Chapter 3
The Washington Input-Output Models for Impact Analysis

The most common application of regional input-output (I-O) tables is impact analysis. Actually, in most cases the sole reason for constructing a regional I-O table is to use it as an analytical tool for conducting economic impact analysis. The analysis measures the changes in output (i.e. production), employment, and labor income in all state industries as a consequence of: (1) known demand changes in the output of some particular industries in the state—the **Simple Analysis**; or (2) a new activity or industry not identified in the input-output table—the **Complex Analysis**. The complex analysis procedure presumes that the output, employment, labor income, and first-round purchases of the activity/project are known.

An impact spreadsheet file is provided for downloading. This file contains two sheets used to perform the simple analysis and the complex analysis, respectively:

"Simple" and Complex" impact worksheets

To be used as a tool for economic impact analysis, the I-O table needs to be transformed into an analytical "model." This model should be able to quantify how an external change in final demand will invoke a chain of reactions in the economy: the demand-induced increase in one industry's output will require it to raise its inputs/purchases, which then raises the demand for other industries' output and their purchases of inputs, and so on. The chained reactions are generally referred to as the "ripple effect." The interindustry transaction or intermediate demand part of an I-O table (component 1 of Table 1-1) actually serves this purpose, and thus is used as the core of the I-O impact model.

The first step it takes to build an I-O impact analysis model is to convert the interindustry transactions into "direct purchase coefficients." This is done by dividing each interindustry transaction in Table 1-1 by the respective industry's total input (i.e. value in the last cell of the industry column). Table 3-1 contains the resulting industries' direct purchase coefficients for the aggregate Washington input-output model. For example, in the manufacturing/construction industry column, the value in the first cell shows the ratio of the purchases of natural resource/utilities industry inputs by manufacturing/construction industry to total manufacturing/construction input; the value is 0.01858 (=4210.1/226590.0) (the transaction values can be found in Table 1-1).

Each coefficient (a_{ij}) can be interpreted as the proportion of industry *j*'s total production input supplied by industry *i*. So the value of a_{12} implies that the manufacturing/construction industry, for every dollar of its total input, requires $.01858 cents of natural resource/utility products from Washington establishments.

Entries in the fourth row are labor earnings as a portion of the industry's total input payments. The fourth column contains entries showing personal consumption of industry *i*'s product as a portion of total earnings.

Table 3-1
2007 Washington Direct Purchase Coefficients Table
(Dollars Purchased Per Dollar of Total Input)

	Resources & Utilities	Manufacturing &Construction	Trade & Services	Personal Consumption
Resources & Utilities	0.08051	0.01858	0.00610	0.03021
Manufacturing & Construction	0.08663	0.08717	0.05995	0.05113
Trade & Services	0.12433	0.13984	0.18663	0.61197
Labor Income	0.27782	0.17713	0.35616	0

The interindustry transactions or output needed to satisfy a given level of gross output can be shown as:

$$O = AX$$

where A denotes a matrix containing the direct purchase coefficients, X is a vector consisting of the industries' gross output; and the product O is a vector containing the intermediate demand for industries' output.

An industries total output (X) equals the sum of the intermediate demand for its output and the total final demand for its output:

$$X = O + D$$

where D denotes a vector containing total final demand (including exports) for each industry's output. The two equations can be combined:

$$AX + D = X$$

and then rearranged as follows:

$D = (I - A)X$

leading to:

$X = (I - A)^{-1}D$

and thus $\Delta X = (I - A)^{-1}\Delta D$

The last equation indicates a change in total output is the product of a change in total final demand multiplied by $(I\text{-}A)^{-1}$. The inverse matrix $(I\text{-}A)^{-1}$ is generally referred to as the *"Leontief Inverse"* in input-output modeling. Table 3-2 shows the inverse matrix for the 2007 three-sector aggregate I-O Table. The elements in this matrix are "total requirement coefficients." For example, values in the second data column of the table show that, for a one-dollar increase in final demand for the state's manufacturing/construction sector, local resources/utilities and trade/services industries have demands that raise their output by $0.0396 and $0.5039, respectively.

Table 3-2
2007 Washington State Inverse (Total Requirement) Coefficients Table
(Total Dollars of Input per Dollar of Output)

	Resources & Utilities	Manufacturing/ Construction	Trade & Services	Personal Consumption
Resources & Utilities	1.1138	0.0396	0.0367	0.0581
Manufacturing & Construction	0.1783	1.1542	0.1566	0.1602
Trade & Services	0.6250	0.5008	1.7630	1.1234
Labor Income	0.5636	0.3938	0.6658	1.4446

Once an Inverse I-O matrix is derived, total impact of a proposed project or activity on the state economy can be estimated by multiplying this matrix by changes in the final demand caused by the respective project/activity. This computation is implemented in the impact spreadsheets.

Magnitudes of the estimated impact vary by the degree of model closure. The model developed in this study produces what are generally referred to as the "type II" impact estimates. Basically, the impact estimation captures the interindustry ripple effects and earnings-induced changes in personal consumption. The model excludes the effects on the government sector and on investment spending. Other I-O models that incorporate government and/or investment will result in higher impact estimates.

Limitations of Input-Output Impact Analysis

The input-output model for impact analysis inherits all of the properties of an input-output table: the input-output table represents a static depiction of the economy at a point in time; the linear, fixed-proportion production function implied in an input-output table dictates constant returns to production scale, and no substitution between intermediate goods, capital, and labor inputs; and the assumption of additivity (i.e. total output is the sum of the individual output) among industrial sectors excludes the consideration of external economies or diseconomies. All of these properties, or assumptions, impose restrictions on the uses of input-output models for impact analysis:

(1) The model will better approximate the economy the closer to the year for which the model is constructed. In other words, the farther away from the model year, the less accurate the impact estimation would be.

(2) The model assumes a fixed employment-to-output ratio at the industry level and uses these ratios to calculate employment impact. Moving away from the model year, growth in labor productivity would increasingly reduce the validity of using these fixed ratios to estimate employment impact.

(3) The model assumes local supply is perfectly elastic, meaning there is no capacity problem. For this assumption to be upheld, the projects or activities to be assessed need to be small or marginal relative to the economy's production input system. Otherwise, the projects will disrupt equilibrium prices, leading to significant factor or import substitution.

(4) I-O analysis estimates total impact from an external change in final demand. For projects that bring into the state investment money or other spending from outside the state and thus result in direct external changes in final demand, using an I-O model to estimate total economic impact caused by these projects is straightforward. When the project's funding is not external, such as a local government investment activity funded by tax dollars, the impact needs to be evaluated on both the activity (positive effect) and the corresponding funding (taxes' negative effect on consumption) to derive a "net" impact.