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Input-Output Analysis of the Puerto Rican Economy

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A. Background of the Study

EFFECTIVE pursuit of a project of statistical analysis, we are told, imposes some rather arduous requirements on the investigator. Before beginning his work, he should have a clear idea of his purpose. He should have in mind a suitable model for implementation. And he should be familiar with the various sources of relevant information and the costs of exploiting them.

The input-output analysis of the Puerto Rican economy was begun, in the fall of 1949, without any considerable satisfaction of the conditions mentioned. A model had been formulated, or rather a family of models. Wassily Leontief's *The Structure of the American Economy, 1919-1929*, and his few journal articles discussing the open model as contrasted with the original closed one, constituted almost the entire source of published material. The Bureau of Labor Statistics had carried out an analysis of the United States economic structure, under Leontief's guidance, based upon 1939 data. The methodology was unpublished, but several articles had appeared indicating application of the results. All in all, it might be said that, apart from the skeletal structure of the analysis—the basic general equilibrium formulation in terms of simultaneous equations—whatever knowledge there was of the developmental potentialities of the model and of the procedures for its implementation was confined to the minds of a few people. Even within those limits, thinking had been concentrated on the features of the model applicable to the United States.

To understand the purpose of the sponsors of the Puerto Rican study, a little descriptive background is required. The pressing problems of this insular society, characterized by a rapidly rising population, limited resources, and low average income, have been faced with energy and spirit by a local government that is democratically elected and has considerable autonomy within its status of United States commonwealth. The attitude is expressed in a willingness to experiment and in a strong interest in pertinent scientific inquiry.

Among the many research agencies officially supported, the Social Science Research Center of the University of Puerto Rico has devoted its efforts to carrying out scholarly inquiries that should in some way serve the aims of social and economic betterment. It was the director of this center who recommended an input-output analysis of the economy. The study was to present a picture of the "structure" of the economy, and was to contain a number of "industry studies." Beyond that, the details of purpose as well as method were left to Leontief, who agreed to serve as supervising director of the project, and to the present writer, who undertook the work of statistical inquiry and organization of results.

It is believed that the circumstances noted have some general relevance. The relatively underdeveloped areas of the world have become conscious of the contrast between their own socioeconomic status and that attainable by man. For a model of the possible in certain respects, they look to us. To the chagrin and bewilderment of some of our citizens, however, this discovery of contrast and apparent potentiality has acted as a stimulus in the direction of government planning for development. Whether out of basic concern for human need, or for personal aggrandizement and the spread or retention of personal power, the leaders of such areas are following this pattern. They generally recognize their helplessness without some significant advance of knowledge—knowledge of the organization and magnitudes of some features of their society, and knowledge of the applicable principles for change. In these fields, as in all branches of technology, it is felt that the newest must be the best. Almost certainly, this is one of the chief reasons for the present wide and growing interest in the input-output technique manifested by the governments of underdeveloped areas and by international agencies concerned with such areas. They feel that perhaps this is the elusive device that can be put to work to formulate and solve their problems and to set them on the road toward the American standard of living. Because of these possibly exaggerated hopes, it is important to consider the usefulness of input-output analysis in other types of economy than our own, the kinds of variation of the model that may be necessary in such cases, and the problems of statistical implementation.

Of the third condition, that for most effective statistical investigation, or knowledge of the sources of relevant information, not a great deal could be claimed by the writer when he was trying to plan the project and when he arrived in Puerto Rico to set up a

working staff. Obviously, this is an extreme handicap in such a study. It is decisive as regards planning and organization, and it seriously affects the issues of purpose and model. How can a detailed model be constructed when it is not known whether the boxes can be filled with any degree of reliability? To some extent the model must be tailored to the available data. This was the crux of Leontief's original strategic departure from traditional general equilibrium theory; he abstracted from subjective demand and price-substitution considerations, which would have been impossible to quantify, and limited the body of constants to magnitudes of input-output relationship, for which objective data could be secured. This compromising attitude must remain as the technique is applied to other areas and problems.

It will be seen later that the statistical sources in Puerto Rico are relatively extensive. Yet some of them did not come to the writer's attention until fairly advanced stages of the study. When they did, they sometimes necessitated revisions of work done or indicated duplication of work that could have been avoided.

Personal experience has been cited here for its illustrative value. The gathering of material for an input-output analysis is so inclusive in its demands that it imposes two more or less conflicting requisites on the directing investigator. He must proceed with a reasonably clear set of purposes and a reasonably detailed and appropriate model, so that the considerable time and cost involved will not be inordinately extended; otherwise, he will find himself running into blind alleys, or omitting the collection of data that could be obtained with relative ease simultaneously with other items, if the need for them is originally recognized, but that become very costly if the recognition arises afterward. Yet in order to set up the purposes, the model, and the details of methodology, he must have a fairly thorough knowledge of the character of the economy under study; unfortunately, this is the kind of knowledge that normally will be at hand only as the result of the projected analysis.

The dilemma has been put baldly and with some implicit exaggeration. Also, it is not limited to input-output research. But it applies here with special seriousness, if only because of the need to economize in a kind of activity that has so far proved expensive. It seems that the resolution of the difficulty can come from two approaches. One is the benefit to be gained from the experience of others. If each completed structural analysis is followed by a full account of methods used, describing not only the details of pro-

cedure but the reasoning leading to their selection in terms of basic aims and statistical resources, then a methodological background will be available for adaptation to new statistical analysis. The usability of this background will increase with the variety of types of economy reported. The second approach is one that should be followed in any case but perhaps would not be quite so necessary if publications on the conceptual and methodological features were at hand, namely, that the investigator, before setting a staff to work, spend some time in acquiring a rounded and reasonably complete grasp of the nature of the economy, and that he familiarize himself with the existing or potential sources of information and with some preliminary estimate of their relative reliability. In the writer's experience this is a prerequisite; staff members cannot be expected to fill the gaps of knowledge as the work proceeds.

It would be unrealistic to imply that the above conditions for successful planning of the project can ever be fully met, or that they would permit the initial formation of a program so thoroughly well-founded that it could be carried through with absolute fidelity and success. Frustrations will arise, and the need for deviations is the only development that can be confidently expected. But it is believed that emphasis on the proposed approaches will help to reduce waste to reasonable tolerance; this belief has been repeatedly impressed on the writer in his current effort, especially as the analysis enters its final stages.

B. The Puerto Rican Economy

From what has been said, it may be understood that in order to gain any benefit from the experience to be reviewed—from the discussion of aims, methods, and problems—one must have some knowledge of the pertinent features of the Puerto Rican economy. A brief description is therefore in order.

Puerto Rico is a Caribbean island about 30 by 100 miles in size, situated some 1,000 miles east of Florida and 1,400 miles southeast of New York. It has a population of approximately 2,200,000, and a population density of 645 per square mile. Its birth rate is approximately 40 per 1,000, and its death rate 10 per 1,000. As a United States possession it is within our tariff area, subject to our Constitution and to special laws of Congress, and its citizens are, of course, citizens of the United States and unrestricted in their movements within the nation.

Puerto Rico elects its own governor, lives under laws enacted by its own parliamentary body (so long as they do not conflict with

relevant federal law), and has its own fiscal structure as regards both internal taxation and expenditure. Considering these facts, as well as the cultural differentiation from the continental United States, and the geographic separation which acts as a deterrent to factor movements, it seems justifiable to consider the island as "an economy." This is reflected, and perhaps partly supported, by the fact that the local government considers the island's problems—chiefly the economic—to be unitary in character, separate from the problems of the United States as a whole, and fundamentally requiring their own vital concern and active resolution.

The insular economy is generally classified as underdeveloped. The net income in fiscal 1947-1948, the year of our study, was estimated at $617 million, and the per capita income at $287, which was far from equally distributed. Of this total, about 24 per cent was estimated to have originated in agriculture (10 per cent in sugar cane cultivation alone), 13 per cent in manufacturing, 20 per cent in federal and insular government agencies, 21 per cent in trade, —2 per cent in net capital outflow, and the remaining 24 per cent in construction and miscellaneous services. In that year, goods were exported with a value of about $196 million, all but about $6 million being shipments to the United States mainland. Merchandise imports had an f.o.b. value of about $366 million, including $24 million from foreign countries; an additional cost of $27 million for ocean transportation of the imports added to the deficit in the current external balance, for practically none of the shipping is in Puerto Rican vessels. Evidence of the significant dependence on specialization is given by the fact that sugar made up over 60 per cent of the shipments to the United States, needlework products 18 per cent, and tobacco and tobacco manufactures 5 per cent. Rum, which had constituted 26 per cent of the shipments in 1944, had fallen to less than 1 per cent in 1948 (about $1 million compared with the earlier $35 million); this decline resulted solely from change in United States demand conditions, and some reversal in trend has since occurred.

A critical feature of the economy is the extraordinary magnitude of continuous unemployment. Of a labor force of about 760,000 in 1947-1948, it was estimated that 110,000 were unemployed and 150,000 others working less than 30 hours a week. This accentuates the significance of the net current rate of population growth of about 30 per 1,000. Some offset arose from the net emigration of about 35,000 per year, but since many of the migrants were drawn

from the trained working force, the alleviation could not be accepted as sheer relief. Federal grants in aid in 1948 amounted to about $6,500,000, and remission of customs duties and mainland excise taxes on Puerto Rican rum to $6,000,000 more; federal agricultural payments and subsidies added about $15,600,000. Rapid improvement in public health facilities under both federal and local sponsorship had contributed largely to reduction in the death rate, and local family relief grants and widespread informal charity contribute to the subsistence of a sizable part of the population.

Evidently, the central economic problem of the island is to raise its income—with the qualification that this be done along socially acceptable lines and in directions promising stability and expansion. This would carry as a corollary the avoidance of dangerous specialization, or of mere amelioration through greater federal aid. The insular government considers this economic problem one of its basic responsibilities and has investigated many suggestions, through trial as well as study. It appears that no untapped natural resources in the usual sense are available. Some improvement of land use is possible, and progress has been made in that area. But clearly the greatest resource potential is manpower; the task is to find useful employment for the 100,000 or so unemployed and more effective activity for the 150,000 underemployed. Beyond this, the objective is to raise the productivity of all factors through investment, training, and the alteration of the economic structure in directions contributing most fully to income creation. If input-output analysis could contribute anything in this area of exploration, it seems clear that it should be so oriented.

C. Puerto Rican Statistical Sources

The Puerto Rican study was made for the fiscal year ending June 30, 1948. When work upon it was begun in the fall of 1949, it was decided that the base period indicated would be sufficiently recent so that relationships derived from the data would have considerable validity, while not so recent that some principal records and statistics would not yet be available. The latter assumption turned out to be incorrect in some important respects, but it was felt that data for an earlier year would be so seriously affected by war conditions that the underlying assumption of long-run general equilibrium would be significantly violated. The fiscal year was chosen instead of the calendar period because a number of important sets of data were customarily on this basis and because the important sugar

crop roughly coincided in growing, harvesting, and milling cycle with this interval.

The most important sources of information were the following:

1. The *Puerto Rico Census of Manufactures, 1939*, and corresponding censuses of business, population, and agriculture, all carried out by the United States Bureau of the Census. Unfortunately, these were so remote in time, and the information was deemed so unadaptable to the investigators' needs, that they were in general ignored as sources of actual magnitudes.

Similar censuses had been taken for 1949, but the censuses of manufactures and of business were not published until 1952, and the other censuses are unpublished as of this writing. The writer had access to the schedules of the two published censuses, and from them obtained some useful, detailed information, not only in advance of the date of general availability but beyond what could be learned from the tables to be published.[1]

Had the 1949 censuses been available when the study was begun, they (and especially the *Census of Manufactures*) would have been used in much the same way the 1947 censuses served the BLS interindustry study: to specify the activity levels of industries, the payrolls of production and nonproduction workers, and the control totals of materials used and of value added (as the *Census of Manufactures* defines this) with adjustments or substitutions where apparently more valid information was obtained. This would have altered the classification scheme and the over-all method of procedure. As it was, it did not seem worthwhile to recast the entire study when the *Census of Manufactures* tables came to hand, so that this source has been used to a comparatively minor extent. It may be added that the independent estimates developed for both activity levels and input ratios of payroll or materials seldom deviate substantially from those ascertainable from the census. Where they did, it was usually thought that the investigators' estimates, based on knowledge of the industrial structure,[2] were more reliable than the census aggregates.

[1] It is interesting to note that, in reviewing the schedules, the writer detected a number of errors in reporting and classification, some leading to clearly impossible industry levels. They had gone unrecognized by the best informed statistical experts of the Puerto Rican government, who had been associated with the collection and processing of the data. This familiarity with the details, as well as the broad characteristics of the economy, is one of the results of the pursuit of such a structural study.

[2] For certain industries, for which it was believed no reliable estimates would otherwise be possible, industry levels were estimated by extrapolating or ad-

2. The net income estimates for the Puerto Rican economy. A typical social accounting scheme was set up by Daniel Creamer for the period 1940 to 1946, and has been continued on a current basis by an agency of the insular government. However, it was not until 1951 that the analysis for 1947-1948 became available, and it has served chiefly as one means of checking gross discrepancies of estimates, rather than as a basic source.

3. The gross product estimates for the Puerto Rican economy, also established by Creamer and carried on subsequently by the insular government. This analysis too was not available for 1947-1948 until 1951. In addition, as its typical method of estimating domestic industry levels[3] seemed to be liable to unmeasurable error, this source was practically never used for activity levels, even after the data were forthcoming.

4. Records of the State Insurance Fund (generally referred to hereafter as the Fund). This is a compulsory workmen's compensation agency for all employers of three or more workers. Productive activities are classified into some 150 kinds, frequently by type of product, though basically according to risk to the worker, and the employer reports his annual payroll for each of these categories. The Fund runs a number of tabulations of these data, two of which are of great statistical value. One list classifies each employer according to his "governing code"—the category of his primary employee activity—and enters his entire payroll into this class, summing the tabulations for each category. A second list—the "pure code" tabulation—presents, for each category, wage payments for all workers so occupied, irrespective of the primary activities of their employers; the category totals here would roughly indicate production worker payrolls in each activity throughout the economy, overcoming the usual loss of detail where multiproduct producers report their payrolls by firm or establishment. Some of the ways in which these important tabulations were used are described below. Their most serious limitation derived from the divergence of the classification system from our own. Further reservations were necessitated by the circumstances of possible underreporting, limitation of re-

justing the census figures back to 1947-1948, and in a very few cases individual schedule production figures were adopted or adapted (where the census classification cut across our own, for example).

[3] This consists of extrapolating the 1939 census figures by link relative ratios based on changes in operating receipts of sample firms in an industry in consecutive years.

ported individual salaries to $5,000, the three-employee cutoff point, misclassifications, and the fact that force account construction payrolls were included in the "governing code" tabulations, whereas the "pure code" report would in general omit administrative and office workers, drivers, etc.

5. Series prepared by the insular Bureau of Labor Statistics, including estimates of production worker payrolls in manufacturing by industries, using the Standard Industrial Classification employed by the census and based on sample enumeration. The bench mark had been a census of manufactures taken by the insular BLS in 1946, but the 1949 estimates were in some cases found to diverge seriously from the results of the United States census of Puerto Rico; the latter have become the new bench mark. The input-output study had in some cases been using the BLS estimates, and late in the study found it necessary to discard them—a cause of further perturbation, adjustment, and delay.

6. Estimates of yields of individual agricultural products, by volume and by farm value, prepared annually by an insular government office, and varying considerably in reliability among the different products. Except where manifestly superior sources, chiefly newer revisions, were available, these estimates were used.

7. Individual industry cost studies, prepared by local agricultural agencies, the Puerto Rico Minimum Wage Board, and the Federal Wage and Hour Division of the Department of Labor. These studies varied in scope, period covered, reliability, and appropriate industrial classification.

8. A detailed listing of Puerto Rican imports and exports in the fiscal year, giving f.o.b. shipping weight and value, by country of origin. The listings were taken from the monthly reports of the United States Department of Commerce, based on shipping declarations to customs, and used the department's classification, which differs from the Standard Industrial Classification.

9. The annual balance of payments of Puerto Rico, prepared by an insular agency, and fairly detailed in character.

10. Reports and records of various insular government agencies. Almost invariably, these are well kept and in good detail. For example, the Annual Auditor's Report gives a breakdown of expenditures of the administrative departments, often by object.

11. Income tax returns in the files of the insular Treasury Department. The broad tax base and the recent stress on enforcement have

made these records a basic primary source. For the analysis they could yield information on both outputs and inputs. They are fundamental for the net income and gross product constructs, and for certain aspects of the balance of payments. Until 1950, no summaries such as those of our Bureau of Internal Revenue tables were published. Since then, listings have been made classifying each reporting unit by industry and tabulating for each unit certain items: gross income, payroll, rent received, etc. But examination of these listings indicates the likelihood of serious errors in the data. The great majority of firms are unincorporated.[4] The enterpriser will often engage in several activities, and his personal financial accounts (such as rent or interest received) may be combined with those of his main business. Furthermore, his indication of the kind of business is especially likely to be casual or vague. The Treasury Department grants access to the files of tax returns to government research units deemed sufficiently important and necessitous,[5] and extended this privilege to the input-output study.

12. Interviews with individuals possessing special knowledge, or having control over important accounting or other records. Certain characteristics of the Puerto Rican economy impart peculiar significance to this avenue of information. The island's small size is associated with pronounced geographical and numerical concentration of many activities; according to the *Census of Manufactures: 1949*, of the 1,998 establishments in the island, 884 were located in the three metropolitan areas, and the value added figure for these establishments constituted almost $47 million of a total of $93 million. The importance and comparative ease of personal contact for both data collection and clarification have great weight, therefore, in certain fields. In some cases two or three firms might compose or dominate the industry, permitting virtually full coverage.[6]

The degree of success in this canvassing of individual firms is worth mentioning. The writer visited hundreds of enterprises, requesting information that in the nature of the case would be guarded

[4] In most manufacturing industries and in some service industries, however, incorporated firms dominate in value of output and value added.

[5] One of the purposes of setting up the income tax listings described was to free the tax files and staff from the great volume of statistical inquiry regarding individual returns. But the results demonstrate that the value of such apparently routine tabulations depends heavily on the judgment and training of the coding clerks.

[6] This kind of data collection is not always feasible in an underdeveloped economy. It would probably be limited to manufacturing and major utilities, and even then would not be appropriate in broad geographical areas with considerable industrial dispersion, such as India.

closely. Initial resistance was often met, but only one case can be recalled in which a final refusal occurred.[7]

The above list is by no means exhaustive of sources of relevant data. It is meant to convey the apparent breadth and variety of statistical resources appropriate to such a study and awaiting exploitation. In some cases this apparent wealth of data was deceptive and sometimes embarrassing when different sources gave appreciably different estimates or supposed aggregates. This is no novelty to the social statistician. The problem grows in seriousness when there is practically no recourse to prior studies to test the relative reliability of magnitudes. There was little choice but to select the value that seemed most acceptable, work with it, and then reappraise its acceptability in the light of later dovetailing. The ultimate necessity of reconciliation throughout the system is one of the trials, as well as a virtue, of input-output research.

The absence of critical evaluation and elucidation of existing statistics in an economy such as that of Puerto Rico is another reason for the indispensability of personal interviews with experts, and especially with respondents who furnish basic data. Some published figures were subject to complete reinterpretation as the result of such clarification, particularly in instances where the officials responsible for collecting the data had to some extent misunderstood their meaning. For this reason the writer believes that the active director of an input-output study should almost invariably remain resident in the economy being analyzed; here perspective comes from proximity rather than distance.

D. Plan of Statistical Procedure: The General Method

At the outset it was decided that investigation should be restricted entirely to the derivation of goods-flow coefficients.[8] This would presumably yield the set of relationships describing the dependence of the output of any sector upon the inputs from other sectors, as well as the dependence of these inputs upon the sectors producing them, and so back to the ultimate resources of the economy.

[7] Other staff members, mostly residents, were often less successful in inquiries, and it seems that the differentiating advantages may have been the prestige attached to the directing position, the fact of being an *Americano*, and the possession of wider knowledge regarding both the study itself and the particular industry or problem being investigated. Familiarity with the field that the enterpriser considered his own was often decisive in inviting confidence and respect.

[8] The time limitation initially stipulated for the project impelled this decision.

As the work proceeded, the realization grew that this plan was not feasible. The analysis was carried on almost entirely from the input side, e.g. the estimation of the specific materials and services required to produce a given output of cement. However, to have any reasonable assurance of an accurate total of such inputs in any particular case, it would be necessary to know the sum of the residual components of output value—depreciation, rent, profits, and any other "financial" items.[9] Hence, it became worthwhile to make the full analysis of inputs, both those representing real resources and those more closely akin to transfers. At the same time, the effort would be made to yield an analysis adaptable to the measurement of insular income and product. The attainment of other purposes mentioned in the final section—the integration of scattered statistical measures, testing of their consistency, and development of gap-filling statistics—would naturally accompany the operations.

An attempt was also made to obtain some information for the estimation of capital coefficients. Partial results of this phase are given in a later section of this paper.[10]

E. Classification

The scheme of classification had to be decided at the outset. This initial choice must clearly rest on the most careful deliberation, since it determines to a considerable extent the course of any investigation, and delimits the ultimate applicability of the results. Great flexibility of use will be gained from a highly detailed classification. Against this is to be weighed the availability of data. In the present case, the absence of timely census information removed the otherwise powerful inducement to use the census classification. With inadequate knowledge of the character and reliability of the other statistical sources, it was decided to use a fairly pure product classification. Conceptually, this would not differ greatly from a schema of the census type if there were few important cases of establishments producing secondary products. Where secondary products are significant, the use of the census classification probably necessitates employment of some device such as that of the United States BLS interindustry analysis—the fiction that secondary products are sold by their producers to the industry for which these products are

[9] This distinction is not meant to imply that no economic value corresponds to such payments. But there is good reason for distinguishing them from payments for the kinds of input that can be created in response to current need, or that are limitational in the short run.

[10] See pp. 353-354 below.

primary, and then become part of a pool of output for general distribution.[11] There are a number of theoretical problems involved in this matter, but to the writer it appears that a pure classification is preferable, if feasible. One handicap is that it may greatly restrict the discovery or application of control totals, which are rarely available for such pure categories.

Table 1 presents the classification system underlying the analysis.

TABLE 1

Classification of Sectors Used in Input-Output Analysis of Puerto Rican Economy

AGRICULTURE

1. Sugar cane
2. Tobacco
3. Coffee
4. Milk
5-41. Other agricultural products
42. Fishing

MANUFACTURING

43. Agricultural products processing (n.e.c.)
44. Alcohol distilling
45. Alcohol rectifying and bottling
46. Artificial flowers
47. Baking, bread and pastry
48. Baking, crackers
49. Baking, macaroni and spaghetti
50. Beer and malt
51. Buttons
52. Candy and chocolate products
53. Canning
54. Cement
55. Chemicals
56. Cigars and cigarettes
57. Clay products
58. Coffee processing
59. Concrete products
60. Diamond polishing
61. Fertilizers
62. Foundries and metalwork
63. Furniture, metal
64. Glass
65. Ice
66. Ice cream
67. Knit goods
68. Leather products
69. Manufacturing (n.e.c.)
70. Mattresses and pillows
71. Medications and toilet water
72-82. Needlework, apparel and other
83. Paper
84. Paper products
85. Printing, commercial
86. Printing, newspapers and periodicals
87. Rugs, wool, and string
88. Salt
89. Soft drinks
90. Sugar milling
91. Sugar refining
92. Tire retreading
93. Tobacco processing
94. Wood furniture
95. Wood millwork

SERVICES AND MISCELLANEOUS

96. Accounting and legal services
97. Advertising
98. Airlines
99. Banking
100. Barber shops and beauty parlors
101. Business services (n.e.c.)
102. Communications
103. Construction
104. Doctors and dentists
105. Electricity generation and distribution
106. Foreign and United States expenses
107. Funeral service
108. Government, federal

(continued on next page)

[11] See W. Duane Evans and Marvin Hoffenberg, "The Interindustry Relations Study for 1947," *The Review of Economics and Statistics*, May 1952, pp. 105-107.

TABLE 1—*continued*

109. Government, municipal
110. Government, insular
111. Hospitals, private
112. Hotels
113. Imports—alcoholic products
114. Imports—animal products
115. Imports—chemicals and drugs
116. Imports—clay products
117. Imports—consumer goods (n.e.c.)
118. Imports—glass goods
119. Imports—industrial goods (n.e.c.)
120. Imports—leather
121. Imports—leather products
122. Imports—machinery and parts
123. Imports—metals, unfabricated and semimanufactured shapes
124. Imports—metal shapes, fabricated
125. Imports—minerals and mineral products
126. Imports—paper and paper products
127. Imports—petroleum products
128. Imports—rubber products
129. Imports—textiles
130. Imports—tools
131. Imports—vegetable products, unprocessed
132. Imports—vegetable products, processed
133. Imports—wearing apparel
134. Imports—wood and semifinished wood products
135. Imports—wood products, finished
136. Insurance
137. Laundries, dry cleaning, dyeing
138. Maintenance of buildings, contract
139. Milk pasteurizing
140. Molasses distribution
141. Motion-picture theaters and distributors
142. Nonprofit organizations
143. Passenger transportation, buses
144. Passenger transportation, *publicos* (jitneys)
145. Passenger transportation, taxis
146. Personal services (n.e.c.)
147. Photographic studios
148. Professions (n.e.c.)
149. Quarrying and allied
150. Radio broadcasting
151. Railroads
152. Repair shops, automobile
153. Repair shops, other
154. Restaurants and bars
155. Schools, private
156. Shipping facilities
157. Services (n.e.c.)
158. Trade
159. Trucking for hire
160. Water supply and sewer services
161. Payroll, production workers
162. Payroll, nonproduction workers
163. Rent
164. Interest
165. Depreciation
166. Profits
167. Other financial items
168. Inventory change
169. Household purchases
170. Capital formation
171. Exports
172. Undistributed

n.e.c. = not elsewhere classified.

It is not final or complete. Presentation of the completed table will involve considerable consolidation of classes, for convenience of preparation and publication. Also, reconciliation will probably necessitate some consolidation. On the other hand, a number of the categories are themselves consolidations of basic data or estimates that were established separately, either because of the way in which the analysis was built up or because it was believed that the detail might be valuable for potential users. An example of the first case is the category of private schools. No reliable control totals or

estimates were available here. The final estimates were attained by analyzing separately both the outputs and the inputs of three different types: commercial schools, Catholic schools, and noncommercial non-Catholic schools. Illustrating subclassification largely for the sake of detail, the rectifying and bottling of alcoholic beverages was divided into production for domestic sale, for foreign sale, and for mainland United States sale. The last type, for example, involves heavy advertising and other expenses on the mainland, whereas domestic sale omits these but has its own special inputs.

It may be seen that the classification scheme is thus not entirely consistent in the meaning of the "pure product" concept. The basic classification criterion, for effective use, is that it should validate the assumption of constancy of the coefficients; to satisfy this criterion fully, the classes should be truly elemental activities. Since this is statistically impracticable, almost every category is to some extent a consolidation, and the relevant issue is, How heterogeneous is the class? Or, how stable is the ratio of the components over time with change in the total activity level of the class? Whether these conditions are fulfilled for a particular classification scheme could hardly be known in advance of the study itself, and their validation would involve considerable testing. Such tests were not carried out, and more or less intuitive judgment as to homogeneity or stability were applied.[12] It was assumed, for example, that the inputs of activities producing various types of concrete product were sufficiently uniform or stable in composition to be combined, and that the same held for canning. Construction, truly a conglomerate activity, was accepted as a single class because of the aggregative or residual mode of identification of most of the input constituents.

F. Derivation of Coefficients

The typical procedure for deriving coefficients, presented by Leontief in his first structural study and continued thereafter, is to determine the aggregate production of a sector in the base year, to charge to this sector the aggregate individual quantities of other sectors' products used by it, and to compute the coefficients as ratios of each aggregate input to the aggregate output of the using sector. An alternative suggested by Leontief is the derivation of coefficients from engineering analysis. While the latter method may be superior to the other in some respects, it seems inferior as a basis for predic-

[12] Some general evidence of stability is given in Table 5 and the discussion of it.

tion of total activity levels for flow requirements; also, the aggregative method yields the concomitant picture of the year's estimated flows at actual levels.[13] The present study adopted the conventional methodology—the estimation of aggregate outputs and inputs. This is not as straightforward as it might seem. In some cases, total output was estimated by the application of a ratio of output per unit input to the estimated total value of the particular input by the sector. In other cases, the total value of an input was estimated by applying a sample input ratio to the total output. When such methods of estimating aggregates are used, the subsequent "derivation" of the respective coefficients by the use of the aggregates is circular.

The table entries are stated, in general, in producer's value—that is, net of markups, added transportation costs, and excise taxes. Special valuation concepts were developed for a few products, such as banking, insurance, and shipping services, for which the standard value definition was not analytically profitable.

G. Estimation of Outputs and Inputs

Since this paper is concerned essentially with the broader issues raised in applying interindustry analysis to an underdeveloped economy, its scope and size prevent any substantial account of the various statistical devices used to derive the required estimates. Their variety was indeed considerable, as could be expected in such a pioneering effort. But among them emerged a few general techniques worth indicating—for the interest they may offer in themselves, and to call attention to some of the theoretical and empirical problems involved in seeking to implement the model.

In the agricultural sector, the pure product classification plan seemed to agree perfectly with the available output data. A government agency had prepared estimates of annual production for each of forty-two crops, in physical and value terms; since these estimates were the basis for any subsequent aggregation, no accuracy could be lost by accepting the individual crop outputs instead of working with an over-all production total. The problem then was to match input analyses to these categories. For these the investigators turned to a number of individual crop cost studies, already existent or specially prepared for them by several local government units. Much time and effort were given to securing these studies and adapting them to needs of the investigation, for they seemed to offer the ideal kind of information to supplement the crop

[13] It has other functions discussed below; see pp. 358-359.

estimates. But the sense of accomplishment ebbed when it was found that application of these input ratios gave industry input values generally widely different from whatever independent estimates were available (such as wages reported for a few individual crops by the State Insurance Fund). This is an example of the kind of statistical inconsistency revealed by input-output analysis and of the contribution rendered by the very imposition of the comprehensive schema. It is true that the agricultural statisticians could have made the same discovery, but they had not; the various sets of statistics had been prepared by different groups, and it was not surprising that each had failed to test the consistency of its own results with those in fields with which it was not directly concerned.

It would have been possible to ignore this problem of inconsistency by consolidating the agricultural sector and accepting available aggregate input estimates, such as those for labor, fertilizer, animal feeds, etc.; an undistributed input residual component would then have included the net sum of errors in outputs and inputs. But this would at the least have precluded the presentation of results permitting policy makers to estimate the repercussions following upon the shift of the pattern of agricultural production—a matter of serious concern. Fortunately, the investigators were confident that their analyses of the input structures for several major crops had a high degree of validity; for the others, the final choice between individual analysis and consolidation will rest upon the degree of reconcilability of the figures implicit in the individual cost studies. Table 2 presents the preliminary analysis of the sugar cane growing industry, as an illustration of the degree of detail obtainable with a fairly high degree of confidence in this most important agricultural sector. Further processing will reduce the inputs to items fitting the basic classification scheme, measured in producer's value.

In the manufacturing and service sectors, a major problem was that of output estimation. For a few industries, the measurement of output was simplified by the availability of figures for aggregate physical production, collected by government agencies in the course of their administrative activities. But for most, original estimates had to be developed. Full coverage was feasible—from income tax returns or company records—when a few firms comprised the industry. Elsewhere, energy and invention were considerably strained. The single method that might be considered general was the expansion of the ratio of output to labor input of sample firms in an industry, on the basis of the total payroll for the industry as reported

TABLE 2

Preliminary Analysis of Sugar Cane Growing in Puerto Rico in 1947-1948

(*dollars in thousands*)

		Producer's Value	*Quantity*
Output		$90,760	9,531,232 tons
Cane	$75,735		
Subsidy	15,025		
Inputs		*Purchaser's Value*	
Agriculture—timber (posts)		$ 50	
Fertilizer		10,423	207,900 tons
Foundries and metalwork		50	
Sugar milling (administration, repairs, etc.)		196	
Accounting and legal services		380	
Communications		214	
Doctors		100	
Electricity		487	
Government, federal (postage)		32	
Government, insular (taxes)		2,000	
Imports—chemicals		280	
Imports—consumer goods		172	
Imports—industrial goods (n.e.c.)		853	
Imports—machinery parts		653	
Imports—metal shapes, fabricated		160	
Imports—office supplies		535	
Imports—petroleum products		2,214	
Imports—rubber (tires, tubes)		228	
Imports—textiles (waste)		1	
Imports—tools		68	
Imports—animal feeds		100	20,252 cwt.
Imports—rope		100	
Insurance premiums		1,572	
Nonprofit organizations		19	
Passenger transportation		21	
Professional (n.e.c.) (veterinarians)		68	
Repair shops, automobile		200	
Repair shops, other		62	
Trucking for hire (for cane)		905	
Water (for irrigation)		374	
Payroll		47,992	
Direct labor	$40,611		
Indirect labor	1,949		
Supervisory	2,251		
Administrative	2,164		
Other salaries	739		
Bonus and vacation	278		
Retirement pay, pensions		19	
Rent		3,056	
Interest		1,762	
Depreciation		2,375	
Profit		13,036	
Undistributed		3	
Total inputs		$90,760	

n.e.c. = not elsewhere classified

to the Fund. Special interest attaches to this method of estimation because its use rests on one of the usual assumptions of input-output analysis—the stability of the labor input ratio. In the predictive use of input coefficients the stability assumption refers to time,[14] and in the present case it refers to industry-wide homogeneity, but the principle is the same. Where comparable census output data were obtained subsequently, these were generally close to the results from the indicated method, and discrepancies of more than 5 per cent were almost always explainable by differences in classification, time period, or output concept. In keeping with the pure product criterion, the investigators used the Fund "pure code" payrolls—those relevant to workers carrying on the designated activity anywhere in the economy, whether or not this was the primary activity of their employers. It must be recognized that this approach, analytically valuable as it may be, creates the statistical disadvantage that it bans the direct use of aggregative data available for industries defined by firms or establishments instead of by pure products.

The general method of estimating the allocation of products and resources among sectors was from the input side. Typically, a sample study of income tax returns or company records in a given industry would be made to determine the ratios of inputs to output; each of these ratios was multiplied by the industry's output to obtain estimates of its aggregate individual inputs.[15] For a few local products, and for some listed imports, government information was available that might permit their distributed allocation to using sectors on the basis of knowledge of industrial processes and of the composition of the Puerto Rican economy. Examples are the figures given for division of total fertilizer production into "tobacco fertilizer," "sugar cane fertilizer," etc., or of division of denatured alcohol production into the quantities "entering inventory" or "delivered to plants" producing bay rum, etc. It turned out that farmers were not so discriminating regarding the kind of fertilizer they used as the statistics implied, and that alcohol "delivered to plants" included exports because exports were not listed as a separate category on the report form. Repeated discovery of conflicting statistics such as these, leading to investigations of the sources and reasons for the

[14] Of course, the assumption is not rigid, and it is expected that any discoverable corrections, such as those arising from technical change, will be introduced.

[15] Such an input-oriented approach may seem to be a natural one, but it does not appear to have been the typical method used in Leontief's analysis of the United States economy for 1919 and 1929, or in the BLS analysis for 1939. It is, however, the procedure largely stressed in the 1947 BLS interindustry study.

discrepancies, revealed the deception lurking within apparently precise calculations. This citation is not intended to lend support to a general distrust of social statistics. But it is characteristic of input-output research that its requirement of internal consistency brings such conflicts clearly into the open, and necessitates the most careful selection when a choice is possible, with some guidance being offered by the dovetailing nature of the tableau.

Tables 3 and 4 represent preliminary analyses of two important industries in the manufacturing and public utilities sector—sugar milling and generation and distribution of electricity. The statistical results here are considered to have high validity.

For the great majority of industries, of course, full coverage of accounting records or income tax returns was impossible. A true random sample was not attempted in the selection of firms for input analysis, but an approximation of representativeness was sought, and the sample was usually so large that, barring considerable bias in the selection, the sampling choice could be considered acceptable. But variations in accounting procedures, and in the amount of detail offered, made it inevitable that only for broad input categories would each item in the sample yield a value. Consequently, the sample would vary in size for each input to be estimated, depending

TABLE 3

Preliminary Analysis of Sugar Milling in Puerto Rico in 1947-1948

(*dollars in thousands*)

	Producer's Value f.o.b. Mill	*Quantity*
Output	$116,768	
Raw sugar	$106,260	1,108,262 tons
Molasses	9,821	54,257,000 galls.
Electricity	119	8,618,490 kw.-hr.
Management services	88	
Machine and repair shops	159	
Hospitals	44	
Shipping facilities	81	
Railroad services	186	
Bagasse	2	
Trucking for hire	8	
Inputs	*Purchaser's Value*	
Sugar cane	$75,735	9,531,232 tons
Chemicals	530	
Foundries and metalwork	976	
Accounting and legal services	294	
Air lines	10	

(continued on next page)

TABLE 3—*continued*

	Purchaser's Value
Communications	$67
Electricity	120
Expenses in U.S.	144
Government, federal (postage)	8
Government, insular (taxes)	1,250
Hospitals, private	60
Hotels	2
Imports—chemicals	205
Imports—consumer goods (n.e.c.)	14
Imports—glass goods	9
Imports—industrial goods (n.e.c.)	413
Imports—leather products	1
Imports—machinery parts	656
Imports—metal shapes, fabricated	65
Imports—minerals	196
Imports—office supplies	104
Imports—paper products	33
Imports—petroleum products	951
Imports—rubber products	43
Imports—textiles (bags, etc.)	3,849
Imports—tools	18
Imports—animal feeds	1
Imports—vegetable, processed	16
Imports—wood (lumber)	100
Imports—wood products (ties)	202
Insurance premiums	851
Nonprofit organizations	134
Passenger transportation	30
Professions (n.e.c.)	33
Quarrying and allied	19
Railroads	1,478
Repair shops, automobile	1
Repair shops, other	3
Restaurants	13
Shipping facilities	2
Trucking for hire	883
Water	36
Payroll, wages	9,706
Payroll, salaries	2,638
Pensions, allowances, etc.	78
Interest	763
Depreciation	2,160
Profit	10,065[a]
Bad debts	25
Other financial items	333
Undistributed	1,445
Total inputs	$116,768

n.e.c. = not elsewhere classified

[a] Profit including financial income was $13,608.

TABLE 4

Preliminary Analysis of the Generation and Distribution of Electricity in Puerto Rico in 1947-1948

(*dollars in thousands*)

	Purchaser's Value	*Quantity*
Output	$10,164	350,087,761 kw.-hr.
Inputs		
Foundries and metalwork	$ 17	
Printing, commercial	18	
Sugar milling (electricity produced and sold)	119	8,618,490 kw.-hr.
Accounting and legal services	3	
Communications	10	
Expenses in United States	42	
Government, municipal and insular (taxes)	74	
Hotels	11	
Imports—chemicals	13	
Imports—clay products (insulators)	3	
Imports—machinery parts	8	
Imports—metal (wire, line hardware, etc.)	163	
Imports—office supplies	39	
Imports—petroleum products		
Fuel oil	2,413	883,393,700 bbls.
Gasoline	19	
Lubricants	30	
Imports—tires and tubes	11	
Imports—miscellaneous materials	19	
Insurance premiums	117	
Passenger transportation	23	
Professions (n.e.c.)	4	
Restaurants	23	
Water supply	17	
Payroll, wages	356	
Payroll, salaries	2,385	
Pensions	118	
Awards for injuries and damages	29	
Rent of land and buildings	68	
Rent of office equipment	34	
Interest	1,383	
Depreciation	1,158	
Profit	1,395	
Undistributed	42	
Total inputs	$10,164	

n.e.c. = not elsewhere classified.

on how many records contained that particular detail. The method amounted to the use of more or less fortuitously selected samples of shifting composition for the estimation of various input components. Since it was employed without quantitative assurance of

reliability or homogeneity, it might be held that the results are possibly very deficient as bases for the establishment of coefficients.[16]

One possible test of accuracy is to compare results of the sample analysis with those of the 1949 census that are conceptually comparable. The census required and tabulated only three components of cost: wages of production workers, wages and salaries of all employees, and "materials" (really all purchases from other firms). For the present comparison, all items in the independent analysis considered to correspond to the census category "materials" were summed, as were those considered to be included in "salaries and wages." Table 5 compares the percentage of materials to output, and of payroll to output, as calculated from the census figures, with the corresponding percentages derived from the investigators' preliminary analyses. The columns headed "Coverage" indicate the total value of output of the establishments contained in the census industry and in the corresponding input-output sample. The choice of industries for comparison was limited to those for which the analysis was sufficiently close to finality to seem to warrant consideration, and for which corresponding census categories existed and could be analyzed without violating the law on disclosure. For most of the industries shown, it is evident that the disparity between the percentages from the two sources is not high. Practically all the cases of striking disagreement arise from conceptual differences.[17]

The value of construction activity in Puerto Rico in 1947-1948 was estimated at about $63 million, a considerable amount in relationship to the estimated gross product of $750 million, and in view of the low per capita income. For statistical convenience, this activity is being treated as a single industry, but the gross coefficients thus derived conceal a wide heterogeneity of segments which it would be highly desirable to treat as separate industries. The size of government activity here, and the responsiveness of various kinds

[16] This possibility is independent of the mere fact of sampling, for even complete and perfect aggregates of inputs and outputs are subject to the same criticism when they are thought of as samples from a universe of annual inputs and outputs, for the estimation of which the base-year coefficients are to be predictively applied.

[17] For the diamond-polishing industry, for example, the uniform principle was followed of reducing all outputs to a homogeneous measure, in this case including the value of the diamonds, even for those firms merely contracting to work on stones shipped from the mainland; the census output total contains a conglomerate of gross and net values, just as reported by the various establishments. The census soft-drink industry output similarly aggregates reports, of which some include and some exclude the value of bottle deposits.

TABLE 5

Comparison of Input Ratios Derived from Input-Output Analysis and from *Census of Manufactures* Data

INDUSTRY	*Materials* (*per cent of output*)		*Payroll* (*per cent of output*)		*Coverage* (*thousands of dollars*)	
	I-O	*Census*	*I-O*	*Census*	*I-O*	*Census*
Artificial flowers	22	26	54	73	$ 278	$ 517
Bread and pastry	66	65	22	22	2,425	8,860
Macaroni and spaghetti	74	78	15	14	993	1,328
Crackers and biscuits	63	64	17	19	2,292	2,263
Beer and malt	60	60	20[a]	17	6,102	6,052
Pearl buttons	45	44	40	38	1,020	1,056
Chocolate candy and cocoa	57	56	11	14	221	749
Cigars	43	47	39	27	172	1,797
Concrete products	49	53	29	25	2,502	1,057
Diamond polishing	82	30	15	48	3,885	[b]
Fertilizers	78	79	5	5	11,505	13,224
Ice	38	37	39	43	446	1,029
Ice cream	59	56	19	19	1,036	1,375
Mattresses and pillows	70	72	14	16	1,070	1,599
Soft drinks	54	60	23	19	2,928	5,000
Sugar milling	64	75	10	13	124,643	127,654
Sugar refining	82	87	3	3	27,229	26,483
Wood furniture	48	53	27	26	1,170	3,116
Wood millwork	58	48	21	26	962	1,124

[a] 18 per cent excluding directors' fees, which may have been omitted in census schedules.

[b] Not published by census to avoid disclosure. Percentages computed from schedules.

of private construction to public policy decisions, emphasize the need to be able to trace separately the interindustrial effects of changes in the volume of construction of roads, schools, dwellings of various types, factories, and of hydroelectric or irrigation projects. Data leading to such refined input analyses were collected, and will ultimately be processed for the development of more detailed coefficients.

The activity of domestic trade has two distinct phases, which must yet be integrated in the structural analysis. As a resource-using sector it is significant, accounting for an estimated 21 per cent of Puerto Rico's net income in 1947-1948. As a medium of transfer, it adds to the value of commodity outputs and imports the margins that convert these into input values. The output of trade was considered as the value of its service, measured by the difference be-

tween its costs of goods and its receipts from their sale.[18] This is gross profit on sales, which equals the sum of gross margins. While these two phases must be integrated, it was necessary to approach them from different directions, for there was no satisfactory statistical source permitting their simultaneous measurement. An added difficulty was that trade did not follow a simple wholesale-retail pattern, since importers variously sold directly to final buyers, to retailers, or to wholesalers, and some importers sold to all three. Therefore, it seemed necessary to find means of estimating the percentage markup for each kind of commodity and for each kind of purchaser; the sum of dollar margins so derived should equal the total value of services rendered by trade. There is no space here to describe the methods used, but it may be stressed that this was one of the most arduous areas of the research.

The "output" of the government sector was considered to consist of its receipts: income and excise taxes, licenses, fines, etc. In the investigators' model, the value of government activity is entirely within the category of final demand,[19] so that there are no coefficients linking it directly with the rest of the economy. But in this field, as in construction, it would be undesirable to accept the consolidation as more than a preliminary treatment. Further analysis would allow estimation of the differential effects of changes in the magnitude of specific branches of activity—education, health services, administration, law enforcement, etc.

Agencies of the federal government spent about $57 million in Puerto Rico in 1947-1948 for personnel, commodities, and services. This sector could not be considered comparable to the insular government. Decisions as to the magnitude and direction of federal expenditures came from outside the island. The question as to whether these expenditures should be fully included in the gross product of the economy is even more difficult to answer than in the case of domestic government expenditures, in view of the status of the island and of the fact that about 70 per cent of the total was expended by military establishments. But this issue apart, it was important to measure the full impact of these expenditures upon the insular economy, and this could not be assessed either by the value

[18] This is greater than the net income originating in trade by the value of the goods and services bought by trade from other establishments, not including goods to be sold or capital items. The concept is the same as that used in the BLS interindustry analysis. See Evans and Hoffenberg, *op. cit.*

[19] This excepts government-operated utilities and other enterprises; in fact, since the time of study a number of these have been sold to private interests.

originating in federal agencies or by their total outlays. Their value originating omitted the indirect contribution to insular income through the demand for construction, local produce, etc., and total outlays included considerable sums for imported goods that had little effect on the local economy. Therefore, it was necessary to discover the precise objects of expenditure and to identify them as domestically produced or imported, i.e. to apply the type of analysis used in other sector studies.

H. Foreign Trade

External trade is vitally important for Puerto Rico, and was given corresponding consideration in constructing the details of the input-output model and in the collection of data.[20] Exports have a high value relative to total output but are specialized. Obviously, they had to be identified in order to prepare the analytic framework for tracing the domestic repercussions of shifts in their individual importance. Imports are at least as important aggregatively,[21] and the intensive effort of the insular government to study and to stimulate means of raising income and developing local manufacture pointed to the need for careful analysis of this aggregate. Every import is a drain on domestic income, and an obvious course would be to create opportunities for at least some of the 75,000-100,000 regularly unemployed members of the labor force to substitute local production in the most effective fields. Historically and purposively, the economy is changing, so that the pattern of import inputs cannot be accepted as given. With this in mind, the attempt was made to identify every commodity input specifically and as to whether it was imported. In the other structural studies known to the writer, imports "similar to" the products of a domestic industry are considered as "competing," and are charged to that industry as part of its inputs, becoming then part of its output as well.[22] If the import and the domestic product are in fact identical, no other course would be meaningful. But in Puerto Rico it seems rather evident that the existence of such apparent competition generally expresses real difference between the two kinds of product rather than the existence of economic factors such as increasing cost. If a single chemical industry is posited, it may be this crudeness of classification that makes it appear that imported chemicals are competing directly with local

[20] See pp. 360-361 for further discussion of some of these considerations.

[21] Puerto Rico has an habitual deficit in its balance of trade, offset by items in the capital account and by federal transfers.

[22] See Evans and Hoffenberg, *op. cit.*, p. 109.

items of different formulas, since the two groups are indistinguishable in the model.

The alternative need not be the extreme of classifying separately every kind of truly noncompeting import. It is true that there is no theoretical objection to this extreme. Imports constitute one kind of ultimate resource of an economy; when other inputs have been successively traced to imports, the line of dependence has ceased.[23] In the mathematical formulation, therefore, the import-input coefficients are most easily assigned to a set of equations outside the general coefficient matrix. It is only convenience that limits the number of these additional equations, and so the number of import categories. As shown in Table 1, the classification scheme includes twenty-three such categories. But the industry analysis work sheets, in most cases, specify imported inputs in far greater refinement and permit adaptation to correspondingly finer classification.

Not all external expenditures required specific identification. Royalties paid abroad, traveling expenses of employees outside the island, and advertising on the mainland or in foreign countries have been consigned to a single category. There was no possibility that such items could be produced domestically, so there seemed to be no reason for distinguishing them. Their only general effect was on the balance of payments, and a consolidated classification would adequately reveal this.

The concept of valuation of imports was a special issue, and was still undefined when it was decided to use producer's value as the general measure. The "producer" of all imports is the foreign trade sector,[24] but imports could be considered as fully produced either at the port of shipment or when the carrier lands in Puerto Rico. Conceptually, valuation c.i.f. was acceptable, for the shipping facilities en route were not connected with the Puerto Rican economy. But there were two reasons for valuing imports f.o.b. port of shipment, both related to the desirability of charging ocean transport costs to imports individually. One was that this would permit the ancillary shipping facility costs in Puerto Rican harbors to be readily charged

[23] In intereconomy analysis, this would not be true.

[24] In the open model, it is misleading to consider *the* foreign trade sector as that which enters both row and column of the flow matrix. The relationship between exports, the "inputs" of the foreign trade sector, and imports, the "output" of this sector, is very different from that between the inputs and the output of a domestic industry. Within the model, imports and exports are not functionally interrelated; exports may require specific imports (as they may require inputs of any other sector), but over-all equivalence of the two would be accidental.

to individual imports in the same way. The other was that the freight costs of specific commodities remain a matter of much concern to Puerto Rico. Studies have been made to show the effects of changes in freight rates, for example, and the valuation concept indicated would allow such effects to be traced most readily.

It was necessary to undertake a complete analysis of freight costs for the study.[25] Official rates were applied to each of the thousands of items listed in the customs' publication of imports, insofar as these could not be suitably combined; estimated insurance rates were added. The resulting costs made it possible to estimate individual freight charges and also to convert the f.o.b. values of the imports, as published, into c.i.f. values.

Among exports to foreign countries, an appreciable proportion constituted re-export of commodities from the mainland United States. Puerto Rico is a transshipping distribution center for the Caribbean area for many items. Such exports have a different relevance from those locally produced. Schematically, they may be accounted for by charging directly from the import row to the export column, or they may be eliminated entirely from imports. In either case, they must be revalued when leaving the island; following some investigation, a uniform 20 per cent markup was applied to the c.i.f. value to arrive at re-export value, where no more specific knowledge pertained. Identification of re-exports was often difficult and questionable. It could not possibly be effected accurately on the basis of nominal identity, or difference in the listings of imports and exports. Familiarity with the precise character of domestic products and their distribution was needed to distinguish between seemingly like products.

I. Estimating Errors and Reconciliation

The stage of general reconciliation has not been reached in this study. However, the appearance of numerous discrepancies and the certainty of further disparities when the table entries are completed compel formulation of some of the more important problems and implications involved.

The input-output model is derived from the notion of general economic equilibrium. As regards the actual flows in the year of

[25] The balance of payments unit had been estimating total freight costs on the basis of division of imports into a few categories to which rates were applied. The investigators' detailed analysis indicated a 10 per cent aggregate error in this total.

study, this is not even theoretical; it is truistic. Any discrepancies between the sums of corresponding table rows and columns defined in this way must be statistical errors. If all values were derived from data of uniformly high quality, the discrepancies would be within the range of error inevitably accompanying measurement. This has been far from the case in this Puerto Rican analysis. The reader can have assured himself, from consideration of some of the sources and methods described above, that the errors run a wide range. But just how wide may we judge them to be?

The official estimate of the insular net income for 1947-1948 was 12 per cent under the comparable measure achieved by adjustment of the gross product estimate. This somewhat understates the probable discrepancy, because of the identical sources of certain components of each estimate. The analysis used elements from these studies to some extent, but was cut off from doing so fully by the original decision to set up a relatively pure product classification. The outstanding disadvantage of such a decision is that it prevents the use of any existing control totals otherwise classified, and the cutting across of the two sets of categories throws doubt on the applicability of any particular control even when the classes seem to be identical.[26] Thus, even if we accept the 12 per cent income-product difference as an indication of the aggregate error in those measures, we do not have the comfort of this particular evidence that our aggregate output error is similarly limited. The investigators disregarded that possible assurance in the interest of a more useful structure and in the hope for greater accuracy in individual sectors.

Apart from the possible faultiness of the various methods of estimation of both inputs and outputs, there is the question as to the credibility of the data. The investigators depended extensively on income tax returns, payroll reports in connection with workmen's compensation insurance, and accounting records. How trustworthy are these? It is the judgment of the investigators that they are excellent where the corporate form prevails, and less so where this is not true, and as the size of the firm decreases. It would seem that the major sources of error are in the sampling procedures. These were used for estimating most inputs and outputs. Yet for these also

[26] The sacrifice of output estimates of local goods from the gross product analysis—after they became available in the course of work—was not held to be a great loss in the study, since these were probably not very accurate. The failure to use the 1949 census as the general source of controls was mitigated by the fact that, where it was possible to compare results, the differences were not great.

it is believed that the resulting errors were not high.[27] In manufacturing, services, and government, errors of more than 10 per cent are not expected for either output or major input estimates, and they should generally not exceed 5 per cent.[28] These expectations do not apply to the agricultural and trade sectors. For sugar-growing, the analysis is probably good, but the studies of other agricultural products depended on doubtful output estimates and on sample cost studies, which have not seemed to stand up well when their input expansions have been compared with relevant available statistics. In the trade sector the basic problem is that of the validity of trade margins.

Assuming that the first full set of table entries will result in numerous discrepancies, what is the character of the reconciliation that will apparently be required? If an industry's output does not equal the sum of its uses by other sectors, the errors could be the result of one or all of the following: (1) faulty estimate of output; (2) faulty estimate of its input by one or more of the using sectors; (3) faulty trade margins where the inputs were originally measured in purchaser's values, and these were converted to producer's values by subtracting the margins; (4) faulty estimate of inventory increase or decrease. If (2) is applicable, this could be due to faulty estimate of the output of the using industry, or faulty input ratio. And so on. If the item in question is an imported commodity, its output means the value of importation, which could also be in error.

There can be no rule for the correct order of adjustments. Where one of the estimates involved has an extremely weak basis, and the interlocking values are believed to be very sound, the doubtful estimate can be made to fit. This really amounts to deriving it as a residual. The case for estimating by residuals when there are many other component elements is good only if these are indeed known to have high validity relative to that of the value chosen for alteration.

With so much uncertainty as to the relative reliability of various values in the Puerto Rican study, it will in many cases be impossible to decide legitimately where the adjustments for complete reconciliation should be made. In such cases it is questionable whether reconciliation adds anything to the validity of the results. If specific discrepancies exceed 5 per cent, let us say, there is reason to seek adjustment. As indicated, this should take the form of alteration of

[27] See pp. 343-344 for some evidence from comparison with census data.

[28] The undistributed input residual is almost always well below 5 per cent, but this is no measure of error.

those values the bases for which are, for independent reasons, thought to be especially weak.

Unfortunately, there cannot be a definite appraisal of reliability for each general source. One illustration will serve. The Department of Commerce's publication of the declared values of imports must be considered as generally of good quality. This lists the value of mother of pearl and other shells imported in 1947-1948 as $178,000. With full coverage of the pearl button industry, it was found that its use of shells was about $448,000—all imported—with an increase in its material inventory besides. This must be interpreted as a 250 per cent error in the Department of Commerce data. It cannot be taken to indicate the over-all quality of this source, but at least it means that its reliability is always questionable for particular items.

In this case, the reconciliation problem was easily solved, and involved no repercussions. The Department of Commerce figure could be conveniently ignored, since it applied at the open end of input flows. Furthermore, the alternative value had been obtained from corporate accounting records, with high credibility. The issue is rarely so clear. This example also suggests the absurdity of adopting some mechanical principle of reconciliation, such as the assignment of probability values to specific sources, with the consistent resolution of conflict by elimination of the figure from the lower probability source.

It seems to follow that, in the Puerto Rican study at least, reconciliation has different bearings as it applies to completion of the input-output table or to establishment of presumably valid coefficients. For almost all industries, ratios of inputs to output were derived from sample studies. Many of these analyses were adequately verified when compared with independent sources, such as the *Census of Manufactures*, or invited strong confidence from the broad coverage involved. But even if entirely accurate, these ratios will still yield input aggregates that will not fit into a consistent table if there are errors in the estimates of output of the industry analyzed or of the input-producing industries, errors in inventory changes assumed or in the trade margins adopted. In the ensuing set of changes needed to yield arithmetic consistency of rows and columns, it is virtually inevitable that the relationships underlying the original input ratios will be somewhat altered. Is this justified? Only if the reconciliation leads to improvement of the estimates, and not to mere numerical congruence. Impairment is more likely than

improvement where changes are made for general consistency, without some assurance that the source quality of the original value is so poor, and that of the constraining values so good, as to justify the alteration. There will be cases of the latter type, but there will also be those in which the only motive for adjustment would be to make the table perfectly harmonious. It is the writer's intention in the latter situation to retain the original apparently soundly established coefficients, even if the aggregates based on them result in some inconsistency of flow values.

This decision implies that such adjustments for consistency would not in fact bring the table flows closer to actual events in the year under study. If this is true, the achievement of complete reconciliation has merely aesthetic value as opposed to statistical meaning. Refraining from such adjustments would prevent possible deterioration of the results and afford some measure of ultimate statistical discrepancies otherwise concealed by spurious agreement.

J. Capital Consideration

Up to this point, emphasis has been on aspects of the statistical implementation of a static open model, which would yield estimates of the current levels of the various sectors needed to permit given outputs of selected products. This neglects the problem of determining the capital increases required in industries directly and indirectly supporting any specified expansion of output. While the current and the capital input requirements are conceptually distinct, and may be studied separately, a model intended to approximate reality must include and combine both.

The Puerto Rican input-output study is meant to assist dynamic analysis, so that desirable developments in economic structure may be undertaken or encouraged. This orientation to prospective change places emphasis on capital considerations. For example, analysis of the impact of establishment of a new industry involves estimation of the quantity and kinds of capital needed to permit the assumed level of production. The impact of expansion of an existing industry would also involve analysis of the incremental capital needs. On the monetary side, these estimates would measure total investment and savings needs. On the real component side, existence of appropriate capital and current input coefficients would make it possible to estimate the effects on local resources and on the balance of payments.

Puerto Rico must import virtually all machinery and heavy equip-

ment. Foundries and metalwork shops supply a small fraction of capital needs in special sectors. It seems unlikely that this situation will or should alter appreciably. Heavy capital goods production is not appropriate to a small underdeveloped economy. On this assumption, it is not vital to establish capital coefficients in detail as regards types of machinery input. The two major capital input categories that should be distinguished are equipment and buildings, with the nonbuilding construction specified in such sectors as public utilities. Construction is, of course, a local industry, though input-output analysis is needed to trace its direct and indirect dependence on local resources. There is some value in subdividing capital requirements so as to separate out furniture and fixtures, since some forms of these may be domestically produced.

Effort was devoted chiefly to obtaining information for current input coefficients. This had been the original goal, and the character of the basic sources, which were chiefly current expense records, generally excluded attention to capital aspects. But the importance of the capital phase prompted a measure of exploration.

The investigators' main work in this field was attempted through the analysis of balance sheets. The compulsory filing of all corporate balance sheets with an insular office afforded the opportunity to study the asset values in the industries represented. The procedure was to classify each corporation according to the schema and to list individually its stated values of buildings, machinery, office equipment, vehicles, inventory, and otherwise classified nonfinancial assets in the year 1948. Since some corporations listed book values, and others original cost and depreciation reserve, these were tabulated separately. For those corporations in each industry for which it was possible to secure the value of output in the same year from income tax returns, ratios of net asset values to output were established. Coverage was greatly limited by the unavailability of output measures for firms whose tax returns were under audit and by the restricted degree of incorporation in some industries; samples were therefore small in many sectors.

On the assumption that 1948 was a year of capacity operation, these ratios would represent average capital coefficients: that is, the mean value of capital needed to produce $1 of a sector's output. Table 6 presents a few of these coefficients. They were based on total depreciated value of nonfinancial capital, excluding land and inventories, and were selected because they could be compared with coefficients computed for analogous United States mainland indus-

TABLE 6

Average Capital Coefficients in Selected Puerto Rican Industries, 1948

INDUSTRY	*Ratio of Depreciated Capital to Output*
Advertising	.0432
Baking	.1520
Canning	.0696
Cigar manufacturing	.0236
Hospitals	.3061
Laundries	.2670
Motion-picture theaters	.1763
Newspapers	.1628
Railroads	.9301
Soft drinks	.3205
Wood furniture and millwork	.0132

Source: Output from income tax returns; capital values from balance sheets filed with Property Tax Office of Government of Puerto Rico.

tries by the Harvard Economic Research Project under Leontief. The latter were generally derived from 1939 data. They were preliminary in nature, and are therefore not reproduced. But it may be said that, with one exception, they exceeded the Puerto Rican ratios in every industry compared. In most cases, they were about twice the latter in size, and in one industry thirteen times as great. The direction of difference was to be expected if the principle of factor substitution, consequent on the wide labor cost differential, operated to any extent.

The intricate problems arising when one attempts a precise operational definition of capacity will be disregarded here, for this issue is minor in comparison with the question as to the adequacy of the average coefficients just described for measuring capital requirements. The purpose in studying the relationship of capital to output was to estimate the needs for output expansion. Therefore, the measures required were incremental. It seems doubtful that the average ratios would approximate these. Expansion of capital facilities can be expected to follow along the lines of most recent technology appropriate under the circumstances,[29] whereas much of the

[29] Whether or not labor is substituted for capital relatively, technological progress probably occurs. Also, the recent tendency has been to introduce the most modern methods in an absolute sense, even in underdeveloped economies with cheap labor.

capital underlying the average coefficients was probably outmoded. Whether the use of net capital values would adjust effectively for the lower productivity of the older equipment is something that cannot be decided a priori.

Many other considerations of experience and theory point toward the view that in this field of inquiry it is necessary to make a detailed technical-economic study in each industry, if it is desired to establish adequately the types and costs of capital expansion implied by a given increase in output. In an underdeveloped economy, this would be the only possibility in the common situation where initiation of a new industry might be considered.

A beginning in this direction was made in connection with the studies of some of the Puerto Rican industries, for which data were secured from individual firms as to their expansion in the value of both capital and output in recent periods. This information was at least incremental, though it did not yet meet the standard described in the preceding paragraph. For newly established industries, such as textiles, the detailed value of capital and of the corresponding output were available, but the operations were clearly not yet at or near capacity, because of need for further labor training and other factors related to initial adjustment.

The estimation of incremental inventory requirements posed another set of formidable problems. For first approximations, there were available the corporation balance sheet data mentioned above; from these and the firms' corresponding production figures it was possible to compute ratios of inventory holdings to output. Since the balance sheets did not separate inventories of finished goods from inventories of materials, it was necessary to estimate the division and the identities of the materials. Some of the detailed information required was secured from the records of firms by visit. The *Census of Manufactures* afforded comparison and supplementation for certain industries by furnishing tables of inventory holdings of finished goods and of materials plus goods in process at the beginning and end of the census year. But the complexity of the functions determining inventory holdings prevented any simple satisfactory application of this information. The preparation of average ratios of inventory to output, however detailed, would be a crude substitute for incremental coefficients. To the extent that such coefficients are technically determined, it appears that their discovery would require research into the relevant considerations in each industry.

It may be concluded from this discussion that much work can be done in the area of capital requirements to add to the accuracy and usefulness of our results. In itself this is no deprecation of the contribution offered. An input-output study encompasses the economy, as a totality and in detail. The first sketch should be rich in discovery, and should point directions for improvement.

K. Aims of Input-Output Analysis Appropriate to Underdeveloped Economies

It remains to consider specifically the major purposes that may be achieved from a completed input-output study. Purposes imply values, and their sum is presumably to be weighed against the cost of the pursuit as the basis for decision regarding its undertaking. Such a calculation will not now be essayed—although attention will again be given to the general question after particular aims have been suggested. Despite the absence of definitive plus and minus value measures, it may be necessary and even desirable to accept indecisiveness at the present stage of progress; a hard-boiled insistence on this kind of precision can be impractical in an area where potential uses continue to come into sight in the process of activation.

What is vagueness from one point of view is richness and flexibility of application from another. Those who have worked in the input-output field, especially in the empirical phases, have often stated that it is not primarily a unique model for fact finding but, instead, a method of approach to problems whose rationale centers in the quantification of interdependent elements in selected sectors of some economic system. This general concept becomes the recognized structural analysis of an economy when the sectors are identified chiefly as industries and when the application comprehends the entire economy. But even with this concept in mind, there are possibilities of considerable variation in the specification of the magnitudes to be measured, depending on the emphases of purpose.

No attempt will be made here to give an exhaustive list of possible aims of input-output analysis, but a few relevant goals will be indicated. These bear on the Puerto Rican illustration, especially in its aspect as an underdeveloped economy. The selection of particular goals among the many that are possible has important consequences for the kind of information to be gathered, and this aspect also will be considered.

1. The description of actual moneyflows among the economic sectors in the year of study. These would include factor payments (with possible extension to include implicit incomes), interenterprise purchases of materials and services, final purchases of consumer and investment goods, transfer payments, inventory changes, imports, exports, etc. Such a picture can be exceedingly revealing and can be made to tie in with national income and product analysis to give more meaning to the latter. It signifies an approach to what Simon Kuznets described as the useful extreme of the "grossest of the gross" of moneyflows, in contrast with net income or product. Especially for an economy in which such flows have not yet been measured, a comprehensive picture of this kind would have great value. It is highly important to know the actual levels of the various activities, in addition to their interrelationships in ratio terms as expressed by input coefficients.[80]

Aside from the present study, no attempt had, of course, been made to describe such a picture for Puerto Rico. The insular net income analysis gave a partial account, by indicating factor payments by industrial origin. The balance of payments study added to this by revealing current and capital flows to and from the island. The gross product analysis was framed in terms of the consumption of various final products, so that its tables did not distinguish between imported and domestically produced portions of any particular kind of finished good consumed. A comprehensive moneyflow analysis would use these sources and go much beyond them.

2. The organization and integration of previously existing statistical information. An empirical input-output study does this in-

[80] It does not seem necessary here to consider the various uses to which such results can be applied. The continual increase in the efforts to disaggregate national income and product totals, as well as to surpass the "grossness" of these series, is evidence of the sense of need for such elaboration. For a major effort, the results of which are intermediate in detail between income-product series and input-output findings, see Morris A. Copeland, *A Study of Moneyflows in the United States*, National Bureau of Economic Research, 1952. To avoid misunderstanding, it should be indicated that the concept of "moneyflows" is far from obvious or unambiguous in meaning, and that an input-output analysis could hardly yield flow values defined as Copeland specifies. Beyond this, in this study the choice of a pure product classification prevents the intersector table values from representing real historical flows to the extent that establishments carried on joint production processes. This illustrates the fact that, while an input-output analysis can serve various purposes, it cannot aim simultaneously to fulfill them all completely, since the conceptual elements required for the different purposes almost always conflict to some extent. The result that may be expected is a compromise in which no aim is perfectly met but by which the total usability is supposedly maximized.

evitably. A by-product, which can be given more or less emphasis, is the discovery of agreement or inconsistency of estimates from various sources through the intrinsic postulate of internal consistency, with the implied necessity of making judgments as to relative and comparative reliability where conflict is found. Another result is the discovery of gaps of information that may be roughly filled in temporarily, pointing out areas for needed investigation. The significance of this aspect of input-output analysis is difficult to overstate in an economy where statistical procedures are in a relatively early stage and where errors of ignorance or misjudged reliability may lead to faulty policy making. The comprehensive input-output model is so demanding statistically that it drives the investigator to almost every conceivable source of possible data. In the course of investigation, he very probably will develop such a detailed knowledge of what is known—or what he thinks should be known—about the economy, that the sources he has canvassed will be ranked and related in terms of over-all validity. In addition, the investigation is apt to necessitate the preparation of various new statistics or the casting of series in new forms that should have value far beyond his immediate requirements. Several such experiences have been mentioned. Problems of statistical integration have been illustrated throughout the methodological discussion.

3. The establishment of coefficient values—the number of units of input of one sector required to permit the creation of a unit of output of another sector. These may be current (flow) or capital (stock) coefficients. There has been some impression that the derivation of coefficients is the sole purpose of an input-output table. The discussion above should indicate the incompleteness of this view. However, it is true that in practically every study this will be a major objective, and therefore the information should be gathered with such application in mind.

It is appropriate here to state several of the purposes for which the coefficients may be desired.

a. The planning of a program of final goods (the "bill of goods"). Here the coefficient matrix serves to derive the intermediate and final resource requirements, and therefore to indicate the feasibility of the program. Such use is indicated in a mobilization action, for example, and becomes more significant as the degree of planning increases. The tendency toward planning is strong in many underdeveloped economies.

b. The prediction of flows or activity levels in some given period.

Here the bill of goods is not planned but is itself estimated. It seems to the writer that the line between this use and that of planning is by no means decisive. The very attempt to derive future activity levels implies that, if the estimate indicates an undesirable result, such as the expectation of considerable unemployment, some corrective action will be contemplated, even if restricted in scope. The consequences of such action can again be measured with the help of the coefficient matrix.

c. Determination of the effects of specified activity levels in particular sectors of the economy upon other sectors. This will be elucidated by means of several illustrations, since it has special application to the present study. Suppose it is desired to measure the net benefits to an economy of the introduction or expansion of some specified industry. Net benefits are considered here not so much in terms of opportunity cost as in terms of income creation. For Puerto Rico this is in some ways the more relevant criterion. Where there is considerable unemployment, the additional use of labor has little opportunity cost except that of leisure. For the problem indicated, the matrix of coefficients serves to estimate the increase in employment following directly and indirectly from the rise in the activity level of any given industry.

Indirect labor requirements had been recognized, of course, before input-output analysis was devised. In a recent study by the Puerto Rican Planning Board it was stated that every new manufacturing or agricultural job generates two new jobs in services.[31] This conclusion was based upon the measures of estimated increases in total manufacturing employment and in total service employment in the island during the preceding ten years. The refinement of this gross average is one of the advantages of the present technique. The knowledge of differential indirect labor input requirements is of obvious importance in an economy with limited savings and a desire to concentrate its efforts most effectively in attracting outside enterprise and capital.

The creation of value by nonlabor factors necessitates that the structural analysis include data for measuring the direct and indirect sum of these other factor payments at given activity levels of each

[31] The full quotation reads, "During the decade there has been an increase in employment of 55,000 in the primary industries (agriculture and manufacturing) and 118,000 in secondary industries. Therefore, for every new job created in agriculture or manufacturing, approximately two additional jobs are provided in other segments of the economy." From *Economic Development of Puerto Rico 1940-50, 1951-60*, Economic Division, Puerto Rican Planning Board, February 1951.

industry. For an economy such as that of Puerto Rico, which depends so heavily on imported materials for most activity, it might be said that total insular value added relevant to any domestic product consists of all its production requirements, direct and indirect, except imports. This is an alternative to saying that it is highly important to know the effect on the balance of payments resulting from the full set of repercussions accompanying the change in any given activity level of an industry. This purpose is served by the determination of sufficiently detailed import-input coefficients, so that their identity is not diffused in some general category that cannot be separated from the product of domestic industry.[32]

There is another salient reason for identifying import-input requirements as specifically as possible. An underdeveloped economy with relatively heavy import needs and considerable unemployment is naturally to be considered in the light of dynamic possibilities; a basic purpose in examining its structure is to yield information helpful for the desirable alteration of that structure. Economizing imports by the use of unemployed resources for substitute production domestically is a natural goal, and in some cases the decision as to profitability of the new venture would rest upon adequacy of the local market for the particular product. If imported inputs are sufficiently detailed in identity, the total increase in requirements for some selected product can be traced in consequence of anticipated expansion in the industries or sectors using this product.[33]

Balance of payments implications in another respect might conceivably be explored with the help of input-output analysis. If imports were identified not only as to nature but as to country of origin, and if functional relationships were established between imports and exports flowing between the economy under study and other individual countries, then the interaction of changes in activity

[32] I.e. there should be general avoidance of their handling as "competitive imports," as the term is used in the United States input-output study of the Bureau of Labor Statistics.

[33] The discovery, through input-output analysis, that establishment of a local industry for production of a commodity hitherto imported would be justified by the total demand for it—direct and indirect—would not be an adequate ground for going about setting up such an industry without regard to other possibilities. Such a view would be equivalent to the extreme principle that opportunity costs play no part in an economy with unemployed resources. The writer's point, instead, is that only through an approach such as that of input-output is it possible to tell what the possibilities *are*. When these have been brought to light, the full background for judgment must be rounded out through the use of comparative cost analysis, sociological considerations, and the inclusive dynamic elements that must enter into a satisfactory theory of location.

levels in both countries could be made part of a single model. On the import side, this seems to have no relevance to an economy such as that of Puerto Rico. The magnitude of their imports from the mainland United States, for example, is so small relative to the total production of such goods in the United States that it in no way affects the latter's ability to purchase Puerto Rican goods. The reverse, however, is not necessarily the case. The island's ability to buy United States mainland goods strongly depends on its sales to the latter, and these sales (of sugar, needlework, rum, tobacco) are functions of direct or derived demand in the mainland economy. Here, there is opportunity for investigation and theoretical research beyond anything undertaken in the present study.

Any list of possible uses of input-output results is incomplete because the structural, detailed, and comprehensive nature of the analysis makes it suitable for adaptation to various new problems as they arise. Two examples will be cited from the Puerto Rican experience. Request was made for estimates of shipping facilities that would be required to carry on industry-by-industry activity under various assumptions of restricted carrying capacity. Without describing the estimating method actually used, it may be said that it was an aggregation of subjective judgments, without consideration of interdependence. Had the full input-output results been available, it would have been possible to estimate itemized or aggregate import requirements for any assumed set of final goods, and the shipping facilities applicable to those imports.

A second illustration pertains to the request for measurement of the total effect of tourism upon the island. The investigator in this case had estimates of tourist expenditures for various items, such as hotel accommodations, local transportation, and handicraft work. With input coefficients, the ultimate repercussions of these expenditures could be traced.

There is a lively professional debate concerning the over-all usefulness of input-output analysis. Economic resources are competitively allocated, even among economists, and workers in a new and relatively costly field of research are legitimately asked to justify the consideration and support for which they ask. But there is a risk that the questions put to test the value of the research may be framed so narrowly as to fail in their purpose. This is especially true when there is a strong sense of need to meet some pressing problem, such as that of resource use in mobilization, or the optimum pattern of change in an underdeveloped economy. When the writer

first arrived in Puerto Rico, he gave several talks to acquaint government personnel with the general character of input-output analysis. One official, for whom the proposal of appropriate new industries was a personal responsibility, asked, "Will it tell us what industries to bring to Puerto Rico?" When the answer was "no," he exclaimed, "Then what good is it!"

Interindustrial structural analysis cannot solve all economic problems, and is even, alone, far from an adequate basis for answering practical questions involving the interdependent effects of changes in the variables that it chooses, perforce, to call independent. The present model, for example, having abstracted from variable demand and production functions, must be supplemented with analytical considerations that take into account the neglected factors of importance; basic research in improvement of the model is seeking to move in this direction.

It seems to the writer that the input-output approach, because of the logic of its internal structure, opens a prospect for expanding uses beyond any now definable limit. An indication of this has been given in the listing of some possible applications for underdeveloped economies. Restrictions as well as new areas of use may follow from the nature of the economy involved. It may be that the rate of dynamic change expected or desired is so great as to make it impractical to derive and employ an inverse matrix, which fixes the production coefficients irrevocably. In such a circumstance, it might be better to use only segments of the coefficient matrix, or to substitute anticipated engineering coefficients for some of those statistically derived. But it does appear that many of the issues to which input-output analysis contributes are important, and that the resulting gains in knowledge could not otherwise be effectively achieved.

COMMENT

DANIEL CREAMER, *National Bureau of Economic Research*

Amor Gosfield occupies a unique position in that he is a specialist both in the use of input-output estimating techniques and in Puerto Rican statistical materials. For this reason it requires more than one person to discuss his paper; it requires a specialist in the application of input-output models to regional economies and a specialist in Puerto Rican statistical data. I hope our discussion by collaboration will be more effective than the famous essay on Chinese metaphysics, prepared by combining an encyclopedic article on China with one on metaphysics.

Gosfield states his objective in the following terms: ". . . it is important to consider the usefulness of input-output analysis in other types of economy than our own, the kinds of variation of the model that may be necessary in such cases, and the problems of statistical implementation." Since my only claim to expertness in this particular area is some specialized knowledge of Puerto Rican statistics, it was probably assumed that I would restrict my comments to the problems of statistical implementation. However, I shall not so restrict myself for several reasons. First, members of this Conference, I am sure, have little interest in the Puerto Rican estimates as such and would therefore regard a review of Gosfield's procedures and appraisals of data as an imposition. Second, I find little to quarrel with in Gosfield's use of the island's statistical resources. Even a casual reading of his paper would make it clear that Gosfield brought to his task a high level of professional competence. He exercised much ingenuity in testing the quality of his data and displayed a degree of diligence and perseverance that is unusual. Third, I doubt that Gosfield's estimating procedures and problem solutions have much carry-over value for estimators attempting to develop input-output tables in other underdeveloped countries.

This last judgment is based on several considerations. As Gosfield points out, the variety and the coverage of economic statistics in Puerto Rico are substantial. Indeed, Puerto Rican statistics exceed both in quantity and in quality those in some industrially developed economies. With few exceptions, the statistics available to investigators in other underdeveloped countries are likely to be much inferior to those available to Gosfield in Puerto Rico. Moreover, his technique for supplementing nonexistent or unreliable data—personal interview of enterprisers and examination of their accounts—is feasible only when the absolute number of important transactors is small and they are highly concentrated geographically, say within an area 30 by 100 miles, the size of Puerto Rico. In very few areas will these conditions be found, and for these reasons I believe the particular estimating techniques and problems encountered in Puerto Rico can provide only meager assistance to those who might follow.

My final reason for not restricting myself to the problems of statistical implementation is that the paper raises, but leaves unanswered, a much more fundamental question—namely, the usefulness of input-output analysis in underdeveloped economies.

Gosfield devotes a section to "Aims of Input-Output Analysis Ap-

propriate to Underdeveloped Economies." He notes that "no attempt will be made here to give an exhaustive list of possible aims of input-output analysis, but a few relevant goals will be indicated. These bear on the Puerto Rican illustration, especially in its aspect as an underdeveloped economy." The first objective listed is "the description of actual moneyflows among the economic sectors in the year of study." In elaboration Gosfield states, "Such a picture [of actual moneyflows] can be *exceedingly revealing* and can be made to tie in with national income and product analysis to give *more meaning* to the latter" (italics added). Revealing for what, or in what way it has more meaning, is never indicated.

Writing in the same vein, Gosfield tells us, "Especially for an economy in which such flows have not yet been measured, a comprehensive picture of this kind would have *great value.* It is *highly important* to know the actual levels of the various activities . . ." (italics added). Again, it can be asked, Great value for what, and highly important in what kind of contexts? Perhaps there are uses for a description of actual moneyflows, but it seems clear that those uses are not established by using honorific adjectives devoid of specific content.

Gosfield's second objective, and I assume he lists them in order of importance, is "the organization and integration of previously existing statistical information." Incidentally, this objective is also second on the list prepared by W. Duane Evans and Marvin Hoffenberg. This appears to me as a curious justification for input-output estimates. One can accept it as a by-product, but to claim it as a primary objective or use strikes me as padding the account. If improvement of statistics is the objective, would you not do a more effective job by making a frontal attack on the problem of improving a country's statistics? Indeed, I can conceive of the input-output table being a mischievous guide in the performance of this task. For example, Gosfield expresses surprise that, despite the importance of the needlework industry to the Puerto Rican economy, and despite the fact that both federal and insular authorities regulate the minimum wages of the industry, there are no statistics on the volume of needlework sold on the Puerto Rican market. There is enough information to know that by far the largest part of the industry is organized on a contract basis and by far the largest part of its output is sold in markets external to Puerto Rico. I should like to ask why, under these conditions, there should be such statistics? The regulating authorities need to know the cost of production in Puerto

Rico and in alternative locations. They know from bitter experience that, with a minimum wage equal to the statutory level prevailing in the United States, the industry takes its work elsewhere. The critical problem, then, is how closely they can approximate the statutory minimum wage in the United States without any significant reduction in the level of activity of Puerto Rico's needlework industry. For this judgment it is not necessary to know how much of the industry's output is sold in Puerto Rican markets. However, it is necessary information if all cells in the input-output table are to be filled.

My point is that the statistical demands of the input-output table are not a reliable guide for establishing the order of priority in which economic statistics should be collected or improved. And I suggest that, if this is the objective, it is best done directly.

The third principal objective is "the establishment of coefficient values." I can conceive how such coefficients might serve as a useful point of departure in mobilizing an economy for war. But Puerto Rico does not face this possibility, and I think it is safe to say that other underdeveloped areas generally do not have industries that can be mobilized for armaments production. Underdeveloped countries cannot wage modern wars, although they can participate by contributing manpower. Coefficient values for this purpose, therefore, will not find any use in underdeveloped countries.

I can also conceive how coefficient values might be helpful in operating a totalitarian planned economy, which Puerto Rico is not, provided the economy is already well advanced toward industrialization. If the totalitarian economy is underdeveloped, its economic objective, like that of all underdeveloped areas, is to increase capital per worker on a sustained basis. The problem that transcends all others in importance is how to discover the specific opportunities for profitable new investment. In other words, what new industries can be developed? Now, it is not at all clear to me that it is useful to know the coefficient values of pre-existing industries in some more or less remote past year in going about the job of trying to alter substantially the economy's coefficient values by developing new industries.

How widely these doubts as to the usefulness of input-output analyses in underdeveloped areas are shared, I do not know, of course. However, I am sure there must be wide agreement that this crucial issue needs a more penetrating discussion than is given in Gosfield's paper. Pending the appearance of such an analysis, I

incline toward the view that the construction of input-output tables for underdeveloped countries results in a serious disequilibrium between the investigator's input and his output. And until the issue is clarified, we can also serve the underdeveloped areas by restraining our missionary zeal.

WALTER ISARD, *Massachusetts Institute of Technology*

Everyone who has read Amor Gosfield's paper will undoubtedly agree with me that thus far it represents an excellent study. Those who have a fair acquaintance with the characteristics of the Puerto Rican culture must realize the painstaking care, the infinite patience, and the high quality of thought that have gone into this study.

There are no major points about which I feel qualified to take issue with Gosfield. However, I wish to comment upon an underlying theme that runs throughout his paper and that brings up major considerations in the use of input-output tables for planning programs in underdeveloped areas and regions.

Gosfield is to be applauded "for identifying import-input requirements as specifically as possible" and for retaining a fine classification of imports. However, I cannot subscribe to one of his reasons for doing this. He states, "An underdeveloped economy with relatively heavy import needs and considerable unemployment is naturally to be considered in the light of dynamic possibilities; a basic purpose in examining its structure is to yield information helpful for the desirable alteration of that structure. Economizing imports by the use of unemployed resources for substitute production domestically is a natural goal. . . ." And elsewhere, "Every import is a drain on domestic income. . . ."

It seems to me that this sort of argument is dangerous. Unfortunately, it is the type of argument that is already cropping up in regional input-output work. This gives me much concern.

A mere listing of imports into an area, or derived deficits of an area, whether it be Puerto Rico or any other region, is no indication whatsoever of the type of production that ought to be encouraged in that area. It may be that the very item that is imported most ought to be imported still more, in order to furnish input requirements for greater exports, or more items for households in order that labor may be more productive in domestic or export industry. At the other extreme, the industry that exports most might be the very industry whose production should be discouraged because of its inefficient use of resources: for example, the textiles of New England. Or, consider an item where imports and exports are negligible, and

hence not even visible when one looks at the import rows and export column. *This might be the item whose production should be stimulated.* In particular, if we consider Puerto Rico, with its chief resource of plentiful and cheap labor, should not importation be encouraged all along the line, in order to use this resource most effectively and to raise levels of income through greater productivity and exports?

In short, what I am driving at is this: in determining which basic industries should be brought into an area, input-output tables are of no help except as a source of statistical data. This statement applies as well to regional input-output tables, and to the derived surpluses and deficits by regions of the United States mainland. Hence, for basic industrial development purposes, one must fall back upon comparative cost studies, location theory, and market and regional analysis. Once the basic industries that should be brought into an area have been identified, then the structural relations of input-output are useful to estimate derived effects.

In the case of Puerto Rico, attention to the input-output table—with its listing of imports and exports—will not point up the basic industries to be fostered. What is needed is a careful study of how Puerto Rico interrelates with the several regional economies of the United States mainland. For this study it is insufficient to consider the mainland as a whole. Rather, the mainland must be divided into specific regions, such as the Atlantic Seaboard, the Gulf Coast, and the Pacific Coast, since the potential markets for Puerto Rican products in the several regions show tremendous differences in magnitude.

One final comment: Gosfield is to be commended for his decision not to attempt a complete reconciliation of his input-output table by the "forced" elimination of any discrepancies between the sums of corresponding rows and columns. Reconciliation that involves juggling high-quality input structure data obtained from reliable sources is clearly to be avoided, for it should be kept in mind that reconciliation simply to facilitate the inversion of a matrix would be a farce in the case of Puerto Rico. The input coefficients are changing so rapidly in this developing economy that the use of an inverted matrix for projection purposes is invalid. If one desires to use input-output tables for projection purposes for Puerto Rico as of today, one should use the iterative or round-by-round approach, changing coefficients as he proceeds from round to round. For this type of approach, deterioration of input structure data for the sake of reconciliation cannot be justified.