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NOAA FISHERIES

Regional Economic Analysis for Fishery-dependent Communities in Southwest Alaska

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ABSTRACT

Most traditional regional economic models developed for North Pacific fisheries depict either the whole state (i.e., Alaska) or a large sub-region (e.g., the Southeast region). While these models are well suited to calculate the impacts of fishery management actions on those relatively large regions, they may not as accurately represent impacts on smaller "fishing communities", or fishing-dependent areas such as individual boroughs or census areas (BCAs). Therefore, results from traditional models may be less useful for fishery managers, policy makers and other entities interested in examining impacts on specific communities, especially ones with very unique, fishing-dependent economic structures. No existing study has yet developed models designed to estimate impacts on individual fishing-dependent communities in Alaska.

Recently, Alaska Fisheries Science Center (AFSC) collected regional economic information (including employment and expenditures) for six BCAs in the Southwest Alaska (SWAK) region from surveys of fish harvesting vessel owners and interviews with key informants including seafood processors and local input supply businesses. In a follow-up project, the AFSC constructed a 10 region multi-regional social accounting matrix (10MRSAM) based on the aforementioned data and other supplementary information. Based on this MRSAM, AFSC developed 10MRSAM *model* for SWAK fisheries.

Based on the 10MRSAM model, AFSC and AKRO economists conducted a project to develop a web-based software application that the analysts, without in-depth knowledge of regional economic models, can use to estimate the economic impacts of fishery management actions or environmental shocks. This project resulted in user-friendly software and a user manual. This report is intended for those analysts in ESSR, AKRO, and NPFMC who are not familiar with regional economic modeling but will use this software. This report (i) introduces the basics of the regional economic models that are often used for economic impact analyses for fisheries, and (ii) provides a description of the model used in the software, called the Adjusted Demand-driven Multi-regional Social Accounting Matrix (MRSAM) model. A separate document (Miller et al. 2022) contains a user manual that provides step-by-step instructions on how to use the regional economic analysis web-based application software to model impacts of species-based shocks, gear-based shocks, or a combination of the two shocks.

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INTRODUCTION

Federal laws governing U.S. marine fisheries require that an analysis of regional or community economic impacts from a proposed fishery management action be conducted. These laws include, among others, the Magnuson-Stevens Fishery Conservation and Management Act (MSA, reauthorized in 2007), National Environmental Policy Act (NEPA), and Executive Order 12866. National Standard 8 (MSA Section 301[a][8]), for example, mandates that, to the extent practicable, fishery management actions minimize economic impacts on fishing communities. To satisfy the National Standard 8, fishery managers must take into account the economic impacts arising from management actions on various stakeholder groups (e.g., fishermen, processors, and fishing-dependent communities).

In an effort to meet these requirements, the Economic and Social Science Research (ESSR) group in the Alaska Fisheries Science Center (AFSC) has conducted a myriad of studies of Alaska fisheries using different types of regional economic models. These studies examined the regional economic effects of potential fishery management actions and environmental shocks such as climate change. For example, Seung and Waters (2009) computed the economic impacts on Alaska of a hypothetical reduction in pollock TAC in terms of output, employment, value added, and household income. Seung and Waters (2013) evaluated the regional economic impacts of Steller sea lion protection measures for Alaska.

Although there are many studies of economic impacts of Alaska fisheries conducted by ESSR, none of the models used for these studies have been utilized by the analysts (economists and social scientists) in Alaska Regional Office (AKRO), North Pacific Fishery Management Council (NPFMC), and other agencies who are tasked to evaluate the economic impacts of proposed fishery management policies. There are several reasons for this. First, there is a gap between the time when the analysts need the economic impact analysis for the policies at hand and the time when the model development is completed by ESSR. It usually takes an enormous amount of time to develop a regional economic model designed to address a specific proposed fishery management action. In contrast, the analysts are usually tasked with completing the impact analysis in a relatively short time frame. Second, even when the models are available for the analysts, the AKRO and Council analysts may not be familiar with the structure of the models and, therefore, find it difficult to implement the models and to interpret the model results.

To address these issues, AFSC and AKRO economists launched a project to develop a web-based software application that analysts lacking in-depth knowledge of regional economic models can use to estimate the economic impacts of fishery management actions or environmental shocks. This project was completed in 2018, resulting in user-friendly software, the user manual, and a Technical Memorandum (Seung and Miller 2018). However, the model used in the software has only three large regions – Alaska, West Coast (WA, OR, and CA), and the rest of the US (RUS), hence called three region (3MRSAM) model. Therefore, this model has the limitation that the model can calculate only the state-level (i.e., Alaska) impacts of a fishery management policy. While this model may be useful to evaluate the impacts of fishery management actions on those relatively large regions, it will not accurately calculate the impacts on smaller “fishing communities”, or fishing-dependent areas such as individual boroughs or census areas (BCAs). Therefore, results from traditional models may be less useful for fishery managers, policy makers and other entities interested in examining impacts on specific communities, especially ones with very unique, fishing-dependent economic structures. No existing study has yet developed models designed to estimate impacts on individual fishing-dependent communities in Alaska.

To overcome this limitation of the 3MRSAM, AFSC collected regional economic information (including employment and expenditures) for six BCAs in the Southwest Alaska (SWAK) region from surveys of fish harvesting vessel owners and interviews with key informants including seafood processors and local input supply businesses. In a follow-up project, AFSC constructed a 10-region multi-regional social accounting matrix (10MRSAM) based on the data mentioned above and other supplementary information. The 10 regions include an at-sea "region" (AT-SEA), six SWAK BCAs, the rest of Alaska (RAK), U.S. West Coast (WOC, Washington, Oregon, and California), and rest of the U.S. (RUS). The six SWAK BCAs are as follows: Aleutians West Census Area (AWCA – including Atka, Unalaska, and Dutch Harbor), Aleutians East Borough (AEB – including Akutan, King Cove, and Sand Point), Lake and Peninsula Borough (LPB – including Chignik, Ugashik, and Egegik), Bristol Bay Borough (BBB - Naknek), Dillingham Census Area (DCA – including Dillingham and Togiak), and Kodiak Island Borough (KIB). (See Figure 1 for Alaska map with BCAs). Based on this MRSAM, AFSC developed 10MRSAM model for SWAK fisheries, and user-friendly software for 10MRSAM.

This report is intended for those analysts in ESSR, AKRO, and NPFMC who are not familiar with regional economic modeling but may have a need to use this software to estimate regional economic effects of proposed fishery management actions. This report introduces the basics of the regional economic models that are often used for economic impact analyses for fisheries, and describes the model used in the software, called the Adjusted Demand-driven Multi-regional Social Accounting Matrix (MRSAM) model. The 10MRSAM model used in the software is particularly useful for analysis of community or BCA-level impacts of Alaska fisheries. A separate document (Miller et al. 2022) contains a user manual for the web-based application software that provides step-by-step instructions on how to use the regional economic analysis software.

Alaska Fisheries and Economy

In 2018, fish harvest from waters off Alaska accounted for about 58% by weight of the total U.S. commercial fish harvest [National Marine Fisheries Service (NMFS) 2020]. This constituted about 5.4 billion pounds of fish and shellfish with an ex-vessel value of about $1.8 billion. In the same year, harvest of groundfish generated about 54.3% of this ex-vessel value, followed by salmon (30.0%), shellfish (9.9%), halibut (4.8%), and herring (0.4%). Commercially, pollock is the most valuable among the groundfish species caught in Alaska waters. In 2018, the pollock harvest was 1.54 million metric tons (t) or 69% of the total groundfish catch. The ex-vessel value from the pollock harvest was $494.6 million, accounting for 50% of the total ex-vessel value for groundfish. Other commercially important groundfish species are Pacific cod, sablefish, and several species of flatfish [North Pacific Fishery Management Council (NPFMC) 2019]. In the same year, the Alaska seafood industry directly accounted for about 2.8% of total state employment of 326,924 jobs, and about 2.5% of $18.0 billion total state earnings (Alaska Department of Labor and Workforce Development, http://live.laborstats.alaska.gov/qcew/ee18.pdf).

The Alaska economy depends to a large extent on the economies of the rest of United States, via importing large amounts of factors of production and input commodities from the rest of the United States. This means that a significant portion of the economic impact from fishery and non-fishery policies for Alaska leaks out of the state. First, a large proportion of workers in many Alaska industries are non-residents. In 2018, non-Alaskan residents made up about 20.7% of total private and state and local government employment in Alaska. As a result, about 15.0% of the total labor earnings from the private and the state and local government sectors leaked out of the state. The seafood processing sector suffers the largest leakage of labor income (66.6%), followed by agriculture, forestry, and fishing and hunting (40.1%, mostly fishing); accommodation (33.8%); mining (31.6%); transportation and warehousing (25.6%); and arts, entertainment, and recreation (24.9%) sectors (Alaska Department of Labor and Workforce Development 2020). Second, a large amount of capital used in Alaska industries (fishing vessels and processing plants in the case of seafood industries) is owned by non-Alaskan residents, which implies that much of the capital income generated in the state flows to the other states. Third, many of the goods and services used by Alaska seafood and non-seafood industries and by households are imported from other states. A previous study (Seung 2014a) indicates that, in 2008, the total value of imports of all commodities to Alaska ($15.9 billion) from states other than Alaska is about 31% of the total value of production ($51.2 billion) in the state.

Regional Economic Models

Most of this section is from Seung and Miller (2018).

Input-Output Models

In an Input-Output (IO) model, multipliers are derived from the relationships among different industries in an economy. Analysts use the multipliers to compute the economic impacts from a change in final demand which is usually estimated outside of the model. Since Wassily Leontief developed an IO model of the United States in the 1930s, IO models have been a basic tool for regional economic impact analysis. Applications of the models have been wide-ranging; the models have been used in analyses of regional economic development, resource management problems, and environmental issues. For fisheries, analysts have used the models to assess the economic impacts from commercial and recreational fisheries. This section provides a short overview of the fundamental features of single-region IO models, based on Miller and Blair (1985) and Seung and Waters (2005). For a discussion of interregional and multiregional IO models, see, for example, Miller and Blair (1985) and Hewings and Jensen (1986). Richardson (1985) provides a survey of IO studies conducted before 1985. For a review of IO studies for fisheries, see Andrews and Rossi (1986) and Seung and Waters (2006).

Input-Output Model Basics

Suppose a regional economy consists of n sectors. Let sector i's total output and total final demand for sector i's product be denoted X_i and Y_i, respectively. Then, the following relationship holds:

$$X_i = Z_{i1} + Z_{i2} + \ldots + Z_{ii} + \ldots + Z_{in} + Y_i,\ i = 1, 2, \ldots, n, \qquad \text{Eq. (1)}$$

where Z_{ij} are dollar value of interindustry purchase by sector j from sector i. The jth equation in the above equation system describes how sector j's output is distributed to the other sectors (industries) and the final users. The elements in the ith column on the right-hand side of the equation system above are $[Z_{1i}, Z_{2i}, \ldots, Z_{ii}, \ldots, Z_{ni}]$. These elements represents sector i's purchases of n different products from the n different sectors. These products are used as inputs in sector i's production. These inputs are called intermediate inputs. A fundamental assumption in IO models is that the flows of the intermediate input from i to j depend entirely and exclusively on the level of total output of sector j. Thus, a technical coefficient or input-output coefficient (a_{ij}) is defined as the ratio of the flow of input from i to j (Z_{ij}) to sector j's output (X_j):

$$a_{ij} = \frac{z_{ij}}{x_j} \text{ or } Z_{ij} = a_{ij}X_j\ . \qquad \text{Eq. (2)}$$

Substituting Equation (2) into Equation (1) and rearranging the terms yields,

$$\begin{aligned}
&(1-a_{11})X_1 - a_{12}X_2 - \ldots - a_{1i}X_i - \ldots - a_{1n}X_n = Y_1 \\
&-a_{21}X_1 + (1-a_{22})X_2 - \ldots - a_{2i}X_i - \ldots - a_{2n}X_n = Y_2 \\
&. \\
&. \\
&-a_{i1}X_1 - a_{i2}X_2 - \ldots + (1-a_{ii})X_i - \ldots - a_{in}X_n = Y_i \\
&. \\
&. \\
&-a_{n1}X_1 - a_{n2}X_2 - \ldots - a_{ni}X_i - \ldots + (1-a_{nn})X_n = Y_n.
\end{aligned} \qquad \text{Eq. (3)}$$

Expressing the system of equations in (3) in matrix terms,

$$\boldsymbol{(I-A)X = Y} \qquad \text{Eq. (4)}$$

or

$$\boldsymbol{X = (I - A)^{-1}Y}\ , \qquad \text{Eq. (5)}$$

where $\boldsymbol{I}$ is an $n \times n$ identity matrix; $\boldsymbol{A}$ is an $n \times n$ input-output coefficient matrix of a_{ij}'s; $\boldsymbol{X}$ is a column vector of X_i's (industry outputs); and $\boldsymbol{Y}$ is a column vector of Y_i's (final demand for commodities). Here, $\boldsymbol{X}$ is a vector of endogenous variables and $\boldsymbol{Y}$ a vector of exogenous variables. $\boldsymbol{(I-A)^{-1}}$ is often referred to as Leontief inverse whose elements represent total impacts on individual sectors (industries) when there is an exogenous change in final demand *by one unit*.

So Equation (5) can be used to calculate the total impact on output (***X***) in the different sectors of the economy when there is a change in final demand (***Y***).

The final demand (***Y***) for a sector's product in Equation (5) comprises household demand, government demand, investment demand, and exports. Households spend their labor income to purchase goods and services for their final consumption. The amount of their purchases depends on their labor income, which they earn in return for their labor services to production processes. Therefore, their labor income depends on the level of output of each of the production sectors. Because household expenditures make up a major fraction of the final demand in most economies and because the level of household income (labor income) is determined by the level of industry output in an economy, one could make the household sector an endogenous sector. This is known as closing the model with respect to households. Hence the model closed with respect to households is called a "closed model" while the model in Equation (5), where only production sectors are endogenous, is called an "open model."

Direct, Indirect, and Induced Effects

There are three types of effects calculated in an IO model -- direct, indirect, and induced effects. Direct effects refer to the initial changes in the final demand. Indirect effects represent the effects transpired by iteration of changes in industries' purchases from other industries in response to the direct effects. Induced effects are the additional changes caused by the change in household income and spending which is generated by the direct and indirect effects.

Total effects are the sum of direct and indirect effects in an open IO model while, in a closed IO model, the total effects are the sum of all the three types of effects above. Multipliers are obtained simply by dividing the total effects by the direct effects. Depending on which of the two models (open or closed model) is used, two types of multipliers are computed – simple multipliers and total multipliers. The former is derived using only direct and indirect effects (from an open model) while the latter is calculated using all the three types of effects (from a closed model). To calculate the multipliers, the Leontief inverse in Equation (5) is used; the multiplier for an industry is derived by summing the elements in the column representing the industry in the Leontief inverse.

Backward Linkage and Forward Linkage

In regional economic impact analysis, there are two broad categories of inter-industry linkages that need to be considered, depending on the direction the impacts that occur – backward linkage and forward linkage. Backward linkage refers to the relationship between an industry and the industries from which the first industry buys the inputs needed to produce its output. So an exogenous change in the first industry will generate backward-linkage effects on the industries that supply inputs to the industry. The IO model in Equation (5) is designed to capture only the backward-linkage effects. Forward linkage is the relationship between an industry and the industries to which the first industry sells the outputs needed to produce outputs in the industries that buy the first industry's output. So an exogenous change in the first industry will produce forward-linkage effects on the industries that depend on the first industry for its output, however these forward linkages are not included in IO models.

Social Accounting Matrix Models

A social accounting matrix (SAM) is a matrix consisting of expenditure and income accounts, and it is a useful way of representing an economy at one point in time. Rows record incomes or receipts to economic agents and columns record expenditures or payments by the economic agents. The matrix is a balanced matrix, meaning that total receipts (the sum of the elements in a row for an account) are equal to total expenditures (the sum of the elements in the column for the account). SAM accounts are an extension of traditional IO accounts. To build a SAM, one starts with specifying the IO accounts. IO accounts show detailed industry, commodity, factor, and final demand transactions. These accounts are balanced to reflect market-level equilibrium, as well as the aggregate income-expenditure equilibrium. In addition to these IO accounts, a SAM has the accounts showing non-market financial flows such as tax payments by households and firms and fund transfers between households or institutions. See King (1985) and Pyatt and Round (1985) for a more detailed discussion of a SAM. Table 1 presents the structure of a regional SAM (2004 Alaska SAM), which is the basis for the multi-regional social accounting matrix (MRSAM) model used in the web-based software application.

While an IO model is developed using an IO table, a SAM model is constructed based on a SAM. IO models capture a major source of linkages in an economy by including the transactions of intermediate inputs among industries. However, one limitation of IO models is that the models fail to capture the flows from producing sectors to factors of production (value added), and then on to institutions such as households and government, and finally back to demand for goods and services. Because SAM models capture these flows, the models enable assessment of the distributional effects of policies by allowing one to examine the distribution of income between wages and profits and the distribution of wages and profits between various types of households. Discussion of the structure of SAM models below is based on Adelman and Robinson (1986), Holland and Wyeth (1993), and Seung and Waters (2013).

Table 1 illustrates an Alaska SAM as an example. The endogenous accounts in the SAM includes has industries, value-added accounts (employee compensation, proprietary income, other property income, and indirect business tax), household accounts (low-, medium-, and high-income households), and a state and local government account. The exogenous accounts include federal government, capital account (savings and investment), and the rest of the world (ROW) account recording imports of goods from, and exports of goods to, both states other than Alaska and foreign countries.

The first step in developing a SAM model using a SAM is to divide each element in a column by the sum of the elements in the column. This yields a matrix of coefficients. Next, to obtain the matrix of SAM direct coefficients, the coefficients in the columns and rows for the exogenous accounts are removed. The matrix with the remaining coefficients is the matrix of SAM direct coefficients denoted **S**, which is shown below:

$$
\mathbf{S} = \begin{bmatrix} \mathbf{A} & \mathbf{0} & \mathbf{0} & \mathbf{C} & \mathbf{GD} \\ \mathbf{V} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{IBT} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{F} & \mathbf{0} & \mathbf{IHT} & \mathbf{STR} \\ \mathbf{0} & \mathbf{SF} & \mathbf{BTS} & \mathbf{HTX} & \mathbf{IGT} \end{bmatrix}, \quad \text{Eq. (6)}
$$

where:

S = matrix of SAM direct coefficients.
A = matrix of technical coefficients.
V = matrix of primary factor payments coefficients.
IBT = matrix of indirect business tax coefficients.
F = matrix of coefficients showing factor payments to households.
SF = matrix of state and local factor tax coefficients.
BTS = matrix of state and local indirect business tax coefficients.
C = matrix of household consumption coefficients.
IHT = matrix of inter-household transfer coefficients.
HTX = matrix of coefficients showing household tax payments to state / local government.
GD = matrix of state and local government demand coefficients.
STR = matrix of state and local government transfer coefficients.
IGT = matrix of intergovernmental transfers.

In an IO model, which is built using the IO technical coefficients, the only endogenous sectors are the industries shown in the matrix of technical coefficients (**A**). Compared to an IO model, a SAM model, which is constructed based on a SAM, has additional endogenous accounts or sectors. For example, the matrix of primary factor payments coefficients (V) accounts for how income from producing sectors is distributed to different factors of production. The matrix of coefficients showing factor payments to households (F) represents how the factor income is distributed to different types of households. By adding these additional endogenous accounts in the SAM, the SAM model below can address the distributional effects of policies, which is not possible within an IO model.

The SAM model can be represented as follows:

$$
\begin{bmatrix} \mathbf{Q} \\ \mathbf{V} \\ \mathbf{IBT} \\ \mathbf{H} \\ \mathbf{SG} \end{bmatrix} = \mathbf{S} \begin{bmatrix} \mathbf{Q} \\ \mathbf{V} \\ \mathbf{IBT} \\ \mathbf{H} \\ \mathbf{SG} \end{bmatrix} + \begin{bmatrix} \mathbf{eq} \\ \mathbf{ev} \\ \mathbf{et} \\ \mathbf{eh} \\ \mathbf{eg} \end{bmatrix} \quad \text{Eq. (7)}
$$

$$\text{or} \quad \begin{bmatrix} \mathbf{Q} \\ \mathbf{V} \\ \mathbf{IBT} \\ \mathbf{H} \\ \mathbf{SG} \end{bmatrix} = (\mathbf{I}-\mathbf{S})^{-1} \begin{bmatrix} \mathbf{eq} \\ \mathbf{ev} \\ \mathbf{et} \\ \mathbf{eh} \\ \mathbf{eg} \end{bmatrix} , \qquad \text{Eq. (8)}$$

where:

Q	=	vector of industry regional output (endogenous).
V	=	vector of total primary factor payments (endogenous).
IBT	=	indirect business tax payments (endogenous).
H	=	vector of total household income (endogenous).
SG	=	total state and local government revenue (endogenous).
eq	=	vector of exogenous demand for regional output.
ev	=	vector of exogenous factor payments.
et	=	exogenous indirect business tax payments.
eh	=	vector of exogenous federal transfers to households.
eg	=	federal transfers to state and local government.

Here $\mathbf{(I-S)^{-1}}$ is called the SAM multiplier matrix or matrix of SAM inverse coefficients.

In Equation (8) above, the elements in ***Q***, ***V***, ***IBT***, ***H***, and ***SG*** are endogenous variables. The exogenous variables are the elements in vectors ***eq***, ***ev***, ***et***, ***eh***, and ***eg***. Vectors ***eq***, ***eh,*** and ***eg*** are non-zero exogenous demand vectors. Vector ***eq*** is the final demand vector whose elements include investment demand, federal government demand, and export demand. Elements of ***eh*** include federal government transfers to households and financial returns from capital holdings outside Alaska. The components of ***eg*** include (i) federal government transfers to state and local government, (ii) income from leases, trusts, and investments, and (iii) taxes paid by non-residents to Alaska. Injections of income into the region are represented by final demand components in ***eq*** and extra-regional payment components in ***eh*** and ***eg***. Leakages of income occur through factor income payments to nonresident factor owners, taxes paid to the federal government, savings, and payments for imports of goods and services.

Single Region Versus Multiregional Models

The IO and SAM models presented above are single-region models which focus on the economic impacts of a policy that occurs only in the region for which an initial policy shock is introduced and, therefore, ignore the effects occurring in the regions whose economies are linked to the economy of the first region. However, if a strong economic linkage exists among these regions, single-region models will miss a portion of the economic impacts transpiring in the regions with strong economic ties with the first region as well as an additional effect on the first region.

Generally, two different types of inter-regional or multi-regional effects are produced when a policy shock is introduced for a region -- spillover effects and feedback effects. Spillover effects refer to the effects transpiring in the other regions because these other regions will have to increase (decrease) production of goods and services and their exports to the first region in order to meet the increased (decreased) industry production in the first region caused by the policy. Feedback effects are additional effects occurring in the first region because the first region will need to increase (decrease) the production of goods to satisfy the increased (decreased) production in the other regions. To capture these multi-regional effects, one will need a multi-regional model.

The economies of regions within the United States (such as state economies) are inter-connected. Large amounts of goods and services are traded between U.S. regions, and factors of production (labor and capital) are highly mobile among them. Multi-regional models are particularly useful for economic impact analysis of Alaska fisheries. A distinctive feature of Alaska fisheries is that the fisheries depend to a large extent on imports of goods and services and factors of production from other states (especially states on the U.S. West Coast). Large shares of the fishing vessels, crew, and intermediate inputs used in these fisheries are supplied from distant West Coast ports. Therefore, single-region models for Alaska would not be able to capture the additional impacts occurring in these other states. Alaska's dependence on the imports is not limited to seafood industries. Large proportions of the goods and services used in non-seafood industries and by households in Alaska are from other states.

To overcome the weakness of a single-region SAM model, we developed a 10-region multi-regional SAM (10MRSAM) model which is used for the software. The 10 regions include an at-sea "region" (AT-SEA), six SWAK BCAs, the rest of Alaska (RAK), U.S. West Coast (WOC, Washington, Oregon, and California), and rest of the U.S. (RUS). The six SWAK BCAs are as follows: Aleutians West Census Area (AWCA – including Atka, Unalaska and Dutch Harbor), Aleutians East Borough (AEB – including Akutan, King Cove and Sand Point), Lake and Peninsula Borough (LPB – including Chignik, Ugashik, and Egegik), Bristol Bay Borough (BBB - Naknek), Dillingham Census Area (DCA – including Dillingham and Togiak), and Kodiak Island Borough (KIB). The model will enable analysts to examine the economic effects of fishery management policies on each of the 10 regions.

Alaska Multi-Regional Social Accounting Matrix (MRSAM) Model

This section relies on Seung (2014b) and Seung (2017).

Model Structure

This section provides a description of the MRSAM model. The structure of the MRSAM is similar to those in Round (1985). In this section, for simplicity of explanation, we assume that there are only three regions. Table 2 presents a simplified diagram of the MRSAM used in this section while Table 3 displays a somewhat more detailed schematic of the MRSAM. The structure of the *actual* MRSAM (10MRSAM) used in the software is illustrated in Table 4.

The MRSAM model can be represented as follows:

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} Z_{11} & z_{12} & z_{13} \\ z_{21} & Z_{22} & z_{23} \\ z_{31} & z_{32} & Z_{33} \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} + \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}, \quad \text{Eq. (9)}$$

where $\boldsymbol{y_i}$ and $\boldsymbol{x_i}$ denote the column vectors of endogenous and exogenous accounts, respectively, for region *i* and $\boldsymbol{Z_{ii}}$ is a submatrix containing coefficients showing the intra-regional transactions and $\boldsymbol{z_{ij}}$ a submatrix containing coefficients showing inter-regional transactions, respectively. All the coefficients in $\boldsymbol{Z_{ii}}$ and $\boldsymbol{z_{ij}}$ are derived by dividing the elements in the columns in the MRSAM by the column totals. Alternatively, Equation (9) can be written as:

$$Y = (I - S)^{-1}X, \quad \text{Eq. (10)}$$

where $Y = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix}$, S= $\begin{bmatrix} Z_{11} & z_{12} & z_{13} \\ z_{21} & Z_{22} & z_{23} \\ z_{31} & z_{32} & Z_{33} \end{bmatrix}$, and $X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$. $\boldsymbol{S}$ is the matrix of direct MRSAM

coefficients and $(I - S)^{-1}$ is called the MRSAM multiplier matrix or the matrix of MRSAM inverse coefficients.

$\boldsymbol{y_i}$ is a column vector for region *i* consisting of the following endogenous sub-vectors:

$\boldsymbol{A_i}$ = vector of regional industry output.
$\boldsymbol{Q_i}$ = vector of regional commodity output.
$\boldsymbol{V_i}$ = vector of total primary factor payments.
$\boldsymbol{IBT_i}$ = indirect business tax payments.
$\boldsymbol{H_i}$ = vector of total household income.
$\boldsymbol{SG_i}$ = total state and local government income or revenue.

$\boldsymbol{Z_{ii}}$ for region *i* is as follows:

$$Z_{ii} = \begin{bmatrix} 0 & M_i & 0 & 0 & 0 & 0 \\ U_i & 0 & 0 & 0 & C_i & GD_i \\ V_i & 0 & 0 & 0 & 0 & 0 \\ IBT_i & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & F_i & 0 & 0 & STR_i \\ 0 & 0 & SF_i & BTS_i & HTX_i & IGT_i \end{bmatrix},$$

where:

$\boldsymbol{U_i}$ = matrix showing the use of commodities by industries in production.
$\boldsymbol{V_i}$ = matrix of primary factor payments coefficients.
$\boldsymbol{IBT_i}$ = matrix of indirect business tax coefficients.

M_i = market share matrix (i.e., elements in make matrix[1] divided by total output).
F_i = matrix of factor payment to household coefficients.
SF_i = matrix of state and local factor tax coefficients.
BTS_i = matrix of state and local indirect business tax coefficients.
C_i = matrix of household consumption coefficients.
HTX_i = matrix of state and local government direct household tax coefficients.
GD_i = matrix of state and local government demand coefficients.
STR_i = matrix of state and local government transfer coefficients.
IGT_i = matrix of intergovernmental transfers.

z_{ij} is as follows:

$$z_{ij} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & IM_{ij} & 0 & 0 & 0 & 0 \\ 0 & 0 & LK_{ij} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix},$$

where IM_{ij} is matrix of imports from region i to j and LK_{ij} is matrix of leakage of factor income from region j to region i. x_i is a column vector consisting of the following exogenous sub-vectors:

ea_i = vector of exogenous demand for regional industry output.
eq_i = vector of exogenous demand for regional commodity output.
ev_i = vector of exogenous factor payments.
et_i = exogenous indirect business tax payments.
eh_i = vector of exogenous federal transfers to households.
eg_i = federal transfers to state and local government.

There are three non-zero exogenous demand vectors – $\mathbf{eq_i}$, $\mathbf{eh_i}$ and $\mathbf{eg_i}$. The elements of $\mathbf{eq_i}$ are components of final demand for commodities including federal government demand, investment demand, and export demand. The elements of $\mathbf{eh_i}$ include federal government transfers to households and remittances from ROW to households. The components of $\mathbf{eg_i}$ include federal government transfers to state and local government. Injections of income into a region occur through final demand components in $\mathbf{eq_i}$ and extra-regional payment components in $\mathbf{eh_i}$ and $\mathbf{eg_i}$. Leakages include taxes paid to the Federal government, savings, and payments for commodities imported from ROW.

Dealing With Exogenous Output Change

The IO and SAM models discussed above are often called Leontief demand-driven models because change in final demand "drives", or is applied as an initial shock to, the models and the models calculate the economic impacts. However, in some cases, government policies directly change the output (supply) level of an industry. An example is an exogenous decrease in

[1] Make matrix shows the quantities of different commodities produced by an industry.

the TAC for a fish species triggered by the low level of the stock. If Leontief demand-driven models are used to compute the effects of the exogenous change in output (e.g., a change in the TAC for a fish species) the model results could be biased. This is because, in the Leontief demand-driven model, the final demand shock in the amount equal to the exogenous change will generate impacts that are larger than the exogenous change (specified as a final demand shock in the model) due to its indirect effects on the industry whose output is exogenous.

Due to this problem, some studies (e.g., Leung and Pooley 2002, Johnson and Kulshreshtha 1982, Eiser and Roberts 2002) contend that it is more appropriate to use a mixed endogenous-exogenous (MEE; Miller and Blair 1985) version of IO models when output level is directly altered. Examples of the MEE version of SAM models include Roberts (1994), Marcouiller et al. (1995), and Seung and Waters (2009).

Studies that use the MEE approach either ignore the forward-linkage effects because the effects are negligible or use the Ghosh approach (Ghosh 1958) to estimate forward-linkage effects (e.g., Eiser and Roberts 2002, Leung and Pooley 2002). However, the Ghosh approach has a serious theoretical problem. Economists have severely criticized the approach because of its fundamental assumption that sales from industry *i* to the industries that buy from industry *i* are proportional to the industry *i*'s output (i.e., fixed output allocation coefficient assumption). This assumption is neither intuitive nor economically valid. Consequently, results from the Ghosh models should be interpreted with caution. In particular, it is advisable that the backward-linkage effects from original MEE approach (Miller and Blair 1985) and the forward-linkage effects from the Ghosh approach should not be added together to determine the total economic impacts.

To overcome the weaknesses of these previous approaches to computing the impacts of exogenous shocks to output level, an adjusted demand-driven model is used. The model is labeled as an "adjusted demand-driven model" because the model is adjusted in the sense that, when running the model, (i) the exogenous changes in output are treated as final demand shocks, and (ii) the regional purchase coefficients (RPCs) are set to zero for the outputs of all the directly impacted industries and the forward-linked industries. Setting RPCs for these industries is equivalent to setting the row elements for these industries in the matrix of direct SAM coefficients (**S** matrix above). Zero RPCs for the directly impacted industry prevent the regional industries from buying output from the directly impacted industry and thereby avoid the biased results that are typically encountered when the unadjusted demand-driven models are used to approximate the effects of exogenous changes in output. In addition, the adjusted demand-driven model overcomes (avoids) the problems of the Ghosh approach by setting RPCs to zero for the output of all the forward-linked industries and by running the model with exogenously specified changes in the output of the forward-linked industries given as initial shocks to the model. This type of approach was used in several previous studies (e.g., Tanjuakio et al. 1996; Steinback 2004). More details on this approach can be found in Seung (2014b) and Seung (2017). The next sub-section details how this approach is applied to Alaska fisheries within the MRSAM framework.

Adjusted Demand-driven MRSAM Model for Alaska Fisheries

This section describes how the original MRSAM model was adjusted to yield an adjusted demand-driven MRSAM model for Alaska fisheries that are used in the software. Suppose that pollock harvest is reduced due to a lowered TAC or an environmental shock. To calculate the economic impacts, one should first estimate the decrease in the ex-vessel value of the directly impacted seafood commodity (raw pollock) and the resulting decrease in the first wholesale value of the forward-linked commodity (processed pollock). Then, the MRSAM model is run with these changes as final demand shocks with zero RPCs for all the commodities produced in all the seafood industries in all the three regions,[2] resulting in an adjusted demand-driven MRSAM model.

Note that one should estimate the change in the output of the forward-linked commodity exogenously (i.e., outside the MRSAM model), before running the model, using available information. This change is given as an initial shock to the model along with the change in the directly impacted commodity. By treating both (i) the change in the directly impacted commodity (pollock) and (ii) the change in the forward-linked commodity (processed seafood) as initial shocks to the model, there is no need to calculate endogenously the forward-linkage effects on processed seafood of change in pollock TAC, and thus avoids the problem of Ghosh approach.

Setting RPCs for the seafood commodities to zero is equivalent to setting the row elements for the commodities to zero in the matrix of direct MRSAM coefficients (**S** matrix above). The zero RPCs prevent the fish processing industries from purchasing more raw fish from fish harvesting industries (due to indirect and induced effects) than is needed to achieve the exogenously specified change (i.e., direct effect) in harvest. RPCs can be applied to either commodities or industries. In the MRSAM model in which industries and commodities are separately identified, the RPCs are set to zero for all the commodities produced by all seafood industries.

For a single-region model (e.g., for Alaska), the zero RPCs for the seafood commodities (raw fish) technically mean that a change in the intermediate demand by the fish processing industries for the raw fish is met by imports of the raw fish from outside of the region (including all non-Alaska U.S. states and ROW) rather than by regional harvest. However, this technicality does not distort the model results because the initial change in the output of the regional fish harvesting industries has already been incorporated into the direct impact vector. Since the RPCs for the non-seafood commodities are not set equal to zero, the demand by fish harvesting and processing industries for the non-seafood commodities (inputs) is satisfied by regional production and/or imports as in an unadjusted demand-driven model.

The idea of zero RPCs can be similarly applied to a multi-regional model. In the adjusted demand-driven MRSAM model, the RPCs for all the seafood commodities (species) harvested by all the seafood industries in all three regions are set to zero. This means technically that the

[2] The section titled "Example scenario" below provides an example scenario where Alaska pollock TAC was curtailed, hypothetically, by 10%, and the results are presented.

change in Alaska's demand for imports of two commodities (pollock and processed seafood in the present case) from the other two regions, which arises due to the exogenous shock in Alaska, is not met by the additional production of these commodities in the two regions but is satisfied by imports from ROW. With zero RPCs for all regions, the adjusted demand-driven MRSAM model guarantees that the seafood industry output in the other two regions is not affected at all by policies altering fish harvest levels in Alaska. This is a reasonable assumption because, in all U.S. fisheries, the annual harvests of most species are set by the fishery managers through TACs. Therefore, a change in TAC for a species caught in Alaska waters will not alter the harvest levels of the other species (commodities) in Alaska and those of all the species in the other two regions.

Direct, Indirect, and Induced Effects in MRSAM Model

In this example case above where pollock TAC is curtailed, the direct effects (initial shocks) include the exogenous changes in two commodities; that is, the change in TAC for pollock and the change in the quantity of processed seafood arising from the change in the TAC. As mentioned above, impacts on the forward-linked commodity (processed seafood) are not calculated endogenously within the model but are estimated exogenously outside the model.

Next, the model transforms the direct effects into changes in industry output through the market share matrix (or "make" matrix). Indirect effects are the effects generated from a change in intermediate demand for non-seafood industries' output caused by the direct effects. However, in the adjusted demand-driven MRSAM model which is designed to avoid double-counting, the indirect effects do not include the indirect effects of the exogenous change in processed seafood on raw pollock and other species because the direct effects on pollock (a negative number) and other species (zeroes) are already specified as exogenous shocks as above.

Induced effects in the MRSAM model are the additional impacts resulting from the direct and indirect changes in household income and state and local government revenue. That is, a decrease in fish harvesting and processing output (direct effects) in Alaska will result in a reduction in intermediate demand for non-seafood industries' output via backward linkage (indirect effect). This will in turn lead to a decrease in value added, indirect business taxes, household income, and state and local government revenue, thereby resulting in a further reduction in consumption of commodities by households and state and local governments in all regions (induced effect).

Unlike in a single-region model, the MRSAM model generates these indirect and induced effects in the two non-Alaska regions (spillover effects) as well as in Alaska region because the economies of the three regions are dependent on each other. Total effects are computed simply as the sum of all three effects.

Calculating Economic Impacts from Charter Sector

The 10MRSAM model can also be used to calculate the economic impacts of change in charter sector policies. We use the expenditure categories (Table 5) for the charter sector obtained from charter sector survey (Lew and Lee 2018). These categories are mapped to the industries or commodities in the 10MRSAM. Thus, when there is change in charter sector expenditure and the users estimate the amount of expenditure for each expenditure item, they can enter it into the software and can calculate the economic impacts. Note that, while we use the Adjusted Demand-driven 10MRSAM model for commercial fisheries, we do not use the Adjusted Demand-driven 10MRSAM model to calculate the impacts from charter sector. Instead, we use original 10MRSAM model where the RPCs for seafood industries are not equal to zero. This is because the initial shocks in the impact analysis for charter sector are final demand shocks.

Data Methods

This section relies on Seung et al. (2020) which provides a more detailed discussion of the data and methods used to create the 10MRSAM.

Issues with Regional Economic Data on Alaska Fisheries

Economists conducting economic impact analyses often use IMPLAN data sets to develop models such as IO, SAM, or computable general equilibrium (CGE) models. However, the seafood industry data in IMPLAN suffers from several important weaknesses, some of which concerning the Alaska seafood industry are described below.

First, in the IMPLAN data, it is assumed that the production technology for a regional industry is the same as the national average production technology for that industry. This assumption is problematic because the seafood industries in different U.S. regions harvest different species and so may be dramatically different from the national average. This is especially true for fish harvesting and processing industries operating in remote regions in Alaska. For this reason gathering cost and earnings data for regional seafood industries via primary data collection such as surveys is often required.

Second, many crew members on fish harvesting vessels are self-employed, seasonal or part-time workers. But because IMPLAN uses data from state unemployment insurance program which omit these "uncovered" employees, IMPLAN tends to underestimate seafood industry employment, especially in the harvesting sector.

Third, IMPLAN has only a single fish harvesting sector that combines all commercial fishing activities, regardless of the vessel type or species caught. Using models that include only a single, aggregate fish harvesting sector it is difficult to assess the economic impacts of fishery management actions affecting individual species or individual harvesting and processing sectors. In order to address the economic impacts from a change in the harvest of a particular species or in the activity of a particular vessel type, it is necessary to disaggregate the harvesting sector into several different subsectors by vessel type and/or species, and to collect data for the disaggregated sectors via a survey.

Fourth, a unique feature of Alaska fisheries is that a large portion of capital (harvesting vessels and processing facilities) is owned by non-Alaskan residents, and many of the crew members and processing workers in Alaska fisheries are non-Alaskan residents. Therefore, a large share of the capital income and labor income generated in Alaska fisheries leaks out of the local region and the state. IMPLAN data does not capture this type of information for the different sectors of the seafood industry.

Fifth, industries in Alaska, including seafood industries, rely heavily on imports of goods and services from outside of the state, especially shipments from Washington State. A correct assessment of the regional impacts of fishery management actions, therefore, requires correctly identifying the source and estimating and magnitude of goods and services imports used as intermediate inputs in Alaska.

Sectors in the 10MRSAM

To overcome these weaknesses in the IMPLAN fishery sector data, a data collection project was implemented to obtain the necessary economic data to develop a model for analyzing SWAK fisheries. For details on the data collection project, including the survey instruments and results, see Cascade Economics (2016). For details on how the 10MRSAM was constructed, see Seung et al. (2020). This subsection provides only descriptions of the data elements in the final 10MRSAM.

We developed two different versions of the 10MRSAM – a gear-based fishery industries version (GB) and a species-based industries version (SB). The final 10MRSAM has a total of up to 466 endogenous accounts in the GB [34 in the At-sea region + 53 in each of 6 SWAK BCAs + 38 in each of 3 non-SWAK BCA regions]; and 574 endogenous accounts in the SB [52 in the At-sea region + 68 in each of 6 SWAK BCAs + 38 in each of 3 non-SWAK BCA regions]. Note that some of these accounts are zero in some regions. Both MRSAM versions include four overall exogenous accounts that represent final demand for goods and services and help balance financial flows in the MRSAM [savings-investment, federal government revenue and spending, foreign trade (imports and exports), and trade-balancing financial flows]. Below we explain the individual accounts or sectors specified in the MRSAM.

<u>SWAK BCAs</u>

There are six fish harvesting sectors in the GB identified depending on the type of fishing vessels and species delivered to SWAK shore-based processors. These sectors include Trawl, Hook and Line, Groundfish Pot, Salmon Gillnet, Crabbers, and Other Gear. We assigned fish harvesting vessels to a fish harvesting industry sector based on the gear type responsible for the largest share of each vessel's ex-vessel revenue. Each fish harvesting sector or industry produces (catches) up to eleven relevant aggregated species "commodities." The eleven species or commodities are: 1. Tanner Crab (tanner crab and snow crab), 2. King Crab (mostly Bristol Bay red king crab but also includes brown king crab and blue king crab), 3. Other Crab (mostly Dungeness crab), 4. Pacific cod, 5. Pollock, 6. Sablefish, 7. Rockfish, 8. Flatfish, 9. Salmon, 10. Halibut, and 11. All other species combined (in the base year of 2014 this was mostly herring).

The endogenous accounts in the GB include up to 19 industries, 24 commodities, six value-added accounts (fisheries labor income, non-fisheries labor income, fisheries proprietors' income, non-fisheries proprietors' income, other property income, and indirect business taxes), three household accounts (low-, medium-, and high-income households),[3] and a combined state and local government account in each of the six SWAK BCA regions. The industry accounts (Table 6) include up to seven seafood-related sectors (6 harvesting industries and 1 processing industry) and 12 other aggregated industries. Commodity accounts include up to 11 fish species, one processed seafood commodity, and 12 aggregated non-seafood commodities. In the GB MRSAM there are six fish harvesting industries (as defined above) and a single shoreside processing industry in each SWAK BCA. Each of these fish harvesting industries "produces" (catches) some or all of the 11 different fish species. These species are processed in the shoreside processing industry in each SWAK BCA.

In the GB, the expenditure functions are defined for fishing and seafood processing industries that produce (catch or process) multiple commodities (species). These functions are useful for estimating the impacts of a change in the activity of a given vessel sector designated by gear type. However, this structure makes it difficult to isolate the impacts of a change in harvest of individual fish species. Therefore, we constructed the SB where species-specific expenditure (production) functions are defined for each particular species type, rather than by vessel or gear type. These functions show the value of intermediate inputs used in catching and processing each individual species. In order to derive species-specific expenditure functions we first calculated the revenue fraction of each species produced by each gear sector, and then applied those fractions to each gear-based fish harvesting sectors' expenditure functions. We used a similar procedure to derive species-specific processing expenditure functions.

Eleven fish harvesting industries are enumerated in the SB, each of which is dedicated to harvesting a single fish type. For example, the pollock harvesting industry catches only pollock. There is also a unique, shore-based processing sector dedicated to processing each of the 11 fish species, resulting in up to 11 total seafood processing sectors in each SWAK BCA.[4] Up to 34 industries and 24 commodities are included as endogenous accounts in each SWAK BCA region in the SB. Industries include up to 22 seafood industries (i.e., the 11 harvesting industries and 11 processing industries) and 12 aggregated non-seafood industries. Commodity accounts include up to 11 raw fish species, one processed seafood commodity, and 12 aggregated non-seafood commodities. The other endogenous accounts (six value-added accounts, three household accounts, and a combined state and local government account) are the same as in the GB.

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[3] Low-, Medium-, and High-income households are aggregations of the nine household categories in IMPLAN. The Low-income category includes households with income up to $25,000; the Medium-income category includes households with income from $25,000 to $75,000; and the High-income category includes households with incomes in excess of $75,000. Note that the IMPLAN household income brackets have remained the same for some time.

[4] Since in most cases the collected data were insufficient to associate particular expenditures with the individual species harvested and processed, species-specific expenditure functions were imputed for each SWAK region. Species-specific harvesting expenditure functions were developed by prorating gear-based sectors' total expenditures by the ex-vessel values of species caught, and summing the imputed expenditures across all harvesting sectors that caught that species in the region. Similarly, species specific processing functions were developed by prorating each processors' total expenditures according to the first wholesale value of each species processed in the region.

Non-SWAK Regions

The 38 endogenous accounts comprising each of the three non-SWAK regions are the same in both the GB and the SB. Each non-SWAK region has 14 industries and 14 commodities. The 14 industries include two seafood industries (one harvesting industry and one processing industry) and 12 aggregated non-seafood industries. The 14 commodities include one raw fish commodity, one processed seafood, and 12 non-seafood commodities. The other endogenous accounts in non-SWAK regions are defined the same as those for each SWAK BCA region in the two MRSAM versions (i.e., six value-added accounts, three household accounts, and a combined state and local government account).

At-sea Region

The At-sea sector "region" consists only of activities associated with fishing and processing by catcher-processors (CP), mothership processors (MS), and catcher vessels delivering to motherships operating in Bering Sea, Aleutian Islands, and Western GOA. All industry inputs, including factors of production, are imported from other regions in the MRSAM. There are only four industry accounts in the GB At-sea sector (Catcher Processor harvesting, Catcher Processor processing[5], Mothership processing and catcher vessels delivering to Motherships). All seafood products produced by the CP processing and MS processing sectors are assumed exported to RUS and ROW regions. Other endogenous accounts in the At-sea sector region in the GB include 16 non-zero commodities (six non-zero fish species, one processed seafood commodity, and nine non-zero non-seafood commodities), and three non-zero value-added accounts (fisheries labor income, fisheries proprietors' income, and indirect business taxes).

In the SB, endogenous accounts comprising the At-sea sector region include six non-zero industries[6] (i.e., one for each fish species category caught), 14 non-zero commodities (six non-zero fish species, one processed seafood commodity, and seven non-zero non-seafood commodities[7]), and three non-zero value-added accounts (fisheries labor income, fisheries proprietors' income, and indirect business taxes).

Since all value-added generated by the At-sea sector industries is transferred to other regions in the MRSAM, there are no endogenous household or state and local government institutional accounts in the At-sea sector region in either version of the MRSAM; and also no non-fisheries-related value-added accounts such as other labor income, other proprietors' income or other property income.

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[5] Catcher-processing activities consists of fish harvesting activity and fish processing activity. Therefore for modeling purposes the catcher-processing sector is divided into two sub-sectors: harvesting and processing.

[6] The six fish species categories caught and processed by the SWAK At-sea sector are Pacific cod, pollock, sablefish, rockfish, flatfish, and other species. The SWAK At-sea sector does not catch the other five MRSAM species categories.

[7] All non-seafood commodities used in the At-sea region are imported from other MRSAM regions.

Operating the Model in the Software

This section provides a brief description of the steps to follow to operate the adjusted demand-driven 10MRSAM model in the software. See the user manual (Miller et al. 2022) for detailed step-by-step guidance and instructions on how to use the software.

GDP Deflator Adjustment of Baseline Data

The 10 MRSAM model allows the users to choose a GDP deflator to adjust the baseline data before computing the economic impacts associated with GB or SB shock. Recall that the baseline data is for 2014. Thus, if a shock is to be entered based on dollar values from a later year then the base data should be adjusted to that same year using the deflator for that year.

The GDP deflators appear in the application as a pulldown menu and were derived based on GDP current dollars and chained 2012 dollars for U.S.[8] The GDP deflator is set to one for year 2014 (base year for the MRSAM). However, if a policy change occurred in a different year, for example in 2016, the user can choose the deflator for the year (1.02010935 for 2016) and the application will adjust the base data. It should be noted that the shock caused by the policy is entered in actual (nominal) reported dollar values in the year in which the shock occurs. Note that if a shock is entered and then the deflator is changed, it will not change the impacts on non-employment variables (such as output, value added, and household income) because the relationship (represented by MRSAM coefficients) does not change due to a change in the deflator. However, the baseline data will change as the deflator is changed, while holding a shock constant, thus affecting the impacts from shocks as a percentage of the base data. As a result, Tables A, C, and E all change, while Tables B and D (quantity impacts) do not change as the deflator is changed when shock(s) remain constant.

GDP Deflator Effect on Employment Impacts

Recall that the MRSAM assumes that the level of employment, by region, does not change from the base year of 2014. Further, impacts to employment from a shock are calculated using the ratio of employment to output and this ratio will change as the deflator is changed. For example, suppose that the output of an industry (call it Industry A) in 2014 is 1,000 and its employment is 50. The employment to output ratio for the industry is 0.05. Suppose further that the initial shock (to whichever industry, call it Industry B) is 100 and the impact on the output in the first industry (Industry A) is 60. Then the impact on employment in Industry A will be 60*0.05 = 3. Now if we apply the deflator of 1.02010935 for year 2016, the output of the industry in 2016 is now equal to 1,000*1.02010935 = 1,020. Thus, in 2016, the employment to output ratio for the industry will be 50/1,020 = 0.049, which shows how the employment to output ratio in Industry A decreases as the deflator is increased. The impact of the same shock to Industry B (100) on the output of Industry A is the same (60). Then, the impact on Industry A's

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[8] Bureau of Economic Analysis (BEA). Current-dollar and "real" gross domestic product: annual and quarterly series online spreadsheet. https://apps.bea.gov/national/xls/gdplev.xlsx

employment from the same shock (100) will be 60*0.049 = 2.94 in 2016, which is smaller than the employment impact that will be obtained if the same shock is given in 2014.

The software lists the GDP deflators for years 2014-2019; 2019 was the most recent year in the current- and chained-dollar GDP series (https://apps.bea.gov/national/xls/gdplev.xlsx) when the web-based software was developed. Therefore, there will be three cases when the users may not want to use one of the deflators in the list but want to choose "Custom" and enter the deflator of their choice before running the model. First, they may not agree to the deflator given in the list. Second, the users need to calculate the economic impacts of a fishery management policy implemented in a year (e.g., 2021) which is not in the list of GDP deflators in the software when they use the software but for which the GDP series is updated at the BEA website. In this case, the users can calculate the GDP deflator for the desired year by dividing the GDP for the desired year in the current-dollar series by the GDP in the chained-dollar series and rescaling it for the year 2014. Third, the users may want to assume a value for the GDP deflator for a future year (e.g., 2025) if the fishery management policy under consideration will be implemented in a future year. They may assume a GDP deflator value for that future year based on the previous year's GDP deflator or based on experts' opinion.

Species-based (SB) and Gear-based (GB) Shocks

The initial shocks applied in the model can be either (i) the changes in the ex-vessel values of landings of individual species (species-based shock, SB shock), (ii) changes in the ex-vessel values of gear-based sectors (gear-based shock, GB shock), or (iii) both. For example, if the TAC of a certain species is increased, the users may want to use the SB shock. But if there is a change in the total amount of catch by a certain vessel sector (e.g., Trawlers) regardless of the species that the vessel sector catches, the users may want to use the GB shock. In some (rare) cases, the users may need to evaluate the economic impacts from a fishery policy that involves applying shocks to both species and the vessel sectors such as change in TAC for a species and restrictions placed on the activity of a vessel sector. In this case, the users may choose to use both types of shocks simultaneously.

Typically, each type of shock involves entering more than one number in the input section in the software. For example, in case of SB shock, if pollock TAC has been increased, the users need to enter both the change in the ex-vessel value of pollock and the estimated resulting change in the first wholesale value of the processed pollock. Similarly, in case of the GB shock, if the landings by Trawlers has been decreased, the users need to enter both the decrease in ex-vessel value of the vessel sector and the resulting reduction in the first wholesale value of Shoreside processors. This is how the use of the adjusted demand-driven MRSAM model is different from the use of a typical demand-driven model. While in a typical demand-driven model only one number (i.e., change in final demand for a commodity) is entered to calculate the impacts, in the adjusted demand-driven MRSAM model, the users should enter both the change in the final demand sector (e.g., processed seafood) and its backward-linked commodity (e.g., pollock). The reason for using this method is to avoid the double-counting problem as discussed above.

Therefore, in order to calculate the economic impacts of certain fishery management actions, the users need to have ready the estimates of both the change in the ex-vessel value of species (or vessel sector in case of gear-based shock) and the change in the first wholesale value of the processed fish (or processing sector in case of gear-based shock). In a special case where there is a change in total first wholesale value in the CP sector due to some management change, the change in the implicit ex-vessel revenue from the raw fish processed in the sector needs to be estimated, before applying shocks. For example, if the change in the first wholesale revenue for the CP sector is $100 and if the change in the implicit ex-vessel revenue from the raw fish processed in the sector is estimated to be $30, the two shock numbers to be entered are $30 and $100 CP-harvesting and CP-processing sectors, respectively.

Once the model inputs are entered, the software calculates the economic impacts automatically. For more details about how to use the software, see Miller et al. (2022).

Example Scenario

This section presents results from an example scenario where pollock landings in AWCA decreased hypothetically by 10 % due to a lowered TAC. The impacts were calculated using the software. We assume that this reduction caused the quantity of (and revenue from) the processed pollock in AWCA decreased by the same percentage. Based on 2014 data, the reductions in the raw pollock landed and the processed pollock are, respectively, $12.58 million and $27.46 million. These two numbers are given to the SB version of the model as initial shocks.

Tables 7, 8, and 9 present the results, and are from the output files from the software. Table 7 presents baseline values of important regional economic variables which include output, employment, value added, household income, and state and local government revenue. Tables 8 and 9 present the economic impacts for the variables in quantity (in $million or the number of jobs) and in percentage changes, respectively. These two tables show that the total AWCA harvesting industry output decreases by $12.58 million (or 3.79%) while the total Alaska processing industry output decreases by $27.46 million (or 4.88%), resulting in a total decrease of $40.04 million (or 4.48%) in the total seafood industry output. The total non-seafood industry output for AWCA decreases by $4.85 million (or 1.05%).

Results also indicate that the 10% reduction in pollock landings in AWCA does not affect the seafood industry output for non-AWCA regions (Table 8). This is an anticipated result because of the way the model is constructed. However, the shocks in AWCA do produce spillover effects on non-seafood industries in the these other regions because, with non-zero RPCs set for non-seafood commodities for all regions, the change in economic activity in AWCA induced by the initial shocks will lead to a change in imports of non-seafood commodities from these regions. The model estimates that total non-seafood industry output, for example, in WC and RUS decreases by $25.22 million and $24.51 million, respectively. Table 8 also presents the impacts of the reduced pollock landings on the household income and the state and local government revenue. For some additional example scenarios, see Miller et al. (2022).

Concluding Remarks

This report is intended for the economists and social scientists who need to undertake economic impact analyses for Alaska fisheries. To help them understand the model used in the software, this report, among other things, provides the fundamentals of regional economic analysis by introducing several regional economic models such as IO and SAM models, and explains the MRSAM model used in the software.

The MRSAM model used in the software is for both commercial fishing and recreational fishing. However, the model version for the recreational fishing is only for calculating the impacts from charter boat fishing; the model cannot compute the impacts from more general recreational fishing in Alaska (such as shore-based sport angling). Recreational fishing is also a very important sector in Alaska and fishery managers are concerned with the economic impacts from recreational fishing. A future work will extend the model version for recreational fishing to calculate the impacts of more general recreational fishing.

On a longer time horizon, this project can be extended to develop similar software for other United States regions and software for the United States as a whole. These software products, once developed, will serve as a very useful tool set for estimating the economic impacts of regional and national fishery management policies.

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CITATIONS

Adelman, I., and S. Robinson. 1986. U.S. agriculture in a general equilibrium framework: Analysis with a social accounting matrix. Am. J. Agricult. Econ. 68: 1,196-1,207.

Alaska Department of Labor and Workforce Development. 2020. Non-residents working in Alaska, 2018. Alaska Department of Labor and Workforce Development, Juneau, AK.

Andrews, M., and D. Rossi. 1986. The economic impacts of commercial fisheries and marine related activities: a Critical review of northeastern input-output studies. Coast. Zone Manage. J. 13: 335-367.

Cascade Economics. 2016. Collecting Borough and Census Area-Level Data for Regional Economic Modeling of Southwest Alaska Commercial Fisheries. Final Report to Pacific States Marine Fisheries Commission and Alaska Fisheries Science Center.

Eiser, D., and D. Roberts. 2002. The employment and output effects of changing patterns of afforestation in Scotland. J. Agricult. Econ. 53: 65–81.

Ghosh, A. 1958. Input-output approach to an allocative system. Economica 25 (1):58–64.

Hewings, G., and R. Jensen. 1986. Regional, interregional, and multiregional input-output analysis. Handbook of Regional and Urban Economics. P. Nijkamp (ed.), Amsterdam: Elsevier.

Holland, D., and P. Wyeth. 1993. SAM multipliers: their decomposition, interpretation, and relationship to input-output multipliers. Research Bulletin XB 1027, College of Agricultural and Home Economics Research Center, Washington State University.

Johnson, T., and S. Kulshreshtah. 1982. Exogenising agriculture in an input-output model to estimate relative impacts of different farm types. W. J. Agricult. Econ. 7: 187-198.

King, B. 1985. What is a SAM? Pyatt, G. and J. Round (ed.), Social Accounting Matrix, World Bank.

Lew, D. K., and Lee, J. 2018. Costs, Earnings, and Employment in the Alaska Saltwater Sport Fishing Charter Sector, 2015. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-383, 85 p.

Leonard, J., and P. Watson. 2011. Description of the input-output model for Pacific Coast fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-111, 64 p.

Leung, P., and S. Pooley. 2002. Regional economic impacts of reductions in fisheries production: a Supply-driven approach. Mar. Res. Econ. 16: 251-262.

Marcouiller, D., D. Schreiner, and D. Lewis. 1995. Distributive economic impacts of intensive timber production. Forest Sci. 41: 122-139.

Miller, R. E., and P. D. Blair. 1985. Input-Output Analysis: Foundations and Extensions. Englewood Cliffs, NJ: Prentice Hall Inc.

Miller, S., C. Seung, and neXus Data Solutions, LLC. 2022. *Regional Impact Analysis User Manual.*

Minnesota IMPLAN Group, Inc. 2004. IMPLAN Pro User's Guide.

National Marine Fisheries Service (NMFS) (2020). Fisheries of the United States, 2018. U.S. Department of Commerce, Office of Science and Technology, Fisheries Statistics and Economics Division, Silver Spring, MD.

North Pacific Fishery Management Council (NPFMC) (2019). Stock assessment and fishery evaluation report for the groundfish fisheries of the Gulf of Alaska and Bering Sea/Aleutian Island Area: Economic Status of the Groundfish Fisheries off Alaska, 2018. North Pacific Fishery Management Council, Anchorage, AK.

Pyatt, G., and J. I. Round. 1985. Social Accounting Matrices: A Basis for Planning. Washington, D.C.: The World Bank.

Richardson, H. 1985. Input-output and economic base multipliers: Looking backward and forward. J. Reg. Sci. 25: 607-661.

Roberts, D. 1994. A modified Leontief model for analysing the impact of milk quotas on the wider economy. J. Agricult. Econ. 45(1): 90-101.

Round, J. 1985. Decomposing multipliers for economic systems involving regional and world trade. Econ. J. 95 (378): 383-399.

Seung, C. and E. Waters. 2005. A review of regional economic models for Alaska fisheries. AFSC Processed Rep. 2005-01, 119 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE, Seattle WA 98115.

Seung, C. and E. Waters. 2006. A review of regional economic models for fisheries management in the U.S. Mar. Res. Econ. 21(1): 101-124.

Seung, C., and E. Waters. 2009. Measuring the economic linkage of Alaska fisheries: a Supply-driven social accounting matrix (SDSAM) approach. Fish. Res. 97: 17-23.

Seung, C., and E. Waters. 2013. Calculating impacts of exogenous output changes: Application of a social accounting matrix (SAM) model to Alaska fisheries. Annals Reg. Sci. 51 (2): 553-573.

Seung, C. 2014a. Measuring spillover effects of shocks to the Alaska economy: an Inter-regional social accounting matrix (IRSAM) model approach. Econ. Syst. Res. 26: 224–238.

Seung, C. 2014b. Estimating effects of exogenous output changes: an Application of multi-regional social accounting matrix (MRSAM) method to natural resource management. Reg. Sci. Pol. Pract. 6(2): 177-193.

Seung, C. 2017. A Multi-regional economic impact analysis of Alaska salmon fishery failures. Ecol. Econ. 138: 22-30.

Seung, C., and S. Miller. 2018. Regional economic analysis for North Pacific fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-380, 86 p.

Seung, C. K., E. Waters, and M. Taylor. 2020. Developing a Multi-Regional Social Accounting Matrix (MRSAM) for Southwest Alaska Fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-399, 33 p.

Steinback, S. 2004. Using ready-made regional input-output models to estimate backward linkage effects of exogenous output shocks. Rev. Reg, Studies 34 (1): 57-71.

Tanjuakio, R., S. Hastings, and P. Tytus. 1996. The economic contribution of agriculture in Delaware. Agricult. Res. Econ. Rev. 25 (1): 46-53.

The Research Group. 2007. Estimating economic impacts of Alaska fisheries using a computable general equilibrium model – Data acquisition and reduction task documentation. Prepared for the Alaska Fisheries Science Center. Corvallis, Oregon.

Waters, E., C. Seung, M. Hartley, and M. Dalton. 2014. Measuring the multiregional economic contribution of an Alaska fishing fleet with linkages to international markets. Mar. Pol. 50 (Part A): 238-248.

Table 1. -- Structure of the 2004 Alaska SAM.

	ENDOGENOUS ACCOUNTS					EXOGENOUS ACCOUNTS			TOTAL
	INDUSTRIES	FACTORS	INDIRECT BUSINESS TAX	HOUSEHOLD	STATE /LOCAL GOV'T	FEDERAL GOV'T	CAPITAL	REST OF WORLD	
INDUSTRIES	Interindustry demand			Household demand	S & L gov't demand	Federal gov't demand	Investment demand (gross business investment)	Exports	Total industry output
FACTORS	Payments to factors								Total factor receipts
INDIRECT BUSINESS TAX	Indirect business tax payments								Total indirect business tax
HOUSEHOLD		Factor payments to households		Interhousehold transfers (interest payments)	S&L gov't transfers to households	Federal transfers to households	Household dissavings; financial returns from capital holdings outside Alaska		Total household income
STATE/ LOCAL GOV'T		S & L gov't factor taxes	Indirect business tax to S & L gov't	S&L gov't taxes (property tax and other taxes)	Inter-government transfers	Federal transfers to S&L gov't	S&L gov't borrowing; income from leases, trusts & investments, taxes paid by non-residents to Alaska		Total S&L gov't revenue
FEDERAL GOV'T		Federal factor taxes	Indirect business tax to fed. gov't	Federal income tax		Intra-government transfers	Federal gov't borrowing, Federal income tax paid by non-residents		Total federal gov't receipts
CAPITAL		Payments to enterprises; Capital consumption allowances		Household savings	S&L gov't savings	Federal gov't savings	Net inventory change, retained earnings	External savings	Total savings
REST OF THE WORLD	Imports Leakage of factor income for seafood industries	Leakage of factor income for non-seafood industries		Imports	Imports	imports	Imports		Total ROW receipts
TOTAL	Total industry outlays	Total factor payments	Total indirect tax payments	Total household payments	Total S&L gov't payments	Total federal gov't payments	Total investment payments	Total ROW expenditure	

Source: Seung and Waters (2013).

Table 2. -- Basic MRSAM structure (Waters et al. 2014).

	Alaska (AK)	West Coast (WC)	Rest of United States (RUS)	Rest of the World (ROW)
Alaska (AK)	Alaska Economy	WC Purchases from AK	RUS Purchases from AK	AK Exports
West Coast (WC)	AK Purchases from WC	West Coast Economy	RUS purchases from WC	WC Exports
Rest of United States (RUS)	AK Purchases from RUS	WC Purchases from RUS	RUS Economy	RUS Exports
Rest of the World (ROW)	AK Imports	WC Imports	RUS Imports	

Table 3. -- More detailed MRSAM structure (Waters et al. 2014) (See the next page for descriptions of acronyms and abbreviations).

		AK (incl H&G)				WOC				RUS				ROW		
		Ind	**Com**	**VA**	**Inst**	**Ind**	**Com**	**VA**	**Inst**	**Ind**	**Com**	**VA**	**Inst**	**Fed**	**Invest**	**Exports**
AK (incl H&G)	**Ind**		Make													
	Com	Ind Use			Consump		imp from AK				imp from AK			fed demand	inv demand	ROW exports
	VA	fac inc & IBT to AK				fac inc paid to AK				fac inc paid to AK						
	Inst			reg fac income										transfers	remitt	
WOC	**Ind**						Make									
	Com		imp from WOC			Ind Use			Consump		imp from WOC			fed demand	inv demand	ROW exports
	VA	fac inc paid to WOC				fac inc & IBT to WOC				fac inc paid to WOC						
	Inst							reg fac income						transfers	remitt	
RUS	**Ind**										Make					
	Com		imp from RUS				imp from RUS			Ind Use			Consump	fed demand	inv demand	ROW exports
	VA	fac inc paid to RUS				fac inc paid to AK				fac inc & IBT to RUS						
	Inst											reg fac income		transfers	remitt	
ROW	**Fed**		tariffs	fac tax	inc tax		tariffs	fac tax	inc tax		tariffs	fac tax	inc tax			fed borrow
	Savings													fed saving		
	Imports		imp from ROW				imp from ROW				imp from ROW					

Definitions of acronyms and abbreviations presented in Table 3

MRSAM	: multi-regional social accounting matrix
AK	: Alaska
WOC	: West Coast
RUS	: rest of United States
ROW	: rest of the world
Ind	: industry
Com	: commodity
VA	: value added
Inst	: institutions
Fed	: federal government
Invest	: investment
Ind Use	: industry use matrix
fac inc & IBT	: factor income and indirect business tax
Make	: make matrix
imp from	: imports from
reg fac income	: regular factor income
fac tax	: factor tax
Consump	: consumption
inc tax	: income tax
fed demand	: federal government demand
fed saving	: federal government savings
inv demand	: investment demand
remit	: remittances
fed borrow	: federal government borrowing

Table 4. -- Structure of the 10MRSAM used in the software.

	At-Sea	Aleutians West Census Area	Aleutians East Borough	Lake and Peninsula Borough	Bristol Bay Borough	Dillingham Census Area	Kodiak Island Borough	Rest of Alaska	Washington, Oregon and California	Rest of the U.S.	*Exogenous Accounts / ROW*
At-Sea	**AS**	*Exports: AS to AWCA*	*Exports: AS to AEB*	*Exports: AS to LPB*	*Exports: AS to BBB*	*Exports: AS to DCA*	*Exports: AS to KIB*	*Exports: AS to RoA*	*Exports: AS to WOC*	*Exports: AS to RUS*	*Exports: AS to RoW*
Aleutians West Census Area	*Imports: AWCA to AS*	**AWCA**	*Exports: AWCA to AEB*	*Exports: AWCA to LPB*	*Exports: AWCA to BBB*	*Exports: AWCA to DCA*	*Exports: AWCA to KIB*	*Exports: AWCA to RoA*	*Exports: AWCA to WOC*	*Exports: AWCA to RUS*	*Exports: AWCA to RoW*
Aleutians East Borough	*Imports: AEB to AS*	*Imports: AEB to AWCA*	**AEB**	*Exports: AEB to LPB*	*Exports: AEB to BBB*	*Exports: AEB to DCA*	*Exports: AEB to KIB*	*Exports: AEB to RoA*	*Exports: AEB to WOC*	*Exports: AEB to RUS*	*Exports: AEB to RoW*
Lake and Peninsula Borough	*Imports: LPB to AS*	*Imports: LPB to AWCA*	*Imports: LPB to AEB*	**LPB**	*Exports: LPB to BBB*	*Exports: LPB to DCA*	*Exports: LPB to KIB*	*Exports: LPB to RoA*	*Exports: LPB to WOC*	*Exports: LPB to RUS*	*Exports: LPB to RoW*
Bristol Bay Borough	*Imports: BBB to AS*	*Imports: BBB to AWCA*	*Imports: BBB to AEB*	*Imports: BBB to LPB*	**BBB**	*Exports: BBB to DCA*	*Exports: BBB to KIB*	*Exports: BBB to RoA*	*Exports: BBB to WOC*	*Exports: BBB to RUS*	*Exports: BBB to RoW*
Dillingham Census Area	*Imports: DCA to AS*	*Imports: DCA to AWCA*	*Imports: DCA to AEB*	*Imports: DCA to LPB*	*Imports: DCA to BBB*	**DCA**	*Exports: DCA to KIB*	*Exports: DCA to RoA*	*Exports: DCA to WOC*	*Exports: DCA to RUS*	*Exports: DCA to RoW*
Kodiak Island Borough	*Imports: KIB to AS*	*Imports: KIB to AWCA*	*Imports: KIB to AEB*	*Imports: KIB to LPB*	*Imports: KIB to BBB*	*Imports: KIB to DCA*	**KIB**	*Exports: KIB to RoA*	*Exports: KIB to WOC*	*Exports: KIB to RUS*	*Exports: KIB to RoW*
Rest of Alaska	*Imports: RoA to AS*	*Imports: RoA to AWCA*	*Imports: RoA to AEB*	*Imports: RoA to LPB*	*Imports: RoA to BBB*	*Imports: RoA to DCA*	*Imports: RoA to KIB*	**RoA**	*Exports: RoA to WOC*	*Exports: RoA to RUS*	*Exports: RoA to RoW*
Washington, Oregon and California	*Imports: WOC to AS*	*Imports: WOC to AWCA*	*Imports: WOC to AEB*	*Imports: WOC to LPB*	*Imports: WOC to BBB*	*Imports: WOC to DCA*	*Imports: WOC to KIB*	*Imports: WOC to RoA*	**WOC**	*Exports: WOC to RUS*	*Exports: WOC to RoW*
Rest of the U.S.	*Imports: RUS to AS*	*Imports: RUS to AWCA*	*Imports: RUS to AEB*	*Imports: RUS to LPB*	*Imports: RUS to BBB*	*Imports: RUS to DCA*	*Imports: RUS to KIB*	*Imports: RUS to RoA*	*Imports: RUS to WOC*	**RUS**	*Exports: RUS to RoW*
Exogenous Accounts / ROW	*Imports: RoW to AS*	*Imports: RoW to AWCA*	*Imports: RoW to AEB*	*Imports: RoW to LPB*	*Imports: RoW to BBB*	*Imports: RoW to DCA*	*Imports: RoW to KIB*	*Imports: RoW to RoA*	*Imports: RoW to WOC*	*Imports: RoW to WOC*	

Table 5. -- Charter sector cost categories.

Cost category	
Vessel fuel	
Fish handling, processing, packaging, and shipping	
Broker or agent referral/commission fees	
Vessel cleaning	
Supplies (examples: ice, bait, food and beverage)	
Other vessel or trip operating expenses	
Non-wage payroll costs, including health insurance and other employee benefit	
Utilities, including telephone and internet service	
Repair and maintenance expenses	
Insurance (vessel, hull, property & indemnity, liability, etc., excluding health insurance)	
Travel, meals, and entertainment (include transportation and per diem costs for employee or crew if paid by business, and trade show/marketing-related travel)	
Office and general supplies	
Legal and professional services, accounting, and advertising	
Financial services (merchant and bank fees) and mortgage interest payments	
Taxes and licensing fees	
Vehicle fuel costs	
Other general overhead expenses	
vessel(s) and major vessel-related equipment	Cash Payments
vessel(s) and major vessel-related equipment	New Investments
Vehicles (Car/ truck)	Cash Payments
Vehicles (Car/ truck)	New Investments
Fishing gear, tackle, personal safety equipment	Cash Payments
Fishing gear, tackle, personal safety equipment	New Investments
Other machinery and equipment	Cash Payments
Other machinery and equipment	New Investments
Moorage/slip, boatyard and equipment storage space	Cash Payments
Moorage/slip, boatyard and equipment storage space	New Investments
Office space, lodging, and other shore-side facilities	Cash Payments

Office space, lodging, and other shore-side facilities	New Investments
Transferable fishing permits and licenses	Cash Payments
Transferable fishing permits and licenses	New Investments
Other business-related property and assets	Cash Payments
Other business-related property and assets	New Investments
Total labor earnings including Vessel operators/guides, Deckhands and other on-board crew, On-shore employees	

Table 6. -- IMPLAN Industries in the 2014 SWAK MRSAM.

IMPLAN SECTORS (536 Industries)	INDUSTRIES in MRSAM
Sector 17 (Replaced with estimated data)	At-Sea Catcher-Processor (CPs, harvesting)
Sector 17 (Replaced with estimated data)	CVs delivering to At-Sea Mothership Processors
Sector 17 (Replaced with estimated data)	Trawlers delivering to Shore-based Processors
Sector 17 (Replaced with estimated data)	Longliners delivering to Shore-based Processors
Sector 17 (Replaced with estimated data)	Crabbers delivering to Shore-based Processors
Sector 17 (Replaced with estimated data)	Salmon Netters delivering to Shore-based Processors
Sector 17 (Replaced with estimated data)	Other Harvesters delivering to Shore-based Processors
Sector 93 (Replaced with estimated data)	At-Sea Catcher-Processors (CPs, processing)
Sector 93 (Replaced with estimated data)	At-Sea Mothership Processors (MS)
Sector 93 (Replaced with estimated data)	Shore-based Processors
Sectors 1-16, 18-40	Agriculture and Mining
Sectors 41-51, 519, 522 and 525	Utilities
Sectors 52-64	Construction
Sectors 65-92 and 94-105	Other Food Processing
Sectors 106-394	Other Manufacturing
Sector 395	Wholesale Trade
Sectors 396-407	Retail Trade
Sectors 408-416	Transportation
Sectors 417-440, and 442-517	All Other Services
Sectors 441, and 527-530	Miscellaneous
Sectors 521, 523-524, 526, and 531-534	State and Local Government Services
Sectors 518, 520, and 535-536	Federal Government Services

Table 7. -- Baseline Data.

Industry	AT-SEA	AWCA	AEB	LPB	BBB	DCA	KIB	RAK	WOC	RUS
INDUSTRY OUTPUT ($million)										
HARVESTING										
H-Kcrab-A	0	60.22	28.5	0	0	0	2.24	0	0	0
H-Tcrab-A	0	93.29	33.13	0	0	0	0.14	0	0	0
H-Ocrab-A	0	0	0.24	0	0	0	0.66	0	0	0
H-Pcod-A	114.93	35.02	30.16	0	0	0	22.22	0	0	0
H-Pollock-A	237.8	125.78	65.66	0	0	0	34.23	0	0	0
H-Sablefish-A	8.61	4.94	8.21	0	0	0	13.6	0	0	0
H-Rockfish-A	33.03	0.09	0.11	0	0	0	4.39	0	0	0
H-Flatfish-A	88.08	0.05	0.04	0	0	0	4.33	0	0	0
H-Salmon-A	0	0	29.58	21.34	135.12	22.99	40.32	0	0	0
H-Halibut-A	0	12.02	6.82	0	0	0.13	16.51	0	0	0
H-OtherSpp-A	24.46	0.43	0.45	0	0	1.28	3.31	0	0	0
OTHHARV-A	0	0	0	0	0	0	0	423.49	1146.55	2351.44
TOTAL HARVESTING	506.91	331.85	202.9	21.34	135.12	24.4	141.95	423.49	1146.55	2351.44
PROCESSING										
P-Kcrab-A	0	78.79	28.79	0	0	0	4.31	0	0	0
P-Tcrab-A	0	144.58	55.47	0	0	0	0.56	0	0	0
P-Ocrab-A	0	0.01	0.42	0	0	0	1.1	0	0	0
P-Pcod-A	252.96	45.45	82.79	0	0	0	44.29	0	0	0
P-Pollock-A	747.84	274.58	215.88	0	0	0	90.01	0	0	0
P-Sablefish-A	10.9	5.94	9.4	0	0	0	16.53	0	0	0
P-Rockfish-A	69.62	0.25	0.37	0	0	0	14.85	0	0	0
P-Flatfish-A	200.33	0.05	0.34	0	0	0	11.35	0	0	0
P-Salmon-A	0	0	72.1	49.83	252.17	61.85	117.5	0	0	0
P-Halibut-A	0	12.14	6.89	0	0	0.17	20.74	0	0	0
P-OtherSpp-A	63.23	0.43	1.07	0	0	14.37	3.34	0	0	0
SHOREPROC-A	0	0	0	0	0	0	0	1111.43	3427.19	6596.18

TOTAL PROCESSING	1344.88	562.22	473.53	49.83	252.17	76.4	324.58	1111.43	3427.19	6596.18
SEAFOOD TOTAL	1851.79	894.08	676.43	71.17	387.28	100.8	466.53	1534.92	4573.74	8947.63
NON-SEAFOOD TOTAL	0	464.35	115.76	111.89	155.74	418.32	1084.99	84458.47	5047736	26686292
TOTAL ALL INDUSTRIES	1851.79	1358.43	792.2	183.06	543.02	519.12	1551.53	85993.38	5052310	26695239
EMPLOYMENT (Total workers)										
HARVESTING										
H-Kcrab-A	0	295.01	138.9	0	0	0	10.93	0	0	0
H-Tcrab-A	0	454.61	161.46	0	0	0	0.7	0	0	0
H-Ocrab-A	0	0.02	6.14	0	0	0	5.43	0	0	0
H-Pcod-A	593.48	463.6	435.68	0	0	0	353.25	0	0	0
H-Pollock-A	1413.79	416.89	241.59	0	0	0	133.77	0	0	0
H-Sablefish-A	44.36	91.12	190.11	0	0	0	271.59	0	0	0
H-Rockfish-A	170.24	1.65	2.67	0	0	0	20.14	0	0	0
H-Flatfish-A	454.72	0.22	0.26	0	0	0	15.77	0	0	0
H-Salmon-A	0	0	821.85	689.16	4319.56	678.98	1646.22	0	0	0
H-Halibut-A	0	298.95	174.25	0	0	3.94	393.73	0	0	0
H-OtherSpp-A	126.09	6.95	2.52	0	0	39.82	81.01	0	0	0
OTHHARV-A	0	0	0	0	0	0	0	8135.5	13730.72	55335.17
TOTAL HARVESTING	2802.69	2029.03	2175.44	689.16	4319.56	722.75	2932.55	8135.5	13730.72	55335.17
PROCESSING										
P-Kcrab-A	0	567.93	244.23	0	0	0	42.02	0	0	0
P-Tcrab-A	0	1042.17	470.57	0	0	0	5.43	0	0	0
P-Ocrab-A	0	0.05	3.6	0	0	0	10.73	0	0	0
P-Pcod-A	1663.05	327.58	702.29	0	0	0	432.04	0	0	0
P-Pollock-A	4499.35	1979.18	1831.32	0	0	0	877.98	0	0	0
P-Sablefish-A	71.72	42.84	79.75	0	0	0	161.21	0	0	0
P-Rockfish-A	457.93	1.78	3.13	0	0	0	144.84	0	0	0
P-Flatfish-A	1317.12	0.35	2.9	0	0	0	110.75	0	0	0
P-Salmon-A	0	0	611.66	1247.87	3254.4	1574.73	1146.16	0	0	0

P-Halibut-A	0	87.54	58.45	0	0	4.43	202.3	0	0	0
P-OtherSpp-A	415.88	3.12	9.12	0	0	365.95	32.62	0	0	0
SHOREPROC-A	0	0	0	0	0	0	0	3546.86	10020.27	20549.76
TOTAL PROCESSING	8425.06	4052.55	4017	1247.87	3254.4	1945.1	3166.08	3546.86	10020.27	20549.76
SEAFOOD TOTAL	11227.74	6081.58	6192.44	1937.03	7573.96	2667.85	6098.63	11682.36	23750.99	75884.93
NON-SEAFOOD TOTAL	0	2095.27	788.16	881.35	1183.82	2972.73	7565.82	428110.7	28383515	1.56E+08
TOTAL ALL INDUSTRIES	11227.74	8176.85	6980.6	2818.38	8757.78	5640.57	13664.45	439793	28407266	1.56E+08
VALUE ADDED ($ million)										
LAB FISH	379.69	165.36	121.88	21.16	72.77	21.64	103.87	243.17	1440.59	1360.61
LAB OTHER	0	158.19	40.85	56.67	52.33	162.57	455.55	27083.44	1667606	8160601
PROPR FISH	196.98	170.56	194.17	37.33	109.52	49.64	172.38	297.14	973.26	890.83
PROPR OTHER	0	11.5	0.88	0.44	3.89	7.99	31.38	3204.85	216464.1	1125407
OPI	0	86.78	20.71	13.54	17.01	60.16	206.68	19273.87	935146.3	4310781
INDT	13.16	28.99	16.23	5.89	14.9	15.69	37.36	8419.85	192621.4	978190.1
TOTAL VALUE ADDED	589.84	621.38	394.72	135.04	270.42	317.71	1007.22	58522.32	3014251	14577230
HOUSEHOLD INCOME ($ million)										
TOTAL HOUSEHOLD INCOME	0	274.28	139.78	101.98	59.82	233.13	667.26	36736.42	2485913	12589659
STATE AND LOCAL GOV'T REVENUE ($million)										
SLGOVTSPEND	0	128.57	55.42	81.15	55.81	168.67	286.55	15146.72	802583	3463466

Table 8. -- Economic impacts (quantity change).

Industry	AT-SEA	AWCA	AEB	LPB	BBB	DCA	KIB	RAK	WOC	RUS
INDUSTRY OUTPUT ($million)										
HARVESTING										
H-Kcrab-A	0	0	0	0	0	0	0	0	0	0
H-Tcrab-A	0	0	0	0	0	0	0	0	0	0
H-Ocrab-A	0	0	0	0	0	0	0	0	0	0
H-Pcod-A	0	0	0	0	0	0	0	0	0	0
H-Pollock-A	0	12.58	0	0	0	0	0	0	0	0
H-Sablefish-A	0	0	0	0	0	0	0	0	0	0
H-Rockfish-A	0	0	0	0	0	0	0	0	0	0
H-Flatfish-A	0	0	0	0	0	0	0	0	0	0
H-Salmon-A	0	0	0	0	0	0	0	0	0	0
H-Halibut-A	0	0	0	0	0	0	0	0	0	0
H-OtherSpp-A	0	0	0	0	0	0	0	0	0	0
OTHHARV-A	0	0	0	0	0	0	0	0	0	0
TOTAL HARVESTING	0	12.58	0	0	0	0	0	0	0	0
PROCESSING										
P-Kcrab-A	0	0	0	0	0	0	0	0	0	0
P-Tcrab-A	0	0	0	0	0	0	0	0	0	0
P-Ocrab-A	0	0	0	0	0	0	0	0	0	0
P-Pcod-A	0	0	0	0	0	0	0	0	0	0
P-Pollock-A	0	27.46	0	0	0	0	0	0	0	0
P-Sablefish-A	0	0	0	0	0	0	0	0	0	0
P-Rockfish-A	0	0	0	0	0	0	0	0	0	0
P-Flatfish-A	0	0	0	0	0	0	0	0	0	0
P-Salmon-A	0	0	0	0	0	0	0	0	0	0
P-Halibut-A	0	0	0	0	0	0	0	0	0	0
P-OtherSpp-A	0	0	0	0	0	0	0	0	0	0
SHOREPROC-A	0	0	0	0	0	0	0	0	0	0

TOTAL PROCESSING	0	27.46	0	0	0	0	0	0	0	0
SEAFOOD TOTAL	0	40.04	0	0	0	0	0	0	0	0
NON-SEAFOOD TOTAL	0	4.85	0.02	0	0	0.01	0.2	4.26	25.22	24.51
TOTAL ALL INDUSTRIES	0	44.89	0.02	0	0	0.01	0.2	4.27	25.22	24.51
EMPLOYMENT (Total workers)										
HARVESTING										
H-Kcrab-A	0	0	0	0	0	0	0	0	0	0
H-Tcrab-A	0	0	0	0	0	0	0	0	0	0
H-Ocrab-A	0	0	0	0	0	0	0	0	0	0
H-Pcod-A	0	0	0	0	0	0	0	0	0	0
H-Pollock-A	0	41.69	0	0	0	0	0	0	0	0
H-Sablefish-A	0	0	0	0	0	0	0	0	0	0
H-Rockfish-A	0	0	0	0	0	0	0	0	0	0
H-Flatfish-A	0	0	0	0	0	0	0	0	0	0
H-Salmon-A	0	0	0	0	0	0	0	0	0	0
H-Halibut-A	0	0	0	0	0	0	0	0	0	0
H-OtherSpp-A	0	0	0	0	0	0	0	0	0	0
OTHHARV-A	0	0	0	0	0	0	0	0	0	0
TOTAL HARVESTING	0	41.69	0	0	0	0	0	0	0	0
PROCESSING										
P-Kcrab-A	0	0	0	0	0	0	0	0	0	0
P-Tcrab-A	0	0	0	0	0	0	0	0	0	0
P-Ocrab-A	0	0	0	0	0	0	0	0	0	0
P-Pcod-A	0	0	0	0	0	0	0	0	0	0
P-Pollock-A	0	197.92	0	0	0	0	0	0	0	0
P-Sablefish-A	0	0	0	0	0	0	0	0	0	0
P-Rockfish-A	0	0	0	0	0	0	0	0	0	0
P-Flatfish-A	0	0	0	0	0	0	0	0	0	0
P-Salmon-A	0	0	0	0	0	0	0	0	0	0
P-Halibut-A	0	0	0	0	0	0	0	0	0	0

P-OtherSpp-A	0	0	0	0	0	0	0	0	0	0
SHOREPROC-A	0	0	0	0	0	0	0	0	0	0
TOTAL PROCESSING	0	197.92	0	0	0	0	0	0	0	0
SEAFOOD TOTAL	0	239.61	0	0	0	0	0	0	0	0
NON-SEAFOOD TOTAL	0	26.82	0.16	0.03	0	0.05	1.57	25.82	138.45	123.7
TOTAL ALL INDUSTRIES	0	266.43	0.16	0.03	0	0.05	1.57	25.82	138.45	123.71
VALUE ADDED ($ million)										
LAB FISH	0	8.93	0	0	0	0	0.1	1.09	3.94	1.08
LAB OTHER	0	1.74	0	0	0	0	0.07	1.3	7.83	6.4
PROPR FISH	0	6.25	0	0	0	0	0	1.99	2.15	0.31
PROPR OTHER	0	0.16	0	0	0	0	0.01	0.22	1.07	0.96
OPI	0	1.06	0	0	0	0	0.05	0.9	4.91	4.29
INDT	0	1.12	0	0	0	0	0.01	0.27	1.08	0.93
TOTAL VALUE ADDED	0	19.25	0.01	0.01	0	0	0.23	5.77	20.97	13.97
HOUSEHOLD INCOME ($ million)										
TOTAL HOUSEHOLD INCOME	0	5.39	0	0	0	0	0.12	4.26	14	8.96
STATE AND LOCAL GOV'T REVENUE ($million)										
SLGOVTSPEND	0	1.09	0	0	0	0	0.02	0.38	2.03	1.52

Table 9. -- Economic impacts (percentage change).

Industry	AT-SEA	AWCA	AEB	LPB	BBB	DCA	KIB	RAK	WOC	RUS
INDUSTRY OUTPUT ($million)										
HARVESTING										
H-Kcrab-A	0	0	0	0	0	0	0	0	0	0
H-Tcrab-A	0	0	0	0	0	0	0	0	0	0
H-Ocrab-A	0	0	0	0	0	0	0	0	0	0
H-Pcod-A	0	0	0	0	0	0	0	0	0	0
H-Pollock-A	0	10	0	0	0	0	0	0	0	0
H-Sablefish-A	0	0	0	0	0	0	0	0	0	0
H-Rockfish-A	0	0	0	0	0	0	0	0	0	0
H-Flatfish-A	0	0	0	0	0	0	0	0	0	0
H-Salmon-A	0	0	0	0	0	0	0	0	0	0
H-Halibut-A	0	0	0	0	0	0	0	0	0	0
H-OtherSpp-A	0	0	0	0	0	0	0	0	0	0
OTHHARV-A	0	0	0	0	0	0	0	0	0	0
TOTAL HARVESTING	0	3.79	0	0	0	0	0	0	0	0
PROCESSING										
P-Kcrab-A	0	0	0	0	0	0	0	0	0	0
P-Tcrab-A	0	0	0	0	0	0	0	0	0	0
P-Ocrab-A	0	0	0	0	0	0	0	0	0	0
P-Pcod-A	0	0	0	0	0	0	0	0	0	0
P-Pollock-A	0	10	0	0	0	0	0	0	0	0
P-Sablefish-A	0	0	0	0	0	0	0	0	0	0
P-Rockfish-A	0	0	0	0	0	0	0	0	0	0
P-Flatfish-A	0	0	0	0	0	0	0	0	0	0
P-Salmon-A	0	0	0	0	0	0	0	0	0	0
P-Halibut-A	0	0	0	0	0	0	0	0	0	0
P-OtherSpp-A	0	0	0	0	0	0	0	0	0	0
SHOREPROC-A	0	0	0	0	0	0	0	0	0	0

TOTAL PROCESSING	0	4.88	0	0	0	0	0	0	0	0
SEAFOOD TOTAL	0	4.48	0	0	0	0	0	0	0	0
NON-SEAFOOD TOTAL	0	1.05	0.02	0	0	0	0.02	0.01	0	0
TOTAL ALL INDUSTRIES	0	3.3	0	0	0	0	0.01	0	0	0
EMPLOYMENT (Total workers)										
HARVESTING										
H-Kcrab-A	0	0	0	0	0	0	0	0	0	0
H-Tcrab-A	0	0	0	0	0	0	0	0	0	0
H-Ocrab-A	0	0	0	0	0	0	0	0	0	0
H-Pcod-A	0	0	0	0	0	0	0	0	0	0
H-Pollock-A	0	10	0	0	0	0	0	0	0	0
H-Sablefish-A	0	0	0	0	0	0	0	0	0	0
H-Rockfish-A	0	0	0	0	0	0	0	0	0	0
H-Flatfish-A	0	0	0	0	0	0	0	0	0	0
H-Salmon-A	0	0	0	0	0	0	0	0	0	0
H-Halibut-A	0	0	0	0	0	0	0	0	0	0
H-OtherSpp-A	0	0	0	0	0	0	0	0	0	0
OTHHARV-A	0	0	0	0	0	0	0	0	0	0
TOTAL HARVESTING	0	2.05	0	0	0	0	0	0	0	0
PROCESSING										
P-Kcrab-A	0	0	0	0	0	0	0	0	0	0
P-Tcrab-A	0	0	0	0	0	0	0	0	0	0
P-Ocrab-A	0	0	0	0	0	0	0	0	0	0
P-Pcod-A	0	0	0	0	0	0	0	0	0	0
P-Pollock-A	0	10	0	0	0	0	0	0	0	0
P-Sablefish-A	0	0	0	0	0	0	0	0	0	0
P-Rockfish-A	0	0	0	0	0	0	0	0	0	0
P-Flatfish-A	0	0	0	0	0	0	0	0	0	0
P-Salmon-A	0	0	0	0	0	0	0	0	0	0
P-Halibut-A	0	0	0	0	0	0	0	0	0	0

P-OtherSpp-A	0	0	0	0	0	0	0	0	0	0
SHOREPROC-A	0	0	0	0	0	0	0	0	0	0
TOTAL PROCESSING	0	4.88	0	0	0	0	0	0	0	0
SEAFOOD TOTAL	0	3.94	0	0	0	0	0	0	0	0
NON-SEAFOOD TOTAL	0	1.28	0.02	0	0	0	0.02	0.01	0	0
TOTAL ALL INDUSTRIES	0	3.26	0	0	0	0	0.01	0.01	0	0
VALUE ADDED ($ million)										
LAB FISH	0	5.4	0	0.02	0	0	0.1	0.45	0.27	0.08
LAB OTHER	0	1.1	0.01	0	0	0	0.01	0	0	0
PROPR FISH	0	3.66	0	0	0	0	0	0.67	0.22	0.04
PROPR OTHER	0	1.35	0.02	0.01	0	0	0.02	0.01	0	0
OPI	0	1.22	0.02	0.01	0	0	0.02	0	0	0
INDT	0	3.88	0.01	0	0	0	0.03	0	0	0
TOTAL VALUE ADDED	0	3.1	0	0.01	0	0	0.02	0.01	0	0
HOUSEHOLD INCOME ($ million)										
TOTAL HOUSEHOLD INCOME	0	1.97	0	0	0	0	0.02	0.01	0	0
STATE AND LOCAL GOV'T REVENUE ($million)										
SLGOVTSPEND	0	0.85	0	0	0	0	0.01	0	0	0

Appendix A: Glossary

Adjusted demand-driven model

An adjusted demand-driven model is used to assess the economic impacts of an exogenous shock to the output or the productive capacity of an industry. The model is run with the regional purchase coefficients (RPCs) set to zero for the relevant industries / commodities and with the initial shock treated as a final demand shock.

Backward linkage

The relationship between an industry and the industries from which the first industry buys its inputs needed to produce its output.

Capital income

Non-labor income that includes business profits (dividends), interest income, and rental income. In the case of fisheries, capital income includes the profits of the owners of vessels and processing firms.

Demand-driven model (or Leontief demand-driven model)

An IO or SAM model that is "driven by" final demand. In a demand-driven model final demand is applied as an initial shock to the model and the model calculates the economic impacts endogenously.

Direct effects

The initial impacts introduced to an economy, typically specified as a direct final demand change.

Direct input coefficients

See Input-output coefficients.

Economic impact analysis

An economic impact analysis estimates the change in economic activity arising from a policy or a project. Economic impacts are typically measured in terms of industry output/sales, employment, household spending, and government revenue. Economic impact analysis is different from benefit-cost analysis (BCA) which estimates the value of a project by comparing its benefits and costs. When calculating the costs, BCA considers the opportunity cost of a project (i.e., what must be given up to realize the benefits of the project) while an economic impact analysis does not.

Feedback effects

Feedback effects refer to the additional effects that transpire in the region where a policy or a shock is introduced. These effects are caused by the spillover effects occurring in the other regions that arise from the effects in the first region.

Final demand

Demand for goods and services sold to final users. The final demand includes household demand, government demand, investment demand, and exports, but excludes the demand for the goods and services by industries that are used as intermediate inputs.

Forward linkage

The relationship between an industry and other industries to which the first industry sells its output that is used to produce the outputs in these other industries.

GDP deflator

The GDP deflator (also called GDP Price deflator or GDP Implicit Price Deflator) gauges the price level of all domestically produced final goods and services within an economy. It accounts for changes in the average price level for the economy, and therefore, is often used to measure inflation.

IMPLAN

IMPLAN (IMpact analysis for PLANning) provides regional economic data for all counties and states in US, and is also a software used to run IO models with these data.

Indirect business tax

Indirect business taxes include sales taxes, property taxes (levied on businesses), and other fees, fines, licenses, and permit fees, but excludes corporate income tax.

Indirect effects

The impacts caused by iteration of changes in industries' purchases from other industries in response to the direct effects.

Induced effects

The additional impacts transpired due to the change in household spending from a change in household income generated by the direct and indirect effects.

Input-output coefficients (also called Technical coefficients or Direct input coefficients)

Coefficients showing how many dollars of inputs from industries are needed to produce a dollar's worth of output in an industry. The coefficients are derived by dividing the elements in a column in the IO table by the total output of the industry represented by the column.

Input-output table (or transaction table)

A table or matrix showing the transactions among different industries. Columns represent purchasing sectors and rows selling sectors.

Intermediate demand

Industries' demand for goods and services that are used as intermediate inputs in industry production.

Labor income

Labor income consists of (i) employee compensation and (ii) proprietor income. Employee compensation is the total payroll cost paid by the employers, which includes wages, salaries, and all employer-provided benefits (such as social insurance contributions, health care, and retirement). Proprietor income is the income that proprietors pay themselves for their labor in managing their businesses.

Leontief inverse

A matrix showing the total economic impacts on the outputs of all the industries in an economy generated per unit change in the final demand for an industry's output. The sum of the elements in a column (industry) measures the multiplier for that industry.

Make matrix

A matrix showing the quantities of different commodities that an industry produces.

Market share matrix

A matrix showing the proportions of different commodities produced by an industry. The elements in the matrix are derived by dividing the elements in the make matrix by total output of an industry.

Matrix of SAM inverse coefficients

See SAM multiplier matrix.

Multiplier

Total impacts generated per unit change in final demand. In the Leontief inverse, the multiplier for an industry is calculated as the sum of the elements in the column representing the industry. Here, total impacts are the sum of direct, indirect, and induced effects. Multipliers may be calculated for industry output, employment, and other variables.

Regional purchase coefficient (RPC)

The fraction of the total demand for a commodity by all users (household, industries, and government) in a region that is supplied by the producers within the region. An RPC of 0.7 for a commodity, for example, means that the producers in the region supply 70% of its total demand with the remainder (30%) satisfied by imports.

Social Accounting Matrix (SAM)

A matrix showing both transactions of commodities and non-market financial flows among industries, value added accounts, households, and governments. It is an extension of IO table because a SAM adds to the IO table accounts recording non-market financial flows from and to sectors like value added sectors, households, and governments. The column entries in a SAM represent expenditures or payments made by the economic agents. The row entries represent receipts or income to agents.

SAM Model

An economic impact model constructed based on a SAM, and overcomes the limitation of input-output model by addressing the distributional effects on, for example, factor owners, households, and government.

SAM direct coefficients

Coefficients showing how the total receipt for an account is spent on commodities or allocated /distributed to non-industry sectors. The coefficients are derived by dividing the elements in a column in a SAM by the column sum. SAM direct coefficients are similar to IO coefficients, but include coefficients for non-industry accounts as well as industry accounts.

SAM multiplier matrix (or Matrix of SAM inverse coefficients)

A matrix showing the total impacts on sectors (including industries, value added accounts, households, and government) generated by a unit change in the exogenous demand for a sector (final demand in case of industries). The sum of the elements in a column, which represent an industry or a non-industry sector, measures the multiplier for the industry or the sector.

Spillover effects

Suppose that economic impacts occur owing to a policy change or a shock in a region. Spillover effects refer to the effects occurring in other regions that have economic linkages with the region where the initial economic impacts transpire.

Supply-determined (or supply-driven model)

An IO or SAM model that is “driven by” industry output or productivity capacity. In a supply-driven model, exogenous change in industry output is applied as an initial shock to the model and the model calculates the economic impacts endogenously.

Supply- driven model

See Supply-determined model.

Technical coefficients

See Input-output coefficients.

Transaction table

See Input-output table.

Use matrix (absorption matrix)

A matrix showing the quantities of different commodities used by each industry in producing the industry’s output.

Value added

The difference between an industry's total output value and its payment for the intermediate inputs used in production. Value added consists of labor income, capital income, and indirect business taxes.

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