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Technical Document for Computing Coal Dependent Employment Estimates

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Abstract

This document presents the basis for estimating coal-dependent employment in a reference region, then establishing a weighting factor for each industry that can be used to provide a quantitative estimate of the existing employment or employment change in a county that can be attributed to existing or change in coal employment. The Matlab function is provided. Although coal is the industry of interest in this document, any other industry could be targeted for similar study.

1 Data Foundation

This procedure relies on several sources of data. The first source is the Bureau of Economic Analysis, who publish the Benchmark Input-Output Accounts. The second database is the CEW (Census of Employment and Wages) county-level employment database published by the Bureau of Labor Statistics, and in this case, cleaned and structured by a third party vendor. Finally, we use an in-house BLS-to-BEA national concordance to generate national employment by industry.

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2 Definitions, Derivation and Use

2.1 Definitions

The variables used are defined as follows:

$a_{ij} \in A$ direct technical coefficients

$b_{ij} \in B = (I - A)^{-1}$ total requirements coefficients

$e_i \in E$ employment by industry

$x_i \in A$ output by industry

$w_i \in W$ industry employment per output dollar

subscript or superscript c denotes the coal industry

subscript or superscript R denotes a region specific variable

$\lambda_i \in \lambda$ denotes employment by industry in support of regional coal production

2.2 Derivation

The objective is to define industry specific total employment requirements for the production of a specified level of regional output, λ. In the absence of superior data, we assume that productivities, in terms of output per employee, are spatially invariant. With this goal in mind and the variables defined above, the derivation is as follows.

$$w_i = \frac{e_i}{x_i} \tag{1}$$

$$w_i b_{ic} x_c^R = \lambda_i^R \in \lambda \tag{2}$$

2.3 Use

The variable λ now represents the industry-specific employment levels required to satisfy coal industry supply chain needs. By comparing these "sufficiency" output levels to the observed regional industrial employment levels, we can estimate the share of observed regional output by industry that is potentially supporting coal industry production. If a regional industry has less than the number employees needed to meet supply chain requirements, then the share of employment potentially directed to the coal industry supply chain, $s_i \in S$, will be 1.0, otherwise the value of s_i will be the ratio of sufficiency to observed. This is shown formally in (3), below.

$$s_i = \begin{cases} 1.0 & \lambda_i \geq e_i^R \\ \\ \frac{\lambda_i}{e_i^R} & \lambda_i < e_i^R \end{cases} \tag{3}$$

Note that in this document, we have used a conversion from output to employment, using a fixed relationship between the two for each industry. It would be equally feasible to substitute wages for employment in these steps as a means of estimating industry supply chain sufficiency. Depending on the problem domain context, one variable might be preferred to the other on theoretical grounds.

3 Supporting Algorithm(s)/Code

```
function [S L] = sc_depend(a,c,en,er,x)
% This function is used to produce vector of regional supply chain
% dependencies for industry c, using technical coefficients matrix a,
% regional and national employment vector er and en

%-----------------------------------------------------------------------------
%
%   USAGE: result = sc_depend (a,c,en,er,x)

% Input Variables:
% c      ==> index of the target industry
% a      ==> national technical coefficients matrix
% er     ==> column vector of regional employment by industry
% en     ==> column vector of national employment by industry
```

```
% x     ==> column vector of national output by industry

% Other Variables:
% b_ij in B=(I-A)^{-1}  ==>  total requirements coefficients
% w_i in W               ==> industry employment per output dollar
% L_i in lambda  ==> denotes support employment by industry i
% w ==> employees per unit output

%------------------------------------------------------------------------------
%
% RETURNS: vector s
% S = industry dependency vector
%
%  Function created by Randy Jackson, 03/17
%
%------------------------------------------------------------------------------


% compute the w vector as employee/output
if (size(x,1) == size(en,1))
    w = en./x;
else
    disp('inconformable arrays, en and w')
    return;
end

% compute Leontief Inverse
b = inv(eye(size(a,1)) - a);

% Target regional industry sector output
xc = er(c)/w(c);

% compute lambda ==> supply chain employment requirements
if (size(w,1) == size(b,1))
    L = w .* b(:,c) * xc;   % output requirements to serve region,
                            % converted to employment
else
    disp('inconformable arrays, w and b')
    return;
end

S = zeros(size(L,1),1);
for i = 1:size(L,1)
    if (L(i) >= er(i))   % if demand exceeds supply,
        S(i) = 1.0;      % all supply supports target industry
```

```
    else
        S(i) = L(i) / er(i);  % portion of regional supply demanded
    end
end
```

References

NONE