WHEN TECHNOLOGICAL COEFFICIENTS CHANGES NEED TO BE ENDOGENOUS

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24th Inforum World Conference
Osnabrueck 29 August 2 September 2016
Import shares in an Inforum Model

When the IO table is available in domestic (or total) and imported flows, a matrix of import shares

\[ MM \]

is available

MM is a component of the multisectoral model, playing an important role in the price side of the model
Between real side and price side

After the real side loop, a new IO table is built.

Multiplying element by element this ‘updated’ IO table by MM matrix, the ‘updated’ import flows matrix is obtained.

The row sum of this matrix gives the vector of imports:

\[ m^\wedge \]

Import (behavioral) equations give the vector of imports:

\[ m \]
Between real side and price side

**In general**  \( m \neq m^\wedge \)

\( m \) comes from behavioral equations so that it must prevail on \( m^\wedge \)

Problem: how to shape MM so that its row sum be equal to \( m \)?
If the model is forced to take more imports than it has demand for a certain industry, then output for that industry will be calculated as negative in Seidel(). This unreasonable result, if not corrected in Seidel(), will then cause other parts of the model to react strangely. For a forecast of imports to be reasonable, then imports must be less than or equal to domestic demand.
Modelling matrix MM

MM matrix does not play any role in solving the real side of the IO model.

Actually, it is central in the nominal side
The algorithm for MM

Inforum suggests an algorithm to adjust the MM coefficients

The algorithm provides increases and decreases of import shares (the elements of matrix MM) greater for low shares and lower for great shares under the constraint $mm_{ij} \leq 1$
When this algorithm is unsuitable

If non-zero import shares are all equal to one and imports estimated are greater than imports calculated, $m > m^\wedge$,

their differences cannot be ‘allocated’ by changing MM coefficients
When the growth of imports causes trouble

Imports vs negative outputs

or

Running a model and run into negative outputs

and the model builder’s dilemma

fixing or modeling?
The Leontief equation for a two sectors economy

\[
\begin{bmatrix}
1 - a_{11} & -a_{12} \\
-a_{21} & 1 - a_{22}
\end{bmatrix}
\begin{bmatrix}
q_1 \\
q_2
\end{bmatrix}
= 
\begin{bmatrix}
c_1 \\
c_2
\end{bmatrix}
\]
Reading the equations by rows

\[(1 - a_{11})q_1 - a_{12}q_2 = C_1\]

\[-a_{21}q_1 + (1 - a_{22})q_2 = C_2\]
Reading the equations by columns

\[
\begin{bmatrix}
1 - a_{11} \\
- a_{21}
\end{bmatrix} q_1 +
\begin{bmatrix}
- a_{12} \\
1 - a_{22}
\end{bmatrix} q_2 =
\begin{bmatrix}
c_1 \\
c_2
\end{bmatrix}
\]
The Hawkins-Simon conditions revisited

The corollary:

“A necessary and sufficient condition that the $q_i$ satisfying $Aq+f=q$ be all positive for any set $f>0$ is that all principal minors of the matrix $A$ are positive”
The geometrical analogue of the Leontief equation: the vector basis
The representation of vector \( C \) when the Hawkins-Simon conditions are satisfied
But even if vector $C$ is not strictly positive $q_i$’s satisfying $Aq + f = q$ are still positive.
Vector $\mathbf{C}$ is not strictly positive but now $q_i$‘s satisfying $Aq + f = q$ are no longer positive.
Changing the vector basis, $q_i$'s satisfying $Aq + f = q$ are positive again.
Changing the vector basis

Changing the coordinates

\[ a_{21}^* > a_{21} \text{ and } a_{22}^* > a_{22} \]

economically significant solutions are obtained
Changing the Base IO Table

<table>
<thead>
<tr>
<th>RESOURCES</th>
<th>USES</th>
</tr>
</thead>
<tbody>
<tr>
<td>output</td>
<td>imports</td>
</tr>
<tr>
<td>Com 1</td>
<td>61</td>
</tr>
<tr>
<td>Com 2</td>
<td>55</td>
</tr>
<tr>
<td>Com 3</td>
<td>32</td>
</tr>
</tbody>
</table>
The IO Table to be updated
Imports of Com 3 increase

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HOW TO TACKLE GROWING IMPORT SHARES OVER TOTAL RESOURCES

AN INSIGHT THROUGH INFORUM COUNTRY MODELS
Continue... with numerical examples

A GLANCE AT IMPORTS SUBSTITUTION IN THE ITALIAN ECONOMY
WARNING

WHEN IMPORTS DISPLAY A GENERAL POSITIVE TREND, THE TECHNOLOGY OBSERVED IN THE BASE YEAR (OR IN THE LAST AVAILABLE YEAR) MAY NOT BE APPROPRIATE TO GENERATE PLAUSIBLE FORECAST

(AS SHOWN ABOVE BY MEANS OF GEOMETRICAL REPRESENTATION)
A way to tackle such a problem is to make import equations ‘silent’.

The present release of the INFORUM French model offers an example of such makeshifts.
The new INFORUM French model
Two makeshifts for imports

if(t>=imp.LastDat) imp=ebemul(outc,imprat);
.
or
.
if(t>=imp.LastDat) {
   provv=outc.sum();
   Outsum.set(provv);
   imp=ebemul(impfac,(Outsum-outc));
}
Makeshifts compromise in the INFORUM Italian model

if(t>impshr.LastDat)impshrfunc(rimpsh, imptiml,rp);

if(t>=imp.LastDat) {
  importfunc(sc1cpa, impshr, outc);
  provv=outc.sum();
  imp[4] =ratMinCav[t]*(provv-outc[4]);
  imp[6] =ratAbbi[t]*(provv-outc[6]);
  imp[12]=ratFarma[t]*(provv-outc[12]);
  imp[15]=ratMetalli[t]*(provv-outc[15]);
  imp[17]=ratInforma[t]*(provv-outc[17]);
  imp[20]=ratAuto[t]*(provv-outc[20]);
  imp[33]=ratTAereo[t]*(provv-outc[33]);
  imp[3]=ratPesce[t]*(provv-outc[3]);
  imp[31]=ratTerra[t]*(provv-outc[31]);
}
The compromise

• imports of the sector responsible for generating negative outputs may be linked to the Total output of the economy
• in such cases sectoral imports are computed as share of the economy total output
• This makeshift is useful if applied to a short number of sectors and preferably those where the researcher’s interest is minor.
How to avoid makeshifts

A model builder’s proposal
Seidel2 implementation

sum = f[i];
for(j = first; j <= last; j++) sum += A[i][j]*q[j];

sumNet = sum - f[i];
sum -= A[i][i]*q[i]; // Take off the diagonal element of sum
sum = sum/(1.- A[i][i]);

//                if (i == 31 && iter == 0) {
if (sum < 0.0) {
    ratio =(q[i]-f[i])/sumNet;
    for(j = first; j <= last; j++) A[i][j] *=ratio;
    sum = q[i];
}
}
Three Scenarios

- **Scenario A** – Land transport services imports are modelled as a ratio of the economy’s total output.

- **Scenario B** - Total resources import shares equations are used to compute sectoral imports.

- **Scenario C** - Land transport services intermediate consumptions (technical coefficients) are adjusted just when its output becomes negative.
Import shares observed and forecasted in Scenarios B and C

Products of agriculture
import shares observed and forecasted

Mining and quarrying
import shares observed and forecasted
Land transport services

Output

2010 2015 2020 2025 2030

SCENARIO_A
SCENARIO_B
SCENARIO_C
Support services for transportation

- Output

<table>
<thead>
<tr>
<th>Year</th>
<th>Baseline</th>
<th>ImportsFunction</th>
<th>TecCoef_adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>85000</td>
<td>62500</td>
<td>40000</td>
</tr>
<tr>
<td>2015</td>
<td>80000</td>
<td>60000</td>
<td>40000</td>
</tr>
<tr>
<td>2020</td>
<td>80000</td>
<td>60000</td>
<td>40000</td>
</tr>
<tr>
<td>2025</td>
<td>80000</td>
<td>60000</td>
<td>40000</td>
</tr>
<tr>
<td>2030</td>
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Coke and refined petroleum products

- Output

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A Scenario number 4

An experiment Adjusting the A matrix every year
Seidel2 implementation

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}
}
Impact of the Vector bases on output

\[
\begin{bmatrix}
C_1 \\
C_2
\end{bmatrix}
= 
\begin{bmatrix}
1-a_{11} \\
1-a_{22}
\end{bmatrix}
\]
When a vector basis cannot produce positive outputs
Some Technical coefficients
Land transport services

aa  bb  cc  dd
Continue.........