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Identifying channels of economic impacts: An inter-regional structural path analysis for Alaska fisheries

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ABSTRACT

Alaska fisheries have strong spillover effects on economies of other states (especially the state of Washington) due to their dependence on imports from these other states. Several studies attempt to develop inter-regional or multi-regional economic impact models to investigate these spillover effects, and calculate the multipliers for Alaska fisheries. However, these multipliers measure only total economic impacts, failing to provide fishery managers with the information on how and along what channels these total economic impacts are generated and transmitted throughout the regions. This paper uses an inter-regional structural path analysis (IRSPA) to identify the various channels (paths) through which the economic impacts of an initial shock to a seafood sector are transmitted, amplified, and spilled over to other regions, within an inter-regional social accounting matrix (IRSAM) framework for two US regions – Alaska and the rest of US (RUS).

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1. Introduction

Much of the labor income generated in seafood-related industries in Alaska flows out of the state because a large share of workers are nonresidents. In 2010, about 20% of total private and state and local government employment in Alaska was accounted for by nonresidents. Consequently, about 14% of the total labor income produced in private industries and state and local governments in Alaska leaked out of the state. Outflows of labor income are the largest in (i) seafood processing (65%)[1]; (ii) agriculture, forestry, fishing, and hunting (43%, mostly fishing); (iii) mining (29%); (iv) accommodation (26%); (v) transportation and warehousing (23%); and (vi) arts, entertainment, and recreation (20%) sectors [1].

In addition, a large amount of capital used in Alaska industries, including seafood, is owned by nonresidents. This means that much of the capital income from these industries leaks to other states. Many fishing vessels operating in waters off Alaska are owned by non-Alaskan residents. Also, many of the goods and services used by consumers and industries in Alaska are imported from other states. In 2008, the total value of imports to Alaska ($16 billion) from non-Alaska US states accounted for about 31% of the total value of production ($51 billion) in the state [20]. Therefore, there are additional impacts from exogenous shocks to fisheries or other industries in Alaska affecting those other states that are not captured in a single-region economic impact model.

Several studies have used an inter-regional or multi-regional economic impact model such as social accounting matrix (SAM) model [19,20] to capture these additional impacts of Alaska fisheries, and calculated the inter- or multi-regional multipliers. For example, Seung [19] calculated the economic impacts of Alaska fisheries for three regions in the US including Alaska, the West Coast, and the rest of US using multipliers from a three-region SAM model. However, these multipliers measure only total economic impacts, failing to provide fishery managers with the information on how and along what channels these total economic impacts are generated and transmitted throughout the regions.

The present study departs from these studies, and uses an inter-regional structural path analysis (IRSPA) to identify various paths (channels) through which an initial shock to Alaska fisheries generates inter-regional impacts within an inter-regional social accounting matrix (IRSAM) for two regions, Alaska and the rest of US. Conventional economic impact analysis would provide the fishery managers only a multiplier number measuring the overall economic impacts of a seafood industry. As such, it would not

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[1] That is, 65% of labor income in this industry leaks out of the state.

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explain how and through what paths the initial shocks are transmitted in generating the total economic impacts.[2] Unlike the conventional multiplier analysis, the IRSPA can reveal the mechanism of interactions among different economic sectors in the two regions, and serve as a complementary tool to the conventional multiplier analysis in fishery managers' decision-making. In the next section (Section 2), a description of an IRSAM model for Alaska fisheries is provided. Section 3 describes the IRSPA with a brief review of previous structural path analysis (SPA) studies. Section 4 provides a description of data used, which is followed by Section 5 where results are discussed. Conclusions follow.

2. Alaska fisheries IRSAM model

This section describes the 2008 IRSAM model used in this study. It relies on Seung [19] except that this section describes a two-region IRSAM while Seung [19] describes a three-region SAM. Readers are referred to King [6] for a more detailed discussion of a SAM, Holland and Wyeth [4] for a regional level SAM model, and Round [17] and Roberts [15] for the structure of an IRSAM. The structure of the IRSAM used in this study is similar to that in Round [17] and Roberts [15], and is available upon request.

In the IRSAM, each region has 61 endogenous accounts; thus, with two regions there are a total of 122 (61 × 2) endogenous accounts in the IRSAM. The 61 endogenous accounts for each region include 28 industries, 26 commodities, 3 value-added accounts (labor income, capital income, and indirect business tax), 3 household accounts (low-, medium-, and high-income households), and a state and local government account. The 28 industries (Table 1) include 14 seafood industries (11 fish harvesting industries and 3 seafood processing industries) and 14 non-seafood industries. The 26 commodities include 11 fish species (corresponding to the 11 fish harvesting industries), one processed seafood (which is an aggregation of the commodities produced in the three seafood processing industries), and 14 non-seafood commodities (corresponding to the 14 non-seafood industries). Major species (commodities) in the model are Pacific cod, pollock, sablefish, crab, halibut, and salmon. The three processing industries are catcher-processors, motherships, and shorebased processors.

The IRSAM has 4 exogenous accounts, which include the federal government, capital (savings and investment), an account to handle international trade and financial flows, and an account balancing between the two regions and the rest of the world (ROW).

The IRSAM model is represented as:

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} Z_{11} z_{12} \\ z_{21} Z_{22} \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} + \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \tag{1}$$

where y_r and x_r denote the column vectors of endogenous and exogenous accounts, respectively, for region r and $\boldsymbol{Z_{rr}}$ is a submatrix containing coefficients showing the intra-regional transactions and $\boldsymbol{z_{rs}}$ a submatrix containing coefficients showing inter-regional transactions (i.e., transactions between regions r and s, $r \neq s$). All the coefficients in $\boldsymbol{Z_{rr}}$ and $\boldsymbol{z_{rs}}$ matrices are derived by dividing the elements in the columns in the IRSAM by the column totals.

Alternatively, Eq. (1) can be expressed as following:

$$Y = (I - S)^{-1} X \tag{2}$$

where $Y = \begin{bmatrix} y_1 \\ y_2 \end{bmatrix}$, $S = \begin{bmatrix} Z_{11} z_{12} \\ z_{21} Z_{22} \end{bmatrix}$, and $X = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$. Here $\boldsymbol{S}$ is matrix of direct IRSAM coefficients and $(I - S)^{-1}$ is the IRSAM multiplier matrix. Here $(\mathbf{I}-\mathbf{S})^{-1}$ is called the IRSAM multiplier matrix or matrix of IRSAM inverse coefficients. $\boldsymbol{y_r}$ is a column vector for region r consisting of the following endogenous sub-vectors:

$\boldsymbol{A_r}$ = vector of regional industry output
$\boldsymbol{Q_r}$ = vector of regional commodity output
$\boldsymbol{V_r}$ = vector of total primary factor payments
$\boldsymbol{IBT_r}$ = indirect business tax payments
$\boldsymbol{H_r}$ = vector of total household income
$\boldsymbol{SG_r}$ = total state and local government income or revenue
$\boldsymbol{Z_{rr}}$ for region r is:

$$Z_{rr} = \begin{bmatrix} 0 & M_r & 0 & 0 & 0 & 0 \\ U_r & 0 & 0 & 0 & C_r & GD_r \\ V_r & 0 & 0 & 0 & 0 & 0 \\ IBT_r & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & F_r & 0 & 0 & STR_r \\ 0 & 0 & SF_r & BTS_r & HTX_r & IGT_r \end{bmatrix}$$

where:

$\boldsymbol{U_r}$ = absorption matrix
$\boldsymbol{V_r}$ = matrix of primary factor payments coefficients
$\boldsymbol{IBT_r}$ = matrix of indirect business tax coefficients
$\boldsymbol{M_r}$ = market share matrix
$\boldsymbol{F_r}$ = matrix of factor payment to household coefficients
$\boldsymbol{SF_r}$ = matrix of state and local factor tax coefficients
$\boldsymbol{BTS_r}$ = matrix of state and local indirect business tax coefficients
$\boldsymbol{C_r}$ = matrix of household consumption coefficients
$\boldsymbol{HTX_r}$ = matrix of state and local government direct household tax coefficients
$\boldsymbol{GD_r}$ = matrix of state and local government demand coefficients
$\boldsymbol{STR_r}$ = matrix of state and local government transfer coefficients
$\boldsymbol{IGT_r}$ = matrix of intergovernmental transfers
$\boldsymbol{z_{rs}}$ is:

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

where $\boldsymbol{IM_{rs}}$ is matrix of imports from region r to s and $\boldsymbol{LK_{rs}}$ is matrix of leakage of factor income from region s to region r. $\boldsymbol{x_r}$ is a column vector consisting of the following exogenous sub-vectors:

$\boldsymbol{ea_r}$ = vector of exogenous demand for regional industry output
$\boldsymbol{eq_r}$ = vector of exogenous demand for regional commodity output
$\boldsymbol{ev_r}$ = vector of exogenous factor payments
$\boldsymbol{et_r}$ = exogenous indirect business tax payments
$\boldsymbol{eh_r}$ = vector of exogenous federal transfers to households
$\boldsymbol{eg_r}$ = federal transfers to state and local government.

There are three non-zero exogenous demand vectors – $\boldsymbol{eq_r}$, $\boldsymbol{eh_r}$ and $\boldsymbol{eg_r}$. The elements of $\boldsymbol{eq_r}$ are components of final demand for commodities including Federal government demand, investment demand, and export demand. The elements of $\boldsymbol{eh_r}$ include Federal government transfers to households and remittances from ROW to households. The components of $\boldsymbol{eg_r}$ include Federal government transfers to state and local government. Injections of income into a region occur through final demand components in $\boldsymbol{eq_r}$ and extra-

[2] This may be an overstatement because conventional economic impact analysis conducted using input–output (IO) and SAM models can also identify the upstream (i.e., backward linkage) sectors that will be impacted by a policy shock. Compared with conventional economic impact analysis, however, a structural path analysis goes one step further because it can investigate the concentration, strength, and speed of various transmission channels of economic impacts generated.