two levels, a three-order and a 49-order level. The dimensions written under the equations that follow are the dimensions for the 49-order model. The dimensions for the three-order model may be computed by subtracting 46 (which is 49 minus 3) from the row and column dimensions of all matrices that include 49-sector activity.

A '1' with a set of dimensions written under it indicates a matrix of ones.

A total flow matrix was prepared:

$$\begin{bmatrix} A^* & F^* \\ H^* & 0 \end{bmatrix}$$

where: A^* (49 x 49) is the matrix of interindustry flows,

H^* (10 x 49) is the matrix of value added flows,

F^* (49 x 11) is the flow matrix of final demand sales.

(1) $\quad W^* \quad = \quad 1 \quad H^*$

$\quad$ (1 x 49) $\quad$ (1 x 10)(10 x 49)

where W^* is the row vector of value added flows by industry.

Let R be a 1 by 49 vector of ratios of value added received by families to total value added by industry.

$$(2) \quad W_f^* \quad = \quad V^* \; \hat{R}$$

$$(1 \times 49) \quad (1 \times 49)(49 \times 49)$$

where W_f^* is a vector of value added received by families by industry,

$$(3) \quad W_r^* \quad = \quad W^* \; - \; W_f^*$$

$$(1 \times 49) \quad (1 \times 49)(1 \times 49)$$

where W_r^* is a residual vector of value added by industry not accruing to households.

Let D be a 15 by 49 coefficient matrix, each column of which shows how income generated in that industry is distributed among 15 per capita income classes (per consumer unit income classes in the 3-order model).

$$(4) \quad V^* \quad = \quad D \quad \hat{W}_f^*$$

$$(15 \times 49) \quad (15 \times 49)(49 \times 49)$$

where V^* is a flow matrix of total income received by income class for each industry.

$$(5) \quad D_s^* \quad = \quad V^* \quad 1$$

$$(15 \times 1) \quad (15 \times 49)(49 \times 1)$$

where D_s^* is a vector of total income accruing to each income class.

Let N_p^* be a 15 by 1 vector of the number of people in each income class.

$$(6) \quad \bar{D}_s \quad = \quad D_s^* \; / \; N_p^*$$

where '/' represents term by term division and $\bar{D}_s$ is a vector of income per person by income class.

Let λ be a 1 by 15 vector of ratios of expenditure to income per person for each income class.

$$(7) \quad \bar{E} = \lambda' \quad \hat{D}_s$$
$$(1 \times 15) \quad (1 \times 15)(15 \times 15)$$

where $\bar{E}$ is a vector of expenditure per person by income class.

Engel curves were estimated for each of the 49 sectors. Let α be the 49 by 1 vector of expenditure constants and β the 49 by 1 vector of expenditure coefficients.

$$(8) \quad \bar{C} = \alpha \quad 1 + \beta \quad \bar{E}$$
$$(49 \times 15) \quad (49 \times 1)(1 \times 15) \quad (49 \times 1)(1 \times 15)$$

where $\bar{C}$ is the matrix of per capita expenditure on each of 49 sectors.

$$(9) \quad C^* = \bar{C} \quad \hat{N}_p$$
$$(49 \times 15) \quad (49 \times 15)(15 \times 15)$$

where C^* is a matrix of total consumption by income class on each of 49 sectors.

Let X^* be the 49 by 1 column vector of total outputs, $\tilde{X}^*$ be the 64 by 1 augmented X^* vector, where elements 50 to 64 are total income by income class. Let Y^* be the 49 by 1 column vector of exogenous demand, Thus, Y^* equals investment plus government plus export demand for, less imports of, sector output. Let $\tilde{Y}^*$ be the 64 by 1 Y^* vector augmented with 15 zeroes.

Let $\tilde{A}^*$ be the flow matrix

$$\left[\begin{array}{c|c} A^* & C^* \\ \hline V^* & 0 \end{array} \right]$$

and $\tilde{A}$ the corresponding coefficient matrix:

$$\left[\begin{array}{c|c} A & C \\ \hline V & O \end{array}\right]$$

Thus, each element of $\tilde{A}$, $\tilde{A}_{ij}$, equals $\tilde{A}^{*}_{ij} / \tilde{X}^{*}_{j}$.

We now have the following equality:

$$(10) \quad \tilde{X}^{*} = \left[\begin{array}{c|c} A & C \\ \hline V & O \end{array}\right] \tilde{X}^{*} + \tilde{Y}^{*}$$

$(64 \times 1) \quad (64 \times 64)(64 \times 1) \quad (64 \times 1)$

Let M^{*} be the 49-order import flow matrix. Let M be the corresponding import coefficient matrix, where each element of M, M_{ij}, equals M^{*}_{ij} / X^{*}_{j}.

Let M_h be the 49 by 1 vector of ratios of household imports to total household consumption by sector.

$$(11 \quad M_{c} = \hat{M}_{h} \quad C$$

$(49 \times 15) \quad (49 \times 49)(49 \times 15)$

where M_{c} gives the ratio of household imports by sector and income class to total income by income class.

Let Z^{*} be the 49 by 1 vector of exogenous investment plus government plus export demand for sector output. (Thus, Z^{*} equals X^{*} plus a vector of total imports by sector.) Let $\tilde{Z}^{*}$ be a 64 by 1 vector of Z^{*} augmented with 15 zeroes. Therefore,

$$(12) \quad \tilde{X}^{*} = \left[\begin{array}{c|c} A - M & C - M_{c} \\ \hline V & O \end{array}\right] \tilde{X}^{*} + \tilde{Z}^{*}$$

$(64 \times 1) \quad (64 \times 64) \quad (64 \times 1) \quad (64 \times 1)$

thus,

$$(13) \quad X^{*} = \left[\begin{array}{c|c} I + M - A & M_{c} - C \\ \hline -V & I \end{array}\right]^{-1} \tilde{Z}^{*}$$

$(64 \times 1) \quad (64 \times 64) \quad (64 \times 1)$

These other matrices were used in the models: First, W_{r}, which is the vector of coefficients of residual value added by sector. Each element in

W_r, $(W_r)_j$, equals $(W_r^*)_j$ / X_j^*. Second, $\bar{D}$, a 15 by 49 matrix of income per person (income per consumer unit in the 3-order model) by sector and income class. Third, N^*, a 18 by 26 consumer matrix showing employment by 18 occupations in 26 sectors. Fourth, N, the manpower coefficient matrix showing employment by occupation per dollar of sector output. N was computed by first aggregating X^* to a 1 by 26 vector, X_a^*. Each element of N, N_{ij}, equals N_{ij}^* / $(X_a^*)_j$.

If we now think of $\tilde{Z}{}^*$ and $\tilde{X}{}^*$ as variables, different vectors of total output may be generated with different vectors of exogenous demand, as was done in the final stage of the models. For a hypothetical $\tilde{Z}{}^*$, we calculated $\hat{X}{}^*$ and the following other results:

(a) VA: FAM. Value added to families is equal to

$$(14) \quad 1 \quad \cdot \quad V \quad \cdot \quad X^*$$

$$(1 \times 15) \quad (15 \times 49) \quad (49 \times 1)$$

(b) NAT INC. National income equals

$$(15) \quad (1 \quad V \quad + \quad W_r) \quad X^*$$

$$(1 \times 15)(15 \times 49) \quad (1 \times 49) \quad (49 \times 1)$$

(c) SUPPORTD. The number of people supported by the economy is computed as follows: first, a matrix G^* is set equal to

$$(16) \quad G^* \quad = \quad (V \quad \hat{X}{}^*) / \bar{D}$$

$$(15 \times 49) \quad (15 \times 49)(49 \times 49) \quad (15 \times 49)$$

where '/' indicates term by term division. G^* shows the distribution of people (consumer units in the 3-order model) among income classes and sectors of employment of head of household. The number of people supported is:

$$(17) \quad 1 \quad G^* \quad 1$$

$$(1 \times 15) \quad (15 \times 49)(49 \times 1)$$

(d) PER CAP Y: Per Capita income equals value added to families (a) divided by 2,467,564, the population of Puerto Rico in 1963.

(e) H H CONS: Total Household Consumption equals:

$$(18) \quad 1 \ [0 \ \ C] \ \overset{\sim*}{X}$$

$$(1 \times 49)(49 \times 64)(64 \times 1)$$

(f) IMPORTS: Total imports required for the exogenous demand program $\overset{\sim*}{Z}$ equals:

$$(19) \quad 1 \ [M \ \ M_c \ ] \ \overset{\sim*}{X}$$

$$(1 \times 49)(49 \times 64)(64 \times 1)$$

This figure does not include direct exogenous demand for imports.

(g) KUZNETS: The Kuznets ratio of income inequality is computed as follows. Set W^*, a 15 by 1 column vector, equal to the last 15 elements of $\overset{\sim*}{X}$. Let:

$$(20) \quad w_i \ = \ W_i^* \ / \ (\sum_{j=1}^{15} W_j^*) \quad i = 1, 15$$

Moreover, let:

$$(21) \quad P^* = G^* \quad 1$$

$$(15 \times 1) \quad (15 \times 49)(49 \times 1)$$

$$(22) \quad p_i \ = \ P_i^* \ / \ (\sum_{j=1}^{15} P_j^*) \quad i = 1, 15$$

Thus, w_i is the fraction of total personal income accruing to income class i and p_i the fraction of total people supported (total consumer units supported in the 3-order model) in income class i. The Kuznets ratio is:

$$(23) \quad \sum_{i=1}^{15} \ \left| p_i - w_i \right| \quad 100$$

(h) GINI: The Gini coefficient is another measure of income inequality. To compute it, let:

$$(24) \quad W_i \ = \ \sum_{j=1}^{i} \ w_j \qquad i = 1, 15$$

$$(25) \quad P_j \ = \ \sum_{j=1}^{i} \ p_j \qquad i = 1, 15$$

The Gini coefficient equals:

$$(26) \quad 1 \ - \ \sum_{i=1}^{15} \ (P_i - P_{i-1})(W_i + W_{i-1})$$

where P_o equals 0 and W_o equals 0.

(i) EMPLOYMENT: The vector of total employment by occupation generated by each program equals:

$$(27) \qquad N \qquad X_a^{*}$$

$$(18 \times 26) \ (26 \times 1)$$

Total employment is the sum of employment by occupation. Occupational data was broken down by sex and the ratio of men to women employed (MEN/WOMN) was also computed.

FORTY-NINE ORDER MODEL

In Appendices I, II, and III are shown, respectively, M_{pu}^*, M_{pr}^*

$$\begin{bmatrix} A^* & F^* \\ \hline V_j^* \\ W_r^* & 0 \end{bmatrix}$$

Matrix D is shown in Table I.17. It is a 15 by 49 matrix and shows the fractional shares of value added to households received by each income class in each of the 49 sectors. The information was derived from the first budget study for the 8 sectors listed on page   and disaggregated to 49 sectors according to the schemen on the same page. The 15 income classes used were defined on an income per capita basis and are as follows:

Income Class Code	Per Capita Income Levels
INC 1	$ 0 – 200
INC 2	201 – 400
INC 3	401 – 600
INC 4	601 – 800
INC 5	801 – 1000
INC 6	1001 – 1200
INC 7	1201 – 1600
INC 8	1601 – 2000
INC 9	2001 – 2400
INC 10	2401 – 2800
INC 11	2801 – 3200
INC 12	3201 – 3600
INC 13	3601 – 4000
INC 14	4001 – 4800
INC 15	4801 and above

V^* and D_s^* were then computed according to Equations (4) and (5).

Vector N_p^*, showing the number of people in each income class, was computed in the first budget study. It is shown in Table I.18. $\bar{D}_s$ was then computed according to Equation (6). Vector λ was computed in the second budget study and is shown in Table I.19. The per capita expenditure $\bar{E}$ was then computed according to Equation (7).

The two 49 by 1 vectors α and β were estimated in the second budget study. These vectors are shown in Table I.19. The 49 by 15 expenditure matrix $\bar{C}$ was then computed according to Equation (8). Because of the linear form of the Engel curves, negative expenditures on certain sectors were computed. These negative elements were set to zero. Each column of expenditure was then summed, and each element of the column divided by its column sum to yield a 49 by 15 matrix showing the distribution of expenditure over 49 sectors by income class. Each column j of this matrix was then multiplied by $\bar{E}_j$ to

balance the column sums of $\tilde{C}$ with $\tilde{F}$. $\tilde{C}$ is shown in Table I.20.

C^* was then computed according to Equation (9). Since C^* was derived from sample estimates, its elements did not balance with input/output consumption data. Total household consumption of the total flow matrix was used as control totals for expenditure flows, and C^* was balanced by multiplying each of its rows by the ratio of household consumption according to the input/output data to its row sum.

Next we constructed the 64 by 74 total flow matrix:

$$\begin{bmatrix} A^* & C^* & F^* \\ \hline V^* & & \\ W_r & O & \end{bmatrix}$$

Two import matrices M_{pu} and M_{pr}, corresponding to M^*_{pu} and M^*_{pr}, were created. M_{pr} is shown in Appendix IV. Two 49 by 1 vectors, M_{hpu} and M_{hpr}, showing the ratio of household imports in purchaser and producer value respectively to total household consumption by sector, were computed. M_{hpu} is shown in Table I.21.

M_{cpu} and M_{cpr}, 49 by 15 matrices showing the ratio of household imports by sector and income class to total income by income class, were then computed according to Equations (11$'$) and (11$''$) respectively. M'_{cpr} is shown in Table I.22. Of particular interest are the totals in column 50 which show a declining import leakage as income rises.

In Appendix V is shown the domestic coefficient matrix:

$$\begin{bmatrix} A - M_{pu} & C - M_{cpu} \\ \hline V & \\ W_r & O \end{bmatrix}$$

Note in particular columns 50 to 64 of row 66 which show the ratio of expenditure on domestic goods to income for each income class and, thus shows the net effect of savings and import leakage.

The domestic import matrix was compiled accordingly:

$$
\left[
\begin{array}{c|c}
I + M_{pu} - A & M_{pu} - C \\
\hline
- V & I
\end{array}
\right]^{-1}
$$

Table I.23 shows $\overline{D}$, a 15 by 49 matrix of income per consumer unit by sector and income classes. This was computed in the first budget study for the 8 sectors listed on page 12 and then disaggregated to 49 sectors according to the scheme on that page.

Table I.24 shows $K \cdot 1,000,000$, employment by occupation per \$1000m of output by sector. N was derived by aggregating X^* to the 26-sector vector X_a^* according to the aggregation scheme on Tables II.D and II.C, and dividing each column of N^*, shown in Appendix II.2, by the corresponding entry in X_a^*.