REGIONAL INPUT-OUTPUT MODELS ADJUSTED BY IMPORT-EXPORT SURVEY DATA

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INTRODUCTION

Regional analysis has been accepted as a subdiscipline of economics. The signal importance and outlines of the discipline were perhaps most clearly stated in a survey by Meyer in 1965: He asserted that the most characteristic feature of regional analysis was its pragmatic origin [10]. Regional analytic models seem to have grown out of needs to understand and analyze regional problems, despite significant conceptual and data problems. Conceptually, all classical economic theory is involved. In addition, more modern dimensions of location and equilibrium of multiple economies must be confronted. Data problems are magnified by the spatial dimension, since the accounting series implied for most aggregate analysis is available only on a national basis.

Data requirements involve staggering complexities. On the product side of the economy, information regarding interregional trade flows by consumption and investment activity is important. On the income side, the data problem is compounded by commuters producing and earning in one region while consuming in another. In addition, national corporate ownerships' profits sometimes defy regional allocation.

Region identification is another problem. While concepts such as homogeneity of resources and nodality are important, pragmatic roots of regional analysis apparently indicate that a programming or policy oriented approach is most appropriate — in the sense that regions such as economic development districts and area planning and development commissions may have some operational significance in identification and solution of regional problems. Operational ability seems to lie at the heart of regional analysis, a focal point of this paper.

THE PROBLEM

A fundamental concept of decision-making in economics is that operational problems should be defined within the context of available data or those that can be obtained at reasonable costs. This does not mean that basic conceptual problems and costly data should not be generated, but certainly a research program will have a visable benefit when it is immediately responsive to recognized problems, i.e., the research effort maintains an active circular flow. Problems and data must be thought of as flowing rapidly into a research unit, results flowing out to interact with further problems causing a still further flow of problems and data. One means of achieving a circular flow of research activity is to maintain master general models whose coefficients can be viewed as storehouses of existing economic information. New information can be placed therein for updated and current economic analysis. Designing a master general model that is operational — in that it can be systematically maintained and can yield results useful to regional planners — is a general problem of regional analysis. In particular, ability of regional analysts could be improved and their costs lowered if a subregional model were constructed. This could be done by adjusting a larger, more aggregate regional model with a limited amount of survey data.

OBJECTIVES

One objective of a broad-based analysis project at the University of Georgia has been to con-

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struct regional input-output models. Some of the problems encountered and their solutions are presented here. Specifically, this paper seeks to provide a relatively low-cost method of constructing a sub-region input-output model by ammending (with questionnaire data) an existing regional model.

PRIOR WORK AND AVAILABLE RESULTS

An early and still-important master model for regional analysis was the export base model [1]. Recently, pervasiveness of input-output models indicates that despite difficulties in research planning, this more general model is now being used by many regional analysts [13].

Generally, the input-output technique has been used in the planning process to give impact or multiplier analysis (Isard and Langford [5]), or in the development of strategic information systems (Leven, Legles and Shapiro [6]). The technique has been viewed as the core of a wider accounting framework (Barnard [2]) and has been allied with an increasing awareness of planning as a cyclical and continuous process (Boyce, Day and McDonald [3] and Massey and Cordey-Hayes [9]). In such a process, input-output models can be used to elaborate implications of alternative strategies; they can help evaluate these alternatives and, consequently, can contribute to formulation and reformulation of planning objectives.

A major drawback to widespread application of input-output models at the urban and regional levels is their large data requirements. Consequently, non-survey or minimum-survey methods for constructing regional input-output tables are attractive to model builders because of the relatively small costs involved.

APPRAISAL OF NONSURVEY TECHNIQUES

To date, numerous attempts have been made to produce a matrix of interregional trade coefficients from one of national technical coefficients. Several recent studies have attempted accuracy evaluations of regional non-survey tables to search for a method of reducing the cost of constructing regional input-output tables.

Czamanski and Malizia have presented a paper about applicability and limitations in use of national input-output tables for regional studies [4]. Based on a case study of the Washington State model, it appears that although national input-output tables cannot be used for purposes of regional studies without considerable adjustments, acceptable results can still be achieved. To obtain acceptable results, the following should be considered: (1) exclude tertiary sectors through aggregation, and (2) use field surveys to obtain input-output coefficients for (a) primary industries and (b) industries in which the regional economy is specialized.

Location quotient methods, of which there are several, are the principal non-survey methods of constructing input-output tables. A description of various methods is contained in Morrison and Smith [8], who attempted to construct input-output tables for a given sub-region by several different methods. Their conclusions suggested that the location quotient approach was the most successful in both their current study and in earlier work by Schaffer and Chu [14]. A critical economic assumption of all methods is similarity of linear production functions among regions. A second critical point is that regional imports and exports are always estimated by residual methods. Thus, general conclusions from the literature are that imports and exports should be obtained from surveys when possible and, likewise, surveys are needed for input-output coefficients of primary and specialized industries [15].

Although primary surveys appear appealing, they involve significant pitfalls. Sometimes simple defintion of industry sectors can be a major task — sector accounting terms are unknown to industries and, thus, even if they cooperate they seem unable to furnish reliable information on source of purchases by regional sector. Only when the sector source of major purchases is obvious, as when agriculture purchases from agribusiness or agribusiness purchases from agriculture, does questionnaire data reveal significant results [11].

However, it has been found respondents to questionnaires can give reliable information on location of purchases and sales. Therefore, a method was designed to adjust a non-survey location quotients model with regional import-export data from surveys. As will be seen, this adjustment method also partially compensates for the assumption of homogeneity of technical coefficients among areas.

GENERAL DESCRIPTION OF LOCATION QUOTIENT APPROACH

An algorithm developed by Mustafa and

Jones was used, and an adjustment process was added to their program. The principal points of the procedure are defined as follows [12]. (Notation, however, is that of the authors.)

The location quotient approach is a procedure for comparing the relative importance of a given sector's output in a region to total output at a national level. If the region is a sub-state area, then relative importance of output could be compared to the state. The location quotient is defined as:

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

where x_i = national output of industry i for the base year

X_i = national output industry i for the base year

x = total regional output for the base year

X = total national output for the base year

i = 1, . . ., I j = 1, . . ., J and I = J

Specifically, LQ_i compares the percentage share of a particular sector output of a region with the percentage share of that sector output of the nation or state. If the location quotient is greater than 1, the region's industry is assumed to export the surplus production. This condition defines Case 1.

Case 1 IF $LQ_i \geq 1$

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

As an exporting region with LQ greater than 1, the region is assumed to be similar to major industries that comprise the national industry. Therefore, the regional technical coefficient a_{ij} is assumed to be similar to the national coefficient, A_{ij}. If LQ is less than 1, the region is assumed to import the deficient production, meaning that interindustry flows generating a_{ij} will be smaller than similar interindustry flows at the national level. This condition defines Case 2, where a_{ij} is made proportionately smaller than A_{ij}.

Case 2 IF $LQ < 1$

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

Given the value of a_{ij} the region flow table is calculated as follows:

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

$$y_i = Y_i \frac{x_i}{X_i}$$

$$v_i = V_i \frac{x_i}{X_i}$$

A_{ij} = national technical coefficient (base year)

a_{ij} = regional technical coefficient to be estimated (current year)

x_{ij} = regional flows from the ith to the jth industry to estimated (current year)

y_i = regional final demand of sector i in the regional model (current year)

Y_i = final demand of sector i in the nation or state model (current year)

v_i = value added of sector i to be estimated in the regional model (current year)

V_i = value added sector i in the national or state model (base year)

This procedure leaves exports and imports to be computed as residuals.

Imports: $m_{ij} = A_{ij} \ x_i - x_{ij}$

Exports: $e_i = x_i - \sum_{j=i}^{J} x_{ij} - y_i$

J = number of regional sectors which must be the same as number of national sectors.

Value of e_i may be nagative in this procedure. Therefore, a balancing correction is necessary because the negative export (e_i) means import, and the import is supposed to be taken care of by import row; then when negative e_i occurs,

$x_{ij}^{N} = x_{ij} \dfrac{x_i}{x_i - e_i}$, where superscript N means the adjusted flow.

Similarly:

$y_i^{N} = y_i \dfrac{x_i}{x_i - e_i}$ Note: e_i has a negative value.

and $m_{ij}^{N} = A_{ij}\, x_i - x_{ij}^{N}$

$$e_i^{N} = x_i - \sum_{j=1}^{J} x_{ij}^{N} - y_i^{N}$$

In a recent study, an existing state input-output model was substituted for national data and an input-output table for the Coosa Valley (a 10 county area in Georgia) was estimated. Output estimates for the sub-area were made by Liu [7]. Thus, with only output estimates available, an input-output table could be estimated by techniques cited above. As indicated by previous work, however, it was assumed that additional descriptive data were necessary. A survey was completed in 1973 that described economic conditions in 1972.

The theory of adjustment by new survey data related to this model is based on the principle that, in any system of linearly independent equations, i.e. an accounting system, there may be one residual value determined for every equation. Since exports and imports cannot be residuals if their exogeneous survey estimates exist, then some other economic variable may be chosen. Final demand other than exports was chosen as the residual in equations defining regional sales. It seemed to be the variable least likely to be estimated directly from survey data. Primary survey data for food demand alone can be a formidable task. At this point, it seems improbable that research money will be available to define final demand in a multi-sector input-output model for a small area. If, however, the residual final demand were negative after adjustment by questionnaire interindustry sales flows in that sector were reduced. This occurred in only six of the 28 sectors of the model and required an upward balancing adjustment in imports to maintain equalities among total purchases and total sales. The procedure for questionnaire adjustment, and a balancing correction for negative residual final demand, is defined below.

QUESTIONNAIRE ADJUSTMENT

When survey data are available for imports and exports, the are incorporated into the regional economic flows according to the following equations, where superscript Q indicates an adjusted flow.

OMP_j = The weighted average percent of regional imports of purchased inputs, as derived from questionnaire data.

M_j = Aggregate estimates of regional imports by jth industry, or

$$\sum_{i=1}^{I} m_{ij}$$

$$M_j^Q = (M_j - \sum_{i=1}^{I} x_{ij}) \ OMP_j$$

ADD_j = Total regional purchased inputs by jth industry from J industries

$$ADD_j = M_j + \sum_{i=1}^{I} x_{ij} - M_j^Q$$

x_{ij}^Q = Regional interindustry flows adjusted for import data.

$$x_{ij}^Q = \frac{x_{ij}}{\sum_{i=1}^{I} x_{ij}} \ ADD_j$$

OEP_i = The weighted average percent of regional exports i as derived from questionnaire. data.

e_i = Aggregate estimate of regional exports by ith industry.

$$e_i^Q = x_i \ OEP_i$$

y_i^Q = Regional final demand

$$y_i^Q = x_i - \sum_{j=1}^{s} x_{ij}^Q - e_i^Q$$

y_i^Q may be negative in this case.This has happened calling for relatively small balancing corrections (less than one percent of total output). Negative final demand (y_i^Q) implies less interindustrial sales and more import purchase. If y_i^Q is negative, interindustry sales are adjusted downward on the assumption that total output and exports are already best estimates of sales flows.

This assumption seems warranted on the grounds that: (1) regional exports will be the most recent sample estimate of this data; (2) The use of a location quotient method begins with the assumption that good estimates of regional sector output, x_i, are available to compare with national sector output, X_i. Estimates of x_i offer a challenge, but various aggregate time series data on employment, wages, sales and use taxes, electrical energy use and income taxes are frequently available for econometric models that estimate x_i.

x_{ij}^{QQ} = Interindustry sales adjusted for balancing negative final demand and superscript QQ indicates the final balanced results.

$$x_{ij}^{QQ} = \left(x_{ij}^{Q}\right) \frac{\sum_{j=1}^{J} x_{ij}^{Q} + y_i^{Q}}{\sum_{j=1}^{J} x_{ij}^{Q}}$$

$$y_i^{QQ} = x_i - \sum_{j=1}^{J} x_{ij}^{QQ} - e_i^{Q}$$

Finally $$M_j^{QQ} = x_j - \sum_{i=1}^{I} x_{ij}^{QQ} - v_j$$

APPLICATION AND RESULTS

The importance of import and export data was apparent for the Coosa Valley area of Georgia. In many instances imports and exports were 100 percent of purchases and sales, Table 1. Obviously, in these cases, interindustry regional flows are zero, as are resulting technical coefficients. This exemplifies, then, the direct effect of adjustments for imports and exports on estimates of regional technology. According to the adjustment technique, technical coefficients retain the same relationship to each other but become smaller than national, or base coefficients, as imports become relatively large.

Table 1. IMPORTS AS A PERCENTAGE OF TOTAL INTERINDUSTRY PURCHASE AND EXPORTS AS A PERCENT OF TOTAL SALES FROM QUESTIONNAIRE DATA IN SELECTED INDUSTRIES OF THE COOSA VALLEY, 1972

Industry	Weighted Import Percent for the Industry	Weighted Export Percent for the Industry
Contract Construction	100	0
Food and Kindred Products	88.22	41.58
Textile Mill Products	93.95	94.99
Apparel and Related Products	N/A	100
Lumber and Wood Products	100	100
Furniture and Fixtures	100	92
Chemicals and Allied Products	80	65
Rubber and Misc. Plastics	100	100
Stone, Clay and Glass Products	100	100
Primary Metal Industries	100	98
Machinery, Except Electrical	100	95

N/A-Not Available.

In the Coosa Valley area, adjustments for import-export surveys resulted in some rather significant differences, noted in Table 2. As might be expected, the major difference occurred in the area's major industry. Imports of textile mill products were 261 million dollars as estimated by questionnaire adjustment and only 58.4 million in the unadjusted model. Export was likewise greater, 1,008 million compared to 879 million unadjusted. Industries where exports were estimated to be 100 percent, Table 1, in the questionnaire data resulted in residual final demand of zero, Table 2. Even in the unadjusted model, however, final demand estimates were relatively small for those same industries. In the opinion of Coosa Valley personnel who reviewed the results, there was little doubt that the questionnaire adjusted model was the better representation of the regional economy.

CONCLUSIONS

Construction of regional input-output tables by non-survey methods has been proceeding for some time. The basic assumption is that national input-output coefficients apply at a regional level. This paper presented a technique by which a currently-used and available non-survey method can be adjusted and presumably improved by questionnaire data.

A comparison of adjusted with unadjusted output reveals relatively large differences in import and export flows. This is to be expected, and adjustment is always recommended when possible. The adjustment technique used here is consistent with a currently available algorithm. It's adjustment can be used by other researchers as a sub-routine that can be inserted as needed into the Mustafa-Jones algorithm. In fact, equations defining the adjustment may be applied to any existing I-0 model for which new survey data on imports are available.

Table 2. IMPORTS, EXPORTS AND RESIDUAL FINAL DEMAND ESTIMATED BY A NON-SURVEY METHOD OF LOCATION QUOTIENTS AND THE SAME ESTIMATES ADJUSTED BY QUESTIONNAIRE DATA, COOSA VALLEY OF GEORGIA, 1972

Industry	Import		Export		Residual Final Demand	
	Location Quotients	Questionnaire Adjusted Location Quotients	Location Quotients	Questionnaire Adjusted Location Quotients	Location Quotients	Questionnaire Adjusted Location Quotients
			(Millions of Dollars)			
Agriculture	7.448	7.534	23.870	23.870	11.592	22.605
Mining	1.579	2.024	11.232	11.232	0.297	0.054
Contract	13.508	28.468	0.0	0.0	75.751	77.214
Food & Kindred Products	14.553	32.553	23.536	34.622	51.604	43.897
Textile Mill Products	58.444	261.040	879.449	1,008.112	2.608	17.550
Apparel & Related Products	4.484	8.343	98.499	111.399	7.184	0
Lumber & Wood	1.653	2.797	6.129	9.232	0.249	0
Furniture & Fixtures	2.355	5.731	13.916	18.040	4.884	1.348
Paper & Allied Products	7.897	9.180	48.966	48.966	0.408	11.173
Printing & Publishing	0.691	0.714	2.969	2.969	3.301	3.357
Chemicals & Allied Products	5.230	13.656	24.543	35.821	4.923	12.396
Rubber & Misc. Plastics	3.829	12.592	43.423	53.905	1.127	0
Leather & Leather Products	0.069	0.109	0.0	0.0	0.930	0.951
Stone, Clay & Glass Products	1.720	5.528	10.429	16.067	0.186	0
Primary Metal Industries	1.420	3.160	13.510	16.087	0.170	0
Fabricated Metal Products	2.708	3.929	17.167	17.167	1.476	6.687
Machinery, except Electrical	2.220	5.196	13.551	21.332	5.209	0
Electrical Machinery & Equip.	6.627	8.313	55.448	55.448	1.853	2.724
Transportation Equipment	0.105	0.133	0.0	0.0	1.445	1.446
Misc. Manufacturing	0.247	0.321	0.619	0.619	1.203	1.343
Transportation Services	2.631	2.661	6.483	6.483	10.156	12.056
Communication & Utilities	5.365	5.381	6.221	6.221	28.954	36.690
Wholesale & Retail Trade	13.731	14.257	0.0	0.0	129.603	152.916
Finance, Insur., Real Estate	20.769	20.902	0.0	0.0	96.536	99.824
Services	16.982	17.252	0.0	0.0	92.035	96.869
Federal Govn't. Enterprises	1.379	1.395	9.699	9.699	1.884	3.038
State & Local Govn't. Enterp.	3.218	3.222	7.442	7.442	1.646	1.960
Unallocated Industries	6.072	6.213	7.574	7.574	1.163	6.731

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