ESTIMATING REGIONAL INPUT-OUTPUT COEFFICIENTS

William A. Schaffer*

Georgia Institute of Technology

Interest in constructing regional input-output models through inexpensive means has inspired frequent investigation of procedures based on national coefficients. A common criticism of models produced with "nonsurvey" techniques, which rely entirely on published data, is that they do not specifically account for imports and exports, resembling more their national counterpart than true regional models. With this criticism in mind, Teddy T. Su recently proposed an interesting alternative combining national coefficients and a survey of import proportions [14]. But little has been done to empirically substantiate either the arguments of the critics or the methods themselves.¹

In addition to proposing a second "semisurvey" method for constructing regional models, this paper attempts to at least partially fill the empirical void associated with both nonsurvey and semisurvey estimating techniques. Specifically, I propose to demonstrate that: 1) nonsurvey techniques for constructing regional input-output models do explicitly account for imports and exports; 2) while overestimating local interindustry relations, nonsurvey techniques still produce estimates of regional production coefficients which are closer to survey results than they are to national coefficients; 3) the more reasonable approach to combining minimum survey with national coefficients may be to survey exports rather than imports.

In accomplishing these tasks I will (1) review the more common nonsurvey techniques, (2) compare estimated regional input-output tables with a survey-based table for the state of Washington and with the 1958 table for the United States, (3) outline two semisurvey techniques, and (4) test these techniques using Washington data.

NONSURVEY TECHNIQUES²

As a basis for discussion, I outline four of the more common techniques for constructing regional input-output tables without direct survey. The model we examine is static, open, and descriptive. Comparing the region with the rest of the world, the model is based on a regional transactions table of the form sketched in Table 1. Given a correspondingly aggregated national transactions table and given estimates of regional outputs (x_i) and regional final demands (y_f), the task is to estimate regional gross flows (x_{ij}), exports (e_i), imports (m_{ij}), and value added (v_j). Or given an input-output system

$$\sum_{j=1}^s A_{ij} X_j + \sum_{f=1}^t Y_{if} + E_i = X_i \quad (i = 1, 2, 3, \dots, s),$$

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and given regional outputs and demand, we derive the regional input-output system

$$\sum_{j=1}^s a_{ij}x_j + \sum_{f=1}^t y_{if} + e_i = x_i \quad (i = 1, 2, 3, \dots s).$$

TABLE 1. SIMPLIFIED REGIONAL TRANSACTIONS TABLE

Outputs Inputs		Selling industries					Local final demand		Ex-ports	Total Sales	
		1	2	3	...	s	1	...	t		
Purchasing industries	1	x_{11}	x_{12}	x_{13}	...	x_{1s}	y_{11}	...	y_{1t}	e_1	x_1
	2	x_{21}	x_{22}	x_{23}	...	x_{2s}	y_{21}	...	y_{2t}	e_2	x_2
	3	x_{31}	x_{32}	x_{33}	...	x_{3s}	y_{31}	...	y_{3t}	e_3	x_3
	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
	s	x_{s1}	...			x_{ss}	y_{s1}	...	y_{st}	e_s	x_s
Value added		v_1	v_2	v_3	...	v_s	u_1	...	u_t		
Imports		m_1	m_2	m_3	...	m_s	n_1	...	n_t		
Total inputs		x_1	x_2	x_3	...	x_s	y_1	...	y_t		

We use lower-case letters to represent variables in the regional model and upper-case letters to refer to variables in a correspondingly aggregated national model. Thus, A_{ij} and a_{ij} are the $s \times s$ production coefficients ($A_{ij} = X_{ij}/X_j$, $a_{ij} = x_{ij}/x_j$) in the national system and the regional system respectively, X_i and x_i are the outputs of industry i , Y_{if} and y_{if} are the final demands from industry i of consuming sector f , and E_i and e_i are exports.

Location-Quotient Procedure

A location quotient compares the relative importance of an industry in a region to its relative importance in the nation or some other base economy. In its simplest form the quotient is defined for industry i as

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

where x_i and X_i are defined as before and x represents total regional output and X the total national output.

A location quotient equal to one for industry i means the region is self-sufficient in this industry. A location quotient less than one suggests that the region imports some of its needs of output i , and a quotient greater than one indicates that the region exports some of output i .

This interpretation is easily applied to determining regional input-output coefficients. If $LQ_i > 1$, set $a_{ij} = A_{ij}$. With local final demand either given or estimated (in all of our procedures it is estimated as $y_{if} = Y_{if} \cdot x/X$), the exports of industry i may be computed as a residual.

If $LQ_{ij} > 1$, imports are necessary, and regional production coefficients for row i are computed as $a_{ij} = LQ_{ij} \cdot A_{ij}$. Imports of product i are then computed as the amount necessary to satisfy production requirements.

Cross-Industry Quotient Procedure

A related approach uses what may be called the cross-industry quotient." This quotient compares the region's proportion of the national output of selling industry i to that for purchasing industry j :

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

If $CIQ_{ij} > 1$, $a_{ij} = A_{ij}$ 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 . Regional gross flows ($a_{ij} \cdot x_j$) in this case are the local purchasing industry's share of national gross flows ($X_{ij} \cdot x_j/X_j$).

If $CIQ_{ij} < 1$, $a_{ij} = CIQ_{ij} \cdot A_{ij}$. Here regional gross flows become the local selling industry's share of national gross flows ($X_{ij} \cdot x_i/X_i$).

As in the location-quotient technique, imports and exports are computed as remainders. If exports are negative, then balancing corrections may be necessary to construct a balanced transactions table.

Supply-Demand Pool Technique

The supply-demand pool technique derives from the concept of regional commodity balances [7]. It is also the basis for one of the more well-known nonsurvey models, the Utah model of Moore and Petersen [9].

Let r_i be the row sum for each industry i of total input requirements (r_{ij} and c_{if}), computed from national production and consumption coefficients for each cell.

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

$$c_{if} = y_f \cdot \frac{Y_{if}}{Y_f}$$

Then the commodity balance (b_i) for each industry can be computed as

$$b_i = x_i - r_i$$

When b_i is positive, $a_{ij} = A_{ij}$, $x_{ij} = r_{ij}$, $y_{if} = c_{if}$, and $e_i = b_i$, where e_i is exports for industry i . A positive commodity balance represents an exportable surplus.

When the commodity balance is negative, regional production coefficients are computed as proportions of the national coefficients.

$$a_{ij} = A_{ij} \cdot \frac{x_i}{r_i}$$

The remainder of total production requirements in each cell is imported.

This pool procedure allocates local production, where adequate, to meet local needs; where the local output is inadequate, it allocates to each purchasing industry j a share of regional output i based on the needs of the purchasing industry itself relative to total needs for output i ($x_{ij} = x_i \cdot r_{ij}/r_i$).

An Iterative Procedure

This last procedure not only assumes that the national production technology applies but also attempts to distribute local production according to both the national sales pattern and local needs.

Basically, we compute the required inputs r_{ij} for producing estimated regional output x_i for each industry and estimate local final demand as a proportion of national demand. If the commodity balance b_i is positive, we follow the supply-demand pool procedure, setting $a_{ij} = A_{ij}$, $x_{ij} = r_{ij}$, and $e_i = b_i$. But if b_i is negative, we allocate local sales for each industry, basing this initial step on the national sales-distribution pattern:

$$d_{ij} = x_i \cdot \frac{X_{ij}}{X_i} \quad dy_{if} = x_i \cdot \frac{Y_{if}}{X_i}$$

We then compare requirements and allocations to determine surplus allocations to cells (z_{ij}) and construct for each industry a surplus pool available for reallocation (P_i). If P_i is positive, we proceed to reallocate. If z_{ij} is positive or zero, regional gross flows are

$$\begin{aligned} x_{ij} &= r_{ij} \\ y_{if} &= c_{if} \end{aligned}$$

If z_{ij} is negative, regional gross flows are

$$x_{ij} = d_{ij} + P_i \cdot X_{ij} / X_i$$

This step is repeated until the pool P_i diminishes to 0, spreading surplus local output among industries on the assumption that the local sales pattern tends toward the national sales pattern.

Imports are computed as described in earlier procedures.

Summary

The problem in estimating regional input-output coefficients is to separate the national coefficients (A_{ij}) into two components: regional coefficients (a_{ij}) and import coefficients (m_{ij}). Contrary to commonly held opinion,³ each of the methods listed above makes a clear effort to solve this problem by estimating imports. The location quotient determines the adequacy of local production by national standards and establishes import needs in constant proportions for the appropriate rows. The cross-industry quotient is an alternative which permits variation in these import proportions within rows. The supply-demand pool technique, like the location-quotient procedure, establishes import needs in constant proportions for industries with a deficit balance of trade. The fourth procedure modifies the supply-demand pool technique to follow the national sales pattern in distributing local output before reallocating it to best satisfy local needs.

SOME EMPIRICAL TESTS

To test the usefulness of this approach, I have simulated a 33-industry model of the state of Washington using each of the above procedures. The results of these simulations can be compared with two other models: the survey-based 1963 Washington study and a similarly aggregated national model.⁴

In matrix notation, we estimate a regional model

$$x = (I - A + m)^{-1} y$$

and compare it with a survey-based model

$$x = (I - a)^{-1} y$$

and a national model

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

We look at imports and exports, at regional coefficients, and at output and income multipliers. The test statistics are reported in Table 2, around which the following discussion revolves.

Imports and Exports

Estimated imports are significant in magnitude. The iterative procedure has Washington importing 130 percent of actual survey-reported imports, while the supply-demand pool procedure leads to imports totaling 83 percent of actual imports. With a highly significant correlation between survey-based and simulated imports, each procedure yields figures reasonably associated with the actual imports. But the procedures vary in their abilities to estimate values for individual industries. Regression coefficients greater than one indicate that the location-quotient and supply-demand pool procedures overestimate imports below their industry means and underestimate imports for industries above these means.

Exports tell a slightly different story. Underlying the nonsurvey techniques is an assumption of maximum local trade. This assumption is quite evident here, with no procedure estimating total exports greater than 75 percent of the survey value. While estimated and survey columns are still highly correlated, the regression analysis indicates that the procedures severely underestimate almost all exports.

An examination of estimated exports columns (not reproduced here) reveals another critical flaw of tables based on national coefficients. Only the cross-industry quotient procedure provides an estimate of exports for each industry; the other procedures estimate exports for an industry only when the industry is large enough to supply all local needs for its products. Obviously this approach is unreasonable and shows the severity of an implicit assumption of no cross-hauling. It is just what one would expect from a purely mechanistic approach.

Regional Coefficients

Estimates yield regional input-output coefficients which on the average are substantially different from national coefficients. The ratio of total local purchases to total sales (the "weighted average total" input-output coefficient, Table 2) for the nation is 37 to 86 percent greater than the estimated ratios, while the survey is only 11 to 35 percent smaller. It seems clear that, for the matrix as a whole, the estimated coefficients must be quite different from national coefficients.

When individual columns in the interindustry matrices are compared, the results are not so clear. While statistical tests of the similarity of two columns of numbers are difficult, two rough measures have been computed:

TABLE 2. COMPARISON OF REGIONAL INPUT-OUTPUT TABLES
ESTIMATED THROUGH NONSURVEY TECHNIQUES WITH THE
NATIONAL TABLE FOR 1958 AND WITH THE SURVEY-BASED
TABLES FOR WASHINGTON, 1963

Variable	U. S. Washington		Nonsurvey technique			
	study	survey	LQ	CIQ	Pool	Iteration
Imports						
Total industry	-	2424	2024	2278	2012	3145
Percent of survey value	-	-	83	94	83	130
Correlation	-	-	0.76	0.79	0.75	0.69
Regression constant	-	-	-10.97	8.82	-5.05	1.81
Regression coefficient	-	-	1.38	0.94	1.29	0.75
Exports						
Total	-	3517	1957	2630	1971	1441
Percent of survey value	-	-	56	75	56	41
Correlation	-	-	0.80	0.80	0.79	0.67
Regression constant	-	-	56.65	34.39	53.50	64.35
Regression coefficient	-	-	0.89	0.91	0.89	0.97
Input-output coefficients						
Weighted average total	.490	.235	.353	.339	.354	.264
Survey value as a percent	-	-	67	69	66	89
National value as a percent	-	-	139	145	138	186
Significant chi-square						
Compared with survey	-	-	5	0	4	7
Compared with nation	-	-	1	7	1	7
Interdependence coefficients						
Mean	2.01	1.26	1.50	1.63	1.51	1.29
Survey value as a percent	-	-	84	77	83	98
National value as a percent	-	-	134	123	133	156
Compared with survey						
Correlation	-	-	0.52	0.05	0.52	0.52
Regression constant	-	-	0.60	1.20	0.58	0.60
Regression coefficient	-	-	0.44	0.04	0.45	0.50
Compared with nation						
Correlation	-	-	0.64	0.76	0.65	0.82
Regression constant	-	-	0.58	0.49	0.52	0.30
Regression coefficient	-	-	0.95	0.94	0.98	1.02
Simple income multipliers						
Mean	2.22	1.31	1.60	1.73	1.61	1.38
Survey value as a percent	-	-	82	76	81	95
National value as a percent	-	-	139	128	138	161
Compared with survey						
Correlation	-	-	0.80	0.46	0.81	0.77
Regression constant	-	-	-0.05	0.12	-0.04	0.04
Regression coefficient	-	-	0.61	0.34	0.40	0.35
Compared with nation						
Correlation	-	-	0.43	0.68	0.44	0.63
Regression constant	-	-	6.29	5.88	6.27	5.76
Regression coefficient	-	-	1.02	1.62	1.05	1.50

NOTES FOR TABLE 2
(Continued)

The 1958 input-output table for the U.S. was aggregated in the same patterns used to perform the simulations. This aggregated table was then used to calculate the tables of direct requirements, direct and indirect requirements and simple income multipliers summarized in the column headed "U.S. study."

The criterion value for chi-square is taken to be 18.5. Generally, the computed values of the chi-square statistic are either below the criterion or quite high.

Simple income multipliers are computed as the ratio of direct and indirect income change to direct income change in accordance with procedures described in [9] and [6].

Unless otherwise noted, correlation coefficients compare survey with simulated values and regression parameters describe a linear regression of survey on simulated values.

Sources: See footnote 4.

chi-square statistics and correlation coefficients.⁵ Using the chi-square test we have no reason to reject the hypothesis that our methods can yield production coefficients which are the same as survey-based coefficients for a total of 16 industries. Interestingly, the nonsurvey coefficients also compare favorably with the national coefficients for 16 industries, though not for the same industries nor for the same techniques as in the survey comparison.

The correlation between estimated and national coefficients is significant at the .05 level for nearly every industry and for every estimating technique. Enough coefficients remain unaltered by the estimating techniques to insure correlation. Our techniques also yield coefficients surprisingly close to those of the survey. Regional production coefficients are correlated at the .05 level with survey coefficients for 26 industries in the iterative tables, for 29 in the location-quotient tables, and for 27 in the others. Given our simple aggregation with no regard for product mix and given the different populations of the national and state studies, our success seems remarkable.

Multipliers

Now let us look at some of the analytical results associated with our models. Output multipliers, or interdependence coefficients (sums of columns in the inverse matrix), are, on the average, much closer to survey results than to national results. Survey results range from 2 to 23 percent lower than simulated results while national output multipliers are 23 to 56 percent higher. Both survey and national values are highly correlated (significant at the .01 level) with simulated values. But the regression parameters show that, while substantially larger in magnitude, the national output multipliers more closely parallel simulated values. On the other hand, the survey-based multipliers are underestimated at low values and overestimated at high values by the simulations.

Simple income multipliers, computed as the ratio of direct and indirect to direct income changes, show similar relations. Survey results range from 5 to 24 percent lower than simulated values while national income multipliers are 28 to 61 percent higher. The regression analysis shows that simulated values are usually much higher than survey-based income multipliers while being substantially lower than national income multipliers.

Summary

Empirically, then, at least for the state of Washington, nonsurvey methods produce regional input-output models more closely resembling survey-based regional models than their national counterpart. Imports and exports are substantial and regional production coefficients are, on the average, much lower than national coefficients. While income and output multipliers are still high compared with survey values, they are much lower than national multipliers. These analytical results, however, are not uniform and bring into question the acceptability of the 1958 national table as a basis for mechanically simulating accurate regional models. The next section explores this question further.

SEMISURVEY METHODS

This section explores the less expensive alternatives to survey-based models. These procedures are best described as "semisurvey methods". Both rely on the technology embodied in the national input-output study, but one develops an imports matrix through a survey while the other similarly derives an export vector.

Properly done, an input-output model is constructed on the basis of a survey of industries and final consumers which documents both purchases and sales. That is, each respondent is first asked to designate purchases from local and nonlocal industries and payments such as wages and salaries, profits, depreciation allowances, taxes, etc. These purchases and final payments outline the "production technology" of each industry. The respondents are then asked to designate sales to local industries and to final users such as consumers, governments, and nonlocal industries. Theoretically, purchases and sales should balance when aggregated to form the regional input-output table. Actually, sampling and reporting error force the analyst to achieve balance by tediously assaying the reliability of responses and by juggling numbers until totals finally match.

One basic alternative to this full-survey approach is the "rows-only" method. First used by Hansen and Tiebout, this method assumes

...that firms know the destination of their outputs far better than the origin of their inputs, especially where regional breakdowns are required. In other words, in terms of input-output flows, information for the "rows" is easier to obtain than information for the "columns." The reason for this is that the bundle of inputs is usually so varied and complex that their origins are difficult even for firms involved to track down accurately. However, the same firms and especially concerned with where and to whom they sell their output [4, p. 411].

The "rows-only" approach permits the analyst to avoid a complex data reconciliation. It produces only one entry per cell in the transactions table; the full-survey method forces the analyst to check his work by producing two estimates of cell values.

A second basic alternative to the full-survey approach is what could be called the "columns-only" or "purchases-only" method. This approach assumes that business firms know their sources of supply better than they do their customers. Harmston and Lund argue that this approach takes advantage of the detailed knowledge of expenditures required by businessmen for control and tax purchases [5, p. 67]. Producing data in the same simple form as that yielded by the rows-only method, the purchases-only approach seems particularly well-suited for use in small regions characterized by a relatively large number of locally-owned firms.

A third approach was recently introduced by Teddy T. Su. In this "imports-only" method, he suggests that we ask respondents to identify the proportion of inputs they purchase from each nonlocal industry; from these replies we construct an import-requirements matrix ($\underline{m}$) and then estimate the direct-requirements matrix for the region as $\underline{a} = \underline{A} - \underline{m}$. As Dr. Su points out, this procedure has several advantages: it avoids the reconciliation problem, the questionnaire is easier to complete than that for a full survey, and it is more acceptable to the businessman in that he reveals only proportions and not absolute figures. But on the other hand, purchases appear more difficult to trace to their regional origins. It may be just as convenient to use a "columns-only" approach to estimating the $\underline{a}$ matrix, ignoring the national coefficients altogether.

If an economical survey is our goal and we can afford neither of the more powerful alternatives to a full survey, then I suggest that an "exports-only" survey may be more acceptable than the "imports-only" approach. This fourth alternative is simpler and, if Hansen and Tiebout are correct, asks questions for which more reliable answers are available. In this approach we simply canvass firms in the area, asking information on three items: their

SIC code, value of sales for the year, and the proportion of their sales going to out-of-area purchases. The first two answers permit the analyst to classify replies and to properly weight export proportions in constructing the transactions table. This approach is simply a variant of the supply-demand pool procedure discussed above, where regional production coefficients are computed as

$$a_{ij} = A_{ij} \cdot \frac{x_i - e_i}{r_i}$$

This approach satisfies export requirements first and then allocates the remainder of local production to satisfying local needs in proportion to requirements.⁶

MORE TESTS

We have simulated the 1963 Washington study using both of the above semisurvey methods and can compare these simulations with survey-based results. Table 3 reports these tests.

Imports-Only Method

The imports matrix for the Washington table is reported in sufficient detail to allow us to construct a 25-industry model. In our first attempts at implementing this method we found the simulated total flows matrix (A-m) to contain 65 negative entries, indicating that national and regional technology matrices are not identical. To obtain the most favorable results possible, these negative values were replaced by zeros.⁷ Further, we assumed that local final demand was as reported in the Washington study.⁸ With this assumption, exports were still negative in seven out of the 25 industries. Since these estimates of exports were made merely to complete the transactions table and have no bearing on estimating regional production coefficients by the imports-only method as strictly interpreted, we made no other corrections.⁹

The imports-only method produces a matrix of regional input-output coefficients with average values only slightly different from those of the nonsurvey methods. Only one column in the matrix meets our chi-square criterion. The average interdependence coefficients are comparable to those of the nonsurvey techniques and are slightly better by the correlation tests. The same can be said for the income multipliers. In general, then, we can conclude that the imports-only method yields results comparable with, but not better than, the nonsurvey methods.

Exports-Only Method

With only exports and gross purchases as data from the survey-based study, we have simulated the 25-industry Washington model using the exports-only method. Only two adjustments in the supply-demand pool technique are necessary for these simulations: 1) we substitute $(x_i - e_i)/r_i$ for the ratio x_i/r_i , and 2) we stipulate that if $(x_i - e_i)/r_i$ is greater than one, then m_{ij} is zero. This latter condition reduces local value added (which is computed as a residual), but this has no effect on the tests.

By the exports-only method, total imports is only slightly overestimated and industry imports seem reasonably correlated with survey-based imports. The average input-output coefficient is lower than that for all but one of the previously tested techniques. Seven columns in the input-output coefficients and income multipliers, on the average, are closer to survey-based values than are those for all other methods except the iterative procedure.

TABLE 3. COMPARISON OF REGIONAL INPUT-OUTPUT TABLES
ESTIMATED THROUGH SEMISURVEY TECHNIQUES WITH
THE SURVEY-BASED TABLES FOR WASHINGTON, 1963

	Washington survey	Semisurvey Technique	
		Imports only	Exports only
Imports by industries			
Total	2424	2424	2808
Percent of survey value	-	100	116
Correlation	-	1.00	0.85
Regression constant	-	0.00	19.40
Regression coefficient	-	1.00	0.69
Exports			
Total (million of dollars)	3517	- ^a	3517
Input-output coefficients			
Weighted average total	.235	.318	.294
Survey value as a percent	-	74	80
Significant chi-square ^b	-	1	7
Interdependence coefficients			
Average	1.26	1.50	1.38
Survey value as a percent	-	84	91
Correlation	-	0.71	0.64
Regression constant	-	0.29	0.14
Regression coefficient	-	0.65	0.81
Simple income multipliers			
Average	1.31	1.61	1.47
Survey value as a percent	-	81	89
Correlation	-	0.95	0.78
Regression constant	-	0.06	0.01
Regression coefficient	-	1.27	0.90

^aTotal exports by the imports-only method is \$2530 million. Since seven industries have "negative exports" by this method, the number makes little sense.

^bThe criterion value for chi-square is taken to be 13.0. Generally, the computed values of the chi-square statistics are either below the criterion or well above it.

While showing only slightly less significant correlation with survey-based values than for the imports-only method, these values also appear to be the best predictors of survey-based interdependence coefficients and multipliers.

CONCLUSIONS

Nonsurvey techniques for constructing regional input-output tables rely on conventional tools of economic analysis to estimate import and export patterns for regions. Mechanical in nature, they necessarily yield rough estimates. But these estimates are close enough to survey-based patterns to be reasonably realistic and are clearly distant from national values.

Tested using data from the 1963 Washington study, semisurvey methods appear to be comparable to nonsurvey techniques. The imports-only method clearly suffers from problems of industry technology and product mix but produces a matrix of input-output coefficients of about the same quality as the other methods. The exports-only method yields a balanced regional table and appears to be just superior to the other methods tested.

These methods have been tested under conditions of hardship. The 1958 input-output study, with detail for only 28 industries, does not permit the analyst to account for regional differences in product mix and is a strong handicap in simulating existing survey-based tables. In addition, we have not taken price changes into account in constructing the regional tables nor have we allowed any judgment to enter into the estimating procedures.

Allowing in detail for regional peculiarities, survey-based procedures remain superior to the various estimating techniques for constructing regional models. But they are time-consuming and expensive; Unless used by an organization capable of continuing analysis and action, they may not be worth the effort. Perhaps the 1963 national tables, with their added industry detail, and a judicious use of such techniques as outlined above may permit us to construct tables which are acceptable in terms of both cost and accuracy.

FOOTNOTES

¹Earlier attempts at testing these procedures are reported in [3], [11], and [12].

²This section is abstracted from [11]. This article and [12] discuss and document these and other methods and test their usefulness by simulating tables for comparison with survey-based tables for Washington, Utah, and New Mexico.

³For example, in constructing the rationale for his method of constructing regional models, Dr. Su states that other regional input-output models often ignore imports [14, p. 326]. Dr. Su qualifies this assumption in a footnote statement. "This refers to all regional input-output models which have totally or partially adopted national input coefficients for an analysis of a local economy, i.e., $\underline{A}$ is interpreted as $\underline{a}$, or part of $\underline{A}$ is taken as the corresponding part of $\underline{a}$." Such models do obviously ignore imports but by common definition are not regional input-output models; rather they are what Isard might call "input-requirements models." Regional tables of this genre which reflect regional industry composition are also discussed in [13].

Su does acknowledge the supply-demand pool approach of Moore and Petersen but quickly dismisses it as yielding "... derived regional coefficients ... not very different from the aggregated national coefficients." Far from ignoring imports, this method in fact clearly develops a_{ij} and m_{ij} matrices. Whether the division is adequate or not is an open question which should be submitted to test.

⁴The simulated models are discussed in [11] and [12]. The 1963 Washington study is reported in [1]; our comparisons are with the 33-industry model aggregated from the 59-industry tables in [2]. The simulations and aggregated national model are based on gross outputs taken from the above references and interindustry transactions from the 1958 National Input-Output Study [10].

⁵These tests and associated difficulties are discussed in [12]. Chi-square are is computed for each column as

$$\chi_j^2 = \sum_i \frac{(a_{ij} \text{ base} - a_{ij} \text{ survey})^2}{a_{ij} \text{ base}}$$

The production coefficients (a_{ij}) are expressed as percents to permit a uniform number of "observations" in each case and to allow some chance of rejecting the hypothesis.

⁶One criticism of nonsurvey techniques noted by William H. Miernyk is that national coefficients can be adjusted downward but not upward [8]. This criticism stems from, among other things, the fact that national coefficients showing the behavior of an aggregate industry may not reflect the upper limits for the regional input-output coefficients of a regional industry bearing the same title but differing substantially in industry or product composition. In partial correction of this flaw, the "exports-only" method permits the coefficients to be adjusted upward. In the test reported in the next section, coefficients in 4 rows are adjusted upward. Miernyk's criticism remains quite valid, especially in such mechanical simulations as reported here, where no attention has been paid to product mix.

⁷Two changes in the imports matrix were also made. To better match national technology, imports of alumina were shifted from the chemicals to the nonferrous-metals industry. And to account for heavy imports of oil from foreign sources, the imports matrix was altered such that the simulated purchases of the petroleum-refining industry from the mining industry in Washington were equal to actual purchases (zero).

⁸Imports to final demand are not available by importing industry in the Washington study.

⁹As an experiment, we did try the imports-only method followed by proportional reductions in interindustry transactions to allow for survey-reported exports. This procedure overestimated imports by 35 percent. Since it reduces estimated total local purchases to exactly the survey-reported figure, the average interdependence coefficient (1.32) and average income multiplier (1.38) are much closer to survey results.

Other adjusting procedures could be devised. But if sufficient resources are available to acquire information on imports and on final demand, the analyst might as well conduct a proper survey and avoid the by-now-obvious problems of working with national coefficients.

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