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AN APPRAISAL OF NONSURVEY AND MINIMUM SURVEY TECHNIQUES FOR ESTIMATING THE LANSING TRI-COUNTY REGION INPUT-OUTPUT TABLES

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ABSTRACT

AN APPRAISAL OF NONSURVEY AND MINIMUM SURVEY TECHNIQUES FOR ESTIMATING THE LANSING TRI-COUNTY REGION INPUT-OUTPUT TABLES

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The application of a regional input-output model is invariably a compromise between the desire for theoretical satisfaction and comprehensive data coverage, on the one hand, and the need to economise on time and resources on the other. Nonsurvey and minimum survey techniques for constructing regional input-output tables are attractive to regional analysis because of the relatively smaller cost involved as compared with direct survey techniques. Yet, attempts at such nonsurvey and minimum survey techniques have not been successful. The distance between the survey and the nonsurvey direct cofficients matrices is quite large in absolute terms. In fact, until recently there were no accurate comparisons between tables constructed by survey and nonsurvey methods. Thus, a study on nonsurvey and minimum survey techniques of constructing regional input-output tables would likely contribute greatly to progress in regional economics.

In order to make this contribution, the relative efficiency of six reducing techniques--(1) Simple Location Quotient, (2) Purchase Only Location Quotient, (3) Cross Industry Quotient, (4) Modified Supply-Demand

Pool, (5) RAS, and (6) Schaffer-Chu Iterative Procedure--in estimating the Tri-County Region's (Eaton, Clinton and Ingham Counties of Michigan) direct coefficients, the Type I and Type II income multipliers were compared and evaluated.

The relative efficiency of each reducing technique was measured as distance or relative distance between the estimated direct coefficients, the Type I and the Type II income multipliers, and the "True" direct coefficients, the Type I and the Type II income multipliers computed from the survey table. In judging which of the estimated coefficients and multipliers are closest to the equivalent survey based table, three comparative tests were used: (1) The mean absolute percentage deviation, (2) The mean of relative change, and (3) The mean of similarity index.

In estimating the regional direct coefficients, none of the reducing techniques appraised in this study were entirely satisfactory. The distance between the survey and nonsurvey matrices was too large, to be accptable to the author. It was apparent that the RAS technique produced superior estimates when judged by the three comparative techniques. This is not entirely surprising, given the technique employs a certain amount of survey data. Among the purely nonsurvey techniques, the Schaffer-Chu Iterative procedure and the Cross Industry Quotient technique emerged as being superior to the other nonsurvey techniques, when judged by the mean of similarity index, which is the most ideal comparison test employed in this study.

This study revealed that the relative efficiency of the six reducing techniques was better when they were used to estimate the Type I and the Type II multipliers, than when they were used to estimate the regional direct coefficient. It was observed, that the RAS technique produced the best estimates of the Type I and the Type II multipliers when judged by any comparison tests employed in this study. Among the purely nonsurvey techniques, the Schaffer-Chu iterative procedure and the Cross Industry Quotient produced the best simulation of the Type I and Type II income multipliers.

In estimating regional direct coefficients, Type I, and Type II income multipliers, it was found that the greatest deviations occurred in three groups of sectors: (1) Sectors in which the regional economy is highly specialized, (2) Sectors of primary activities, and (3) Sectors which have been obtained through a high degree of aggregation. In order to obtain more acceptable results, it was recommended to use field surveys to obtain the regional direct coefficients of these three groups of sectors.

Dedicated to

Ros and Rina Nasoetion

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CHAPTER I

INTRODUCTION

Problem Setting

In general, most state, regional and county planners are interested in local socio-economic evaluation and potential impacts of resource programs and plans. Information on costs, benefits, and other regional and environmental trade-offs are needed by decision makers, planners, and local participants, before recommending and implementing a plan. Indeed, this information cannot be just a localized national economic development display, but has to reflect the regional economy, including the interindustry and intraindustry flow of goods and services. Reliable information has to be developed so that alternative regional development plans and strategies can be prepared and analyzed. In general, two major kinds of information are necessary: reliable estimates of structural relationships in a regional economy and direct and indirect impacts of planned economic activities. New economic activities must be translated into shifts in final demand on an industry by industry basis. For this purpose, input-output models are very useful, because they can be used to estimate structural relationships in a regional economy and impacts of planned new economic activities.

Wassily Leontief spent a number of years in constructing input-output tables for the U. S. economy for 1919 and 1929. His results, which he used to analyze the working of American economy were published in 1941 and 1951.[1] An 87 sector input-output model of the U. S. economy for the year 1958, was published by the Office of Business Economics (now Bureau of Economic Analysis) in 1964. The largest U. S. economy input-output model is the 370 sector table published by Bureau of Economic Analysis in 1969 for the year 1963. The newest national model was published in 1974 for 1967. "With the publication of these results, the number of comparable benchmark input-output tables is increased to four and the time span covered by these studies is extended to 20 years covering the period of 1947 to 1967."[2]

Leontief in his analyses focused his attention on intersectoral relations, and based his analysis upon general equilibrium theory. While the general equilibrium theory of Walras did not go beyond writing down a set of equations with symbolic coefficients, Leontief estimated

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[1] Leontief, Wassily. 1941, 1951. The Structure of American Economy. New York: Oxford University Press.

[2] U. S. Department of Commerce, Bureau of Economic Analysis, "The Input-Output Structure of the U. S. Economy: 1967," Survey of Current Business, LIV (February, 1974), 24-56.

such a system with empirically obtained numerical coefficients. In his conception, the statistical data collected fill in the "empty box" of the theory. Hypothetical production and consumption equations gain explicit meaning as soon as the algebraic symbols are replaced by observed numerical values. Once empirical foundations are thus established, the vague generalities of abstract theoretical statements acquire empirical significance.

The endeavors to make general equilibrium theory correspond to economic reality led to linearization of economics. This, together with the development of aggregation schemes wherein millions of households could be represented by a single sector and hundreds of firms of an industry by another, and so on, made the system amenable to analysis by use of matrix algebra. And Leontief used it with a telling effect.

Essentially, input-output is a method of analysis that takes advantage of the relatively stable pattern of the goods and services in the short run, among elements of the economy to bring a more detailed statistical picture of the system into the range of manipulation by economic theory.

Input-output analysis is applied intensively in the study of regional economy. An important reason for this is that input-output techniques can be implemented empirically in a field where data shortages and underdeveloped theoretical constructs restrict the scope for hard empirical research. Moreover, it provides virtually the sole avenue of escape from partial equilibrium analysis.[1] The other general equilibrium theories available, Walrasian general equilibrium, Neo-Keynesian interregional macroeconomics, may be a little more satisfying theoretically but they are much more difficult to apply empirically. In particular, interregional trade flows are much easier to measure and make consistent with theory within an input-output framework. Moreover, some versions of interregional input-output models of which the gravity technique is typical, have the added advantage for analysis of the space economy that they take distance in the form of transportation cost explicitly into account as a relevant variable.

There are at least four basic purposes of an input-output model:

1) It can provide a detailed description of a national or regional economy by quantifying linkages among sectors of the economy and the sources and origin of exports and imports,
2) Given a set of final demands (exogenous), total output in each industry and requirements for primary factors and resources can be determined,
3) The effects of change in final demands, arising in either the private or public sector, can be traced and predicted in detail,
4) Changes in production technology or relative prices can be incorporated by changing the technical coefficients of production.[2]

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[1]Richardson, Harry W. 1972. Input-Output and Regional Economics. Trowbridge, Wiltshire, England: Redwood Press Limited, 294 p.

[2]Lewis, W., Cris. 1971. Regional Economic Development: The Role of Water (Logan: Utah State University Foundation) p. 5).

These advantages go a long way to offset the well known drawbacks--the restrictive assumptions, the high cost involved in obtaining data required, and practical obstacles in the way of operationalizing the dynamic models needed for long run regional planning. However, because of its usefulness, regional economists in most cases must depend heavily upon input-output analysis. Their involvement can usually be traced to pragmatic grounds--that given the objective of their research, available data and research resources, input-output modeling is the most useful technique currently available.

Objective of the Study

The implementation of regional input-output models is invariably a compromise between the desire for theoretical satisfaction and comprehensive data coverage, on the one hand, and the need to economise on time and resources on the other. Nonsurvey and minimum survey methods for constructing regional input-output tables are attractive to model builders because of the relatively smaller cost involved as compared with full survey methods. Yet, attempts at such nonsurvey and minimum survey techniques have not been successful. The distance between the survey and the nonsurvey direct coefficients matrices is quite large in absolute terms. In fact, until recently there were no accurate comparisons between tables constructed by survey and nonsurvey methods. Thus, a study of nonsurvey and minimum survey methods of constructing regional input-output tables would likely to contribute greatly to progress in regional economics.

Input-output tables of the Lansing Tri-County Region (Eaton, Ingham and Clinton Counties) have been constructed by O'Donnell, et al., of Michigan State University in 1960,[1] for the year of 1958 based upon primary data collected by a survey method. The purpose of this study is to construct nonsurvey and minimum survey input-output tables for the same region, for the year 1958, based upon the United States national input-output tables for 1958, by using six reducing techniques, i.e.: (1) The Simple Location Quotient, (2) The Purchase Only Location Quotient, (3) The Cross Industry Quotient, (4) The Modified Supply-Demand Pool, (5) The RAS Method, and (6) The Schaffer-Chu Iterative Procedure.

The Type I and Type II sectoral income multipliers will be computed based upon the direct coefficients matrices produced by each reducing technique.

The direct coefficients estimated by the nonsurvey and minimum survey techniques, as well as the Type I and Type II income multipliers generated by each technique will be compared to the "True" direct coefficients, the Type I and Type II multipliers computed by O'Donnell, et al.

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[1]O'Donnell, John L., et al., 1960. Economic and Population Base Study of the Lansing Tri-County Area: An Inter-Industry Relation Analysis. Michigan State University, 319 p.

Comparisons will be performed by using three tests: (1) The Mean Absolute Percentage Deviation, (2) The Mean of Relative Change, and (3) The Mean of Similarity Index.

Limitations of the Study

The results of this study are applicable only to the Lansing Tri-County Region. Although the techniques appraised here may be applied elsewhere, extension of specific quantitative results is not warranted.

The empirically derived input-output model of the Tri-County Region is a regional version of the traditional Leontief open, static input-output model, and thus the non-survey and minimum survey techniques tested in this study produced input-output model which suffers from all problems and limitations of the Leontief open, static input-output model.

The basic assumption of all techniques is that the national direct coefficients assumed appropriate at the regional level and that the regional direct coefficients differ from the national direct coefficients to the extent that goods and services are imported from, or exported to other regions. This assumption clearly implies the constraints that the regional direct coefficients must always be less than or equal to the national coefficients.

Outline

Background information on previous related studies is presented in Chapter II. Research methodology is described in Chapter III. Results of this study are discussed in Chapter IV. Finally, Chapter V provides a summary, conclusions, and recommendations for further research on the nonsurvey and minimum survey input-output techniques.

CHAPTER II

LITERATURE REVIEW

The Theoretical Foundations of Input-Output Analysis

The theoretical foundations and problems of input-output analysis are discussed briefly in this chapter, to facilitate presentation and discussion of nonsurvey and minimum survey techniques in Chapter IV. The more elaborate discussions on this topic can be found in Richardson (1972),[1] and Miernyk (1965)[2].

The input-output method is an adaptation of general equilibrium theory to the empirical study of the quantitative interdependence between interrelated economic activities. Leontief's idea was as follows: An economy consists of a large number of consumers and producers who conduct among themselves transactions--sales and purchases of goods. The interdependence between the individual industries of the given system may be described by a set of linear equations. Coefficients of these equations must be determined

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[1]Richardson, Harry W. 1972. Input-Output and Regional Economics. Trowbridge, Wiltshire, England: Redwood Press Limited, 294 p.

[2]Miernyk, W. H. 1965. The Elements of Input-Output Analysis. New York: Random House.

empirically. In the analysis of structural characteristics of an economy they usually are derived from a so-called statistical input-output table.

Transactions Matrix

Assume that one industry produces one commodity, there is no joint production. Hence, the number of industries is the same as the number of commodities. Assume further that no changes occur in inventories of the commodities. By definition:

$$\sum_{j=1}^{n} x_{ij} + x_j = x_i \text{ , } i = 1,2,\ldots n\ldots \tag{1}$$

where:

x_{ij} = intermediate demand for the i^{th} industry's output by the j^{th} industry's output; $i = 1,2,\ldots n.$

x_j = final demand by consumers for the i^{th} industry's output; $j = 1,2,\ldots n.$

x_i = Gross output of industry i; $i = 1,2,\ldots n.$

The $[x_{ij}]$ form a transaction matrix of processing sectors.

Input Coefficients

The static input output model assumes constant proportions among inputs and outputs for each industry. This production relationship rules out factor substitutability. Ratios between input from each industry and the total outlay,

$$a_{ij} = x_{ij}/X_j \text{ ; } i,j = 1,2,\ldots n. \tag{2}$$

are called input or direct coefficients and can be arranged as follows:

	1	2	....	n
1	a_{11}	a_{12}	....	a_{1n}
2	a_{21}	a_{22}	....	a_{2n}
.	...	...	....	...
.	...	...	....	...
.	...	...	....	...
.	...	...	....	...
.	...	...	....	...
n	a_{n1}	a_{n2}		a_{nn}
	a_{01}	a_{02}		a_{0n}

It should be noted that all of these coefficients are non-negative.

Gross Output Needed to Produce Given Final Demands

A model to compute gross output needed to produce given final demands is needed in constructing an input-output table as well as in forecasting. The model can be formulated as follows:

From (2),

$$x_{ij} = a_{ij} \cdot X_j; \; i,j = 1,2,\ldots n \qquad (3)$$

Substituting (3) into (1),

$$\sum_{j=1}^{n} a_{ij} \cdot X_j + x_j = X_i; \; i,j = 1,2,\ldots n \qquad (4)$$

Let:

a = input coefficient matrix = $[a_{ij}]$

$\overline{X}$ = column vector of X_i; i = 1,2,...n

$\overline{x}$ = column vector of x_i; i = 1,2,...n

Then in matrix notation, (4) can be written as follows:

$$A\overline{X} + \overline{x} = \overline{X}; \tag{5}$$

Therefore:

$$\overline{(I - A)}\cdot\overline{X} = \overline{x}$$

If $\overline{(I - A)}$ is nonsinglular, then,

$$\overline{X} = \overline{(I - A)}^{-1}\cdot\overline{x} \tag{6}$$

In formula (6), the (i,j) element of the Leontief inverse $\overline{(I - A)}^{-1}$ indicates by how much the gross output of the i^{th} industry has to be changed corresponding to a unit increase or decrease in the j^{th} industry's final demand. In this sense, each element of the Leontief inverse can be called multisector multiplier. In input-output analysis the multiplier represents the propagation effects through intermediate demand.

For Example,

$$X_1 = \frac{1}{V}\left(B_{11}x_1 + B_{21}x_2 + \ldots + B_{n1}x_n\right) \tag{7}$$

where v is the determinant of (I - A) and B_{ij} are cofactors of the (i,1) elements of (I - A). The rate of change of the first industry's gross output with respect to the i^{th} industry's final demand is:

$$\frac{\partial X_i}{\partial x_i} = \frac{B_{i1}}{v} \tag{8}$$

Feasible Outputs

In input-output analysis, output of the economy is limited by available primary factors. For an output vector X, the total labor needs are:

$$x_0 = \sum_{j=1}^{n} x_{0j} = \sum_{j=1}^{n} a_{0j} X_j = a_0' (I - A)^{-1} x \qquad (9)$$

where:

a_{0j} = the employment coefficients that is the ratio between the labor input and output

a_0 = column vector of a_{0j}; j = 1,2,...n

X_j = total outlay

Prime indicates transpose of the matrix or vector.

The Prices in Input-Output Systems

Let the prices of n commodities be p_i; the price of labor be w, and the total labor needs for sector j (j = 1,2,...n) are x_{0j}, then for each commodity,

$$\sum_{i=1}^{n} p_i x_{ij} + w x_{0j} = p_j X_j \qquad (10)$$

substituting (3) and (4) in (10),

$$\sum_{i=1}^{n} p_i a_{ij} X_j + w a_{0j} X_j = p_j X_j \qquad (11)$$

Therefore:

$$\sum_{i=1}^{n} p_i a_{ij} + w a_{0j} = p_j \qquad (12)$$

Let:

p = column vector of p_i; i = 1,2,...n. Then in matrix notation (12) is equivalent to

$$\bar{p}'\bar{A} + \overline{wa}_0 = \bar{p} \tag{13}$$

That is,

$$\bar{p}'\ \overline{(I - A)} = \overline{wa}_0' \tag{14}$$

$$\bar{p}' = \overline{wa}_0'\ \overline{(I - A)}^{-1} \tag{15}$$

Thus, <u>ceteris paribus</u>, given the wage rate, the prices of the commodities are determined by the input coefficients.

Post multiply (14) through by X, obtaining,

$$\bar{p}'\ \overline{(I - A)}\bar{X} = \overline{wa}_0\bar{X} \tag{16}$$

and premultiply (7) through p', obtaining

$$\bar{p}'\ \overline{(I - A)}\bar{X} = \bar{p}'\bar{x} \tag{17}$$

Expressions (16) and (17) imply that,

$$\overline{wa}_0'\bar{X} = \bar{p}'\bar{x} \tag{18}$$

Expression (18) states that income of the factor, labor, equals expenditure on final goods.

Assuming constant returns to scale, the relative prices of the commodities are determined by the technological condition represented by A, independently of output levels of these commodities.

Some Problems of Input-Output Analysis

Theoretical Problems

Input-output models incorporate the basic assumptions of the general Leontief model. Theoretically, each commodity is supplied by a single industry or sector of production, only one process is used for producing each commodity and each sector has only one primary output. There are, therefore, no joint products. Inputs purchased by each sector are a function only of the output of that sector. However, the translation into empirical tool involved lumping together only those plants with similar output and input structures. The practical solution is to group processes and products which differ in some respect but which behave sufficiently uniformly to be used as a basis for aggregation.

The emphasis on linear production relationships also creates some problems. The essence of the Leontief model is the technological relationship that purchases of any sector (except final demand) from any other sector depend, via a linear production function, upon the level of output of the purchasing sector. The constant and linear production function assumption solves some kinds of difficulties, for instance it eliminates factor substitution and economies of scale, but creates others. Time is missing, yet the purchase of inputs by one industry to make goods to sell to other industries implies a period analysis. Moreover, the notion of a linear production function is not very meaningful in many nonindustrial sectors such as agriculture, services sectors and the government sectors, where production functions are usually not linear. In 1951, Samuelson[1] showed how the assumption of linear relationship and no factor substitution are not as rigid as first appears. The Samuelson theorem as it is called, assumes that each industry produces only one commodity and that each industry uses only one scarce primary factor which is homogeneous for all firms in the industries. If it is further assumed that there are constant returns to scale, Samuelson found that even if each firm had a wide choice of alternative production processes, it is compatible with overall efficiency for each firm to use only one of the processes available.

Extending input-output analysis to an interregional setting creates more problems, because it is necessary to make additional assumptions. A regional interindustry analysis must not only assume stable direct coefficients but also stable trading coefficients, so that repercussions of autonomous changes are not distorted by geographical differences in the location of final demand or in sources of supply. This means that all consuming industries absorb the domestic output of any given type of good and service combined in a fixed proportion with a certain

[1]Samuelson, P. A. 1951. Abstract of a Theorem Concerning Substitutability in Open Leontief Model. In: T. C. Koopmans (ed.) Activity Analysis in Production and Allocation. John Wiley, pp. 142-146.

type of its competitive imports, the proportion itself being determined by the ratio of the total imports of the particular type of goods to their total supply. This assumption freezes the spatial structure of each region, and implies fixed regional supply areas for each and every consuming industry using a particular input. This assumption is restrictive since in reality the supply patterns of individual sectors for a given input may vary widely because of vertical integration, competition, different locations within a given region, entry of new firms, exit of firms or institutional ties.

The interregional input-output analysis also implies comparative stability in relative prices between regions and no changes in interregional competitiveness in the supply of particular commodities. This implication is restrictive since in reality, there is probably even less justification for expecting stability in imports coefficients than in direct coefficients.

Finally, interregional input-output analysis assumes that imports enter a region only through the matrix of interdependence. Imports of a commodity are therefore considered as inputs and are fed directly into producing sectors, they enter final demand only indirectly as part of a regional industry domestic output. In some cases, it may be unrealistic to assume that imports enter only the producing sectors as inputs and never go directly to final consumption; for example, if a large consuming center is located near the supplying region's boundary while the production plants of a sector are located at the maximum distance from that boundary, we would expect to find supplies of finished goods being sent directly to the point of consumption rather than the commodity being exported as an input to the distant plants, converted into final output and returned to the consumption center.

Operational Problems

A major drawback to the widespread application of input-output models at the urban and regional levels is a shortage of the requisite data. The successful implementation of an input-output model demands an extensive data set which few other models need. Data are rarely published in a form directly useful for regional input-output studies, so the local analyst must collect all or some of the data through empirical survey, or can attempt to produce an input-output table from the available published statistics. The former option will clearly be the most expensive, the latter the least accurate, but often the most attractive from the cost point of view. It should be noted that although survey based input-output tables are probably more accurate than the nonsurvey or minimum survey table, the former are frequently out of date when published, since research workers rarely pay for the cost of continuous updating. Thus, in most cases, nonsurvey tables may have to be based upon out-of-date input-output tables.

CHAPTER III

RESEARCH METHODS

This chapter consists of six parts. The first is a brief review of some previous reducing techniques which are not appraised in this study. In the second part, the procedure and assumptions of the six reducing techniques appraised in this study will be discussed. In the third part, the procedure and assumptions of income multiplier analysis are outlined. In the fourth part comparative techniques employed in this study are presented. Part five contains a description of the structure of the Lansing Tri-County Region input-output tables. Finally, in the sixth part, the procedure and assumptions of sector aggregations adopted in this study are discussed.

Review of Some Previous Reducing Techniques Which Are Not Appraised in this Study

Modification of National Technical Coefficients

These techniques involve the modification of national coefficients as a result of detailed knowledge of certain local characteristics obtained either from an empirical survey or from published data. Into this cateogry can be placed the work of Isard and Kuenne on Greater New York-

Philadelphia,[1] and the work of Moore and Petersen on Utah.[2] They obtained a crude transaction table by using national direct coefficients to obtain sector columns from control totals. They then adjusted the row and column distribution for each industry in the light of regional production processes, marketing practices and product mix.

Although in some respect this method could result in a more realistic regional input-output matrix, the subjectivity involved when changes are made in individual cells makes it difficult to test the reliability of the table in the absence of a survey based input-output table. The only other possible evaluative test for this technique is to assess the forecasting power of the table.

The Supply-Demand Pool Technique

Actually, this approach involves extending balance of trade computations to construct a regional input-output table. Commodity balances for each industry i is the difference between input requirements and locally produced supply. If the commodity balance is positive, the national production coefficient can be substituted for the regional coefficient, sets imports to zero, and the surplus is assumed equal to export. If the commodity balance is

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[1] Isard, W., and R. E. Kuenne. 1953. The Impact of Steel upon the Greater New York-Philadelphia Urban Industrial Region. Review of Economics and Statistics 35:289-301.

[2] Moore, F. T., and J. W., Petersen. 1955. Regional Analysis: An Interindustry Model of Utah. Review of Economics and Statistics 37:363-383.

negative, exports are set at zero, imports are calculated as the difference between regional input requirements and locally available requirement plus imports for final demand and regional coefficients are estimated as:

$$a_{ij} = A_{ij}(x_i/r_i)$$

where a_{ij} is regional direct coefficient, A_{ij} is the national direct coefficient, x_i is the regional output of industry i, and r_i represents total regional requirements (for inputs and final demand) of product i. Thus, the regional direct coefficient is obtained by multiplying the national direct coefficient by the ratio of regional supply to regional demand of producing sector i. This procedure allocates local production, where adequate, to meet local needs. Where the local output is inadequate, to meet local needs, however, the procedure allocates to each purchasing industry j its share of regional output i, based on the needs of the purchasing industry itself to total needs for output i.

<u>McMeanamin-Haring Technique</u>

In 1974, McMenamin and Haring proposed a new method for estimating regional input-output tables.[1] This method is simple in application and cost effective in that it requires little input data. It is only applicable to the problems of estimating a regional table at one date (year 1)

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[1]McMenamin, D. G., and J. E. Haring. 1974. An Appraisal of Nonsurvey Techniques for Estimating Regional Input-output Models. <u>Journal of Regional Science</u> 14(2): 191-206.

based on similar table from an earlier point in time (year 0). The technique adjusts the regional table at year 0 for changes in price, the effect of substitution and the effect of fabrication which have taken place between year 0 and year 1. First of all it is appropriate to introduce some notations which are used in the discussion of this technique,

$X = x_{ij}$ = regional input-output table for year 0

$Y = y_i$ = vector of total gross output for year 1

$Z = z_j$ = vector of total gross outlay for year 1

$X_j = x_t, ij$ = the regional input-output table after t/2 iterations

i = 1,2,...m = the number of rows, including the payments sectors, and

j = 1,2,...n = the number of columns, including the final demand sector.

First of all this technique adjusts the regional input-output (year 0) for changes in relative prices, giving an estimated table X*. The iterative procedure begins by constraining the row sums of the gross flows (sales) in X* to the associated total gross output:

$$x_{1,ij} = y_i / \sum_{k=1}^{n} x_{ik}) \; (x^*_{ij})$$

The column sums of these row constrained gross flows (purchases) are further constrained to the total gross outlay:

$$x_{2,ij} = (z_i / \sum_{k=1}^{n} x_{1,kj}) \; (x_{1,ij})$$

These column-constrained gross flows can be constrained to the total gross output. The technique alternates in this fashion until in iteration number t/2,

$$x_{t-1,ij} = (y_i / \sum_{k=1}^{n} x_{t-2,ik}) \; (x_{t-2,ij})$$

$$x_{t,ij} = (z_j / \sum_{k=1}^{m} x_{t-1,kj}) \; (x_{t-1,ij})$$

The process is continued until the vectors of row and column totals for the estimated matrix have converged to within e of the total gross output and total gross outlay,

$$y_i - \sum_{j=1}^{n} x_{t,ij} < e$$

$$z_j - \sum_{i=1}^{m} x_{t,ij} < e$$

The matrix thus obtained, X_t, is the estimated regional input-output table for year 1.

The assumption behind the method are exactly parallel to those RAS processes, and thus it is subject to the aggregation problem and uniform substitution effect. However, it avoids the problem of having to estimate the total intermediate output and total intermediate input vectors. The only data needed for the procedure are an input-output table for year 0 and total gross outlay vectors for year 1.

Test of Accuracy of Regional Nonsurvey Techniques

Morrison and Smith[1] compare the results of the application of several regional nonsurvey input-output tables in a consistent way with a survey based input-output model for the city of Peterborough, England. Their results are tabulated in Table 1.

It is apparent from the table that the RAS method produces a superior simulation when judged by some of the measure distances. Of course, this is not entirely surprising given that the technique employs certain amounts of survey material. Some interesting features do emerge, for example, the Simple Location Quotient technique emerges as being superior to the Purchase Only Location Quotient on all five tests. The Cross Industry Quotient approach produced the poorest simulations on three most reliable tests and ranked seventh out of eight on the other two. It is perhaps a little surprising that the simplest of the tested methods (SLQ) emerges, on the whole, as the best of the purely nonsurvey approaches.

Reducing Techniques Appraised in this Study

In this part the procedure and assumptions of the six reducing techniques tested in this study are discussed.

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[1] Morrison, W. I., and P. Smith. 1974. Nonsurvey Input-Output Techniques at the Small Area Level: An Evaluation. Journal of Regional Science 14(1):1-14).

Table 1. Evaluation of Simulated Tables: Methods Ranked for Each Test*

Rank	Mean Absolute Difference	Test Correlation Coefficient	Mean Similarity Index	Information Content	Chi-Square
1.	RAS	RAS	RAS	RAS	RAS
2.	SLQ	SDP	SLQ	SLQ	CMOD
3.	POLQ	SLQ	POLQ	POLQ	SLQ
4.	CMOD	POLQ	SDP	CMOD	POLQ
5.	SDP	CMOD	CMOD	CILQ	CILQ
6.	CILQ	CILQ	CILQ	SDP	SDP

*Source: Morrison, W. I., and P. Smith. 1974. Nonsurvey Input-Output Techniques at Small Area Level: An Evaluation. Journal of Regional Science.14(1):1-14)

Key initials of nonsurvey methods are as follow:

SLQ: Simple Location Quotient

POLQ: Purchase Only Location Quotient

CILQ: Cross Industry Location Quotient

CMOD: Modified Cross Industry Quotient

SDP: Supply-Demand Pool

RAS: RAS

The Simple Location Quotient Technique

The Location Quotient is a measure comparing relative importance of an industry in a region and its relative importance in the nation. Thus, for industry i,

$$LQ_i = \frac{x_i/x}{X_i/X}$$

where x_i represents the regional output of industry i, x is the total regional output, X_i is the national output of industry i and X is the total national output.

If $LQ_i \geq 1$, we assume that local production is adequate to supply local needs, then we may set $a_{ij} = A_{ij}$, where a_{ij} is regional direct coefficient defined as x_{ij}/X_j, and A_{ij} is the national direct coefficient defined as X_{ij}/X_j. Knowing regional industry outputs x_j and having established a_{ij}, we may compute regional interindustry flow as:

$$x_{ij} = a_{ij} \quad x_j$$

since, $A_{ij} = a_{ij}$,

and $\quad A_{ij} = X_{ij}/X_j$

then, $\quad x_{ij} = X_{ij}(x_j/X_j)$

If the remainder of local final demand is known, as the region's share of national consumption, investment and government expenditure vector ($y_{if} = Y_{if} \cdot x/X$), where f indicates one of t final demand columns. Then, the exports of industry i may be computed as a residual:

$$e_i = x_i - \sum_j^n x_{ij} - \sum_f^t y_{if}$$

If $LQ_i < 1$, we assume that regional production is inadequate to satisfy local needs, then we may set $a_{ij} = LQ_i \cdot A_{ij}$, and regional gross flow as:

$$x_{ij} = a_{ij}\, x_j$$

since $a_{ij} = LQ_i\, A_{ij}$,

and $A_{ij} = X_{ij}/X_j$,

then $x_{ij} = X_{ij}\, LQ_i (x_j/X_j)$

Imports of product i (m_{ij}) are computed as the amount necessary to satisfy production requirements,

$$m_{ij} = A_{ij}\, x_j - x_{ij}$$

The procedure just outlined empirically is grossly deficient. There is no guarantee, for example, that local production is adequate to satisfy local needs when $LQ_i \geq 1$, nor that local production is inadequate to supply local needs when $LQ_i < 1$. Thus, because of the problems of these assumptions, to insure success in using the Simple Location Quotient technique, the local industry structure must resemble the national structure, this requirement is seldom met.

The Purchase Only Location Quotient Technique

Due to problems encountered in using the Simple Location Quotient technique, Charles Tiebout suggested a modification of that technique for the CONSAD Corporation to use in constructing state input-output models.[1] The Purchase Only Location Quotient may be defined as:

$$LQ_i' = \frac{x_i/x'}{X_i/X'}$$

where the prime indicates that summation includes only the outputs of those industries which purchase from industry i. Formulations for computing regional direct coefficients are not affected by the modification. The difference in these approaches lies in the values of the location quotients and thus in the determination of which industries are export producing and which are not. We cannot predict whether the Simple Location Quotient approach or the Purchase Only Location Quotient approach will yield the larger regional coefficients.

The Cross Industry Quotient Technique

This quotient compares the proportion of national output of selling industry i in the region to that for purchasing industry j,

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[1] CONSAD Corporation. 1967. Regional Federal Procurement Study. United States Department of Commerce Contract.

$$CIQ_{ij} = \frac{x_i/X_i}{x_j/X_j}$$

If $CIQ_{ij} \geq 1$, $a_{ij} = A_{ij}$ for cell ij. Since the output of industry i is larger than that of industry j in the region relative to the nation, we assume that local industry i can provide all of the output required by local industry j. The reason is, if industry i in the region is producing a larger percentage of the national economy's product i than regional industry j is producing its product, it is likely that industry j can obtain all the product i it needs within the region. If $CIQ_{ij} < 1$, $a_{ij} = CIQ_{ij} \cdot A_{ij}$. The regional direct coefficients becomes the national distribution coefficient for industry i weighted by the ratio of the regional size of the selling industry to that of the purchasing industry.

The Modified Supply-Demand Pool Technique

The pool technique has been modified in several ways. Kokat suggested an alternative which adjusts the Supply-Demand Pool technique for the case in which regional final demands are predetermined.[1] The Supply-Demand Pool is not affected if commodity balances are positive. The difference arises when commodity balances are negative. Imports are assumed to enter the region as inputs but never for final demand, and exports are set at zero.

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[1]Kokat, R. G. 1966. The Economic Component of a Regional Socioeconomic Model. IBM Technical Report 17-210, IBM, Inc. Advanced System Development Division.

The procedure in this approach is as follows: Compute input requirements based on national technology and estimates of local output,

$$r_{ij} = X_j A_{ij}$$

Given the final demand matrix for the region (Y_{if}) compute total regional demand for goods excluding exports (e_i),

$$r_i = \sum_j^s r_{ij} + \sum_f^t y_{if}$$

Compute commodity balances (b_i),

$$b_i = x_i - r_i$$

where x_i is total gross output of industry i.
Where b_i is positive, substitute the national direct coefficient for regional coefficients, set imports at zero and compute exports,

$$a_{ij} = A_{ij}$$

$$x_{ij} = r_{ij}$$

$$m_{ij} = 0$$

$$e_i = (X_{ij}/X_i)\ b_i$$

Where b_i is negative, compute imports (m_{ij}), set exports at zero and compute regional flows and coefficients,

$$e_i = 0$$

$$m_{ij} = (r_{ij}/\sum_{j}^{s} r_{ij}) - b_i$$

$$m_{ij} = (r_{ij}/(r_i - y_i)\ (r_i - x_i)$$

where y_i is total final demand sector which can be treated as *a priori* assumption. Regional flows are computed as residuals,

$$x_{ij} = r_{ij} - m_{ij}$$

or

$$x_{ij} = r_{ij}\ (x_i - y_i)/(r_i - y_i)$$

This expression indicates that to each purchasing industry j we allocate its share of regional output i available to producers, based upon the needs of purchasing industry itself relative to the needs of all purchasing industries.

RAS

Stone and Brown,[1] developed a method of estimating an input-output table for a certain date (year 1), from a table constructed for an earlier date (year 0). This technique, called the RAS method, obtains the estimated table through adjustment of the direct coefficient, a_{ij}, of the base year table to account for changes which have been taken place between these two periods. These changes are of the following three types: (1) changes in the relative level

[1]Stone, R., and A. Brown. 1962. *A computable Model of Economic Growth (A Programme for Growth 1)*. London: Chapman and Hall.

of prices, (2) changes in the degree to which commodity i has uniformly been substituted for or replaced by other intermediate inputs (called the substitution effect), and (3) changes in the degree to which intermediate inputs have uniformly increased or decreased in weight in the fabrication of commodity j.

In this study the RAS method has been adopted to the problem of estimating regional input-output tables from the national table. The adjustment process forms an iterative procedure which has been shown to converge under certain conditions. The method requires the following data as input: (1) the national direct coefficient matrix, (2) the regional total gross output vector, (3) the regional total intermediate input and intermediate output vectors. Stone and Brown obtained the total intermediate input vector by subtracting the value added vector and import vector from the total gross output vector. They obtained the total intermediate output vector as the difference between the total gross output vector and the total final demand vector.

Assumptions of the technique can be summarized as follows:

(1) Price differences operate uniformly along rows, whenever there is difference in the average price of the products of a sector, it is charged in the same proportion to all users.

(2) Whenever there is a substitution of one product

for another due to difference in demand or industry mix, it affects all users to the same extent.

(3) Wherever there is a change in the degree of fabrication, it unifromly affects all productive processes.

In the skeletal procedure below, the notational conventions are that the lower case letters refer to vectors, upper case letters refer to matrices, hatted letters denote diagonalized vectors, subscripts refer to successive estimates, a prime indicates a transposed matrix, and i is the identity vector. A is the matrix of national input-output coefficients, and u, v, and x are vectors of regional intermediate output, intermediate input and gross output respectively.

In the first stage of the procedure, the national input-output matrix is treated as a first estimate of the regional table and is combined with the vector of regional gross output to yield an estimated vector of intermediate outputs. Thus,

$$u_1 = A_1 x$$

The matrix is then adjusted to conform with row constraint (u),

$$A_2 = \hat{u}\hat{u}_1^{-1} A_1$$

The matrix A_2 is then used to estimate a vector of intermediate inputs,

$$v_1 = i\hat{x}A_2'$$

The matrix is then adjusted to conform with the column constraint (v),

$$A_3 = A_2 v v_1^{-1}$$

The matrix A_3 is then substituted into $u_1 = A_1 x$, and this process is repeated until the matrix converges to a state in which both row and column constraints are fulfilled.

The RAS method was tested in national level (Belgian input-output table) by Paelinck and Waelbroeck.[1] It seems that the RAS method tends not to work very well, probably because the method spreads any changes evenly along rows and down columns and such spreading may be inappropriate. Czamanski and Malizia, adopted the RAS method to the problem of estimating regional input-output tables from national tables.[2] This study also measured the accuracy of the estimated tables through the use of a summary of the "deviations between estimated and true regional input-output coefficients." The authors concluded

> It appears that although national input-output tables cannot be used for the purposes of regional studies without considerable adjustments, acceptable results can be achieved by the methods tried on the Washington State table.

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[1]Richardson, Harry W. 1972. Op Cit., p. 175.

[2]Czamanski, S., and E. E. Malizia. 1969. Applicability and Limitations in the use of National Input-Output Tables for Regional Studies. Papers and Proceedings, Regional Science Association 23:65-77, p. 77.

Czamanski and Malizia are concentrating on obtaining the interindustry direct coefficient. However, this is only part of the bigger problem of estimating an entire regional input-output table, which includes estimating final demand by sector, value added and imports. Particularly troublesome in regional tables is the generation of imports and exports by industry. Yet Czamanski and Malizia have ignored these problems and have in fact assumed these sector levels to be known. Thus, the accuracy tests performed by them give results under the best possible conditions and thus place a lower limit on the possible errors generated by the method.

Schaffer-Chu Iterative Procedure

Schaffer and Chu[1] have constructed input-output tables from national tables using a technique that they called the iterative simulation technique. The Regional Input-Output Table (RIOT) simulator not only assumes that the national direct coefficient applies, but also attempts to distribute local production according to both the national sales pattern and local needs.

Simply stated, they compute the required inputs (r_{ij}) for producing estimated regional output (x_j) for each industry and estimate local final demand r_{ij} as a

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[1] Schaffer, W. A., and Kong Chu. 1969. Nonsurvey Techniques for Constructing Regional Interindustry Models. Papers and Proceedings, Regional Science Associations 23:83-101.

proportion of national final demand. They then allocate local sales for each industry, basing the initial step on the national sales distribution pattern. Next, they use an iterative process to reallocate local sales, row by row until local production and consumption needs are satisfied to the extent possible. If local output is in excess of locally required sales for an industry, the exports are computed as a remainder. They record imports in a matrix as the positive difference, for each cell in the regional transactions matrix between local production requirements and the local output available to meet these requirements. This completes the computations for a regional gross flow table.

In a more formal expression the procedure may be described as follows:

(1) Compute purchases required to produce regional output (r_{ij}), based upon national direct coefficients matrix (A_{ij}),

$$r_{ij} = x_j \cdot A_{ij}$$

(2) Distribute regional sales (d_{ij}) initially by national distribution,

$$d_{ij} = x_i \ (X_{ij}/X_i)$$

(3) Compare requirements and allocations to determine surplus allocation to cells (z_{ij}) and construct for each row i a pool of surplus

available for allocation ($POOL_i$) and pool of needed reallocations ($NEEDS_i$). The final demand matrix (z_{yif}) is treated the same way; therefore,

$$z_{ij} = d_{ij} - r_{ij}$$

$$z_{yif} = d_{yif} - c_{if}$$

$POOL_i$ = sum of all positive z_{ij} and z_{yif}

$NEEDS_i$ = sum of all negative z_{ij} and z_{yif}

(4) Allocate sales for industries with exportable surpluses $POOL_i > -NEEDS_i$,

$$x_{ij} = r_{ij}$$

$$y_{if} = c_{if}$$

$$e_i = POOL_i + NEEDS_i$$

Each buying industry receives all its needs of product i and the remainder is exported.

(5) Reallocate local sales of industries with outputs insufficient to meet local needs ($0 < POOL_i \leq -NEEDS_i$)

If z_{ij} is positive or zero,

$$x_{ij} = r_{ij}$$

When z_{ij} is smaller than zero, compute

$$x_{ij} = d_{ij} + POOL_i \ (d_{ij}/x_i)$$

This procedure is iterated until $POOL_i$ goes to zero. When $POOL_i$ is equal to zero there is nothing to add to d_{ij}; thus, the iterations cease. This spreads the surplus of local output among industries on the basis of relative need.

In general, the Schaffer-Chu Iterative procedure differs from the Supply-Demand Pool technique in attempting to follow the national sales pattern to distribute local output and in reallocating local sales from one cell to another as necessary to best satisfy local needs. It thus appears to represent the feasible maximum of local trade.

Income Multiplier Analysis

The propagation effects of change in the level of expenditure upon income in a region can be estimated by a multiplier. The concept of the multiplier was first introduced into economic theory by R. Kahn in his article "The Relation of Home Investment to Unemployment" published in the Economic Journal in June 1931. The multiplier concept was elaborated, adapted and made an important part of his theory of income and employment by J. M. Keynes.[1] Both Keynes and Kahn dealt primarily with

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[1]Keynes, J. M. 1935. The General Theory of Employment, Interest and Money. Harcourt, Brace and Co., New York, pp. 112-131.

aggregate multipliers. In general, they were interested in measuring the total income and employment changes in a national economy resulting from exogenous changes in investment. Of course, such aggregate economic analyses have become important guides to national economic policy decisions.

Aggregate economic analysis is sufficient for many purposes. But if we are interested in the impact of changes in a single sector upon all other sectors, it is necessary to go beyond the aggregative analysis. The advantage of the input-output model is that it permits the analyst to focus attention on individual sectors of the economy. Given the available data--in the form of production and consumption functions--it is possible to compute income multipliers for the sectors defined by an input-output table.

The Aggregate Income Multiplier

The general expression for the Keynesian income multiplier is:

$$K = \frac{1}{1 - \frac{\Delta C}{\Delta Y}}$$

where:

K = the multiplier

ΔC = changes in consumption

ΔY = changes in income

The above equation indicates that aggregate income multiplier is a function of the marginal propensity to consume. It is assumed that with each increment of income there would be an increase in consumer spending, but that some fraction of the increment to income would also be saved. Thus, the marginal propensity to consume would always be less than one. Keynes made the further assumption that as income continued to rise the propensity to consume would become smaller. In this formulation of the multiplier the only leakage is that to savings. It also indicates that each injection of new income will produce successive rounds of consumer spending.

Sectoral Income Multiplier

The technique for estimating a sectoral income multiplier is more complex than procedure described above. This is true at the level of national economy, moreover the difficulties are increased when sectoral income multipliers are estimated for region, as have been done in this study. The reasons are: (a) the requirement that a consumption function for each regional sector must be computed, (b) the problem of additional leakages which make estimation of sectoral consumption rather difficult.

Sectoral income multipliers have been calculated in some earlier input-output studies. However, the Moore and Petersen,[1] and Hirsch[2] studies were pioneering studies

[1]Moore, F. T., and J. W. Petersen. 1955. Regional Analysis: An Iterindustry Model of Utah. The Review of Economics and Statistics. Vol. XXXVII, No. 4, pp. 368-383.

in regional input-output analysis, and they represent an improvement over earlier input-output studies. In these studies, however, only a limited number of sectoral consumption functions were used, and these are based upon national data. Thus, in neither case were the writers able to show the leakages in consumer spending with given increases in income and this imparted an upward bias to their regional income multipliers. Although this is recognized by the author of this study, it was not possible to make the necessary improvements, because of lack of data.

Two types of sectoral income multipliers have been computed for this study: i.e., (1) Type I Multiplier, and (2) Type II Multiplier. The Type I income multiplier is the ratio of direct and indirect to direct income change resulting from the delivery of one dollar to final demand by a given sector. Type II multipliers are the ratio of direct, indirect and induced to the direct income change, resulting from the delivery of one dollar to final demand by a given sector.

Thus the Type I multipliers should be considered as first approximation, particularly for an "open" economy. The Type II multipliers, which are larger in every sector are more accurate estimates of the income changes produced in the region by changes in final demand. In other

[2]Hirsch, W. Z. 1959. Interindustry Relation of A Metropolitan Area. The Review of Economics and Statistics. Vol. XLI, No. 4, pp. 360-369.

words, the Type II multipliers show the effects of successive rounds of consumer spending (including the induced effects) in addition to the direct and indirect effects of increases in sales to final demand.

The procedures for computing these multipliers can be described as follows:

The Type I Income Multipliers

(1) Define,

A = a 20 by 20 matrix of direct coefficients, a_{ij}, where the household sector is not included in the processing sector.

A_h = a 21 by 21 matrix of direct coefficients, a^h_{ij}, where household industry is included in the processing sector.

(2) Compute the Leontief inverse,

$$(I - A)^{-1}$$

where I is an identity matrix.

(3) Define H_r as the vector of direct income change, where H_r is the household row of matrix A_h.

(4) Calculate the direct and indirect income change as:

$$(I - A)^{-1} \cdot H_r$$

(5) Calculate indirect income change as: Direct and indirect income change - Direct income change (see Appendix B, Table 1-7, column 4).

(6) Compute the Type I income multiplier as:

$$\frac{\text{Direct and indirect income change}}{\text{Direct income change}}$$

The Type II Income Multiplier

(1) Define:

A_h = a 21 by 21 matrix of direct coefficients, a^h_{ij}, where household industry is included in processing sectors.

(2) Compute Leontief inverse using the augmented matrix A_h,

$(I - A_h)^{-1}$

where I is an identity matrix.

(3) Define the direct, indirect and induced income change as the household column of $(I - A_h)^{-1}$.

(4) Compute Indirect and induced income change as: Indirect income change + Induced income change (see Appendix 7, Tables 1-7, column 7.

(5) Compute the Type II income multiplier as:

$$\frac{\text{Direct, indirect, and induced income change}}{\text{Direct income change}}$$

Comparative Techniques

An important part of this study is to establish and select some objective means of evaluating the distance--or relative distance--between matrices. In other words, it is desirable to have some consistent test of judging which of the estimated coefficients matrices is closest to the equivalent survey based table. Indeed, this implies that the coefficient of the survey based table are assumed to be "true" (assume that no error exists).

In this study three comparative techniques are used in evaluating the efficiency of each reducing technique. Those are:

(1) The mean absolute percentage deviation,

(2) The mean of relative change, and

(3) The mean of the similarity index.

First of all it is appropriate to introduce some notations which will be used in the discussion of this part,

a_{ij} = direct coefficient for the survey table

b_{ij} = direct coefficient for the estimated table

n = number of industries in producing sector

m = total number of direct coefficients.

The Mean Absolute Percentage Deviation

Define the absolute percentage deviation as:

$$d_{ij} = \frac{|a_{ij} - b_{ij}|}{a_{ij}} \text{ , for } a_{ij} \neq 0$$

The mean of these absolute is thus,

$$d_{ij} = \frac{\sum_{i=1}^{m} \sum_{i=1}^{n} d_{ij}}{m}$$

The standard deviation of these absolute percentage is:

$$s_d = \sqrt{\sum_{i=1}^{m} \sum_{j=1}^{n} d_{ij}^2 - \left(\sum_{i=1}^{m} \sum_{j=1}^{n} d_{ij}\right)^2}$$

This technique is not ideal, the disadvantage is that it cannot handle a situation where a_{ij} is zero and b_{ij} is not zero--a situation which is not uncommon in this type of study. In this case, such elements are omitted in the calculation, and no credence is given to actual estimated values. Instead, the technique is used only as a tentative measure.

<u>The Mean of Relative Change</u>

Define the index of relative change as:

$$RC_{ij} = \frac{|a_{ij} - b_{ij}|}{1/2(a_{ij}+b_{ij})}$$

The mean of these indexes of relative change is thus,

$$RC = \frac{\sum_{j=1}^{m} \sum_{i=1}^{n} R_{ij}}{m}$$

A rather unconventional feature of this mean is that it ranges from zero to two. The closer the value to zero, the better the estimates.

Mean of the Similarity Index

The similarity index is defined as:

$$S_{ij} = 1 - \frac{|a_{ij} - b_{ij}|}{(a_{ij} + b_{ij})}$$

The mean of these index is thus,

$$S = \frac{\sum_{i=1}^{m} \sum_{j=1}^{n} S_{ij}}{m}$$

The value of this index ranges from zero to one. Of course, the closer the value is to one the better the estimates.

The Structure of the Lansing Tri-County Region Input-Output Tables

In this part the structure of the Lansing Tri-County Region input-output tables is discussed briefly. The more elaborate discussion of this topic can be found in O'Donnel, *et al*.[1]

The Lansing Tri-County region input-output tables consist of 24 intermediate demand or processing sectors and six final demand or autonomous sectors. The processing sectors are: (1) Livestock, Dairy and Poultry, (2) Crops, Vegetables, Fruits, and Nuts, (3) Food and Kindred Products, (4) Lumber and Furniture, (5) Printing

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[1] O'Donnell, John L. 1960. Economic and Population Base Study of the Lansing Tri-County Area: An Inter-Industry Relation Analysis. Michigan State University, 319 p.

and Publishing, (6) Chemicals and Allied Products, (7) Miscellaneous Nondurable Products, (8) Primary Metal, (9) Fabricated Metal Products, (10) Machinery including Electrical, (11) Motor Vehicles, (12) Miscellaneous Durable Products, (13) Electric Power and Gas, (14) Transportation and Communication, (15) Wholesale Trade, (16) Retail Trade, (17) Finance and Insurance, (18) Real Estate and Rental, (19) Personal Services and Amusements, (20) Business Services, (21) Repair Services, (22) Medical and Other Professional Services, (23) Education and Non-Profit Organizations, and (24) Mining and Others.

The final demand sectors are: (1) New and Maintenance Construction, (2) Non-Competitive Imports, (3) Federal Government, (4) State and Local Governments, (5) Gross Private Capital Formation, and (6) Households.

The aggregation scheme adopted in this study, as well as the definition for each category will be presented in Table 2.

It is not possible to make definite appraisal in general about the accuracy of the entries in the table. On the average 60 percent of the inputs of the processing sectors were obtained by direct survey method. Wherever possible the data in the table cover the calendar year of 1958, but in some cases some small and medium sized firms reported fiscal year of 1958 data.

The numbers in the transaction table are in thousand dollars, each set of numbers in particular column

Table 2. The Study Area Aggregation Scheme

No.	Industry Sectors Title	1958 T-C Sectors	1958 U.S. Sectors	1957 SIC Codes
1.	Livestock and Livestock Products	1	1	013, pt. 014, 0913, pt.02 pt.072
2.	Other Agricultural Fishery Products, and Services	2,3	2,3,4,14	011, 012, pt.014, 0192,0199 pt.02, 074, 081, 082, 084, 086, 091, 071, 0723, pt.0729, 085, 098, pt.02
3.	Furniture, Lumber, Woods, Products	4	20,21,22, 23	pt.24, pt.25
4.	Printing, Publishing, and Allied Industries	5	26	271-9, pt.73
5.	Chemical and Allied Products	6	27,28,29 32	2833, 2841-43, 2871, 2872
6.	Miscellaneous Non-durable Products	7	16,17,18, 19,31	pt.221-224, pt.226, pt.227, pt.229, pt.239, pt.29
7.	Primary Metals	8	37,38	pt.331, 3321-3322, 3352, 3359, 3361, 3391, pt.3392, 3393, 3399
8.	Fabricated Metal Products	9	39,40,41 42	pt.34, pt.35

Notes: T-C: Tri-County Region; SIC: Standard Industrial Codes; pt: Part of.

Table 2. (Continued)

No.	Industry Sectors Title	1958 T-C Sectors	1958 U.S. Sectors	1957 SIC Codes
9.	Machinery Including Electrical	10	43-58	35, 361-367, 369
10.	Motor Vehicles	11	59	371
11.	Miscellaneous Durable Products	12	35-36, 62-64,82	32, 381-386, 39
12	Electric Power, Gas, and Sanitary Services	13	68	49
13	Transportation and Communication	14	65,66	pt.40, pt.41, pt.42, pt.43, pt.48
14	Wholesale and Retail Trade	15,16	69	50, pt.51, 52-57, pt.58,59
15	Finances, Insurance, Real Estate and Rental	17,18	70-71	60-67, pt.73, pt.76, 81, pt.89
16	Personal and Amusement	19	72,76	pt.70, pt.72, pt.76, pt.78, 79
17	Business Services	20	73	pt.73, pt.51
18	Repair Services	21	75	75
19	Medical, Educational Services, and Nonprofit Organizations	22,23	77	0722, 7361, 80, 82, 84, 86, 8921
20	Mining and Others	24	8,9	1311, 1321, 141, 142, 144, 145, 148, 149

Notes: T-C: Tri-County Region; SIC: Standard Industrial Coees; pt.: Part of.

represents the purchases or receipts of the sector name in the caption (at the top) from the sectors listed at the left side (in the stubs). Conversely, the set of numbers in a particular row represents the sales of the sector named in the stub to the sectors listed in the column captions.

Sector Aggregations

Most of the practitioners of input-output analysis are aware of the importance of the aggregation problem and the fact that results of the analysis depend upon the aggregation procedures employed. The purpose of introducing the aggregation process into input-output analysis is to reduce the number of equations and unknowns. A user of input-output analysis often needs to reduce a given table to smaller size. A large tabel--say 100 by 100--is cumbersome for many purposes. It should be recognized, however, that if the results are to be useful, the system must be reduced to manageable size and yet still must describe significant relationships between many components of the aggregates. It is even possible that the particular information lost may be of greater importance than the more general information available in the solution made possible by aggregation. Thus, the aggregation decision involves a trade off between information lost due to aggregation and cost of data analysis.

The sector aggregation decisions in this study are based upon several considerations, i.e.:

(1) The purpose of the study. The purpose of this study is to evaluate six nonsurvey and minimum survey reducing techniques for estimating the Lansing Tri-county region input-output table. In general, a very detailed input-output table is not necessary for testing reducing techniques, because results of this study cannot be used directly to guide policy making.

(2) The nature or sector detail of the base model input-output analysis in this study is based on a 87 sector model of national input-output for 1958. Working with a 87 by 87 matrix is not only cumbersome but also expensive.

(3) Cost of data analysis. Budget available for this study is very limited, and the cost of inverting a matrix rises exponentially with the size of the matrix.

In this study, two base model matrices were used, i.e.:

(1) A 87 by 87 matrix of 1958 National input-output table.

(2) A 24 by 24 matrix of 1958 Tri-county Region input-output table.

The purpose of the aggregation procedure in this study is to reduce the size of both matrices to a 20 by 20 standard matrix (that is the size of matrix we used in this study). The reason for adopting this aggregation scheme is that even if in general the national table is less aggregated than the regional table, for some specific sectors the regional table is more detailed (e.g., sectors number 22 and 23 of 1958 Tri-county region matrix). Thus, these sectors must be aggregated to match the corresponding national sectors. The entire sector aggregation scheme is shown in Table 2.

As illustrated in Table 2, four aggregations have been performed in reducing the 24 by 24, 1958 Tri-county region matrix to a 20 by 20 standard matrix. The four aggregations are:

(1) Sector number 2 and number 3 of the Tri-county matrix (the Crops, Vegetables, Fruits, and Nuts; and Food and Kindred Products respectively) have been aggregated into one sector and termed Other Agricultural, Fishery Products and Services.

(2) The Wholesale and Retail Trade sectors (sector number 15 and 16 respectively) of 1958 Tri-county matrix have been aggregated into one sector, that is the Wholesale and Retail Trade sector (sector number 14 in the standard matrix).

(3) The Finance and Insurance; and Real Estate and Rental sectors (sector numbers 17 and 18 respectively) of 1958 Tri-county matrix have been aggregated into one sector, that is the Finance, Insurance, Real Estate and Rental sector

(sector number 15 of the standard matrix).

(4) Sector numbers 22 and 23 (Medical and Other Professional Services; and Education and Nonprofit Organizations sectors respectively) of 1958 Tri-county matrix have been aggregated into one sector--Medical, Educational and Nonprofit Organizations--that is sector number 19 in the standard matrix.

In order to be compatible with these aggregations, the 87 by 87 endogenous sectors of 1958 national matrix have been aggregated, following guide lines as suggested by Census of Employment data.

Before discussing results of this study, it is appropriate to point out some assumptions made in preparing the study area input-output model from the national model.

Assumption 1. Sector composition of the study area is similar to the national sector composition.

Sectors are composed as a rule, of firms having similar input requirements. To the extent that a sector at the regional level contains firms with different input requirements from those in the nation, some aggregation errors may be introduced to the results of the study. The greater the aggregation, the less troublesome will be a violation of this assumption; but also the less detailed will be the conclusions, which can be drawn about a specific industry.

Assumption 2. The production function of any sector i is similar in the study area as for in the nation.

This implies that all inputs produce with the same degree of efficiency in the region as in the nation. It leaves open the possibility that some industries will have to import from outside the region. The reducing techniques tested in this study contain mechanisms to adjust the coefficients for imports (if the region industry i is able to supply only half of the total requirements of other endogenous industries for product i, the remainder will be imported).

CHAPTER IV

RESULTS AND DISCUSSION

This chapter consists of three parts. In the first part the assumptions of the six data reducing techniques appraised in this study will be discussed and compared. The second part will concern the relative efficience of each reducing technique in estimating the regional direct coefficients derived from the national tables. Finally, in the third part, the relative efficiency of each reducing technique in estimating the value of the Type I and the Type II multipliers is evaluated.

The six reducing techniques tested in this study employ mechanical routines to adjust the direct coefficients of the United States model to reflect the economic structure of the Tri-county region.

The six methods differ in their data requirements. The first three methods, i.e.: the Simple Location Quotient, the Purchase Only Location Quotient, and the Cross Industry Quotient, require only the total gross output figures for each industry in the study area. The Supply-Demand Pool and the Schaffer-Chu Iterative techniques require the total gross output and the final demand data of the study area which are estimated from the final demands of the United States model. The last technique, the RAS, requires not only the total gross output, but also the total intermediate input and total intermediate output of every industry in the study area.

Each technique involves different costs, however, the RAS technique is the most costly because it employs a certain amount of survey data.

The Assumptions of the Six Reducing Techniques Compared

As may be expected, the relative efficiencies of reducing techniques is adjusting the national input-output model to reflect the economic structure of the Tri-county region differ from one another. These differences are due to differences in assumptions. Thus, it is important to discuss and compare the assumptions of each technique. This may facilitate the interpretation of the results of this study.

The Simple Location Quotient Technique

As has been pointed out earlier, the Location Quotient is the ratio between the percentage of total output supplied by industry i in the region, and the percentage of total output supplied by industry i in the nation. Thus, a location quotient of unity for industry i means that the region has its proportionate share of the entire production of industry in the nation economy judged in terms of total regional production, relative to total national production.

Then, if $LQ_i \geq 1$, it is assumed that the region is producing more than its local consumption and has product available for exports. If $LQ_i \geq 1$, regional production is assumed to be inadequate to supply local requirements; so that imports are necessary. The reader must be aware of the limitations of these assumptions. These assumptions must be seriously qualified. Indeed, there is no guarantee that a surplus for exports will exist when $LQ_i \geq 1$, nor that local production is inadequate to supply local needs, in case $LQ_i < 1$. The reasons are: (1) tastes and propensity to consume among households of the same type and income differ between region. In Southern Florida, little fuel is needed by households; in Michigan greater amounts. This means that for the fuel manufacturing sector, a location quotient of one for Southern Florida may involve exports of fuel, and for Michigan it will most likely involve major import of fuel oil; (2) income levels of households differ among regions. Families in Michigan consumed, per household, more shoes than is the case in Georgia. Given this, a location quotient more than one in Michign for the shoe manufacturing industry could be consistent with imports of shoes, meanwhile, a location quotient below unity in Georgia may result in net exports; (3) production efficiency differ among regions, and (4) industrial mixes vary considerably among regions.

The shortcomings of these assumptions have far reaching implications for the direct coefficients generated by the Simple Location Quotient technique. It has been described earlier that if $LQ_i \geq 1$, that the regional direct coefficient is identical to the national direct coefficient; and if $LQ_i < 1$, the regional direct coefficient is equal to LQ_i times the national direct coefficient. Thus, the national direct coefficient can only be adjusted downward but not upward. As a consequence, this method cannot handle adequately a situation where a "true" regional direct coefficient is far larger than the corresponding national direct coefficient. The downward adjustment process in this procedure also has some drawbacks. To illustrate this, we may define a_{ij} as the regional direct coefficient, and A_{ij} as the national direct coefficients of row i. Even if a_{ij} is larger than A_{ij}, in a case of $LQ_i < 1$, it follows that A_{ij} must be adjusted further downward. Thus, the adjustment process is based upon "average variation" among rows and cannot handle variations within a row. This discussion suggests that the Simple Location Quotient technique is likely to give satisfactory results, that is, it generates regional direct coefficients that adequately represent the region's economic structure or sectoral linkages when the local industry structure closely resembles the national model structure.

The preceeding discussions regarding the problems of the Simple Location Quotient technique does not mean to suggest that the Simple Location Quotient technique is useless, but rather to point out some of its limitations, so that the reader is aware of the problems of this technique.

The location quotient for each industry in the Tricounty region has been calculated in this study and the results are presented in Table 3.

As can be observed from Table 3, on the surface it would appear that only two industries--(1) Motor Vehicles, and (2) Medical, Educational Services and Nonprofit Organizations--whose location quotients are more than unity, are export industries, and the rest (18 industries) whose location quotients are less than unity are import industires. This statement must be partially rejected. Indeed, the "Motor Vehicles" and the "Medical, Educational Services, and Nonprofit Organizations" are export industries. However as the survey based table revealed,[1] there are three more export industries--(1) Other Agricultural, Fishery Products, and Services, (2) Chemical and Allied Products, (3) Finances, Insurance, Real Estate and Rental--out of the 18 industries, whose location quotients is less than unity. Thus, it may be concluded that, even if an industry's location quotient is smaller than unity, it is not necessarily an import industry.

Based upon the location quotient in Table 3, the estimated direct requirement per dollar of output were

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[1] O'Donnel, John L., <u>et al</u>., 1960, <u>Op cit</u>., p. 256.

Table 3. The Estimated Location Quotient and the Estimated Purchase Only Location Quotient for the Tri-County Region.

No.	Sector Name	Techniques LQ_i [1]	$POLQ_i$ [2]
1.	Livestock and Livestock Products	.34995	.45125
2.	Other Agricultural, Fishery Products and Services	.30316	.42279
3.	Furniture, Lumber, Woods Production	.21508	.20860
4.	Printing, Publishing and Allied Industries	.34512	.34512
5.	Chemical and Allied Products	.12100	.12384
6.	Miscellaneous Nondurable Products	.06268	.06268
7.	Primary Metals	.40454	.47329
8.	Fabricated Metal Products	.54545	.54783
9.	Machinery including Electriaal	.26657	.26657
10.	Motor Vehacles	12.86422	12.29768
11.	Miscellaneous Durable Products	.27664	.27664
12.	Electric Power, Gas and Sanitary Services	.43351	.43351
13.	Transportation and Communication	.24460	.24460
14.	Wholesale and Retail Trade	.45441	.45441
15.	Finances, Insurance, Real Estate and Rental	.49832	.49832
16.	Personal Services and Amusements	.40093	.64551
17.	Business Services	.20245	.20471
18.	Repair Services	.54511	.54511
19.	Medical, Educational Services and Nonprofit Organizations	1.69892	1.71613
20.	Mining and Others	.08788	.14245

[1] LQ_i = Location Quotient

[2] $POLQ_i$ = Purchase Only Location Quotient

developed for the Tri-county region and the results are presented in Appendix A-1.

Estimated regional direct coefficients are compared with "true" regional direct coefficients later in this chapter. However, at this stage, it is appropriate to compare statistical characteristics of the estimated coefficients to the true direct coefficients. The comparison is presented in Table 4.

Table 4. The Statistical Characteristics of the "True" Direct Coefficients (Survey Method) Compared to the Statistical Characteristics of the Estimated Direct Coefficients (SLQ)

Characteristics	Techniques	
	DSM[1]	SLQ[2]
Mean	.019	.009
Variance	.002	.001
Standard deviation	.050	.024
Kurtosis	31.249	62.153
Skewness	5.191	6.830

[1]DSM = Direct Survey Method

[2]SLQ = Simple Location Quotient

As shown in Table 4, the Simple Location Quotient technique on the average, underestimates the regional direct coefficients by around 50 percent. And, it follows that both variances and the standard deviation are underestimated by 50 percent also. Indeed, this is not really surprising, because only two sectors--(1) Motor Vehicles, and (2) Medical, Educational Services, and Non-profit Organizations--out of 20 sectors, have location quotients greater than unity. Thus, the estimated direct coefficients of these two sectors remained identical to the United States coefficients, since in these two sectors adequate local production is available to meet both processing and final demands requirements. The estimated direct coefficients of the other 18 sectors were computed by adjusting downward the corresponding national direct coefficient by the average of their location quotients.

Kurtosis is that property of a distribution which expresses its relative peakedness. The greater the value of kurtosis, the more peaked will be its distribution. A normal distribution has a kurtosis value of 3, and is called mesokurtic. If the kurtosis is greater than 3, as in this case, the distribution is called leptokurtic. As seen in Table 4, the kurtosis of the estimated direct coefficients produced by the Simple Location Quotient is almost two times as large as the kurtosis of the "true" regional direct coefficients.

Skewness means lack of symetrical distribution. A negative sign indicates that the tail of the distribution is skewed to the smaller values. If the sign is positive, as in this case, the distribution will be skewed to the right. Thus, the mean is located to the right of the mode and the median.

To help understand the implications of differentials in value of kurtosis, we may perceive the distribution of estimated direct coefficients consists of three areas: (1) area around its mean, (2) area between area 1 and its minimum, and (3) area between area 1 and its maximum. In this case, the shape of the distribution of the estimated direct coefficients is more peaked than the distribution of the "true" direct coefficients. This means that while the Simple Location Quotient technique overestimates the value of the direct coefficients around its mean, this technique underestimates the direct coefficients in area 2 and area 3.

The Purchase Only Location Quotient (POLQ) Technique

In essence, the Purchase Only Location Quotient is not so different from the Simple Location Quotient, thus it also inherits most of the drawbacks of the Simple Location Quotient technique. The difference is in summation of total gross output of both the region and the nation. Instead of using total gross output of the region and the nation in computing the location quotient, this technique uses only the total output of the industries which purchase from industry i. The formulas are not presented here, because they have been presented in Chapter III.

This technique generates either a larger or smaller estimated direct coefficient than the Simple Location Quotient depending upon the size of the output of the industries which are exluded, both at regional and national levels.

Theoretically there are at least two advantages of this method over the Simple Location Quotient approach. They are:

(1) By this procedure, the adjusted coefficient is not affected by large outputs of industries which are not directly related to the selling industries.

(2) This technique can handle a situation where the needs of regional industries for output i, relative to the needs of the national industries for output i, are not the same as the ratio of total regional to total national output, a situation which the Simple Location Quotient technique can not handle adequately.

The Purchase Only Location Quotient for each industry in the Tri-county region has been computed, and presented in Table 3. The regional direct coefficients generated by this method are presented in Appendix A-1.

The statistical characteristics of the direct coefficients produced by the Purchase Only Location Quotient have been computed. In Table 5, these characteristics are compared to the statistical characteristics of the direct coefficients obtained from the direct survey table.

Compared to the Simple Location Quotient, estimates generated by the Purchase Only Location Quotient differ

Table 5. The Statistical Characteristics of the "True" Direct Coefficients (Survey Method) Compared to the Statistical Characteristics of the Estimated Direct Coefficients (POLQ)

Characteristics	Techniques	
	DSM[1]	POLQ[2]
Mean	.019	.010
Variance	.002	.001
Standard deviation	.050	.027
Kurtosis	31.249	52.828
Skewness	5.191	6.443

[1]DSM = Direct Survey Method

[2]POLQ = Purchase Only Location Quotient

slightly in two major characteristics: the mean and the kurtosis. The mean of estimates generated by the Purchase Only Location Quotient is slightly larger, but its kurtosis is smaller.

This situation can be explained by the value of the Purchase Only Location Quotient, relative to the Location Quotient (see Table 3). In comparison to the values of the Location Quotient, the values of the Purchase Only Location Quotient are similar in 9 sectors, slightly larger in 9 sectors, and more than unity in two sectors. Thus, direct coefficients for both methods are similar in 11 sectors, because when the quotient is larger than unity, value of the estimated direct coefficients are identical to the national coefficients. Thus, difference occurs only in 9 sectors. That is probably the reason the mean of the estimated direct coefficients generated by the Purchase Only Location Quotient are just slightly larger than the mean of those coefficients generated by the Simple Location Quotient. In contrast the kurtosis and skewness of direct coefficients generated by the Purchase Only Location Quotient are slightly smaller than those generated by the Simple Location Quotient.

The foregoing discussion indicates that this technique makes only marginal impacts upon the results, as compared to the Simple Location Quotient technique.

The Cross Industry Quotient (CIQ) Technique

One of the potential drawbacks of the Location Quotient technique is that only the size of the selling industry is taken into account, although theoretically the relative size of the purchasing industry may also be of crucial importance. An advantage of the Cross Industry Quotient technique is that it enables import proportions to vary within the rows, whereas the Simple Location Quotient technique establishes import needs in constant proportion to the appropriate rows. The Cross Industry Quotient compares the proportion of national output of selling industry i in the region to that of the purchasing industry j. The ij^{th} cell of the national direct coefficient matrix is then adjusted according to the corresponding cross industry quotient, as has been discussed in Chapter III.

The cross industry quotient for each cell of the transaction matrix has been computed in this study and then used to estimate the direct coefficient matrix for the Tri-county region. The direct coefficient for the Tri-county region generated by this method is presented in Appendix A-1. The summary of the statistical characteristics of these estimates is presented in Table 6.

Table 6. The Statistical Characteristics of the "True" Direct Coefficients (Survey Method) Compared to the Statistical Characteristics of the Estimated Direct Coefficients (CIQ)

Characteristics	Techniques	
	DSM[1]	CIQ[2]
Mean	.019	.022
Variance	.002	.003
Standard deviation	.050	.054
Kurtosis	31.249	20.142
Skewness	5.191	4.309

[1]DSM = Direct Survey Method

[2]CIQ = Cross Industry Quotient

As can be seen from Table 6, in contrast to the Simple Location Quotient and the Purchase Only Location Quotient, the Cross Industry Quotient overestimates the direct coefficients in an average of about 25 percent. While the two location quotient techniques adjust the national direct coefficients downward drastically, the Cross Industry Quotient tends to overestimate the regional direct coefficients.

There are some reasons why the Cross Industry Quotient technique overestimates the regional direct coefficients:

(1) In contrast to the location quotient techniques, the adjustment process in the Cross Industry procedure takes place within the rows. Hence, there is a tendency that the Cross Industry Quotient will take more national direct coefficients than the location quotient techniques. For example in this study the estimated direct coefficients generated by this technique are similar to the national direct coefficients in 222 cells. In contrast, the estimated direct coefficients produced by the Simple Location Quotient and the Purchase Only Location Quotient are similar to the national direct coefficient in only 40 cells each. If the average of the national direct coefficients is significantly larger than the average of the regional direct coefficients, like in this study, then there is a tendency of the Cross Industry Quotient to overestimate the regional direct coefficient.

(2) The Cross Industry Quotient has a very distinct property, that is:

$$CIQ_{ij} = LQ_i/LQ_j$$

Clearly, if i = j, it follows that $LQ_i = LQ_j$. Thus, for every cell where i = j (those diagonal cells) the value of CIQ_{ij} is unity and the estimated direct coefficient for the cells is identical to the corresponding national direct coefficients. In other words, the implicit assumption is made that every sector can obtain all its requirements of output from its own sector locally, regardless of the size of the sector. It is felt by the author that this is a somewhat misleading assumption to make, particularly for a relatively small sector.

From the discussion it may be concluded that: (1) there is a tendency that the Cross Industry Quotient overestimates the regional direct coefficients; (2) the average of the estimated regional direct coefficients generated by this technique is the closest to the average of the national direct coefficients as compared to those direct coefficients generated by the other methods tested in this study.

The Modified Supply-Demand Pool Technique

The Modified Supply-Demand Pool technique relies on computing the commodity balance between regional output of good i and the local requirements of good i. The local requirement of good i is estimated by using national direct coefficients. If the commodity balance is positive, it is assumed that regional supply is sufficient to satisfy regional demand and that the national direct coefficients may be used in row i of the regional trade coefficients matrix. When the commodity balance for row i is negative it is assumed that the regional demand is larger than regional supply and importation of good i is necessary. In this case, the national direct coefficients of row i are reduced by the ratio of regional output to the regional requirement.

The Tri-county regional direct coefficients ahve been estimated by using this technique and the results are presented in Appendix Table A-1.

Before comparing the relative performance of the Modified Supply-Demand Pool technique to performance of the other reducing techniques in estimating regional direct coefficients, it is appropriate to discuss briefly the statistical characteristics of estimates produced by this technique (Table 7).

As can be seen from Table 7, the Modified Supply-Demand Pool technique is similar to the Location Quotient technique in underestimating the regional direct coefficients. As in the Location Quotient technique, in this procedure downward adjustments of national direct coefficients are carried out if the balance of commodities for that row is negative. The estimated value of direct coefficients

Table 7. The Statistical Characteristics of the "True" Direct Coefficients (Survey Method) Compared to the Statistical Characteristics of the Estimated Direct Coefficients (MSDP)

Characteristics	Techniques	
	DSM[1]	MSDP[2]
Mean	.019	.022
Variance	.002	.001
Standard deviation	.050	.033
Kurtosis	31.249	29.545
Skewness	5.191	4.834

[1]DSM = Direct Survey Method

[2]MSDP = Modified Supply-Demand Pool

is identical with the value of national coefficients if the balance of commodities is positive. Thus, the national direct coefficients would never be adjusted upward. The difference between the Modified Supply-Demand Pool technique and the Location Quotient technique lies in the difference of factors used to adjust the national direct coefficients downward. In Location Quotient techniques the value of the location quotient is used, while in the Modified Supply-Demand Pool technique, the ratio of regional output and regional requirement is used. Since the ratio of regional output and the regional requirement average larger than the average of the location quotients, the mean of the estimated direct coefficient produced by the

Modified Supply-Demand Pool technique is larger than the mean of the same coefficient generated by the Location Quotient technique.

RAS Method

As has been pointed out in Chapter II, the RAS method was developed for the purpose of projecting input-output tables, using a base period matrix and projection period row and column totals introduced as constraints. In this study the RAS method has been used to project the 1958 national input-output table to regional dimensions by being made to conform with regional constraints. This study involved the use of the following sources of data:

(1) 1958 Tri-county region total gross output (x)

(2) 1958 Tri-county region total intermediate output (u)

(3) 1958 Tri-county region total intermediate input (v)

(4) 1958 The United States input-output coefficients (A_{ij})

The regional data were obtained through direct survey.

The logic of this technique is simple. The adjustment process forms an iterative procedure. Each stage of iteration generates a new estimated total intermediate output and total intermediate input. The ratio of regional total intermediate output to estimated total intermediate output is used as an adjustment factor for corresponding rows. Likewise, the ratio of regional total intermediate input to estimated total intermediate input is used as an adjustment factor for associated columns. Thus, adjustment processes take place in two directions, row and column. At some stages of iterations, in this study after 12 iterations, the value of estimated total intermediate output equals the value of regional total intermediate output, and in parallel the value of estimated total intermediate input equals the value of regional total intermediate input. Thus, the adjustment factor for both rows and columns reaches unity and the iterative process ceases.

This method has been used to estimate the Tri-county regional direct coefficients, and the results are presented in Appendix Table A-1.

The direct coefficients estimated by the RAS method will be compared to the "true" direct coefficients computed from survey table in the second part of this chapter. At this stage it is appropriate to compare their statistical characteristics. This comparison is presented in Table 8.

As can be seen from Table 8, the RAS method in average underestimates the value of direct coefficients. However its kurtosis, was almost two times the kurtosis for the "true" direct coefficients. This means the distribution shape of direct coefficients produced by the RAS method is more peaked than the distribution of "true" direct coefficients. To explain this situation, the frequency distribution of "true" direct coefficients can be divided into three areas: (1) area around its mean, (2) area between

Table 8. The Statistical Characteristics of the "True" Direct Coefficients (Survey Method) Compared to the Statistical Characteristics of the Estimated Direct Coefficients (RAS)

Characteristics	Techniques	
	DSM[1]	RAS[2]
Mean	.019	.015
Variance	.002	.003
Standard deviation	.050	.053
Kurtosis	31.249	51.936
Skewness	5.191	6.969

[1]DSM = Direct Survey Method

[2]RAS = RAS

area 1 and its maximum, (3) area between area 1 and its minimum. Information from Table 8 suggests that while the RAS method underestimates the value of direct coefficients in area 2 and area 3, this method underestimates the value of direct coefficients in the area around its mean.

Because the total frequency of distribution in area 2 and area 3 is larger than the total frequency in area 1, the RAS method on the average tends to underestimate the "true" regional direct coefficient.

Schaffer-Chu Iterative Method (SCM)

The first step in the Schaffer-Chu technique is to calculate inputs requirements for producing regional output j by using national direct coefficients. Then, regional sales are distributed in accordance with the national sales distribution patterns. Next, requirements and sales are compared, and a pool of surplus available for reallocations are constructed for each row i. If $Pool_i$ is larger than $Needs_i$, each buying industry receives all its requirements of product i, and the excess is exported. On the other hand, in sectors where $pool_i$ is smaller than $needs_i$, the pool is spread by an iterative process among industries in accordance with their relative need, until $pool_i$ diminishes to zero. In this study, $pool_i$ diminishes to zero after two iterations and then the iteration process ceases.

The estimated direct coefficients obtained by using this method are presented in Appendix Table A-1.

The value of estimated direct coefficients will be compared to the "true" direct coefficients (obtained from the survey table) later in the second part of this chapter. At this point, however, it is appropriate to compare the statistical characteristics of the estimated direct coefficients to the statistical characteristics of the "true" direct coefficients. This comparison is presented in Table 9.

As illustrated in Table 9, the Schaffer-Chu technique on the average overestimates the value of direct coefficient by around 40 percent. This situation can be analyzed in relation to the kurtosis of both distributions.

Table 9. The Statistical Characteristics of the "True" Direct Coefficients (Sruvey Method) Compared to the Statistical Characteristics of the Estimated Direct Coefficients (SCM)

Characteristics	Techniques	
	DSM[1]	SCM[2]
Mean	.019	.026
Variance	.002	.003
Standard deviation	.050	.056
Kurtosis	31.249	15.799
Skewness	5.191	6.513

[1]DSM = Direct Survey Method

[2]SCM = Schaffer-Chu Iterative Procedure

The distribution of "true" direct coefficients is more peaked than the distribution of the estimated direct coefficients. Assuming that the distribution of the regional direct coefficients consists of three parts: (1) area around its mean, (2) area between area 1 and its maximum, and (3) area between area 1 and its minimum. The information from Table 9 suggests that while underestimating the direct coefficients around its mean, the Schaffer-Chu technique overestimates the regional direct coefficients in area 2 and area 3. Because the total frequency of distribution in area 2 and area 3 is larger than the total frequency distribution in area 1, therefore the Schaffer-Chu technique on the average overestimates the value of direct coefficients. The difference in skewness is not singificant. Thus, the differences in the mean of direct coefficients generated by these methods may be attributed to the differences in kurtosis.

Comparisons of Relative Efficiency of the Six Reducing Techniques in Estimating Direct Coefficients

In this section, relative efficiencies of the six techniques tested in this study are compared. Relative efficiency means the degree of closeness in value of direct coefficients generated by each technique to the "true" direct coefficients obtained from the direct survey (assuming zero error).

The relative efficiency of each reducing technique has been judged by using three comparison tests. These are: (1) the mean absolute percentage deviation, (2) the mean of relative change, and (3) the mean of similarity index. The properties of the comparison tests have been discussed in Chapter III. However, to facilitate interpretations of the results of this study, it is appropriate to discuss elaborately the properties of the comparison tests used in this study.

Throughout the discussion of this chapter a_{ij} is defined as the direct coefficient of the direct survey table, and b_{ij} as the direct coefficient of the estimated table.

The first comparison technique employed in this study is the mean absolute percentage deviation (d_{ij}). The d_{ij} can be defined as follows:

$$d_{ij} = \frac{|a_{ij} = b_{ij}|}{a_{ij}}$$

Two advantages of this statistic are that it is easy to calculate and to understand. For example, a d_{ij} equal to .50 means that the deviation is equal to 50 percent of the "true" direct coefficient. However, this technique is deficient in other properties. The most serious deficiencies of this technique are:

(1) It can not handle a situation in which a_{ij} is equal to zero and b_{ij} is positive. In this case, regardless of the value of b_{ij}, d_{ij} is infinite if a_{ij} is zero. Thus, in the situation, where a_{ij} is zero and b_{ij} is also zero no credit is given to the relative efficiency of the reducing technique. Because a zero a_{ij} is not uncommon in this type of study, this technique is likely not ideal.

(2) Deviations between small coefficients affect the results far more than deviations between large coefficients. In other words, this technique may give different weights to the same absolute percentage deviation. To make clear this deficiency, one might consider two cases:

<u>Case No. 1</u>

Let $a_{ij} = .100$

$b_{ij} = .001$

Thus,

$$d_{ij} = \frac{|.100 - .001|}{.100} = .990$$

<u>Case No. 2</u>

Let $a_{ij} = .001$

$b_{ij} = .100$

Thus,

$$d_{ij} = \frac{.001 - .100}{.001} = 99.000$$

If we compare case No. 1 and No. 2, it is clear that even if the absolute deviations are the same in both cases, that is .099, the d_{ij} of case No. 2 is one hundred times larger than d_{ij} of case No. 1. In interpreting the results, the reader must be aware of this problem.

The second comparison technique used in this study is the mean of relative change. This technique lacks some of the deficiencies inherent in the mean absolute percentage deviation technique. The mean relative change (R_{ij}) can be defined as follows:

$$R_{ij} = \frac{|a_{ij} - b_{ij}|}{\frac{1}{2}(a_{ij} + b_{ij})}$$

Advantages of this technique are:

(1) It could handle a situation where a_{ij} is equal

to zero.

(2) Deviations between small coefficients affect the results in the same degree as with between large coefficients.

However, this technique is deficient in another respect, that is, it ranges in value from zero to two. This value is not only awkward but also confusing.

The third technique, the mean of similarity index, is the most satisfactory comparison technique used in this study. The similarity index can be defined as follows:

$$S_{ij} = 1 - \frac{|a_{ij} - b_{ij}|}{(a_{ij} + b_{ij})}$$

It should be recognized that the closer the value of S_{ij} to unity, the better the relative efficiency of the particular reducing technique.

In general, this technique lacks the deficiencies inherent in the first two comparison tests (this technique can handle a situation where a_{ij} is equal to zero, and its value is not confusing because it ranges from zero to one, however it is somewhat difficult to compute.

The direct coefficients produced by the six reducing techniques tested in this study have been judged by using the three comparison tests outlined earlier, and the results are presented in Table 10.

Based upon data in Table 10, the six reducing techniques have been ranked in accordance with their relative

Table 10. Comparisons of the Relative Efficiency of the Six Reducing Techniques Used in This Study

Reducing Techniques[1]	Comparison Techniques: The mean absolute percentage deviations	The mean of relative change	The Mean of similarity index
SLQ	1.099	.987	.507
POLQ	1.126	.980	.510
CIQ	2.230	.940	.530
MSDP	2.798	.942	.529
RAS	.9399	.694	.653
SCM	1.759	.857	.572

[1]SLQ = Simple Location Quotient; POLQ = Purchase Only Location Quotient; CIQ = Cross Industry Quotient; MSDP = Modified Supply-Demand Pool; RAS = RAS; SCM = Schaffer-Chu Iterative Procedure.

efficiency, and the results are presented in Table 11.

As can be seen from Table 10 and Table 11, it is apparent that the RAS method produces the best estimates when judged by any of the three comparison techniques. Indeed, this seems logical, given that the technique requires a certain amount of survey data. However, the degree of its superiority is not significant. For example, the mean absolute percentage deviation for the best non-survey method, that is the Simple Location technique, is only around 10 percent higher than that produced by the RAS method. Consistently, the RAS method produces a

Table 11. Evaluation of Estimated Tables: Reducing Techniques Ranked for Each Comparison Test

Rank	Comparison Tests		
	The mean absolute percentage deviations	The mean of relative change	The mean of similarity index
1	RAS	RAS	RAS
2	SLQ	SCM	SCM
3	POLQ	CIQ	CIQ
4	SCM	MSDP	MSDP
5	CIQ	POLQ	POLQ
6	MSDP	SLQ	SLQ

Note: SLQ = Simple Location Quotient; POLQ = Purchase Only Location Quotient; CIQ = Cross Industry Quotient; MSDP = Modified Supply-Demand Pool; RAS = RAS; SCM = Schaffer-Chu Iterative Procedure

superior result when judged by the mean of relative change and the mean of similarity index.

Among the purely nonsurvey reducing techniques, there are more variations in the results. The Simple Location Quotient and the Purchase Only Location quotient emerge as being superior to the other reducing techniques when judged by the mean absolute percentage deviation test, however, both of the techniques perform poorly when judged by the mean relative change and the mean of similarity index. In contrast, the Schaffer-Chu and the Cross Industry Quotient techniques emerge as being inferior to the other techniques when judged by the mean absolute percentage deviation test, but they perform better when judged by the mean similarity index and the mean of relative change tests.

These inconsistencies are probably due to the tendency of the Schaffer-Chu and Cross Industry Quotient to overestimate the smaller value of regional coefficients. This in turn will cause a significant increase in the value of the mean absolute percentage deviation for each overestimated cell. On the other hand, when we overcome this problem, that is when we judged the Schaffer-Chu and the Cross Industry Quotient technique with the mean of relative change and the similarity index, it seems that these two techniques perform better than the Simple Location Quotient and the Purchase Only Location Quotient techniques.

The Modified Supply-Demand Pool technique, is the poorest reducing technique when judged by the mean absolute percentage deviation test. However, it is interesting that it emerges as being superior to the Simple Location Quotient and the Purchase Only Location Quotient techniques when judged by the last two comparison tests.

As is apparent from Table 10, the relative efficiencies of the six reducing techniques appraised in this study are not really satisfactory to the author. Consequently it is appropriate at this stage to discuss briefly possible source of errors in estimating direct coefficients, when using the six reducing techniques.

As has been pointed out earlier, the models in this study are based on the 1958, 78 by 78 input-output table of the United States and the 1958, 24 by 24 input-output table of the Tri-county region. Both matrices have been aggregated into a 20 by 20 standard matrix, which was used in this study. Probably by increasing the degrees of aggregation, the likelihood of including more firms with different production functions into one sector increased. Indeed this situation may introduce more aggregation error into the results of this study. For further study in this field, this writer recommends using a less aggregated matrix.

Next, a more detailed examination of errors by sector will be made. A close observation of the estimated direct coefficients generated by each technique reveals that the greatest deviations occur in sectors in which the regional economy is specialized. All reduction techniques appraised in this study performed poorly in estimating the direct coefficients for this type of sector. Included in this type of sector are: (1) Motor Vehicles, (2) Medical, Educational Services and Nonprofit Organizations, and (3) Chemical and Allied Products. Probably the sectors in which the regional economy is highly specialized have a different technology from the national average, and their input-output coefficients cannot be estimated by the shortcut techniques used in this study.

The second group of sectors in which large deviations are to occur are those in primary activities. In this group are included: (1) Other Agricultural, Fishery Products and Services, and (2) Mining and Others. Agricultural crops in the Tri-county region, for example would include different activities from the United States average. This may be even more true of mining. Many types of mining activities included in the United States sector do not exist in the Tri-county region.

The last factor which may be responsible in introducing errors into the results of this study is the size of the Tri-county region relative to the size of the United States. The Tri-county region constitutes only a small part of the United States. It seems that the smaller the region the less the probability that the economic structure of the region will resemble the economic structure of the nation. And ceteris paribus the less similar the economic structure of a region compared to the national economy, the more errors will be introduced in estimating the input-output coefficients of the region from the national input-output table.

Income Multiplier Analysis

In this part the relative efficiency of the six reducing techniques in estimating the Type I and the Type II income multipliers will be compared. In comparing the results, it is assumed that the Type I and Type II multipliers produced by the direct survey method are "true" (assuming zero error). Thus, the relative efficiency of a reducing technique is a measure of closeness of the multipliers estimated by the technique to the "true" multipliers computed from the survey table.

As has been pointed out earlier, the Type I income multiplier is the ratio of direct and indirect income change to the direct income change resulting from the delivery of one dollar to final demand by a given sector. The Type II income multiplier is the ratio of direct, indirect and induced to the direct income change, resulting from the delivery of one dollar to final demand by a given sector.

In computing the Type I income multiplier, it is assumed that the local household consumption expenditures (direct sales to local household) as being exogenous to the model.

The Type II income multiplier assumes local households consumption expenditures as being endogenous to the model. This means that local households are treated as another industry in the system. Households rent property, sell labor, provide financing, etc., and their purchases of locally produced goods and services are considered to be parallel with those emanating from other local industiral sectors. It should be recognized, however, that when households are treated as a processing sector, household inputs are assumed to vary proportionally with household output. As is true of other processing sectors, a "production function" is assumed for households. Because households are in fact final consumers, this amounts to the assumption of a linear homogenous consumption function. Indeed, this is a somewhat rigid assumption. However, due to very limited resources, there is no attempt here to relax the homogeneity assumption by developing, for example, linear nonhomogenous consumption functions using national consumption data. However, there are strong economic arguments for treating local households as an industry. When output changes in response to a change in final demand (assuming constant population), by definition household income increases. The increment of income in turn theoretically results in new household consumption expenditures and new savings. New expenditures generate repercussions of their own on the local economy. The Type II income multiplier is used to estimate the magnitude of these repercussions on an industry to industry basis.

The Type I Income Multiplier

The Type I Income Multipliers, based upon the direct coefficients estimated by the six reducing techniques have been computed in this study. The results, along with the Type I multipliers computed from the direct survey input-output table are presented in Table 12. The more complete results of multiplier analysis (including the direct, indirect and induced income changes) for each reducing technique are presented in Appendix B (Tables 1-7).

Table 12. The Type I Income Multiplier of the Tri-County Region (Direct Survey Method) Compared to the Type I Income Multiplier Produced by the Six Reducing Techniques Tested in This Study

Sectors No.	Name		Reducing Techniques					
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
1	LVSTOCPRD	2.0714	1.1922	1.2796	1.9530	1.4163	2.6392	2.0087
2	OTAGFISHPRDTS	2.0058	1.2716	1.4000	2.3610	1.5349	2.6760	2.4802
3	WOODPRDTS	1.4363	1.1018	1.0985	1.6970	1.0944	1.2128	1.6971
4	PRINTPRDTS	1.5551	1.1467	1.1487	1.5626	1.4537	2.5161	1.5747
5	CHMCLPRDTS	1.3926	1.1589	1.1661	2.1330	2.8673	1.0457	1.9919
6	MISNONPRDTS	1.8447	1.0619	1.0625	1.7646	1.1708	1.2994	2.7967
7	PRIMA	2.4008	1.5804	1.6985	2.8593	1.3573	1.8914	2.4673
8	FABMEPRDTS	1.4865	1.2930	1.2982	1.6845	1.1366	1.3260	1.6966
9	MACHINELECT	1.5475	1.2070	1.2092	1.8687	1.5485	1.2384	1.8699
10	MOVEHIC	2.3726	2.1011	2.1024	2.2142	2.1289	2.2995	2.2137
11	MISDURPRDTS	1.3983	1.1722	1.1737	1.7402	1.4125	1.1438	1.7300
12	ELPOGASA	1.2715	1.1874	1.1893	1.5500	1.3527	1.2100	1.5844
13	TRANSCOMM	1.6067	1.1359	1.1382	1.6238	1.1708	1.3442	1.6288
14	WHORTRAD	1.3123	1.2524	1.2566	1.7218	1.3094	1.0871	1.7287
15	FBRSERVICE	1.9215	1.4684	1.4728	2.1442	1.8199	1.8380	2.1889
16	PERSERAM	1.1099	1.0603	1.1001	1.1606	1.1104	1.0555	1.1300
17	BUSSERVICE	1.2834	1.1506	1.1541	1.6024	1.8841	1.0823	1.5259
18	REPSERVICE	1.1954	1.0651	1.0649	1.5790	1.1004	1.1642	1.1588
19	MDEDNONPFT	1.0540	1.0304	1.0307	1.0376	1.0327	1.0277	1.0498
20	MINOTHER	1.6135	1.0259	1.0426	1.2868	1.1608	1.7363	1.5693

In the following tables an abbreviated sector name is used, in addition to the sector number, for convenience in reading the table. The full sector names and abbreviations are as follow:

Sector Number	Abbreviated Sector Name	Full Sector Name
1.	LVSTOCKPRD	Livestock and Livestock Products
2.	OTAGFISHPRDTS	Other Agricultural, Fishery Products and Services
3.	WOODPRDTS	Furniture, Lumber and Wood Products
4.	PRINTPRDTS	Printing, Publishing and Allied Products
5.	CHMCLPRDTS	Chemical and Allied Products
6.	MISNONPRDTS	Miscellaneous Non-durable Products
7.	PRIMA	Primary Metals
8.	FABMEPRDTS	Fabricated Metal Products
9.	MACHINELECT	Machinery including Electrical
10.	MOVEHIC	Motor Vehicles
11.	MISDURPRDTS	Miscellaneous Durable Products
12.	ELPOGASA	Electric Power, Gas and Santiary
13.	TRANSCOMM	Transportation and Communication
14.	WHORTRAD	Wholesale and Retail Trade
15.	FBRSERVICE	Finance, Insurance, Real Estate and Retail
16.	PERSERAM	Personal Service and Amusements
17.	BUSSERVICE	Business Services
18.	REPSERVICE	Repair Services
19.	MDEDNONPRT	Medical, Educational Services and Non-Profit Organizations

20. MINOTHER Mining and Others

In the same manner, in the following tables, the reducing techniques, are known by their initials as set below:

DSM = Direct Survey Method

SLQ = Simple Location Quotient

POLQ = Purchase Only Location Quotient

CIQ = Cross Industry Quotient

MSDP = Modified Supply-Demand Pool

RAS = RAS

SCM = Schaffer-Chu Iterative Procedure

The Type I multipliers discussed here should be considered first approximations, particularly for an economy as "open" as that of Tri-county region. The Type II multipliers which will be discussed later, are larger in every case, and are more accurate estimates of the income changes produced in the area by changes in final demand. The latter shows the effects of successive rounds of consumer spending (including induced effects), in addition to the direct and indirect effects of increases in sales to final demand by each of the processing sectors.

As is apparent from Table 12, we could classify the six reducing techniques into three groups: (1) techniques which in every sector underestimate the Type I income multipliers for every sector, (2) techniques which in every sector overestimate the Type I multipliers for every sector, and (3) techniques which overestimate the Type I multipliers in some sectors, while underestimating them in the other sectors.

In a more detailed fashion the interpretation of Table 12, can be summarized as follows:

(1) The Simple Location Quotient and the Purchase Only Location Quotient techniques underestimate the Type I income multipliers in all sectors.

(2) The Cross Industry Quotient technique overestimate the Type I income multipliers in 14 sectors and understimate them in 6 sectors.

(3) The Modified Supply-Demand Pool technique overestimates the value of the Type I multipliers in 7 sectors, while underestimating them in 13 sectors.

(4) The RAS method overestimates the Type I multiplier in 5 sectors, while underestimating them in 15 sectors.

(5) The Schaffer-Chu technuque overestimates the Type I multipliers in all 20 sectors.

This fact is not entirely surprising. The value of estimated Type I multipliers to some extent depends upon the estimated direct coefficients. As has been discussed earlier, both the Simple Location Quotient and the Purchase Only Location Quotient techniques tend to underestimate the direct coefficients. From 20 sectors of the Tri-county region, only in two sectors are the location quotients greater than unity. In these two sectors (40 cells), the estimated direct coefficients are identical to the national coefficients, while in the remaining 18 sectors, the national direct coefficients have been adjusted downward. In contrast, the Cross Industry Quotient and the Schaffer-Chu procedures take the value of the national coefficients in 222 cells and 206 cells respectively. Because the national direct coefficient in general is larger than the regional direct coefficients, the estimated Type I multipliers generated by the Cross Industry Quotient and the Schaffer-Chu techniques in most cases are larger than those produced by the Simple Location Quotient and the Purchase Only Location Quotient techniques. This finding is consistent with the fact that the value of the Type I multiplier of a large region is usually larger than that of smaller regions for a particular sector. From the discussion we may conclude that the more likely a reducing technique takes the value of the national direct coefficients, the greater the possibility that the technique overestimates the Type I multipliers.

The relative efficiency of each reducing technique in estimating the Type I income multipliers has been computed in this study. Three comparison tests: (1) the mean absolute percentage deviation, (2) the mean of relative change, and (3) the mean of similarity index, have been used to judge the reliability of estimates generated by each reducing technique. The results are presented in Table 13.

Table 13. Comparison of the Relative Efficiency of the Six Reducing Techniques in Estimating the Type I Income Multiplier

Reducing Techniques	Comparison Tests		
	The mean absolute percentage deviation	The mean of relative change	The mean of similarity index
SLQ	.207	.242	.879
POLQ	.196	.227	.887
CIQ	.152	.138	.931
MISP	.215	.215	.893
RAS	.150	.130	.935
SCM	.154	.135	.932

Based on data in Table 13, the six reducing techniques have been ranked in accordance with their relative efficiency, and the results are presented in Table 14.

As may be expected, it is apparent that the RAS method generates the best estimates when evaluated by the three comparison tests used in this study. Probably this is due to the fact that the RAS method used a certain amount of direct survey data. However, the degree of its superiority is not significant. For example, the mean absolute percentage deviation of the second best technique,

Table 14. Evaluation of Estimated Type I Income Multiplier: Reducing Techniques Ranked for Each Comparison Test

Rank	Comparison Tests: The Mean absolute percentage deviation	The mean of relative change	The mean of similarity index
1	RAS	RAS	RAS
2	CIQ	SCM	SCM
3	SCM	CIQ	CIQ
4	POLQ	MSDP	MSDP
5	SLQ	POLQ	POLQ
6	MSDP	SLQ	SLQ

that is the Cross Industry Quotient, is .152, while the RAS method's mean absolute percentage deviation is .150.

Among the nonsurvey techniques, the Cross Industry Quotient emerges as being superior to the Simple Location Quotient and the Purchase Only Location Quotient techniques when judged by the three comparison tests. The Schaffer-Chu Iterative procedure emerges as being the second best when judged by the last two comparison tests. The Modified Supply-Deman Pool technique is the poorest technique when judged by the mean absolute percentage deviation test, however, this technique produces a better result when judged by the last two comparison tests.

One general conclusion can be suggested from this discussion: all of the techniques tested in this study perform better in estimating the Type I income multipliers than in estimating the direct coefficients. For example, the range of the mean absolute percentage deviations in estimating the Type I multipliers is between .150 and .215, the range of this index is between .9399 and 2.798 whenever the six techniques are used to estimate the direct coefficients. Thus, it seems that the use of these techniques to estimate the Type I multipliers is really promising.

We next proceed to a detailed examination of errors by sector. Below is the list of sectors, in which the greatest deviations do occur when we use these techniques to estimate the Type I income multipliers.

Simple Location Quotient and Purchase Only Location Quotient

1. Livestock and Livestock Products
2. Other Agricultural, Fishery Products and Services
3. Primary Metal
4. Finances, Insurance, Real Estate and Rental

Cross Industry Quotient

1. Chemical and Allied Products
2. Primary Metals

Modified Supply-Demand Pool

1. Livestock and Livestock Products

2. Other Agricultural, Fishery Products and Services
3. Chemical and Allied Products
4. Miscellaneous Nondurable Products
5. Primary Metals
6. Transportation and Communication
7. Business Services

RAS

1. Livestock and Livestock Products
2. Other Agricultural, Fishery Products and Services

Schaffer-Chu Iterative Procedure

1. Other Agricultural, Fishery Products and Services
2. Chemical and Allied Products

In concluding, it is fair to say that most of the reducing techniques appraised in this study perform poorly when used to estimate the Type I income multipliers in Livestock and Livestock Products, and Other Agricultural, Fishery Products and Services.

The Type II Income Multipliers

The results of the Type II income multiplier analysis of the Tri-county regional economy are summarized in Table 15. The more complete results of multiplier analysis which include the direct, indirect and induced income change are presented in Appendix B.

Table 15. The Type II Income Multiplier of the Tri-County Region (Direct Survey Method) Compared to the Type II Income Multiplier Produced by the Six Reducing Techniques Tested in This Study

Sectors No.	Name		Reducing Techniques					
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
1	LVSTOCKPRD	5.7601	2.3873	2.1504	5.9692	3.3446	7.7575	6.2296
2	OTAGFISHPRDTS	7.7769	4.2526	4.6255	9.6704	5.6087	8.2782	10.2012
3	WOODPRDTS	1.7843	1.2582	1.2580	2.1344	1.2853	1.5592	2.1452
4	PRINTPRDTS	1.9166	1.2830	1.2811	1.9823	1.7739	1.9955	1.9958
5	CHMCLPRDTS	2.0485	1.4245	1.4411	3.2526	4.1867	1.3902	3.0708
6	MISNONPRDTS	4.3552	2.2292	2.2584	5.1704	2.6998	3.4135	6.9260
7	PRIMA	2.8188	1.6848	1.8276	3.3588	1.4376	2.2071	2.8453
8	FABMEPRDTS	1.8340	1.4925	1.5055	2.2353	1.3046	1.8463	2.3174
9	MACINELECT	1.9971	1.4176	1.4256	2.5061	1.9483	1.6755	2.4701
10	MOVEHIC	5.0539	3.7971	3.8399	5.1780	4.2308	5.8014	5.2552
11	MISDURPRDTS	1.8346	1.3685	1.3754	2.3540	1.7683	1.4774	2.2903
12	ELPOGASA	2.0520	1.6892	1.7042	1.7028	2.0834	2.0098	2.7950
13	TRANSCOMM	2.9769	1.8000	1.8201	3.1599	2.0126	2.6641	3.2236
14	WHORTRAD	5.3641	3.9290	4.0009	6.6687	4.6348	5.0297	6.8204
15	FBRSERVICE	5.5756	3.4312	3.4860	6.2882	4.5576	5.5898	6.4715
16	PERSERAM	1.9902	1.6407	1.7196	2.2395	1.8604	1.9369	2.1922
17	BUSSERVICE	1.5538	1.2996	1.3098	2.3044	2.7609	1.2489	2.0049
18	REPSERVICE	1.7999	1.3984	1.4060	1.8284	1.5426	1.8349	1.8502
19	MDEDNONPFT	2.2392	1.8170	1.8366	2.3775	1.9995	2.2185	2.4420
20	MINOTHER	2.3902	1.0541	1.0828	1.7005	1.3168	2.5410	2.2317

Theoretically, the values of the Type II income multiplier are a constant multiple of the values of the Type I income multiplier. The ratio of the two multipliers can be expressed as:[1]

$$R = \frac{1}{1 - \{h + H_r (I-A)^{-1} H_c\}}$$

where:

R = the ratio of the Type II and the Type I multipliers

A = direct coefficients matrix

h = intrahousehold consumption coefficient

H_r = row vector of household coefficients

H_c = column vector of household consumption expenditure coefficients

Aside from the apparent novelty of this formula, there is a practical gain in that once the Type I multipliers are known, it is no longer necessary to construct an augmented matrix which includes the household sector and obtain its inverse in order to derive the Type II income multipliers.

However, the reader must be aware that the ratio of the Type II and the Type I income multipliers is constant only if the total final demands is equal to total payments when the model is closed, that is when the household sector is moved into the processing sector. In a situation

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[1]Richardson, Harry W., 1972, Op cit., p. 43.

where the total final demand is not equal total payments, when the model is closed, as in the Tri-county input-output model,[1] the ratio of the two multipliers may not be constant. That is the reason that the ratio of the Type II and the Type I multipliers computed from the survey table (see Appendix B, Table 1) are not equal to a constant.

As can be seen from Table 15, the Simple Location Quotient and the Purchase Only Location Quotient underestimate the Type II multipliers in all sectors. In contrast, the Cross Industry quotient and the Schaffer-Chu techniques overestimate the Type II multipliers in all but one sector. The Supply-Demand Pool underestimates the multipliers in 17 sectors, while overestimating them in 3 sectors. The most balanced technique is the RAS. While it overestimates the multipliers in 8 sectors, it underestimates them in 12 sectors.

As shown in Table 15, the values of the Type II income multiplier in 5 sectors: (1) Livestock and Livestock Products, (2) Other Agricultural, Fishery Products and Services, (3) Motor Vehicles, (4) Wholesale and Retail Trade, and (5) Finances, Insurance, Real Estate and Rental, are relatively larger than in other sectors. Based on their properties we may classify these 5 sectors into two groups: (1) Sectors in which the Tri-county

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[1] O'Donnell, John L., <u>et al</u>., 1960, <u>Op cit</u>., p. 256.

region is highly specialized, and (2) Sectors which have been obtained through high degree of aggregation. In the first group, it seems logical that in sectors where the region is specialized the indirect and induced income change are relatively larger than the direct income change. Because in computing the value of the Type II income multiplier we divide the direct, indirect and induced income change by the direct income change, we may expect that the Type II multipliers in these sectors are relatively higher than in the other sectors. In the second group, we artificially enlarge the sectors by aggregation. It is possible that the larger the sector, the larger the indirect and induced income change relative to the direct income change. So that it is not surprising that the Type II multipliers of these sectors are relatively higher than of those smaller sectors.

From our discussions we may conclude that the value of Type II income multipliers may be very high in two groups of sectors: (1) sectors in which the Tri-county region is specialized, and (2) large sectors, which have been obtained through a high degree of aggregation.

The relative efficiency of the six reducing techniques in estimating the Type II multipliers have been computed in this study. Three comparison tests: (1) the mean absolute percentage deviation, (2) the mean of relative change and (3) the mean of similarity index, have been used to evaluate the relative efficiency of each technique, and the results are presented in Table 16.

Table 16. Comparison of the Relative Efficiency of the Six Reducing Techniques in Estimating the Type II Income Multipliers

Reducing Techniques	Comparison Tests		
	The mean absolute percentage deviation	The mean of relative change	The mean of similarity index
SLQ	.318	.438	.781
POLQ	.308	.391	.804
CIQ	.191	.177	.911
MIDP	.284	.293	.854
RAS	.159	.123	.938
SCM	.199	.173	.914

Based upon data in Table 16, the six reducing techniques have been ranked according to their relative efficiency in estimating the Type II multipliers. The results are presented in Table 17.

If we compare the efficiency of the six techniques in estimating the Tyep II income multipliers to their efficiency in estimating the Type II income multipliers, we may conclude that the relative efficiency of each technique in estimating the latter is lower. Indeed, this situation is not surprising because when a technique is used to estimate the Type II income multipliers induced

Table 17. Evaluation of Estimated Type II Income Multiplier: Reducing Techniques Ranked for Each Comparison Test

Rank	Comparison Tests		
	The mean absolute percentage deviation	The mean of relative change	The mean of similarity index
1	RAS	RAS	RAS
2	CIQ	SCM	SCM
3	SCM	CIQ	CIQ
4	MSDP	MSDP	MSDP
5	POLQ	POLQ	POLQ
6	SLQ	SLQ	SLQ

income change is estimated in addition to direct and indirect income change. Thus, it is only natural that some errors are introduced when the technique to estimate the induced income change is used.

The results in general are promising. The superiority of the RAS method is apparent. Its mean absolute percentage deviation is only 15.88 percent. However, this situation is not unexpected, because this method employs a certain amount of survey data. Moreover, even the purely nonsurvey technique produced satisfactory results. For example, the Cross Industry Quotient, the second best technique when judged by the mean absolute percentage deviation test, produced estimates which on the average deviate from the "true" value by only 19 percent. The Simple Location Quotient and the Purchase Only Location Quotient techniques are among the poorest when judged by all comparison tests. The Schaffer-Chu Iterative procedure gives superior results among the purely nonsurvey techniques, when judged by the mean of relative change and the mean of similarity index.

Thus, by observing the results, we may come to the conclusion that the use of RAS, the Cross Industry Quotient and the Schaffer-Chu Iterative techniques to estimate the Type II multipliers is promising.

Next, we could proceed to a more detailed examination of errors by sector. A close observation of the estimated Type II income multipliers produced by each technique would reveal that the greatest deviations occur in the following sectors.

<u>Simple Location Quotient</u>

1. Livestock and Livestock Products
2. Other Agricultural, Fishery Products and Services
3. Miscellaneous Nondurable Products
4. Primary Metals
5. Mining and Others

The mean absolute percentage deviations of these five sectors is 49.76 percent, while the mean of total deviation is 31.79 percent.

Purchase Only Location Quotient

1. Livestock and Livestock Products
2. Other Agricultural, Fishery Products and Services
3. Miscellaneous Nondurable Products
4. Mining and Others

The mean absolute percentage deviation of these four sectors is 51.51 percent, while the mean of total deviation is 30.81 percent.

Cross Industry Quotient

1. Chemical and Allied Products
2. Business Services

The mean absolute percentage deviation of these two sectors is 53.54 percent, while the mean of total deviation is 19.09 percent.

Modified Supply-Demand Pool

1. Livestock and Livestock Products
2. Chemical and Allied Products
3. Primary Metals
4. Mining and Others

The mean absolute percentage deviation of these four sectors is 60.06 percent, while the mean of total deviation is 28.37 percent.

RAS

1. Livestock and Livestock Products

2. Other Agricultural, Fishery Products and Services

The mean absolute percentage deviation of these two sectors is 62.25 percent, while the mean of total deviation is 15.88 percent.

Schaffer-Chu Iterative Procedure

1. Chemical and Allied Products

2. Miscellaneous Nondurable Products

The mean absolute percentage deviation of these two sectors is 54.47 percent, while the mean of total deviation is 19.90 percent.

This analysis concludes the discussion of the results of this study. The summary and conclusions from the results are presented in the next chapter.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

In the last two decades, the demand for input-output models at the small region level has been increasing, and is reflected to some extent by the number of studies which have been completed and are currently in progress. In general this trend has been allied with an increasing awareness of planning as a continuous and cyclical process. In a planning process input-output models could be used to elaborate the implications of alternative strategies, they can help in the evaluation of these alternatives and consequently also could be useful in formulating and reformulating the planning objectives.

A major obstacle to the widespread application of input-output analyses at the regional level is a shortage of requisite data. An implementation of an input-output model requires extensive data which few other models require. However, few other models possess the comprehensiveness of the input-output analysis. Unfortunately data are rarely collected and published in a form directly appropriate for regional input-output analyses, so the regional analysts must collect all or a part of the data through direct survey or can attempt to produce an input-output table from the available published data.

As discussed in Chapter II, many attempts have been made to produce a matrix of regional direct coefficient from a matrix of national direct coefficients. Yet efforts at such nonsurvey and minimum survey techniques have not been highly successful in the past. Thus a study on nonsurvey or minimum survey techniques could contribute greately to progress in empirical regional economic analysis.

Summary of this Study

As has been pointed out earlier, an empirical input-output table constructed for the Lansing Tri-county region for the year 1958 by O'Donnell, *et al.*, has provided this study a basis for testing of the relative efficiency of nonsurvey and minimum survey techniques, based upon the United States input-output tables for the year 1958. The purpose of this study is to integrate previous work on nonsurvey and minimum survey input-output techniques at the regional level by comparing results of the application of the most promising of the earlier nonsurvey and minimum survey tehcniques in a consistent way with an empirically derived survey-based input output model for the Lansing Tri-county region. The empirically derived input-output model of the Tri-county region is a regional version of the traditional Leontief open, static input-output model, and thus the nonsurvey and minimum survey techniques tested in this study produced tables of this nature.

The sectoring arrangement adopted in this study is presented in Table 2. The purpose of the aggregation procedure was to reduce the size of a 87 by 87 national input-output table, and a 24 by 24 input-output table of the Tri-county region to a 20 by 20 standard matrix.

The six reducing techniques appraised in this study divide naturally into three major categories. These are:

a. Quotient Approaches

   Included in this category are: (1) The Simple Location Quotient, (2) The Purchase Only Location Quotient, and (3) The Cross Industry Quotient.

b. Commodity Balance Approach

   Included in this category is the Modified Supply-Demand Pool technique.

c. Iterative Approaches

   Included in this category are: (1) The RAS technique, and (2) The Schaffer-Chu Iterative Procedure.

All the techniques operated on the national input-output matrix and attempt to adjust the coefficient to produce regional coefficients that adequately represents the Tri-county region's economic structure or interindustry linkages. The basic assumption of all techniques is that the national technology is assumed the same with technology at the regional level and that the regional direct coefficients differ from the national direct coefficients to the extent that goods and services are imported from or exported to other regions. This assumption clearly implies the constraint that the regional direct coefficients must alwasy be less than or equal to the national coefficients. If the goods and services are exported to other regions, the direct coefficients of the exporting industry are identical to national coefficients for the particular row, and if goods and services are imported from other regions, the national direct coefficients are adjusted downward.

Based upon the direct coefficients produce by each technique, the Type I and the Type II income multipliers were computed.

An essential part of this study was to establish some objective means of evaluating the relative efficiency of each technique. The relative efficiency is a measure of distance or relative distance between the value of estimated direct coefficients, the Type I and the Type II income multipliers, and the "true" direct coefficients, the Type I and the Type II income multipliers computed from the survey-based input-output table. For this purpose three comparative tests have been employed. These are: (1) The mean absolute percentage deviation, (2) The mean of relative change, and (3) The mean of similarity index.

The mean absolute percentage deviation test has two major deficiencies. These are: (1) It can not handle a situation where the "true" direct coefficient is zero, and (2) In this test, deviations between small coefficients affect the results far more than those between large coefficients.

The mean of relative change and the mean of similarity index lack of these deficiencies. However, the mean of relative change has another problem, that is its value ranges from zero to two. This feature is not only confusing but also awkward. Thus, it may be suggested that the mean of similarity index is the most ideal of the three comparison tests employed in this study.

Relative Efficiency of the Six Reducing Techniques in Estimating the Direct Coefficients

When judged by the three comparison tests, it appears that the RAS technique produces the best estimates. However, the degree of its superiority is not really significant. For example, the mean absolute percentage deviation of estimates generated by the RAS method is only 10 percent lower than the mean absolute percentage deviation of estimates produced by the second best technique (the Simple Location Quotient). Among the purely non-survey reducing techniques, there is more variation in the results. The Simple Location Quotient and the Purchase

Only Location Quotient emerge as being superior to the other reducing techniques when judged by the mean absolute percentage deviation test. However, both techniques perform poorly when judged by the mean of relative change and the mean similarity index. In contrast, when judged by the mean of similarity index and the mean of relative change, the Cross Industry Quotient and the Schaffer-Chu Iterative techniques produced better estimates than those produced by the other techniques. These inconsistencies are probably due to the fact that the Cross Industry Quotient and the Schaffer-Chu techniques tend to overestimate the small regional direct coefficients.

The Modified Supply-Demand Pool technique produced the poorest estimates when judged by the mean absolute percentage deviation test. However, it is interesting that it emerges as being superior to the Simple Location Quotient and the Purchase Only Location Quotient when judged by the other two comparison tests.

Relative Efficiency of the Six Reducing Techniques in Estimating the Type I Multiplier

It was observed that all of the techniques tested in this study perform better in estimating the Type I multipliers than in estimating the regional direct coefficients. For example, the range of the mean of absolute percentage deviation in estimating the Type I multipliers is between .150 and .215, while this range is between .939 and 2.798 whenever the six techniques are used to estimate the direct coefficients.

As may be expected, it was apparent that RAS method generated the best estimates of the Type I income multipliers when judged by any of the comparison tests.

Among the purely nonsurvey techniques, the Cross Industry Quotient emerges as being superior to the Simple Location Quotient and the Purchase Only Location Quotient when evaluated by the three comparison tests. The Schaffer-Chu technique produced the second best estimates when judged by the mean of relative change and the mean of similarity index. The Modified Supply-Demand Pool technique produced the poorest estimates when judged by the mean absolute percentage deviation. However this technique emerges as being superior to the Simple Location Quotient when evaluated by the other two comparison tests.

Relative Efficiency of the Sic Reducing Techniques in Estimating the Type II Income Multiplier

If the efficiency of the six methods in estimating the Type II income multipliers to their efficiency in estimating the Type II income multipliers is compared, it can be concluded that, in general, their efficiency in estimating the latter is decreased. However, this situation is not really unexpected, because when a technique is used to estimate the Type II multipliers, in addition to estimating the direct and indirect income change, it also estimates the induced income change. Thus, probably additional error was introduced when the technique is used to estimate the Type II income multipliers.

The results of the Type II multiplier analysis were promising in general. The superiority of the RAS method was apparent. Its mean absolute percentage deviation was only 15.88 percent. Moreover, even the purely nonsurvey technique produced satisfactory results. For example, the Cross Industry Quotient technique, the second best technique when evaluated by the mean absolute percentage deviation test, produced estimates which on average deviate from the "true" value by only 19 percent. The Simple Location Quotient and the Purchase Only Location Quotient techniques are among the poorest when judged by all comparison tests. The Schaffer-Chu Iterative procedure gave a superior result when evaluated by the mean of relative change and the mean of similarity index.

The Possible Sources of Estimation Errors

In estimating regional direct coefficients, Type I and Type II income multipliers, the greatest deviations have occurred in three groups of sectors.

The first group of sectors in which large deviations were expected to occur were those in which the Tri-county regional economy is highly specialized. In this study, this group was represented by the Motor Vehicles sector. It seems that sectors in which the Tri-county regional economy is highly specialized have different production functions than the United States average. Consequently, their direct coefficients cannot be estimated from national coefficients by using mechanical techniques.

The second group of sectors, which we may call primary activities, were represented in this study by three sectors: (1) Livestock and Livestock Products, (2) Other Agricultural, Fishery Products and Services and (3) Mining and Others. Probably it may be safe to assume that these high levels of errors can be largely explained by the difference of mix of economic activities within a given sector. For example, agricultural crops or fish products in the Tri-county region may include different activities from the national average.

The last group of sectors in which large deviations were expected to occur were those sectors which have been obtained through a high degree of aggregations. By increasing the degree of aggregation, it is likely this will simultaneously increase the possibility of including more and more firms with different production functions into one sector. This situation may introduce more aggregation errors into the results of the study.

Conclusions and Recommendations

In estimating the regional direct coefficients, none of the reducing techniques appraised in this study were entirely satisfactory to the author. The distance between the survey and nonsurvey direct coefficients matrices is still too large in absolute terms to be acceptable. The Simple Location Quotient and the Purchase Only Location Quotient appeared to adjust some coefficients downward drastically. In contrast, the Schaffer-Chu iterative procedure and the Cross Industry Quotient technique appeared to overestimate some coefficients.

This study revealed that the more frequently a reducing technique equates the regional direct coefficints to the national direct coefficients, the more likely that the technique overestimates the regional direct coefficients.

While the RAS method performs slightly better than nonsurvey techniques, it must be remembered that the method employed a certain amount of survey data. Of course, data collection requires costs. It should be noted that (1) the RAS method produced estimates which only slightly better than the other techniques,(2) the RAS method likely is less cost effective than the other techniques. Therefore, from a cost point of view, the RAS method is not necessarily more effecient than the other techniques.

Among the purely nonseuvey techniques, it was observed that the Simple Location Quotient and the Purchase Only Location Quotient produced superior estimates of direct coefficients when evaluated by the mean absolute percentage deviation test. However, when judged by the mean of relative change and the mean of similarity index, it appeared that the Cross Industry Quotient and the

Schaffer-Chu iterative procedure emerged as being superior to the other nonsurvey techniques. These inconsistencies were probably due to the tendency of the Cross Industry Quotient and the Schaffer-Chu techniques to overestimate the small regional direct coefficients.

This study revealed that the relative efficiencies of the reducing techniques were better when used to estimate the Type I and Type II income multipliers, than when used to estimate regional direct coefficients.

It was observed that the RAS method (the best technique when judged by all comparison tests) produced the estimates of the Type I and Type II multipliers with mean absolute percentage deviation of 15.0 percent and 15.9 percent respectively. Among the purely secondary data reducing techniques, the Schaffer-Chu procedure and the Cross Industry Quotient, consistently produced the best estimates of the Type I and the Type II income multipliers when judged by any of the comparison tests. Therefore, the most promising techniques for estimating the Type I and the Type II multipliers are: (1) the RAS technique, (2) the Schaffer-Chu iterative procedure, and (3) the Cross Industry Quotient technique.

In estimating the regional direct coefficients, and Type I and Type II income multipliers it was found that greatest deviations occurred in three groups of sectors: (1) Sectors in which the regional economy is highly specialized, (2) The Primary Activity sectors, and

(3) Sectors which have been obtained through a high degree of aggregation. In order to obtain more acceptable results, it is recommended that a field survey be used to obtain regional direct coefficients for these three groups of sectors.

It is also recommended that national and regional input-output statistics be published in greater detail (less aggregation), especially with regard to service industries. This would be of considerable benefit to planners and other regional analysts desiring to apply some kind of nonsurvey and minimum survey techniques.

Further research and experimentation with the six reducing techniques appraised in this study is needed in order to improve their relative efficiency in estimating direct coefficients, and the Type I and Type II income multipliers. If relative efficiencies of the reducing techniques can be improved significantly, it will help planners and other regional analysts in making appropriate response to policy questions by using input-output models.

APPENDICES

APPENDIX A

ESTIMATED DIRECT COEFFICIENTS GENERATED BY THE SIX REDUCING TECHNIQUES, COMPARED TO THE "TRUE" DIRECT COEFFICIENTS COMPUTED FROM SURVEY DATA

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ESTIMATED DIRECT COEFFICIENTS GENERATED BY THE SIX REDUCING TECHNIQUES, COMPARED TO THE "TRUE" DIRECT COEFFICIENTS COMPUTED FROM SURVEY DATA

The Results of Direct Coefficients Estimation

Direct requirements per dollar of gross output for each sector estimated by each reducing technique are presented in Table A-1. To facilitate comparison, these coefficients have been placed side by side with the "true" direct coefficients computed from survey data.

In an ateempt to save the space, a sector appears in Table A-1 as its number, instead of its full name. Row numbers refer to producing industries, while the column numbers refer to purchasing industries. The sector numbers and the full sector names are as follow:

Sector Number	Full Sector Name
1.	Livestock and Livestock Products
2.	Other Agricultural, Fishery Products and Services
3.	Furniture, Lumber, and Woods Products
4.	Printing, Publishing and Allied Industries
5.	Chemical and Allied Products

Sector Number	Full Sector Name
6.	Miscellaneous Non-durable Products
7.	Primary Metals
8.	Fabricated Metal Products
9.	Machinery including Electrical
10.	Motor Vehicles
11.	Miscellaneous Durable Products
12.	Electrical Power, gas and Sanitary Services
13.	Transportation and Communication
14.	Wholesale and Retail Trade
15.	Finances, Insurances, Real Estate and Rental
16.	Personal Services and Amusements
17.	Business Services
18.	Repair Services
19.	Medical, Educational Services and Non-Profit Organizations
20.	Mining and Others

In addition each reducing technique appears in Table A-1 in its initials as shown below:

SLQ : Simple Location Quotient

POLQ: Purchase Only Location Quotient

CIQ : Cross Industry Quotient

MSDP: Modified Supply-Demand Pool

RAS : RAS

SCM : Schaffer-Chu Iterative Procedure

DSM : Direct Survey Method

Table A-1. The Tri-county region direct requirements per dollar of gross-output (survey based) compared to direct requirements per dollar of gross-output generated by the six reducing techniques used in this study.

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
1	1	.2456	.0554	.0722	.1583	.0999	.0989	.1583
1	2	.2130	.0737	.0961	.2106	.1330	.4766	.2106
1	3	0.	0.	0.	0.	0.	0.	0.
1	4	0.	0.	0.	0.	0.	0.	0.
1	5	.0020	.0001	.0001	.0002	.0001	.0002	.0002
1	6	.0062	.0012	.0016	.0034	.0022	.0037	.0035
1	7	0.	0.	0.	0.	0.	0.	0.
1	8	0.	0.	0.	0.	0.	0.	0.
1	9	0.	0.	0.	0.	0.	0.	0.
1	10	0.	0.	0.	0.	0.	0.	0.
1	11	0.	0.	0.	0.	0.	0.	0.
1	12	0.	0.	0.	0.	0.	0.	0.
1	13	.0002	0.	0.	.0001	0.	.0001	.0001
1	14	0.	0.	0.	0.	0.	0.	0.
1	15	0.	.0035	.0046	.0070	.0063	0.	.0100
1	16	0.	.0002	.0003	.0006	.0004	.0009	.0007
1	17	0.	0.	0.	0.	0.	0.	0.

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
1	18	0.	0.	0.	0.	0.	0.	0.
1	19	.0027	.0001	.0001	0.	.0001	.0008	.0002
1	20	.0094	0.	0.	0.	0.	0.	0.
2	1	.2667	.1162	.1620	.3319	.1961	.1793	.3380
2	2	.1678	.0629	.0877	.2037	.1061	.3519	.2112
2	3	.0281	.0364	.0507	.1200	.0614	.0204	.1200
2	4	.0001	0.	0.	0.	0.	0.	0.
2	5	.0035	.0043	.0060	.0142	.0073	.0098	.0142
2	6	.0007	.0092	.0129	.0304	.0156	.0011	.0304
2	7	0.	.0001	.0001	.0002	.0002	.0009	.0002
2	8	0.	0.	0.	0.	0.	0.	.0003
2	9	0.	0.	0.	0.	0.	0.	0.
2	10	0.	0.	0.	0.	0.	0.	0.
2	11	.0033	.0008	.0011	.0025	.0013	.0027	.0025
2	12	.0002	0.	0.	0.	0.	0.	0.
2	13	.0055	.0011	.0015	.0037	.0019	.0043	.0037
2	14	.0011	.0024	.0033	.0052	.0040	.0055	.0079

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
2	15	0.	.0050	.0069	.0099	.0084	0.	.0164
2	16	.0004	.0003	.0004	.0007	.0005	.0010	.0010
2	17	0.	0.	0.	0.	0.	0.	0.
2	18	.0103	.0024	.0034	.0014	.0041	.0210	.0056
2	19	.0705	0.	0.	0.	0.	0.	0.
2	20	.0001	0.	0.	0.	0.	0.	0.
3	1	.0001	0.	0.	0.	0.	0.	0.
3	2	.0013	.0005	.0005	.0016	.0005	.0048	.0017
3	3	.2544	.0882	.0797	.3832	.0756	.0798	.3832
3	4	.0001	.0001	.0001	.0003	.0001	.0002	.0003
3	5	.0010	.0005	.0004	.0021	.0014	.0018	.0021
3	6	.0011	.0001	.0001	.0005	.0001	.0005	.0004
3	7	.0016	.0003	.0003	.0008	.0003	.0049	.0008
3	8	.0049	.0026	.0025	.0048	.0024	.0196	.0048
3	9	.0104	.0015	.0015	.0056	.0014	.0239	.0058
3	10	.0052	.0002	.0002	0.	.0002	.0133	.0003
3	11	.0106	.0025	.0024	.0089	.0023	.0153	.0090

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
3	12	.0006	0.	0.	0.	0.	.0002	.0001
3	13	.0001	.0002	.0001	.0006	.0001	.0002	.0001
3	14	.0008	.0004	.0004	.0010	.0004	.0017	.0100
3	15	.0038	.0001	.0001	.0002	.0001	.0016	.0002
3	16	.0005	.0003	.0003	.0007	.0003	.0016	.0008
3	17	.0011	0.	0.	0.	0.	0.	0.
3	18	.0004	0.	0.	0.	0.	0.	0.
3	19	.0006	0.	0.	0.	0.	.0004	0.
3	20	.0020	.0001	.0001	.0005	.0001	.0001	.0005
4	1	0.	.0001	.0001	.0002	.0001	.0001	.0002
4	2	.0007	.0005	.0005	.0015	.0011	.0036	.0015
4	3	.0021	.0015	.0015	.0042	.0032	.0010	.0042
4	4	.0758	.0447	.0451	.1295	.0985	.0636	.1295
4	5	.0060	.0011	.0011	.0031	.0023	.0030	.0031
4	6	.0001	.0002	.0002	.0006	.0004	.0002	.0006
4	7	.0010	.0005	.0005	.0012	.0011	.0055	.0007

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
4	8	.0027	.0009	.0009	.0016	.0020	.0048	.0030
4	9	.0011	.0003	.0003	.0009	.0007	.0037	.0009
4	10	.0017	.0002	.0002	0.	.0004	.0097	.0005
4	11	.0298	.0163	.0165	.0473	.0360	.0734	.0473
4	12	.0004	.0001	.0001	.0002	.0002	.0004	.0003
4	13	.0063	.0017	.0017	.0050	.0038	.0083	.0050
4	14	.0013	.0009	.0009	.0021	.0021	.0027	.0027
4	15	.0116	.0018	.0019	.0037	.0040	.0271	.0053
4	16	.0039	.0006	.0006	.0014	.0013	.0023	.0017
4	17	.4034	.0900	.0909	.2608	.1984	.2861	.2608
4	18	.0016	.0001	.0005	.0008	.0010	.0004	.0013
4	19	.0227	.0050	.0051	.0030	.0111	.0546	.0146
4	20	.0016	.0001	.0001	.0002	.0001	0.	.0017
5	1	0.	.0004	.0004	.0011	.0032	0.	.0011
5	2	.0223	.0027	.0027	.0087	.0219	.0007	.0029
5	3	.0004	.0047	.0048	.0217	.0385	.0001	.0022
5	4	0.	.0020	.0021	.0057	.0164	.0001	.0005

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
5	5	.0890	.0334	.0346	.2762	.2762	.0034	.2762
5	6	.0011	.0065	.0068	.0539	.0539	.0008	.0539
5	7	0.	.0026	.0027	.0065	.0217	.0011	.0006
5	8	.0010	.0025	.0025	.0045	.0203	.0005	.0018
5	9	.0023	.0029	.0030	.0111	.0243	.0012	.0112
5	10	.0002	.0044	.0045	.0003	.0361	.0006	.0004
5	11	.0460	.0070	.0072	.0253	.0579	.0011	.0258
5	12	0.	.0001	.0001	.0003	.0011	0.	.0003
5	13	.0005	.0010	.0011	.0042	.0084	.0002	.0042
5	14	.0001	.0005	.0005	.0010	.0039	0.	.0011
5	15	.0003	.0003	.0003	.0006	.0026	.0002	.0006
5	16	.0064	.0026	.0027	.0064	.0212	.0004	.0065
5	17	.0004	.0006	.0006	.0031	.0052	.0001	.0005
5	18	.0008	.0045	.0047	.0082	.0372	.0001	.0029
5	19	.0015	.0036	.0037	.0021	.0298	.0014	.0022
5	20	.0031	.0013	.0014	.0110	.0110	0.	.0110
6	1	.0175	.0001	.0001	.0004	.0004	.0002	.0024

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
6	2	.0237	.0010	.0010	.0340	.0025	.0055	.0166
6	3	.0377	.0027	.0027	.0127	.0064	.0014	.0435
6	4	.0042	.0002	.0002	.0004	.0004	.0002	.0024
6	5	.0130	.0035	.0035	.0286	.0082	.0074	.0552
6	6	.0902	.0190	.0190	.3030	.0499	.0478	.3030
6	7	.0148	.0006	.0006	.0014	.0013	.0049	.0091
6	8	.0039	.0007	.0007	.0013	.0017	.0029	.0113
6	9	.0057	.0003	.0003	.0013	.0008	.0029	.0053
6	10	.0136	.0010	.0010	.0001	.0023	.0391	.0153
6	11	.0182	.0012	.0012	.0043	.0028	.0041	.0191
6	12	.0058	.0008	.0008	.0019	.0019	.0030	.0129
6	13	.0304	.0027	.0027	.0110	.0064	.0098	.0430
6	14	.0015	.0006	.0006	.0014	.0015	.0013	.0098
6	15	.0047	.0004	.0004	.0008	.0010	.0048	.0066
6	16	.0140	.0020	.0020	.0051	.0048	.0063	.0325
6	17	.0030	.0004	.0004	.0022	.0010	.0011	.0091
6	18	.0113	.0005	.0005	.0009	.0012	.0004	.0082

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
6	19	.0038	.0005	.0005	.0003	.0011	.0039	.0076
6	20	.0116	.0005	.0005	.0060	.0013	.0001	.0085
7	1	.0001	0.	0.	0.	0.	0.	0.
7	2	0.	.0002	.0002	.0004	.0001	.0001	.0004
7	3	.0175	.0139	.0163	.0344	.0090	.0010	.0344
7	4	0.	.0005	.0006	.0012	.0003	.0001	.0001
7	5	.0040	.0082	.0096	.0202	.0053	.0023	.0074
7	6	0.	.0001	.0001	.0003	.0001	0.	.0003
7	7	.2294	.1248	.1461	.3085	.0804	.1424	.3084
7	8	.2463	.2066	.2419	.3786	.1331	.1120	.2041
7	9	.1085	.0546	.0639	.1349	.0351	.0620	.1349
7	10	.0949	.0399	.0467	.0031	.0257	.2149	.0034
7	11	.0076	.0162	.0190	.0400	.0104	.0073	.0400
7	12	.0105	.0014	.0017	.0033	.0009	.0007	.0036
7	13	.0023	.0012	.0014	.0030	.0008	.0006	.0030
7	14	0.	.0001	.0001	.0002	.0001	0.	.0003
7	15	0.	.0001	.0002	.0003	.0001	.0002	.0001

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
7	16	0.	.0001	.0002	.0004	.0001	0.	.0004
7	17	0.	.0003	.0004	.0008	.0002	.0001	.0008
7	18	.00001	0.	0.	0.	0.	0.	0.
7	19	0.	0.	0.	0.	0.	0.	0.
7	20	.0313	.0012	.0014	.0029	.0008	0.	.0029
8	1	.0005	.0012	.0012	.0021	.0005	.0002	.0021
8	2	.0012	.0116	.0116	.0213	.0051	.0064	.0213
8	3	.0246	.0260	.0261	.0476	.0115	.0014	.0476
8	4	.0002	.0011	.0011	.0019	.0005	.0001	.0020
8	5	.0005	.0091	.0091	.0167	.0040	.0020	.0167
8	6	0.	.0042	.0042	.0077	.0018	.0011	.0077
8	7	.0026	.0161	.0161	.0295	.0071	.0145	.0293
8	8	.1195	.0587	.0588	.1075	.0259	.0252	.0895
8	9	.0562	.0270	.0271	.0495	.0119	.0245	.0495
8	10	.0764	.0396	.0371	.0029	.0163	.1576	.0371
8	11	.0119	.0140	.0141	.0257	.0062	.0050	.0257
8	12	.0014	.0045	.0045	.0082	.0020	.0017	.0082

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
8	13	.0016	.0009	.0009	.0016	.0004	.0003	.0016
8	14	.0002	.0013	.0013	.0024	.0006	.0003	.0024
8	15	.0001	.0002	.0002	.0003	.0001	.0002	.0003
8	16	.0010	.0009	.0009	.0017	.0004	.0003	.0007
8	17	.0015	0.	0.	0.	0.	0.	0.
8	18	.0074	.0082	.0083	.0151	.0036	.0006	.0195
8	19	.0002	.0005	.0005	.0003	.0002	.0004	.0004
8	20	.0125	.0030	.0030	.0054	.0013	.0001	.0054
9	1	.0009	.0002	.0002	.0004	.0004	0.	.0004
9	2	.0020	.0009	.0009	.0030	.0021	.0006	.0004
9	3	.0070	.0031	.0031	.0117	.0072	.0002	.0117
9	4	.0053	.0012	.0012	.0034	.0027	.0002	.0035
9	5	.0021	.0026	.0026	.0096	.0059	.0007	.0096
9	6	.0017	.0005	.0005	.0019	.0012	.0002	.0019
9	7	.0099	.0088	.0088	.0216	.0203	.0100	.0330
9	8	.0384	.0238	.0238	.0437	.0549	.0128	.0447
9	9	.1747	.0588	.0588	.2205	.1354	.0670	.2205
9	10	.0349	.0154	.0154	.0012	.0356	.0625	.0021

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
9	11	.0079	.0103	.0103	.0371	.0236	.0046	.0385
9	12	.0041	.0004	.0004	.0009	.0009	.0002	.0019
9	13	.0014	.0031	.0031	.0115	.0070	.0015	.0114
9	14	.0002	.0013	.0013	.0029	.0030	.0004	.0030
9	15	0.	.0005	.0005	.0010	.0012	.0008	.0005
9	16	.0003	.0068	.0068	.0171	.0158	.0006	.0017
9	17	.0053	.0108	.0108	.0404	.0248	.0034	.0404
9	18	.0422	.0093	.0093	.0170	.0214	.0009	.0174
9	19	.0017	.0003	.0003	.0002	.0007	.0003	.0007
9	20	.0163	.0068	.0068	.0256	.0157	.0009	.0256
10	1	.0014	.0009	.0009	.0009	.0009	.0001	.0009
10	2	.0037	.0004	.0004	.0004	.0004	.0004	.0004
10	3	.0018	.0006	.0006	.0006	.0006	0.	.0006
10	4	0.	.0002	.0002	.0002	.0002	0.	.0002
10	5	.0005	0.	0.	0.	0.	0.	0.
10	6	0.	0.	0.	0.	0.	0.	0.
10	7	.0005	.0021	.0021	.0021	.0021	.0008	.0021

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
10	8	.0059	.0135	.0135	.0135	.0135	.0025	.0135
10	9	.0020	.0117	.0117	.0117	.0117	.0046	.0117
10	10	.2764	.2959	.2958	.2958	.2958	.3483	.2959
10	11	.0036	.0034	.0034	.0034	.0034	.0005	.0034
10	12	.0039	.0001	.0001	.0001	.0001	0.	.0001
10	13	.0129	.0024	.0024	.0024	.0024	.0004	.0024
10	14	.0005	.0024	.0024	.0024	.0024	.0002	.0024
10	15	0.	.0002	.0002	.0002	.0002	.0001	.0002
10	16	.0001	0.	0.	0.	0.	0.	0.
10	17	.0008	.0002	.0002	.0002	.0002	0.	.0002
10	18	.1859	.1496	.1496	.1496	.1496	.0048	.1496
10	19	0.	.0001	.0001	.0001	.0001	0.	.0001
10	20	.0144	.0013	.0013	.0013	.0013	0.	.0013
11	1	.0001	.0001	.0001	.0002	.0001	0.	.0002
11	2	.0015	.0022	.0022	.0073	.0046	.0019	.0006
11	3	.0061	.0073	.0073	.0263	.0149	.0006	.0263
11	4	.0049	.0028	.0028	.0081	.0057	.0005	.0086

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
11	5	.0050	.0042	.0042	.0151	.0086	.0086	.0151
11	6	.0036	.0026	.0026	.0096	.0054	.0011	.0096
11	7	.0103	.0045	.0045	.0112	.0093	.0065	.0119
11	8	.0054	.0076	.0076	.0139	.0156	.0051	.0147
11	9	.0143	.0068	.0068	.0247	.0140	.0097	.0247
11	10	.0115	.0052	.0052	.0004	.0106	.0345	.0043
11	11	.0954	.0641	.0641	.2320	.1317	.0359	.2320
11	12	.0017	.0007	.0007	.0015	.0014	.0004	.0016
11	13	.0036	.0013	.0013	.0046	.0026	.0008	.0027
11	14	.0021	.0020	.0020	.0044	.0041	.0007	.0027
11	15	.0090	.0007	.0007	.0013	.0014	.0012	.0014
11	16	.0329	.0092	.0092	.0228	.0188	.0046	.0241
11	17	.0430	.0091	.0091	.0328	.0186	.0036	.0328
11	18	.0040	.0057	.0057	.0105	.0118	.0007	.0111
11	19	.0132	.0057	.0057	.0034	.0118	.0077	.0036
11	20	.0034	.0026	.0026	.0094	.0054	.0010	.0094
12	1	.0032	.0015	.0015	.0035	.0025	.0005	.0035

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
12	2	.0035	.0026	.0026	.0061	.0044	.0034	.0061
12	3	.0070	.0043	.0043	.0099	.0072	.0006	.0099
12	4	.0061	.0019	.0019	.0045	.0032	.0005	.0045
12	5	.0070	.0070	.0070	.0160	.0117	.0037	.0160
12	6	.0067	.0042	.0042	.0098	.0071	.0026	.0098
12	7	.0168	.0122	.0122	.0282	.0205	.0260	.0282
12	8	.0241	.0054	.0054	.0099	.0090	.0054	.0105
12	9	.0127	.0027	.0027	.0063	.0046	.0059	.0109
12	10	.0061	.0020	.0020	.0002	.0034	.0205	.0047
12	11	.0215	.0083	.0083	.0192	.0139	.0070	.0320
12	12	.0175	.0764	.0764	.1763	.1281	.0688	.1763
12	13	.0050	.0024	.0024	.0055	.0040	.0021	.0052
12	14	.0033	.0096	.0096	.0210	.0160	.0051	.0210
12	15	.0063	.0019	.0019	.0038	.0032	.0053	.0044
12	16	.0276	.0073	.0073	.0169	.0123	.0056	.0169
12	17	.0042	.0051	.0051	.0118	.0085	.0030	.0118
12	18	.0215	.0087	.0087	.0159	.0145	.0015	.0169

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
12	19	.0270	.0082	.0082	.0048	.0138	.0166	.0052
12	20	.0100	.0044	.0044	.0100	.0073	.0083	.0100
13	1	.0316	.0054	.0054	.0153	.0060	.0034	.0162
13	2	.0229	.0090	.0090	.0296	.0100	.0209	.0314
13	3	.0500	.0169	.0169	.0690	.0187	.0039	.0690
13	4	.0220	.0069	.0069	.0201	.0077	.0033	.0213
13	5	.0400	.0084	.0084	.0342	.0093	.0079	.0343
13	6	.0118	.0103	.0103	.0423	.0115	.0114	.0423
13	7	.0178	.0135	.0135	.0333	.0150	.0512	.0341
13	8	.0197	.0084	.0084	.0154	.0093	.0152	.0163
13	9	.0167	.0051	.0051	.0190	.0056	.0194	.0178
13	10	.0396	.0054	.0054	.0004	.0060	.0973	.0078
13	11	.0497	.0112	.0112	.0405	.0124	.0168	.0430
13	12	.0504	.0053	.0053	.0123	.0059	.0086	.0131
13	13	.0741	.0164	.0164	.0672	.0183	.0263	.0672
13	14	.0031	.0040	.0040	.0087	.0044	.0038	.0037
13	15	.0121	.0036	.0036	.0073	.0040	.0178	.0077
13	16	.0172	.0031	.0031	.0078	.0035	.0042	.0083

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
13	17	.0183	.0086	.0086	.0354	.0096	.0092	.0046
13	18	.0102	.0042	.0042	.0076	.0046	.0013	.0081
13	19	.0199	.0034	.0034	.0020	.0038	.0124	.0107
13	20	.0050	.0065	.0065	.0267	.0073	.0007	.0267
14	1	.0404	.0162	.0162	.0357	.0178	.0114	.0357
14	2	.0213	.0181	.0181	.0398	.0199	.0056	.0398
14	3	.0161	.0346	.0346	.0762	.0381	.0111	.0762
14	4	.0062	.0111	.0111	.0245	.0123	.0017	.0245
14	5	.0087	.0145	.0145	.0320	.0160	.0018	.0320
14	6	.0046	.0130	.0130	.0286	.0143	.0019	.0286
14	7	.0132	.0195	.0195	.0429	.0215	.0099	.0429
14	8	.0177	.0272	.0272	.0498	.0299	.0066	.0598
14	9	.0165	.0213	.0213	.0469	.0235	.0109	.0469
14	10	.0073	.0146	.0146	.0110	.0160	.0350	.0043
14	11	.0116	.0233	.0233	.0512	.0256	.0047	.0512
14	12	.0041	.0057	.0057	.0125	.0063	.0012	.0125
14	13	.0202	.0130	.0130	.0287	.0144	.0028	.0287

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
14	14	.0013	.0083	.0083	.0182	.0091	.0011	.0182
14	15	.0136	.0071	.0071	.0142	.0078	.0047	.0151
14	16	.0103	.0164	.0164	.0361	.0180	.0030	.0361
14	17	.0049	.0092	.0092	.0202	.0101	.0130	.0020
14	18	.0582	.0403	.0403	.0739	.0444	.0017	.0788
14	19	.0241	.0087	.0087	.0051	.0095	.0042	.0054
14	20	.0050	.0078	.0078	.0172	.0086	.0010	.0172
15	1	.0218	.0093	.0093	.0187	.0143	.0042	.0188
15	2	.0551	.0055	.0055	.0110	.0084	.0090	.0110
15	3	.0167	.0115	.0115	.0230	.0176	.0019	.0231
15	4	.0133	.0204	.0204	.0409	.0312	.0068	.0474
15	5	.0155	.0095	.0095	.0191	.0146	.0063	.0191
15	6	.0081	.0075	.0075	.0151	.0116	.0059	.0152
15	7	.0099	.0068	.0068	.0137	.0104	.0183	.0137
15	8	.0108	.0115	.0115	.0210	.0176	.0147	.0126
15	9	.0092	.0085	.0085	.0171	.0131	.0231	.0171
15	10	.0025	.0034	.0034	.0003	.0052	.0081	.0029
15	11	.0175	.0099	.0099	.0199	.0152	.0105	.0199

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
15	12	.0155	.0043	.0043	.0087	.0067	.0049	.0087
15	13	.0345	.0261	.0261	.0524	.0400	.0295	.0524
15	14	.0082	.0380	.0380	.0763	.0583	.0257	.0763
15	15	.2084	.0633	.0633	.1271	.0971	.2204	.1271
15	16	.0769	.0359	.0359	.0720	.0550	.0345	.0720
15	17	.0262	.0283	.0283	.0568	.0434	.0212	.0568
15	18	.0512	.0341	.0341	.0624	.0522	.0075	.0672
15	19	.0354	.0412	.0412	.0242	.0632	.1053	.0261
15	20	.0125	.0669	.0669	.1342	.1025	.0051	.1342
16	1	0.	0.	0.	0.	0.	0.	0.
16	2	.0002	.0002	.0002	.0003	.0004	.0002	.0004
16	3	0.	.0012	.0019	.0029	.0020	.0001	.0029
16	4	.0022	.0006	.0009	.0015	.0010	.0001	.0015
16	5	0.	.0003	.0006	.0009	.0006	.0002	.0009
16	6	0.	.0006	.0009	.0014	.0009	.0003	.0014
16	7	0.	.0005	.0008	.0012	.0008	.0009	.0012
16	8	0.	.0009	.0014	.0016	.0015	.0008	.0016

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
16	9	0.	.0006	.0010	.0015	.0010	.0012	.0009
16	10	0.	.0003	.0004	0.	.0004	.0024	0.
16	11	0.	.0003	.0005	.0009	.0006	.0003	.0009
16	12	0.	0.	0.	0.	0.	0.	0.
16	13	.0002	.0003	.0005	.0008	.0005	.0003	.0008
16	14	0.	.0015	.0024	.0033	.0025	.0007	.0006
16	15	.0012	.0017	.0028	.0035	.0029	.0044	.0035
16	16	.0727	.0412	.0665	.1028	.0703	.0288	.0835
16	17	.0122	.0030	.0048	.0074	.0050	.0016	.0074
16	18	.0102	0.	0.	0.	0.	0.	0.
16	19	.0022	.0035	.0057	.0021	.0060	.0065	.0021
16	20	0.	.0001	.0001	.0002	.0001	0.	.0002
17	1	0.	.0004	.0004	.0010	.0018	0.	.0018
17	2	.0040	.0058	.0059	.0193	.0288	.0028	.0021
17	3	.0105	.0028	.0028	.0131	.0139	.0001	.0142
17	4	.0076	.0092	.0093	.0268	.0456	.0009	.0289
17	5	.0480	.0104	.0105	.0516	.0516	.0020	.0516

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
17	6	.0056	.0027	.0028	.0135	.0135	.0006	.0135
17	7	.0013	.0021	.0021	.0051	.0102	.0016	.0026
17	8	.0064	.0040	.0041	.0074	.0199	.0015	.0102
17	9	.0083	.0049	.0049	.0183	.0241	.0039	.0098
17	10	.0055	.0051	.0051	.0004	.0250	.0188	.0250
17	11	.0063	.0047	.0047	.0169	.0231	.0015	.0182
17	12	.0025	.0024	.0024	.0055	.0117	.0008	.0059
17	13	.0063	.0036	.0037	.0149	.0179	.0012	.0160
17	14	.0064	.0111	.0111	.0244	.0547	.0022	.0060
17	15	.0073	.0055	.0056	.0110	.0271	.0056	.0119
17	16	.0243	.0065	.0066	.0163	.0323	.0018	.0176
17	17	.0304	.0053	.0054	.0262	.0262	.0012	.0262
17	18	.0063	.0041	.0042	.0076	.0204	.0003	.0204
17	19	.0031	.0053	.0053	.0031	.0260	.0039	.0033
17	20	.0006	.0062	.0063	.0306	.0306	.0001	.0076
18	1	.0032	.0012	.0012	.0023	.0018	.0012	.0023
18	2	.0080	.0021	.0021	.0038	.0030	.0075	.0038

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
18	3	.0070	.0050	.0049	.0091	.0071	.0018	.0091
18	4	.0011	.0006	.0006	.0011	.0008	.0004	.0011
18	5	.0020	.0005	.0005	.0009	.0007	.0007	.0009
18	6	.0022	.0004	.0004	.0007	.0005	.0007	.0007
18	7	.0013	.0003	.0003	.0005	.0004	.0017	.0005
18	8	.0022	.0012	.0012	.0023	.0017	.0034	.0023
18	9	.0023	.0005	.0005	.0009	.0007	.0030	.0010
18	10	.0016	.0002	.0002	0.	.0003	.0035	.0004
18	11	.0066	.0011	.0011	.0021	.0016	.0027	.0004
18	12	.0025	.0007	.0007	.0013	.0010	.0018	.0013
18	13	.0216	.0124	.0122	.0227	.0176	.0306	.0227
18	14	.0057	.0052	.0051	.0095	.0074	.0077	.0095
18	15	.0015	.0013	.0013	.0023	.0018	.0097	.0023
18	16	.0140	.0038	.0038	.0070	.0055	.0080	.0070
18	17	.0008	.0031	.0030	.0056	.0043	.0050	.0056
18	18	.0273	.0096	.0095	.0176	.0137	.0046	.0176
18	19	.0020	.0012	.0012	.0007	.0017	.0068	.0022

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
18	20	.0157	0.	0.	0.	0.	0.	0.
19	1	.0035	.0054	.0054	.0054	.0054	.0010	.0026
19	2	.0004	.0009	.0009	.0009	.0009	.0006	.0009
19	3	.0021	.0018	.0018	.0018	.0018	.0001	.0019
19	4	.0023	.0011	.0011	.0011	.0011	.0002	.0011
19	5	.0012	.0012	.0012	.0012	.0012	.0013	.0011
19	6	.0009	.0010	.0010	.0010	.0010	.0003	.0010
19	7	.0012	.0012	.0012	.0012	.0012	.0013	.0012
19	8	.0020	.0017	.0017	.0017	.0017	.0009	.0017
19	9	.0021	.0011	.0011	.0011	.0011	.0012	.0018
19	10	.0011	.0010	.0010	.0001	.0010	.0051	.0010
19	11	.0020	.0012	.0012	.0012	.0012	.0005	.0013
19	12	0.	.0009	.0009	.0009	.0009	.0004	.0003
19	13	.0048	.0011	.0011	.0011	.0011	.0005	.0045
19	14	.0024	.0011	.0011	.0011	.0011	.0003	.0011
19	15	.0061	.0021	.0021	.0021	.0021	.0030	.0072
19	16	.0057	.0010	.0010	.0010	.0010	.0004	.0044

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
19	17	.0053	.0002	.0002	.0002	.0002	.0001	.0002
19	18	.0013	.0011	.0011	.0011	.0011	.0001	.0011
19	19	.0052	.0134	.0134	.0134	.0134	.0134	.0134
19	20	0.	.0009	.0009	.0009	.0009	0.	.0009
20	1	.0130	0.	0.	0.	0.	0.	0.
20	2	.0043	.0001	.0001	.0002	.0004	.0032	.0009
20	3	0.	0.	0.	0.	0.	0.	0.
20	4	0.	0.	0.	0.	0.	0.	0.
20	5	.0070	.0002	.0003	.0015	.0010	.0032	.0020
20	6	.4484	.0180	.0294	.2041	.1026	.3832	.2041
20	7	.0003	.0002	.0004	.0005	.0012	.0008	.0024
20	8	.0015	0.	0.	0.	.0001	.0005	.0002
20	9	.0009	0.	0.	.0001	.0001	.0015	.0002
20	10	0.	0.	0.	0.	0.	0.	0.
20	11	.0331	.0026	.0043	.0094	.0148	.0751	.0295
20	12	.0159	.0054	.0088	.0124	.0306	.1659	.0608
20	13	.0001	0.	0.	0.	0.	.0001	0.

Table A-1. (Continued)

Row	Column	Techniques						
		DSM	SLQ	POLQ	CIQ	MSDP	RAS	SCM
20	14	0.	0.	0.	0.	0.	.0001	.0001
20	15	0.	.0001	.0002	.0003	.0008	.0127	.0015
20	16	0.	0.	0.	0.	0.	0.	0.
20	17	0.	0.	0.	0.	0.	0.	0.
20	18	0.	0.	0.	0.	0.	0.	0.
20	19	0.	0.	0.	0.	0.	0.	0.
20	20	.0103	.0019	.0031	.0218	.0110	.0040	.0218

APPENDIX B

THE RESULTS OF SECTORAL INCOME MULTIPLIERS ANALYSIS

APPENDIX B

THE RESULTS OF SECTORAL INCOME MULTIPLIERS ANALYSIS

The Results of Sectoral Income Multipliers Analyses

In this section, the results of sectoral income multipliers analyses are presented. Each table contains the information as to: (1) direct, (2) direct and indirect, (3) indirect, (4) direct, indirect and induced, and (5) indirect and induced income change, as a result of delivery of one dollar to final demand sectors, by a particular sector. In addition the Type I and Type II income multipliers are also presented. The estimates produced by a reducing technique are presented separately one from the other.

In these tables (Table B-1, Table B-2, Table B-3, Table B-4, Table B-5, Table B-6, and Table B-7) an abbreviated sector name is used, in addition to the sector number, as a convenience in reading the table. The full sector names and abbreviations are as follows:

Sector Number	Abbreviated Sector Name	Full Sector Name
1.	LVSTOCKPRD	Livestock and Livestock Products
2.	OTAGFISPRDSERV	Other Agricultural, Fishery, Products and Services

Sector Number	Abbreviated Sector Name	Full Sector Name
3.	WOODPRDTS	Furniture, Lumber, Wood Products
4.	PRINTPRDTS	Printing, Publishing and Allied Products
5.	CHMCLPRDTS	Chemical and Allied Products
6.	MISNONPRDTS	Miscellaneous Non-durable Products
7.	PRIMA	Primary Metals
8.	FABMEPRDTS	Fabricated Metal Products
9.	MACHINELECT	Machinery including Electrical
10.	MOVEHIC	Motor Vehicles
11.	MISDURPRDTS	Miscellaneous Durable Products
12.	ELPOGASA	Electric Power, Gas and Santiary Services
13.	TRANSCOMM	Transportation and Communication
14.	WHORETRAD	Wholesale and Retail Trade
15.	FBRSERVICE	Finances, Insurance, Real Estate, and Rental
16.	PERSERAM	Personal Services and Amusements
17.	BUSSERVICE	Business Services
18.	REPSERVICE	Repair Services
19.	MDEDNONPFT	Medical, Educational Services and Non-profit Organizations
20.	MINOTHER	Mining and Others

Table B-1. Income multipliers for the Tri-county Region (1958), obtained from survey table

Producing Sector	Direct Income Only	Direct, Indirect Income	Indirect Income Only	Type I Multi-plier	Direct, Indirect, Induced Income	Indirect, Induced Income	Type II Multi-plier
1. LVSTOCKPRD	.3018	.6252	.3234	2.0714	1.7384	1.4366	5.7601
2. OTAGFISPRDSERV	.3698	.7417	.3719	2.0058	2.8759	2.5061	7.7769
3. WOODPRDTS	.4070	.5846	.1776	1.4363	.7262	.3192	1.7843
4. PRINTPRDTS	.5936	.9231	.3295	1.5551	1.1377	.5441	1.9166
5. CHMCLPRDTS	.2047	.2851	.0804	1.3926	4.193	.2146	2.0484
6. MISNONPRDTS	.2365	.4363	.1998	1.8447	1.0300	.7935	4.3552
7. PRIMA	.4013	.9634	.5621	2.4008	1.1312	.7299	2.8188
8. FABMEPRDTS	.3519	.5231	.1712	1.4865	.6454	.2935	1.8340
9. MACHINELECT	.3750	.5803	.2053	1.5475	.7498	.3739	1.9971
10. MOVEHIC	.1893	.4491	.2598	2.3726	.9567	.7674	5.0538
11. MISDURPRDTS	.4195	.5866	.1671	1.3983	.7696	.3501	1.8346
12. ELPOGASA	.5602	.7123	.1521	1.2715	1.1495	.5893	2.0519
13. TRANSCOMM	.5809	.9333	.3524	1.6067	1.7293	1.1484	2.9769
14. WHORTRAD	.6498	.8527	.2029	1.3123	3.4856	2.8358	5.3641
15. FBRSERVICE	.5615	1.0789	.5174	1.9215	3.1307	2.5692	5.5756
16. PERSERAM	.5717	.6345	.0628	1.1099	1.1378	.5661	1.9902
17. BUSSERVICE	.3705	.4755	.1050	1.2834	.5757	.2052	1.5538
18. REPSERVICE	.4453	.5323	.0870	1.1954	.8015	.3562	1.7999
19. MDEDNONPFT	.7848	.8272	.0424	1.0540	1.7524	.9676	2.2329
20. MINOTHER	.4044	.6525	.2481	1.6135	.9666	.5622	2.3902

Table B-2. Income multipliers for the Tri-county Region (1958), estimated by the Simple Location Quotient

Producing Sector	Direct Income Only	Direct, Indirect Income	Indirect Income Only	Type I Multi-plier	Direct, Indirect, Induced Income	Indirect, Induced Income	Type II Multi-plier
1. LVSTOCKPRD	.3018	.3598	.0580	1.1922	.7205	.4187	2.3873
2. OTAGFISPRDSERV	.3698	.4702	.1004	1.2716	1.2018	1.2028	4.2526
3. WOODPRDTS	.4070	.4484	.0414	1.1018	.5121	.1051	1.2582
4. PRINTPRDTS	.5936	.6807	.0871	1.1467	.7616	.1680	1.2830
5. CHMCLPRDTS	.2047	.2372	.0325	1.1589	.2916	.0869	1.4245
6. MISNONPRDTS	.2365	.2511	.0146	1.0619	.5272	.2907	2.2292
7. PRIMA	.4013	.6342	.2329	1.5804	.6761	.2748	1.6848
8. FABMEPRDTS	.3519	.4550	.1031	1.2930	.5252	.1733	1.4925
9. MACHINELECT	.3750	.4526	.0776	1.2070	.5316	.1566	1.4176
10. MOVEHIC	.1893	.3977	.2084	2.1011	.7188	.5295	3.7971
11. MISDURPRDTS	.4195	.4918	.0723	1.1722	.5741	.1546	1.3685
12. ELPOGASA	.5602	.6652	.1050	1.1874	.9463	.3861	1.6892
13. TRANSCOMM	.5809	.6598	.0798	1.1359	1.0456	.4647	1.8000
14. WHORTRAD	.6498	.8138	.1640	1.2524	2.5531	1.9033	3.9291
15. FBRSERVICE	.5615	.8245	.2630	1.4684	1.9266	1.3651	3.4312
16. PERSERAM	.5717	.6062	.0345	1.0603	.9380	.3663	1.6407
17. BUSSERVICE	.3705	.4263	.0558	1.1506	.4815	.1110	1.2996
18. REPSERVICE	.4453	.4743	.0290	1.0651	.6227	.1774	1.3984
19. MDEDNONPFT	.7848	.8086	.0238	1.0304	1.4260	.6412	1.8170
20. MINOTHER	.4044	.4149	.0105	1.0259	.4263	.0219	1.0542

Table B-3. Income multipliers for the Tri-county Region (1958), estimated by the Purchase Only Location Quotient

Producing Sector	Direct Income Only	Direct, Indirect Income	Indirect Income Only	Type I Multi- plier	Direct, Indirect, Induced Income	Indirect, Induced Income	Type II Multi- plier
1. LVSTOCKPRD	.3018	.3838	.0820	1.2716	.7052	.4934	2.6349
2. OTAGFISPRDSERV	.3698	.5177	.1479	1.4000	1.7105	1.3407	4.6255
3. WOODPRDTS	.4070	.4471	.0401	1.0985	.5120	.1050	1.2580
4. PRINTPRDTS	.5936	.6819	.0883	1.1487	.7652	.1716	1.2891
5. CHMCLPRDTS	.2047	.2387	.0340	1.1661	.2950	.0903	1.4411
6. MISNONPRDTS	.2365	.2513	.0148	1.0625	.5341	.2976	2.2584
7. PRIMA	.4013	.6816	.2803	1.6985	.7334	.3321	1.8276
8. FABMEPRDTS	.3519	.4568	.1049	1.2982	.5298	.1779	1.5055
9. MACHINELECT	.3750	.4534	.0784	1.2092	.5346	.1596	1.4256
10. MOVEHIC	.1893	.3980	.2087	1.1024	.7269	.5376	3.8399
11. MISDURPRDTS	.4195	.4924	.0729	1.1737	.5770	.1575	1.3754
12. ELPOGASA	.5602	.6662	.1060	1.1893	.9547	.3945	1.7042
13. TRANSCOMM	.5809	.6612	.0803	1.1383	1.0573	.4764	1.8201
14. WHORTRAD	.6498	.8165	.1667	1.2566	2.5998	1.9500	3.4860
15. FBRSERVICE	.5615	.8270	.2655	1.4728	1.9574	1.3959	3,4860
16. PERSERAM	.5717	.6289	.0572	1.1001	.9831	.4114	1.7196
17. BUSSERVICE	.3705	.4276	.0571	1.1541	.4853	.1148	1.3099
18. REPSERVICE	.4453	.4742	.0289	1.0649	.6261	.1808	1.4060
19. MDEDNONPFT	.7848	.8089	.0241	1.0307	1.4414	.6566	1.8366
20. MONOTHER	.4044	.4216	.0172	1.0426	.4379	.0335	1.0828

Table B-4. Income multipliers for the Tri-county Region (1958) estimated by the Cross Industry Quotient

Producing Sector	Direct Income Only	Direct, Indirect Income	Indirect Income Only	Type I Multi-plier	Direct, Indirect, Induced Income	Indirect, Induced Income	Type II Multi-plier
1. LVSTOCKPRD	.3018	.5894	.2876	1.9530	1.8015	1.4997	5.9692
2. OTAGFISPRDSERV	.3698	.8731	.5033	2.3610	3.5761	3.2063	9.6704
3. WOODPRDTS	.4070	.6908	.2838	1.6974	.8687	.4617	2.1344
4. PRINTPRDTS	.5936	.9276	.3340	1.5626	1.1767	.5831	1.8923
5. CHMCLPRDTS	.2047	.4366	.2319	2.1330	.6658	.4611	3.2526
6. MISNONPRDTS	.2365	.4173	.1808	1.7646	1.1228	.8863	4.7476
7. PRIMA	.4013	1.1474	.7461	2.8593	1.3479	.9466	3.3588
8. FABMEPRDTS	.3519	.5928	.2409	1.6845	.7866	.4347	2.2353
9. MACHINELECT	.3750	.7008	.3258	1.8687	.9398	.5648	2.5061
10. MOVEHIC	.1893	.4191	.2298	2.2142	.9802	.7909	5.1780
11. MISDURPRDTS	.4195	.7300	.3105	1.7402	.9875	.5680	2.3540
12. ELPOGASA	.5602	.8683	.3081	1.5500	1.5141	.9539	2.7028
13. TRANSCOMM	.5809	.9433	.3624	1.6238	1.8356	1.2547	3.1599
14. WHORTRAD	.6498	1.1189	.4691	1.7218	4.3333	3.6835	6.6687
15. FBRSERVICE	.5615	1.2040	.6425	2.1442	3.5308	2.9693	6.2882
16. PERSERAM	.5717	.6635	.0918	1.1606	1.2803	.7086	2.2395
17. BUSSERVICE	.3705	.5937	.2232	1.6024	.8538	.4833	2.3045
18. REPSERVICE	.4453	.5156	.0703	1.1579	.8142	.3689	1.8284
19. MDEDNONPFT	.7848	.8143	.0295	1.0376	1.8659	1.0811	2.3775
20. MONOTHER	.4044	.5204	.1160	1.2868	.6877	.2833	1.7005

Table B-5. Income multipliers for the Tri-county Region (1958), estimated by the Modified Supply-Demand Pool

Producing Sector	Direct Income Only	Direct, Indirect Income	Indirect Income Only	Type I Multi-plier	Direct, Indirect, Induced Income	Indirect, Induced Income	Type II Multi-plier
1. LVSTOCKPRD	.3018	.4274	.1256	1.4163	1.0094	.7076	3.3446
2. OTAGFISPRDSERV	.3698	.5676	.1978	1.5349	2.0741	1.7043	5.6087
3. WOODPRDTS	.4070	.4454	.3084	1.0944	.5231	.1161	1.2853
4. PRINTPRDTS	.5936	.8629	.2693	1.4537	1.0530	.4594	1.7739
5. CHMCLPRDTS	.2047	.5869	.3822	2.8673	.8570	.6523	4.1866
6. MISNONPRDTS	.2365	.2769	.0404	1.1708	.6385	.4020	2.6998
7. PRIMA	.4013	.5447	.1434	1.3573	.5769	.1756	1.4376
8. FABMEPRDTS	.3519	.4000	.0481	1.1366	.4591	.1072	1.3046
9. MACHINELECT	.3750	.5807	.2057	1.5485	.7306	.3556	1.9483
10. MOVEHIC	.1893	.4030	.2137	2.1289	.8009	.6116	4.2309
11. MISDURPRDTS	.4195	.5926	.1731	1.4125	.7418	.3223	1.7683
12. ELPOGASA	.5602	.7578	.1976	1.3527	1.1671	.6069	2.0834
13. TRANSCOMM	.5809	.6801	.0992	1.1708	1.1691	.5882	2.0126
14. WHORTRAD	.6498	.8508	.2010	1.3094	3.0117	2.3619	4.6348
15. FBRSERVICE	.5615	1.0219	.4604	1.8199	2.5591	1.9976	4.5576
16. PERSERAM	.5717	.6348	.0631	1.1104	1.0636	.4919	1.8604
17. BUSSERVICE	.3705	.6980	.3275	1.8841	1.0229	.6524	2.7609
18. REPSERVICE	.4453	.4900	.0447	1.1004	.6869	.2416	1.5426
19. MDEDNONPFT	.7848	.8105	.0257	1.0327	1.5692	.7844	1.9995
20. NINOTHER	.4044	.4723	.0679	1.1680	.5325	.1281	1.3168

Table B-6. Income multipliers for the Tri-county Region (1958), estimated by the RAS Method

Producing Sector	Direct Income Only	Direct, Indirect Income	Indirect Income Only	Type I Multi-plier	Direct, Indirect, Induced Income	Indirect, Induced Income	Type II Multi-plier
1. LVSTOCKPRD	.3018	.7965	.4947	2.6392	2.3412	2.0394	7.7575
2. OTAGFISPRDSERV	.3698	.9896	.6198	2.6760	3.0613	2.6315	8.2782
3. WOODPRDTS	.4070	.4936	.0866	1.2128	.6346	.2276	1.5592
4. PRINTPRDTS	.5396	.9000	.3064	1.5161	1.1845	.5909	1.9955
5. CHMCLPRDTS	.2047	.2141	.0094	1.0457	.2846	.0799	1.3903
6. MISNONPRDTS	.2365	.3070	.0708	1.2994	.0873	.5708	3.4135
7. PRIMA	.4013	.6788	.2775	1.6914	.8857	.4844	2.2071
8. FABMEPRDTS	.3519	.4666	.1147	1.3260	.6497	.2978	1.8463
9. MACHINELECT	.3750	.4644	.0894	1.2384	.6283	.2533	1.6755
10. MOVEHIC	.1893	.4353	.2460	1.2995	1.0982	.9089	5.8014
11. MISDURPRDTS	.4195	.4798	.0603	1.1438	.6198	.2003	1.4775
12. ELPOGASA	.5602	.6779	.1177	1.2100	1.1259	.5657	2.0098
13. TRANSCOMM	.5809	.7809	.2000	1.3442	1.5476	.9667	2.6641
14. WHORTRAD	.6498	.7064	.0566	1.0871	3.2683	2.6185	5.0297
15. FBRSERVICE	.5615	1.0320	.4705	1.8380	3.1387	2.5772	5.5898
16. PERSERAM	.5717	.6034	.0317	1.0555	1.1072	.5355	1.9367
17. BUSSERVICE	.3705	.4010	.0305	1.0823	.4627	.0922	1.2498
18. REPSERVICE	.4453	.5184	.0731	1.1642	.8173	.3720	1.8354
19. MDEDNONPFT	.7848	.8065	.0217	1.0277	1.7411	.9363	2.2185
20. MINOTHER	.4044	.7022	.2978	1.7363	1.0276	.6232	2.5410

Table B-7. Income multipliers for the Tri-county Region (1958), estimated by the Schaffer-Chu Iterative Procedure

Producing Sector	Direct Income Only	Direct, Indirect Income	Indirect Income Only	Type I Multi-plier	Direct, Indirect, Induced Income	Indirect, Induced Income	Type II Multi-plier
1. LVSTOCKPRD	.3018	.6062	.3044	2.0087	1.8801	1.5783	6.2296
2. OTAGFISPRDSERV	.3698	.9172	.5474	2.4802	3.7724	3.4026	10.2012
3. WOODPRDTS	.4070	.6907	.2837	1.6971	.8731	.4661	2.1452
4. PRINTPRDTS	.5936	.9347	.3411	1.5747	1.1847	.5911	1.9958
5. CHMCLPRDTS	.2047	.4077	.2030	1.9919	.6286	.4239	3.0708
6. MISNONPRDTS	.2365	.6614	.4249	2.7967	1.6380	1.4015	6.9260
7. PRIMA	.4013	.9901	.5888	2.4674	1.1418	.7405	2.8453
8. FABMEPRDTS	.3519	.5970	.2451	1.6966	.8155	.4636	2.3174
9. MACHINELECT	.3750	.7012	.3262	1.8699	.9263	.5513	2.4701
10. MOVEHIC	.1893	.4190	.2297	2.2137	.9948	.8055	5.2552
11. MISDURPRDTS	.4195	.7257	.3062	1.7300	.9608	.5413	2.2903
12. ELPOGASA	.5602	.8876	.3274	1.5844	1.5658	1.0056	2.7951
13. TRANSCOMM	.5809	.9462	.3653	1.6288	1.8726	1.2917	3.2236
14. WHORTRAD	.6498	1.1233	.4735	1.7287	4.4319	3.7821	6.8204
15. FBRSERVICE	.5615	1.2291	.6676	2.1889	3.6344	3.0729	6.4727
16. PERSERAM	.5717	.6460	.0743	1.1300	1.2553	.6836	2.1953
17. BUSSERVICE	.3705	.5653	.1948	1.5259	.7428	.3723	2.0049
18. REPSERVICE	.4453	.5160	.0707	1.1588	.8293	.3786	1.8502
19. MDEDNONPFT	.7848	.8239	.0391	1.0498	1.9165	1.1317	2.4420
20. NINOTHER	.4044	.6346	.2302	1.5693	.9025	.4981	2.2317

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