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REDUCING SYSTEM BIAS AND SPECIFICATION ERROR IN MICRO-IMPLAN

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Reducing System Bias and Specification Error in Micro-IMPLAN[1]

Wilbur Maki, Richard Lichty, and Scott Loveridge[2]

Micro-IMPLAN--an acronym for Impact Analysis for Planning--is probably the most widely used regional impact analysis and forecasting system in the U.S. today. It maintains this standing because of its ready availability to any person or organization. Its database currently covers the 3,124 counties in the U.S. These counties, individually or as multi-county areas, are now the focus of its current applications among several hundred active users.

Problem Focus

Micro-IMPLAN faces the long-standing criticism of input-output modeling that it is simply an accounting system. The criticism results, in part, from the use of fixed-price coefficients in the estimates of individual industry multipliers. The accounting system criticism, on the other hand, points to one of the strengths of the Micro-IMPLAN system. It is based on the detailed U.S. National Income and Product Accounts (NIPA), much like other economic modeling systems that forecast the Gross Domestic Product and its components. The highly disaggregated industry estimates provide the specificity that is essential for accurately estimating county-level economic activity. The input-output component, because of the double-entry approach, also gives an economic model the added strength of consistent estimates of interindustry transactions--purchases and sales--that critically affect the GDP values.

Often cited in a critique of economic impact predictions is the lack of standard statistical measures of variance and error, other than observing the difference between the predicted (or simulated) values and the corresponding actual values (Miller and Blair, 1984). More critical, however, to the "real world" practitioner is the adequacy and relevance of the forecasts for their intended clients and decision applications. A growing body of literature addresses this question by comparing the results of several regional modeling systems (Brucker, Hastings, and Latham III, 1987, 1990). Results reviewed include measures of local industry output and employment, as well as population and income and responses to given changes in demand for the locally-produced output (Crifield and Campbell, 1991, 1992; Grimes, Fulton and Bonardelli, 1992). They include also some comparisons of the critical model parameters, like import propensities (Rickman and Schwer, 1993).

The remarks that followed the first of the two papers on "comparing five ready-made models" are the points of departure for this assessment. Also important is the suggestion that "a truly flexible ready-made model will enable the introduction of survey-based trade coefficients in some sectors

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while continuing to balance the rest of the sectors in a truly unbiased manner" (Bruckner, Campbell, and Latham III, 1990, p. 136). System effectiveness requires not only a truly flexible model but one that invites "coefficient fix-up" with superior information, coupled with "software and/or handbooks that guide the user (professional or lay) through the intricacies of final demand determination" (Bruckner, Campbell, and Latham III, 1990, p. 137). Continuing in this spirit of constructive criticism we address the two sets of concerns that affect the credibility of the Micro-IMPLAN forecasts and local impact assessments: *system bias* and *specification error*. We combine the comparisons of model results with a careful examination of the overall framework for model construction and application.

System bias is a consistent over- or under-estimate of parameters and variables in the regional economic model and database. It arises, in part, from the underlying structural assumptions in model and database estimation. These vary from one modeling system to the next. For example, Micro-IMPLAN ignores the effects of commuting across county boundaries or the spatial variations in earnings per worker and output per worker among individual industries.

Future model updates will change model structure, not only by incorporating a new social accounting matrix (SAM), but, also, by replacing existing, with improved, model features. For example, the identification of the total income payments and receipts by origin and destination, whether in the the given area or outside, provides a direct answer to the journey-to-work problem presented by the commuting worker. This feature also addresses the question of capital resource ownership at the work site. Moreover, use of three income classes of personal consumption expenditures helps account for regional differences in (1) the direct and indirect effects and (2) the induced effects of a given change in household expenditures. Differences in the distribution of total households among the three income classes, each with a unique distribution of expenditures, account for differences in direct purchases and their indirect effects on suppliers. They also account for differences in the induced effects from differences in purchasing patterns and labor force participation rates among the three income classes.

Figure 1.1 shows the current Micro-IMPLAN model structure and the key documents Micro-IMPLAN generates initially for any county or multi-county area. The documents include the regional use matrix of commodity rows and industry columns, the final payments by the producing sector to resource owners, and competitive and non-competitive imports of intermediate inputs. They also include the regional make matrix of industry production (rows) of one or more commodities (columns) and the purchases of local commodity production and competitive and non-competitive imports by the final demand sectors.

Specification error is the result of an incomplete or otherwise inadequate representation of the causal system accounting for the values of parameters and variables in the regional impact model and database. A key culprit is lack of accurate information about the geographically-differentiated determinants of industry production and the productivity of its primary inputs and the occurrence of spatial correlation among economic activities (Goetz and Debertin, 1993). Another important source of specification error is the final demand sector. Lack of a separate module that covers commodity-specific final sales in purchaser prices to their unique mix of outputs in producer prices ignores the existence of regional variation in the individual marketing margin components.

Figure 1.2 shows a regionalization scheme based on the use of the labor market areas (LMAs) presented in a research report published by the U.S. Department of Agriculture (Tolbert and

Killian, 1987). We propose using the LMAs for a more accurate spatial differentiation of commodity production, final sales, marketing margins, exports, and imports to reduce system bias and specification error. These efforts focus on the further regionalization of technology, trade, and final sales structures. They include the calculation of interindustry transactions with place-specific production functions and regional purchase coefficients (RPCs). They also include the use of commodity margins that convert final sales in purchaser prices to commodity output in producer prices.

Modeling System Formulation

Modeling system formulation refers to both the design and the implementation of the regional modeling system. This involves input-output structures at the national as well as regional level, and the model mechanics. We present a step-by-step approach, highly condensed however, to the building of the modeling system. We also present a series of tabular summaries of the results of using this system for estimating the economic impact of a given change in demand on local economic activity in two rural counties and two metropolitan area counties. We relate these results to the broader issue of linkage between regional structures and regional performance and the understanding of their role and importance in regional input-output analysis and forecasting.

Input-Output Structure

The production levels and relationships from the detailed 485-sector 1977 and 1982 U.S. Input-Output tables provide estimates of the current Micro-IMPLAN model structure. The U.S. National Income and Product Accounts (NIPA) and the U.S. Department of Commerce Regional Economic Information System (REIS) provide the U.S. control totals for the Micro-IMPLAN updates. The U.S. economy serves as a frame of reference for comparing individual state and county estimates of economic activity.

Model formulation starts with the adjustment of technical coefficients to new control totals--the latest being 1991--for industry output, value added, and final sales. This requires the use of the long-enduring biproportional procedure for adjusting, for example, the latest, that is, 1982, U.S. Input-Output Table and the Benchmark Accounts to the 1991 control totals from the National Income and Product Accounts (NIPA). Finally, the biproportional adjustments apply to the county-level measures of industry value added and local final demands. Use of state-level control totals introduces systematic differences between these county estimates and the corresponding values reported in the Regional Economic Information System county-level employment, earnings and income series.

Model Mechanics

The first step in model reformation is to calculate *total regional commodity demand*. We multiply the regional absorption matrix by the regional industry output to obtain the intermediate input purchases of each industry. We add our estimate of gross final commodity demand to the estimate of intermediate demand to obtain total commodity demand.

The U.S. estimates of industry purchases include both domestic production and foreign imports. Thus, the input profile for each industry includes all commodity inputs of that industry. In addition, each industry may produce more than one commodity. The estimates of gross domestic exports relate to both the commodity production and the regional demand for this production.

The next step relates to the calculation of *total regional commodity supply*. Again, the estimate of total regional industry output enters into the calculation, but in multiplication with the industry byproduct ratios from the U.S. byproducts matrix. The result is the regional make matrix that shows the commodity production (columns) by each industry (rows). These estimates, together with the estimates of institutional commodity output (commodity sales by government and from inventory depletion), yield the total commodity output for the regional economy.

Finally, to estimate trade flows, the *regional purchase coefficient (RPC)* is the key parameter.[3] The RPC value times the corresponding value in the regional gross use matrix yields the regional industry use of the locally-supplied commodity (Figure 2.1). Similarly, the *import propensity* for a given commodity times the corresponding value in the regional gross use matrix yields the regional *industry domestic imports* of each commodity. This procedure applies also in estimating regional institutional use and regional institutional imports, that is, the commodity purchases by the local final demand sectors.

The calculation of *domestic commodity exports* results from subtraction of regional commodity demand from regional gross commodity supply. The individual commodity imbalances in the U.S. estimates of foreign exports and foreign imports carry through to the individual county or multi-county Micro-IMPLAN models. Domestic exports and domestic imports theoretically balance for the domestic economy as a whole, but not for individual counties or multi-county areas. However, the criteria for allocating the two sets of exports and imports differ greatly. Micro-IMPLAN allocates U.S. *foreign commodity exports* to the regions according to its share of the U.S. commodity production. It also allocates U.S. *foreign commodity imports* to the regions by the same rule. Estimates of a region's total imports and total exports thus derive from a variety of data sources and allocation criteria.

While local commodity production provides the basis for allocating foreign exports and foreign imports, uniquely-generated local regional purchase coefficients (RPCs) provide the basis for estimating domestic exports and domestic imports for each county or multi-county area. These estimates of gross domestic imports relate to both the commercial production and the demand for

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[3]The estimated RPC for s commodity is derived empirically from a regression using county-level variables and regression coefficients based on the 1977 Multi-Region Input-Output Accounts (MRIOA). The regression equation for each commodity, based on commodity shipments for the 50 states and the District of Columbia from the 1977 U.S. Census of Transportation by the U.S. Department of Commerce, is of the form:

$$RPC = a + b*\text{wage ratio} + c*\text{employment} + d*\text{location quotient} + e*\text{area ratio} \quad (2.1)$$

where the wage ratio is total employee compensation divided by total employment of the industry, employment is total industry employment, location quotient is the proportion of total regional employment in the specified industry divided by the corresponding ratio for the U.S., and area ratio is the proportion of the total U.S. area accounted for by the region. Lack of one or more variables to account for the effects of regional variations in spatial-economic structures remains a serious deficiency of current model. Moreover, most of the regression coefficients--MRIOA sectors 1 to 84--apply only to the shippable commodities--agriculture to manufacturing. A single constant value of each state represents the remaining 52 MRIOA sectors. For some states, for example, California, the constant value is 1 for each of the 52 MRIOA sectors. For most states, however, this value is less than 1 for most commodities. Finally, each RPC value has an upper bound that is given by the regional net commodity supply/gross demand pool ratio (S/DP) ratio.

this production in a given region. Model reformulation calls for similar criteria in allocating U.S. foreign imports to individual industries and regions.

The industry output and outlay accounts and the commodity supply and demand accounts now balance. However, the remaining social accounts--factors, institutions, and trade--do not currently balance. Figure 2.2 presents the regional social accounts as a social accounting matrix (SAM) in Part 1 of the tabular summary. The preliminary model lacks balance in its capital and trade accounts. These accounts balance in Part 2. The principal difference between the two is the introduction of factor imports to cover the imbalance between total exports and total imports. This represents, for example, the use of regional savings to pay for the excess of imports over exports.

Refinements and Applications

Several types of refinements are available for the outcomes of the preceding steps (Alward et al, 1989). These include (1) changing regional supply, (2) modifying industry production function, (3) editing RPCs, and (4) controlling for induced effects once better information becomes available. Superior local knowledge warrants changing the ready-made data base values in each category. Superior local knowledge also warrants changing regional purchase coefficients, by institution, industry or commodity. The RPC adjustments for an industry or institution result in the given change being applied to all commodities, by industry or by institution. Overlooked, however, is the further regionalization of the final local sales accounts and the industry margins that convert industry output from producer prices to purchaser price. This process requires detailed, regionally-differentiated estimates of final product sales to households, governments and businesses. Furthermore, input-output models generally, although not necesarily, are demand driven with no supply constraints.

The lack of capacity limits for industry expansion and the assumption of full resource use or availability, including labor, result in overestimating industry production response to demand changes. Fixed price multipliers add to this problem by over-estimating the multiplier effects and under-estimating the substitution effects of exogenous changes (Koh, Schreiner, and Shin, 1994). Also the current modeling system sidesteps the issue of the effects of commuting on the induced effects of a demand change by introducing estimates of local personal consumption expenditures and employment associated with the demand change as proxies for both the resident and non-resident work force employed by local industry. These attributes of input-output models ultimately result in underestimating or overestimating factor income responses to market changes.

Reducing System Bias

A persistent *system bias* originates from the estimation of industry output for each state and county based initially on U.S. output per worker ratios, adjusted to state-level estimates of gross state product and its components. Current gross state product estimates help regionalize initial industry output estimates. However, the high level of industry disaggregation reduces system bias that would otherwise result from county-to-county differences in industry mix.

Regionalization of Technology and Database

We present some current shortcomings of Micro-IMPLAN with the end-in-view of correcting them, either by system improvements or extension of the existing system. We allude to the immensity of this task, however, by summarizing the results of a series of simple tests of model performance in estimating its RPC and Type 1 and Type 3 multiplier values.

Included among procedures for the regionalization of input-output structures and databases noted in the problem focus section of this paper is the use of labor market areas (LMAs) for a more accurate spatial differentiation of industry production functions. For this purpose, we selected four counties in Minnesota cited in Table 2.1--two in the northwest tier of counties bordering Canada and two in the Twin Cities Metropolitan Statistical Area--for these tests. These counties illustrate an increasingly common occurrence in any regional economy--the concentration of export-producing jobs in one locality and residentiary activities that cater to the resident commuter population in another locality.

Table 2.1 Total population, resident earnings, and personal income of commuters as percent of resident income, Minnesota, 1990

County	Total Population (no.)	Commute Income (pct.)	Resident Earnings (mil.$)
Minneapolis-St. Paul MSA:			
Ramsey	485,765	-32	9,566
Washington	145,896	45	1,400
Northeast Minnesota:			
Lake of the Woods	4,076	15	26
Roseau	15,026	-16	195

The businesses located in the City of St. Paul account for most of the economic activity in Ramsey County while Washington County is a residential community with a commuter population largely employed in the higher-paying jobs in St. Paul. Lake of the Woods County in the Duluth-Superior LMA has an abundance of natural amenities but few well-paying or even lesser-paying jobs. Roseau County has two successful manufacturing businesses--windows and snowmobiles--that employ a total work force spread over several counties along the U.S.-Canada border. The negative commuter income for Ramsey and Roseau counties denotes a loss of income and earned in the county to its non-resident work force of more than $3 billion for Ramsey County and roughly $30 million for Roseau County.

Regional Purchase Coefficients

The frequency distributions of Micro-IMPLAN's RPC values for the one-digit commodity groups in each of the four counties in Table 2.2 reveal, not only the much greater diversity of industry in the metropolitan area, but, also the virtually complete lack of 100-percent locally-produced commodity purchases. For most services, however, the RPC values are close to unity. Lack of a particular industry dictates a zero entry for the corresponding commodity group. Exceptions occur because of having one industry in the locality with by-products that lack the other industries producing the same by-product. Accurate estimates of RPC values can evolve, however, from refinements of current procedures that make use of locally-acquired estimates of the proportion of the most important commodities that are produced locally rather than imported.

Table 2.2 Frequency distributions of RPC values for specified commodity groups,
Ramsey, Washington, Lake of the Woods, and Roseau counties, MN, 1990 (percent)

County and RPC	Agriculture	Mining	Contract Construct	Manu-facturing	Tran., Com. Utilities	Wholesale & Retail	Fin., Ins. & Real Estate	Private Services	Total
Minneapolis-St. Paul MSA:									
Ramsey	4.9	3.8	1.6	66.1	2.5	1.6	1.3	18.1	100.0
0	2.0	3.6	0.0	12.1	0.0	0.0	0.0	1.1	18.8
0.01 to 0.49	2.7	0.2	0.0	47.1	0.7	0.0	0.2	1.3	52.2
0.50 to 0.99	0.2	0.0	0.9	6.9	1.8	1.6	1.1	15.8	28.3
1	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.7
Washington	4.9	3.8	1.6	66.1	2.5	1.6	1.3	18.1	100.0
0	1.4	3.4	0.0	1.3	0.0	0.0	0.0	1.4	7.6
0.01 to 0.49	1.6	0.4	0.0	62.7	1.1	0.9	0.5	6.0	73.2
0.50 to 0.99	1.8	0.0	0.5	2.2	1.4	0.7	0.7	10.7	18.1
1	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.1
Northwest Minnesota:									
Lake of Woods	4.9	3.8	1.6	66.1	2.5	1.6	1.3	18.1	100.0
0	2.2	3.8	0.4	42.2	0.7	0.0	0.0	10.5	59.8
0.01 to 0.49	1.3	0.0	0.2	22.3	0.7	0.9	0.7	4.7	30.8
0.50 to 0.99	1.4	0.0	0.2	1.6	1.1	0.7	0.5	2.9	8.5
1	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.9
Roseau	4.9	3.8	1.6	66.1	2.5	1.6	1.3	18.1	100.0
0	1.4	3.4	0.2	44.4	0.4	0.0	0.0	4.7	54.5
0.01 to 0.49	1.4	0.4	0.2	20.5	1.6	0.7	0.7	7.1	32.6
0.50 to 0.99	2.0	0.0	1.1	1.3	0.5	0.9	0.5	6.3	12.7
1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2

Regionalization of effects of the technology and trade results in larger demand multipliers for the metropolitan areas with a diversity of export-producing, as well as local support, industry. This is clear from the frequency distribution of the Type 1 multipliers for the one-digit industry groups in Table 2.3. The differences currently are quite small--the result, probably, of persistent underestimation of metropolitan area RPCs and overestimation of rural areas RPCs.

Table 2.3 Frequency distributions of Type 1 multiplier values for specified industry groups,
Ramsey, Washington, Lake of the Woods, and Roseau counties, MN, 1990

County and RPC	Agriculture	Mining	Contract Construct	Manu-facturing	Tran., Com. Utilities	Wholesale & Retail	Fin., Ins. & Real Estate	Private Services	Total
Minneapolis-St. Paul MSA:									
Ramsey	5.3	0.7	3.0	63.2	3.6	3.3	2.3	18.5	100.0
1 to 1.49	5.3	0.7	2.6	60.9	3.3	3.3	2.0	15.9	94.0
1.5 to 1.99	0.0	0.0	0.3	2.3	0.3	0.0	0.3	2.6	6.0
Washington	11.2	1.7	5.1	37.1	6.7	5.1	3.9	29.2	100.0
1 to 1.49	10.1	1.7	5.1	36.5	6.2	5.1	3.9	28.7	97.2
1:5 to 1.99	1.1	0.0	0.0	0.6	0.6	0.0	0.0	0.6	2.8
Northwest Minnesota:									
Lake of Woods	21.5	1.3	8.9	11.4	10.1	11.4	7.6	27.8	100.0
1 to 1.49	21.5	1.3	8.9	10.1	10.1	11.4	6.3	27.8	97.5
1.5 to 1.99	0.0	0.0	0.0	1.3	0.0	0.0	1.3	0.0	2.5
Roseau	18.6	2.9	7.8	12.7	8.8	8.8	5.9	34.3	100.0
1 to 1.49	18.6	2.9	7.8	12.7	8.8	8.8	5.9	34.3	100.0

The frequency distribution of Type 3 multiplier values for the one-digit industry groups differs sharply from Type 1 multipliers. The Type 3 multiplier values are unexpectedly large for the metropolitan commuter county, particularly for services. Most of the manufacturing industry multipliers in the core county are small--a likely possibility if core area manufacturers depend largely on intermediate input suppliers from the rural areas. Large variations may occur, however, from one area to the next. This may require additional local data to verify the "ready-made" estimates of RPCs and other parameters that affect the multiplier values (Table 2.4).

Table 2.4 Frequency distributions of Type 3 multiplier values for specified industry groups, Ramsey, Washington, Lake of the Woods, and Roseau counties, MN, 1990

County and RPC	Agriculture	Mining	Contract Construct	Manu-facturing	Tran., Com. Utilities	Wholesale & Retail	Fin., Ins. & Real Estate	Private Services	Total
Minneapolis-St. Paul MSA:									
Ramsey	3.7	0.7	3.0	64.2	3.4	2.0	4.1	18.9	100.0
1 to 1.49	0.0	0.7	0.3	18.6	1.0	0.0	0.3	0.3	21.3
1.5 to 1.99	3.7	0.0	2.4	38.9	1.0	0.7	1.4	5.4	53.4
2 to 2.49	0.0	0.0	0.3	6.8	1.4	1.0	0.7	4.7	14.9
2.5 and over	0.0	0.0	0.0	0.0	0.0	0.3	1.7	8.4	10.5
Washington	11.1	1.7	5.0	36.7	6.7	5.6	3.9	29.4	100.0
1 to 1.49	0.0	0.6	0.0	3.9	1.1	0.0	0.6	0.6	6.7
1.5 to 1.99	2.8	1.1	3.9	25.6	2.2	0.6	1.1	2.2	39.4
2 to 2.49	3.9	0.0	1.1	6.1	1.7	0.0	1.7	7.8	22.2
2.5 and over	4.4	0.0	0.0	1.1	1.7	5.0	0.6	18.9	31.7
Northwest Minnesota:									
Lake of the Woods	21.0	1.2	8.6	11.1	9.9	11.1	7.4	29.6	100.0
1 to 1.49	6.2	1.2	6.2	8.6	4.9	1.2	3.7	8.6	40.7
1.5 to 1.99	14.8	0.0	2.5	2.5	4.9	4.9	2.5	11.1	43.2
2 to 2.49	0.0	0.0	0.0	0.0	0.0	4.9	1.2	4.9	11.1
2.5 and over	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	4.9
Roseau	18.4	2.9	7.8	12.6	8.7	8.7	6.8	34.0	100.0
1 to 1.49	12.6	2.9	7.8	12.6	8.7	3.9	4.9	19.4	72.8
1.5 to 1.99	5.8	0.0	0.0	0.0	0.0	4.9	1.9	12.6	25.2
2 to 2.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9
2.5 and over	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Model reformulation may be a less viable remedy for some model deficiencies than finding another modeling system that allows for price endogenous effects on local production, consumption, and investment. The classic limitations of the input-output modeling systems apply to Micro-IMPLAN. Evaluating the effects of huge shifts in industry exports on the local housing market, for example, calls for a model with local capacity constraints and endogenous price responses to local housing demand. The problem focus thus defines the modeling system that best meets the information requirements of those confronted with the problem.

Reducing Specification Error

Specification error results in part from failure to include relevant information in the estimation of the ready-made database from the available *reference data systems*. Use of existing information sources along with the current procedures for estimating county-level "non-disclosures" is one alternative for reducing specification errors. Another is simplifying existing procedures for using local information. Still another is through workshops and classroom instruction that familiarize users with the unique local determinants of local industry production and commodity sales as well as the new data adjustment procedures and local information sources.

Reference Data System

The U.S. Department of Commerce, the U.S. Department of Labor, and the U.S Department of Agriculture maintain the *reference data systems* for Micro-IMPLAN. The U.S. Department of Commerce houses the periodic censuses of population and employment, agricultural, manufacturing, wholesale and retail trade, and selected business services, as well as the annual statistical series on personal income and industry employment and earnings of the employed industry work force. State-and-county-level data sources most critical for early fix-up and updating of the current database are the individual state County Business Patterns reports, ES-202 files on covered industry employment and payroll, and the agriculture censuses.

A common problem in using each of these data sources is the occurrence of non-disclosures. Use of priors in the biproportional adjustment procedures for filling in the missing data, for example, would allow for closer correspondence of the remaining calculated values with the values reported by the U.S. Department of Commerce.

Delays in the reporting cycles for the reference data systems result in two- to three-year lags in the availability of each new update of the county-level Micro-IMPLAN database. Reducing the lags in data availability probably may be a less feasible alternative, howevr, than forecasting new control totals for the biproportionally-adjusted U.S., state and county input-output tables.

A hybrid approach that combines local surveys of critically important industries with the forecast approach facilitates the likelihood of attaining both greater timeliness and greater accuracy in the regional impact assessments. Such an approach incorporates various measures of linkage between core and peripheral labor market areas, like survey-based estimates of the physical volume and market value of commodity shipments between the core area and periphery.

County Clusters and Local Labor Markets

Cost-effective use of the Micro-IMPLAN modeling system in a real-world setting that overcomes model limitations stemming from system biases and specification errors depends on quick access to readily understood procedures for re-estimating and updating the ready-made regional database. These adjustments would account for the structural differences among *clusters of counties and local labor market areas*. Currently, the Micro-IMPLAN procedures provide for geographic differentiation of RPC values among selected commodity groups by substate regional development district. These multi-county areas, established in the 1960s, follow state boundaries and, hence, are not always functional economic areas.

A labor market area meets the criterion of a functional economic area. It provides an objective means of accounting for similarities and differences in the economic activities and the related linkages among individual counties that form an economic region. The labor market area (LMA) is essentially the commuting area of a local labor market. It typically has a central county or counties and a number of surrounding counties with a majority of its commuting labor force employed in the local core area rather than the core areas of adjoining LMAs. Each LMA, in turn, is part of an economic region consisting of many LMAs that, also, have their core LMA and peripheral LMAs. The Minneapolis-St. Paul LMA consisting of 14 counties, for example, is the core area of the Upper Midwest Economic Region that covers all or parts of seven states--Minnesota, northern Wisconsin, the Upper Peninsula of Michigan, much of Iowa, parts of Nebraska, and almost all of the two Dakotas. Expansion of the Denver and Salt Lake City economic regions into Montana occurs at the expense of the Minneapolis-St. Paul economic region.

Delineation of the LMAs within an economic region introduces a spatial structure into the organization of the Micro-IMPLAN database. This helps address the two-fold problem focus--system bias and specification error. Each of the problem sources, whether industry production functions, RPCs, marketing margins, or industry output, varies between center and periphery. Investment per worker is lower in the periphery and rate of return on investment also is lower when discounted for perceived investment risk. However, high levels of commodity trade occur between center and periphery. This emanates from the unique competitive advantage of each of the two types of export-producing systems with the center specializing in high order, high profit services and the periphery in standardized commodity production.

The use of labor market areas and the center-periphery structure of these areas applies especially to the organization of transportation and local land use impact assessments. Commodity transportation originates from dispersed farms, mines, and factories. It concentrates at major shipping centers that also are the primary and secondary core LMAs of the U.S. trading regions. Air transportation concentrates even more than commodity transportation in the primary core areas. This concentration of high-order economic services near the globally-connected air nodes of core metropolitan areas apparently accounts for the higher productivity of both labor and capital in the core areas.

Regional Workshops and Classroom Instruction

The current *regional workshops* for Micro-IMPLAN users and clients provide a focused approach to competency training in the operation and use of the Micro-IMPLAN modeling system. They generally cover only the key elements of system design and implementation so that workshop participants have sufficient time for hands-on modeling experience under the guidance of trained workshop instructors and supervisors. Spending more time on procedures for adjusting questionable coefficients calls for either an increase in course duration or simplification of Micro-IMPLAN modeling procedures or both.

A *new course* on Regional Economic Impact Analysis and Forecasting now offered at the University of Minnesota provides for a comprehensive program of instruction and one-on-one supervision in building and modifying a ready-made regional economic model, using Micro-IMPLAN or ADOTMATR as a case study. ADOTMATR (from Resource Economics and Management Associates, Inc., Lincoln, NE) provides the software to first build a regional database and then use the database for a regional economic impact assessment. The option of using either a student-directed classroom version of Micro-IMPLAN, rather than the current Micro-IMPLAN, or ADOTMATR is especially suited to classes with a mixture of students, some from developing countries or with interests in international economic development.

Students currently prepare term papers on topics proposed by a panel of decision makers. They have the help and counsel of those members of the panel suggesting the selected topics. Teleconferencing facilitates the learning processes for both students and decision makers, as well as the course instructors. Thus, the one-quarter course provides an opportunity for gaining theoretical as well as practical experience in regional systems modeling. The course complements the hands-on operational experience provided by the University of Minnesota IMPLAN workshops.

Supporting resources for any of the University of Minnesota IMPLAN workshops include the University of Minnesota IMPLAN Group, the accompanying instructional manuals and visual aids, the off-campus cooperators, like the ones serving on the decision-maker panel for the on-campus, one-quarter regional course, and a new classroom-oriented version of Micro-IMPLAN. The complement of supporting resources make possible a concerted effort to shift the emphasis from a completely ready-made regional modeling system to one that facilitates a hybridization of that system. The movement is towards a new system that depends more and more on local information to replace the most troublesome segments of the ready-made system.

The differentiation between the "fundamental economic structure" (FES) and the "nonfundamental economic structure" (NFES) of a region is most helpful in identifying the division of effort between the local user who is intimately familiar with his region's economic structure and data sources and the provider of the ready-made modeling system (Jensen, West, and Hewings, 1986). The FES is highly predictable, the NFES is not--an extremely useful criterion for optimizing the allocation of the total effort in building credible regional modeling systems.

The authors of another paper cited earlier (Brucker, Hastings, and Latham III, 1990, page 136) offer an important qualifying condition to any division of labor between the local user and provider of the ready-made system: that it "necessitates at least two priors. First, that the profession set forth clear and approved methods for determining in which sectors or for which behaviors data collection is most accuracy-enhancing. Second, that ready-made models facilitate the accommodation of 'coefficient fix-ups and source data wherever they exist'" (the latter a quote from Round, 1987, page 27).

A new classroom-oriented Micro- IMPLAN would prepare students for a solid understanding of the strengths and weaknesses of the Micro-IMPLAN that can help in objective evaluations of its professional applications. Simply having a version of Micro-IMPLAN that is less complex, with fewer "bells and whistles," than the current Micro-IMPLAN should facilitate its introduction into regional courses and training sessions for practitioners. It should also reduce learning costs. Such a version of Micro-IMPLAN is now under construction at the University of Minnesota. It has both a beginner's option and an advanced option.

The two classroom options provide for the flexibility in modeling procedures and easy access to the basic Micro-IMPLAN features as well as convenient coefficient fix-up. A primary goal in designing the advanced student option of Classroom IMPLAN is to facilitate the substitution of superior local information for that generated from the ready-made model and database. Similarly, an important goal of the Classroom IMPLAN workshop for the advanced workshop participant is to provide opportunities for learning how to incorporate superior local information into a revised and improved regional modeling system and database.

Micro-IMPLAN already offers the option of constructing hybrid social accounts. This option provides for several suboptions, namely, *viewing the initial study area, editing the initial study area, modifying imports and exports, and modifying production functions*. The *view* suboption displays the Micro-IMPLAN database in spreadsheet format. The *edit* suboption allows changes in the initial values based on superior local information. The *modify imports and exports* suboption requires the construction, first, of the initial social accounts and the estimates of individual "Average Regional Purchase Coefficients" and "Directly Allocated Exports Coefficients" for editing. Reconstruction of the social accounts must follow the one or more sets of changes in the RPCs and DAECs. The *modify production function* suboption involves editing of the individual commodity-industry (row-column) entries in the initial social accounts. The advanced classroom version of Micro-IMPLAN incorporates each of the suboptions into a readily-accessible User Modify Menu.

Addressing Methodological Issues

The addressing of *methodological issues* in Micro-IMPLAN development and application is a continuing challenge in workshop and classroom instruction. Maintaining an up-to-date inventory of Micro-IMPLAN applications is a first step in building an active Micro-IMPLAN user network for addressing methodological issues. A new user bulletin board and an improved electronic mail access also facilitate information interchange. Among the issues addressed are some that go beyond the estimation of *sector responses* to changes in commodity demand. These include the *income effects* of sectoral changes and the related changes in *interregional trade and regional advantage*.

Sector Responses to Product Markets and Public Policies

Traditional input-output analysis focuses on the responses of individual economic sectors in a region to changes in external demand conditions. Current applications of the University of Minnesota IMPLAN Group relate to the teaching mission of the land grant university. The student papers in the current one-quarter regional economic modeling class, for example, focuses on critical issues addressed by the State of Minnesota, its academic institutions, legislature, government agencies, and civic organizations. These include changes in export markets and public policies affecting final sales to households and businesses, among others. In many instances, the issues are current and controversial, with great potential for misinterpretation and misuse of study findings that addressed them.

The adequacy of specific study findings and their interpretation is an important concern of most Micro-IMPLAN applications. The measure of adequacy derives from (1) the intended use of the findings, (2) the alternative models and approaches for assessing the economic impact of the given changes in markets and policies, (3) the economic analysis accompanying the findings, and (4) the documentation of the findings and their interpretation. Associated with each measure of adequacy is the question of whether or not, and to what extent, system biases and specification errors affect the conclusions drawn from the studies.

We provide student opportunities to test the measures of adequacy by referring to a series of recently-completed Micro-IMPLAN applications. These studies deal with the local economic effects of (1) the North American Free Trade Agreement, (2) the relocation of a wood products plant to another county in a neighboring state, and (3) the present and prospective recreation development in a natural resources-dependent Lake Superior North Shore county. Students critically examine each of the Micro-IMPLAN studies for content and relevance.

Income Effects of Sectoral Changes

The Micro-IMPLAN database is the repository for the variables in the social accounts--the values of the final sales to each final demand sector and the income payments to resource owners engaged in the production of local goods and services. (For possible extensions of these accounts, see: Holland and Wyeth, 1993; Ratajczak, 1980; Rose and Beaumont, 1989; Round, 1989; Stevens and Trainor, 1980). The social accounting matrix (SAM) extends the previous social accounts for assessing the distributive effects of exogenous events represented by changes in final sales. This component is critical to achieving the balancing of a region's institutional, factor input, and trade accounts.

Inclusion of a SAM with each Micro-IMPLAN model provides an alternative basis for estimating local income effects of exogenous events. The SAM module distributes the income payments to the resource owners, that is, households, governments, and businesses, whether in the region or outside the region. This deals directly with the territorial assignment problems associated with commuting and absentee ownership.

Use of three income classes of personal consumption expenditures in the final demand sector now becomes an extremely versatile feature in Micro-IMPLAN. It accounts for regional differences in (1) the direct and indirect effects and (2) the induced effects of a given change in household expenditures. Differences in the distribution of total households among the three income classes, each with a unique distribution of expenditures, result in corresponding differences in direct purchases and their indirect effects on suppliers. They also account for differences in the induced effects resulting from both the differences in purchasing patterns and the differences in labor force participation rates among the three income classes. Thus, we readily identify "winners" and "losers" of changes in a given public policy or the competitive position of a local industry in its product and factor markets.

One glaring deficiency in the current Micro-IMPLAN modeling system is lack of any structural representation and accompanying data on labor earnings for every industry listed in the IMPLAN reports. The criticism is addressed with the construction of complementing matrices of labor earnings by industry and occupation. Inclusion of this feature in Classroom IMPLAN allows students to simulate the local income effects of alternative policy options and market forecasts on specific sectors of the local economy. When combined with database values that incorporate known differences within and between labor market areas, Classroom IMPLAN becomes an exciting educational resource for exploring the economic effects of proposed state and national policies on households and businesses in different parts of a labor market area and economic region. When conjoined with a vacancy chain model of the progression of changes in housing occupancy, for example, it provides students with new insights about boom-and-bust cycles and their effects on local housing and labor markets.

Further breakdown of consumption and investment spending in purchaser prices is essential for the use of a more readily formulated menu of exogenous changes to trigger the IMPLAN application. Also important for future IMPLAN development is differentiation of state and local government by (1) level of government, e.g., state versus local, and (2) government function, e.g., health, welfare, transportation, utilities, and police and corrections, as well as education.

Because of the fixed-price coefficients and the lack of supply constraints, the over-estimation of the production response may extend to its income response. This depends, of course, on the income levels generated by the affected production activities.

Interregional Trade and Regional Advantage

Interregional trade is synonymous with commodity shipments. Most commodity shipments move from producing areas to export markets by truck, rail and barge. However, an increasing volume of high-value manufactured products move by air transportation to and from the designated air transportation nodes. These shipments typically move by truck to the larger air transportation nodes, like Chicago. Micro-IMPLAN currently fails to account for such multi-modal shipments.

Micro-IMPLAN currently generates estimates of imports and exports by labor market areas, with differentiation between core, transitional, and peripheral areas. These results potentially provide the origins and destinations of interarea commodity shipments. The transportation routes and volumes implied by the origin and destination values can be simulated with a selectively constrained optimizing model. Presently, however, the total of all domestic imports, aggregated over all counties, fail to equal domestic exports, aggregated over all counties because of the unconstrained estimation of the RPCs.

Technology transfer is an increasingly important form of interregional trade. It is also a singularly important factor in accounting for a region's competitive advantage in specialized production and its export to other regions. It is associated, in part, with the total value of technology-intensive manufactured products in a given region. Again, Micro-IMPLAN, when conjoined with an optimizing transportation network model, can simulate the local economic effects of technology transfer. This application may extend to the role of a state's research universities in the formation and strengthening of spatially-separated, functionally-integrated industry clusters. These clusters are viewed by at least one student of regional growth and change as the new industrial systems of the emerging information economy (Saskenian, 1994).

The agglomeration economies and the many informal relationships within the workforce of a large metropolitan-industrial complex help sustain its self-generating growth capacities (Saxenian, 1994). The research universities and the markets in intellectual property they support are an important part of this urban complex. The possibility exists, however, that the contribution of the research universities to the vitality of these markets and their spillover to other factor markets depends on the number of such universities in the metropolitan area or, alternatively, the close working relationships each university has with other research universities. This includes the employment opportunities they offer for the creative talents of the individual researchers that nurture and sustain these critically important institutions.

The existence of collaborating research universities in major metropolitan area compares with the existence of technology-intensive enterprises that form the nucleus of an emerging industry cluster. Such a cluster facilitates the informal exchange of information and the networking of the individual members of this cluster, as noted by von Hippel (1988, pages 76-116), into an active local labor market that serves the emerging or already-existing technology-intensive regional industrial system. This highlights, again, the importance of the identifying the Micro-IMPLAN model with a labor market area as the defining territorial entity for the study of regional industry linkage and agglomeration in technology transfer.

Input-output models, like computable general equilibrium models, assume the existence of a *general equilibrium* for each regional economy. Probably the more realistic assumption is that of disequilibrium from one period to the next with a general equilibrium being the tendency, but not the reality, at any given moment. Micro-IMPLAN provides for model closure with the inclusion of a social accounting matrix (SAM).

The classroom version of Micro-IMPLAN also provides for model closure in each period. It would provide this closure even in its role as the core module in a multi-period economic modeling system. It could also allow for the inclusion of supply constraints and endogenous price changes (via the use of relative prices and complementing regression equations) as well as the highly disaggregated production responses cited earlier. The additional modifications would extend to the demand-side with the disaggregation of the current local final demands into purchaser categories that include the price-endogenous marketing margins. (See: Glickman, 1980; Nijkamp and Reggiani, 1989.) However, the additional features require an expanded modeling system for dealing with multi-period changes in all tradable commodities, including those that constitute a region's economic base (Treyz, 1993; Treyz, Rickman, and Shao, 1992).

Summary

Comments on ready-made models discussed in a series of recent articles in regional science journals are the points of departure for this assessment of the Micro-IMPLAN regional modeling system. They suggest that an adequately flexible ready-made model must allow the use of superior local data and survey-based trade coefficients in some sectors while continuing to balance the rest of the sectors in a truly unbiased manner. System effectiveness requires not only a truly flexible model but one that invites the use of superior local information and provides the user manuals and workshops to facilitate this process.

We present some current shortcomings of Micro-IMPLAN with the end-in-view of correcting them, either by system improvements or extensions of the existing system. We allude to the immensity of this task, however, by summarizing the results of a series of simple tests of model performance in estimating its RPC and Type 1 and Type 3 multiplier values. We selected four counties in Minnesota--two in the northwest tier of counties bordering Canada and two in the Twin Cities Metropolitan Statistical Area--for these tests. These counties illustrate an increasingly common occurrence in any regional economy--the concentration of export-producing jobs in one locality and residentiary activities that cater to the resident commuter population in another locality.

Continuing in a spirit of constructive criticism we address the two sets of concerns that affect the credibility of the Micro-IMPLAN forecasts and local impact assessments: *system bias* and *specification error*. *System bias* is a consistent over-estimate or under-estimate of parameters and variables in the regional impact model and database. It arises, in part, from the underlying structural assumptions in model and database estimation. These vary from one modeling system to the next. For example, Micro-IMPLAN ignores the effects of commuting across county boundaries as well as the spatial variations in earnings per worker and output per worker among individual industries.

Specification error is the result of an incomplete or otherwise inadequate representation of the causal system accounting for the values of parameters and variables in the regional impact model and database. A key culprit is lack of accurate information about the geographically-differentiated determinants of industry production and the productivity of its primary inputs and the occurrence of spatial correlation among economic activities. Another important source of specification error is the final demand sector. Lack of a separate module that convers commodity-specific final sales in purchaser prices to their unique mix of outputs in producer prices ignores the existence of regional variation in the individual marketing margin components.

Future model updates will change model structure, not only by incorporating a new social accounting matrix (SAM), but, also, by replacing existing, with improved, model features. For example, the identification of the total income payments and receipts by origin and destination, whether in the the given area or outside, provides a direct answer to the journey-to-work problem presented by the commuting worker. This also deals directly with the ownership of the capital resources at the work site. Moreover, use of three income classes of personal consumption expenditures helps account for regional differences in (1) the direct and indirect effects and (2) the induced effects of a given change in household expenditures. Differences in the distribution of total households among the three income classes, each with a unique distribution of expenditures, account for differences in direct purchases and their indirect effects on suppliers. They also account for differences in the induced effects from differences in purchasing patterns and labor force participation rates among the three income classes.

Included among procedures for the regionalization of input-output structures and databases is use of labor market areas for a more accurate spatial differentiation of industry production functions and regional commodity purchase coefficients. For this purpose, we prepared a preliminary regionalization of U.S. labor market areas (LMAs) for use in modifying existing model structures and databases.

This paper thus addresses three concerns, namely, the regionalization of the industry production function, the estimation of the regional purchase coefficient, and the estimation of margins that convert producer prices into purchaser prices, in the design and use of the Micro-IMPLAN modeling system. It presents comparisons of Micro-IMPLAN model results for contrasting areas--two densely-populated and two sparsely-populated, with each of the two linked by commuting from place-of residence in one county to place-of-work in the neighboring county. A step-by-step discussion of modeling system implementation from a model user's perspective in a classroom or workshop environment accompanies the second set of comparisons.

A review of supporting resources for implementing a new series of Regional IMPLAN workshops and classroom exercises follows the discussion of modeling system implementation. This concludes with an examination of important methodological issues and performance criteria addressed in the reformulation of the Micro-IMPLAN modeling system. The ultimate aim of the assessment of modeling system performance is to improve the total effectiveness of Micro-IMPLAN in producing accurate and reliable decision information for teaching and policy-making purposes.

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Figure 1.1

MICRO-IMPLAN INPUT-OUTPUT DATA FILES AND ACCOUNTS

EXPENDITURES

RECEIPTS	Industries (1, 2, 3, 4)	Commodities (A, B, C)	Factors	Institutions (HH, Govt, Capital)	Trade (D Exp, F Exp)	Total
Industry 1 Industry 2 Industry 3 Industry 4		Make Matrix, MID.103 (By-products Matrix, MID.105) (Market Share Matrix, MID.104)				Total Industry Output
Commodity A Commodity B Commodity C	Use Matrix, MID.101 (Absorption Matrix, MID.102)			Final Demand, MID.106	Exports, MID.106	Total Comm Output
Factors	Final Payments, MID.107					TotFact
Households Government Capital		Final Sales, MID.106 Government and Inventory	SAM	SAM	SAM	Total Institution Sales
Import of A Import of B Import of C Factor Imports	Competitive Imports, MID.110 Non-competitive Imports, MID.108			Comp Imports Matrix, MID.111 (Non-comp Imp Mat, MID.109)	Transhipments	Total Imports
Total	Total Industry Outlay	Total Commodity Supply	TotFact	Total Final Demands	Total Exports	

Industry output and outlay balance!

Domestic exports (the residual after local consumption).

Commodity supply and demand balance!

Source: Greg Alward, U.S. Forest Service, Ft. Collins, 1993

Micro-IMPLAN Structure Format

The "input-output" part of the social accounts is emphasized. Numbers following each input-output account refer to its file designation in Micro-IMPLAN. The institutional account provides for income payments to and income receipts by each of the input-output accounts.

Figure 1.2

AIRNODE ECONOMIC REGIONS

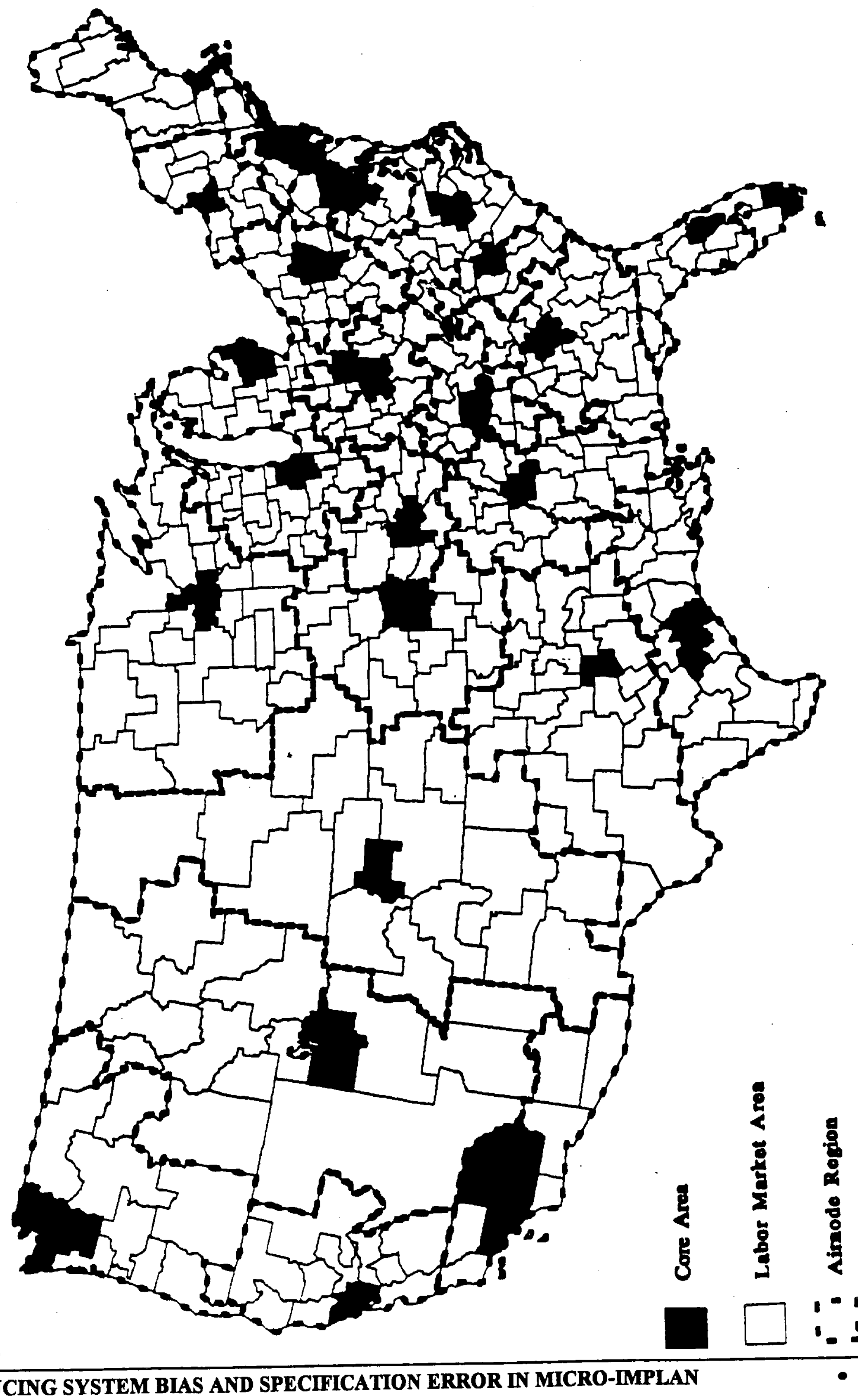
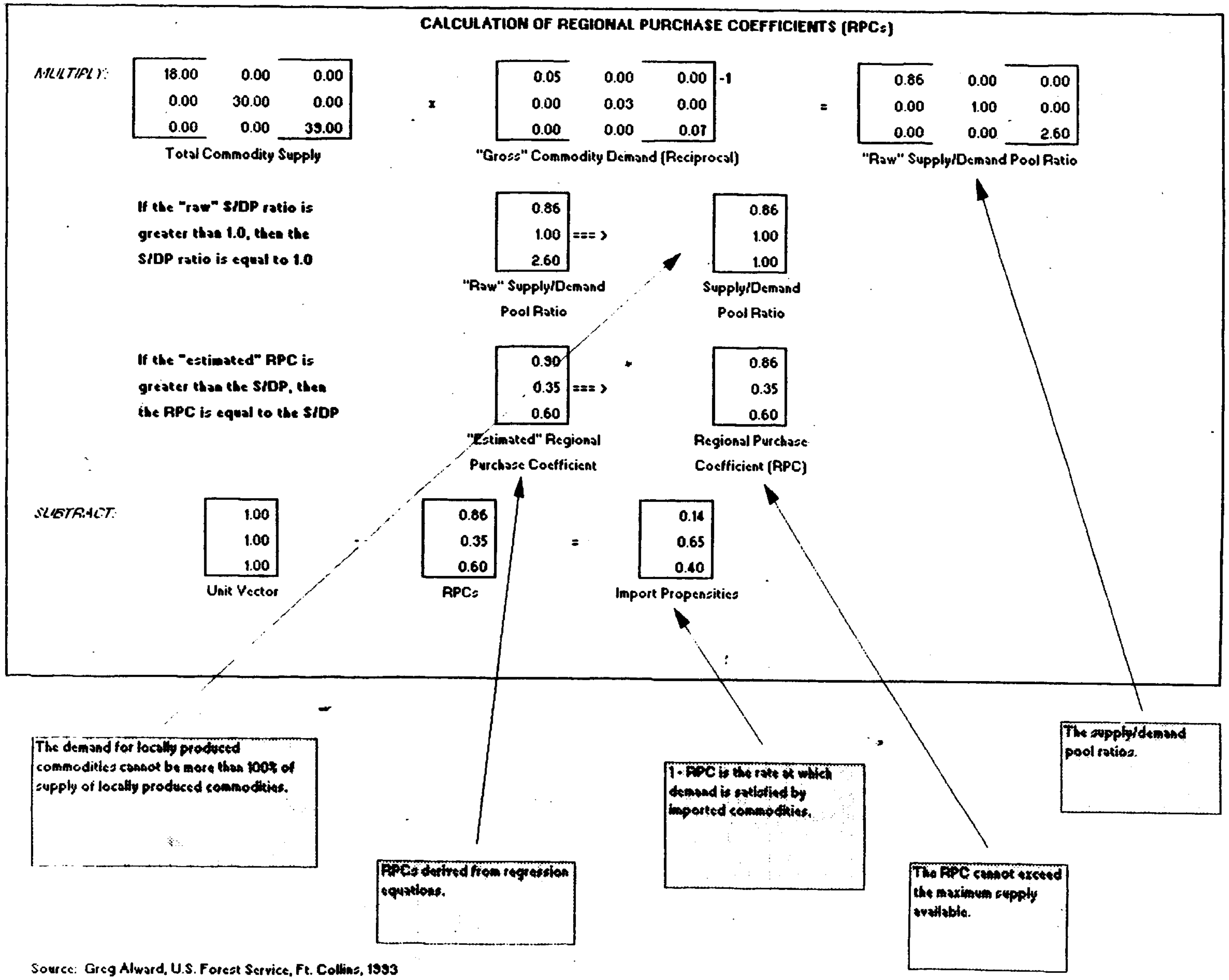


Figure 2.1



Step 4. Derivation of the Regional Purchase Coefficients

The rate at which commodity demand is satisfied from local sources of supply rather than from imports is given by the Regional Purchase Coefficient (RPC). Estimates of the RPC for each commodity are derived from regression equations. The estimated RPC has an upper bound constraint, which is given by the supply/demand pool ratio (SD/P), the ratio of regional commodity supply and demand.

Figure 2.2

PRELIMINARY AND BALANCED REGIONAL SOCIAL ACCOUNTS

PRELIMINARY ACCOUNTS (NOT BALANCED)

EXPENDITURES

RECEIPTS	Industries 1	2	3	4	Commodities A	B	C	Factors	Institutions HH	Govt	Capital	Trade D Exp	F Exp	Total
					9.00	0.00	1.00							10.00
Industry 2					0.00	30.00	0.00							30.00
Industry 3					4.00	0.00	36.00							40.00
Industry 4					0.00	0.00	0.00							0.00
Commodity A	0.43	0.00	6.86	0.00					4.29	4.71	0.86	0.00	0.86	18.00
Commodity B	0.35	1.05	0.00	0.00					2.10	4.90	2.10	19.50	0.00	30.00
Commodity C	1.20	1.80	1.20	0.00					1.50	3.00	0.30	30.00	0.00	39.00
Factors	6.50	24.00	30.00	0.00										60.50
Households					0.00	0.00	0.00	36.30	1.00	2.50	1.50	8.70		50.00
Government					4.00	0.00	2.00	12.10	4.50	1.80	2.70	2.90		30.00
Capital					1.00	0.00	0.00	12.10	1.20	0.80	2.00	2.90		20.00
Import of A	0.07	0.00	1.14	0.00					0.71	0.79	0.14	0.00	0.14	3.00
Import of B	0.65	1.95	0.00	0.00					3.90	9.10	3.90	0.00	0.00	19.50
Import of C	0.80	1.20	0.80	0.00					1.00	2.00	0.20	0.00	0.00	6.00
Factor Imports								0.00						
Total	10.00	30.00	40.00	0.00	18.00	30.00	39.00	60.5	20.2	29.60	13.70	64.00	1.00	

BALANCED REGIONAL SOCIAL ACCOUNTS

	1	2	3	4	A	B	C	Factors	HH	Govt	Capital	D Exp	F Exp	Total
Capital					1.00	0.00	0.00	12.1	31.00	1.20	8.90	2.90		56.50
Factor Imports	0.80	1.20	0.80	0.00				0.00			36.50			36.50
Total	10.00	30.00	40.00	0.00	18.00	30.00	39.00	60.5	50	30.00	56.50	64.00	1.00	

Preliminary and Balanced Regional Accounts

Interinstitutional transfers have been added. Note that institutional receipts and expenditures do not balance until the factor imports/exports are introduced with adjustments in investment/savings.

Transfers between insititutons without (dis)savings.

Institutional receipts and expenditures don't balance!

Source: Greg Alward, U.S. Forest Service, Ft. Collins, 1993