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Estimating Regional Economic Impacts in an Economic Analysis

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This paper presents several methods that can be used to estimate the regional economic impacts from changing in expenditures related to agricultural production, recreation, construction, commercial fishing, and other water related activities. The methods described include: economic base analysis, income-expenditure analysis, input-output based analysis, and computable general equilibrium analysis. The advantages and disadvantages of each method are presented. The choice of a regional impact estimation method ultimately depends on the size and complexity of the region under consideration, the time and budget available to complete the impact analysis, the level of detail required, and the information available.

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Estimating Regional Economic Impacts in an Economic Analysis

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EXECUTIVE SUMMARY

This paper presents several methodologies that can be used to estimate the regional economic impacts from changes in expenditures related to agricultural production, recreation, construction, commercial fishing, and other water related activities. The methodologies described include: economic base analysis, income-expenditure analysis, input-output-based analysis, and computable general equilibrium analysis. The advantages and disadvantages of each method are presented.

The economic base and income-expenditure methods are the most simplistic approaches and are generally best used in analyses which require less precision in the estimated impacts, in analyses of regions which are relatively small and uncomplicated, and in cases where the study budget is insufficient to fund a more sophisticated type of analysis. Input-output-based analyses are better for larger impact regions that have more complicated trade patterns and more complex production/consumption relationships. Computable general equilibrium models can account for price changes related to changes in input requirements and substitution of inputs that may occur as a result of the impacts under consideration in the analysis. As a result, an analysis based on a computable general equilibrium model is most appropriate when impacts are estimated for a large change in production or output in a large region which could be reasonably expected to affect regional input and output prices.

Regardless of the method used to estimate impacts from a project or action, there are three basic steps in a regional impact analysis: determining the impact region of concern, evaluating the types of activities that will be affected by the action under consideration and the expenditures associated with each activity, and determining the changes in expenditures that represent a true change in final demand.

The size of the impact region analyzed effects the magnitude of the estimated impacts. The region included in the study area should represent the primary area of concern to policy makers relying on the analysis. In addition, the impact area should include linkages between the site where the primary impacts occur and outlying areas that are economically and socially connected to the site.

Changes in the level of economic activity (final demand) must be estimated and used as input for the regional impact model. A description of the type of expenditure data needed to complete a regional economic impact analysis is presented. Sources of data for estimating the expenditures associated with different activities are also presented.

The expenditures that represent true changes in final demand are described. Specific examples are given for recreation, agriculture, construction, municipal and industrial water supplies, and commercial fishing. This paper also includes an example that

demonstrates how to complete a regional impact analysis where changes in reservoir storage and irrigation deliveries result in changes in recreational visitation and agricultural production.

Specific computer programs that are commercially available for estimating regional impacts are not covered in detail because the purpose of this paper is to address the practical problems associated with correctly evaluating regional economic impacts and estimating changes in expenditures that will actually influence the regional economy. However, some of the more popular regional impact analysis computers are described as a partial list of available regional impact software.

A variety of regional impact estimation techniques are presented in this paper. Each has distinct advantages and disadvantages. The choice of a regional impact estimation method ultimately depends on the size and complexity of the region under consideration, the magnitude and types of changes in expenditures associated with the action under consideration, the time and budget available to complete the impact analysis, the level of detail required, and the information available.

INTRODUCTION

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (Principles and Guidelines) provide guidelines for the formulation and evaluation of water and land related projects. Four accounts are addressed in the Principles and Guidelines: national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE).

The EQ account represents impacts on ecological and cultural resources, and the OSE account reflects impacts on the community in terms of life, health, and safety. These two accounts do not directly include economic analysis, although the impacts addressed in these two accounts can have economic effects, and changes in economic activity can affect environmental quality and can have other social effects. The NED account reflects economic effects on a national scale, and the RED account presents impact that only occurs within the study region. The Principles and Guidelines state that the NED account is the only required account in an evaluation of the economic feasibility of a project, and information from the other accounts is needed to the extent that it is required by a specific law or will have an important impact on the decision making process. However, the impact of proposed projects and other actions on regional economies has become increasingly important to cities and counties and is included in many planning and environmental studies, including environmental impact statements.

The primary purpose of this guide is to provide the user with sufficient background theory and practical examples to understand what a regional economic impact analysis involves and how to complete a regional impact analysis. Specific information is provided for agricultural production, recreation, construction, municipal and industrial water supply, and commercial fishing activities for use in evaluating impacts on these sectors. Several methods of estimating impacts are presented. The strengths and weaknesses of each method are presented, along with the conditions under which each technique is most applicable. Potential sources of regional impact models and data are also presented.

The Distinction Between a NED and a RED Analysis

The National Economic Development (NED) account measures the economic benefits and costs of an action on the national economy. Therefore, a NED analysis accounts for offsetting gains and losses across different regions of the nation. A NED analysis is required for project justification (Principles and Guidelines, 1983). A project is justified if the benefits generated by the project are greater than or equal to the costs of the project. Benefits represent an increase in utility (welfare or satisfaction) to society from changes in resource use due to some action. Costs are represented as a loss in utility as measured by the opportunity cost (value of the resource use forgone) from an action. Many benefits and costs may not be easily quantifiable due to the lack of a market structure from which economic values can be obtained. However, these benefits and costs should be accounted for in a NED analysis.

The Regional Economic Development (RED) account measures the changes in the distribution of regional economic activity as a result of an action and does not account for gains or losses outside the region of study. Traditionally (as described in the Principles and Guidelines), the RED account includes measurement of income and employment impacts from an action. However, the overall impacts of an action on the value of industry output in a region as well as the value added (income generated by local factors of production and payments to government) by local production are also valid measures of regional economic activity. The RED account is a measure of regional activity, while the NED account is a measure of economic benefit to the nation as a whole.

The NED and RED accounts are not directly comparable because they do not measure the same effects. The NED account measures benefits which represent the value of a resource or resource related activity to society. The RED account measures regional impacts which are flows of money (or employment) into or out of a region. The regional impacts from an action may result in substantial increases in income or employment within a specific region, but may generate little or no benefits to society at the national level. It is also possible that an action may result in reduced regional output and income in a particular area, while generating positive benefits to the nation as a result of environmental enhancement or other improvements which are not translated into actual money flows.

A NED analysis is concerned with gains in economic efficiency and social welfare which are the result of employing resources in their highest and best uses. A RED analysis is concerned with the distribution of income and wealth, where the impacts of an action to a specific region are evaluated. A NED analysis results in estimates of economic values, while a RED analysis results in estimates of changes in money flows into and out of a region. Therefore, the benefits and regional impacts from an action are not directly comparable and the results from a RED analysis cannot generally be subtracted from the results of a NED analysis to accurately portray the impacts or benefits of an action on the rest of the nation outside the region considered in the RED analysis.

Importance of a RED Analysis

A RED analysis is important to local interests where an action is under consideration. An action that will attract new sources of revenues and activities to a region may result in increased employment, income, and production to that region. Local government officials, business leaders, and the general population would likely want to know the extent of these impacts for future planning purposes and how their community would be affected. If the local economy is currently experiencing high unemployment and low income levels, then the action may be encouraged locally. However, if the action is perceived as causing growth related problems such as overcrowding and high housing costs with little benefit, then the action may be opposed locally. The RED analysis provides information to local parties most affected by a proposed action and estimates the effect of the action on the local economy.

A RED analysis is also potentially important from an equity standpoint. A RED analysis provides information on where the greatest economic impacts are occurring and the extent of those impacts. These impacts could be positive or negative for different regions of economic impacts. As a result, a RED analysis can be used to evaluate the equity of changes in income, employment, and the value of output that result from an action.

A RED analysis can also be used to address environmental justice issues. Environmental justice is similar to the equity concerns discussed above. It refers to the pursuit of equal protection under environmental laws for a clean environment for all people regardless of socioeconomic status, race, or ethnicity. An action that harms the environment and provides little or no improvement in income or employment in a low income area but provides economic improvements to a wealthy region may violate the intent of environmental justice. A RED analysis combined with a demographic analysis can be used to identify areas which have potential environmental justice concerns.

METHODS THAT CAN BE USED TO EVALUATE REGIONAL ECONOMIC IMPACTS FOR A RED ANALYSIS

There are a wide variety of methods that can be used to evaluate the regional economic effects of a proposed project or action. The applicability of each method to a particular analysis depends on several factors, including the size of the affected area included in the analysis, the number of activities within a region, the level of detail needed for the analysis, and the magnitude of the impacts generated by the project or action under consideration. The methods described include economic base analysis, income-expenditure analysis, input-output analysis, and computable general equilibrium models.

Economic Base Analysis

The economic base method of estimating the regional impacts from a project or action is based on simple macroeconomic income accounting relationships and assumptions about the sources of regional economic growth. The Gross Regional Product (GRP) of a regional economy can be represented as:

$$GRP = C + I + G + E - M \qquad (1)$$

where: C = consumption
I = investment
G = local government spending
E = export sales
M = import purchases

Any of the five components of GRP included in equation 1 represent potential sources of regional economic growth. It is assumed in the economic base model that exports are the primary source of regional economic growth. It is also assumed that the other four potential sources of growth can be ignored without introducing significant error into the analysis.

Conceptually, the base model approach divides the economy into two sectors: the export or base sector and the non-export or service sector. The base sector includes all economic activities that provide goods and services to individuals and businesses outside the region. The service sector includes all economic activities that serve only individuals and businesses within the region.

Assuming the proportion of service activity to base activity remains constant over the period of analysis, the ratio of service activity to export (base) activity can be expressed as a constant.

$$k = S/E \tag{2}$$

where: k = constant
E = export activity
S = service activity

Therefore, the change in total regional activity from a change in export activity can be expressed as:

$$Y = (1 + k)E \tag{3}$$

where: Y = total activity

Equation 3 says that any change in total regional economic activity is solely a function of a change in export activity, and the multiplier is $(1+k)$. Since k is positive under normal circumstances, the multiplier will always be greater than one. The multiplier reflects the impact of spending within the region that occurs when export expansion takes place within a region. Changes in export and service activities will affect the value of the multiplier. For example, a decrease in S and an increase in E will result in a smaller multiplier.

To estimate the regional impacts from an action using an economic base analysis, the analyst must know the change in spending associated with the action by good or service categories, the extent to which those goods and services are purchased within the region, and the extent of the service and base industries in each category of spending. These data are not easily obtainable, so professional judgement may be needed to estimate the multiplier effects of changes in spending and the amount which is actually spent in the region. These factors will be more difficult to estimate for larger economies because of the large number of interconnected activities and the difficulty in evaluating complicated trade patterns. Therefore, use of an economic base analysis is limited to relatively small and less diversified economies.

Fundamental Assumptions of an Economic Base Analysis

There are several assumptions associated with an economic base analysis that limit the applicability of an economic base analysis. Several of these assumptions and their resulting limitations are presented below.

- The assumption that exports are the sole source of regional economic growth. This limits the applicability of the approach to relatively small-scale economies that are highly dependent on exports. Examples of regions that could fit this assumption are: fishing villages, agricultural communities, timber areas, and some specialty tourist areas such as ski resorts.

- It is assumed that the export sector is very uniform and homogeneous, or, at the very least, a change in spending for one type of commodity sold outside of the region would have the same impact as the same change in spending for another export commodity. The impact on the economy is estimated in the base model to be the change in the volume of exports times the multiplier, $1 + k$, regardless of the type of commodity exported. However, it is likely that the leakages associated with different export activities probably differ because of differences in the proportions paid to local labor and suppliers of materials and because of differences in the expenditure patterns of the employees in the different activities. As a result, the multiplier would not be expected to be uniform for all exports.

- It is also assumed that the parameter k is constant over the period of analysis. However, as an economy grows and the local markets for various commodities grow, some goods and services that were previously imported into the region may be produced within the region. As a result, the value of k would probably rise as the economy grows.

- A change in the level of exports from the economy is assumed to have no effect on subsequent exports that could result from trade linkages between the study region and other regional economies. In other words, it is assumed that there are no interregional feedback effects.

- It is also assumed that a pool of underutilized resources exist and an increase in the demand for exports will result in a proportional increase in the quantity of goods and services needed to produce those exports. If, however, there are input constraints that prevent an increased level of production of exports, an increase in export demand may only result in an increase in the prices of exported commodities.

The Base Model is a comparative static model. The economy is assumed to initially be in equilibrium, and changes in export results in a new equilibrium level of activity. The two levels of activity are compared to evaluate regional impacts.

Potential Problems with the Methodology

There are several shortcomings associated with the economic base methodology apart from the assumptions listed above that can compromise the accuracy of regional impacts estimated using this methodology. First, it is sometimes difficult to determine the appropriate unit of measure for economic activity associated with producing exports. Jobs and income are frequently used measures of activity. However, the impacts using these two measures may be very different.

Another problem is distinguishing between the service and the base (export) activities in a region. Some goods and services may be produced for both within region and export use. Several techniques have been used to try to solve the problem of determining base and service sectors, including judgement, a survey of household and business spending patterns, a location quotient, and the minimum requirements method. Judgement simply requires the analyst to evaluate which goods and services are predominately exported, based on observations and available regional trade information. Surveys of spending patterns are an accurate method for determining where goods and services are purchased, although the cost of such a survey may be fairly high.

A location quotient is a ratio of the percentage of regional employment in a particular industry divided by the percentage of national employment in a particular industry. This can be represented as:

$$LQ_i = (R_i/R) / (N_i/N) \qquad (4)$$

where: LQ_i = location quotient
R_i = regional employment in sector i
R = total employment in the region
N_i = national employment in sector i
N = total national employment

If the estimated location quotient for an industry is greater than 1, then a disproportionately high portion of employment in that industry is attributable to exports compared to the rest of the nation. As a result, that industry would be considered to be a base activity.

The minimum requirements technique for determining if a sector is part of the base is based on the estimated employment requirements to satisfy local demand for a good or service, and any employment beyond that number would be assumed to be required for meeting export demand. The minimum requirement would be determined by studying the sector employment data in a region similar in size and structure and calculating the ratio of sector employment to total employment. The region with the lowest ratio would represent the minimum requirement to meet local demand.

Advantages of the Economic Base Methodology

The primary advantage of the economic base methodology of estimating regional impacts is the simplicity of applying the method. If the service to export activity ratios for the goods and services affected are accurate, then the method can produce useful results. The logic behind the method is also fairly straightforward and easy to understand by non-economists (although not everyone may agree with the fundamental assumptions of the technique). Finally, although the method may be simplistic, the results can be sufficiently accurate to compare regional impacts between alternatives.

Summary of Economic Base Analysis

An economic base analysis is a suitable method of estimating regional impacts in areas with fairly simple trade patterns, easily identifiable base or export sectors, and a proposed action that have well-defined effects on input demands. When an economy is large or diversified, the simplifying assumptions of the methodology lead to errors in the impact estimates that are likely to be unacceptable for policy analysis.

Income-Expenditure Analysis

Income-expenditure analysis is an extension of the Keynesian multiplier model. In this model, expenditures derived from household income drive changes in regional economic activity. A multiplier similar to a multiplier used in macroeconomic analysis is estimated based on the marginal propensity to consume, base levels of consumption that would occur regardless of income level, tax rates, the marginal propensity to import, and any other factors influencing the level of local spending. The marginal propensity to consume represents the percentage of additional income that would be spent on consumption of goods and services (as opposed to income that is saved). The marginal propensity to import represents the percentage of additional income that is spent on goods imported into the region. A simple regional income multiplier can be represented by:

$$\text{Income multiplier} = 1/[1 - (1 - t)(c_1 - m_1)] \qquad (5)$$

where: t = tax rate
c_1 = marginal propensity to consume
m_1 = marginal propensity to import.

Equation 5 shows that the multiplier is inversely dependent on leakage rates and the marginal propensity to save $(1 - c_1)$. Estimating a regional income multiplier can be demonstrated through a simple example.

Assume that the tax rate (t) within a region is 20 percent of income and that 10 percent of all income earned is saved (S). Further, assume that the purchase and consumption of locally produced goods and services (LC) represents 50 percent of income and the purchase of goods and service from outside the region (OC) represents 20 percent of total income.

To estimate regional impacts, the analyst must also know the proportion of inputs purchased from local (within a region) suppliers for each sector of consumption. For example, assume local consumption is divided into three sectors: 50 percent at food stores (F), 20 percent at general stores (G), and 30 percent at service stations (SS). Suppose that food stores import (F_{imp}) 90 percent of the inputs needed to produce food, general stores import (G_{imp}) 70 percent of inputs, and service stations import (SS_{imp}) 80 percent of inputs. This provides enough information to estimate a regional impact multiplier based on expenditures and saving of income in the region and the types of goods and services purchased with that income.

The multiplier can be calculated two ways, either on the basis of leakages outside of the region or on the basis of consumption expenditures within the region. The multiplier based on leakages outside the region would be calculated using equation *(5)* and the following relationships:

$c_1 = (LC + OC)/(1 - t)$ (6)

$m_1 = \{OC + LC[(F \times F_{imp}) + (G \times G_{imp}) + (SS \times SS_{imp})]\}/(1-t).$ (7)

Using the values from the example, the regional income multiplier is equal to: $1/\{1 - [(1-.2) \times (.875 - .76875)]\} = 1/.915 = 1.0929$. The term c_1 is equal to: $(.5 + .2)/(1 - .2) = .875$. The term m_1 is equal to $\{.2 + .5[(.5 \times .9) + (.2 \times .7) + (.3 \times .8)]\}/(1-.2) = .76875$. This multiplier represents the impact of an increase in income which is spent on the three goods and services included in the example in the proportion presented in the example. Additional leakages representing expenditures that occur outside the region can be added to the model, as needed, to determine local impacts more accurately.

Using the consumption side, the percentage of expenditures for local consumption is multiplied by the weighted average of local input expenditures for each good or service produced. In the above example, the multiplier based on local consumption would be:

$$\text{Regional multiplier} = 1/\{1-\{LC \times [(F \times (1 - F_{imp}))+(G \times (1 - G_{imp}))+(SS \times (1 - SS_{imp}))]\}\} \quad (8)$$

or $1/\{1-\{.5 \times [(.5 \times .1)+(.2 \times .3)+(.3 \times .2)]\}\} = 1/\{1-\{.5 \times [.17]\}\} = 1/(1 - .085) = 1.0929$.

Fundamental Assumptions of an Income-Expenditure Technique

There are several simplifying assumptions that are necessary when using the income-expenditure technique. These include:

- The multiplier coefficients (the tax rate, the propensity to consume, the marginal propensity to import, and any other relevant factors) are assumed to be constant over the period of analysis. The constant-coefficients assumption further implies that the patterns of expenditures in the first round are identical in succeeding rounds.

- Each producing sector is homogeneous and there are no capacity constraints on the producing sectors of the model.

- Feedback effects between regions are negligible. The magnitudes of interregional feedback effects are positively related to the region's share of national income and inversely related to the region's self-sufficiency. For small and somewhat isolated regions, interregional feedback effects are not likely to be significant. If interregional feedback effects are determined to be a factor, the data necessary to incorporate interregional feedback effects within the multiplier is typically difficult to obtain.

Potential Problems With the Methodology

The marginal propensities for consumption, savings, imports, and taxes for local residents are conceptually the correct measures for estimating regional multipliers because the project or action under consideration represents an addition to or subtraction from current economic activity and income. However, marginal propensities may be difficult to estimate, so average propensities are frequently used as an approximation of the marginal propensities. In some cases, these two numbers may be significantly different, and the multipliers may be off by a large percentage. For example, if unemployed resources are used to meet demand resulting from increased local spending, it is possible that the propensities to consume, save, import, and pay taxes of those who were unemployed could be much different from the average propensities.

Another practical problem is the possibility that a significant amount of capital investment could be induced within a region, resulting in greater regional impacts compared to the assumption that leakages remain constant. These changes in capital investment and production within the region would need to be incorporated into a multiplier model.

The income-expenditure approach has some advantages over the economic base approach which is based primarily on employment data. First, using income as a unit of measurement provides a more sensitive indicator of change in economic activity than does employment. Second, a dollar of income is an unambiguous measure of economic activity, while employment is difficult to compare because of a mixture of full-time, part-time, and seasonal employment. Third, the income-expenditure model can incorporate consumption patterns which vary from the community average. Fourth, fiscal operations of the local government can be explicitly included in the model.

Advantages of the Income-Expenditure Methodology

As with the economic base methodology, an important advantage of the income-expenditure methodology is the relative simplicity of the method compared to input-output-based techniques. The categories of consumption and the marginal propensities to consume and import may be more intuitive than the base and service sectors in the economic base analysis. However, the basic foundation of both techniques are essentially the same: to determine the extent to which the production of goods and services in the region depend on inputs from the local region and to estimate the change in spending on specific goods and services.

Summary of the Income-Expenditure Methodology

The income-expenditure model is most appropriately applied to small-scale, regional economies where inter-sectoral relationships are simple enough to be modeled without the need for a large amount of data. The use of income as a measure of economic activity makes the income-expenditure method somewhat more flexible than the economic base methodology. However, the simplifying assumptions required for the technique limits the use of the model in larger and more complicated economies.

Input-Output Analysis

An input-output (I-O) model is a mathematical model that depicts the flows of money between the various sectors of a regional economy. These flows are estimated by determining the inputs needed by each industry from other industries to produce a dollar's worth of output. I-O models also describe the proportions of sales that go to wage and salary income, proprietors' income, and taxes based on the industry's estimated production function. Multipliers can be estimated from I-O models based on input requirements for different activities and the propensity of firms and households to purchase goods and services from local sources (regional purchase coefficients). A region that is relatively self sufficient will have fewer leakages and larger multipliers relative to a region that depends heavily on imports. The multipliers can be used to estimate regional economic impacts from an action that results in changes in economic activities in a region.

I-O based multipliers capture the direct, indirect, and in some cases the induced effects of an economic activity. Direct effects are the production changes created by the original, first round, change in spending for goods and services. Indirect effects are the production changes resulting from various rounds of re-spending of the primary industry's receipts in other backward-linked industries (industries supplying products and services to the primary industry). Induced effects are the changes in economic activity resulting from household spending of income earned directly or indirectly as a result of the change in spending for goods and services.

For example, the direct result of an increase in recreation visitation would be increased sales in the lodging sector. The additional lodging services result in associated payments for wages, taxes, and supplies and services that are direct effects of recreation spending. The increase in lodging activities lead to changes in sales, jobs, and income in the linen industry that represent indirect effects of changes in expenditures for lodging. Businesses that supply products for the linen industry represent another round of indirect effects. Eventually, all the economic sectors that can be linked to lodging are included as a part of indirect effects. Last, lodging and linen supply employees, supported directly or indirectly be recreation spending, spend their income in the local region for housing, food, and other household goods and services. The sales, income, and jobs resulting from household spending of added income are induced effects.

Together, the indirect effects and induced effects are called secondary effects. Through these secondary effects, a change in spending in one specific sector can have an impact on nearly every sector of the economy. The size of the multiplier depends on the propensity of households and businesses to purchase goods and services from local suppliers and can vary considerably from region to region and sector to sector. There are several different types of multipliers reflecting which secondary effects are included and which measure of economic activity is included. For example:

- Type I sales multiplier = (direct sales + indirect sales)/direct sales
- Type II sales multiplier = (direct sales + indirect sales + induced sales)/direct sales, where Type II multipliers include households as a sector of the economy
- Type III sales multiplier = (direct sales + indirect sales + induced sales)/direct sales, where Type III multipliers treat households as exogenous
- Type III income multiplier = (total direct, indirect, and induced income)/direct sales
- Type III employment multiplier = (total direct, indirect, and induced employment)/ direct sales

Some Basics of Input-Output Analysis

The most important component of an I-O analysis of regional impacts is the construction of a transactions table that shows the flow of commodities from each producing industry to all consuming industries and to final demand. A final demand can be defined as purchases of goods and services for final consumption as opposed to an intermediate purchase where the good is further re-manufactured or processed. These flows of commodities determine the impact to a region that result from changes in local demand for a good or service. The flows estimated in a transactions table can be used to develop a table of technical coefficients (direct requirements) and a table of direct and indirect coefficients (total requirements), which are then used to estimate regional multipliers.

The Transactions Table

A transactions table shows the flow of goods and services among industries in terms of dollar values over a given period of time. Sales and purchases within an economy are represented in a matrix of rows and columns. Each row in the transactions table represents the output sold by each industry in the regional economy and each column represents inputs purchased by each industry. Each cell represents a purchase for the column industry and a sale for the row industry. An example of a transactions table is presented in Table 1.

Table 1. — Transactions Table

Producing Industries	**Purchasing Industries** Industry A	Industry B	Industry C	Final Demand	Total Output
Industry A	15	10	10	15	50
Industry B	5	5	10	30	50
Industry C	10	5	5	30	50
Primary Inputs	20	30	25	0	75
Total Outlay	50	50	50	75	250

The entries in the first column of Table 1 show Industry A purchasing $15 worth of output from itself, $5 worth of output from Industry B, $10 worth from Industry C and $20 from primary inputs such as labor, for a total outlay of $50. The entries in the first row of Table 1 show industry A sells $15 worth of output to itself, $10 to Industry B, $10 to Industry C, and $15 to final demand. Summing the purchases results in a total output value of $50.

A transactions table shows four separate groups of transactions within a regional economy: intermediate production and consumption, final output from production or final demand, primary inputs to production, and primary inputs to final demand. Primary inputs to final demand could include items such as income from government employees, government program payments, or imports consumed directly by households in the region. The upper left-hand portion of Table 1 represents the intermediate production and consumption portion of the transactions table, showing the production and purchasing relationships between industries A, B, and C. Intermediate consumption and production is endogenous to the model, meaning these values are determined within the framework of the model and all other transactions values are exogenous to the model. Final demand represents the ultimate consumers' purchases from the producing industries. Households, businesses, and government can all be considered final consumers.

A transactions table can be used to describe factors in addition to consumption and production patterns. As shown in Table 1, the sum of the values across a row (intermediate demands from purchasing industries plus final demand) equals the value of total gross output for the row industry. The sum of the values down a column (intermediate inputs plus primary inputs) equals the total gross outlays of the column industry. The equality of the columns and corresponding rows indicate that gross regional income is equal to gross regional product.

The Technical Coefficients, or Direct Requirements, Table

The transactions table can be used to create a technical coefficients, or direct requirements, table. The entries in a direct requirements table represent the input requirements for each producing sector to produce one dollar's worth of final demand. These input requirements represent an efficient level of input use and no wasted resources. Table 2 is a direct requirements table based on the information provided in Table 1.

Table 2. — Direct Requirements Table

	Purchasing Industries		
Producing Industries	Industry A	Industry B	Industry C
Industry A	0.30	0.20	0.20
Industry B	0.10	0.10	0.20
Industry C	0.20	0.10	0.10
Primary Inputs	0.40	0.60	0.50

The technical coefficients, or direct requirements, are determined by dividing the column entries for Industry A, Industry B, and Industry C in Table 1 by the total outlay of that column. For example, assume that Industry B purchases $0.20 (10/50) worth of inputs from Industry A, $0.10 (5/50) worth of inputs from Industry B, and $0.10 (5/50) worth of inputs from Industry C to produce $1.00 of output. The $0.20 can be interpreted as the value of inputs from Industry A for each dollar's worth of output from Industry B. The remaining inputs to Industry B come from primary inputs which are exogenous to the model. The direct coefficients reflect several simplifying assumptions of input-output analysis, which are described in detail in the Fundamental Assumptions of an Input-Output Analysis section below.

The Direct and Indirect Coefficients, or Total Requirements, Table

When all the columns and rows balance, that is total outlays and output are equal, the system is in equilibrium. The input-output model provides estimates of the output levels for each industry within the regional economy when the system is in equilibrium. Therefore, if there is a change in final demand for a particular output, the input-output model can be used to trace the effects throughout the economy. These effects could be traced using the direct requirements shown in table 2, iterating through the rounds of impacts. However, matrix inversion and multiplication can be used to estimate these rounds of impacts directly by producing a total requirements table.

Using the information from Tables 1 and 2, a system of equations can be developed which describes the flow of dollars within an economy:

$$\begin{aligned} X_1 &= .30\,X_1 + .20\,X_2 + .20\,X_3 + Y_1 \\ X_2 &= .10\,X_1 + .10\,X_2 + .20\,X_3 + Y_2 \\ X_3 &= .20\,X_1 + .10\,X_2 + .10\,X_3 + Y_3 \end{aligned} \tag{9}$$

X_1, X_2, and X_3 are the total outputs of the three endogenous industries and Y_1, Y_2, and Y_3 represent sales to final demand. The coefficients are the entries in the direct requirements table shown in table 2. In matrix notation, the system becomes:

$$\begin{bmatrix} \mathbf{X_1} \\ \mathbf{X_2} \\ \mathbf{X_3} \end{bmatrix} = \left[\begin{bmatrix} .30 & .20 & .20 \\ .10 & .10 & .20 \\ .20 & .10 & .10 \end{bmatrix} \times \begin{bmatrix} \mathbf{X_1} \\ \mathbf{X_2} \\ \mathbf{X_3} \end{bmatrix} \right] + \begin{bmatrix} \mathbf{Y_1} \\ \mathbf{Y_2} \\ \mathbf{Y_3} \end{bmatrix} \tag{10}$$

which can be simplified to:

$$\mathbf{X} = \mathbf{AX} + \mathbf{Y}. \tag{11}$$

X is the vector of total outputs, **A** is the matrix of direct coefficients, and **Y** is the vector of final demands. The system of equations can be rewritten as:

$$\begin{aligned} X_1 - .30\,X_1 - .20\,X_2 - .20\,X_3 &= Y_1 \\ X_2 - .10\,X_1 - .10\,X_2 - .20\,X_3 &= Y_2 \\ X_3 - .20\,X_1 - .10\,X_2 - .10\,X_3 &= Y_3 \end{aligned} \quad \text{or:} \quad \begin{aligned} (1-.30)X_1 - .20\,X_2 - .20\,X_3 &= Y_1 \\ -.10\,X_1 + (1-.10)X_2 - .20\,X_3 &= Y_2 \\ -.20\,X_1 - .10\,X_2 + (1-.10)X_3 &= Y_3 \end{aligned} \tag{12}$$

In matrix notation:

$$\begin{bmatrix} (1-.30) & -.20 & -.20 \\ -.10 & (1-.10) & -.20 \\ -.20 & -.10 & (1-.10) \end{bmatrix} \times \begin{bmatrix} \mathbf{X_1} \\ \mathbf{X_2} \\ \mathbf{X_3} \end{bmatrix} = \begin{bmatrix} \mathbf{Y_1} \\ \mathbf{Y_2} \\ \mathbf{Y_3} \end{bmatrix} \tag{13}$$

The matrix can be rewritten using the identity matrix and matrix multiplication to get:

$$\left[\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} .30 & .20 & .20 \\ .10 & .10 & .20 \\ .20 & .10 & .10 \end{bmatrix} \right] \times \begin{bmatrix} \mathbf{X_1} \\ \mathbf{X_2} \\ \mathbf{X_3} \end{bmatrix} = \begin{bmatrix} \mathbf{Y_1} \\ \mathbf{Y_2} \\ \mathbf{Y_3} \end{bmatrix} \tag{14}$$

which can be reduced to:

$$(\mathbf{I} - \mathbf{A})\,\mathbf{X} = \mathbf{Y} \tag{15}$$

where **I** is the identity matrix, **(I-A)** is called the Leontief matrix, and **A**, **X**, and **Y** are defined as before.

To find a solution of outputs required to sustain a given vector of final demands, both sides of equation (16) must be pre-multiplied by the Leontief inverse. The Leontief inverse $(I - A)^{-1}$ is defined as the total requirements matrix and can be solved using many computer programs or manual conversion techniques. The system becomes:

$$(\mathbf{I} - \mathbf{A})^{-1}\,(\mathbf{I} - \mathbf{A})\,\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{Y} \tag{16}$$

which reduces to:

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{Y} \tag{17}$$

The coefficients are now in a form that can be used to solve the system and find the total requirements for producing goods and services for final demand. Using the previous information, the following system of equations can be developed.

$$\begin{aligned} X_1 &= 1.6155\ Y_1 + 0.4090\ Y_2 + 0.4499\ Y_3 \\ X_2 &= 0.2658\ Y_1 + 1.2065\ Y_2 + 0.3272\ Y_3 \\ X_3 &= 0.3885\ Y_1 + 0.2249\ Y_2 + 1.2474\ Y_3 \end{aligned} \tag{18}$$

The system of equations presented in equation (18) is the result of the inversion of the **(I - A)** matrix. This information is the basis for the total requirements table, which is shown in Table 3.

Table 3. — The Total Requirements Table

Producing Industries	**Purchasing Industries** Industry A	Industry B	Industry C
Industry A	1.6155	0.4090	0.4499
Industry B	0.2658	1.2065	0.3272
Industry C	0.3885	0.2249	1.2474
Total or output multiplier	2.2698	1.8404	2.0245

When final demand originating from outside of the region increases, the total requirements table can be used to determine the total increase in output needed to meet that demand. For example, if out-of-region final demand for Industry A output increases by $1, Industry A output would need to increase by $1.6155, Industry B output would need to increase by $0.2658, and Industry C output would need to increase by $0.3885, for a total regional increase in the value of total output of $2.2698. The output multiplier is calculated by summing the appropriate column in the total requirements table. Employment and income multipliers can be estimated from the output multipliers, based on labor requirements and wages for changes in output.

Fundamental Assumptions of an Input-Output Analysis

There are several assumptions which are needed to use input-output analysis as a tool for estimating the regional impacts from changes in spending. Some of these assumptions are similar to those presented for the economic base and income-expenditure methodologies. These assumptions include:

- Fixed proportions exist in all production processes, and the direct requirements are constant over the period of analysis.
- All firms in a given industry employ the same production technology, usually a national average is used, and to produce identical products or bundles of products.
- There are constant returns to scale in production. This means that the average cost of production is the same at all output levels and any level of output is obtainable by simply adjusting all inputs proportionately to a new output level.
- There is no substitution among production inputs as the output level changes.
- There are no price effects from changes in output which would influence the use of inputs for production. Similarly, input substitution does not exist.
- I-O models represent one particular year and are based on the national system of accounts.
- Generally, jobs created by additional spending are new jobs which also represent new households in the area. Induced effects are computed using linear changes in household spending with changes in income. Spending by new households may be very different from existing spending patterns.
- An open input-output model does not take into account the increased spending in the economy via the consumption expenditures of households. That is, the open model

considers only sales and purchase linkages within productive sectors of the regional economy and ignores consumption linkages. This can be compared to the economic base and income-expenditure models that account for the induced or consumer respending effect and ignore the indirect or inter-sector linkages. In the base and expenditure models the indirect effect must be determined outside the model.

Induced effects can be incorporated into an input-output model by closing the model with respect to the household sector. That is, the household sector is brought into the endogenous transactions matrix as a column from the exogenous final demands, and the personal income portion of the value-added row is incorporated into the transactions matrix as an additional row. The household sector is now treated as a producing sector, selling its product (labor) to other producing sectors and to final demands, and purchasing inputs from other sectors to maintain the flow of its product.

Potential Problems with the Input-Output Methodology

A major potential problem with an input-output based analysis is the assumption of fixed production coefficients combined with the assumption of no price effects on the mix of inputs used. The assumption of linear relationships is a problem when changes in final demand are large enough that the production relationships are no longer linear but are exhibiting increasing or decreasing returns to scale. If a regional impact analysis is completed for a large region which produces many goods and services, large exogenous changes in final demand for goods and services produced in the region could potentially affect prices and change the mix of production inputs. However, for changes in final demand that are relatively small, the input requirements may increase more or less in direct proportion to the increase in output. In addition, there is evidence that the average cost of producing some goods is independent of the scale of output in some cases.

A mistake that is frequently made when using input-output based techniques is to multiply a sales multiplier times total spending on an activity to get total sales effects. This will generate an inflated estimate of regional impacts because total spending is not the same as the direct effects appearing in the multiplier formula. To properly apply total spending to an input-output model, various margins must be deducted from the purchaser price to factor out returns to the producer. In an input-output model, retail margins accrue to the retail trade sector, wholesale margins to wholesale trade, and transportation margins to the transportation sector and producer prices are assigned to the sector that produces the good. In cases where the producer lies outside the local region, an immediate leakage is created in the first round of spending because the producer portion of the final cost is not a local impact.

Most regional impact models are based on fairly generalized production relationships derived from national data. As a result, production techniques that are unique to a region or more modern (or less modern) than the national average will not be well represented by the impact models. Examples of this problem include agricultural production and mining. Producing cotton in California is likely to require a different mix of inputs than producing cotton in Texas or the southeastern States, yet most general input-output based multiplier programs would use a general cotton production function. Similarly, many different types of coal are mined throughout the United States. The levels of availability vary, requiring very different production techniques.

As a result, the analyst must be aware of the type of production function used in the regional impact model, and the production function may need to be modified to better represent regional conditions. Without these modifications, the input requirements and the estimated regional impacts will not be correctly estimated. Trade associations, government agencies, university publications, and interviews of production managers are all potential sources of information for modifying generic production relationships used in a regional impact model. This effort may not be necessary for models developed at the State or local level.

The Need to Include Forward Linkages in a Regional Impact Analysis

An input-output multiplier type of analysis accounts for the relationship between an industry producing the good or service for which there is a change in final demand and the suppliers of inputs for production of that good or service. This relationship between producers and suppliers of inputs is referred to as a backward linkage. However, when the demand for a product or service changes, the linkage between the industry producing the final good or service and the consumer of that good or service may result in additional impacts. This linkage is referred to as a forward linkage. Forward linkages, which are not captured by an industry multiplier, can be thought of as additional activities beyond final production that are required by the ultimate users of the good or service to use the product or service. Examples could include transportation of goods after final purchase, wholesale distribution of final goods, or any other activity that adds to the cost of the good or service beyond what is accounted for in the multiplier analysis.

For example, suppose an analysis is needed to estimate the regional impacts from a proposed land retirement program. It is anticipated that the program will result in reduced alfalfa production. Assume that a large percentage of the input suppliers for alfalfa production are located in the study area and a trucking company that ships the alfalfa to dairies outside the region is also located in the study area. A standard multiplier type of analysis would generate estimates of the impact of reduced alfalfa production on local suppliers of inputs for alfalfa production. The impact of reduced trucking activities from reduced alfalfa production would not be included in the multiplier analysis; however, trucking impacts represent real impacts that would be felt in the region.

Forward linkages can be accounted for in a regional impact analysis by (1) identifying activities that are needed to provide the good or service under consideration that is not accounted for in the industry multipliers, (2) evaluating the extent to which the forward linked activity is needed to support the use of the final good or service, (3) determining the location of the forward linked activity (inside or outside the study region), and (4) estimating the payments required for the forward linked activity.

In the land retirement example, the change in demand for trucking services due to reduced alfalfa production needs to be included in the analysis to fully reflect the regional impacts from land retirement. Therefore, the value of the change in final demand for trucking services as a result of reduced alfalfa production could be input into the trucking sector of the I-O based model to account for that forward linkage.

If the trucking supplier were located outside the study region, the forward linkage would not be included in the analysis and the analysis including only backward linkages would correctly reflect regional impacts. Therefore, the extent to which forward linkages should be included in a regional impact analysis must be evaluated on a case-by-case basis. The accuracy of the estimated regional effects from forward linkages depends on the accuracy of the estimated change in the level of activity of the forward linked sector.

Advantages of the Input-Output Methodology

The I-O based method of estimating regional impacts has several important advantages over the economic base and income-expenditure approaches. The first and perhaps most important are the level of detail that can be represented in an I-O based analysis and the intricate transactions patterns that can be represented in an I-O model. Large regions with multiple production sectors can be represented more precisely using I-O models than by using the other two approaches.

Another important advantage of an I-O based analysis is the availability of computer packages and data sources for completing an I-O based impact analysis. Models such as IMPLAN from the Minnesota IMPLAN Group, Inc., and the Regional Input-Output Modeling System (RIMS II) from the U.S. Department of Commerce provide consistent and well documented estimates of multipliers and impacts that can be applied to regions of various sizes throughout the United States. The national level data that these computer packages are based on are updated frequently, providing recent information on the production relationships used to estimate impacts.

An I-O based analysis is a static analysis where the coefficients of production are assumed not to change over the period of analysis. However, the analysis can be run using modified production relationships that account for anticipated changes in production technology. In this way, the analysis becomes less static, and realistic changes in future production can be taken into consideration.

Last, given the assumption of linear production functions that can accurately describe the interrelationships between all sectors of an economy, the I-O methodology produces theoretically valid and precise estimates of the inputs needed from each sector to meet a given final demand. In other words, assuming we have good data and linear production relationships, relatively simple matrix operations can be used to solve for the input requirements for production in very complex regional economies.

Summary of the Input-Output Methodology

Using input-output based models to estimate the regional impacts from a proposed project or action allows the analyst to account for inter-industry impacts that are not accounted for in the economic base and income-expenditure methods. Therefore, an input-output based analysis is more realistic in terms of the factors that are likely to generate regional economic impacts.

The input-output methodology is probably best suited for small to medium sized regions. The assumption that no price effects occur as a result of changes in final demand will generally not be a severe problem in smaller regions. However, the significant changes in demand in large regions are much more likely to result in significant input shortages and price effects. The potential for input substitution also increases in larger regions.

Analyses of impacts over a long period of time are complicated by the assumption of constant production coefficients. As a result, a relatively short period of analysis is preferred when using input-output analysis. In cases where changes in production coefficients are expected, an attempt should be made to re-analyze impacts at various intervals during the period of analysis to try to account for changes in production technology.

Computable General Equilibrium Analysis

A computable general equilibrium (CGE) model consists of a system of simultaneous equations representing cost of production functions, demands for factor inputs, and demand for household goods and services. An optimal mix of production inputs is generated by the model that meets the demands resulting from an exogenous shock caused by a project or action. A CGE model is a market clearing general equilibrium model. With this model all markets within the economy are simultaneously in equilibrium. While in equilibrium, all markets clear (supply equals demand),

and prices and quantities do not have a tendency to change. Therefore, a CGE model can be used to estimate a new regional equilibrium after an exogenous disturbance.

There are three general characteristics of CGE models: (1) they include explicit specifications of how consumers and producers behave, (2) they describe how the prices of goods and services are determined through supply and demand decisions made by consumers and producers, and (3) they are computable in that there is a solution to the system of equations specified in the model. Generally, households are represented as utility maximizers, and firms are represented as profit maximizers or cost minimizers. Therefore, through optimizing behavior, the prices of goods, services, and input factors determine consumption and production decisions.

Generally, the basis of a CGE model is a set of input-output accounts, which, as described above, show the flows of goods and services between industries, households, governments, and importers/exporters. These standard input-output accounts are supplemented by elasticity estimates, including elasticities of substitution between production inputs, price and income elasticities for household goods and services, and elasticities of demand for products exported outside of the region. These elasticities are the basis for allowing for adjustment in quantities supplied and demanded as a result of changes in prices.

In the 1970's, the CGE methodology gained interest largely because of major shocks from increased energy prices to the world economy. Modeling changes in the flows of goods and services under these circumstances required theoretically valid methods of accounting for these changes for accurate estimates of impacts.

The Basic Structure of a CGE Model

As an illustration, a CGE model could include five groups of equations representing consumption, production, prices, market clearing, and miscellaneous items such as trade equations and wage equations. Within the consumption group, a distinction may need to be made between imported commodities, domestically produced goods and services, and exports produced for consumption outside the region. Consumption functions must be estimated for each commodity included in the system and for each source of production. The consumption functions are derived from household utility functions and budget constraints and show the quantity of each commodity demanded at various prices. Demand for commodities outside the local region can be estimated similarly.

Production functions are used to estimate the demand for intermediate inputs and primary factors of production. Two aspects of production must be recognized, the activity level of each *industry* and the production level for each *commodity* in each industry. The activity level for each industry is constrained by commodity and factor inputs and the production level for each commodity is constrained by the industry activity level. Input factor substitution can be allowed within the specification.

The primary purpose of the price equations is to ensure that the value of all outputs in an industry equal the value of all intermediate and factor inputs. As prices of individual commodities and factor inputs change, substitution occurs based on the defined consumption and production relationships, and quantities and prices adjust until equilibrium is again reached at the new output levels and prices.

The market clearing equations require that the production of goods and services in the region equal use of those commodities as intermediate inputs. In addition, the use of labor and other capital resources for production is not allowed to exceed the availability of those resources. Other factors such as wages needed to employ labor resources can be included in the model similarly to price effects.

Fundamental Assumptions of a CGE Analysis

The primary assumption of CGE models is consistency with modern neoclassical microeconomic theory, where the demand and supply functions contained in the models are derived from utility and profit maximization characteristics. CGE model equations are generally specified such that a unique solution is found which is Pareto efficient. A Pareto efficient resource allocation is one that leaves no room for unambiguous improvement for either producers or consumers. Pareto efficiency is appealing because it does not require the welfare of one party to be compared against that of another. However, Pareto efficiency is limited in its usefulness because it cannot be satisfied in reality and it may not result in an optimal allocation.

Other assumptions in a CGE analysis include:

- Production technologies do not exhibit increasing returns to scale. This assumption can be relaxed, but solving the systems of equations can become very difficult.

- Firms are price takers, consumers and producers behave rationally, and that utility functions are similar (if not identical) for all individuals. These are assumptions of competitive markets and utility which are needed to obtain unique optimal solutions.

Potential Problems with the CGE Methodology

There are several potential problems associated with the application of a CGE analysis.

- CGE analysis can be difficult to apply in some areas because of the data requirements for accurately modeling linkages between sectors and estimating equilibrium. General equilibrium analysis is more difficult because all markets within the economic system must be considered and the linkages between markets must be modeled accurately to generate the correct equilibrium conditions.

- The microeconomic foundations upon which CGE analysis is based may not be very realistic.

- It is difficult to model increasing returns to scale and technical progress in a CGE model. Increasing returns can result in a positive feedback effect, where production costs are lowered so prices may decrease and quantity demanded increases. When increasing returns are present, some of the microeconomic foundations within the CGE framework are violated. It can also be very difficult to model increasing returns to scale in a dynamic context.

- A CGE model is very sensitive to the model specification. However, this sensitivity can actually be used to evaluate the robustness of the modeling results.

Advantages of a CGE Analysis

The primary advantage of a CGE analysis is that it can account for price changes and substitution of inputs and outputs which may result from a change in final demand for a good or service. The system of equations in a CGE analysis results in a solution where markets within the economy are in equilibrium and each of the markets clear at a new price and quantity after the change in final demand. This advantage may not be worth the time and effort of completing a CGE analysis if the change in demand is not likely to be sufficient to cause any of these effects throughout the economy. However, for larger changes in final demand and large impact areas, a CGE analysis may be warranted.

Another potential advantage of CGE analysis is the ability to incorporate non-linear production relationships which better represent actual production functions. However, as noted above, some functional forms violate some of the microeconomic foundations within the CGE framework. In addition, modeling non-linear production functions within a CGE framework can become very difficult mathematically.

Summary of the CGE Analysis

CGE models are useful because they depict the economy as a system of interrelated sectors, allowing a theoretically correct analysis of effects which account for price changes. CGE models can handle a large amount sectoral detail through the use of available national accounting data. Their advantage over input-output models, which rely on fixed coefficients, is the inclusion of market responses to changes in economic variables. These responses may be fairly general, such as elasticity estimates from previous studies, but they are important in understanding the response to exogenous impacts.

While some of the model specifications may not be completely correct, they can be sufficient to provide insight into the likely effects of exogenous changes in regional expenditures, which include price effects. While CGE modeling can be very data intensive because of the need to estimate large systems of equations, computer software and readily available input-output based data have greatly improved the efficiency of creating detailed regional CGE models.

A CGE analysis is best suited for relatively large and diverse economies for which there is a large amount of regional economic data. The CGE method requires a large amount of data from which market interdependencies can be estimated. In addition, the project or action under consideration, the exogenous shock, must be large enough that price effects would be expected within the region under consideration. Otherwise, an input-output model or other constant coefficient type model would probably be sufficient to estimate regional impacts.

COMPLETING A REGIONAL ECONOMIC IMPACT ANALYSIS

Regardless of the type of methodology used to estimate the regional economic impacts from a project or action, changes in the level of economic activities (final demand) must be estimated and used as input data for the regional impact models. In addition, the change in economic activities must represent the actual change in final demand from consumers outside the region or must represent a change in the distribution of final demands from within the region. A change in the distribution of final demands will result in a change in regional output and income if the demand sectors have different leakage rates. If demand shifts from a good or service sector which has a high level of leakages to a sector with few leakages, there will be a positive effect on overall regional output and income. A variety of issues must be addressed when completing a regional economic impact analysis in order to properly account for the change in final demand which will generate regional impacts.

When completing a regional economic impact analysis, there are three basic steps that must be followed. These steps are:

- Determine the impact region of concern.

- Identify the types of activities that will be affected by the action under consideration and the level of expenditures associated with each. Activity categories could include construction, agricultural production, recreation visitation, power generation, municipal and industrial water supplies, direct government payments to households or businesses in the region, and many others. Expenditure categories could include items such as groceries, gasoline, utilities, vehicles and other equipment, and many others.

- Determine the changes in expenditures that represent a true change in final demand. That is, expenditures that occur in the region must be separated from expenditures that occur outside the region.

Defining the Impact Area

There is no set rule for determining the correct area of consideration for a regional economic impact analysis. However, the region included in the study area should represent the primary area of concern to policy makers relying on the analysis for decision making purposes and should be reasonable in terms of the linkages between the site where the primary impacts occur and outlying areas that are economically and socially connected.

An impact region may be defined in terms of political boundaries. The primary reason for using political boundaries is because most data are gathered in terms of political units such as municipalities, counties, and States. Many economic and social linkages cross these boundaries. Therefore, political boundaries are not the best basis for defining an impact region in many cases. However, since most economic data are gathered at the city, county, State, or Federal level, political boundaries will frequently play a part in determining the impact region. It should be noted that some data are available at the postal Zip Code level. However, for larger studies aggregating Zip Code data can be very difficult and ultimately may be very similar to aggregated county data.

An impact region can also be defined as a set of small areas that share similar physical, social, cultural, or economic characteristics or one primary characteristic. For example, if an action is going to affect Native American government programs, then the impact area may be defined by the location of the Native American population. If an action is going to affect agricultural production, the impact area may include several counties that produce agricultural goods and provide agricultural services.

An impact area can also be defined in terms of economic linkages between areas as reflected through business and trade patterns and interdependency in production. For example, if a lumber mill is operated in a rural location and most of the labor comes from a city in an adjacent county, both counties may be considered as part of the impact region for an action that would affect the lumber mill.

The size of the region used for analysis is also important because it can have a significant influence on the magnitude of the estimated impacts. The region should be large enough to include all the direct impacts of the project or action under consideration; otherwise, some of the impacts will be ignored or the distribution of the impacts will be misspecified. It is nearly as important that the specified study area should not be too large. Using a study area that is too large may inflate the impact estimates and reduce the precision with which the relative location of impacts can be measured. Impacts measured over a large area may show relatively small impacts compared to current level of activity. However, if a large percentage of impacts occur in a much smaller region, then the impacts may be significant compared to current activity in the smaller region.

The size of the defined region can influence the value of the multipliers and the estimated regional impacts. Theoretically, the magnitude of the multipliers will increase as the size of the region included in the study area increases. This is because the number of economic activities within a region increases with the size of the region. The region becomes more self-sufficient with increasing size, and expenditure leakages outside of the region decrease. However, the multipliers generated by some regional impact computer programs may actually decrease with an increase in the size of the region because average multipliers are used as regions are added together. If a low multiplier region is added to a high multiplier region, the resulting larger region will have a multiplier that is lower than the high multiplier region.

In summary, there are two basic questions that need to be answered when determining the size of the impact region to be analyzed: (1) should the analysis show very site specific impacts or the magnitude of impacts over a larger area of influence, (2) should the analysis include a larger area of production with a wider range of production capability and input availability. Multipliers would generally be expected to be larger for larger regions because the leakages would be reduced due to more types of goods and services are produced (a more diverse and self-sufficient economy will have a larger multiplier).

Types of Activities and Expenditures Associated with Each Activity

Once the impact region is defined, the activities that are likely to be affected by a project or action must be identified, and the expenditures associated with each activity estimated. Activities which could be affected by changes in water resources include but are not limited to recreation visitation, agricultural production, direct government payments to households or businesses in the region, construction activities, municipal and industrial water service, and commercial fishing. Many other categories of impacts are possible, but these examples provide a range of impact assessment possibilities.

The expenditures associated with each of these activities need to be placed into categories that represent different sectors of production in the economy. The input requirements associated with different types of expenditures are very different in many cases. Therefore, the flows of goods and services throughout the economy required to produce the good or service demanded are different. Possible expenditure categories for six selected economic activities are presented in Table 4 below.

Table 4. — Illustrative Expenditure Categories

Recreation Food - groceries Food - restaurants Lodging Gasoline Automobile repair and maintenance Privileges and other fees Boat launch, storage, etc. Bait, ice, heating and cooking fuel,other specialty items Small items such as fishing lures,lines, ammunition, other small items	**Agriculture** Livestock purchased Feed Seed Fertilizer Chemicals other than fertilizer Petroleum products Electricity Repair and maintenance Custom work Interest payments Property taxes	**Direct Income** Food - groceries Food - restaurants Housing Utilities Furnishings Apparel Vehicles Gasoline Automobile repair and maintenance Health care Entertainment Insurance/pensions
Construction Concrete Excavation Machinery/equipment Gasoline/diesel Labor Engineering work Steel Electrical Lumber Culverts Pipeline	**Municipal and industrial water supplies** Chemicals Electricity Distribution system pipeline Valves and meters Interest on borrowed debt Management/operation/repair Labor Excavation Equipment Fuel and oil Engineering services	**Commercial fishing** Boats Poles/lines/nets Other miscellaneous equipment Marina rental Sheds/processing buildings Electric motors Fuel and oil Maintenance Labor costs Local taxes/fees/licenses

The direct income category of activity presented in Table 4 represents any change in household income associated with an action. If the action being analyzed includes a Federal payment to local landowners, the portion of that payment that is distributed to households would be included as direct income. If the action resulted in increased agricultural output and higher regional farm income, the portion of income distributed to farm households would be included in the direct income category.

It is important that the expenditures used to estimate regional impacts represent the change in spending that is attributable to the project or action. For example, a project that would increase irrigated agricultural acreage and production may require increased fuel, fertilizer, seed, and other chemical usage. However, the current quantity of farm implements and custom services may be sufficient to serve the region with the project. Therefore, the projected increase in fuel, fertilizer, seed, and other chemical usage with the project can be attributed to the project, but a portion of farm implement cost estimated with the project is probably not attributable to the project. Therefore, simply using average farm expenditures per acre for various categories of use (for example, from the U.S. Census of Agriculture) may not be a good indicator of the change in expenditures for each expenditure category. The analyst must first determine the expenditure categories that will be affected by the action, then estimate a representative change in expenditures for the affected category.

In an impact analysis of changes in recreation visitation, it is important that the trip expenditures represent the variable expenditure actually associated with the trip. That is why the expenditure categories presented in table 4 do not include items that represent a fixed cost, such as boats, fishing poles, rifles, vehicles, and other items that would reasonably be expected to be purchased in the visitor's home region and would be used for a large number of visits at many different sites. For example, including the cost of buying a boat for fishing as a part of fishing expenditures at a specific site will overstate the impacts of that activity to the region because it is unlikely that the visitor will buy the boat in the region being visited.

Some expenditure categories may not be as obvious as the boat example. Therefore, considerable professional judgement may be needed to evaluate the expenditures that are likely to occur within the study region. For example, gasoline expenditures per trip for visitors to a recreation site may occur in both the region they are coming from and the region they are visiting. One-half of the gasoline expenditures per trip may be attributable to the recreation site region. Another example is commercial fishing, where boats and other equipment may or may not be purchased in the local region, depending on the availability of suppliers and price differences of suppliers inside and outside the region. In summary, some method for allocating expenditures to the study region and outside the region is needed for each category of expenditures.

It should also be noted that the expenditures listed under the municipal and industrial water supplies category in Table 4 refer to non-construction expenditures related to operation, maintenance, repair, and energy costs. The impacts related to building treatment plants, pumping plants, storage, and distribution systems would be covered in the construction impact category.

Sources of Expenditure and Distribution of Expenditure Information

Potential sources of expenditure information for completing regional impact analyses include:

Consumer Expenditure Surveys. — Bureau of Labor Statistics. Includes detailed summaries of household spending patterns for the United States at the national and State levels that can be used to evaluate impacts from increased income created directly by the project or action under consideration (for example, land retirement payments).

National Surveys of Fishing, Hunting, and Wildlife-Associated Recreation. — U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. Includes estimates of expenditures for various types of goods and services related to hunting, fishing, and wildlife-related recreation activities at the national and State level.

Census of Agriculture. — U.S. Department of Agriculture, National Agricultural Statistics Service (prior to 1997, the Census of Agriculture was the responsibility of the Bureau of the Census). Contains detailed data about farm revenues by type of operation, cropping patterns, input expenditures, and production at the county and State level.

Individual State recreation related agencies. — Many States conduct recreation surveys and studies as part of on-going efforts to evaluate the impact of recreation facilities on local economies and government revenues. The results of these studies can be useful in estimating the magnitude and types of recreation expenditures in an impact analysis. Agencies that may conduct these surveys include departments of recreation, parks, game and fish, tourism, commerce, and others.

Farm enterprise and budget studies. — Many State agricultural departments, in cooperation with State universities, produce farm enterprise studies that provide representative estimates of input requirements and costs for producing various crops in individual counties and States. These enterprise studies can be used to estimate the change in input costs resulting from a proposed project or action. The Bureau of Reclamation completes farm budget analyses for payment capacity and/or irrigation benefit estimates that portray representative costs and returns for farm operations. These input cost and income estimates can be used as data for a regional economic impact study.

Individual business/farm owners and trade associations. — Information from individual business and farm owners can be used to help determine where they get their supplies for production, the mix of inputs they require for their specific operation, and the cost of those inputs. Trade associations may also be able to provide similar information for areas where information is not available from individual owners or to verify information from individual owners.

Local development and employment agencies. — Local agencies may have information about the types of business and industry in the study area, the current and future location of business and industry in the area, infrastructure requirements including transportation of inputs and finished goods, and the employment requirements of local business and industry. This information can help determine trade patterns and the employment impacts of changes in final demand.

Local water utilities. — Utilities that provide municipal and industrial water service may be able to provide estimates of maintenance, operation, repair, and energy costs and the sources of goods and services for these activities. Similar information may be obtained for construction of water supply facilities.

Previous regional impact analyses. — Previously completed studies of regional impacts for similar types of activities can be useful for categorizing types of expenditures and estimating the magnitude of expenditures. These studies may be found in academic journals or in government publications.

What Expenditures Represent a True Change in Final Demand?

An increase in the demand for goods and services produced within a region by consumers from outside the region represents an exogenous change in demand for goods and services. These expenditures are treated as a change in final demand. The inflow of expenditures results in increased regional output and sales, generating positive regional economic impacts.

A change in the distribution of final demands within a region may result in changes in regional output and sales because of the variation in the multipliers associated with different goods and services. For example, if the value of final demand for agricultural production inputs increases by the same amount as the decrease in value of final demand for recreation goods, and the local region produces more agriculture inputs than recreation products, the end result may be positive impacts to the region.

Two general questions must be answered in order to estimate the expenditures which actually represent a change in final demand and influence regional output.

1. Is the money used to purchase goods and services coming from inside or outside the region of study? Money from outside the region which is spent on goods and services within the region will contribute to regional economic impacts while money which

originates from within the study region is much less likely to generate regional economic impacts. Spending from sources within the region generally represents a redistribution of income and output rather than an increase in economic activity, except as noted in the agriculture/recreation example above.

2. If the money used to purchase goods and services is determined to originate from inside the region, would those expenditures have otherwise flowed outside the region if the activity supported by the action did not exist? For example, if an action will result in improvements that will keep people who live in the study area recreating inside the area, and otherwise those people would have gone to recreation areas outside the study area, then those recreational expenditures retained in the study region represent a positive regional economic impact of the action.

Specific issues associated with these questions are addressed for different types of impact categories below.

Recreation

The recreation expenditures that generate regional economic impacts are the expenditures that occur in the region. Therefore, the spending patterns of visitors must be known. Several questions must be answered to establish spending patterns.

- What proportion of the visitation expenditures occur inside the study region?

- Where does the visitor come from, does he or she live in the study area? The regional economic impacts of expenditures at a recreation site made by a person living within the study region are likely to be very different from the impacts from the same level of expenditures made by a person living outside the study region. Those living within the region may be simply redirecting their spending from one activity to another, resulting in smaller regional impacts than if they live outside the region and bring money into the area. Recreation site managers and previous recreation studies may be good sources of information on the percentage of recreation visitation attributable to residents within the region and out-of-region residents.

  As mentioned above, there is an exception to the idea that recreation spending by local residents will result in relatively small regional impacts. If an action improves recreation opportunities in the study area and the improvement results in an increased study area visitation by local residents and decreased visitation to sites outside the study area, the end result is a net increase in regional spending in the study area. In this case, the recreation spending by local residents represents a net increase in local spending and should be included as an increase in final demand for local goods and services.

- If the visitor comes from the local region, would he or she have spent the money on another type of activity? This is the issue of the distribution of spending between activities within a region versus an actual increase in regional spending. An important related question is whether substitute recreation sites or activities are available. The availability of substitute sites within or outside the study area, as well as the availability of substitute activities, are important considerations.

An analysis of recreation impacts should be based on the changes in expenditures that actually are experienced in the region. For example, suppose that operations at a dam will be changed, and the change will reduce reservoir recreation and increase on-stream recreation activity within the same region. Also, suppose for simplification that all recreation visitation originates from outside the study area; that is, all recreation expenditures represent an increase in demand for final output. If there is a decrease in recreation activities at the reservoir resulting from reoperation of the dam, and at the same time an increase in on-stream recreation activity within the study region, the impact analysis must be based on the net change in recreation expenditures resulting from the change.

The same principle applies to a change that affects one resource in a study area but does not affect another substitute resource in the study region. Suppose one recreation site will be adversely affected by an action resulting in an estimated 1,000 fewer visitor days and $50,000 less in expenditures. Further, suppose that a substitute site in the study region which provides the same type of facilities as the adversely affected site will see 500 of those visitor days shift to the substitute site and the visitors will spend $25,000 at the substitute site. The impact analysis will be based on the change of 500 visitor days and $25,000 in reduced expenditures rather than the entire $50,000 loss at the affected recreation site. However, it should be noted that an analysis of the change in economic benefits would need to take into account the substitution of one site for another because visitors did not originally choose the substitute site; therefore, they must be obtaining a different level of benefit from recreation at the substitute site than they would have obtained at the preferred original site.

How do we estimate the recreation expenditures occurring within the region? For example, suppose a person from outside the region is going to take a trip into the study area of interest. That person will probably purchase fuel, food, and other trip related items in their home region in preparation for the trip. They may then purchase fuel for the return trip in the recreation site region and may purchase other items locally while they are visiting. However, to attribute all the trip-related expenditures to spending at the site region will overestimate the true regional economic impacts of the recreation visit. Some estimate is needed of the actual on-site recreation expenditures.

It could be assumed that half of the trip related fuel expenditures occur in the site region based on re-fueling on-site for the trip home. It could also be assumed that some types of spending, such as permits, fees, bait, and food at restaurants, will occur on-site. However, the pattern of spending for other types of items such as groceries, clothing, household supplies, and cooking supplies cannot be assumed with any confidence. Additional information is needed to estimate the percentage of these types of expenditures made locally.

Agriculture

There are two major considerations when estimating regional impacts from changes in agricultural production. The first is to account for the net change in input expenditures and farm income with the action under consideration compared to input costs and income without the action. The second is to determine where (within the study region or outside the region) the inputs are purchased and the farm income is spent.

A regional impact analysis must always account for the change in farm expenditures that would occur with an action compared to no action. If an action is going to increase or decrease irrigated agricultural activity, the change in activity from the original base is the amount that should be used to determine impacts. For example, if there was dryland agriculture in an area before a project was built that generated $1.0 million in income and input demand and total income and value of inputs with the project were projected to climb to $3.0 million, the regional impacts are based on the $2.0 million change rather than the $3.0 irrigated agriculture value.

The location where agricultural input purchases are made will depend on the cost and availability of the input item. More expensive input purchases may be made farther away from the farm operation to get better prices, but smaller items and farm services may be more likely to be purchased locally because the price difference is not as critical. Some input items may not be purchased within the study region because they are simply not available.

How farm income is spent and where it is spent, if the farm operation makes money, must also be determined. Net farm income needs to be separated into likely expenditure categories. These categories can be based on consumer expenditure surveys from the Department of Commerce, or perhaps from local sources.

In some cases, an alternative may include a nonstructural agricultural component, such as retiring agricultural land to free up water supplies. The land retirement component could include Federal Government payments to landowners to give up short-term or permanent rights to the land. In this case a regional economic impact analysis would need to include the negative regional impacts from reduced agricultural production, as well as any positive impacts from land purchase or lease payments to the land owner. However, the land retirement payments to the land owner would generate positive regional impacts only to the extent that those payments stay in the region. If the landowner sells the land to be retired and then takes the payment and moves out of the region, there would be no positive regional impacts generated by the government payment. However, if the landowner stays in the region and spends some or all of the land payment within the region, then the land payment will generate positive regional impacts.

Construction

When evaluating construction impacts, the most important decision is the location of suppliers of building materials and services and the source of construction funds.

- Where are the construction items purchased? Construction items are more likely to be purchased outside the region and brought to the construction site than some items associated with other activities because of the high cost of many construction items. If high cost items can be found outside the region at significantly lower costs, then the cost savings will justify purchases outside of the region. However, if the project or action is relatively small, labor and a significant amount of materials could be acquired from within the region.

- Where does the money for construction come from? If the project is funded with Federal or State money, the vast majority of construction expenditures represent money from outside the region. If the project is funded through local sources, the effect on the level of spending for other goods and services in the region must be taken into account.

- Over what period of time are the inputs purchased? This is important in determining the magnitude of regional impacts over a particular period of time. Some expenditures, such as operation and maintenance items, are annual expenses that occur over the life of the project. The impacts of annual expenditures over a long period of time need to be presented differently from one-time construction expenditures.

Municipal and Industrial Water Supplies

Municipal and industrial (M&I) water supplies can create regional economic impacts in several ways. The construction and continued operation, maintenance, and repair of M&I facilities can generate regional impacts. Changes in M&I water rates can have a significant impact on the composition of goods and services purchased by households and businesses, resulting in regional impacts. In addition, changes in the availability of reliable and good quality water service may have an important impact on the number and types of businesses locating in a region. Therefore, expanding water supplies may lead to increased commercial activity and positive regional impacts. However, in most cases the increase in commercial activity attributable to expanded water supplies will be very difficult to estimate. Increased supply and reliability problems would probably have the opposite effect, reducing commercial and industrial activity.

Commercial Fishing

The major areas of consideration when estimating the regional impacts from changes in commercial fishing are essentially the same as when completing an agricultural impact analysis. First, the net change in input expenditures and commercial fishing income with the action must be compared to input costs and income without the action. Second, inputs purchased from outside the region must be separated from the inputs purchased within the region. Only the within region purchases generate regional impacts. The location where commercial fishing input purchases are made will depend on the cost and availability of the input item. More expensive input purchases may be made further away from the fishery, and some input items may not be available in the local region. Third, the percentage of commercial fishing income spent in the region and the types of expenditures must be estimated.

Other Activities

Changes in the level of activities in addition to those presented above can result in regional economic impacts. Changes in power generation facilities can influence power revenues and potentially the rates paid by power users within a region. Any action that influences economic activities within a region and results in a change in the flow of money into and out of a region (final demand) will result in regional economic impacts.

COMPARABILITY OF CONSTRUCTION IMPACTS AND IMPACTS FROM OPERATION AND MAINTENANCE EXPENDITURES

Regional impact analyses can become complicated if actions under consideration include sizable expenditures for annual costs, such as operation and maintenance. This complication is the result of estimating impacts that occur during different periods of time. When evaluating the benefits of a project in a NED type of analysis, the correct procedure is clear: bring all benefits into the same base year through a discounting procedure. However, when evaluating regional impacts, the impact values may loose some meaning if they are converted into a base year. A "discounted" estimate of the change in employment from an action may not be a very meaningful indicator of economic impacts. Similarly, the annual equivalent of income and output impacts over the life of a project from construction that occurs over a short number of years does not truly indicate the impacts that would be observed during construction and may linger after the project is completed. This question is potentially problematic in cases where there is no clear alternative and the local economic impacts are a major concern to the community. The choice may be between a large short-term gain in regional output and income and a much smaller long term gain.

The general question that needs to be answered is: what should be the basis for choosing between two projects where one project creates large one-time positive impacts as a result of construction but few annual impacts while a second project creates small initial construction impacts but large annual O&M related impacts over time? The impacts of each alternative need to be presented in comparable terms in order to compare various alternatives equally.

There are several ways in which the impacts can be presented. First, short-term construction related impacts can be kept separate from the impacts from annual expenditures occurring over a long period of time. Construction impacts would be presented in terms of total impacts over a few years while O&M impacts would be presented in terms of impacts per year. This method of presenting impacts does not address the problem of the comparability of impacts, but instead requires policy makers reading the analysis to decide for themselves if long-term or short-term impacts are most important.

A second possibility is to again separate the short-term construction types of impacts from the long-term impacts, but to present both short-term and long-term impacts in terms of an annual average impact or a total impact over the life of the project. This method ignores any discounting that would make the value of impacts comparable over time. However, the impacts are presented in terms of the actual average impacts that would be observed in the region (nominal terms). The primary problem with this type of analysis is that the time value of money, which is the discounting of future (present) dollars into present (future) value in order to make the dollar values comparable, is not recognized. However, this method is compatible with estimating employment impacts, which are measured in terms of jobs.

A third possibility would be to present long term and short term impacts as annual equivalent impacts or total impacts discounted to present (or future) value terms. This method of presenting impacts results in estimates that are comparable between alternatives, although they would not generally represent the impacts that would actually be observed in the study region. In addition, employment impacts could not be presented in this way. The discounted impacts could be presented along with the separated short-term and long term impacts to reflect the timing of impacts that would actually be observed.

REGIONAL IMPACTS FROM CHANGES IN STATE AND LOCAL TAX PAYMENTS

The regional impacts from changes in State and local tax payments can be handled within the multiplier framework. State and local spending can be treated as simply another sector with specific input requirements that create multiplier effects. For example, a land retirement program could reduce local property tax payments. The regional effects of reduced tax payments could then be estimated by reducing demand for State and local government sector activities by the amount of the reduced tax payments. To some extent, this measure of tax impacts may not fully account for the regional impacts from reduced tax receipts. For example, if reduced tax payments resulted in a significant decrease in the quality of public schools, reduced availability of local public services, or reduced police and fire protection, people could be discouraged from living in the area or moving into the area, and this could further erode the tax base and lead to more adverse regional impacts. Therefore, an analysis of local tax impacts must account for the extent to which the proposed change will affect the viability of providing State and local services.

For example, if reduced tax receipts would result in a 50 percent reduction in the budget for local fire protection and the remaining funds were not sufficient to keep a local fire station open, the true regional impacts would be derived from closure of the fire station rather than reduced fire protection expenditures of 50 percent.

ESTIMATING REGIONAL IMPACTS: AN EXAMPLE

Suppose a project is under consideration that would raise the elevation of a reservoir. The construction costs of the project are estimated to be $1.0 million. The project is expected to increase reservoir recreation by approximately 5,000 visits annually, and additional water will be available for irrigation. Also, assume there are currently 10,000 irrigated acres with the current water supply and that an additional 1,000 acres will be irrigated with the project.

To estimate the regional impacts of the project, the construction expenditures must be broken down into construction categories so that the appropriate multipliers can be applied to each cost component. The expenditures associated with reservoir recreation and irrigated agricultural production in the region must also be estimated. Assume that Table 5 shows an accurate breakdown of costs and expenditures for each activity.

The expenditures presented in Table 5 represent the total expenditures associated with the construction and the change in activities resulting from the project. Therefore, expenditures that are made locally need to be determined in order to evaluate the regional impacts from the project. Assume that all of the concrete, steel, and equipment are purchased or rented outside the local area; therefore, these expenditures do not affect the local economy. Also assume that the project is federally funded.

Table 5. — Expenditures Associated with Each Activity for the Hypothetical Project

Expenditure Category	Expenditures Per Unit	Number of Units	Total Expenditures
Construction Expenditures	(NA)	(NA)	
Concrete			$350,000
Iron and Steel			$150,000
Diesel and other Fuel			$50,000
Sand and Gravel			$50,000
Engineering Work			$50,000
Labor			$250,000
Equipment			$100,000
Recreation expenditures	**(Per trip)**	**(Trips)**	
Groceries	$5.00	5,000	$25,000
Restaurants	$5.00	5,000	$25,000
Gasoline	$10.00	5,000	$50,000
Lodging	$10.00	5,000	$50,000
Fishing Equipment (Small Items)	$5.00	5,000	$25,000
Agricultural Input Costs and Income with Irrigation	**(Per acre)**	**(Acres)**	
Seed	$10.00	1,000	$10,000
Fertilizer	$15.00	1,000	$15,000
Chemicals	$10.00	1,000	$10,000
Petroleum Products	$15.00	1,000	$15,000
Custom Work	$5.00	1,000	$5,000
Farm Equipment	$50.00	1,000	$50,000
Farm Labor	$10.00	1,000	$10,000
Water	$5.00	1,000	$5,000
Net Farm Income	$20.00	1,000	$20,000
Agricultural Input Costs and Income without Irrigation	**(Per acre)**	**(Acres)**	
Seed	$2.00	1,000	$2,000
Fertilizer	$5.00	1,000	$5,000
Chemicals	$2.00	1,000	$2,000
Petroleum Products	$5.00	1,000	$5,000
Custom Work	$5.00	1,000	$5,000
Farm Equipment	$15.00	1,000	$15,000
Farm Labor	$5.00	1,000	$5,000
Net Farm Income	$5.00	1,000	$5,000

It is estimated that half of all recreational visitors to the site currently come from outside the local region and the other half are local. Further, assume that if the local visitors fail to recreate at the project site they will go to one of several small substitute recreation sites within the study region. Therefore, the local visitors will spend money for some type of recreation regardless of completion of the project. As a result, only out-of-region visitor recreation expenditures will potentially generate regional impacts. Assume further that all restaurant, lodging, and small fishing equipment expenditures occur at the recreation site and that half of the grocery and gasoline expenditures occur in the region.

The regional impacts from expenditures for agricultural inputs are based on the change in expenditures with the project versus expenditures without the project. Therefore, the agricultural input costs and income that will generate regional impacts are equal to the expenditures and income with the project less the expenditures and income without the project. In addition, the expenditures that occur outside the study region need to be excluded. Assume that all custom work is provided by businesses outside the study region and half the farm equipment is purchased outside the study area. Also assume that all the non-custom farm operations with the project can be performed with currently available equipment. Therefore, there are no impacts associated with equipment rental or purchases. The resulting expenditures that will generate regional economic impacts are shown in Table 6. The expenditures that will actually influence regional output and income are much lower than the total expenditures associated with the project.

The final step is to determine how net farm income will be spent. Using current household expenditure data available from the U.S. Department of Commerce or some other source, these expenditures can be disaggregated into categories such as groceries, vehicles, gasoline, housing, insurance. Once the expenditures that will generate regional economic impacts are estimated, one of the techniques presented above can be used to estimate the multipliers associated with each sector of final demand and regional impacts.

Table 6. — Expenditures Associated with Each Activity for the Hypothetical Project

Expenditure Category	Expenditures Per Unit	Number of Units	Total Spending
Construction expenditures	(NA)	(NA)	
Diesel and other Fuel			$50,000
Sand and Gravel			$50,000
Engineering Work			$50,000
Labor			$250,000
Total			**$400,000**
Recreation expenditures	(Local spending Per trip)	(Non-local trips)	
Groceries	$2.50	2,500	$6,250
Restaurants	$5.00	2,500	$12,500
Gasoline	$5.00	2,500	$12,500
Lodging	$10.00	2,500	$25,000
Fishing Equipment (Small Items)	$5.00	2,500	$12,500
Total			**$68,750**
Additional Agricultural Input Costs and Income with the Project	(Additional amount per acre)	(Acres)	
Seed	$8.00	1,000	$8,000
Fertilizer	$10.00	1,000	$10,000
Chemicals	$8.00	1,000	$8,000
Petroleum Products	$10.00	1,000	$10,000
Farm Labor	$5.00	1,000	$5,000
Water	$5.00	1,000	$5,000
Net Farm Income	$15.00	1,000	$15,000
Total			**$61,000**

SUMMARY

A variety of regional impact estimation techniques have been presented in this paper. Each has distinct advantages and disadvantages. The choice of a regional impact estimation method depends ultimately on the size and complexity of the region under consideration, the magnitude and types of changes in expenditures associated with the action under consideration, the time and budget available to complete the impact analysis, the level of detail required, and the information available.

The economic base and income-expenditure methods are the most simplistic approaches and are generally best used in analyses that require less precision in the estimated impacts, in analyses of regions that are relatively small and uncomplicated, and in cases where the study budget is insufficient to fund a more sophisticated analysis.

Input-output-based analyses are better for larger impact regions that have more complicated trade patterns and more complex production and consumption relationships. The input-output-based method is presented in the greatest detail because it is currently the most widely used technique for estimating regional impacts and is most applicable to the types of analyses performed for evaluating alternatives.

Computable general equilibrium models can account for price changes related to changes in input requirements and substitution of inputs that may occur as a result of the impacts under consideration in the analysis. As a result, an analysis based on a computable general equilibrium model is most appropriate when impacts are estimated for a large change in production and output that would affect regional input and output prices.

Regardless of the impact estimation methodology used, the expenditures that will actually affect the regional economy need to be determined. Therefore, expenditure patterns associated with activities affected by a project or action need to be evaluated. Some important considerations were presented that can be used to help evaluate spending patterns.

Specific, commercially available input-output or CGE models were not covered because this paper was directed more toward the practical problems associated with choosing the type of impact analysis to undertake and estimating changes in expenditures that will actually influence the regional economy. Models are available from many different government and private sources. These include IMPLAN from the Minnesota IMPLAN Group, Inc., the Regional Input-Output Modeling System (RIMS II) from the U.S. Department of Commerce, the Regional Economic Models Inc. (REMI) model, and many others, including models developed by various State agencies and universities.

Finally, a simple example was presented to help illustrate some of the issues which must be addressed when completing a regional impact analysis.

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