Using Ready-Made Regional Input-Output Models to Estimate Backward Linkage Effects of Exogenous Output Shocks

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Background

- Claims that a proposed management action would doom an entire region to economic oblivion

Problem

- Scope of economic analysis of management actions was limited to preparation of benefit/cost analyses
  - Distributional effects that occur beyond the wharf?
  - No credible science-based evidence to contest claims of complete economic devastation
- Legislation was introduced that required federal regulators to recognize and asses the impacts of management actions on communities and fishery dependent and independent businesses

Background: Modeling Approaches

- Cursory review of common analytical approaches
  - CGE, Economic Base (shift-share), Input-Output
- Input-Output models were the most appealing
- HQ purchased IMPLAN software and data for all the NMFS regions ($$$ BIG $$$)

Background: Modeling Concerns

- Used IMPLAN to construct a commercial fishing input-output model for the New England Region
  - Model was employed to assess the relative short-term economic losses (sales, personal income, and employment) associated with the management alternatives proposed under A13 to the Multispecies Groundfish FMP
- Discovered a technical issue that I hadn't previously considered
- Update the model and expand to include the Mid-Atlantic Region (would require considerable effort and caffeine)

Background: Modeling Concerns Continued

- Literature review to find out how others dealt with this issue
- Findings were not encouraging
- Overriding conclusion: The use of traditional input-output models (IMPLAN) to assess the effects of fishery management actions would result in biased multiplier calculations

What's the Problem?

- **Traditional input-output approaches derive sectoral outputs from exogenously specified final demands**

$$X = (I - A)^{-1} * \hat{Y}$$

X = n x 1 column vector denoting endogenous output

I = n x n identity matrix

A = n x n direct input coefficients matrix

$\hat{Y}$ **= n x 1 column vector denoting exogenous final demand**

- **The** $(I - A)^{-1}$ **= the Leontief Inverse, comprised of "industry specific" multipliers** $(\alpha_{ij}'s)$ **that indicate how much the output of each row sector would change if the final demand for sector j's output changed by one dollar**

Problem Continued

- Commercial fishermen (producing sectors) are regulated and not households (final demand sectors)
- Quantifying the short-run economy-wide effects of a commercial fishing production capacity constraint ($\Delta \hat{X}_j$)

$$X = (I - A)^{-1} * \hat{Y}$$

- If a Δ in X_j is treated "as if" it was an exogenous ΔY_j the effects would be overstated
- Overestimation error is a constant percentage calculated from the indirect component of the sector's α_{jj} entry
- If sector j's on-diagonal element was 1.24 the results would overestimate the impact by 24.0%

Commonly Employed Solution

- A mixed exogenous/endogenous variables model
  - Premise is that the traditional Leontief model must be modified so that gross output $\Delta's$ for the constrained sector(s) can be treated as exogenous, as opposed to only final demands
- The basic relationships embodied in the demand-based approach are the same, but the equations that comprise (I – A) * X = Y are rearranged in order to isolate the exogenous variables on the right-hand side and the endogenous variables on the left
- $\Delta\hat{X}_j$ is used as a supply-determined driver in the model
- Avoids overestimation because no multiplier effects are associated with intermediate purchases from the exogenized sector (the $\Delta\hat{X}_j$ is fixed)

Limitations of Mixed Exogenous/Endogenous Variables Model

- **Sectoral detail is limited due to computational complexities so it is difficult to derive disaggregated estimates of indirect multiplier effects**

- **Functional form $\Delta's$ can not be incorporated into IMPLAN (IMPLAN utilizes traditional Leontief techniques)**

Model Adjustments

- Adjustments made to RPCs (regional purchase coefficients) – indicate the portion of total regional demand supplied by local producers
- RPCs for the commercial fishing sectors, seafood dealer sectors, and processing sectors were set to zero to avoid double-counting
- Effectively prevents all local industries from buying these outputs

Derivation of Model Adjustments

$$X = (I - A)^{-1} * \hat{Y}$$

- When the RPC for sector i is set to zero, the row elements for sector i in the A matrix (a_{ij}'s) become zero, and since $(I - A)^{-1}$ is derived by subtracting A from I, the α_{jj} element for sector i in the new $(I - \overline{A})^{-1}$ becomes one while the remaining row elements are forced to zero
- By definition, since $\overline{\alpha}_{jj} = 1$ and the remaining row elements are zero, there are no intermediate demands for sector i's output
- Therefore, the exogenous change will be fixed regardless of the origin of the change ($\Delta \hat{X}_j$ or a $\Delta \hat{Y}_j$)

Adjusted Industry Specific Multipliers

- When $\overline{\alpha}_{jj}$ is set to one, the remaining modified industry specific multipliers in that column j of $(I - \overline{A})^{-1}$ indicates how much the output of each row sector would change if the output of sector j changed by one dollar

- Whereas, in the traditional final demand-based approach these multipliers are related to a one dollar change in the final demand for sector j

Values of Adjusted Industry Specific Multipliers

- Since the values of these multipliers are now related to gross output changes, the multipliers should match those generated from a mixed exogenous/endogenous variables model

- Equivalence between output-based adjustment multipliers and the mixed exogenous/endogenous variables multipliers is demonstrated in the paper

Conclusions

$$X = (I - \overline{A})^{-1} * \hat{Y}$$

- By setting the RPC's of the outputs produced by the directly impacted sectors to zero prior to constructing the A matrix, and then setting the final demand changes equal to the predetermined gross output shocks, IMPLAN can accept gross output changes as entries to provide detailed estimates of indirect multiplier effects without double-counting or overestimating the endogenous effects
- Approach still suffers from the better-known input-output restrictions: fixity of prices and zero-substitution elasticities in consumption and production
- No refund required!