THE FISHING INDUSTRY AND PACIFIC COASTAL COMMUNITIES: UNDERSTANDING THE ASSESSMENT OF ECONOMIC IMPACTS
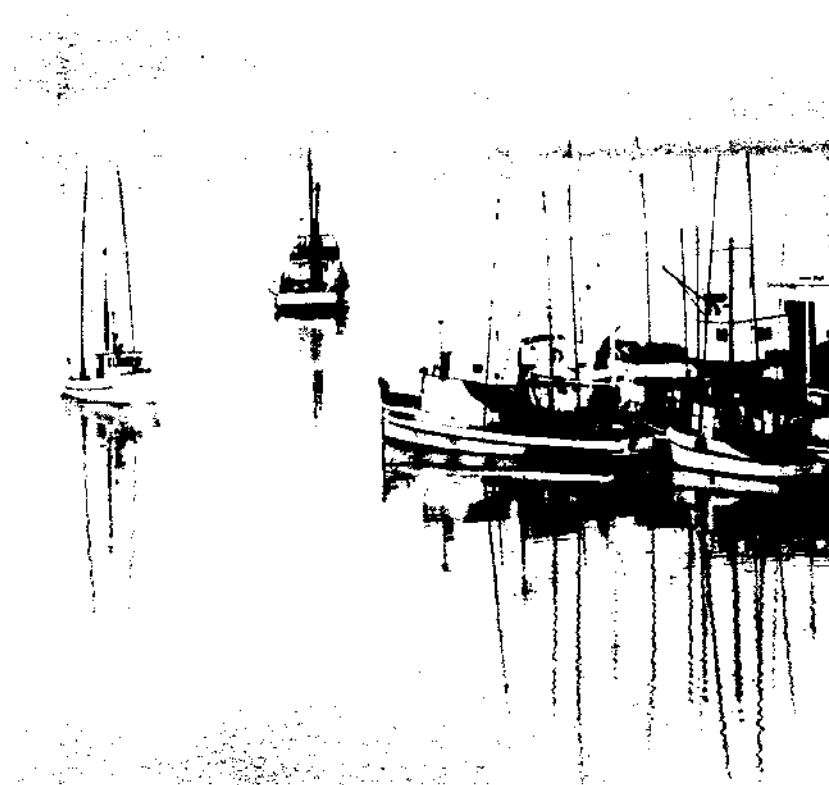
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THE FISHING INDUSTRY AND PACIFIC COASTAL COMMUNITIES: UNDERSTANDING THE ASSESSMENT OF ECONOMIC IMPACTS

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INTRODUCTION

People interested in economic stability or economic development in coastal communities are often interested in estimating the impact of changes or proposed changes on the economy. Such changes may result from plans, policies, or projects of public agencies, or from marketing strategies of private businesses. In coastal communities where fisheries are important, changes in fish availability due to regulatory or natural causes, closures of fish processing plants, and the development of fishing vessel facilities are examples of typical changes with important impacts on local economies. Local citizens are also interested in forecasting changes in business activity, employment, population, and public service demands.

Economic input/output (I/O) models are often used to estimate the impact of resource changes or to calculate the contributions of an industry to local economies. This publication is designed both as an introduction to input/output models and as a guide to the proper use of economic impact terminology. The use of economic jargon is minimized, and a glossary is included on page 9.

This publication grew out of concerns about the lack of understanding and improper use of input/output (I/O) models. This lack of understanding or misuse of I/O models is especially troublesome in situations where groups with opposing views come up with very different estimates of economic impacts. In an attempt to clarify the use of I/O models, the Pacific Sea Grant College Program and the Pacific Fishery Management Council held a workshop in February 1986 to discuss I/O models. Participants included resource economists, fishing industry representatives, and fisheries managers. This publication is one of the products of that workshop.

The information presented is divided into four sections.

I. The first section introduces general concepts of I/O models.

II. The second section defines multipliers and discusses common mistakes and misuses of multipliers.

III. The third section shows what size multipliers can be expected for the fishing industry, given the information available on the West Coast.

IV. The final section discusses procedures that should be followed if community economic impacts are to be assessed properly.

PART I - INPUT-OUTPUT (I/O) MODELS

An input-output (I/O) model approximates the local economy by expressing economic relationships among economic sectors. The local economy may be a county, a city, a state, or any other geopolitical unit. Economic relationships are measured by dollar values of purchases or sales among economic sectors. An economic sector is generally any homogenous grouping of businesses, organizations, or industries. Thus, all commercial fishing could be an economic sector, or all commercial salmon fishing could be an economic sector. Other typical economic sectors in coastal communities include local government, retail businesses, wood products, agriculture, households, and other manufacturing.

A. Transaction Table

Each sector purchases goods and services from itself or other sectors and sells goods and services to itself or sectors. The annual dollar values of these transactions provide the basic data for constructing the I/O model. These data are organized into a table called a "transaction table" or "transaction matrix."

Transaction tables generated by I/O models provide detail useful to anyone concerned with how the local economy works. For example, Table 1 shows a transaction table of a simple economy of four aggregated sectors. Reading down the fisheries column shows that the fisheries businesses purchase $10 from other businesses in the fisheries sector, $4 from

manufacturing, $6 from services, and $16 from primary inputs (labor, etc.) for total annual purchases of $36. Similarly, reading across, sales are $10 to businesses in the fisheries sector, $6 to manufacturing, $2 to services, and $18 to final demand for the product. From such tables, information about total sales, sectorial input requirements, possible input substitutions, etc., can be estimated. A mathematical procedure called "inverting the matrix" is used to estimate the continuous effect of any change in one of the sectors in the model. High-

speed computers are necessary to compute the "inverse" for matrices that represent economies of the coastal economies. These models can contain from 60 to over 200 sectors.

B. Obtaining Data

There are basically two input-output model data sources. The data can be obtained directly from people in each of the economic sectors or can be derived from general economic information developed by various government agencies.

It takes time to ask people about their sales, purchases, to whom they sold, and from whom they purchased. However, if sufficient funds are available, this method can produce models that describe the local economy in great detail. Unfortunately, there are rarely sufficient funds for a comprehensive survey, and projections from small samples are often necessary.

I/O models can also be constructed using published data to estimate the level of local economic activity. One such widely accepted model is the U.S. Forest Service IMPLAN model. This computer model can be used to construct county or multicounty I/O models for any region of the United States. The regional I/O models are derived from input requirements of businesses of a national I/O model and localized estimates of total gross outputs by sectors. The computer program adjusts the national level data to fit the economic composition and estimated trade balance of a region.

Table 1. A simple transaction table.

	Sales to in Dollars				
	Fisheries	Manufac-turing	Services	Final Demand[a]	Total Output
Fisheries	10	6	2	18	36
Manufacturing	4	4	3	26	37
Services	6	2	1	35	44
Primary Inputs[b]	16	25	38	0	79
Total Outlay	36	37	44	79	196

[a]Sales to households in the local area. Also includes sales to governments and exports.

[b]Payments to labor and natural resources, such as land, water, etc. Also includes taxes and other payments to government.

PART II - ESTIMATING IMPACTS

The transaction matrix provides the information used to derive *response coefficients* and *multipliers* used to measure the importance of any economic activity.

The *sales or output multiplier* shows the increase or decrease in local sales or output per dollar of sales made outside the local economy.

The *response coefficients* (total personal income or employment) indicate the response of income or employment to increases or decreases in sales or output.

A. Imports and Exports

One way of measuring the importance of a particular economic activity is to look at the amount of goods and services it sells and buys *outside* the local economy. A local economy has exports and imports similar to state or national exports and imports. Seafood harvested and processed in Grays Harbor or Astoria and shipped to Los Angeles is an *export* that benefits the local economy. The windsurfer from Seattle and the beachcomber from Boise bring money to the Hood River and Crescent City economies. These recreation activities are exports because they bring in "outside" money. Exports from the local economy stimulate local economic activity.

Figure 1. Tourists bring in money from outside the local area that stimulates the community's economy. Tourism, like seafood sold and shipped elsewhere, is a local export.

However, the money brought into a local economy does not all stay in the local economy. This is particularly true for the smaller coastal economies which are far from economically self-sufficient. Many of the goods and services consumed in the local economy must be brought in from outside. These goods and services are the *imports* to the local economy. The money that flows out of the local economy to pay for these imports is referred to as *leakage*.

B. Basic Sectors

Since imports take money out of the economy, it is important for smaller coastal economies to have some exporting sectors. In the I/O terminology, these are called "basic sectors." The dollars brought in by basic or *exporting* sectors begin the multiplier process. The basic sectors stimulate a local economy by originating the multiplier effect. When people talk about a change in the economic base of an area, they are referring to a change in a *basic business sector*.

Sectors other than basic sectors generally do not generate "new dollars," but rather operate on the *circulation* of dollars *already present* in the economy. Therefore, *nonbasic sectors* do not initiate a multiplier effect themselves, but instead contribute to the multiplier effect of basic sectors by preventing leakage. For the coastal communities, the basic sectors are generally resource-based. Examples of basic and nonbasic sectors are listed in Table 2.

Table 2. Examples of basic and nonbasic sectors.

Basic Sector	Nonbasic Sector Examples
1. fish harvesting and processing	1. medical services
2. logging and timber processing	2. movie theaters
3. tourism and recreation	3. grocery stores
4. transfer payments[a]	4. banking services

[a]Transfer payments include such things as social security payments, retirement payments, and nonlocal government salaries.
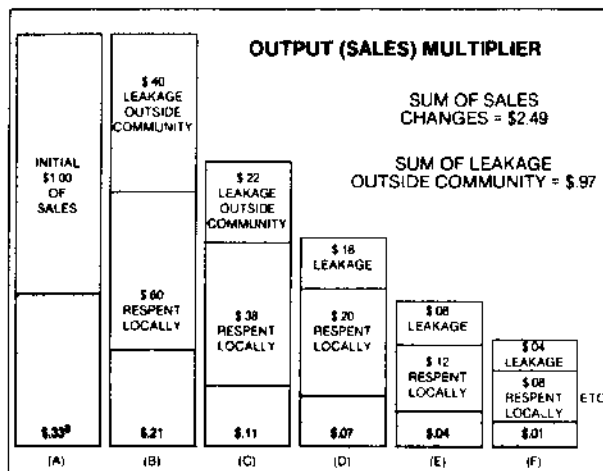
C. Calculating Multipliers and Coefficients

Output (Sales) Multipliers

How is the effect of a dollar of export sales multiplied in a local economy? Suppose a county's fishing industry increases export sales by $1,000. If the economy has an *output multiplier* of 2.49, total business sales through the county are expected to increase by a total of $2,490 as a result of the $1,000 increase in exports and the $1,490 in local sales generated by these exports. (The 2.49 is used as an example only. The actual output multiplier may be different.)

Figure 2 demonstrates how local respending of the export payment by businesses and households creates this multiplier effect. The process begins when a dollar enters the local economy, in this case as the result of an export sale (column A). The dollar will be respent by the exporting firm in order to purchase inputs (goods, services, labor, taxes, profits, etc.) to meet the increased export demand (column B). Sixty cents of the dollar will be received by local businesses and households, but $0.40 will leak out in the form of nonlocal purchases. Thus, in addition to the initial dollar, business respending has generated an additional $0.60 of business activity within the economy. Of the $0.60 that is locally received, $0.38 will be respent within the county, and the rest ($0.22) will leak out (column C). This process continues until the amount remaining in the local economy is negligible (columns D, E, F). Thus, greater leakage at any round of respending leads to a smaller multiplier.

In order to determine the total multiplier value, the initial dollar is added to the sum of the local respending. In this example, the multiplier equals 2.49 ($1.00 initial change + 0.60 + 0.38 + 0.20 + 0.12 + 0.08 and so on until it approaches 2.49). *Thus, $2.49 of local business activity will be generated for each dollar that enters the local economy.* The same process can be used to explain a decrease in export sales.

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OUTPUT (SALES) MULTIPLIER

(A)	(B)	(C)	(D)	(E)	(F)
INITIAL $1.00 OF SALES	$.40 LEAKAGE OUTSIDE COMMUNITY			SUM OF SALES CHANGES = $2.49	
		$.22 LEAKAGE OUTSIDE COMMUNITY		SUM OF LEAKAGE OUTSIDE COMMUNITY = $.97	
			$.18 LEAKAGE		
	$.60 RESPENT LOCALLY	$.38 RESPENT LOCALLY	$.20 RESPENT LOCALLY	$.08 LEAKAGE	$.04 LEAKAGE
				$.12 RESPENT LOCALLY	$.08 RESPENT LOCALLY ETC
$.33[a]	$.21	$.11	$.07	$.04	$.01

[a]The shaded area is that portion of the sales (output) that goes to households in terms of wages, salaries, and profits. This is called local personal income (see Figure 3).

Figure 2. Output (sales) multiplier.

The multiplier presented in this example is an *output (sales) multiplier,* measuring the total change in local sales generated by a $1 increase in export sales. While output multipliers are useful in describing the interrelationships between business sectors, they do not adequately describe the amount of income or employment generated locally by specific business activities.
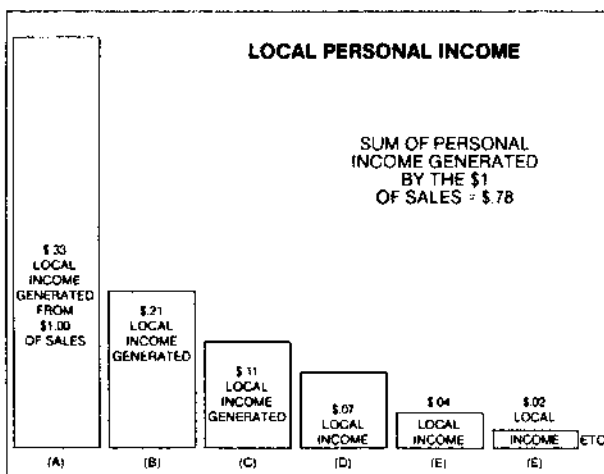

LOCAL PERSONAL INCOME

(A)	(B)	(C)	(D)	(E)	(E)
$.33 LOCAL INCOME GENERATED FROM $1.00 OF SALES			SUM OF PERSONAL INCOME GENERATED BY THE $1 OF SALES = $.78		
	$.21 LOCAL INCOME GENERATED				
		$.11 LOCAL INCOME GENERATED	$.07 LOCAL INCOME	$.04 LOCAL INCOME	$.02 LOCAL INCOME ETC

Figure 3. Personal income coefficient.

Calculating Income Coefficients

A more useful measurement of the contribution of a sector's activity is the amount of local personal income that is directly and indirectly generated from an increase in sales. The distribution of the amount of local personal income generated by a change in economic activity is shown in Figure 3. Local personal income generated is the shaded part of the output (sales) multiplier described in Figure 2.

The "Local Personal Income Coefficient" measures the income generated as a result of a change in sales. In the first round of export sales, $0.33 of local personal income is generated. The other $0.67 in the initial round goes to purchase supplies and services from other industries. These industries also create wages, salaries, and profits. As these sales work through the economy, a total of $0.78 of personal income is generated for every $1 of increase in sales.

The size of the personal income coefficient is largely determined by the amount of personal income generated by the first round. In an industry that is very labor intensive, such as fishing, the output (sales) multiplier may not be very large while the income coefficient is above average. On the other hand, if the industry goes through several transactions but is not very labor intensive throughout the process, the output (sales) multipliers may be large and the income coefficient small. Fish harvesting generally tends to be labor intensive. Because many jobs in the fishing industry are not full-time, most employment figures can be misleading. A full-time equivalent employment figure can be calculated by dividing the total personal income figure by a representative annual full-time equivalent personal income average.

The *output (sales) multiplier* calculates how much money is "stirred up" in the economy, but it does not mean that someone in the local area is making a wage or profit from this money. The differences between *output multipliers* and *income coefficients* are often confused, leading to misuse. People, especially decision-makers, need to know and understand what type of multiplier or coefficient is being used in the assessment of economics of proposed changes.

D. Some Common Mistakes

A common mistake is to use *value added* or *turnover* concepts loosely to represent or misrepresent multipliers.

Value Added

"Value added" refers to the increase in market value of a product at successive production, processing, and marketing levels. For example, crab that sold to the local processor may have a $1.50 exchange value (ex-vessel price). The local processor cleaned, cooked, packed, and shipped the crab and shipped it out of the local economy with a $3.25 exchange value. The value added by the local processor was $3.25 minus $1.50, or $1.75.

This should never be confused with a multiplier. While high value added in the local economy may contribute to a large multiplier, the two numbers are quite different.

Turnover

"Turnover" refers to the number of times a dollar changes hands in the local economy. In Figure 2 we measured the leakages from a dollar brought into the local economy. It required six rounds of exchanges before the fraction of the original dollar respent in the local economy became negligible. We could then say that the turnover was six. Since the multiplier in this example was 2.49, we can see that there is a major difference between the multiplier and the turnover. The number of times the original dollar is turned over has no bearing on the amount of personal income generated.

PART III
MULTIPLIERS IN THE FISHING
AND OTHER RESOURCE-BASED INDUSTRIES

Using output (sales) multipliers or personal income coefficients requires an estimate of the total change in final demand, which is the amount of total output that is to be "exported" out of the region. The analysis, by defining changes in final demand, estimates the impacts backwards throughout the local economy. The point at which the product is exported is therefore the important point of assessment (Figure 4). For the fishing industry, this point is usually the processing level. For the forest products industry, the comparable level is the sawmill or plywood veneer production. Of interest to many residents is how the relationship between the resource use level (ex-vessel price or stumpage price) relates to the final impact on the community. The most useful analysis is one which includes the impact of harvesting as well as processing. The following is a discussion of impacts at the primary resource (fishermen) level, as well as the processing level. The relationships are standard relationships that may reflect multipliers and coefficients of a region such as Humboldt County, California, but should not be viewed as specifically reflecting that area.
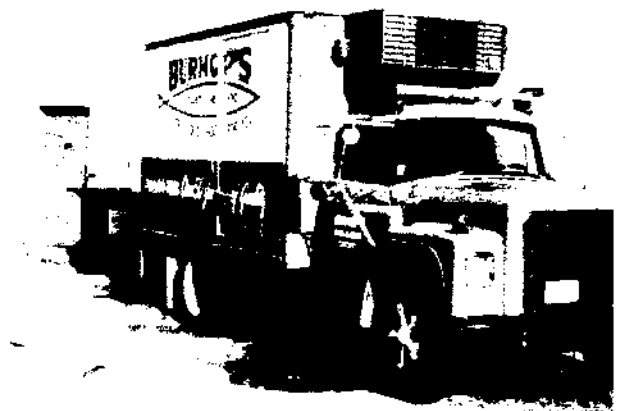

Figure 4. The point at which the product is exported is the important time to assess economic impact on the local economy. For commercial fisheries, this is usually when the product leaves the processing plant or buying station.

5

A. Fisheries Example of Correct and Incorrect Economic Impact Analysis

The U.S. Forest Service IMPLAN model generated the following output multipliers and total personal income coefficients for selected industries in Humboldt County, California (Table 3).

Table 3. IMPLAN Output Multipliers and Income Coefficients, Humboldt County, California

	Output Multiplier	Total Income Coefficient
Fish harvesting	1.2835	0.7692
Fish processing	2.1412	0.7711
Livestock production	1.8109	0.4317
Meat packing plants	2.5150	0.5027
Vegetable production	1.5511	0.8939
Construction	1.7385	0.7982
Logging	1.6284	0.6270
Sawmills	1.9004	0.7478
Veneer and plywood	2.0252	0.7871

The proper procedure for analyzing any impact is to estimate the direct change in sales (or output) that is to be expected because of some event. Then multiply these expected direct changes by the output multiplier or the total income coefficient to estimate the *total change in gross output* and/or *total local personal income*.

By identifying the point at which the product leaves the area (becomes an export), an estimate of the amount of total economic activity and local personal income generated can be made using the *output multiplier* and the *local personal income coefficient*. For example, Table 4 estimates that a total $3,211,800 in economic activity and $1,156,650 of local personal income is generated as a result of an increase of $1,000,000 of harvested fish. The point of export of the product from the local area is the processing plant. All other purchases, such as purchases of raw product, electricity, and processing labor, are included in the calculations.

A common mistake is to *pyramid* the impacts. This usually occurs when the final point of export is not correctly identified, so that impacts at the harvesting level are added to those estimated from changes in the processing sector. Such incorrect procedure will lead to higher impact estimates. In the example of Table 4, such incorrect evaluation leads to an incorrect estimate of $4,495,300 of economic activity.

The same caution of correctly identifying the output change as it leaves the region should be followed by analyzing impacts of any resource changes.

Table 4. Examples of Correct and Incorrect (Pyramided) Estimates of Economic Activity and Income Generated by Increased Fish Landings

Economic Activity Generated Due to Increased Harvest and Processing

Increased Fish Harvest	X	Harvesting Output Multiplier	=	Economic Activity Due to Increased Harvest
$1,000,000	X	1.2835	=	$1,283,500

Increased Fish Harvest	X	Processor's Margin (markup)	X	Processing Output Multiplier	=	Correct Estimate of Increased Economic Activity
$1,000,000	X	1.5[a]	X	2.1412	=	$3,211,800

Economic Activity Due to Increased Harvest	+	Economic Activity Due to Increased Harvest and Processing	=	Incorrect (Pyramided) Estimate of Economic Activity
$1,283,500	+	$3,211,800	=	$4,495,300

Income Generated

Increased Fish Harvest	X	Processor's Margin (markup)	X	Processing Income Coefficient	=	Correct Estimate of Income Generated by Increased Harvest
$1,000,000	X	1.5[a]	X	0.7711	=	$1,156,650

[a]Based on $1 of sales revenue received by a processor. As a rule of thumb, this margin is 1.5 times the original price paid to the fisherman for the raw product. For some specific species, this margin may be different.

PART IV - EVALUATING ECONOMIC IMPACT RESULTS

Since estimates of economic impact play such an important role in public decision making, there is great interest in knowing more about the accuracy and reliability of results. The first step in evaluating results is to understand the methodology. A more detailed explanation is available from several of the references listed in the bibliography. The second step is to understand the differences among the various numbers produced. Finally, an understanding of the data sources and the actual input/output analysis will help in evaluating results.

A. The Overlay Method

When funds or time do not permit collection of data directly from the local economy, data from other sources must be used. For example, the economic impact for a local economy in Oregon may be estimated by using data from a similar local economy in California where the local economy has been studied. This is called the *"overlay method."*

The overlay method can be evaluated by comparing the mix of economic sectors, the distance to major economic centers, and the size of the two local economies.

Mix of Economic Sectors

If the two economies have many similar sectors, and each sector is about the same size, the I/O results are likely to be more useful. However, if the California local economy has a larger manufacturing sector than the Oregon local economy, the multipliers for the Oregon local economy will probably be overstated. The California local economy probably statisfies more of the local manufactured goods needs than does the Oregon local economy, therefore reducing leakages.

Distance from Major Economic Center

If the California local economy is closer to a large economic center than the Oregon local economy, the multipliers for the Oregon local economy will probably be understated. The Oregon local economy will probably be more self-sufficient, since the cost of trading with the large economic center discourages imports from that center.

Size of Local Economy

If the California local economy is substantially larger than the Oregon local economy, it is likely to be more self-sufficient. 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. The sectors in the California local economy will have less need to import goods and services than the Oregon local economy.

If these factors are recognized and proper adjustments are made in the I/O model, the results may be quite accurate. However, some local economies are sufficiently unique that accurate results cannot be obtained by the overlay method.

Timing of the Impacts

The timing of these effects depends a great deal upon the reaction of local fishermen, businesses, and households to changes in income. Changes in expenditures for fish harvesting may take effect within a very short time in relationship to decreases or increases of harvesting income, and people involved in such businesses may experience an almost immediate reduction in income as a result of reduced landings. Personal expenditures for items such as rents, medical bills, and groceries may not be affected for some time. Savings or other transfer payments may be used to keep some of these expenditures at a previous level. However, over time, these sectors will also feel the effects of the changes in harvest income.

Comparison of Published Input/Output Multipliers

An Oregon State University study compared output multipliers for nine rural Oregon counties. Significant variation was observed among sectors as well as among counties. Generally, the output multipliers range between 1.5 and 2.5 (see Figure 5). Care should be taken in using published output multipliers, as the Oregon State University study notes:

> It is important to note that the multiplier merely indicates the impact per dollar of change, not the total amount of impact that will take place. For example, a yogurt stand may have a higher multiplier than a large sawmill, but the sawmill would have a greater economic impact due to its greater volume of sales.

> Those sectors with the highest multipliers are not necessarily those that have the greatest potential economic impact on a community.

> Remember that sales are often not the most important measure of community well-being. Sectors with the greatest impact on sales may not have the greatest impact on income or employment.

(Mandelbaum et al.)

Output (Sales) Multipliers
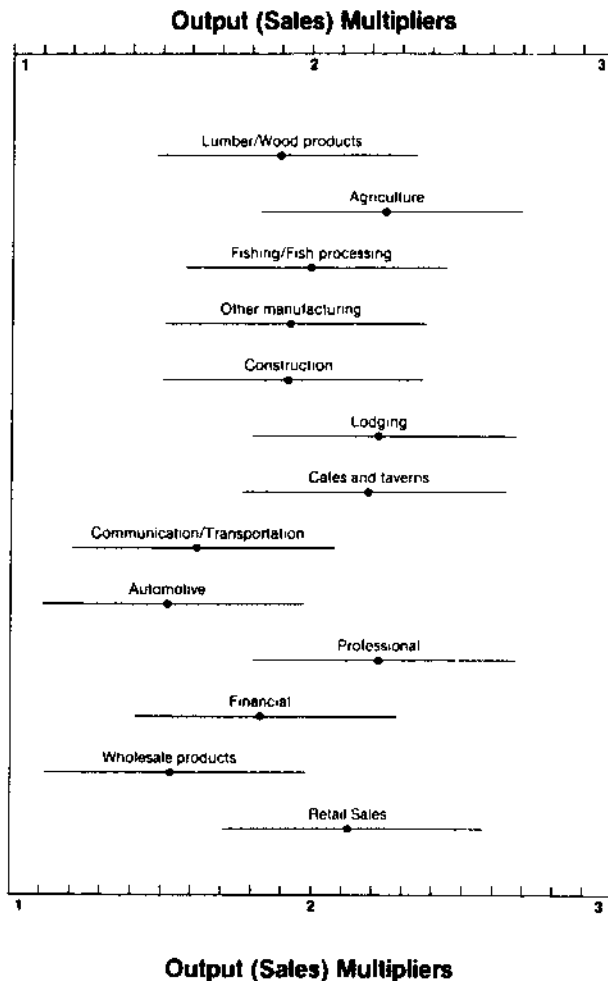

Output (Sales) Multipliers

Figure 5. Typical output (sales) multipliers for sectors (businesses and industries) common to Pacific coastal communities. The dot represents an average multiplier (mean) and the lines represent the typical range of multipliers (standard deviation) found in different communities.

B. Aggregate Versus Disaggregate Multipliers

An input/output model can consist of very few sectors (an "aggregate" model) or very detailed definition of the kinds of industries in a group (a "disaggregate" model). For example, in an aggregated model all fishery-related activities can be combined into a sector called fisheries. A more disaggregated model could contain several different sectors such as salmon fishery, groundfish fishery, etc.

Disaggregate multipliers are more specific and therefore generally tend to be more trustworthy than aggregate multipliers. The accuracy required, and the time and money available, will most likely determine whether the model will be aggregate or disaggregate.

Many I/O models list coefficients and multipliers for aggregate sectors such as fish harvesting or fish processing. These may not fit a specific fishery such as salmon. A Fisheries Economic Assessment Model has been developed for the West Coast Fishery Development Foundation that allows specific expenditure information to be inserted into the I/O model. In effect, information on purchases of the harvesting and processing sector is used to create a new "transaction" table. Specific multipliers and income coefficients can therefore be estimated for every area on the West Coast for the salmon and groundfish fisheries, as well as for any other fishery.

C. Age of the Model

Annual price inflation can affect results in two ways. Changing prices change purchase and sales values, and therefore change the transaction table numbers. Changing prices also bring about purchasing pattern changes, which can also change the transaction table numbers.

Because the transaction table numbers are estimated at one time, changes over time reduce the validity of these numbers. In some local economies, the change may be very small over a period of three or four years, while in others a large change may occur in a matter of months. This is especially the case when price changes for such things as utilities and housing are compared with gasoline and food.

While sector quantities may adjust quickly when prices change, the purchasing patterns adjust more slowly. For example, the seafood processor may reduce the quantities of styrofoam cartons purchased as the price per carton increases, but is likely to continue buying from the same supplier for some time.

8

D. Research Qualifications

Since input/output models have become popular, some researchers with limited experience have been encouraged to develop models. It is important to know the qualifications of the reseacher or researchers for a proper evaluation of the results. It is equally important to know whether the economic study was reviewed by other objective, qualified individuals.

Some organizations can obtain considerable political or economic advantage if the I/O results are favorable to their interests. For example, the developer of a destination resort would like to show very large impacts for the recreation sector. This can be used to help obtain permits, subsidies, and other benefits from the local government. Evaluate carefully I/O studies conducted or funded by an organization with a vested interest.

CONCLUSIONS

Information presented here should provide a basis for evaluating the accuracy and appropriateness of an input/output model in a given situation. To make decisions in very important cases, it is advisable to consult someone trained in the calculation, evaluation, and use of economic impact models. Although input/output models must be used with care, they are helpful in evaluating economic changes within communities. They are particularly enlightening in evaluating the distribution of impact throughout a community, to identify who stands to benefit from a particular economic change, and where some concerns may lie.

GLOSSARY

Aggregated sectors/models - Combines similar smaller sectors into one sector such as fisheries which includes all types of fishing and seafood processing.

Basic sectors - Local businesses that produce exports that bring "new dollars" into the local economy (e.g., fisheries, tourism).

Disaggregate sectors/models - Separating several segments of industry as different sectors (e.g., salmon fishing, crab fishing, seafood processing).

Final demand - The sum of personal consumption expenditures, capital formation (e.g., buying buildings), inventory change, state and local government expenditures, federal government expenditures, and exports.

Imports - Goods and services consumed in the local economy that are brought in from outside the local area.

Income coefficient - Amount of personal income that is directly and indirectly generated from an increase in sales. Sometimes called a response or personal income coefficient.

Input-output model - A description of the relationships between sectors of the local economy described by the dollar value of sales and purchases between sectors.

Leakage - Money that flows out of the local economy to pay for imports.

Nonbasic sectors - Local businesses that operate on dollars already present in the local economy (e.g., movie theaters).

Output (sales) multiplier - Shows increase or decrease in local sales or output per dollar of final demand change.

Pyramiding - Incorrect double adding of the dollar impacts (e.g., adding both the fish harvesting and fish processing impacts together).

Response coefficient - Indicates response of income or employment to increases or decreases in sales or output.

Sales multiplier - See output multiplier.

Sectors - Any homogenous grouping of businesses, organizations, or industries.

Transaction table (matrix) - A table describing the sales and purchases between sectors of the local economy.

Turnover - Number of times that a dollar changes hands in the local economy.

Value added - Increase in market value of a product at successive production, processing, and marketing levels.

Further Reading

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