Using input-output techniques to address economic and energy issues in Malaysia

Teaching material and exercises in how to use input-output techniques with the new Malaysian IO tables for 2000

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Teaching material and exercises in how to use input-output techniques with the new Malaysian IO tables for 2000. (September and November, 2005)
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Participants: Economic Planning Unit in the Prime Ministers Department, Malaysia

Additional material:
Input output Tables for Malaysia 2000, Department of Statistics, 2005
Excel worksheet IO-Malaysia 2000.xls

Exercises in IO-calculations: Monday 19 – Friday 24 September and November 9-17. 2005.

Using the tables: Malaysia 2000 Table 2 and 14 for extracting information

- What are the three major commodity inputs in soft drinks?
- Which commodity in domestic production has the highest import share (share of imports out of total intermediate inputs)
- What is the import share in investments?
- Are the imports for investments taxed more than the domestically supplied
- What is the second largest supplier of household machinery (which activity)
- How should we interpret the large number of supplier for real estate?

Using the simple structure from the Excel file of 3x3 activities.

Expand the basic activity: manufacturing into two activities:

1) high energy intensity
2) low energy intensity

Assume they have equal share of output and their input structure is similar:

Then assume that their production is differently distributed on the final demand components.

1) high intensity: For export 25 (increase the other final demand components proportionally)
2) low intensity: For export 100 (reduce the other final demands proportionally

Then calculate the new input coefficients:

Check coefficients -

Calculate inverse matrix

How can You see the difference of the two manufacturing activities to the original?

Assume electricity intensity:

- high energy intensity 1.4
- low energy intensity 0.4

Now calculate the electricity associated with total manufacturing exports.

Compare with the original calculation

Is this difference in electricity intensity realistic?

Exercise with Malaysian IO tables and the Macro functions Monday and Tuesday 26-27 September

Use the supplied worksheet IO-Malaysia 2000.xls and the macro functions in there.

First use the EXCEL matrix functions to calculate the inverse matrix by using Table 14 as the input coefficients.
Create the ID (identity) matrix
Declare the named arrays in EXCEL
Select an array area for the formula and enter as an array formula

What happens?

Try to use the macro functions to compute instead.

After going through the macro "Main" and subfunctions: minverse94, subtract, stormult etc:

- Compute the content of different services in the final demand for export, private consumption and government(public) consumption.

- Compute the increase in electricity and gas use if increase of:

    - 2 billion RM private consumption
    - 2 billion RM export

Discuss the difference between export and private consumption effects
Discuss assumptions about price and composition of final demand:

For electricity and gas: Can the result be interpreted as a change in kWh demand? (relative change)

Import matrix introduction and exercise on Wednesday 28 September:

Import matrix corresponds to intermediate matrix in size (94 x 94) at least the part we are going to use and we will calculate in the same way.
Imports matrix is given in Table 10. The first issue is how to compare the table 10 with table 14.

Import matrix exercise and construction of global type inverted matrix on Wednesday November 9:

1. Repetition of the import matrix correspondence to the domestic intermediate matrix (table 10 and table 14)
2. Calculate import shares for commodities used as intermediate inputs (use the total intermediate inputs – domestic + imported)

   There are 3 alternative import shares that might be relevant:

   - Direct import share: TABLE 14 include the coefficient for import of commodities in row 100. This figure gives the import share of total inputs in each sector (commodities in the case of table 14).
   - Import share for the commodity input (intermediate inputs) This is the row 100 in table 14 divided by (row 100+ row 95 domestic intermediate inputs)
   - Import share for each commodity input in each sector. This is the entire input coefficient matrix for imports Am divided by (Am+Ad).

   We calculated the second option and evaluated the import shares for a few sectors .

3. Adjust the inverse matrix taking into account the imported intermediate commodities

- First add the two matrices Am and Ad. (This was done two ways a) directly in excel spreadsheet and b) By using the macro subfunction called add)
- Next use the minver94 function to construct $(I-(Am+Ad))^{-1}$

This involved solving an error in the calculation: The reason was the existence of one column of nul in the Table 10 (column 77 ownership of dwellings). This resulted in errors

were dividing by zero for construction import coefficients and this was maintained in the added matrix. The solution was to replace the column 77 import coefficients by zero instead of the errors before adding the two matrices Am and Ad.

- Finally write the new inverse matrix to a spreadsheet and check its consistency.

Check that all diagonal elements are greater than or equal to 1.

4. Calculate the production associated with total final demand

Here the calculation will use the basic input output model

$g = (I-Ag)^{-1} \quad f$

It must be stressed that any of these calculations involving global effects are involving further "rude" assumptions. The basic assumption is that all imports are produced using the same technology as used domestically. That means the input structure is similar to that of Am+Ad. for all final demand (f) regardless of whether domestically produced or imported..

This is problematic, but there is no practical alternative if we want to address the total requirements for specific products (for example energy products) to fulfill the final demands. This is required for an analyses of how global energy price changes might affect final demand (for example private consumption) prices. This analyses will however require a few more assumptions on price changes.

To calculate this global production requirement in the macro function we have to define named ranges in EXCEL for final demand for domestic production in table 14 and final demand for imports from table 10. (the table 14 figures is actually based on coefficients and multiplied by the total final demand figure)

Using the two named ranges they are imported to variables in the macro and added up, where after the calculation is using our newly constructed global inverse matrix (also a named range) to construct globprod (global production) by using matrix multiplication (bigmult). Remember dimensions 94 by 94 matrix multiplied by final demand column 94 by 1 produces one column 94 by 1 of production.

$g = (I-Ag)^{-1} \quad f$

5. Compare the domestic and the global production created by final demand

After writing to spreadsheet output, then comparing the two production figures for the 94 sectors reveals that global production is on average more than double the domestic production. The share is high for products having a high export share and for products that are mostly used in consumption and less for production (services, consumer food products etc).

Further options for analyses not covered during this exercise:

6. Calculate energy content in final demands: Private consumption, export and government consumption

7. Use matrix to compute global content of electricity in production as a share of inputs

Energy sectors in the IO matrices and the direct production input of energy Thursday November 10:

First a thorough repetition of the macro calculations of yesterday:

All functions and their arguments where discussed
A copy of the Main macro and the declared functions is included as an Appendix here.

Next:

1. Identify the energy sectors in the 94 sector IO matrices

- Which ones is energy related and what is their actual interpretation sector wise and regarding energy ?

The three energy sectors were identified and compared.

- Compare the final demand and the intermediate demand for each type of energy

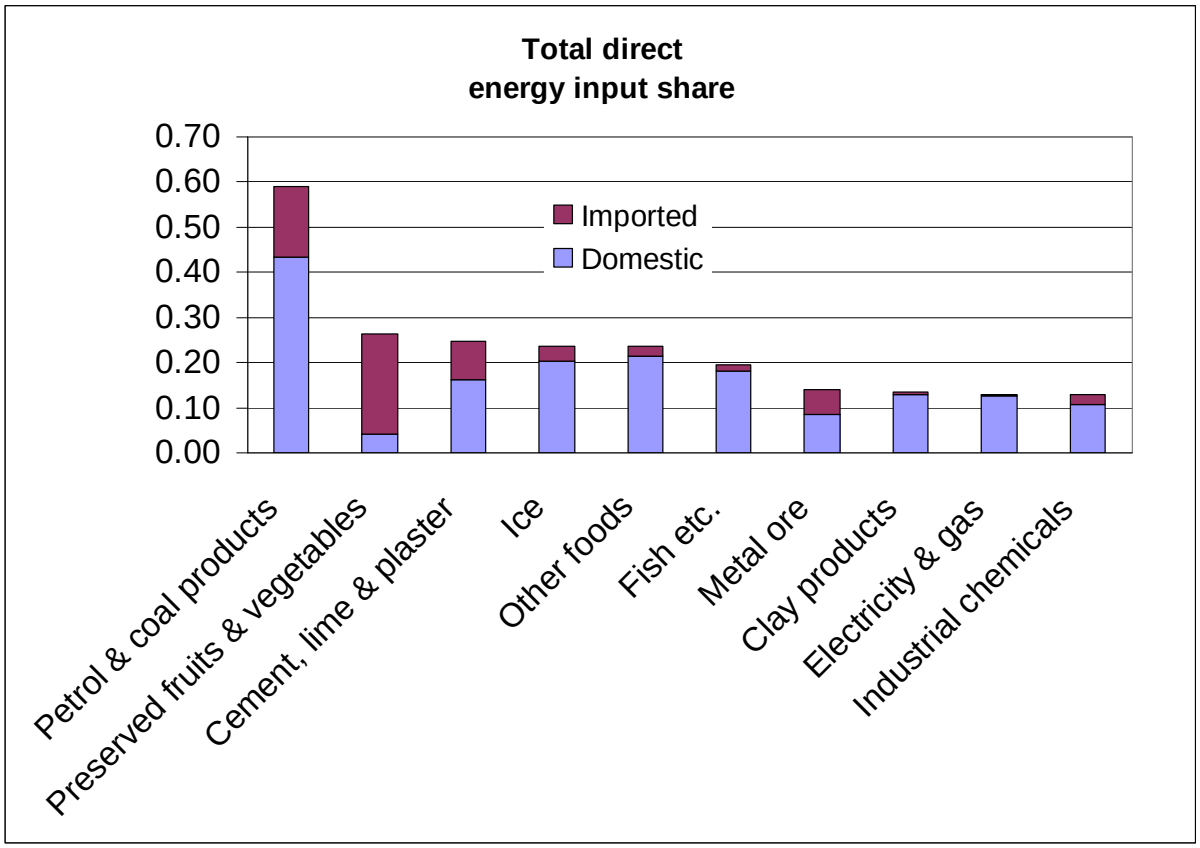
Energy sectors in the IO matrices and the direct production input of energy Friday November 11:

Continuation of energy sectors: (new people were participating)

- Find the total import share for the energy commodity: Is the import share reflecting a priori expectations?
- Can You identify export and imports of crude oil and natural gas?
- Which sectoral splits could be relevant for energy analyses?
- Is it possible to identify petrol use?

2. Add up the energy related inputs in production for domestic and imported and compare.
    - How large is the direct energy related content (share) in production?.
    - Is there a difference in the sectoral importance of energy if sorted by domestic energy content relative to domestic + imported energy content?
    - What is the problem of using these energy contents for describing impact of energy price change?

The result for the energy input can be represented by the graph below:



Monday November 14

Repetition of the basic io examples with 3 sectors and the extension with energy intensive and energy extensive manufacturing sector.

Construction of coefficient and inverse matrix using id matrix and the minverse excel function.

Thereafter adding up of the domestic and the import matrices and calculation of total energy inputs.

Extension of IO table split of energy sectors example: November 16

3. Demonstration of an extension of the io table: the sector (commodity) of electricity and gas: (row, column 66).

- First step is the extension of row dimension by one : The new row 67 is natural gas and rox 66 is electricity. Then we need the input composition on electricity and natural gas for each sector. For that purpose we use data from the energy part of the DOS Manufacturing survey etc. We need cost comparable figures for electricity and gas and not the physical units

- Construction of the input coefficient for the two new rows
- Consistency check – How?
- Adding a new column – different problem
- The intra square new 2 by 2 elements
-

The use of the make matrix to convert io tables: November 16

Introduction to the matrices and the conversion in excel and with the macro's

- **Introduction of the make matrix: Table 2**
- **Construction of conversion matrices from table 2**
- **Interpretation of the two conversion matrices C1 and C2**
- **Conversion from our table 14 to the commodity by activity table 3**
- **Conversion from table 3 to table 16 and 17**
- **Construction of inverse matrix activity by activity table 18**

November 17: The use of the make matrix to convert io tables and convert results obtained in commodity terms to activity terms and vice- versa:

- **Introduction of the make matrix: Table 2**

This table is also referred to as the A matrix and is the basis for construction of the other matrices. For the input output multiplier calculations we need square matrices that are symmetrical in either commodities or activities.

Participants explain the table 2 and identify elements with little correspondence between activity and commodity.

Interpretation of column and row numbers

- **Construction of conversion matrices from table 2**
    - **Construct the C1 by column totals**
    - **Construct C2 by row totals**
- **Interpretation of the two conversion matrices C1 and C2**

What are the shares for the column representing and how do they relate to the total output of a commodity.

Find an element with high correspondence from matrix C1 – diagonal elements – are the energy sectors among these?

Find an element with low correspondence and explain what that means regarding the production of that commodity – the share is as low as around 6%.

Is this commodity produced in just one or a few other activities?

For the C2 matrix explain what these shares mean. - is this shares for total input from activities ?

Relate the total of row s in A to the total of columns in A: How do these to numbers correspond?

- **Conversion from our table 14 to the commodity by activity table 3**

To do this You will need the macrofunctions for matrix multiplication etc.

Use the formula A * C2 = A_D to calculate A Check with table 3 in the IO-2000 publication

- **Conversion from table 3 to table 16 and 17**

How do we transform from our newly constructed table 3 (A matrix)?

Use the C1 * A = A_D (activity by activity terms)

- **Construction of inverse matrix activity by activity table 18**

Now that You have the new activity A_D matrix You can construct the last inverted matrix the Table 18, by first constructing coefficient matrix (Table 17) and then inverting

Exercise using small matrix examples. This exercise can be completed by using only the excel functions. The solution is in the sheet IO-make example

Use the two tables below to construct the activity by activity input matrix and finally construct the LEONTIEF inverse.

*** hint You are going to use the totals of the two tables as well as the individuals numbers.**

Table 2 Make matrix Commodity

Activity	Agriculture	Manufacturing	Services
Agriculture	4.00	2.00	1.00
Manufacturing	2.00	8.00	2.00
Services	4.00	3.00	7.00
Total	10.00	13.00	10.00

Table 3 Input matrix Activity

Commodity	Agriculture	Manufacturing	Services
Agriculture	2.00	2.00	0.00
Manufacturing	1.00	4.00	3.00
Services	1.00	2.00	2.00
Total	4.00	8.00	5.00

Solution:

Step 1

S1	Commodity		
Activity	Agriculture	Manufacturing	Services
Agriculture	0.40	0.15	0.10
Manufacturing	0.20	0.62	0.20
Services	0.40	0.23	0.70
Total	1.00	1.00	1.00

S2	Commodity			
Activity	Agriculture	Manufacturing	Services	Total
Agriculture	0.57	0.29	0.14	1.00
Manufacturing	0.17	0.67	0.17	1.00
Services	0.29	0.21	0.50	1.00
Total	1.02	1.17	0.81	

These two matrices are the matrices used for transformation of data and matrices. Using these two it is possible to construct commodity by commodity and activity by activity matrices which in turn can be inverted. We will do this for the activity by activity matrix.

Step 2 Construction of activity by activity input matrix

	Activity		
Activity	Agriculture	Manufacturing	Services
Agriculture	1.05	1.62	0.66
Manufacturing	1.22	3.26	2.25
Services	1.73	3.12	2.09
Total	4.00	8.00	5.00

Step 3 Construction of input coefficient matrix:

Remember not to use the total of columns from Step 2 as these totals are only the total intermediate inputs.

Use the original Table 2 row sum as this is the total activity output.

Table 2 Make matrix	Commodity			
Activity	Agriculture	Manufacturing	Services	
Agriculture	4.00	2.00	1.00	7.00
Manufacturing	2.00	8.00	2.00	12.00
Services	4.00	3.00	7.00	14.00
Total	10.00	13.00	10.00	33.00

The total activity output has to equal the total input in activities. Column totals are given above in Step 2 which means that agricultural output is 7 and intermediate inputs in

agriculture is 4. The rest is value added = 3 for agriculture. For the coefficient matrix divide by the total input(output) = 7 for agriculture.

Solution for the coefficient matrix (activity by activity) Ad

Input	Activity		
Activity	Agriculture	Manufacturing	Services
Agriculture	0.15	0.13	0.05
Manufacturing	0.17	0.27	0.16
Services	0.25	0.26	0.15
Total	0.57	0.67	0.36

Step 4: Then the final step is the inversion $(I-Ad)^{-1}$

Solution for the inverse matrix (activity by activity)

Input	Activity		
Activity	Agriculture	Manufacturing	Services
Agriculture	1.27	0.28	0.12
Manufacturing	0.41	1.56	0.32
Services	0.50	0.56	1.31
Total	2.18	2.40	1.75

To verify check that the diagonal elements of the inverted table are at least 1. The non-diagonal elements are larger than they would be in a real matrix for example the Malaysian ones that are in the EXCEL workbook.

The use of input-output tables from DOS.

We have been using the Table 2 and Table 14 as softcopy in EXECL. From that we can produce inverse matrix and under a number of assumptions also the activity based tables as given in the other sheets of the workbook.

We have also used the import matrix Table 10 for the calculation of global energy content and construction of the alternative inverted matrix. In the exercises is was demonstrated how the import of intermediate inputs could be added to the domesticly supplied intermediate inputs to derive the total inputs of commodities in the production of each commodity. This is needed for all the calculations of energy content in domestic productions and the possible cost impact of changing international energy prices.

We probably also need the transport margins for any calculations of energy price change that involves transport. This is Table 8 and Table 12. I suggest we exclude any considerations regarding trade margins and commodity taxes for the moment. Tables has only been examined briefly.

Possible work assignments:
These issues was discussed in beginning of November but it was expressed that the skills of participants was not yet good enough for performing calculations involving the Malaysian tables and the macro matrix functions.

1. **For final demand/private consumption**

Are we interested in effect for different categories of consumption goods or mostly the overall effect?

- Effects on consumer prices of increase in energy prices
- Direct import and domestic part
- Indirect energy content in consumption goods
- Consider transport margins on both domestic and imports

2. Production costs

- Possible split of energy sectors (
- Energy content in domestic production
- Energy embodied in imports and used as intermediate input
- Which level of energy types: electricity – foreign fuel etc.?

3. Energy

- Description of energy sectors in IO table and in commodities
- Split of sectors in IO energy relevant

Appendix B: Participants list: Training sessions September 19-28 (14:00-17:30) and November 9-17

Macro section EPU: A total of 9 participants have taken part in the training sessions.

1. Kalawathy
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7. Participant from EPU macro section

8. Participant from EPU macro section

9. Participant from EPU macro section

Appendix C: Extract of the code from macrofunctions Main and Makeuse used for the matrix calculation.

```
Option Base 1
Sub Main()
Dim ad2000, emat
Dim IDMAT, IAG
Dim outmat()
Dim bb()
Dim aa()

With Worksheets("Table 14")
admat = .Range("Ad")
IDMAT = .Range("IDMAT")
findem = .Range("findem")
End With

' Construct (I-Ad) matrix and construct the inverse
d = SUBTRACT(IDMAT, admat, 94, 94, IAG)
d = minver94(IAG, iag94)
' Consistency check by calculating prod based on final demand and the calculated inverse
d = Bigmult(iag94, findem, 94, 1, prod)
With Sheets("output 94")
.Range("b2:b95").Value = prod
End With

With Worksheets("inverse import")
ammat = .Range("Am")
End With

' Add the domestic and the imported intermediate inputs
d = add(admat, ammat, 94, 94, atot)
' Construct the (I-Atot) matrix
d = SUBTRACT(IDMAT, atot, 94, 94, iagtot)
' Inverse this matrix
d = minver94(iagtot, iag94tot)

' Write new inverted matrix to relevant worksheet
With Sheets("inverse import")
.Range("inversetot").Value = iag94tot
End With

' Calculate global production associated with final demand
With Worksheets("Table 10")
findemimported = .Range("findemimp")
End With
d = add(findem, findemimported, 94, 1, findemtot)
d = Bigmult(iag94tot, findemtot, 94, 1, prodglob)
With Sheets("output 94")
.Range("c2:c95").Value = prodglob
End With

' Calculate energy content
' This next step is not finalised so far

globener = Application.SumProduct(prodglob, Worksheets("energy intensities").Range("ecoeff94"))


' The following are just examples for error tracking
'MsgBox Application.MDeterm(Worksheets("Inverse 94").Range("iag94"))
'MsgBox IsArray(ag94)
```

```
'MsgBox IsObject(ag94)
'MsgBox VarType(ag94)

End Sub

 Function SUBTRACT(a, b, n, t, out)
out = a
For i = 1 To n
For j = 1 To t
out(i, j) = a(i, j) - b(i, j)
Next j
Next i
End Function

 Function add(a, b, n, t, out)
out = a
For i = 1 To n
For j = 1 To t
out(i, j) = a(i, j) + b(i, j)
Next j
Next i
End Function

 Function divide(a, b, n, t, out)
out = a
For i = 1 To n
For j = 1 To t
   If b(i, j) = 0 Then out(i, j) = 0 Else out(i, j) = a(i, j) / b(i, j)
Next j
Next i
End Function

 Function mult(a, b, ii, jj, out)
out = a
For j = 1 To jj
For i = 1 To ii
out(i, j) = a(i, j) * b(i, j)
Next i
Next j
End Function

 Function minver94(aa, im)
Dim a(47, 47)
Dim b(47, 47)
Dim c(47, 47)
Dim d(47, 47)
For i = 1 To 47
For j = 1 To 47
a(i, j) = aa(i, j)
Next j
Next i
For i = 1 To 47
For j = 1 To 47
b(i, j) = aa(i, (47 + j))
Next j
Next i
For i = 1 To 47
For j = 1 To 47
c(i, j) = aa(47 + i, j)
Next j
Next i
```

```
For i = 1 To 47
For j = 1 To 47
d(i, j) = aa(47 + i, (47 + j))
Next j
Next i

' new construction without sub-sub matrices HJ sept 2005

a1 = Application.MInverse(a)
With Sheets("inverse 94")
.Range("c3:aw50").Value = a1
End With

' construction of delta matrice
xx = Application.MMult((Application.MMult(c, a1)), b)
xx = SUBTRACT(d, xx, 47, 47, delta)
delta1 = Application.MInverse(delta)

' Calculating elements in final matrix
' First submatrix
xx = Application.MMult(a1, b)
xx = Application.MMult(xx, delta1)
xx = Application.MMult(xx, c)
xx = Application.MMult(xx, a1)
xx = add(a1, xx, 47, 47, nya)
 ' Second sub matrix
xx = Application.MMult(a1, b)
xx = Application.MMult(xx, delta1)
nyb = xx
For i = 1 To 47
For j = 1 To 47
nyb(i, j) = xx(i, j) * -1
Next j
Next i
' Third matrix
xx = Application.MMult(delta1, c)
xx = Application.MMult(xx, a1)
nyc = xx
For i = 1 To 47
For j = 1 To 47
nyc(i, j) = xx(i, j) * -1
Next j
Next i
' Fourth matrix
 nyd = delta1

' Final numbers transferred to 94 by 94 matrix
im = aa
For i = 1 To 47
For j = 1 To 47
im(i, j) = nya(i, j)
Next j
Next i
For i = 1 To 47
For j = 1 To 47
im(i, 47 + j) = nyb(i, j)
Next j
Next i
For i = 1 To 47
For j = 1 To 47
im(47 + i, j) = nyc(i, j)
```

```
Next j
Next i
For i = 1 To 47
For j = 1 To 47
im(47 + i, 47 + j) = nyd(i, j)
Next j
Next i

With Sheets("inverse 94")
.Range("c3:cr97").Value = im
End With

End Function

 Function Bigmult(a, b, n1, n2, ud)
ReDim ud(n1, n2)
ReDim bb(n1)
ReDim aa(n1)

For j = 1 To n2
For i = 1 To n1
bb(i) = b(i, j)
Next i
For s = 1 To n1
For t = 1 To n1
aa(t) = a(s, t)
Next t

ud(s, j) = Application.SumProduct(aa, bb)
Next s
Next j

End Function
```

Sub Makeuse()

```
' Henrik Jacobsen November 16 - 2005 illustration of converting and inverting Malaysian IO matrices
' Use of make matrix to transform from commodity by commodity to commodity by
' activity expression and thereafter to activity by activity expression
' Finally invert the coefficient matrix activity by activity

With Sheets("Table 2")
 make_ac = .Range("Make_actcomm")
 make_ca = .Range("Make_commact")
End With

With Sheets("Table 14")
 advalue = .Range("Advalue")
IDMAT = .Range("IDMAT")
End With

With Sheets("output 94")
prod = .Range("b2:b95")
End With

' calculate prod activity based from commodity based production

d = Bigmult(make_ac, prod, 94, 1, prod_ac)

With Sheets("output 94")
.Range("f2:f95").Value = prod_ac
```

```
End With

' calculate Ad matrix activity based

' First step invert the make matrix coefficient C2 matrix
d = minver94(make_ca, C2_1)

' Next step matrix multiply the Ad matrix in value terms with the inverted C2 matrix
 d = Bigmult(advalue, C2_1, 94, 94, x)

' Write the input matrix commodity by activity Table 3 to the workbook
With Sheets("Table 3 and 16")
.Range("A").Value = x
End With

' Convert from commodity by activity to activity by activity
' Continue from above using the x matrix - matrix multiply C1 with A (x)
d = Bigmult(make_ac, x, 94, 94, xx)

' Write the activity by activity matrix to workbook
 With Sheets("Table 3 and 16")
 .Range("Adact").Value = xx
  End With

' Construct the inverse activity matrix
' Read the activity by activity coefficient matrix
With Sheets("Table 3 and 16")
Ad_act_c = .Range("Ad_act_coeff")
End With

' Construct the (I-Ad) matrix
d = SUBTRACT(IDMAT, Ad_act_c, 94, 94, iagtot)

' With Sheets("Table 3 and 16")
' .Range("inverse_act").Value = iagtot
' End With

' Inverse this matrix
d = minver94(iagtot, iag94tot)

' Write new inverted matrix to relevant worksheet
With Sheets("Table 3 and 16")
.Range("inverse_act").Value = iag94tot
End With

End Sub
```