Staff Papers Series

P90-65

November 1990

AGRICULTURAL POLICY EVALUATIONS USING IMPLAN

L. Eric Siverts and Gregory S. Alward--USDA Forest Service
Wilbur R. Maki, University of Minnesota

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture, Forestry and Home Economics
St. Paul, Minnesota 55108

AGRICULTURAL POLICY EVALUATIONS USING IMPLAN

L. Eric Siverts and Gregory S. Alward--USDA Forest Service
Wilbur R. Maki, University of Minnesota

CONTENTS

AGRICULTURAL POLICY EVALUATIONS USING IMPLAN

L. Eric Siverts and Gregory S. Alward--USDA Forest Service
Wilbur R. Maki, University of Minnesota

SUMMARY AND CONCLUSIONS

IMPLAN has been used for several years by the USDA Forest Service to develop non-survey input-output accounts and models. These models have been used primarily to assist land and resource management planning efforts. IMPLAN has also been used in several other applications, such as preparedness planning for natural disasters and assessing the economic impacts of marine fisheries programs. Its most recent applications are in agricultural policy evaluation, including assessments of Conservation Resource Program (CRP) and the 1988 drought impacts on rural areas.

This paper addresses the use of the most recent Micro-IMPLAN (MI), in regional economic modeling, under three principal headings, starting with an IMPLAN system overview--the modeling system and its input-output and social accounting matrix (SAM) capabilities. This discussion continues with a brief examination of data sources in regional data base and model construction, including the theoretical foundations of input-output and social accounts construction.

The second principal heading is model development, which addresses the measurement of changes in rural economies associated with new agricultural programs. The recent introduction of a social accounting matrix into the IMPLAN system now makes possible a wide-ranging assessment of the community economic effects associated with the Food Security Act of 1985 and its conservation initiatives.

The task of addressing the various conservation initiatives stemming from the Farm Security Act of 1985 and the 1990 Farm Bill requires certain key extensions of the IMPLAN modeling system.

- o Many of the regional economic and social implications that have been accepted as exogeneous must become endogeneous and the linkages between cause and effect in accounting for rural resources productivity and well-being must become explicit.
- o The IMPLAN modeling system must incorporate the feedback from production to consumption and final demand and the SAM institutional accounts must show the corresponding feedback from factor income changes to corresponding resource productivity improvements.
- o The incidence of the benefits and the costs of pollution abatement and resource conservation investments must be built into the SAM accounts.

Strategies for extending input-output modeling capabilities to more effectively address the FSA85 and related conservation initiatives are now being addressed by the IMPLAN Development and Applications Group at the University of Minnesota and the USDA Forest Service. As a consequence of these efforts the new MI SAM accounts are capable of including a distribution of occupations, linked to both industry employment and private and government expenditures for education and training and, also, natural resource stocks and flows and corresponding changes in starting and ending asset values. Substantial extension of the institutional accounts is still necessary to adequately show the several categories of education and training and their corresponding levels of inputs and outcomes--all linked directly or indirectly to the existing value added and final demand accounts in the IMPLAN modeling system.

Finally, the accumulative effects of implementing FSA85 and similar measures are being handled by the complementary use of the University of Minnesota/USDA Forest Service Interactive Policy Analysis Simulation System (IPASS), which is being modified to incorporate the new MI SAM and its extensions. The MI SAM-based agriculture policy assessments are being expanded from a static, "what-if" type of computer simulation to a regional or labor market modeling system based on the spatal-environmental structure of the regional or area economy in its entirety.

Under the third principal heading, issues in agricultural data base preparation, impact area delineation, import leakages and subsititutions, timing, price and direct effects considerations, and economic structure estimation are presented in the concluding discussion of selected agricultural program evaluations using the IMPLAN modeling system. The IMPLAN modeling applications range from USDA Forest Service and USDI BLM studies of the local impacts of timber cutting, cattle grazing, mining and recreational activities on federal lands to USDA Economic Research Service studies of the national and local impacts of textile quotas and Resource Conservation and Development and Conservation Reserve Program activities.

The IMPLAN modeling system thus complements the use of agricultural production modeling in the evaluation of agricultural program and policy effects on agricultural production and rural communities. It is distinguished by its unique capabilities for estimating changes in measures of rural economic well-being in specific rural areas, especially those experiencing severe worker and community dislocations resulting from program and policy implementations at the national level.

10/31/90

AGRICULTURE POLICY EVALUATIONS USING IMPLAN*

L. Eric Siverts and Gregory S. Alward--USDA Forest Service
Wilbur R. Maki--University of Minnesota**

Abstract

Opportunities for applying the IMPLAN (IMpact analysis for PLANning) regional economic modeling system to agricultural policy issues are reviewed. Aspects of IMPLAN pertinent to agricultural concerns are addressed, in particular the sources of data used to estimate regional employment, sales and income, the methods used to determine regional import and export product flows and the extensions available through the social accounting framework.

Regional considerations in model delineation and specification are discussed, including the use of functional economic areas and agricultural production areas for county-level data aggregation. Discussed, also are empirical issues focusing on interregional trade, supply-induced price changes and commodity allocations to agricultural processing sectors.

IMPLAN SYSTEM OVERVIEW

IMPLAN (Alward and Palmer, 1983) has been used for several years by the USDA Forest Service to develop non-survey input-output accounts and models. These models have been used primarily to assist land and resource management planning efforts. IMPLAN has also been used in several other applications, such as preparedness planning for natural disasters (Salkin, 1985) and assessing the economic impacts of marine fisheries programs (Radtke, 1985). Its most recent applications are in agricultural policy evaluation, including assessments of Conservation Resource Program (CRP) and the 1988 drought impacts on rural areas (Martin et al., 1988 Petrulis et al., 1989; Siegel, 1990).

This paper addresses the use of Micro-IMPLAN regional economic modeling briefly describing the technical modeling system and its regional impact

---

* Paper prepared for Thirteenth International Conference, Atlantic Economic Society, Session on Natural Resources Analytical Systems Part III, Williamsburg, VA, October 11-14, 1990.

** The authors acknowledge the helpful comments and suggestions provided by the discussant, Dr. Gerald Schluter.

assessment capabilities. Incorporation of a social accounting matrix (SAM) into the IMPLAN model structure for individual rural areas is a further step in improving its technical capabilities for agricultural policy evaluations, including the role and importance of farm subsidies and federal transfer payments in affecting the economic well-being of rural residents and communities. Much of the paper focuses on specific issues in agricultural policy evaluations starting with agricultural data base preparation for the US and individual states and countries and concluding with illustrative applications of the Micro-IMPLAN system in USDA-sponsored studies.

Modeling System

Micro-IMPLAN (MI) is a modeling system that incorporates traditional input-output procedures with several enhancements producing greater flexibility both inconstructing regional accounts and in deriving predictive models. Also, an extensive MI data base supports applications of MI to regional studies of any combination of states and counties in the United States.

Conceptually, MI consists of four general components shown in Figure 1:

(1) A data base of regional economic statistics for all U.S. counties, including estimates of consumption, industry output, factor incomes and production employment for each of 528 industries;

(2) Methods to construct social accounting matrices for individual or groups of counties using non-survey and semi-survey techniques; (see, for example, Miller and Blair, 1985);

(3) Procedures for constructing predictive models using the regional accounts in order to perform impact analyses; and

(4) A user interface that provides the environment for creating accounts and applying the predictive models to the assessment of the economic effects

of policy options.

Currently, the MI data base consists of regional information for the year 1982, but a new 1985 data base is now complete and ready for use. These data are sufficient to construct social accounting matrices for any county or multi-county area in the US. An earlier data set for 1977 has been prepared for use with the sofware interface. A complete description of the data base is available in Alward (1987).

Input-output and SAM Capabilities

Traditional input-output applications are based on the interindustry accounting format which defines each row of the transaction table as output sales of an industry to other industries or final consumption. The individual columns show the purchases by industries or final consumers from other industries or primary inputs. Each industry is presumed to produce a single homogenous product with little emphasis placed upon non-industrial transactions. The accounts of traditional input-output are oriented primarily toward transactions between industries, and secondarily toward industrial purchases of primary inputs and sales to final consumption. Thus, the traditional input-output format is organized to construct input-output models with an industry reference and it is square by definition.

The MI accounting structure is rectangular. It is not constrained to the "one-industry, one-product" assumption of traditional input-output tables. The accounting definitions explicitly distinguish between the entities that produce output (industries) from the output themselves (commodities). This makes possible differentiation of industry input purchases of commodities from commodity output sales. Further, greater emphasis is given to tracing nominal or "nonmarket" transactions among insitutions like households and governments without involving traditional markets. These transactions often play important roles in the economic consequences of public policies. For example, factor earnings are clearly distinguished from institutional income. Because interinstitutional transactions, like taxes and transfers, are explicitly noted, the MI accounting structure is especially applicable to the evaluation of agricultural policy impacts on rural communities and regional economies.

A comprehensive description of social accounts, especially those parts pertinent to MI, is given in the United Nations report, A System of National Accounts, and is recommended as an international standard by the United Nations (1968). Recent input-output studies of the US economy for 1972 and 1977 (BEA, 1980; 1986), to which MI has close definitional ties, follow many of the UN suggestions. While those portions of a SAM that relate to the traditional input-output tables have received the most attention, the parts involving transactions other than interindustrial flows have been increasingly emphasized in recent years. Such emphasis is particularly important in the studies by Pyatt and Roe (1977) and Bulmer-Thomas (1982) where issues of income distribution in developing countries are critical. Regional applications of SAMs have only recently gained visibility in the United States (Hanson and Robinson, 1989).

Figure 2 illustrates a set of comprehensive, highly aggregated accounts. Table 1 contains an index to the submatrices pertinent to MI. The scope of the accounts shown is very broad to help focus on the specific portions covered by the MI accounts, which also have particular applications to the evaluation of agricultural policy impacts on local economies, including skill requirements of the changing work force and its income receipts and consumption expenditures among various income categories of resident populations.

Current and Capital Accounts

The MI SAM applies only to the current account. This is the restricted portion outlined by the inner rectangle in Figure 2. The current account captures the flow of transactions through a regional economy during a period of time such as a single year. Characteristics of a region's stocks, the status of its assets and liabilities at the beginning and end of the time period, are not addressed by the MI accounts. A dynamic modeling system must be teamed up with IMPLAN to move the MI SAM accounts from one year to the next in a simulation exercise.

Receipts and Expenditures

MI SAMs are organized as "double-entry accounts": entries in the cells of the current account can be interpreted as both expenditures (down the columns) and receipts (across the rows), see Figure 2. Receipts and expenditures are used as references rather than sales and purchases typically used in input-output studies. Many of the transactions appearing in a SAM are nominal or "non-market", not involving exchanges across a commodity or factor market. Examples of these nominal flows are taxes, savings or welfare transfers.

Industries, Commodities, Factors and Institutions

Within the MI SAM table, various labels are used to identify interindustry transactions. For the production account, industries (or other activities) and commodities describe both the production process and the goods and services resulting from that process. Industries are collections of establishments classified according to the 1977 Standard Industrial Classification Manuel (Executive Office of the President, 1974). Industries play a dual role in the MI accounts, serving both as producers (or sellers) of commodities and as consumers (or buyers) of commodities.

Factors of production (i.e., labor and various forms of capital) are also descriptors used in the consumption accounts. These primary inputs to the production processes are used to compute "place of production" income or factor earnings. Factor earnings are distributed among institutions, which encompass non-industrial economic actors, such as households and governments both within and outside the study region. Utilizing an institutional classification for the consumption accounts allows many nominal flows to be explicitly identified (e.g., savings, taxes and transfers). Since some of the institutions are located or reside in a study region, "place of residence" income can computed from the institutional flows.

The shaded submatrices in Figure 2 indicate the parts of a regional SAM that are either available from the data base or are directly estimated using structural matrices. In general, the trade accounts (i.e., the unshaded submatrices) are the parts of a regional SAM that must be derived using indirect procedures. This emphasizes the critical role that estimating regional imports and exports plays in constructing the SAM accounts.

Production, Consumption, Accumulation and Trade

The SAM uses four functional accounts to describe its product and income flows—production, consumption, accumulation and trade. The production account captures the transactions among buying and selling industries as commodities are being produced. These interindustry transactions are the main concern of input-output studies.

A fundamental problem confronted in constructing the production accounts of a regional SAM is the estimation of input purchases and output sales of commodities by the region's industries. Pragmatically, this involves the construction of the regional use and make matrices. The problem arises because there are virtually no systematically collected data for interindustry transactions at the regional level in the US. In order to accomplish this task, MI uses two structural matrices of industrial commodity requirements and commodity production (absorption and secondary products matrices, respectively) derived from the national input-output study as proxies for the structure of a region's industrial system. The regional use and make matrices are derived using these structural matrices to distribute estimated regional TIO.

The consumption account shows how income flows to institutions and production factors and how it is distributed in the form of commodity expenditures. This account incorporates many of the transactions that appear in the "final demand" and "final payments" portions of input-output tables. The ability to trace flows within the consumption account is a distinguishing feature in the use of SAMs.

The accumulation account describes savings and investment transactions, such as capital formation or inventory accumulations and deletions. These flows are usually included in "final demand" and "final payments" parts of input-output tables.

The trade account displays import and export transactions, which are the commodity flows between the study region and the rest of the nation and world. The domestic trade account is especially important in regional studies of agricultural policy impacts.

REGIONAL DATA BASE AND MODEL CONSTRUCTION

Regional statistics appearing in a SAM are periodically published in various reports such as the 1982 County Business Patterns (USDC, 1983), 1982 Census of Agriculture (USDC, 1985) and 1982 Local Area Personal Income, 1977-82 (USDC, 1984). Much of this data has been collected and converted into the SAM accounting conventions and constitutes the data base for implementing the IMPLAN modeling system (Alward, 1987). Other parts of the SAM are derived indirectly using the above data with structural relations to arrive at a consistent set of regional SAM accounts. Many of these structural relationships (e.g., the national by-products and absorption matrices) are also a part of the data base.

Data Sources

The IMPLAN data base consists of (1) total industry outputs (TIO); (2) gross institutional consumption and investment demands for commodities; (3) factor earnings; and (4) foreign commodity exports (Table 2). This leaves the interindustry production, factor disbursements, and interinstitutional submatrices of the SAM to be indirectly estimated using the structural matrices and domestic trade submatrices based on the data reduction technique. However, a great deal of regional data is used in MI accounts construction and, therefore, to say that the MI modeling system constructs "non-survey" accounts is an over-simplification.

By-Products Matrix

A by-products matrix based upon a modified and updated version of the national input-output study (see Alward, et al, 1987) is used to derive the regional make matrices for converting total industry output (TIO) into total commodity output (TCO). The term "by-products" is a misnomer, however, insofar as the matrix is a comprehensive representation of all commodities produced by a given industry, not simply its by-products. Using the national by-products matrix as the proxy for the output structure of a region's industries implements the assumption that the commodity output mix for each industry in any region is the same as the output mix of the corresponding US industry. MI does allow relaxation of this default assumption. It is also presumed that industry output mix is unaffected by scale differences.

Absorption Matrix

Estimates of a region's gross intermediate commodity requirements (given by the regional use matrix including imports) is accomplished using an absorption matrix derived from the national use table. This method of calculating regional gross intermediate commodity demands is based on two assumptions. First, the calculation implies that the demand by an industry for any given commodity is linearly related to that industry's total output. The second assumption is that each regional industry has the same production requirements per dollar of TIO as the national composite industry.

Input requirements are likely to vary among regions depending on the relative costs of commodities, labor and capital. Because the data base contains regional estimates of factor inputs, intermediate input requirements are adjusted to conform with the factor inputs although the composition of intermediate inputs remains the same as that given by the national absorption matrix. This relaxes the strict assumption of fixed input functions to account for regional variations in the relative costs of factors and commodities. In addition to this adjustment, MI permits direct modification of the entire production function so that the unique characteristics accounting for differences in regional production capabilities can be accommodated in the IMPLAN evaluations.

Commodity Trade

Previous versions of IMPLAN utilized a nonsurvey technique called supply/demand pooling to estimate the net regional commodity imports and exports. Gross commodity demand by both industries and institutions (intermediate and final demand, respectively) was estimated and compared with regional commodity production. That is, a simple ratio was computed between regional commodity demand and supply. Based upon this comparison between demand and supply, net imports and exports were estimated by employing the assumption that all regional demand was first satisfied by regional production; any deficit in regional commodity demand was fulfilled by imports and any excess production was presumed exported.

Several researchers have addressed the problem of estimating regional trade flows in the context of input-output modeling, with the most prominent recent work being focused upon the derivation of "regional purchase coefficients" (RPCs). A RPC is defined as the proportion of gross regional commodity demand fulfilled by commodities supplied by producers within the region.

Research has focused on estimating regional RPCs by using cross-sectional data on commodity flows with explanatory variables like the size of the region, the number of producers and consumers and relative transportation costs. The derived RPCs are used subsequently to estimate gross imports and exports in a regional input-output table rather than basing them on set regional supply and demand estimates, as in the case of supply/demand pooling. RPCs explicitly recognize crosshauling as a regional trading phenomenon.

MI utilizes RPCs to estimate regional commodity imports and exports. The methods used to derive the RPCs are presented elsewhere (Alward and Despotakis, 1987). As a result, MI provides estimates of gross trade incorporate industry crosshauling estimates. Moreover, the MI system allows modification of the given RPC values when superior information is available to more accurately represent imports and exports for a given regional economy.

Factor Trade

From a production point of view, the factor earnings matrix (in Table 2) describes all industrial outlays for factor inputs and thus captures all production income at the place where the production activity takes place. While some of these factors inputs are likely to be obtained from outside the study area, the regional economic data base does not include specific measures of factor input flows--a shortcoming in model and data base construction that has proven difficult to remedy.

Model Development

Incorporation of SAM into the IMPLAN model structure facilitates the measurement of changes in rural economies associated with new agricultural programs. The SAM addition makes possible a wide-ranging assessment of the community economic effects of implementing the Food Security Act of 1985 (FSA85). It can show, for example, likely changes in jobs, income and business activity resulting from proposed or projected reductions in agricultural production and corresponding changes in idle farm land or wildlife habitat.

Addressing FSA85 Conservation Initiatives

Boehlje, Raup and Olson (1990), in their evaluation of the effectiveness of the Conservation Reserve Program (CRP) in Minnesota, comment as follows:

> "A land use policy that focuses only on the physical dimensions of use is defective. The ten-year leases that now define the CRP leave unanswered the basic question of, what is to be done when the lease expires? They also ignore the effect on rural communities. If a more permanent retirement of fragile or environmentally sensitive land is the goal, then the concept of the environment that has guided policy to date needs rethinking. Human beings and their institutions are part of that environment."

This comment is particularly appropos to the growing concerns about population out-migration from farm-dependent rural communities of the Midwest and the High Plains and the adverse effects of this migration on those left behind.

FSA85 conservation initiatives, as they pertain to present and prospective IMPLAN applications, include all four measures--the swampbuster, sodbuster and conservation compliance programs and CRP (Rawson, 1990). Each of these programs reduces agricultural production, but differentially between counties, when fully implemented. Participation in CRP, for example, is concentrated in the winter and spring wheat areas, (mostly in the High Plains), the western cornbelt, and eastern and western portions of the cottonbelt.

In Minnesota, 14 of its 87 counties have more than 10 percent of their total farm land under CRP enrollment; they account for 22 percent of total Minnesota farm land and 44 percent of the total CRP enrollment in Minnesota: (Boehlje, Raup and Olson, 1990). The rural communities in these counties are among Minnesota's most farm-dependent. Alternative job opportunities to replace the loss of farm and farm-related jobs are virtually non-existent because of the lack of new business development--the inevitable consequence of limited entrepreneurial skills for accessing available capital financing sources. For these rural communties the ripple effects of farm cutbacks are large and severe.

Conservation proposals in 1990 farm legislation provide for additional support of low-input farming practices, including agricultural research and extension (Zinn, 1990). Successful adoption of low-input farming practices also would be accompanied by some reductions in farm inputs and input-supplying businesses.

Environmental conservation and preservation incur economic and social costs that are disassociated from their benefits. This disassociation between benefits and costs leaves rural communities and people with a disproportionate share of the full costs of clean water and air that are broadly beneficial. Assessments of the program impacts on local communities provides a means of identifying areas and groups adversely or favorably affected by individual features of government programs and policies.

Extending IMPLAN System

The challenge of addressing the various FSA85 and 1990 Farm Bill conservation initiatives calls for certain key extension of the IMPLAN modeling system. Many of the regional economic and social implications that have been accepted as exogeneous must become endogeneous and the linkages between cause and effect in accounting for rural resources productivity and well-being must become explicit. The IMPLAN modeling system must incorporate the feedback from production to consumption and final demand and the SAM institutional accounts must show the corresponding feedback from factor income changes to corresponding resource productivity improvements. The incidence of the benefits and the costs of pollution abatement and resource conservation investments must be built into the SAM accounts.

Strategies for extending input-output modeling capabilities like IMPLAN to more effectively address the FSA85 and related conservation initiatives, include the following:

(1) Expansion of existing SAM accounts to show human resource investment and its accumulative effects, if any, on human resource productivity;

(2) Differentiation of existing accumulation accounts between (a) production, (b) pollution abatement and (c) land conservation and preservation investments;

(3) Construction of new ecologic-economic accounts to show the accumulative effects of current resource withdrawals on future consumption and production;

(4) Construction of generic production function algorithms to account for changing input structure of existing industries and new industries (see Shantz and Maki, 1987);

(5) Construction of new algorithms and related data bases for simulating the year-to-year interactive effects of implementing FSA85 and related conservation initiatives in designated rural labor market areas of individual

states and multi-state regions.

Each of the five strategies are being addressed in IMPLAN model development. The new MI SAM accounts will include a distribution of occupations, linked to both industry employment and private and government expenditures for education and training. However, the implementation of the SAM accounts in the IMPLAN system will require substantial extension of the institutional accounts to show the several categories of education and training and their corresponding levels of inputs and outcomes--all linked directly or indirectly to the existing value added and final demand accounts.

Work on another new set of accounts that introduce natural resource stocks and flows into the MI SAM is being initiated as soon as the currently scheduled updating micro data base is completed. Finally, the accumulative effects of implementing FSA85 and similar measures are being handled by the complementary use of the University of Minnesota and USDA Forest Service Interactive Policy Analysis Simulation System (IPASS), which is being modified to incorporate the new MI SAM and its expansions (Olson, et al, 1984). Thus, the MI SAM-based agriculture policy assessments are being expanded from a static, "what-if" type of computer simulation, to a regional or labor market modeling system based on the spatial-environmental structure of the regional or area economy in its entirety.

AGRICULTURAL POLICY EVALUATIONS

Agricultural policy evaluations presented here are based in large part, on the highly detailed 1982 IMPLAN data base for US counties. Because IMPLAN deals in statics, the impact estimates are "one-shot," "what-if" types of statements that only in a limited way account for interactive and accumulative effects of exogeneously-introduced change in local economies. Use of Type III multipliers (taking into account population change adjustments in personal consumption expenditures), rather than the conventional Type I multipliers, provides a rough approximation of accumulative feedback effects, but only on personal consumption expenditures and not [in business and government] income and expenditures, business investment, and transfer payments.

Agricultural Data Base

The agricultural sector of the MI data base is derived, in large part, from market value and farm sales data supplied by Dr. Gerald Schluter, Economic Research Service, US Department of Agriculture (1989). National and state control totals for each of the 23 agriculture sectors are calculated from the Schluter data and the 1982 US Census of Agriculture. The state control totals are then allocated to individual counties by county-level ratio allocators, again derived from the 1982 US Census of Agriculture (USDC, 1985).

National and state data

For national and state data sets, the Schluter USDA information is supplemented by statistical series on meat animal subsectors and hay and pasture. The meat animal subsectors include (1) ranch-fed cattle; (2) range-fed cattle; (3) cattle feed lots; sheep, lambs and goats; (4) hogs, pigs and swine; and (5) other meat animals. The hay and pasture subsector is based on market value of ranch and range-fed cattle.

The resulting agriculture sector vectors for the US and each state are sets of agricultural market values (T10). They are adjusted for productivity differences by dividing each market value estimate by an output-per-worker measure derived from the US Bureau of Labor Statistics (BLS) growth model data series. The result is a series of estimated employment vectors to be used as coefficients to distribute the US Department of Commerce Regional Economic Information System (REIS) farm data. Again, coefficients from the earnings vectors are used to distribute the REIS earnings data.

County data

County local data derivation is substantially different from the national and state data derivation procedures. State data for each agricultural sector is distributed across counties using 1982 Census of Agriculture number of farms in each county producing each category of output.

Next the market values of all crops are determined. The county distribution for each crop sector, except hay and pasture, is also from the 1982 Census of Agriculture. As noted earlier, hay and pasture estimates are based on the market value of ranch and range-fed cattle.

Finally, a vector of distribution coefficients for each set of counties related to one state is created. Each county agriculture sector entry is divided by the sum of the respective agriculture sectors across all counties in the state to create a row vector of distribution coefficients for distributing the state level data to all counties.

Regional Dimensions

The regional dimensions of impact analysis are addressed in the impact area delineation. These include problem definition and consideration of certain political aspects of problem definition, spatial location, and income leakages due to changes in the rest of nation and rest of world.

Impact Area Delineation

The purpose of an impact area delineation is to provide a meaningful and useful spatial context for the area impact analysis. This step consists of defining the county or groups of counties (and/or states) that are appropriate for inclusion in the project or program effects being studied. Data files for the area selected will contain industry-based information (gross sales, value added and employment) along with necessary final demand information used to construct an input-output model.

Questions addressed are illustrated by the following: (1) What are the likely future effects of a proposed reduction in the total amount of land available for agricultural crop production in a given county or (2) what were the likely employment and income effects of past timber harvesting levels in a given area; or (3) what are the overall local economic effects of a new food processing facility in a given county? Different impact areas for each type of questions may be necessary to adequately develop the economic consequences of the policy or program being studied. The recurring in each of the questions, however, is the geographic extent of the daily activity field of which the problem focus is an integral part.

If only a single county is defined as the impact area, when it is in fact part of a multi-county daily activity field, the total impact of the policy or program being studied will be underestimated. By concentrating on a single county, therefore, the findings may prove less than fully relevant to the problem solution.

Typically, the delineation of an impact area for a targeted activity is based on activity linkages backward to local input suppliers or forward to local processors, wholesalers and retailers. The impact area, if correctly delineated, would include businesses and households that interact on a daily basis over a geographical area covering one or more counties and typically concentrating their activities at the largest population center, characterized by a broad range of goods and services available to its residents and visitors. Whether backward linked to input suppliers or forward linked to processors, wholesalers and retailers, the work force employed in the cluster of interrelated activities would be served by a broad range of residentiary, primarily services-producing, businesses.

If the targeted activity is, for example, a meat packing plant in a given county, employing a work force located primarily in an adjoining county, the location of targeted activity would remain paramount in the problem definition. Clearly, the employed work force for the meat packing plant would be located within the daily activity field of which the meat packing plant is an integral part, unless the meat packing plant were located in the periphery of two daily activity fields. In any event, for study purposes the two counties would be grouped together in one or the other of two daily activity fields, which may be represented also as funcitional economic areas or local labor market areas. The more populous daily activity field would generate the largest regional impact from a given change in the targeted activity.

The US Department of Commerce (BEA) has grouped all counties in the US into 183 Economic Areas based on such characteristics as journey-to-work distances and newspaper circulations, which also represent, in parts of the US, daily commuting fields or functional economic areas, as defined in this report. Smaller areas like the 382 USDA labor market areas delinated by Tolbert and Killian (1989) also have characteristics similar to the functional economic area and they, too, may be appropriatly used for a particular IMPLAN analysis. None of the delineations may be ideal for reporting the study results if some other (e.g., political) considerations take precedence.

In summary, the "ideal" impact area should be large enough to serve as a "functional economic area", i.e., an area with a variety of industries and support services to provide for a relatively high level of closure of local economic activity. It should be small enough such that the estimated impacts can be traced to the affected sectors of the regional economy. An ideal area also satisfies other criteria for defining the spatial characteristics of the study area.

Import Leakages and Substitutions

Finally, import leakages account for differences in regional multiplier values. Sub-national or sub-state regions generally have more "dollar leakage" than an entire nation with specific trade barriers or agreements simply because they are more "open" economies lacking the diversity of interacting economic units found in the larger geographic areas. They also are characterized by a specialized economic base that is more traded-dependent than for the nation as a whole, which also accounts for their lower multiplier values.

Import substitution is a form of economic development in which some commodity, previously imported, is now produced locally. This is a form of structural change in which specific assumptions about regional economic behavior are made. Changing the impact area's boundaries changes the mix and amount of imports for the endogenous industries.

Imports are considered an estimate of the amount of economic activity (leakage) that must occur somewhere else to support industries in the selected area. In short, including more counties reduces the leakages and normally increases the employment and income impact.

Applications to Agricultural Policy

Application of the IMPLAN system to agriculture policy and programs necessitates consideration of the timing of the policy and/or program effects, related price effects, and the industrial or institutional group targeted for the initial change. Treatment of production and consumption activities in input-output modeling emanating from policy and program changes are discussed, also, along with selected agricultural policy applications.

Technical Considerations

Time series. Timing of policy evaluations can be broadly grouped as either ex-ante, occurring prior to the implementation of the policy, or ex-post, occurring after the poicy has been initiated. Both types of application are appropriate. However, special consideration should be given to the base year of the data set used in each type of study--typically, the most recent being preferred. It is important to keep in mind, however, that an input-output model is used to construct a set of relationships for an area that is assumed to hold for some time period into the future. Earlier data sets are being maintained for the IMPLAN system that will permit longitudinal studies of the regional and local impacts of various agricultural policies.

The economic lag time for policy actions is also of concern in the IMPLAN evaluations of projects that have a construction phase, for example, with local impacts that differ from a previous exploration phase or later operating and closing down phases. Separation of each phase of a mineral development project--exploration, construction, operation and closure--would be appropriate in the IMPLAN evaluation.

Frequently questions arise concerning the duration of the ripple effects emanating from a given exogeneous change. Much depends on the structure and behavior of the economy. For economies that have a weak set of industrial linkages the time it takes for all rounds of effects to occur will be shorter than a robust and diverse economy with more internalization of economic activity and fewer leakages.

Price Changes. Input-output model applications are based on constant prices. In multi-year analysis, future year commodity prices are represented by base year prices. Because price change over time differ widely between sectors, individual sector prices deflators rather than an aggregate US price deflator, like those prepared by the US Bureau of Labor Statistics (1984), are used.

As Moses (1974) points out, the perfect elasticities of supply (no price change with quantity) are not represented in input-output models. With constant prices on the output side, input-output models assume that industries face a horizontal demand curve (implying a perfectly competitive market structure). The assumption of horizontal demand curves for agriculture sectors may be more appropriate relative to other industrial sectors with known downward sloping demand curves.

If price-induced output effects are expected, they may be independently estimated outside of the input-output model and then incremently evaluated. Such an anlysis would assume that there is no other price-induced effect within the economy. For situations where substantial price effects are expected or can not be assumed away, a computable general equilibrium (CGE) model (Berck et al., 1990) may be appropriately linked to the IMPLAN system.

Direct Effects. To correctly allocate the direct effects of a given change over specified industrial and institutional group(s), several factors must be accounted for, including the type of transaction, either market or non-market and the accounting conventions used in IMPLAN. Accounting conventions that are important to understand for using the IMPLAN system are related to how the data set is constructed and how subsequent models are built.

Market-oriented final demand is generally of the type with sales specified for a particular industry, e.g. the export sales of grain or timber commodities. Typically the policy or project being analyzed will specify sales level and address the question of regional employment and income effects stemming from the prescribed changes in sales level. A demand-driven input-output model will trace the backward linkages and effects from such a market-oriented sale. However, associated with the initial sales effects are often non-market transactions that should be evaluated. An example of such a non-market transaction is the proportion of annual gross Forest Service stumpage receipts (25-percent funds) that are returned to local governments for road construction and educational purposes. That part of local government spending results in employment and income changes that should be added to the processing and export sales changes of the initial forest service stumpage sales.

Another accounting convention concerns the trade, transportation and insurance sectors which are margined, or only contain the values associated with these services (U.S. Department of Commerce, 1980). Margined sectors and their use become important when initial direct sales are expressed in purchaser prices rather than in producer prices. For example, consumer purchases made while hunting on farm lands are typically in purchaser prices (U.S. Department of Interior, 1988). Allocating these expenditures to trade and transportation sectors means unbundling the total purchase price and determining the correct amount that are sales (margins) from the trade and transportations sectors; the balance of the expenditures are spread across other agriculture and manufacturing sectors as appropriate.

Economic activity estimates. Estimated number of jobs represent full and part time employment; conversions to full time equivalents is possible based on relationships given in the National Income and Product Accounts (NIPA). Because an input-output model is a linear representation of production effects, job increases, or job decreases (negative final demand values), are possible to estimate. Income effects, (payments to factors) are those made to labor (employee compensation), capital (property type income) and governments (indirect business taxes). Gross regional product (income derived) is the sum of all value added components, factor income plus indirect business taxes. Population effects are a linear function of the shifts in the number of jobs, determined by multiplying the change in employment by the population to employment ratio for the region (total population and employment for the area). These parameters are displayed in a variety of reports that depict the industrial distribution of the direct (initial stimulus), indirect (backward-lined industrial purchases), and the induced (household purchases) effects.

The household component of final demand of the regionalized model is often used to distribute purchases made locally from wage payments when they are given as the initial direct final demands. As an example, salary payments made to Forest Service employees are used as an initial final demand change when evaluating various Agency programs. The distributed initial direct effects stimulate additional indirect and induced economic activity that make up the total economic impacts of a particular policy. The MI SAM can then be used to evaluate the distribution of factor incomes amoung various income groups.

The IMPLAN system provides numerical detail for low, medium and high income household groups and, also, a complete distribution of institutional expenditures. In the case of households this distribution includes payments to governments in the form of income taxes as well as savings.

Other techniques include the use of industry direct coefficients (from the A matrix) as final demand expenditure profiles in place of single total sales figures (Alward and Wagner, 1990). This approach has the obvious advantage of having specified regional or policy variations for the industry in question.

Another technique concerns the regionalization of national production coefficients. For some studies the national average production function is inappropriate from either a physical input or timing standpoint. It is possible to use localized production functions that represent regional variations in production. The local production functions can either be derived from surveys of existing firms or possibly from computer generated crop budget systems. For example, Alward and Sullivan (1984) used ranch enterprise budgets to evaluate local rancher responses to grazing fee changes. From a timing perspective, however, the data base may not reflect recent trends in particular sectors as new technology is introduced or shocks from external sources occur, e.g., oil embargos.

Selected Program and Policy Applications

Applications of the IMPLAN system to wide variety of agriculture programs and policies have been conducted by many government agencies, universities and consultant groups. These applications include the USDA Forest Service and Bureau of Land Management in evaluations of timber, grazing, and mineral commodity production as well as recreational uses of federal lands. Use by the Forest Service has included evaluations of alternative long range planning strategies (U.S. Department of Agriculture, 1982; Alward and Palmer, 1983; and Siverts, 1983); policy initiatives such as proposed changes in grazing fees (Alward and Sullivan, 1984); and timber program evaluations (U.S. Department of Agriculture, 1987).

The Economic Research Service researchers have used the IMPLAN system to evaluate various agricultural and trade issues including textile imports, droughts, and Resource Conservation and Development (RCD) activities. Stults and Siverts (1988) evaluated the provisions of a 1989 textile bill that would have limited the value of textile imports by $3 billion. They estimated that if this amount of textiles were produced in the United States rather than imported, output in the cotton sector would change from a $1.6 million decline in Arizona to a $48.6 million gain in Texas. Allocations of larger textile import quotas to trading partners that purchase American raw cotton would benefit growers, especially in the west and southwest where a larger proportion of cotton production is exported. Extended impacts of higher producer prices on consumers were not evaluated.

Petrulis et al. (1989) evaluated drought effects on rural communities in Montana, North Dakota, Wisconsin, Illinois, and Ohio. They concluded that the direct effects depend on the importance of farming and amount of government help provided; indirect effects depended on local spending patterns by farmers, agribusiness and nonagriculture industries. They estimated that direct income loss due to drought as a percent of total gross regional output ranged from almost 18 percent in sparsely populated North Dakota to less than one percent in more industrialized Ohio.

A program review by the Economic Research Service (ERS) of the Resource Conservation and Development (RC&D) activity in the Nebraska Panhandle area was conducted by Kasal and Magleby (1988). They evaluated a broad range of projects including critical area treatments, facility construction for recreation, irrigation and flood control, recreation visitor expenditures and floodwater reduction benefits. Over an 18 year period the impacts were small compared to a base economy, never exceeding a 0.3 percent increase in any economic measure, even in peak impact years. They concluded that measures positively affecting the Panhandle economy may have an adverse impact on areas outside the region as the same amount of activity could have been generated in other areas with the same RC&D expenditures. A two-region input-output modeling system would more fully account for the differential effects of alternative geographic allocations of a given level of funding than the single region modeling system used in this study.

An evaluation of the Conservation Reserve Program (CRP) in three rural counties in Oregon was conducted by Martin et al. (1988). They concluded that individual farmers may benefit from program participation, but their communities may experience a net adverse impact if the retired land is productive or if inputs that are no longer purchased would have been bought locally. They found that the CRP represents a conflict between community and national policy objectives.

The report by Dicks et al. (1988) was identified those communities or areas of the Great Plains most likely to be adversely affected by CRP provisions. Program impacts on five aggregate sectors (agriculture production, input, and processing, manufacturing and households) for 10 western regions were summarized to show the regional change in income, employment and gross output for three program years (1987, 1991, and 1995). Agricultural production effects on income generally ranged from two to 10 percent in 1987 reaching a high of 37 percent in 1995 for the west Texas region.

Several observations on the CAP analyses are offered. The two cited applications concentrated on the agricultural production aspects of the CRP program. These studies assumed that crop production responses were the most important to evaluate. Others studies (e.g. Siegle, 1989) have evaluated the potential recreational activity that could occur on CRP lands, which depended on biological response estimates of game animals populating these lands as well as the expenditure profiles for hunters. Estimates for both game animals and expenditures are possible, but require time and money to accomplish that may not be readily available.

All of the CRP evaluations have rental repayments to farmers in the estimated program effects. However, the shift in the bill of goods that a CRP farmer makes while enrolled in the program, compared to pre-CRP participation, is critical to the analysis. Generally, very limited information is available for estimating marginal changes in consumption, which, therefore, necessitates the use of US averages rather than area-specific household consumption profiles in the area studies. These studies illustrate the wide range of local economic consequences of agricultural policies. They also illustrates the need to separate the policy or program components into separate direct affects for use in the IMPLAN application.

REFERENCES

1. Alward, G.S. and J. Wagner. 1990. Impact Analysis Combining Expenditure Patterns and Response Coefficients. A paper presented at the Southern Regional Science Association Meeting, Washington, D.C., March 22-25, 1990.

2. Alward, G. S. 1987. IMPLAN version 2.0: Methods used to Construct the 1982 Regional Economic Data Base. USDA Forest Service General Technical Report RM-000. Rocky Mountain Forest and Range Experiment Station, Fort Collins CO.

3. Alward, G. S. and Kostas Despotakis. 1987. IMPLAN Version 2.0: Data Reduction Methods for Constructing Regional Economic Accounts. USDA Forest Service General Technical Report RM-000. Rocky Mountain Forest and Range Experiment Station. Ft. Collins CO.

4. Alward, G.S. and B.J. Sullivan. 1984. Estimated Impacts of Increased Federal Grazing Fees on Income and Employment in 13 Western States. Appendix to the 1985 USFS/BLM Grazing Fee Study, October 5, 1984.

5. Alward, G.S. and C. Palmer. 1983. IMPLAN: An Input-Output analysis system for Forest Service Planning. In R. Seppala, C. Row and A. Morgan (eds.) Forest Sector Models: Proceedings of the First North American Conference on Forest Sector Modeling, Williamsburg, VA, Nov. 30-Dec. 4, 1981 (1983, pp. 131-140).

6. Beck, R.C., K.F. Harris, S.E. Kraft, and M.J. Wagner. 1990. Potential Economic Impacts of the proposed Cypress Creek National Wildlife Refuge. Appendix M of the Cypress Creek National Wildlife Refuge: Environmental Assessment, U.S. Department of the Interior, Minneapolis-St. Paul, MN,.

7. Berck, P., S. Robinson, and G. Goldman. 1990. The Use of Computable General Equilibrium Models to Assess Water Policies. Working Paper No. 545, Department of Agriculture and Resource Economics University of California at Berkeley; forthcoming chapter in A. Dinar and D. Zilberman, eds. The Economics and Management of Water Drainage in Agriculture, Amsterdam: Kluwer Publishing Company.

8. Boehlje, Michael, Philip M. Raup and Kent D. Olson, 1990. Land Values and Envrionmental Population. Paper prepared for Conference on Agriculture and the Environment, Lake Itasca, MN, September 24-29, 1990.

9. Bulmer-Thomas, V. 1982. Input-Output Analysis in Developing Countries. New York, John Wiley and Sons.

10. Dicks, M.R., R.W. Johnson, and W. Shalforth. 1988. Community Impacts of The Conservation Title of the 1985 Food Security Act. A draft report for discussion of the Great Plains Agriculture Council, Las Cruces, New Mexico, June 7-9, 1988.

11. Executive Office of the President, Office of Management and Budget. 1974. Standard Industrial Classification Manual. U.S. Government Printing Office, Washington, D.C.

12. Hanson, Kenneth A. and Sherman Robinson. 1989. Data, Linkages, and Models: U.S. National Income and Product Accounts in the Framework of a Social Accounting Matrix. Staff Report No. AGES 89-5, Economic Research Service, U.S. Department of Agriculture.

13. Kasal, J., and R. Magleby. 1988. Economic Impact Evaluation Using IMPLAN: A Case Study of the Nebraska Panhandle Project. Staff Report No. AGES870522, Economic Research Service, U.S. Department of Agriculture, 1301 New York Ave., NW, Washington DC, 20005-4788, 41 pgs.

14. Martin, M., H. Radtke, B. Eleveld, and S.D. Nofziger. 1988. The Impacts of the Conservation Reserve Program on Rural Communities: The Case of Three Oregon Counties. Western Journal of Agricultual Economics, 13(2): 225-232.

15. Miller, Ronald E. and Peter D. Blair. 1985. Input-Output Analysis: Foundations and Extensions. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

16. Moses, L.N. 1974. Outputs and Prices in Interindustry Models. Papers of the Regional Science Association, 32:7-18.

17. Olson, D., C. Schallau and W. Maki, 1984. IPASS: Interactive Policy Analysis Simulation System. USDA Forest Service Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-170.

18. Petrulis, M.F., J.E. Sommer, and F. Hines. 1989. Drought Effects on Rural Communities Vary by Strength of Local Nonfarm Economy. Rural Development Perspectives, U.S. Department of Agriculture Economic Research Service, Vol. 6, Issue 1, October 1989.

19. Pyatt, Graham, and A.R. Roe. 1977. Social Accounting for Development Planning with Special Reference to Sri Lanka. Cambridge University Press.

20. Radke, Hans and William Jensen. 1985. The West Coast Fisheries Economic Assessment Model. Developed for The West Coast Development Foundation, Portland OR.

21. Rawson, Jolan M. 1990. CRS Issue Brief, Agriculture and the Environment. Congressional Research Service, The Library of Congress, Washington D.C. Updated, August 9.

22. Salkin, Larry and Debra Lindsey. 1987. Using Micro Computers to Assess the Economic Impacts of the Earth Quake/85 Excercise. A paper presented at annual meeting of Society for Computer Simulation, San Diego, CA.

23. Schantz, Radford and Wilbur Maki, 1987. "Recent Innovations in Regional Impact Analysis by the Bureau of Mines." Paper presented at Western Regional Science Association Annual Meeting, November 13.

24. Schluter, Gerald. 1989, Private Communication. Economic Research Service, US Department of Agriculture, Washington, D.C.

25. Siegel, P.B. 1990. Economic Impacts of the CRP: Potential Trade-offs Between Agriculture Production and Recreational Activity in Virginia, an Application of the IMPLAN Input-Output Model. A paper presented at the Southern Regional Science Association Meeting, Washington, D.C., March 22-25, 1990.

26. Siverts, E. 1983. Uses of Input-Output Analysis in Forest Planning. A paper presented at the Midwest Forest Economist Conference, University of Wisconsin, Madison, WI, August 29-31, 1983.

27. Stevens, B.H., G.I. Treyz, D.J. Ehrlich, and J.R. Bower. 1980. Estimation of Regional Purchase Coefficients and Their Use in the Construction of Nonsurvey Input-Output Impact Models. Discussion Paper No. 119. Amherst Massachusetts: Regional Science Research Institute.

28. Stults, H. and E. Siverts. 1989. Regional Effects of U.S. Cotton Imports. Staff Paper prepared by U.S. Department of Agriculture, Economic Research Service, 1301 New York Ave., NW Washington D.C., 20005-4788, 11 pgs.

29. Tolbert, Charles M. and Molly Sizer Killian. 1987. Labor Market Areas for the United States. Agriculture and Rural Economy Division, Economic Research Service, US Department of Agriculture, Staff Report AGE870721.

30. United Nations, Department of Economic and Social Affairs. 1968. A System of National Accounts. Series F, No. 2 revision 3. New York: United Nations.

31. U.S. Department of Agriculture. 1982. National Forest System Land and Resource Planning. 36 CFR Part 219, Federal Register, Vol. 47, No. 190.

32. U.S. Department of Agriculture. 1987. Timber Sale Program Information Reporting System: Final report to Congress. Forest Service, Programs and Legislation, Policy Analysis Staff, Washington, D.C.

33. U.S. Department of Commerce. 1986. Definitions and Conventions of the 1977 Input-Output Accounts. Draft copy, Bureau of Economic Analysis, Washington D.C.

34. U.S. Department of Commerce. 1985. Census of Agriculture: 1982. U.S. Department of Commerce, Bureau of the Census. Washington, D.C.

35. U.S. Department of Commerce. 1984. Local Area Personal Income, 1977-82.

USDC, Regional Economic Information System, Bureau of Economic Analysis, Washington, D.C.

36. U.S. Department of Commerce. 1983. 1982 County Business Patterns. U.S. Bureau of the Census, Economic Surveys Division, Washington, D.C.

37. U.S. Department of Commerce. 1980. Definitions and Conventions of the 1972 Input-Output Study. Publication number BEA-SP 80-034, Bureau of Economic Analysis, Washington D.C.

38. U.S. Department of Commerce. 1977. BEA Economic Areas: Component SMSA's, Counties, and Independent Cities. Bureau of Economic Analysis, Washington, D.C.

39. U.S. Department of Interior. 1988. 1985 National Survey of Fishing, Hunting, and Wildlife Association Recreation. Fish and Wildlife Service, Washington D.C.

40. U.S. Department of Labor. 1984. Time series data for Input-Output, Price and Employment. Unpublished data from Office of Economic Growth and Employment Projections.

41. Zinn, Jeffrey A. CRS Report for Congress, Omnibus Conservation Proposals for a 1990 Farm Bills: Background and Comparison. Congressional Research Service, The Library of Congress, July 26.

APPENDIX: Accounts Construction

As previously mentioned, the way regional SAMs are constructed can be described as a series of four steps. Step 1, Estimate Gross Commodity Output, involves deriving the regional make matrix and consequently TCO, given the region's TIO. Step 2, Estimate Gross Commodity Consumption, focuses upon the region's total commodity requirements from industrial and institutional use as well as export trade. The results of Steps 1 and 2 are then combined in Step 3, Estimate Regional Commodity Trade, to determine all commodity import and export trade flows between the study region and the rest of the world. Step 4, Estimate Regional SAM Accounts, completes the accounts by deriving the remaining non-industrial submatrices.

STEP 1: Estimate Regional Commodity Output

Four tasks make up the first step in constructing the regional SAM. The first involves determining the commodity composition of industry production. This produces the regional make matrix narrowly defined to include only industrial production. As a second task, additions to regional commodity supply from non-industrial sources (e.g., sales of government commodity stocks, releases of inventories) augment the regional make matrix. The two sources of commodity supply for a region are combined to compute TCO in the third task. Finally, descriptive matrices are computed that show production market shares and industrial commodity composition.

Commodity production in a regional SAM account is described by the regional make matrix. Construction of this regional make matrix begins with estimates of regional TIO, from the MI data base. TIO is the value of all commodities produced by an industry, whether the industry produces one or many commodities. To construct the regional make matrix, the TIO for each industry that occurs in the study region is disributed among the commodities produced by that industry by using the national by-products matrix.

$$V = q^{\wedge\wedge}B^{*} \quad (1)$$

where:

V = regional make matrix

B* = national by-products matrix

$q^{\wedge\wedge}$ = diagonal matrix of regional TIO reciprocals

Each row of the regional make matrix represents an industry's production of commodities, and each column describes the amounts of a commodity produced by each industry. The sum of each column is the total output of commodities producted by the region's industries. In addition, non-industrial additions to supply sources, such as sales of commodities by governments may exist. This output of commodities may be used by the region's industries as intermediate inputs to further processing, which may be consumed or accumulated by local institutions, or it may be exported from the region.

Implicit in the calculation of the regional make matrix is the assumption that each regional industry produces commodities in the same proportions as the composite of all US establishments classified in that industry. There are obvious limitations to this assumption. For example, the sample may be dominated by larger firms and a small firm may produce commodities in different proportions than the sample aggregate of all U.S. firms. Further, each MI industry, approximating the four-digit Standard Industrial Classification (SIC) scheme, actually represents a composite of many similar firms, each of which may produce different mixes of commodities. For example, in the cases of agricultural products, the coefficients of the national by-products matrix are average coefficients for all farms. Many of the industries which comprise a MI industry at the national level may not occur in the study region. In the absence of better information the regional make matrix calculated in the above manner is a useful approximation of regional commodity production. However, MI provides methods for relaxing this assumption.

In addition, Step 1 includes estimates of regional non-industrial commodity sales (inventory and government sales), the calculation of total commodity output, and calculation of regional market shares and by-products matrices. Once the regional make matrix has been derived and TCO estimated, it is possible to construct both the regional market shares and by-product matrices. While these matrices are not critical to the remaining steps in constructing the regional accounts, they provide useful descriptive information about a regional economy and are important to the subsequent construction of I/O accounts.

STEP 2: Estimate Gross Commodity Consumption

The second step in constructing the regional SAM consists of five tasks. The objective of these tasks is to determine the combined consumption and accumulation requirements of the study region's industries and institutions for commodities plus the region's commodity sales to foreign buyers. The results are the estimated total commodity inputs required by the study region, either for its own use or for export, which may be fulfilled by using the region's own commodity output (determined in Step 1) or through the use of imported goods and services.

Gross industrial commodity consumption

A beginning point for determining the total commodity requirements is to estimate the inputs needed by each of the study region's industries. This involves the development of the regional use matrix. Since the region's TIO are available from the MI data base, the regional use matrix is derived using the national absorption matrix in a manner similar to the construction of the make matrix. This necessitates a similar assumption: the study region's industries utilize commodity inputs at the same rates as do the corresponding national aggregate industries. As with the assumption concerning commodity production, MI provides procedures for relaxing this default assumption. Avilability of regional estimates of factor inputs permits an improved approach, however.

Estimates of regional factor inputs have been derived from regional income statistics, and as a result reflect variations in regional wages, prices of primary inputs, and rates of profits as examples. They indicate that the rates at which industries in a study region utilize factor inputs may differ from the rates implied by the national absorption matrix, suggesting that the rates at which intermediate inputs are used differ as well.

Gross institutional commodity consumption

Households, governments and enterprises consume and accumulate commodities as to industries. The MI data base contains estimates of these total commodity requirements by a region's insttutions. Again, these are "gross" transactions, indicating that they represent purchases both from local and import sources.

Two components of external trade, foreign and domestic exports, complete the regional commodity consumption. Domestic exports are described below. Gross foreign commodity exports are given by the data base.

Finally, total regional commodity demand arising from the four major functions of a regional economy (production, consumption, accumulation and foreign exports) represents the total gross requirements for commodity inputs of all economic activities of the economy. These requirements are met either by utilizing the commodities supplied from local industrial production or they are obtained through import purchases.

STEP 3: Estimate Regional Commodity Trade

Five tasks are listed in Step 3 to determine the study region's import and export flows. A preliminary estimate of each commodity's RPC is made using econometric equations with regional weights. Accounting identities are met by using each commodity supply/demand pool ratio as the upper hand on the corresponding RPC.

The MI accounting format requires that the commodity specific regional purchase coefficient (RPC) be less than or equal to the supply/demand pooling value for that commodity. The supply/demand pooling value, for commodity k, is calculated by dividing total regional commodity demand by total regional commodity output:

$$S = c^*/g, \; 0 < S < 1.0 \qquad (2)$$

where

S = a (1 x k) vector of supply/demand pooling values.

If the commodity specific RPC is greater than the commodity's supply/demand pooling value, then the commodity's suppy/demand pooling value replaces the commodity specific RPC value in matrix R.

Applying the RPCs to the IMPLAN data base results in estimates of gross imports and exports. The RPCs are subsequently applied to the gross industry requirements matrix to produce a regional use matrix and corresponding industrial import matrices, and to the gross institutional requirements matrix to derive regional institutional demand matrices for locally-produced and imported commodities. Total imports and exports are estimated using the adjusted RPC matrix.

STEP 4: **Estimate Regional SAM Accounts**

Finally, the regional SAM accounts are estimated in two tasks by calculating (1) the "net flow" regional use, absorption and industrial commodity import matrices and (2) the regional institutional demand and commodity import matrices.

Earlier, a gross flows regional use matrix was calculated. The "net flow" (i.e., gross purchases less import purchases) regional use matrix is calculated in Step 4. The net flow regional absorption matix is calculated by:

$$A^{\sim} = U^{\wedge} g^{\wedge -1} \qquad (3)$$

where

$g^{\wedge}$ = a diagonal matrix of total industry outputs.

The industrial commodity import matrix is given by:

$$P = U^* \times (Z - R^*) \qquad (4)$$

where

P = the matrix of industrial commodity imports,
U^* = the gross flows regional use matrix,
Z = an (n x k) matrix of 1's,
R^* = the matrix of commodity specific RPC

Regional institutional demand and commodity imports are calculated next in a manner similar to the calculation of the regional use and the industrial commodity import matrices, respectively. The regional institutional demand matrix is calculated using the matrix of commodity specific RPCs.

$$G^{\sim} = G^* \times R^* \qquad (5)$$

where

$G^{\sim}$ = a matrix of net institutional commodity demand,

G^* = a matrix of gross institutional commodity demand,
R^* = a matrix of commodity specific RPC's

The institutional commodity import matrix is calculate using:

$$T = G^* \times (Z - R^*) \qquad (6)$$

where

T = a matrix of institutional commodity imports,
G^* = a matrix of gross institutional commodity demand,
Z = an (n x k) matrix of 1's,
R^* = a matrix of commodity specific RPC's.

Figure 1. General Components of MicroIMPLAN

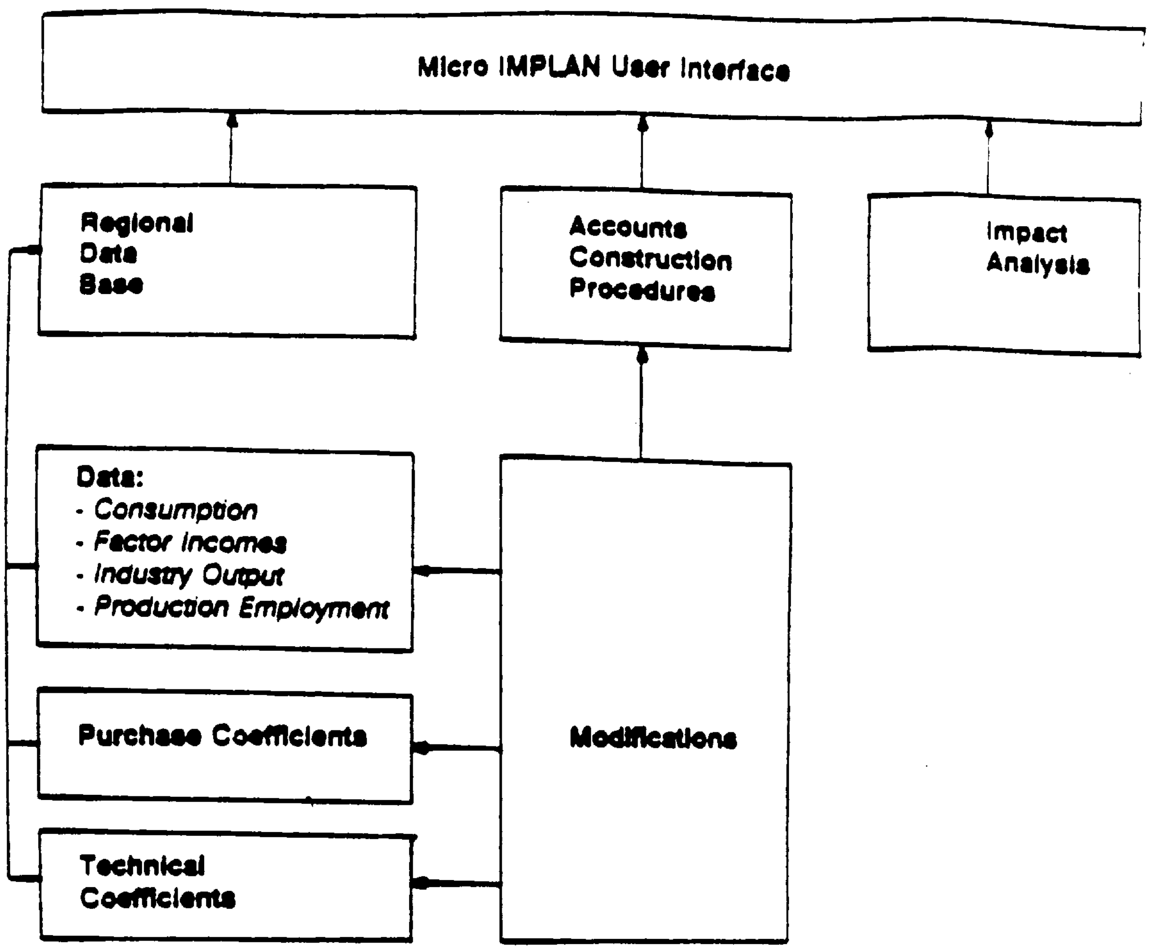

Table 1. Regional Accounting Submatrices

Submatrix and Symbol	Description
Industries	
T_{32}	Use Matrix
T_{42}	Factor Earnings
T_{72}	Domestic Commodity Imports by Industries
T_{82}	Foreign Commodity Imports by Industries
t_2	Total Industry Output
Commodities	
T_{23}	Make Matrix
t_3	Total Commodity Output
Factors	
T_{54}	Factor Distributions
T_{74}	Domestic Factor Imports
T_{84}	Foreign Factor Imports
t_4	Total Factors
Institutions	
T_{35}	Institutional Commodity Consumption
T_{55}	Interinstitutional Transfers
T_{75}	Domestic Commodity Imports by Institutions
T_{85}	Foreign Commodity Imports by Institutions
t_5	Total Institutional Expenditures and Receipts
Investment	
T_{36}	Investment Commodity Consumption
t_6	Total Investment
Domestic Exports	
T_{37}	Domestic Commodity Exports
T_{57}	Domestic Institutional Receipts
T_{77}	Domestic Commodity Transhipments
t_7	Total Domestic Exports
Foreign Exports	
T_{38}	Foreign Commodity Exports
T_{58}	Foreign Institutional Receipts
t_8	Total Foreign Exports

Figure 2 Comprehensive Regional Accounting System

RECEIPTS	EXPENDITURES 1	2	3	4	5	6	7	8	9	Total
A. Opening Asets										
1. Net Assets										
B. Production										
2. Industries			T_{23}							t_2
3. Commodities		T_{32}			T_{35}	T_{36}	T_{37}	T_{38}		t_3
C. Consumption										
4. Factors		T_{42}								t_4
5. Institutions				T_{54}	T_{55}		T_{57}	T_{58}		t_5
D. Accumulation										
6. Investment										t_6
E. Trade										
7. Domestic		T_{72}		T_{74}	T_{75}		T_{77}			t_7
8. Foreign		T_{82}		T_{84}	T_{85}			T_{88}		t_8
F. Ending Assets										
9. Net Assets										
Total		t_2	t_3	t_4	t_5	t_6	t_7	t_8		

Table 2. MicroIMPLAN Data and Structural Matrices

Transactions Data	Submatrix, Figure 2
A. Production and non-industrial sales	t2
1. Total industry output	
2. Federal government sales	
3. State and local government sales	
B. Institutional consumption	T_{35}
1. Total personal consumption expenditures, low income households (<$10,000/year)	
2. Total personal consumption expenditures, medium income households (between $10,000 and $30,000/year)	
3. Total personal consumption expenditures, high income households (>$30,000/year)	
4. Federal government military expenditures	
5. Federal government non-military expenditures	
6. State and local government education expenditures	
7. State and local government non-education expenditures	
C. Factors	T_{42}
1. Employee compensation	
2. Proprietary income	
3. Other property income	
4. Indirect business taxes	
D. Accumulation	T_{36}
1. Total capital formation (producer's durable equip)	
2. Inventory additions	
3. Inventory reductions	
4. Commodity Credit Corporation	
E. Trade	T_{38}
1. Foreign exports	
2. Non-comparable foreign imports	
Structural matrices	
A. Production	
1. National by-products matrix	T_{23}
2. National absorption matrix	T_{32}
B. Consumption and accumulation	
1. Interinstitutional matrix	T_{55}
2. Factor distribution matrix	T_{54}