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ECONOMIC RESEARCH GROUP WORKING
PAPER NO. 4

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Within an Interindustry Framework:
Theoretical Potential
and
Empirical Problems

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Manpower Analysis Within an Interindustry Framework:
Theoretical Potential and Empirical Problems

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ABSTRACT

This paper has two objectives. First of all, an economic activity-manpower impact model capable of generating detailed industrial and occupational manpower requirements from different specified economic budgets is developed in rigorous detail and the fact that several unique types of manpower information are derivable from this basic interindustry model is stressed. Secondly, the severe data problems encountered in the empirical implementation of this model are grouped into three general types for discussion: problems of data incompatibility, problems of data insufficiency, and problems of data irrelevancy. Implications of these problems for the government's methods of collecting and classifying economic and social statistics are indicated.

INTRODUCTION

The development of input-output analysis provided economists with a theory and an empirical methodology for simulating and analyzing the detailed effects of changes in the economic environment, and the tremendous postwar increase in computer sophistication made this type of large-scale analysis feasible. While the application of open model inter-industry analysis to labor market and manpower problems was recognized early, this has only recently begun to be undertaken in a comprehensive and integrated fashion. Here, first of all, a method is indicated for expanding the static open input-output model to form a general national interindustry model capable of generating from alternate economic budgets three distinct types of manpower impacts, two of which have not been previously recognized. Secondly, the severe difficulties associated with the empirical implementation of this type of model are discussed and the important questions these raise concerning the quality and quantity of government statistical data are indicated.

I. A GENERALIZED ECONOMIC ACTIVITY-MANPOWER IMPACT MODEL

Adhering to the traditional assumptions of input-output analysis--linear fixed coefficient production functions, static equilibrium, the absence of externalities, and so forth--the economy may be disaggregated into a specified number of sectors, each composed of firms producing a similar product or group of products. An "industry" may be considered as a separate process of production and each industry combines a set of inputs in fixed proportions to produce its output which it sells to other industries to meet their input requirements.¹ Letting x_{ij} denote the quantity of the

¹All relationships referred to here are assumed to be expressed in comparable units and constant dollars.

output of industry i required by industry j as an input, letting y_i denote the quantity of the output of industry i destined for use by the autonomous sectors, and letting X_i denote the gross output of industry i, a static open input-output model may be represented by the following set of relationships:

$$\begin{aligned}
& x_{11} + x_{12} + \dots + x_{1n} + y_1 = X_1 \\
& x_{21} + x_{22} + \dots + x_{2n} + y_2 = X_2 \\
& \dots \\
& \dots \\
& x_{n1} + x_{n2} + \dots + x_{nn} + y_n = X_n
\end{aligned}
\tag{1}$$

Since it has been assumed that each industry possesses a linear production function with fixed coefficients, the technical structure of an industry may be described by as many homogenous linear equations as there are separate cost elements involved:

$$x_{ij} = a_{ij}X_j, \quad x_{2j} = a_{2j}X_j, \quad \dots, \quad x_{nj} = a_{nj}X_j.$$

The a_{ij} 's are referred to as coefficients of production and, writing these relationships in the form of equation set (1), we have:

$$\begin{aligned}
& a_{11}X_1 + a_{12}X_2 + \dots + a_{1n}X_n + y_1 = X_1 \\
& a_{21}X_1 + a_{22}X_2 + \dots + a_{2n}X_n + y_2 = X_2 \\
& \dots \\
& \dots \\
& a_{n1}X_1 + a_{n2}X_2 + \dots + a_{nn}X_n + Y_n = X_n
\end{aligned}
\tag{2}$$

The elements a_{ij} form an n -by- n technical coefficient matrix A and, letting x denote an n -order gross output vector and y denote an n -order final demand vector, equation set (2) may be written as:

$$(3) \quad x = Ax + y$$

The final demand vector y is the vector of outputs available for disposal outside the processing sector and, letting I denote an identity matrix of order n from (3), we have:

$$(4) \quad x - Ax = (I-A)x = y$$

Assuming that the elements of A are nonnegative and that at least some of the a_{ij} 's are positive insures that $(I-A)$ is nonsingular, and equation (4) may thus be solved for x :

$$(5) \quad x = (I-A)^{-1}y$$

$(I-A)^{-1}$ is the Leontief inverse matrix and the elements a_{ij} of it indicate the output requirements generated directly and indirectly from industry i by industry j per delivery of a dollar's worth of output to final demand.

The manpower demand generating system being developed here may in its simplest form be considered to be a straightforward extension of the Leontief open model in several directions. To begin with, the final demand vector itself may be viewed as the sum of a number of vectors each of which represents the industrial requirements of a distinct component of final demand. Letting u denote the number of final demand activities, g_j

denote an n -by-1 vector specifying the direct output requirements of exogenous activity j , and ϵ_j denote a vector indicating the portion of final demand consumed by exogenous activity j , we have:

$$(6) \quad y = g_1 + g_2 + \dots + g_u; \quad \sum_i^n y_i = \sum_j^u \epsilon_j \left(\sum_i^n y_i \right); \quad \sum_j^u \epsilon_j = 1$$

Writing out the first part of (6) specifically yields linear equations of the following form:

$$(7) \quad y_i = g_{i1} + g_{i2} + \dots + g_{ij} + \dots + g_{iu}; \quad i = 1, 2, \dots, n.$$

For a given time period and specified level and distribution of final demand g_{ij} indicates the direct requirements for the output of industry i generated by activity j , $\sum_i^n g_{ij}$ indicates the total direct output requirements from all industries generated by activity j , and $\sum_i^n g_{ij}$ indicates the total direct requirements for the output of industry i generated directly by all activity components of final demand.

Consider an arbitrary element g_{ij} defined above. As indicated, g_{ij} shows the direct requirements for input i generated by exogenous activity j and the magnitude of this demand will, in general, be determined by two factors: the total amount of final demand absorbed by activity j and the portion of this amount devoted to the purchase of input i . This first factor may be expressed as:

$$\epsilon_j \sum_i^n y_i$$

while the second factor can be written as:

$$g_{ij} / \sum_i^n g_{ij}.$$

Letting

$$p_{ij} \equiv \epsilon_j \sum_i^n y_i$$

and

$$q_j \equiv g_{ij} / \sum_i^n g_{ij},$$

(7) can be rewritten as:

$$(8a) \quad y_i = p_{i1}q_1 + p_{i2}q_2 + \dots + p_{ij}q_j + \dots + p_{iu}q_u; \quad i = 1, 2, \dots, n$$

or, letting P denote an n -by- u activity-industry matrix of activity input coefficients and q denote a u -by-1 activity-expenditure vector:

$$(8b) \quad y = Pq .$$

p_{ij} indicates the direct requirements generated for the output of industry i per dollar of expenditure in final demand sector j and q_j shows the amount of expenditures allocated to activity j . Final demand has thus been disaggregated into the product of an activity-industry matrix showing the percent distribution of expenditures on exogenous activities as direct output requirements and an activity-expenditure vector giving the distribution of national expenditures among economic activity categories.

It is important to recognize the generality and applicability of this method of handling final demand. In input-output analysis, households may be treated as an exogenous industry which supplies outputs (labor services) in return for inputs (consumers' goods and services). Government activity may be handled as an industry which purchases goods and services and collects payments for its product--special types of services--by

taxing other industries, while foreign trade may be considered as a distinct industry which produces imports and consumes exports.² And in static interindustry analysis, investment may initially be treated as a special activity requiring outputs from each industry.³ It is thus theoretically possible to identify gross national product with final demand and, in the recent Office of Business Economics, U.S. interindustry studies input-output data have been integrated with national income and product account data.⁴ Accordingly, each input vector p represents the structure of direct output requirements generated by an exogenous economic activity, and the elements of the expenditure vector q represent the distribution of national expenditures among economic programs and activities.

Within this framework it is possible to determine the direct output requirement generated by alternate distributions of national expenditures among economic activities. For here it is assumed that the elements of the P matrix are fixed over a limited range of expenditure redistribution and the activity-industry matrix thus represents a transformation of expenditures on economic activities into direct output requirements from every industry in the economy. The number of columns in P will vary with the data available and the purposes of the investigation and the empirical analyses conducted with this model thus far have stressed the importance of including as many functional government activities as possible

²For further discussion of the handling of the exogenous sector of an open input-output model, see Leontief [10] and Chapter 6 of Koopmans [9].

³A more useful treatment of investment in static interindustry analysis may be gained by allocating the output of the capital goods industries to the industries actually purchasing the capital goods via a "capital flow" matrix.

⁴The latest Office of Business Economics interindustry study of the U.S. economy is for 1963 and is discussed in [18].

in the activity-industry matrix.⁵ The reorderings of expenditure vector elements may be made to conform to different types of national priorities and it is therefore possible to generate direct industrial output requirements from alternate specified national goals and objectives. Using equation (5), these direct output requirements can be translated into total output requirements from every industry in the economy.

Next, output requirements must be related to employment demands. To accomplish this it is assumed that the employment requirements of an industry are proportional to the industry's output and that this relationship may be expressed in terms of labor input coefficients.⁶ Letting x_i^e denote the total employment in industry i , the labor input coefficient for industry i , θ_i , is:

$$(9a) \quad \theta_i = x_i^e / X_i; \quad i = 1, 2, \dots, n;$$

or:

$$(9b) \quad x_i^e = \theta_i X_i; \quad i = 1, 2, \dots, n.$$

Labor input coefficients are thus derived by dividing industry employment by industry output and they show the employment requirements of an industry per unit of output. Employment in each industry may be related to the components of final demand by substituting the values given for X_i in (5) into equation (9b) to obtain equations of the form:

$$(10a) \quad x_i^e = \theta_i a_{i1} y_1 + \theta_i a_{i2} y_2 + \dots + \theta_i a_{ij} y_j + \dots + \theta_i a_{in} y_n;$$

$$i = 1, 2, \dots, n$$

or, letting x^e denote an n -by-1 vector of elements $x_1^e, x_2^e, \dots, x_n^e$ and Θ denote a diagonal matrix whose elements are $\theta_1, \theta_2, \dots, \theta_n$, the equations in (10a) may be written in matrix notation as:

⁵ Empirical analyses using this basic model are presented in Bezdek [4] and in Bezdek and Scoville [7].

⁶ This term is adopted from Leontief's original work given in [11].

$$(10b) \quad x^e = \Theta(I-A)^{-1}y .$$

Consider the matrix M defined as $M = \Theta(I-A)^{-1}$, whose elements m_{ij} are:

$$(11) \quad m_{ij} = \theta_i \hat{a}_{ij}; \quad i, j = 1, 2, \dots, n .$$

Any element m_{ij} of M shows the total employment required within industry i in order for industry j to deliver a dollar's worth of output to final demand. The relationships contained in M may be set out in an array of the following form:

$$(12) \quad \begin{array}{c} \text{Industry Employment Generated By} \\ \begin{array}{cccccc} & \text{Industry} & \text{Employment} & \text{Generated} & \text{In} & \\ & 1 & 2 & \dots & j & \dots & n \\ 1 & m_{11} & m_{12} & \dots & m_{1j} & \dots & m_{1n} \\ 2 & m_{21} & m_{22} & \dots & m_{2j} & \dots & m_{2n} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ i & m_{i1} & m_{i2} & \dots & m_{ij} & \dots & m_{in} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ n & m_{n1} & m_{n2} & \dots & m_{nj} & \dots & m_{nn} \end{array} \end{array}$$

Each row of (12) indicates the manner in which employment is generated within industry i by required activity in industries $1, 2, \dots, n$ and each column of (12) illustrates how the employment generated by industry j is distributed among all industries. This array is referred to as an interindustry-employment matrix and it represents a concise description of the manner in which employment is generated by and within every industry in the economy.⁷

⁷The interindustry-employment matrix is discussed in detail in Alterman [2], Bezdek [4], and U.S. Department of Labor, Bureau of Labor Statistics [19], [21].

The necessary theoretical framework has now been constructed which permits the transformation of alternate priority-expenditure distributions into distinct interindustry-employment demand patterns. Letting $\overset{*}{Y}$ denote an n-by-n diagonal final demand matrix, the "total" interindustry-employment matrix, M^T , is derived by postmultiplying M by $\overset{*}{Y}$:

$$(13) \quad M^T = M\overset{*}{Y}$$

The elements of M^T show the total employment generated by and within every industry for a generated distribution of final demand reflecting a specified priority alternative.

The final step in the construction of the theoretical model involves the relation of interindustry-employment requirements to demands for occupational categories of manpower resources. This transformation is accomplished by using an industry-occupation matrix showing the occupational distribution of industry employment for the time period under consideration. Denote this matrix by B: the rows of B represent industries, the columns of B represent occupations, and any element b_{ik} of B shows the percent of total employment in industry i composed of persons classified within occupation k.

Let R denote a diagonal matrix whose elements r_{ii} are the row sums of the interindustry-employment matrix and thus show the total employment generated within a specific industry. The first and most widely recognized type of manpower information is derived by premultiplying the industry-occupation matrix by R:

$$(14a) \quad \begin{bmatrix} r_{11} & & & & & & \\ & r_{22} & & & & & \\ & & \bigcirc & & & & \\ & & & \ddots & & & \\ & & & & \bigcirc & & \\ & & & & & \ddots & \\ & & & & & & r_{nn} \end{bmatrix} \cdot \begin{bmatrix} b_{11} & b_{12} & \dots & \dots & \dots & \dots & b_{1h} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ b_{n1} & b_{n2} & \dots & \dots & \dots & \dots & b_{nh} \end{bmatrix} = \begin{bmatrix} (\alpha) & (\alpha) & \dots & \dots & \dots & \dots & (\alpha) \\ s_{11} & s_{12} & \dots & \dots & \dots & \dots & s_{1h} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ (\alpha) & (\alpha) & \dots & \dots & \dots & \dots & (\alpha) \\ s_{n1} & s_{n2} & \dots & \dots & \dots & \dots & s_{nh} \end{bmatrix}$$

or:

$$(14b) \quad RB = S^{(\alpha)}$$

$S^{(\alpha)}$ is a "type α " interindustry-occupation matrix and the elements $s_{ik}^{(\alpha)}$ of it show the total demands for occupation k generated within industry i by a specified distribution of national expenditures. From this matrix it is possible to determine the detailed industrial structure of occupational employment requirements which would result from a particular functional distribution of gross national product as well as the total requirements for each occupation which would be generated. While the possibility of deriving this type of manpower matrix has been recognized previously, the fact has not been fully appreciated that two other important types of information pertaining to the structure of manpower requirements may also be derived from this basic interindustry model.⁸

Letting M denote the transposition of the total interindustry-employment matrix, the second type of manpower impact matrix is derived by premultiplying the industry-occupation matrix by M :

$$\begin{bmatrix} m_{11} & m_{21} & \cdot & \cdot & \cdot & \cdot & m_{n1} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ m_{1n} & m_{2n} & \cdot & \cdot & \cdot & \cdot & m_{nn} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} & \cdot & \cdot & \cdot & \cdot & b_{1h} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ b_{n1} & b_{n2} & \cdot & \cdot & \cdot & \cdot & b_{nh} \end{bmatrix} = \begin{bmatrix} s_{11}^{(\beta)} & s_{12}^{(\beta)} & \cdot & \cdot & \cdot & \cdot & s_{1h}^{(\beta)} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ s_{n1}^{(\beta)} & s_{n2}^{(\beta)} & \cdot & \cdot & \cdot & \cdot & s_{nh}^{(\beta)} \end{bmatrix}$$

⁸What I have termed the "type α " manpower matrix has been developed for the U.S. economy by the Bureau of Labor Statistics in [20] and for the Canadian economy in [1]. However, thus far neither the BLS nor the Canadian Manpower Project has integrated a comprehensive input-output model with national manpower matrices, and the most advanced work along these lines is given in Bezdek [4] and in Bezdek and Scoville [7].

or:

$$(15b) \quad \overset{\circ}{MB} = S^{(\beta)}$$

$S^{(\beta)}$ is referred to as a "type β " interindustry-occupation matrix and the elements $s_{ik}^{(\beta)}$ of it show the demands for occupation k generated by industry i . So while the type α manpower matrix indicates the occupational employment demand generated in every industry, the type β manpower matrix indicates the occupational employment demands generated by every industry. The type β matrix is a useful innovative development: it can be used to identify those industries having the greatest influence on the demands for individual occupations and from it can be read the industries responsible for generating employment demands for any occupation.⁹

Finally, a third type of manpower impact matrix can also be derived. Letting B^k denote an n -by- n diagonal matrix whose elements correspond to the k^{th} column of B , the third type of manpower matrix is derived by premultiplying B^k by the transposed total interindustry employment matrix:

$$(16a) \quad \begin{bmatrix} m_{11} & m_{21} & \dots & m_{n1} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ m_{1n} & m_{2n} & \dots & m_{nn} \end{bmatrix} \cdot \begin{bmatrix} b_{11}^{(k)} & & & \\ & b_{22}^{(k)} & & \\ & & \circ & \\ & & & \ddots \\ & & & & b_{nn}^{(k)} \end{bmatrix} = \begin{bmatrix} s_{11}^{(k)} & s_{12}^{(k)} & \dots & s_{1n}^{(k)} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ s_{n1}^{(k)} & s_{n2}^{(k)} & \dots & s_{nn}^{(k)} \end{bmatrix}; \quad k=1,2,\dots,h$$

or:

$$(16b) \quad \overset{\circ}{MB}^{(k)} = S^{(k)}; \quad k = 1, 2, \dots, h.$$

⁹The "type β " manpower matrix is developed in greater detail in Chapter 3 of Bezdek [4]. Empirical analyses with this matrix are presently being conducted by the author and will soon be available.

Since there are h columns in B --one for each occupational classification--it will be possible to derive h of these S^k matrices. Each S^k matrix is essentially an interindustry-employment matrix for the k^{th} occupation and an element s_{ji}^k shows the employment requirements for occupation k generated within industry i by industry j . These matrices are referred to as occupational employment profiles and they contain a highly detailed description of the structure of demands generated for an individual occupation by a specified distribution of national expenditures. These profile matrices can be used to study the precise manner in which employment demands for a specific occupation are determined and to identify those occupations most strongly tied to specific industries, programs, and activities.¹⁰

Taken together, these three types of manpower impact matrices will provide a comprehensive and highly detailed picture of the employment impacts likely to result from the implementation of alternate types of economic and social programs and priorities.

II. DIFFICULTIES OF EMPIRICAL IMPLEMENTATION

The model outlined above is conceptually straightforward; however, severe difficulties arise in the empirical implementation of it. The data problems encountered and the reasons for them raise a number of questions, the importance of which transcends this particular model. Here discussion will be limited to the major types of empirical difficulties which arise in the implementation of the manpower impact model. Since the scope of this analysis is so broad, the problems mentioned here will be familiar to many researchers, and the generality and widespread nature of these problems will be apparent.

¹⁰These profile matrices are discussed in more detail in Chapter 3 of Bezdek [4], and empirical results obtained from them shall soon be available.

For the purposes of exposition, the types of data problems encountered in a comprehensive economic activity-manpower impact analysis have been classified into three broad problem areas: data incompatibility, data insufficiency, and data irrelevancy.

Problems of data incompatibility result from the existence of large sets of data and statistical series which are available from government sources but which are incompatible with one another. The reasons for this irreconcilability vary in specific instances but, in general, these difficulties arise from differences in classification schemes, sampling procedures, aggregation conventions, activity and employment concepts, and basic definitions among Federal bureaus and agencies. For instance, one of the most serious problems in the implementation of the manpower impact model is the lack of correspondence between the employment coverage of the interindustry-employment matrix and that of the industry-occupation matrix. To begin with, the industry groupings in these two matrices do not relate to one another in any type of rational or consistent manner, even in terms of the basic standard industrial classification (SIC) codes. The interindustry-employment matrix is developed from input-output data derived largely from the periodic census of manufactures, while the industry-occupation matrix is constructed from information obtained from the decennial census of population. The input-output industries were developed in line with an activity concept and detailed SIC industry groups and subgroups were, in many cases, combined into unique types of industries. On the other hand, the industries for which occupational employment distributions are available conform to the more traditional type of SIC groupings. Further, the interindustry-employment job count is obtained from employer records while the industry-occupation matrix job count is derived from individual employee responses.

One of the more serious discrepancies which result from this is that

input-output uses a series count of jobs whereas the industry-occupation matrix is developed according to a series count of persons. Thus in the inter-industry-employment matrix one person holding two jobs is counted twice--once at each job--while in the industry-occupation matrix he is counted only once--at his primary job.

Other frustrating discrepancies also arise between these two matrices. For example, for the occupational data veterinarians are assumed to perform services essential to agriculture and by activity are included in the agriculture, forestry, and fishery industry group. But, within the interindustry-employment matrix veterinarians are allocated to the medical and other health services group. While convincing arguments could be made for including veterinary services in either industry, there is no simple way to reconcile different handling of the same employment category in the two matrices.

The net result of these and similar discrepancies is that it is extremely difficult to accurately and consistently disaggregate the industrial employment requirements generated in the interindustry-employment matrix into demands for occupational categories of manpower resources.¹¹

A severe problem of data incompatibility also arises with respect to the treatment of activity and employment within the government sector. In some cases activity or employment related to the public sector is allocated entirely to a particular level and function of the Federal, state, or local government, while in other instances the government categories pertain only to the strictly administrative functions of government, and other public activities are allocated to related industries within the private sector of the economy. In still other cases government activities financing the major portion of their operating expenses by sales to the general public are grouped

¹¹See Chapter 7 of Bezdek [4].

into uniquely defined special industries. These discrepancies introduce many additional difficulties into a comprehensive integrated analysis: construction carried on within the government may be allocated alternately to general government, private construction, or special government enterprise; teachers employed by certain states or localities may be classified within government employment or within employment in the educational services industry; city and county police may be classified in local government employment or in employment within the protective service industry.

Data insufficiency, the second major type of data problem, refers to the absence of data necessary for the analysis of many types of important economic problems. Despite the large and continually increasing volume of statistics which flow from the Federal government, there remains a critical lack of information in many important areas. The ever increasing importance of the service sectors of the American economy is widely recognized, as is the rapidly growing significance of public activity at all levels of government. Unfortunately, in many instances it is precisely these areas for which available statistical data is most deficient.

It is significant to note that the level of detail of input-output data for the service sectors is not nearly as great as that for the manufacturing sectors. The result is that many critically important detailed changes are obscured in the structure and composition of the service sectors. To supplement this information it is often necessary to rely on additionally unpublished data of questionable accuracy. Thus a dilemma results: the available interindustry data relating to the service sectors is frequently too aggregative to yield the desired information,

while the more detailed data which is available is of such dubious quality that doubt is cast on the validity of the entire analysis.¹²

Detailed and reliable data relating to all levels of government activity are even more difficult to obtain. The economic and employment effects of government programs at the Federal, state, and local level are a topic of vital economic and social concern and, as indicated in the first section of this paper, input-output analysis offers a viable methodology for analyzing many of these problems. Unfortunately, there is a pronounced lack of even the most basic types of data relating to the outputs, expenditure distributions, industrial inputs, and employment requirements of public activities which are required for the analysis of these problems. When one wishes to concentrate on more specialized functional public programs, the data problems often become overwhelming. This lack of reliable data on virtually all aspects of government activities may be the most critical gap in the present day system of economic and social statistics; improving this situation should be given top priority for future research.

Finally, irrelevancy, the third general type data problem, pertains to the fundamental issue of whether or not the information available has been obtained on the basis of outmoded criteria and whether or not more relevant and useful methods exist for collecting and classifying the same data. Interest centers here not upon the availability of sufficient data nor upon whether or not it may be compatible with other related sets of statistics but, rather, on the fundamental question of whether or not it is available in the optimal format.

¹²It is, of course, recognized that this difference in coverage is partially due to the greater ease with which manufacturing industries can be adopted to an input-output framework.

This problem is especially serious with respect to the present occupational classification system used by the Bureau of Labor Statistics and the Census Bureau. To begin with, even the attempt to comprehensively and accurately describe within two or three hundred broad categories the complex occupational structure of the contemporary American economy may be questioned. Worse still, in the existing occupational classification scheme more than thirty percent of the total labor force is classified in categories labeled "not elsewhere classified" (n.e.c.). These categories often account for the majority of the workers classified within a specific occupational group or subgroup and they contain many varied and unrelated classes of workers.

An even more fundamental criticism of the present U.S. system of occupational classification can be raised in relation to the basic system of job classification itself. Individual job categories often encompass such a wide range and diversity of skills, wage levels, managerial responsibilities, and education and training requirements that they cannot be used for many types of analyses. This particular point has been covered in depth elsewhere; here it is merely noted that the present job classification is for many purposes irrelevant and obsolete, being based largely on "social-economic status" which is only roughly linked to the job performed and the skills required.¹³ Further, the heterogeneous nature of the educational and training requirements and requisite vocational preparation within jobs classified in the same category limits the usefulness of the type of model outlined in the preceding section of this paper. Before a

¹³These types of deficiencies in the U.S. system of occupational classification have been thoroughly discussed and analyzed by Scoville in [14] and [15]. In The Job Content of the American Economy [14] Scoville has developed alternate and more useful job classification schemes.

clear idea of the implications for educational and manpower planning of different sets of economic and social priorities can be obtained it is first necessary to have a more valid and meaningful system of occupational employment classification.

Speculating on the causes of this unfortunate state of government social and economic statistics brings a number of factors to mind. First of all, with the data collection and classification functions of the government spread out among so many diverse bureaus, agencies, and departments at the Federal level it is perhaps surprising that the data problems encountered are not even more serious than they are. It is only to be expected that individual bureaus and agencies possess their own unique conventions and procedures for data collection and classification, and the different goals and responsibilities of each agency tend to exacerbate this tendency. Then, too, some of the blame may lay with the present U.S. national economic accounting system. While the primary function of the national accounts is more to provide a broad overview of the national economy than to furnish large quantities of data for use in specialized interindustry, econometric, and sociometric models, a sensible restructuring of the national economic accounts could probably result in a more successful fulfillment of all these functions.¹⁴ In addition, it could be argued that the level of funding traditionally allocated to the statistical data collection and classification functions of the Federal government has been grossly inappropriate to the task at hand. More generally, many of these problems are the result of data collection and classification without a prerequisite theory or, indeed, in many cases, apparently without much thought as to how, when, where, or in what form specific types of

¹⁴

For further discussion of this, see Ruggles and Ruggles [13] and Bezdek [6].

data should be obtained.

In an important sense, though, the economics profession itself cannot escape a major portion of the blame for the existence of this situation which so few of us have criticized. In surveying the development of economics in the past quarter century it often appears that a much higher priority has been given to work with models and systems which are unrealistic, improbable, and inapplicable than to "messy" types of empirical research which may be of practical rather than theoretical interest. In the words of a recent president of the American Economic Association:

Continued preoccupation with imaginary, hypothetical, rather than with observable reality has gradually led to a distortion of the informal valuation scale used in our academic community to assess and to rank the scientific performance of its members. Empirical analysis, according to this scale, gets a lower rating than formal mathematical reasoning. Devising a new statistical procedure, however tenuous, that makes it possible to squeeze out one more unknown parameter from a given set of data, is judged a greater scientific achievement than the successful search for additional information that would permit us to measure the magnitude of the same parameter in a less ingenious, but more reliable way. This despite the fact that in all too many instances sophisticated statistical analysis is performed on a set of data whose exact meaning and validity are unknown to the author or rather so well known to him that at the very end he warns the reader not to take the material conclusions of the entire "exercise" seriously.¹⁵

It has been the experience of this author that government personnel are not unresponsive to constructive suggestions for improving their operations and functions. The continued existence of the problems discussed here may thus bear witness to the fact that so few viable and concrete recommendations pertaining to specific empirical problems and irrationalities have been made.

Whatever their cause, the effect of these data problems is serious.

¹⁵Leontief [12] p. 3.

It implies that anyone undertaking ambitious empirical research must spend an inordinate amount of time struggling with uncooperative data, searching for often nonexistent statistical sources, and devising complex schemes and methodologies for reconciling and rationalizing available information. This not only distorts the results of the analysis and limits the time the researcher has to devote to the original economic problem at hand, but it also tends to discourage investigators from undertaking many types of useful and relevant large-scale empirical studies. Given the poor state of the data, the tremendous volume and frustrating nature of the work involved, and the relative lack of recognition for the results achieved, is it really surprising that so few researchers have been willing to tackle these problems?

III. CONCLUSION

The purpose of this paper has been to theoretically develop a comprehensive economic activity-manpower impact model and discuss the serious difficulties encountered in empirically implementing such a model. The static open input-output model's expansion for generating three distinct types of manpower impacts from shifting expenditure distributions reflecting alternate national goals and priorities has been illustrated. The activity-industry matrix and the manpower impact matrices represent useful concepts which have not been previously recognized. In discussing the empirical difficulties involved here, some important questions were raised concerning the present state of available economic and social statistics. Data problems were grouped into three categories: problems of incompatibility (the difficulty of reconciling data sets compiled by different government bureaus and agencies), problems of insufficiency

(the lack of adequate information pertaining to critical economic sectors), and problems of irrelevancy (the collection and classification of data on the basis of obsolete and irrelevant formats). While the discussion of these problems was conducted within the framework of interindustry manpower analysis, it was stressed that similar problems are encountered by many researchers conducting different types of comprehensive empirical economic and sociological analyses.

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13. ABSTRACT This paper has two objectives. First of all, an economic acitivity-manpower impact model capable of generating detailed industrial and occupational manpower requirements from different specified economic budgets is developed in rigorous detail and the fact that several unique types of manpower information are derivable from this basic interindustry model is stressed. Secondly, the severe data problems encountered in the empirical implementation of this model are grouped into three general types for discussion: problems of data incompatibility, problems of data insufficiency, and problems of data irrelevancy. Implications of these problems for the government's methods of collecting and classifying economic and social statistics are indicated.			

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