Regional Economic Models for the State of Wisconsin: An Application of the Micro-IMPLAN Modeling System

Steven C. Deller
Assistant Professor
and Extension Community Development Economist
Department of Agricultural Economics
University of Wisconsin-Madison / Extension

N.R. Sumathi
Assistant Professor and Director
Center for Economic Development
University of Wisconsin-Superior / Extension

David Marcouiller
Assistant Professor
and Extension Tourism Development Economist
Tourism Research and Resource Center
University of Wisconsin-Madison / Extension

Staff Paper 93.6

Center for Community Economic Development
Department of Agricultural Economics
University of Wisconsin-Madison / Extension

November, 1993

CONTENTS

TABLES

INTRODUCTION

Increasingly, state and local governments require that economic impact analysis be undertaken before proposed investments or policy changes can be approved and implemented. These economic studies are comparable to enviromental impact studies and are intended to assess all aspects, both positive and negative, of the scenario under consideration. These types of questions also arise when communities are forced to face economic shocks, both positive and negative such as a firm opening or closing. Within Wisconsin, state and local officials routinely turn to University researchers and Cooperative Extension personnel to provide this information.

Answers to these questions requires the adoption of some type of methodological approach. While there are many methods of regional economic analysis, there has been a renewed interest in recent years in the use of regional input-output modeling. The renewed interest in input-output modeling is based on several factors. It is an excellent descriptive tool showing in detail the structure of an existing regional economy. It provides important information on individual sectors, behavior, and interactions within and between regional economies. It also shows the relative importance of sectors in terms of their contribution to the local economy. This descriptive aspect of input-output is particularly important because it allows both the analyst and policy-makers to develop a better understanding of the local economy which is so important to crafting sound economic development policy.

Input-output models of regional economies are helpful to the user because they provide a means to predict how the economy will respond to external changes, planned or unplanned. Therefore, it is a useful tool in prescriptive exercises where alternative policies must be evaluated based on the relative merits of alternative outcomes.

An additional reason for the renewed interest in regional input-output modeling is the increased availability of advanced computer software programs and databases. At the core of this increase is the development and release of the IMPLAN (IMpact analysis for PLANning) modeling system developed by the USDA Forest Service (Alward et al. 1989). The IMPLAN system is a powerful software system designed to construct state-of-the-art regional input-output models.

While the IMPLAN software package competes with several currently available input-ouput modeling software (e.g., GRIMP and ADOTMATR), the IMPLAN system provides regional databases for constructing custom models. The database has sufficient detail to create input-output models for any county and / or multi-county regions in the U.S. Combining a consistent database with a state-of-the-art computer software package allows the construction of individual input-output models for a multitude of county regions.

For the past several years the USDA Forest Service has employed IMPLAN to generate and apply regional input-output models. Due to the sheer number of analyses requested of the Forest Service, the developers of IMPLAN have elected to package the IMPLAN computer software and corresponding data sets into a user-friendly media. The Cooperative Extension has been entrusted with the dissemination of the IMPLAN system to interested users. Through a joint effort of the Center for Community Economic Development and the University of Wisconsin-Extension, the IMPLAN system is available for use through the University of Wisconsin-Extension.

The research presented in this report is based on the application of the IMPLAN modeling system to a representative county in Wisconsin, in this case Brown County which includes the City of Green Bay. While the model reported here may be used in preliminary policy analysis, it should be viewed as descriptive in nature. Detailed policy analysis should employ more detailed versions of the model after the IMPLAN provided database has been throughly checked for errors. The intent of this report is to introduce the county faculty to input-output analysis and more specifically to IMPLAN.

BASICS OF INPUT-OUTPUT MODELING

A simple nontechnical discussion of the formulation of input-output (IO) modeling is presented in this section. Similar descriptive treatments are readily available, including Hastings and Bruckner (1993).[1] More advanced discussions of input-output include Miernyk (1965), Hewings (1985), and Miller and Blair (1985). Readers familiar with the concepts of IO may wish to proceed to the analysis of the IO model for Brown County, Wisconsin.

As a descriptive tool, IO analysis represents a method for expressing the economy as a series of accounting transactions within and between the producing and consuming sectors. As an analytical tool, IO analysis expresses the economy as an interaction between the supply and demand for commodities. Given these interpretations, the IO model may be used to assess the impacts of alternative scenarios on the region's economy.

Transactions Table

A central concept of IO modeling is the interrelationship between the producing sectors of the region (e.g., manufacturing firms), the consuming sectors (e.g., households) and the rest of the world (i.e., regional imports and exports). The simplest way to express this interaction is a regional *transactions table* (Table 1). The transactions table shows the flows of all goods and services produced (or purchased) by sectors in the region. The key to understanding this table is realizing that one firm's purchases are another firm's sales and that producing more of one output requires the production or purchase of more of the inputs needed to produce that product.

The transactions table may be read from two perspectives. Reading down a column gives the purchases by the sector named at the top from each of the sectors named at the left. Reading across a row gives the sales of the sector named at the left to those named at the top. In the illustrative transaction table for a fictitious regional economy (Table 1), reading down the first column shows that the agricultural

---

[1] The book in which the Hastings and Brucker paper is contained is an excellent general reference for Input-Output modeling and its application to economic development.

Table 1. Illustrative Transactions Table

Processing Sectors	Agr.	Manu.	Ser.	HH	Exports	Total Output
	Purchasing Sectors			Demand		
Agriculture	10	6	2	20	12	50
Manufacturing	4	4	3	24	14	49
Services	6	2	1	34	10	53
Households (HH)	16	25	38	1	52	132
Imports	14	12	9	53	0	88
Total Inputs	50	49	53	132	88	372

firms *buy* $10 worth of their inputs from other agricultural firms. The sector also buys $4 worth of inputs from manufacturing firms and $6 worth from the service industry. Note that agricultural firms also made purchases from nonprocessing sectors of the economy, such as the household sector ($16) and imports from other regions ($14).[2] Purchases from the household sector represent value added, or income to people in the form of wages and investment returns. In this example, agricultural firms purchased a total of $50 worth of inputs.

Reading across the first row shows that agriculture *sold* $10 worth of its output to agriculture, $6 worth to manufacturing, $2 worth to the service sector. The remaining $32 worth of agricultural output was sold to households or exported out of the region. In this case $20 worth of agricultural output was sold to households within the region and the remaining $12 was sold to firms or households outside the region. In the terminology of IO modeling, $18 (=$10+$6+$2) worth of agricultural output was sold for intermediate consumption, and the remaining $32 (=$20+$12) worth was sold to *final demand*. Note that the transactions table is balanced: total agricultural output (the sum of the row) is exactly equal to agricultural purchases (the sum of the column). In an economic sense, total outlays (column sum, $50) equal total income (row sum, $50),

[2] Note that government has not been entered into the table. If government were to be introduced, payments would be in the form of taxes.

or supply exactly equals supply. This is true for each sector.

The transactions table is important because it provides a comprehensive picture of the region's economy. Not only does it show the total output of each sector, but it also shows the interdependencies between sectors. It also indicates the sectors from which the region's residents earn income as well as the degree of openness of the region through imports and exports. In this example households' total income, or value added for the region is $132 (note total household income equals total household expenditure), and total regional imports is $88 (note regional imports equals regional exports). more open economies will have a larger percentage of total expenditures devoted to imports.

Direct Requirements Table

Important production relationships in the regional economy can be further examined if the patterns of expenditures made by a sector are stated in terms of proportions. Specifically, the proportions of all inputs needed to produce one dollar of output in a given sector can be used to identify linear production relationships. This is accomplished by dividing the dollar value of inputs purchased from each sector by total expenditures. Or, each transaction in a column is divided by the column sum. The resulting table is called the *direct requirements table* (Table 2).

The direct requirements table, as opposed to the transactions table, can only be read down each column. Each cell represents the dollar amount of inputs required from the industry named at the left to produce one dollar's worth of output from the sector named at the top. Each column essentially represents a `production recipe' for a dollar's worth of output. Given this latter interpretation, the upper part of the table (above households) is often referred to as the matrix of technical coefficients. In this example, for every dollar of sales by the agricultural sector, 20 cents worth of additional output from itself, 8 cents of output from manufacturing, 12 cents of output from services, and 32 cents from households will be required.

Table 2. Illustrative Direct Requirements Table

Processing Sectors	Purchasing Sectors Agr.	Manu.	Ser.
Agriculture	.20	.12	.04
Manufacturing	.08	.08	.06
Services	.12	.04	.02
Households	.32	.51	.71
Imports	.28	.24	.17
Total Inputs	1.00	1.00	1.00

Columns may not sum because of rounding.

In the example region, an additional dollar of output by the agricultural sector requires firms in agriculture to purchase a total of 40 cents from other firms located in the region. If a product or service required in the production process is not available from within the region, the product must be imported. In the agricultural sector, 28 cents worth of inputs are imported for each dollar of output. It is important to note that in IO analysis, this production formula, or technology (the column of direct requirement coefficients), is assumed to be constant and the same for all establishments within a sector regardless of input prices or production levels.

Assuming the direct requirements table also represents spending patterns necessary for additional production, the effects of a change in final demand of the output on the other of sectors can be predicted. For example, assume that export demand for the region's agricultural products increases by $100,000. From Table 2, it can be seen that any new final demand for agriculture will require purchases from the other sectors in the economy. The amounts shown in the first column are multiplied by the change in final demand to give the following figures: $20,000 from agriculture, $8,000 from manufacturing, and $12,000 from services. These are called the *direct effects* and, in this example, they amount to a total impact on the economy of $140,000 (the initial change [$100,000] plus the total direct effects [$40,000]).

The strength of input-output modeling is that it does not stop at this point, but also measures the indirect effects of an increase in agricultural exports. In this example, the agricultural sector increased purchases of manufactured goods by $8,000. To supply agriculture's new need for manufacturing products, the manufacturing sector must increase production. To accomplish this, manufacturing firms must purchase additional inputs from the other regional sectors. For every dollar increase in output, manufacturing must purchase an additional 12 cents of agricultural goods ($8,000 x .12 = $960), 8 cents from itself ($8,000 x .08 = $640), and 4 cents from the service sector ($8,000 x .04 = $320). Thus, the impact on the economy from an increase in agricultural exports will be more than the $140,000 identified previously. The total impact will be $140,000 plus the indirect effect on manufacturing totaling $1,920 ($960 + $640 + $320), or $141,920. A similar process examining the service sector increases the total impact yet again by $1,440 ([$12,000 x .04] + [$12,000 x .06] + [$12,000 x .02] = $1,440).

The cycle does not stop, however, after only two rounds of impacts. To supply the manufacturing sectors with the newly required inputs, agriculture must increase output again, leading to an increase in manufacturing and service sector outputs. This process continues until the additional increases drop to an insignificant amount. The total impact on the regional economy, then, is the sum of a series of direct and indirect impacts. Fortunately, the sum of these direct and indirect effects can be more efficiently calculated by mathematical methods. The methodology was developed by Wassily Leontief and is easily accomplished in computerized models.

Total Requirements Table

Typically, the result is presented as a *total requirements table*, or the Leontief Inverse Table (Table 3). Each cell in Table 3 indicates the dollar value of output from the sector named at the left will be required *in total* (i.e., direct plus indirect) for a one dollar increase in final demand for the output from the sector named at the top of the column. For example, the element in the first row of the first column

Table 3. Illustrative Total Requirements Table

Processing Sectors	Purchasing Sectors Agr.	Manu.	Ser.
Agriculture	1.28	.17	.06
Manufacturing	.12	1.11	.07
Services	.16	.07	1.03
Total	1.56	1.35	1.16

indicates the total dollar increase in output agricultural production that results from a $1 increase in final demand for agricultural products is $1.28. The element in the second row of the first column indicates the total increase in manufacturing output due to a dollar increase in the demand for agricultural products is 12 cents.

An additional, useful interpretation of the transactions table, as well as the direct and total requirements tables, is the measure of economic linkages within the economy. Highly linked regional economies tend to be more self-sufficient in production and to rely less on outside sources for inputs. More open economies, however, are often faced with the requirement of importing production inputs into the region. The degree of openness can be obtained from the direct requirements table by reading across the imports row.[3] The higher these proportions are, the more open the economy is. The degree of linkage can be obtained by analyzing the values of the off-diagonal elements (those elements in the table with a value of less than one) in the total requirements table. Generally, larger values indicate a tightly linked economy, whereas smaller values indicate a looser or more open economy.

[3] Openness of the economy can also be discussed in terms of leakages; greater leakages translates into a more open economy.

Input-Output Multipliers

Through the discussion of the total requirements table, the notion of external changes in final demand rippling throughout the economy was introduced.[4] The total requirements table can be used to compute the total impact a change in final demand for one sector will have on the entire economy. Specifically, the sum of each column shows the total increase in regional output resulting from a $1 increase in final demand for the column heading sector. Retaining the agricultural example, an increase of $1 in the demand for agricultural output will yield a total increase in regional output equal to $1.56 (Table 3). This figure represents the initial dollar increase plus 56 cents in direct and indirect effects. The column totals are often referred to as *output multipliers.*

The use of these multipliers for policy analysis can prove insightful. These multipliers can be used in preliminary policy analysis to estimate the economic impact of alternative policies or changes in the local economy. In addition, the multipliers can be used to identify the degree of strucutural interdependence between each sector and the rest of the economy. For example, in the illustrative region, a change in the agriculture sector would influence the local economy to the greatest extent, while changes in the service sector would produce the smallest change.

The output multiplier described here is perhaps the simpliest input-output multiplier available. The construction of the transactions table and its associated direct and total requirements tables creates a set of multipliers ranging from output multipliers to employment multipliers.

The IMPLAN modeling system provides a set of three separate multipliers, all of which are specific to the IMPLAN system. The complete set include:

---

[4] Economic impact analysis is an attempt to model the impacts that an economic change has on regions. Input-output analysis specifies this economic change, most commonly, as a change in final demand for some product. Economists sometimes might refer to this as the "exogenous shock" applied to the system. Simply stated, this is the manner in which we attempt to introduce an economic change.

Type	Definition
1. Output Multiplier	The output multiplier for industry i measures the sum of direct and indirect requirements from all sectors needed to deliver one additional dollar unit of output of i to final demand.
2. Income Multiplier	The income multiplier measures the total change in income throughout the economy from a dollar unit change in final demand for any given sector.
3. Employment Multiplier	The employment multiplier measures the total change in employment due to a one unit change in the employed labor force of a particular sector.

The set of income multipliers may be further refined to include personal income, value-added, and total income multipliers.[5] The personal income multiplier represents a change in employee compensation for every dollar change in final demand for any given sector. The total income multiplier represents a change in total income (employee compensation plus proprietor income plus transfer payments) for every dollar change in final demand. Finally, the value-added multiplier represents a change in total value-added (employee compensation plus proprietary income plus other property income plus indirect business taxes) for every dollar change in final demand for a given sector. The basic difference across income multipliers is included in the definition of income.

While multipliers may be used to assess the impact of changes on the economy, it is important to note that such a practice leads to limited impact information. A more complete analysis is not based on a single

[5] Value added can be defined as the returns to factors of production. These basic factor inputs include land, labor, and capital resources. Regional value added specifies the location of factors of ownership. Often, economic development strategies focus on improving the regional value added within a certain economic sector. One example of this might include programs targeting processing firms to take advantage of regional raw materials such as milk, or timber. Regional process, such as milk into cheese or sawing timber into boards, represents increased utilization of land, labor, and capital resources thus increasing the value added of a region's raw materials.

Accounting systems assess value added in different ways. The IMPLAN system categorizes factor inputs into four categories. These include (1) employee compensation, (2) proprietary income, (3) other property income, and (4) indirect business taxes. The sum of these three equal the above defined value added. It is not fair to assume, however, that these are individually equal to land, labor, and capital factors since labor resources are found in both employee compensation and proprietary income. In a likewise fashion, capital factor inputs are found in both proprietary income and other property type income.

multiplier, but rather, on the complete total requirements table. A general discussion of the proper, and inappropriate, uses of multipliers is presented in an appendix to this text.

Limiting Assumptions

This cursory review of input-output modeling has employed the simpliest form of the IO model. The most direct simplification is the explicit removal of the household sector from the total requirements table. By removing households, the *induced* impact on final demand of increases in value-added, or income, is ignored. Hence, the output mulitipliers reported in Table 3 are an underestimate of the total impact of a one-time change in final demand. That is, if households were included as a sector in the total requirements table, a new set of multipliers, which would be larger than those reported in Table 3, could be obtained.

Other simplifying assumptions include, but are not limited to, the use of `super-sectors'. This example IO model explicitly uses only three sectors (agriculture, manufacturing, and services), yet the national IO model has 466 sectors. While working with a smaller number of sectors may make the modeling process easier and subsequent analysis more tractable, valuable information is lost. The small number of sectors in the model above was used only to stimulate the discussion of IO techniques and procedures.

Despite the simplicity of the example region, the values of input-output modeling as a policy tool are evident. Input-output modeling provides policy makers with a descriptive as well as an analytical tool, allowing the assessment of changes within the economy. Through the use of the total requirements table, economic impact analysis becomes a fairly direct exercise. While policy makers often turn directly to the model's multipliers, the IO model presents a vast array of economic information, ranging from the description of a sector's importance in the economy to the identification of areas for potential development (e.g., sectors exhibiting high imports).[6]

---

[6] More technical limitations to IO become apparent when the assumptions of IO are laid out, these include:

a. The output of each sector is produced with a unique set of inputs (i.e., there is no substitions between inputs).

b. The amount of input purchased by a sector is determined solely by its level of output (i.e., there are no price effects, changes in technology, or economies of scale).

IMPLAN AS A MODELING TOOL

The current version of IMPLAN is constructed on the basis of the national input-output model and allows for 528 producing sectors and 15 areas of final demand. Recalling the transactions table (Table 1), the IMPLAN system allows both the household sector and imports to be divided into four separate components. While the level of detail of the IMPLAN system is impressive, the value of the system comes to light in the supportive data sets used to regionalize the national IO table to county level regions. The strength of the system is its ability to construct custom IO models at the county level. For illustrative purposes a simple representation of Brown County, Wisconsin is selected for presentation and discussion. The 528 industrial sectors identified by the IMPLAN system were aggregated into 13 large sectors. These 13 industry sectors are outlined in the following list.

---

c. There are no external economies of scale (i.e., there are no agglomeration economies, or new industries are included in an addative manner).

d. The in-state and out-of-state distribution of purchases and sales is fixed.

e. There are no constraint on resources (i.e., supply is infinite and perfectly elastic).

f. Local resources are efficiently employed (no under employment of resources).

For this last assumption to hold, IMPLAN requires that all new employment come from employees moving into the region. Conversely, anyone who losses their job will leave the region.

1. Agriculture

- Dairy Farm Products[7]
- Poulty and Eggs
- Feed Grains
- Other

2. Forest Based

- Forest Products
- Millwork
- Other (including commercial fishing)

3. Mining

- Crushed and Broken Granite
- Construction Sand and Gravel
- Other

4. Construction

- New Residential
- New Industrial and Commercial Buildings
- Other

5. Agricultural Processing

- Frozen Foods
- Cheese
- Other

6. Nondurable Manufacturing

- Textiles
- Chemicals
- Other

7. Durable Manufacturing

- Machine Tools
- Electronic Computing Equipment
- Mobile Homes
- Other

---

[7] The sub-listings are only suggestive. The category "Other" contains the bulk of industries within each sector. A complete listing of the aggregation scheme is available from the authors.

8. Paper and Allied Products

    - Pulp Mills
    - Sanitary Paper Products
    - Other

9. Transportation, Utilities and Communications

    - Air Transportation
    - Railroads
    - Electric Services
    - Television and Radio
    - Other

10. Wholesale and Retail Trade

11. Tourism and Recreation

    - Hotels and Lodging Places
    - Eating and Drinking Places
    - Racing and Track Operations
    - Other

11. Financial, Insurance, and Real Estate (FIRE)

12. Services

    - Cleaning Services
    - Automotive Repairs
    - Hospitals
    - Other

13. Other Services

    - Schools
    - Non-Profit Organizations
    - Government
    - Other

Attention is paid to the special structure of Brown County's economy in the construction of these aggregate sectors.

To further simplify the model, the 15 final demand sectors are aggregated into a total of four sectors:

1. Households;
2. Governments;
3. Inventory Adjustments (Investments); and
4. Exports.

The four components comprising value-added were combined into one larger household group, and household and government final demand components also were combined into larger categories.

AN INPUT-OUTPUT MODEL FOR BROWN COUNTY, WISCONSIN

The IMPLAN generated transaction table for Brown County, Wisconsin is reported in Table 4.[8] Total output for the Brown County economy was nearly 9.4 billion dollars, of which 79.7 percent ($7.49 billion) was devoted to final demand, or final consumption. The remaining 20.3 percent ($1.9 billion) was consumed by producers located within Brown County. In terms of industrial contribution to regional output, Paper and Allied Products accounted for 18 percent ($1.69 billion), followed by Agricultural Processing industries with 17.6 percent ($1.58 billion) (Table 5). Natural resource extraction industries, including farm agriculture, forest based industries, and mining account for 2.2 percent of Brown County's regional economic output. This latter finding is reflective of the dominance of the City of Green Bay within Brown County.

Industries contribute to the regional economy, however, in several ways, the least of which may be total industry output. Returns to households, for example, is of particular importance. Within the framework of input-output, value added reflects wages and proprietor income. For Brown County, total value added accounted for 48.7 percent ($4.57 billion) of total industry output (recall total industry output must equal total industry payment). Trade services, including wholesale and retail industries, accounted for 14.5 percent ($664 million) of total value added, followed by Paper and Allied Products with 13.2 percent ($602 million). Other large contributors to value added include Services (12.6 percent; $577 million), finance, insurance and real estate (F.I.R.E.) (12.0 percent; $548 million), and transportation,utilities and communication industries (11.0 percent; $501 million). Note that Agricultural Processing, the second largest contributor to total industry output, accounted for only 6.5 percent ($295 million) of total value added. This may be explained in part by perhaps lower wages in these industries and the more capital

[8] The base year for this analysis is 1990.

Table 4. An Input-Output Transactions Table for Brown County, Wisconsin (1990 Millions of Dollars)

	PURCHASING SECTORS															
	AGR	FOREST	MINING	CONSTR	AG PROC	ND-MAN	D-MAN	PAPER	T-U-C	TRADE	RECRE	FIRE	SERV	OS(GOVT)	TIID	HH
AGR	6.829	0.250	0.001	1.234	74.537	0.019	0.031	0.281	0.161	0.076	1.139	6.493	0.801	0.443	92.296	2.774
FOREST	0.076	0.476	0.001	3.347	0.390	0.010	0.614	3.686	0.101	0.294	0.001	0.000	0.021	0.006	9.024	0.237
MINING	0.003	0.000	0.065	0.141	0.002	0.058	0.012	0.036	0.043	0.001	0.000	0.000	0.001	0.001	0.362	0.012
CONSTR	3.003	0.327	0.124	0.775	1.940	1.107	7.312	9.690	39.366	2.085	1.578	29.913	12.143	18.249	127.614	0
AG PROC	0.136	0.007	0.000	0.011	205.673	0.204	0.062	0.160	0.035	0.001	6.016	0.001	2.850	0.620	215.776	47.326
ND-MAN	0.799	0.515	0.035	0.975	25.223	6.206	8.108	16.969	2.182	8.167	1.856	3.279	6.292	1.411	82.017	5.557
D-MAN	1.483	0.544	0.024	6.566	5.500	3.569	61.585	17.781	0.786	0.179	0.241	0.061	8.922	0.509	107.751	7.302
PAPER	0.182	0.455	0.002	0.441	35.065	9.174	2.810	42.351	0.305	0.607	0.435	0.123	2.177	0.155	94.282	4.696
T-U-C	14.698	2.150	0.808	21.058	48.018	15.823	27.124	167.971	64.395	17.777	8.313	11.819	27.348	10.176	437.479	114.264
TRADE	5.148	1.972	0.144	38.336	40.218	9.846	25.242	56.067	7.098	1.356	2.594	0.799	15.352	1.300	205.471	380.593
RECRE	0.734	0.120	0.122	5.025	1.877	2.597	2.577	7.335	6.476	3.585	3.670	3.089	6.808	0.804	44.818	126.869
FIRE	7.511	0.385	0.346	4.721	4.465	3.083	6.342	6.866	10.877	9.594	4.748	38.922	41.866	6.382	146.109	491.177
SERV	2.876	0.894	0.230	59.888	16.958	10.528	17.715	18.562	22.437	17.022	8.647	20.699	67.457	5.065	268.977	524.589
OS(GOVT)	0.977	0.298	0.076	1.189	4.713	4.546	3.246	26.368	8.182	3.263	1.776	6.131	11.616	2.206	74.587	112.072
INST	0.363	0.084	0.021	2.267	1.348	0.527	1.447	2.801	0.607	0.417	0.159	0.684	1.670	-17.341		
TIIP	44.817	8.477	2.000	145.975	465.929	67.296	164.229	376.924	163.050	64.424	41.173	122.013	205.326	29.987		
TVA	53.06	10.621	8.877	232.405	295.33	140.033	365.336	602.44	500.974	664.089	123.061	547.719	577.568	453.541		
IMPORTS	72.541	12.687	3.126	206.268	897.145	142.752	257.324	711.614	173.225	37.502	41.091	97.007	234.565	33.879		
TIO	170.418	31.785	14.003	584.648	1658.404	350.081	786.889	1690.978	837.249	766.015	205.325	766.739	1017.459	517.407		1817.470

Abbreviation Definitions:

TIID: Total Intermediate Industry Demand
TIIP: Total Intermediate Industry Payment
TIO: Total Industry Output (Total Industry Outlay)
TVA: Total Value Added (Labor)

Table 5. Industry Contribution Summary Table

	Total Ind Output (TIO)	Total Value Added (TVA)	Imports	Exports
Agriculture	1.8%	1.2%	2.5%	1.6%
Forest Based	0.3	0.2	0.4	0.5
Mining	0.1	0.2	0.1	0.3
Construction	6.2	5.1	7.1	0.3
Agr. Processing	17.6	6.5	30.7	29.5
Non-durable Mfg.	3.7	3.1	4.9	5.5
Durable Mfg.	8.4	8.0	8.8	11.9
Paper/Allied Prod	18.0	13.2	24.4	33.9
Trans/Util/Comm	8.9	11.0	5.9	5.6
Trade	8.1	14.5	1.3	3.1
Toursim/Recreation	2.2	2.7	1.4	0.7
F.I.R.E.	8.2	12.0	3.3	2.6
Services	10.8	12.6	8.0	4.4
Other Services (govt)	5.5	9.9	1.2	0.2
Column Sum	100.0	100.0	100.0	100.0

Based on input-output table reported in Table 4.

intensive nature of the agricultural processing production process.

An important element of the regional input-output is that it provides a consistent method for estimating regional imports and exports. Indeed, this element is essential for the construction of the input-output model itself.[9] Export base theory of regional economic growth suggests that the key to growth and development is the promotion of export industries. The Micro-IMPLAN derived input-output model allows for the identification of export strong industries in Brown County. In 1990, 62.7 percent ($4.69 billion) of total industry output was exported from Brown County. By far the two largest contributors to exports are Paper and Allied Products which accounted for 33.9 percent ($1.59 billion) of all exports and Agricultural Processing at 29.5 percent ($1.38 billion). Given the total contribution of these two sectors to total industry output, this latter finding is not surprising.

A summary of industry sales (Table 6) reveals that a number of industries in Brown County export a majority of their respective output. Paper and Allied Products sells 94 percent of its output to consumers outside Brown County. Other industries which export a majority of their product include Mining (89.3 percent), Agricultural Processing (83.6 percent), Non-durable Manufacturing (74.3 percent), Durable Manufacturing (70.8 percent), and Forest Based industries (70.2 percent). The remaining sectors can be said to be "non-basic" in the sense that they tend to satisfy local demand either in the form of intermediate industry demand (sales to other industries) or local final demand (sales to local institutions including households and government).

While exports represent injections of money into the regional economy, imports of goods used in the production process represents leakages of money. Of the $9.4 billion in total industry final payment recall, which must equal total industry output), 31.1 percent ($2.92 billion) is spent to import goods used in the production process. These import levels may exist for three reasons: the goods are not available locally, the price of the imported goods is lower than locally available goods, and finally producers may not be aware of locally supplied goods. Networking local industries as a way to minimize import

[9] While a detailed discussion of the methods used in IMPLAN to derive interregional factor flows (i.e., importans and exports) is beyond the scope of this analysis, the IMPLAN system relies on regional purchase coefficients (RPCs) to create regional flows.

Table 6. Distribution of Industry Sales

	Total Intermediate Industry Demand	Exports	Local Final Demand
Agriculture	54.2%	43.5%	2.4%
Forest Based	28.4	70.2	1.5
Mining	2.6	89.3	8.2
Construction	21.8	2.2	76.0
Agr Processing	13.0	83.6	3.4
Non-durable Mfg	23.4	74.3	2.3
Durable Mfg	13.7	70.8	15.6
Paper / Allied Prod	5.6	94.0	0.4
Trans / Util / Comm	52.3	31.5	16.2
Trade	26.8	18.8	54.3
Tourism / Recreation	21.8	15.1	63.0
F.I.R.E.	19.1	16.1	64.9
Services	26.4	20.4	53.2
Other Services (govt)	14.4	1.8	83.8
Column Sum	100.0	100.0	100.0

Based on input-output transaction table reported in Table 4.

leakages is a popular economic development strategy and the Micro-IMPLAN generated input-output model can serve as a foundation for targeting industries. For example, 54.1 percent ($897 million) of Agricultural Processing's total outlay is for imports (Table 7). However, considering the nature of this industry it makes intutive sense that a significant portion of the imported goods are farm product from surrounding counties.

While the summaries (Tables 5, 6, and 7) of the transactions table (Table 4) provide useful descriptive information about the overall regional economy and the contribution of individual industries, the transactions table of the input-output model can also provide detailed information about individual industries. Reading down an industry column allows the analyst to decribe in detail the purchasing relation of that industry to the whole of the Brown County economy. Reading across an industry column allows for a detailed description of the selling relation of that industry to the whole of Brown County.

Use Paper and Allied Products as an example. Reading across the column reveals that this industry makes only small sales to other Brown County industries save for Agricultural Processing and sales to itself (e.g., pulp mill sales to a finished paper product mill). Sales to local institutions, such as households and government, is small, but sales to consumers outside Brown County (i.e., exports) is significant. Reading down the Paper and Allied Product column reveals the nature of purchases of the Paper industry. For example, the Paper industry makes significant purchases from the Transportation, Utilities and Communication Industry (e.g., significant consumption of electricity and transportation services), Trade, and Other Services (govt). Yet, total value added (labor) is nearly twice the dollar size as total intermediate industry purchases (payments) and imports accounts for 42.1 percent of total expenditures. Much like Agricultural Processing, the Paper industry in Brown County imports a significant portion of the raw wood used in the production process.

While the transactions table reported in Table 4 provides useful information, it is difficult to draw inferences as to the degree of linkage within the economy of Brown County. The direct requirements table, however, provides for easier interpretation because all purchases are placed in terms of one dollar's worth of output. Therefore linkages are not distorted by relative magnitudes. In addition, since all

Table 7. Distribution of Industry Payments

	Total Value Added	Imports	Total Intermediate Industry Payments
Agriculture	31.1%	42.6%	26.3%
Forest Baased	33.4	39.9	26.7
Mining	63.4	22.3	14.3
Construction	39.8	35.3	25.0
Agr Processing	17.8	54.1	28.1
Non-durable Mfg	40.0	40.8	19.2
Durable Mfg	46.4	32.7	20.9
Paper/Allied Prod	35.6	42.1	22.3
Trans/Util/Comm	59.8	20.7	19.5
Trade	86.7	4.9	8.4
Tourism/Recreation	59.9	20.0	20.1
F.I.R.E.	71.4	12.7	15.9
Services	56.8	23.1	20.2
Other Services (govt)	87.7	6.5	5.8

Based on input-output transaction table reported in Table 4.

purchases are in terms of one dollar, the interpretation of the technical coefficients of the direct requirements table is not sensitive to the year in which the model is based (e.g., 1990). A direct requirements table for Brown County is reported in Table 8.

Reading down the first column, the Agricultural Production industry, for each dollar worth of output Agricultural firms in Brown County purchase 4.01 cents worth of output from other Agricultural firms, but only .05 cents from Forest Based firms, and no purchases from Mining. The largest single input purchased for agricultural production is imports: for one dollar worth of output, 42.57 cents are spent on imports. This high level of imports is partially reflected of the openness of a small regional economy.

Examining the value added row, the more labor-intensive industries in Brown County come to light. In particular, the broad catagor Other Services, which is composed primarily of government services, appears to be the most labor intensive industry where 87.66 cents for every dollar worth of purchases is labor (also see the first column of Table 7). The trade services is the second most labor intensive with 86.69 cents of every dollar going to labor. The least labor intensive industry in Brown County is Agricultural Processing where only 17.81 cents of every dollar is spent on labor. A simular analysis can be conducted for regional imports by examining the bottom row of the table.

While the direct requirements table provides a measure of the first-round impacts of a total change in final demand for any particular industry, it does not provide insight into the combined direct and indirect effects. These combined effects are easily obtainable from the total requirements table (or Leontief Inverse table). A total requirements table for Brown County is presented in Table 9. For illustrative purposes, suppose that final demand for agricultural products increase by $1 million. Reading down the first column of the total requirements table for Brown County reveals that the total change in output in the agricultural industry will be $1,042,400. This total includes the intitial impact of the $1 million increase in final demand plus $42,400 worth of direct and indirect impacts on the agricultural industry.

Because of the linkages between the agricultural and forest industries within Brown County, an increase in final demand for agricultural products results in both direct and indirect impacts on the forest based industry. Again, reading down the first column of Table 9 shows the impact as $700. In other

Table 8. An Input-Output Direct Requirements Table for Brown County, Wisconsin

	PURCHASING SECTORS										
	AGR	FOREST	MINING	CONSTR	AG PROC	ND-MAN	D-MAN	PAPER	T-U-C	TRADE	RECRE
AGR	0.0401	0.0079	0.0001	0.0021	0.0450	0.0001	0.0000	0.0002	0.0002	0.0001	0.0056
FOREST	0.0005	0.0150	0.0001	0.0057	0.0002	0.0000	0.0008	0.0022	0.0001	0.0004	0.0000
MINING	0.0000	0.0000	0.0046	0.0002	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000
CONSTR	0.0176	0.0103	0.0088	0.0013	0.0012	0.0032	0.0093	0.0057	0.0470	0.0027	0.0077
AG PROC	0.0008	0.0002	0.0000	0.0000	0.1240	0.0006	0.0001	0.0001	0.0000	0.0000	0.0293
ND-MAN	0.0047	0.0162	0.0025	0.0017	0.0152	0.0177	0.0103	0.0100	0.0026	0.0107	0.0090
D-MAN	0.0087	0.0171	0.0017	0.0112	0.0033	0.0102	0.0783	0.0105	0.0009	0.0002	0.0012
PAPER	0.0011	0.0143	0.0001	0.0008	0.0211	0.0262	0.0036	0.0251	0.0004	0.0008	0.0021
T-U-C	0.0862	0.0676	0.0577	0.0360	0.0290	0.0452	0.0345	0.0993	0.0769	0.0232	0.0405
TRADE	0.0302	0.0621	0.0103	0.0656	0.0243	0.0281	0.0321	0.0332	0.0085	0.0018	0.0126
RECRE	0.0043	0.0038	0.0088	0.0086	0.0011	0.0074	0.0033	0.0043	0.0077	0.0047	0.0179
FIRE	0.0441	0.0121	0.0247	0.0081	0.0027	0.0088	0.0081	0.0041	0.0130	0.0125	0.0231
SERV	0.0169	0.0281	0.0165	0.1024	0.0102	0.0301	0.0225	0.0110	0.0268	0.0222	0.0421
OS(GOVT)	0.0057	0.0094	0.0054	0.0020	0.0028	0.0130	0.0041	0.0156	0.0098	0.0043	0.0087
TVA	0.3114	0.3342	0.6339	0.3975	0.1781	0.4000	0.4643	0.3563	0.5984	0.8669	0.5993
IMPORT	0.4257	0.3992	0.2232	0.3528	0.5410	0.4078	0.3270	0.4208	0.2069	0.0490	0.2001

Table 9. An Input-Output Total Requirements Table for Brown County, Wisconsin (The Leontied Inverse)

	PURCHASING SECTORS										
	AGR	FOREST	MINING	CONSTR	AG PROC	ND-MAN	D-MAN	PAPER	T-U-C	TRADE	RECRE
AGR	1.0424	0.0087	0.0005	0.0026	0.0536	0.0004	0.0003	0.0004	0.0006	0.0003	0.0078
FOREST	0.0007	1.0154	0.0002	0.0059	0.0004	0.0002	0.0010	0.0024	0.0005	0.0004	0.0001
MINING	0.0000	0.0000	1.0046	0.0003	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000
CONSTR	0.0262	0.0167	0.0138	1.0062	0.0056	0.0078	0.0135	0.0128	0.0530	0.0052	0.0126
AG PROC	0.0013	0.0006	0.0004	0.0008	1.1418	0.0011	0.0004	0.0004	0.0005	0.0003	0.0343
ND-MAN	0.0063	0.0186	0.0033	0.0038	0.0189	1.0194	0.0123	0.0117	0.0036	0.0113	0.0108
D-MAN	0.0107	0.0200	0.0024	0.0136	0.0054	0.0122	1.0857	0.0124	0.0022	0.0008	0.0024
PAPER	0.0016	0.0157	0.0004	0.0014	0.0255	0.0276	0.0045	1.0262	0.0007	0.0012	0.0034
T-U-C	0.1024	0.0829	0.0657	0.0467	0.0466	0.0566	0.0446	0.1145	1.0883	0.0276	0.0506
TRADE	0.0354	0.0676	0.0126	0.0695	0.0320	0.0318	0.0373	0.0372	0.0137	1.0033	0.0166
RECRE	0.0063	0.0057	0.0100	0.0105	0.0026	0.0089	0.0047	0.0061	0.0095	0.0054	1.0195
FIRE	0.0521	0.0179	0.0288	0.0158	0.0081	0.0130	0.0121	0.0080	0.0177	0.0151	0.0288
SERV	0.0279	0.0387	0.0229	0.1151	0.0176	0.0377	0.0309	0.0191	0.0386	0.0264	0.0511
OS(GOVT)	0.0082	0.0120	0.0069	0.0046	0.0051	0.0151	0.0059	0.0179	0.0116	0.0052	0.0106
TYPE I Output Multiplier	1.3213	1.3203	1.1724	1.2966	1.3632	1.2318	1.2530	1.2691	1.2405	1.1026	1.2487

words, for the agricultural industry to increase production to satisfy the new level of demand, initial, direct, and indirect, the forst based industry must increase output by $700. A similar process occurs within each industry (i.e., movement down the first column) in Brown County. The total impact on the Brown County economy, in terms of industry output, is measured by the sum of the individual effects (i.e., the cloumn sum), or $1,321,300. The simple Type I output muliplier for agriculture in Brown County is 1.3213. Thus, for every dollar increase in final demand for agricultural products in Brown County, total output in Brown County will increase by slightly more than $1.32. Based on these simple output multipliers the industrial sector that appears to have the largest inter- and intra-industry linkages, hence impact, is the Agricultural Processing industry (1.3632), while the industry with the smallest degree of linkage, hence impact is the Trade industry (1.1026) which includes retail and wholesale industries.

The key to the relative size of the Type I output multiplier reported in Table 9 is the share of total final payments that is devoted to interindustry payments; the larger the share, the larger the ripple or multiplier effect of a change in final demand. As the model has been developed there are two reasons why the share of total inter- and intra-industry linkages may be higher or lower. First is the level of imports required for the production process. The larger the share of imports, the greater the degree of leakage, hence multipliers by definition must be smaller. A general policy rule that is often helpful suggests that the more open a regional economy (i.e., more imports and leakages), the smaller the multiplier effect. As previously mentioned, a viable development strategy that has been widely pursued targets strengthening inter- and intra-industry linkages, thus lowering imports (leakages) and maximizing the multiplier effect.

The second source of leakages not captured by this simple Type I multiplier is that of labor. Note in Table 9 that labor (or value added) has explicitly been removed from the total requirements table. The economic interpretation is that there is no labor in the production process; clearly an unreasonable assumption. If final demand were to increase, as in the agricultural example provided above, not only would the purchase of other inputs need to increase, but also labor. This is accomplished by "closing" the model with respect to labor. By restructuring the total requirements table induced income effects are captured. In other words, because labor is now explicit in the total requirements table, increased income earned by labor is free to enter the regional economy, thus producing an induced effect. The resulting Type III multipler will always be larger than the simplier Type I multiplier because of the additional induced effect. A complete set of Type III multipliers for Brown County is provided in Table 10. Note that in each case, the Type III output multiplier is larger than the simplier Type I output multiplier, again the difference being the treatment of labor income.

AN EXAMPLE IMPACT ANALYSIS FOR BROWN COUNTY

The value of the using input-output as a modeling tool to provide both descriptive information of the regional economy and conduct economic impact analysis can best be seen in an example. We have already demonstrated the power of the approach as a descriptive tool in Tables 4 through 7. We have also hinted at how the tool can be used to analysis changes in the economy through Tables 9 and 10. A more complete impact analysis, however, can be conducted by using variations of the complete total requirements table (Tables 3 and 6).

To see this, a simple case-study approach is adopted. Assume, for illustrative purposes, that final demand for paper products produced in Brown County decreases by $500 million. This level of decrease might be akin to a paper mill closing. If we were to conduct a simple multiplier analysis we would turn to the appropriate type of multiplier from Table 10 for the correct industry. For a change in industry output, we would use an output multiplier for the paper industry. From Table 10, we see that the value of the output multiplier is 1.506, thus total industry output for Brown County would decrease by $753 million ($500 × 1.506).[10]

To compute an employment impact we would need to know the initial number of jobs being eliminated at the paper mill. For the sake of the example, assume this is about 2500 positions. Again, from Table 10, the appropriate employment multiplier is 2.885. Thus, total employment in Brown County

[10] Recall that these are Type III multipliers, thus labor income, or induced, impacts are included.

Table 10. Economic Mulitpliers for Brown County, Wisconsin

Sector	Output	Peronal Income	Total Income	Employment
Agriculture	1.838	4.538	2.659	2.116
Forest Based	1.860	2.210	2.507	2.186
Mining	1.489	1.693	1.498	2.027
Construction	1.837	2.058	2.246	2.321
Agr. Processing	1.553	2.378	2.381	3.337
Non-Durable Mfg.	1.620	1.938	1.904	2.179
Durable Mfg.	1.579	1.728	1.712	2.262
Paper-Allied Prod.	1.506	1.855	1.835	2.885
Trans/Util/Comm	1.598	1.856	1.619	2.245
Trade	1.970	1.630	1.790	1.665
Tourism/Recreation	2.683	2.126	2.820	1.721
F.I.R.E.	1.547	2.381	1.543	2.077
Services	2.004	1.888	2.040	1.872
Other Services (govt)	2.088	1.500	1.723	1.663

These are Type III multipliers, thus labor income, or induced impacts, are captured.

would decrease by 7212 (2500 × 2.885). Given appropriate income, or wage data, we could complete the analysis for income.

The limitation to this approach is that it provides little if any insight into the distribution of the impacts over the regional economy. This makes planning difficult if not next to impossible. A superior approach is to use the information contained in the total requirements table to derive the impact estimates. Recall that the multiplier is a summary scalar describing the information contained in the complete direct requirements table. We have conducted such an analysis using the IMPLAN impact routines. We programmed the scenario simply as a decrease in final demand (equivalent to a decrease in industry output) by $500 million. The results of this fuller analysis is reported in Table 11.

Upon examining the information contained in Table 11, even in this aggregated form, a much greater level of detailed information becomes available. For example, not only does the model provide an estimate of total decline in industry output, $759.5 million, but it also provides a detailed information on the distribution of that impact over the whole of Brown County's economy. Naturally, the largest impact is in the paper sector itself at $513.6 million. This figure includes the intitial $500 million reduction, plus $13.6 million in additional rippling impacts in the paper sector. The next hardest impacted sector is the transportation and utility sector with output declining by $67.4 million. When one considers the energy and transportation intensiveness of the paper industry, this result is not surprising. But it provides policy-makers with much valued additional insight. The least effected sector is mining, with output declining about $19,000.[11]

Although fixed proportion techologies is considered a weakness of input-output modeling (i.e., no input factor substitution or economies of scale in production), it does provide the analyst with an approach to gaining additional information conerning the scenario under consideration. For example, by using fixed employment-output ratios, it is possible to translate a change in output to a change in employment. We can also use simular types of ratios to derive information about the impact on the

---

[11] Mining is probably affected through the decline in the construction industry and the corresponding decline in demand for concrete and gravel.

Table 11. Summary Analysis of a Closing of a Paper Mill in Brown County

Industry	TIO (MM$)	Employee Comp Inc (MM$)	Total Value Added (MM$)	Employment (Number of Jobs)
AGRICULTURE	-.9097	-.0745	-.2832	-12.72
FOREST BASED	-1.2353	-.3282	-.4128	-17.45
MINING	-.0189	-.0048	-.0119	-.17
CONSTRUCTION	-8.9604	-2.7727	-3.5619	-119.36
AGR. PROCESSING	-3.7036	-.4049	-.6595	-12.35
NONDUR-MANUFACTURE	-6.9588	-1.7284	-2.7835	-71.04
DUR-MANUFACTURE	-7.0823	-2.0711	-3.2882	-59.72
PAPER-ALLIED PRODS	-513.6318	-111.2731	-182.9901	-2470.99
TRANS/UTIL/COMM	-67.4081	-17.2276	-40.3341	-614.95
TRADE	-41.6321	-24.1214	-36.0925	-1241.60
TOURISM-RECREATION	-11.0627	-6.1561	-6.6304	-523.97
FIRE	-36.0720	-5.0354	-25.7680	-349.65
SERVICES	-44.4254	-18.7804	-25.2184	-1031.54
OTHER SERVICES(GOVT)	-16.4098	-13.3890	-14.3843	-545.63
TOTAL	-759.5107	-203.3676	-342.4189	-7071.14

Change in Population = -11179.

Scenario: Final demand for a paper mill in Brown County decreases by $500 million dollars. It is assumed that the plant will close.

various measures of income.

By applying such ratios along with the full direct requirements table we see that total employment declined by 7071 jobs as a result of the initial $500 million decrease in demand for paper products in Brown County. Again, the largest sector affected is the paper industry itself, followed by a 1242 job loss in the trade (retail and wholesale) sector and a 1032 job loss in the services sector. This latter finding is expected when one considers the loss in wages and salaries from the mill closure.[12] Again, the smallest impacted sector for employment is the mining sector.

It is also of interest to note that IMPLAN provides an estimate of the change in population that will

[12] Again, it is important to recall that the analysis reported here includes induced impacts. Generally, analysis that includes induced impacts (i.e., changes in labor income) will find large impacts in the trade and service sectors due to the change in labor spending. Analysis that does not include induce impacts will find much smaller impacts in the trade and service sectors.

result from the scenario under consideration. Because input-output assumes that all resources are fully employed, the model does not allow for these 7071 persons to be either unemployed or find other employment within the region. Rather, the model assumes that all these people, along with a fix proportion of additional people (i.e., family members), will be forced to leave the region. One may reasonably argue that this is an unrealistic assumption; people are often tied to a region for personal (e.g., family) and financial (e.g., home ownership) reasons and are not perfectly mobile as the model requires. Therefore, one may reasonable suggest that the estimated impacts provided by IMPLAN are a "worse case" scenario. Even in light of the relatively restrictive assumption of input-output, this example for Brown County demonstrates the power of the model as both a descriptive tool and an analytic tool for conducting economic impact analysis.

SUMMARY AND CONCLUSIONS

The need for sound economic analysis in policy evaluation is unquestionable. One manner in which this analysis can be provided is through the use of economic modeling methods. One such method that is gaining favor due to ease of interpretation and computation is the input-output model.

This report has attempted to provide the reader with a cursory introduction to the concepts of input-output modeling. Using an input-output modeling system developed by the USDA Forest Service, Micro-IMPLAN, a simple input-output model for Brown County, Wisconsin was constructed and described. Through the use of the transactions table, a descriptive analysis of Brown County's economy was provided. Through the use of the direct requirements table, an indication of inter-industry linkages was provided. The total requirements table (Leontief Inverse) provided a method for assessing the impact of a change in final demand for regional products. A table of output, income, and employment multipliers that may be used to assess the impacts of changes in the Brown County economy is a product of this exercise.

In conducting impact analysis, practitioners are often asked what the multiplier effect of a change in final demand will be on the regional economy. If available, the practitioner will be tempted to turn to a set of multpliers such as those reported in Table 10. This practice should be discouraged for several reasons. First, historically, region specific multipliers, such as those for Brown County, have been difficult to obtain. Hence, practitioners may inappropriately apply multipliers for another region, most commonly the state. Because all regional economies are unique, errors will result. Also, if state multipliers are used, the level of openness (leakage) will be smaller, thus the impact will be over-stated for the region of interest. Second, and perhaps more fundemental, is the inherent lack of detailed information derived from the analysis. For example, if a new business in the region were to employ 100 people and the appropriate employment multiplier is 1.5, the economic impact will be 150 new jobs. *The level of information that this type of analysis provides borders on being insignificant.* No insight is provided in terms of income generated, changes in local business activity, or more importantly, which businesses within the region will be the most affected. Finally, the level of industrial aggregation introduces yet another source of error. While the input-output model generated for this report contains only fourteen sectors, the full Micro-IMPLAN model for Brown County consistents of 228 individual sectors.

Working with a regional economic modeling system such as Micro-IMPLAN helps over-come these problems. First, the region of analysis can be costume to the problem at hand. Second, the full total requirements table can be used to "decompose" the total impact into industry specific impacts. Third, sectoral detail becomes relatively easy within the modeling system.

Clearly, Micro-IMPLAN provides an opportunity to provide local policy-makers with detailed descriptive information which can be used to help better understand the regional economy. The database upon which Micro-IMPLAN is built is extremely detailed. Indeed, the data is detailed to the point that care must be taken when examining the descriptive information. Micro-IMPLAN can also serive as a valuable tool for planning, whether the planning take place in a proactive or reactive mode.

References

Alward, Greg, Eric Siverts, Doug Olson, John Wagner, Dave Senf and Scott Lindall. 1989. Micro-IMPLAN.USDA Forest Service, Fort Collins, CO.

Hasting, Steven and Sharon Bruckner. 1993. "An introduction to regional input-output analysis." in Microcomputer-Based Input-Output Modeling: Applications to Economic Development. Editors, Daniel M. Otto and Thomas G. Johnson, Boulder, CO: Westview Press.

Hewings, Geoffrey J.D. 1985. Regional Input-Output Analysis. London: SAGE Publications.

Lamphear, F.C., and Ron Konecny. 1986. ADOTMATR. Lincoln, NE: Resource Economics and Management Analysis.

Miernyk, William H. 1965. The Elements of Input-Output Analysis. New York: Random House.

Miller, Ronald E., and Peter D. Blair. 1985. Input-Output Analysis: Foundations and Extensions. Englewood Cliffs, N.J. Prentice-Hall.

West, Guy. 1988. GRIMP: Input-Output Analysis Computer Program. St. Lucia: University of Queensland.

Appendix A

Misuses and Evaluation of Economic Multipliers[13]

Multipliers are often misused or misunderstood. Problems frequently encountered in applying multipliers to community change include: (1) using different multipliers interchangeably; (2) double counting; (3) pyramiding; and (4) confusing multipliers with other economic measurements, such as turnover and value added. Please note that if IMPLAN is used to generate the multipliers used in the analysis, many of the concerns outline in this appendix are moot.

MISUSES OF MULTIPLIERS

(1) Interchanging Multipliers. As mentioned earlier, multipliers can be estimated for changes in business output, household income, and employment. These different multipliers are sometimes mistakenly used interchangeably. This should not be done, as the sizes of the multipliers are different—and they measure totally different types of activity.

(2) Double Counting. Unless otherwise specified, the direct effect or initial change is included in all multiplier calculations. Consider, for example, a mining business multiplier of 2.20. The 2.20 represents 1.00 for the direct effect, and 1.20 for the indirect effects. The direct effect is thus accounted for by the multiplier and should not be added into the computation (double counted). A $440,000 total impact resulting from an increase of $200,000 in outside income (using the above 2.20 multiplier) includes $200,000 direct spending, plus $240,000 for the indirect effects. The multiplier effect is sometimes thought to refer *only* to the indirect effect. In this case, the initial impact is added to the multiplier effect, and is thereby counted twice—yielding an inflated estimate of change.

[13] This material is based on the reported prepared by Eugene Lewis, Russ Youmans, George Goldman, and Garnet Premer, "Economic Multipliers: Can A Rural Community Use Them?" Western Rural Development Center, Oregon State University, Corvallis, OR. WREP 24, October, 1979.

(3) Pyramiding. A more complicated error in using multipliers is pyramiding. This occurs when a multiplier for a nonbasic sector is used, in addition to the appropriate basic sector multiplier.

For example, sugar beet processing has been a major contributor to exports in many western rural counties. Assume the local sugar beet processing plant were closed, and local officials wanted to determine the economic effect of the closing, as well as the subsequent effect upon local farmers. The multiplier for the sugar beet processing sector includes the effect upon farms raising sugar beets, because the sugar beet crop is sold to local processors and not exported. Therefore, the processing multiplier should be used to measure the impact of changes in the sugar industry on the total economy. The impact estimate would be pyramided if the multiplier for farms, whose effects had already been counted, were added to processing.

Double counting and pyramiding are particularly serious errors because they result in greatly inflated impact estimates. If inflated estimates are used in making decisions about such things as school rooms or other new facilities, the results can be very expensive, indeed.

(4) Turnover and Value Added. Economic measurements incorrectly used for multipliers also result in misleading analysis. Two such examples are turnover and value added. Turnover refers to the number of times money changes hands within the community. In Figure 1, for example, the initial dollar "turns over" five times; however, only part of the initial dollar is respent each time it changes hands. Someone confusing turnover with multiplier might say the multiplier is 5, when the multiplier is actually only 1.66.

Value added reflects the portion of a product's total value or price that was provided within the local community. The value added would consider the value of a local raw product—like wheat delivered to the mill—and subtract that from the total wholesale value of the flour, then figure the ratio between the two. With cleaning losses, labor, bragging, milling, etc., the wholesale value may represent several times the value of the raw product and may be a fairly large number.

EVALUATING MULTIPLIERS

The determination of whether a multiplier is accurate can be a complicated procedure requiring time, extensive research, and the assistance of a trained economist. On the other hand, there are several questions that anyone who uses multipliers should ask. Essentially the test of accuracy for a multiple is: *How closely does that multiplier estimate economic relationships in the community being considered?*

(1) Is the multiplier based on local data, or is it an overlay? Often, multipliers are used that were not developed specifically from data for that area. These multipliers are *overlaid* onto the area on the assumption that they will adequately reflect relationships in the economy. An example would be using the mining multiplier from a county in northwestern Wyoming to estimate a mining impact in northeastern Nevada.

A multiplier is affected by the economy's *geographic location* in relation to major trade centers. Areas where the trade center is outside the local economy have smaller multipliers than similar areas containing trade centers. Geographic obstacles enroute to trade centers also affect a local economy. Multipliers for small plains towns are smaller than those for apparently comparable mountain towns, since plains residents usually do not face the same travel obstacles as mountain residents. More services will characteristically develop in the mountain area because of the difficulty in importing services; the larger services base will lead to a larger multiplier effect.

The *size* of the economy will influence multiplier size. A larger area generally has more businesses; thus, a given dollar is able to circulate more times before leaking than would be the case in a smaller area.

Two economies with similar population and geographic size may have quite different multipliers, depending on their respective economic structures. For example, if two areas have similar manufacturing plants, but one imports raw materials and the other buys materials locally, then the manufacturing multiplier for the two areas would be quite different.

The overlaying practice, when used appropriately, can save money and time—and produce very acceptable results. However, an area's dollar flow patterns may be so unique that overlaying will not work. Also, it is often difficult to find a similar area where impact studies have been completed so that multipliers can be borrowed readily. It is, however, worth checking.

(2) Is the multiplier based on primary or secondary data? Usually, there is more confidence in a multiplier estimated from data gathered in the community, as opposed to published or already-collected data.

Primary data collection is expensive and time consuming. Recent research has indicated that, in some cases, there is little difference between multipliers estimated by primary or secondary data. In fact, primary data multipliers are not necessarily better than secondary data multipliers. While the type of secondary data needed for estimating multipliers may be available from existing sources, the format and/or units of measurement may not permit some multipliers to be estimated. The resulting adjustments made to use the existing data may cause errors. If secondary data is used, it may be advisable to consult individuals familiar with the data regarding its use.

(3) Aggregate versus disaggregate multipliers. As mentioned earlier in this publication, disaggregate multipliers are much more specific and therefore generally more trustworthy than aggregate multipliers. The accuracy required, and the time and money available most likely will determine whether the model will be aggregate or disaggregate. In many cases, an aggregated rough estimate may be sufficient.

(4) If you are dealing with an employment multiplier, is it based on number of jobs or full-time equivalent (FTE)? Employment multipliers are often considered to be the most important multipliers used in impact analysis. This is because changes in employment can be transmitted to changes in population, which in turn affect social service needs and tax base requirements. Employment multipliers can be calculated on the basis of number of jobs or on FTE. One FTE equals one person working full-time for one year.

When multipliers are calculated on a number-of-jobs basis, comparisons between industries are difficult because of different definitions of part-time workers. For example, part-time work in one industry might be four hours per day, while in another it might be ten hours per week. If calculations were based on number of jobs, a comparison of multipliers would be misleading. The conversion of jobs to FTE also helps adjust for seasonal employment in industries such as agriculture, recreation, and forestry.

(5) What is the base year on which the economic model was formulated? Inflation can affect multipliers in two ways: (1) through changes in the prices of industry inputs, and (2) through changes in the purchasing patterns produced by inflation. Each input-output multiplier assumes that price relationships between sectors remain constant over time (at least for the period under consideration). In other words, the studies estimating multipliers assume that costs change proportionally:L utility prices change at nearly the same rate as the cost of food, steel, and other commodities. If some prices change drastically in relation to others, then purchasing patterns and multipliers will likely change.

Marketing patterns change slowly, however, and while they must be considered, they usually do not present a major problem unless the multiplier is several years old. The rate of growth in the local area will influence the period of use for the multipliers.

(6) What can a multiplier do? The multipliers discussed here are static in nature, as are most multipliers encountered by local decisionmakers. Static means that a multiplier can be used in "if/then" situations; they do not project the future. For example, *if* a new mine that employs 500 people comes into the country, *then* the total employment increase would be the employment multiplier times 500. A static model cannot be used to make projections about the time needed for an impact to run its course, or about the distribution of the impact over time. Static multipliers only indicate that *if* X happens, *then* Y will eventually occur.

(7) How large is the impact in relation to the size of the affected industry on which the multiplier is based? Dramatic changes in an industry's scale will usually alter markets, service requirements, and other components of an industry's spending patterns. Assume a mining sector employment multiplier of 2.0 had been developed in a rural economy having 132 FTE. If a mine were proposed several years later with an estimated 300 FTE, the multiplier of 2.0 would probably not accurately reflect the change in employment because of the scale of the project relative to the industry existing when the multiplier was developed. In essence, the new industry would probably change the existing economic structure in the local area.

(8) Who calculated the multiplier—and did the person or agency doing the calculation have a vested interest in the result? Multipliers are calculated by people using statistics, and as such, there is always the opportunity to adjust the size of the multiplier intentionally. Before accepting the results of a given multiplier, take time to assess the origin of the data. Studies conducted by individuals or firms having a vested interest in the study's results deserve careful examination.

(9) Is household income included as a sector similar to the business sectors in the local economic model? The decision to include household income in the model depends upon whether or not the household sector is expected to react similarly to other sectors when the economy changes, or whether personal income is largely produced by outside forces. Discussion of this issue is too lengthy for this publication, but the important point is that multipliers from models that include household sectors are likely to be larger than those from models without household sectors.