15-602E
no. 86
c. 3

Input-output Division

Technical Series

Statistics Canada Statistique Canada

Canada

Input-Output
Technical Series

The Input-Output Division Technical Series are intended for users interested in input-output tables and related research for analysis and applications. Readers of the series are encouraged to contact the authors with comments and suggestions. A complete list of the titles that have been released appears at the back of this paper.

Papers in the series are distributed to Statistics Canada Regional Offices and Provincial Bureaus of Statistics. The series appears in the "Listing of Supplementary Documents" (11-207). A complete set is also maintained in the Statistics Canada Library and is available for consultation.

To obtain the list of titles and/or an individual paper, please contact:

Consulting and Marketing
Input-Output Division
Statistics Canada
23rd Floor, R.H. Coats Building
Ottawa, Ontario, K1A 0T6
(613) 951-3697

Statistics Canada
National Accounts and Analytical Studies
System of National Accounts
Input-Output Division

SNA

Input-Output Accounts Participants' Manual

86

October 3, 6 1997

STATISTICS CANADA STATISTIQUE CANADA
JAN 31 2000
LIBRARY
BIBLIOTHÈQUE

SNA

INPUT-OUTPUT ACCOUNTS

(Participants' Manual)

Presentation at The Business & Economic Statistic Training Program (BEST)
Based on the I-O module , course 0444A prepared by Nugent Miller and Michel Bédard

October 3, 6 1997

Course presented by: Michel Bédard

Training objective:

Identify the basic elements of the input-output accounts.

Content

- The Input-Output accounting framework.
- The Impact Matrix.
- Deflation of the accounts and derivation of benchmark estimates of real GDP by industry.
- Uses and users of the I-O accounts.

Nota: the data file **IOSNA.XLS** is available in the Input-Output Div, on K:\IOSMALL.

Documents which may be consulted:

1. Statistics Canada Catalogue 15-510, The Input-Output Structure of the Canadian Economy, 1961-1981 (Occasional).

2. Statistics Canada Catalogue 15-511, The Input-Output Structure of the Canadian Economy in Constant Prices, 1961-1981 (Occasional).

3. Chenery, H. B., and Clark, P.G., Inter-Industry Economics, Wiley, New York, 1959.

4. Miernyk, W.M., The Elements of Input-Output Analysis, Random House, New York, 1965.

5. O'Connor, R., and Henry, E.W., Input-Output Analysis and Its Applications, Hafner Press, New York, 1975.

6. Lal, K., "Compilation of Input-Output Tables: Canada", in J.V. Skolda (ed.), Compilation of Input-Output Tables, Proceedings of 17th General Conference of the International Association for Research in Income and Wealth, 1981.

7. Lal, K., "Canadian Input-Output Tables and their Integration with Other Sub-Systems of the National Accounts", in Franz, A., and Rainer, N., (ed.) Problems of Compilation of Input-Output Tables,

Proceedings of an International Meeting organized by the Austrian Statistical Society, Vienna, Austria, 1985 (Wien, 1986).

8. Statistics Canada Catalogue, 13-589, Guide to the Canadian System of National Accounts.

9. Statistics Canada Catalogue, 15-201, The Input-Output Structure of the Canadian Economy (Annual).

10. Statistics Canada Catalogue, 15-204, Aggregate Productivity Measures, System of National Accounts (Annual).

11. Statistics Canada Catalogue, 15-601, No. 2: Service Industries in the Canadian Input-Output Accounts, Sources of Data and Methods of Estimation.

12. United Nations, System of National Accounts, 1993.

13. Erik Poole, A Guide to Using the Input-Output Model of Statistics Canada, Technical Series, #58, Input-Output Division.

Historical background

- Quesnay - 18th century.
- Walras - 19th century.
- Leontief - 1930's originator of the INPUT-OUTPUT System.

Input-Output System

Tables:

(i) provide an accounting framework

for recording the

flows of } goods & services

for a particular accounting period

(ii) enables inter-sectoral relationships

(iii) allows the study of economic structure.

Outstanding features of the input-output system

- Disaggregates economic accounts.
- Enables analysis of specific sectors and commodities in the economy.

SQUARE INPUT-OUTPUT TABLE FOR INTERMEDIATE TRANSACTIONS

Ind x ind table.

See **DU92SC** in **IOSNA.XLS.**

SQUARE INPUT-OUTPUT TABLE FOR INTERMEDIATE TRANSACTIONS WITH FINAL DEMAND AND PRIMARY INPUTS

CARACTERISTICS:

- **Intermediate demand**, ind x ind plus primary inputs (**DU92SC** in **IOSNA.XLS).**

- **Final demand**, ind x categories of final demand plus primary expenditures (**DF92SC** in **IOSNA.XLS**).

- All the transactions are at ind level (no specific detail).

See **IO92SSC** in **IOSNA.XLS.**

Rectangular tables

- Developed at STATISTICS CANADA.

- Consist of **THREE** matrices:
    - **MAKE** matrix.
    - **USE** matrix.
    - **FINAL DEMAND** matrix.

Why rectangular I-O tables?

- They admit detail as available from economic records.

- Meaning of each entry straightforward - observed transactions not combined with fictitious transfers.

- Serve as a statistical audit for consistency, integrity and comprehensiveness.

- Contrast with inter-industry (square) matrix. Impossible to make direct observation of transactions in latter.

What are Input-Output tables?

COMMODITIES

INDUSTRIES	MAKE 216 x 619	GROSS OUTPUT OF INDUS-TRY
	GROSS OUTPUT OF COMMODITY	

INDUSTRIES CATEGORIES OF FINAL DEMAND

COMMODITIES	USE 619 x 216	+	FINAL DEMAND 619 x 136	=	GROSS OUTPUT OF COM-MODITY
	+		+		
	INDUSTRY USE OF PRIMARY FACTORS 7 x 216	+	FINAL USE OF PRIMARY FACTORS 7 x 136	=	GDP (INCOME BASED)
	=		=		
	GROSS OUTPUT OF INDUSTRY		GDP (EXPENDITURE BASED)		

Dimensions of I-O tables

AGGREGATION	INDUSTRIES	COMMOD. & PRIMARY INPUTS	CATEGORIES OF FINAL DEMAND
S	16	49	14
M	50	100	29
L	161	485	136
W	216*	627**	156

S and M are published annually.

L is available on request.

Confidential items are deleted from M and L.

* applies to 1981 and subsequent years. Prior to 1981, W = 191.

** applies to 1988 and subsequent years. Prior to 1988, W = 602.

Make Matrix

- Shows **goods** and **services** produced by each industry.

- Total by commodities = **total supply**.

See **OUT92SC** in **IOSNA.XLS.**

Use Matrix

- Provides information on the **goods and services** and **primary inputs** purchased and used by **each industry** in production.

See **INP92SC** in **IOSNA.XLS.**

"Final Demand" Matrix

Shows:

- goods and services and primary inputs purchased by:
  - households and private non-profit institutions (PE)
  - businesses for fixed capital formation
- net additions to and withdrawals from inventories
- purchases (+) and sales (-) by government
- exports
- imports (negative)

See **FD92SC** in **IOSNA.XLS.**

INTERMEDIATE AND FINAL USE INPUT-OUTPUT TABLES

Total by commodity = **total demand** for a specific good or services.

See **USEFD92S** in **IOSNA.XLS.**

The Accounting Framework of the Canadian Input-Ouput Tables				Total
	Commodities	Indus.	Final Demand Categories	
			PE FCF VPCA GGCE X_D X_R Less M Less GR Less VPCW	
Commodities		Use (U)	Final Demand (F)	q
Industries	Make (V)			g
Commodity Indirect Taxes Other Indirect Taxes Less Subsidies Wages and Subsidies Supplementary Labour Income Net Income of Uninc. Business Other Operating Surplus		YI	YF	n
Total	q'	g'	e'	

Unique Features to the Input-Output Accounts

1. **Intermediate Transactions**
   - Purchase of goods and services
     - used for producing other goods and services
     - shown in the Use of Input Matrix.

2. **Degree of detail**
   - Input-output tables: most detailed accounts in the SNA
     - 136 categories
     - 216 industries
     - 619 commodities
     - 7 primary inputs.

3. **Balancing**
   - Each commodity is balanced
   - Each industry is balanced
   - Advantages:
     - Checks (i) underreporting
       (ii) inconsistent valuation
       (iii) misclassification
       (iv) etc.

4. **Integration**
   - Tables integrate both production } accounts
     expenditure

Commodity Balance

01300 Fruits, Fresh, Ex. Tropical

	PURCHASER	RETAIL	WHOLESALE	TAX	T.S.P.	GAS	PRODUCERS
INTERMEDIATE INPUTS							
16 MEAT/MEAT PROD. (EXC. POULTRY)	336	0	53	0	11	0	272
18 FISH PRODUCTS INDUSTRY	351	0	52	0	14	0	285
19 FRUIT AND VEGETABLE INDUSTRIES	85776	0	13400	0	2761	0	69615
20 DAIRY PRODUCTS INDUSTRIES	12992	0	2052	0	458	0	10482
25 BREAD & OTHER BAKERY PROD. IND.	689	0	107	0	27	0	555
27 SUGAR CONFECTIONERY INDUSTRIES	514	0	82	0	25	0	407
33 WINE INDUSTRY	21949	0	3471	0	708	0	17770
182 WHOLESALE TRADE INDUSTRIES	1090	0	177	0	34	0	879
199 ACCOMMODATION SERVICE INDUS.	5453	0	852	0	198	0	4403
200 FOOD & BEVERAGE SERVICE INDUS.	39968	0	6245	0	1454	0	32269
212 CAFETERIA SUPPLIES	17062	0	2666	0	622	0	13774
TOTAL INTERMEDIATE INPUTS	186180	0	29157	0	6312	0	150711
INTERMEDIATE OUPUTS							
2 AGRICULTURE, FIELDCROP	0	0	0	0	0	0	279419
TOTAL INTERMEDIATE OUTPUTS	0	0	0	0	0	0	279419
FINAL DEMAND							
1 CE FOOD & NON-ALCOHOLIC BEV.	756162	172953	91945	0	20363	0	470901
121 INV. RAW MATERIALS & G.P.R.S.	-22998	0	0		0	0	-22998
128 DOMESTIC EXPORTS	55724	0	4159	0	1869	0	49696
129 RE-EXPORTS	4886	0	0	0	0	0	4886
130 IMPORTS	-373777	0	0	0	0	0	-373777
TOTAL FINAL DEMAND	419997	172953	96104	0	22232	0	128708
TOTAL INPUTS + FINAL DEMAND	606177	172953	125261	0	28544	0	279419
TOTAL OUTPUTS - TOTAL INPUTS	-606177	-172953	-125261	0	-28544	0	0

Accounting Identities

– Commodity balance:

- Production + imports = intermediate use
  + domestic final use
  + exports

– Industry balance:

- Total output of an industry (gross output) = its intermediate inputs + primary inputs.

– Gross Domestic Product = Gross Domestic Product.

(GDP expenditure based) = (GDP income based).

ACCOUNTING IDENTITIES

(i) Commodity Balance: The supply of each commodity must equal its use, i.e., Production(q) + Imports(m) + government sales(a) + inventory withdrawals(v) = Intermediate Use(u) + Domestic Final Use(e) + Exports(x)

(ii) Industry Balance: The gross output(g) of an industry is equal to the sum of its intermediate(u) and primary inputs(y).

If we sum these equations over all commodities and industries:
From (I):

$$\sum q = \sum u + \sum e + \sum x - \sum m - \sum a - \sum v$$

From (ii):

$$\sum g = \sum u + \sum y$$

Since as we saw in the Make matrix, $\sum q = \sum g$, we can write:

$$\sum u + \sum e + \sum x - \sum m - \sum a - \sum v = \sum u + \sum y$$

If we remove $\sum u$ from both sides:

$$\sum e - \sum a - \sum v + \sum x - \sum m = \sum y$$

If we add the primary incomes in the fourth quadrant to both sides, we obtain our third identity:

(iii) Expenditure - based GDP (LHS) = Income based GDP (RHS).

Valuation

– Producer prices.

– Purchases prices.

– Margins
- Transportation costs between seller and buyer
- Wholesale markups
- Retail markups
- Commodity taxes
- Storage costs
- Pipeline transportation
- Gas distribution.

– Imports: c.i.f. border plus customs duties.

Inputs into Ind. 16 Valued at Purchaser and Producer Prices

		PURCHASER	PRODUCER
2	OTHER AGRICULTURAL PRODUCTS	4896527	4749500
4	FISHING & TRAPPING PRODUCTS	46	45
6	MINERALS FUELS	30058	17081
7	NON-METALLIC MINERALS	3858	3031
9	MEAT, FISH & DAIRY PRODUCTS	1905743	1864529
10	FRUIT, VEG., FEED, MISC. FOOD PROD.	122600	110966
13	RUBBER, LEATHER, PLASTIC FAB. PRO	32957	30566
14	TEXTILE PRODUCTS	4628	4079
16	LUMBER, SAWMILL, OTHER WOOD PROD	17	15
18	PAPER & PAPER PRODUCTS	132758	126083
19	PRINTING & PUBLISHING	12760	11969
21	METAL FABRICATED PRODUCTS	27186	23325
25	NON-METALLIC MINERAL PRODUCTS	545	473
26	PETROLEUM & COAL PRODUCTS	19502	10852
27	CHEMICALS, CHEMICAL PROD.	11513	9791
28	MISC. MANUFACTURED PRODUCTS	1616	1413
31	REPAIR CONSTRUCTION	12800	12800
32	TRANSPORTATION & STORAGE	13852	22530
33	COMMUNICATION SERVICES	27740	26495
34	OTHER UTILITIES	37687	41375
35	WHOLESALE MARGINS	2658	121104
36	RETAIL MARGINS	0	363
38	OTHER FINANCE, INS., REAL ESTATE	60332	60332
39	BUSINESS SERVICES	30354	30237
40	PERSONAL & OTHER MISC. SERVICE	63247	62476
41	TRANSPORTATION MARGINS	0	101079
42	OPERATING, OFFICE, LAB & FOOD	84407	84407
43	TRAVEL, ADVERTISING, PROMOTION	80538	80538
46	NET INDIRECT TAXES	27830	36305
47	LABOUR INCOME	986276	986276
48	NET INCOME UNINC. BUSINESS	5240	5240
49	OTHER OPERATING SURPLUS	644911	644911
TOTAL		9280186	9280186

Exercise 1-1 (To be done with the participants)

1. A father bought toys for his child. Where would this transaction be entered on the input-output tables?

2. Builders constructed 10 million dollars worth of dwellings. How would this be accounted for in the input-output tables?

3. The petroleum refineries bought a billion dollars worth of crude oil produced in Western Canada last year. How will you account for this in the input-output tables?

4. Mr. X purchased clothing worth $500.00 for which he paid the GST at the rate of 7%. The $500.00 can be broken down into:

   Value at border + duties: $400.00
   Wholesaler's commission: $30.00
   Retailer's commission: $40.00
   Transportation: $30.00

   Show where these transactions would appear in the tables. Provide answers which apply to

   (i) purchaser price tables
   (ii) producer price tables.

Exercise 1-1 (cont'd)

5. **The food industry purchased 100 million dollars worth of new machinery and equipment; and also 10 million dollars worth of parts for existing machines. Show where these would appear in the tables. What are the three possible entries that can be made on the supply side?**

Exercise 1-1 (Answer key)

1. **A father bought toys for his child. Where would this transaction be entered on the input-output tables?**

   Answer: This transaction would be recorded in the "Final Demand Matrix" under "manufactured goods" in the "personal expenditure" category.

2. **Builders constructed 10 million dollars worth of dwellings. How would this be accounted for in the input-output tables?**

   Answer: This must be shown under the "goods industry" and the commodity, "other goods" in the "Make Matrix" which shows production, and also in the "Final Demand Matrix" under the final demand category "fixed capital formation" and the commodity "other goods".

3. **The petroleum refineries bought a billion dollars worth of crude oil produced in Western Canada last year. How will you account for this in the input-output tables?**

Exercise 1-1 (Answer key) (continued)

Answer: The purchase will be entered in the "Use Matrix" - "other goods" purchased by the "goods industry". Since the crude oil was produced last year, inventories of crude oil are reduced by a billion dollars and should be entered in the "Final Demand Matrix" as a negative in the "inventory change" column.

4. Mr. X purchased for his own use imported clothing worth $500.00 for which he paid the GST at the rate of 7%. The $500.00 can be broken down into:

Price at border including duties: $400.00
Wholesaler's commission: $30.00
Retailer's commission: $40.00
Transportation: $30.00

Show where these transactions would appear in the tables. Provides answers which would apply to
(i) purchaser price tables
(ii) producer price tables.

Answer: (i) Enter $535.00 under "manufactured goods" in the "personal expenditure"

Exercise 1-1 (Answer key) (continued)

category of the "Final Demand Matrix". In the "imports" category and "manufactured goods" row of the "Final Demand Matrix" enter $400.00.

(ii) $400.00 of clothing would be recorded under "manufactured goods" and "personal expenditure" in the Final Demand Matrix. It should also be entered under "imports" in the Final Demand Matrix. The Wholesaler's commission, retailer's commission and transportation will be shown as the "services" under "personal expenditure". The tax of $35.00 would also be entered in the Final Demand Matrix under the "net indirect taxes" and "personal expenditure".

5. The food industry purchased 100 million dollars worth of new machinery and equipment; and also 10 million dollars worth of parts for existing machines. Show where these would appear in the tables. What are the three possible entries that can be made on the supply side?

Exercise 1-1 (Answer key) (continued)

Answer: The new machinery will be entered in the "Final Demand Matrix", under "manufactured goods" and "fixed capital formation". The parts will be entered in the "Use Matrix" in the "goods" row and the "goods industry" column.

Three possible sources of supply:
(i) the "goods industry" row and "manufactured goods" column of the "Make Matrix".

(ii) the "import" column and "manufactured goods" of the "Final Demand Matrix".

(iii) the "change in inventory" column and "manufactured goods" row of the "Final Demand Matrix".

Exercise 2 (To be done with the participants)

1. **For any commodity, how would you determine the supply from the input-output tables?**

2. **What are the main categories of the Final Demand Matrix?**

3. **Use the Input-Output Matrices to show that income based GDP is equal to expenditure based GDP.**

4. **Name the primary inputs?**

5. **What is an intermediate input?**

Exercise 2 (Answer key)

1. **For any commodity, how would you determine the supply from the input-output tables?**

   Answer: Take the total output of the commodity from the "Make Matrix" and add to it imports, withdrawals from inventories and sales by government.

2. **What are the main categories of the Final Demand Matrix?**

   Answer: Personal expenditure, fixed capital formation, changes in inventory, government expenditure, exports and imports.

3. **Use the Input-Output Matrix to show that the GDP at market prices is equal to expenditure on the GDP at market prices.**

Exercise 2 (Answer key) (continued)

4. Name the primary inputs?

Answer:
- **Commodity, indirect taxes**
- **Other indirect taxes**
- **Less subsidies**
- **Wages and salaries**
- **Supplementary labour income**
- **Net income unincorporated**
- **Other operating surplus.**

5. What is an intermediate input?

Answer: A good or service purchased for current production of other goods or services; for instance, steel to produce automobiles or cleaning services bought by businesses in order that the surroundings become suitable for work.

The Impact Matrix

– Shows

direct & indirect output

required from each industry to produce

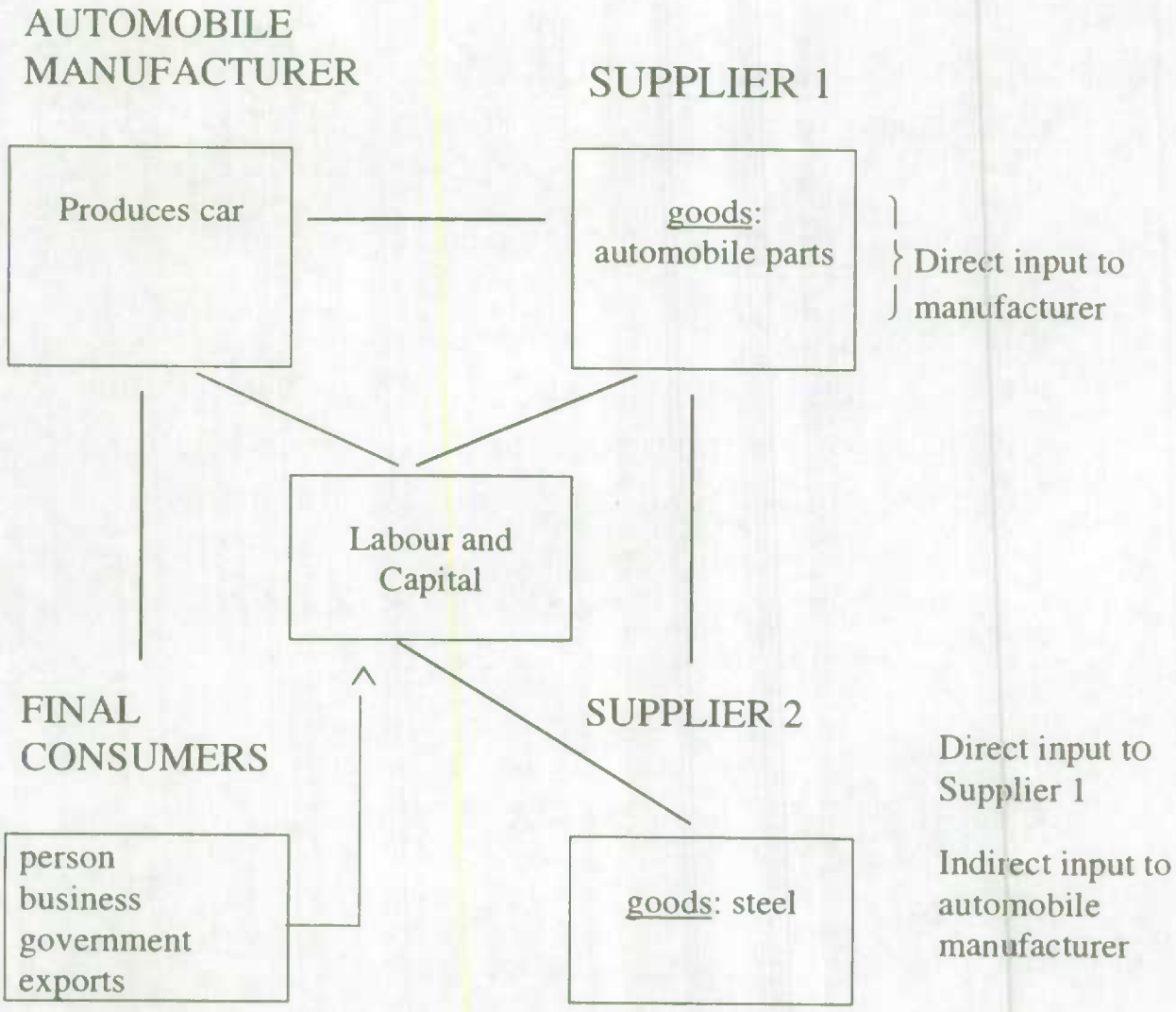
a dollar of final demand of **EACH COMMODITY**

(Assuming that this dollar is spent on **DOMESTIC COMMODITIES**)

– Terms associated with the Impact Matrix:

- Direct effects
- Indirect effects
- Multiplier.

Example of inter-industry and inter-sectoral links



Parameters That May Be Derived From I-O Tables

1. **Matrix of Technological Coefficients**
   – "Use" matrix

   shows direct inputs

   used to produce **industry output**

   - By dividing columns in the **"USE MATRIX"** by industry **totals** the **direct inputs** required to produce a dollar of each industry's output is obtained.

   (The resulting table is called **MATRIX OF TECHNOLOGICAL COEFFICIENTS).**

See **B92SC** in **IOSNA.XLS.**

Parameters That May Be Derived From I-O Tables (cont'd)

2. **Matrix of Market Share Coefficient**
   - Derived from the **MAKE MATRIX**
   - Shows each industry's share of the production of each commodity
   - Market share is obtained by dividing each **ROW** of the **"MAKE"** matrix by the commodity total.

See **D92SC** in **IOSNA.XLS.**

Assumptions for Impact Matrix

(i) $g = Dq$

(i.e.) each industry has a fixed share of the market of any commodity.

(ii) $Ui = Bg$

(i.e.) the technical coefficients of each industry are fixed.

Industry by Industry Table

– Obtained by multiplying the "**Market Share**" Matrix (D Matrix) by the "**Use**" Matrix (U Matrix).

See **DU92SC** in **IOSNA.XLS.**

Example of Impact of $10 Demand For Exports of Manufactures

Assume we have 3 commodities: Manufactures, other goods, services.

We want to know the direct and indirect effects of exporting $10 worth of manufactures, but no units of the other commodities.

So we have a final demand, which can be denoted as:

	Com 1	10
e =	Com 2	0
	Com 3	0

Suppose we have a market share matrix

		Com 1	Com 2	Com 3
	Ind. 1:	1.0	0.5	0.3
D =				
	Ind. 2:	0	0.5	0.7

What this tells us is that:

Industry 1 is the only industry producing manufactures.

Industries 1 and 2 each produce half of the output of commodity 2, other goods.
Industry 1 produces 30% of the output of commodity 3, and industry 2 produces 70%.

This information tells us that all 10 dollars of manufactures demanded by households would be produced by industry 1. If instead, households had demanded 10 dollars of other goods, $5 would have been produced by industry 1 and 5 dollars by industry 2.

Now that we know that industry 1 is required to produce $10 of output, how does it go about it. It has to bring together a number of goods and services in order to do this. Hence we go to the matrix of technological coefficients, B, which is derived from the Use matrix.

		Ind 1	**Ind 2**
	Com 1:	0.2	0.1
B=	**Com 2:**	0.4	0.1
	Com 3:	0.2	0.4
	Primary Coefficients	0.2	0.4

To produce $10 of output industry 1 will require

$2 of commodity 1,
$4 of commodity 2 and
$2 of commodity 3.

Where will these commodities come from? The industries which produce them.

To find that out we must return to the market share matrix D. From this we can see that:

Industry 1 produces all of commodity 1: $2, as well as half of commodity 2: $2, and 30% of commodity 3: 60 cents, for a total of $4.60.

Industry 2 produces half of commodity 2: $2, and 70% of commodity 3: $1.40, for a total of $3.40.

At this point industry 1 has produced $14.60 (the original $10 plus $4.60), and industry 2 has produced $3.40.

The process does not stop here. We need to go back to the matrix of technological coefficients to find out what inputs are required to produce $4.60 of industry 1's output and $3.40 of industry 2's output.

For $4.60 output of industry 1, we need:

.92 of com 1
1.84 of com 2
.92 of com 3

For $3.40 output of industry 2, we need:

.34 of com 1
.34 of com 2
1.36 of com 3

Again, we want to know what industries produce these commodities:

Industry 1 will produce all of commodity 1: .92 + .34 = 1.26, $1.09 of commodity 2, and .68 of commodity 3, making a total of $3.03.

Industry 2 will produce $1.09 of commodity 2 (.92 + .17), and $1.60 of commodity 3, making a total of $2.69.

At this point industry 1 has produced a total of $17.63 and industry 2 has produced $6.09.

To arrive at these figures we took the initial output of $10 and added successive additions for each round of production. Notice that with each round the output decreases, because the intermediate inputs required to produce a dollar of output is less than a dollar.

We can continue to work through the various rounds of production until the additions are so small that we reach a limit. This should be about $24 for industry 1 and $12 for industry 2.

An impact matrix is published showing the output required from each industry to produce a dollar's worth of each commodity. If

we had an impact matrix for the market share and technological coefficient matrices in our example, these results would comprise one line of the matrix - i.e., for the commodity manufactures, we would have the values 2.4 and 1.2 under industries 1 and 2.

Usually the computation is not that simple as there are leakages in the form of the use of imports or commodities produced by the government. For the interprovincial model one province uses the output of another province, and when this occurs activity in one province generates output not only in that province but in the supplying provinces as well. If we have a trade flow matrix we can tell what proportion of a commodity used comes from a particular province and calculate the direct and indirect effects on the output of that province.

(i) $\mathbf{g = Dq}$

(ii) $\mathbf{Ui = Bg}$

(iii) $\mathbf{q = Bg + e}$

q is the total commodity output vector;

Bg is the intermediate input vector

and **e** is the total final demand input vector

($q = Bg + e$ is the accounting balance between the supply and total disposition of each and every commodity.)

Multiply both sides of equation (iii) by D:

Now $Dq = DBg + De$

From equation (i) $Dq = g$

$g = DBg + De$

$(I-DB)\, g = De$

$g = (I-DB)^{-1}\, De$

We publish $(I-DB)^{-1}\, D$.

e is exogenously specified by users.

Leakages

Flows originating from outside the business sector or from production in a previous period are termed leakages.

1. Imports (μ)

2. Withdrawals from inventory (α)

3. Government sales (β)

4. Other, e.g., disinvestment of machinery and equipment as scrap.

To take account of leakages the solution may be re-written:

$$g = [I-D(I-\mu-\alpha-\beta)B]^{-1}D$$

and the impact matrix is written:

$[I-D(I-\mu-\alpha-\beta)B]^{-1}$ per dollar of industry output.

$[I-D(I-\mu-\alpha-\beta)B]^{-1}D$ per dollar of commodity output.

Input-Output Model

Input-Output Model: detailed accounting model of inter-industrial structure of economy.

Captures structure of the economy.
Useful tool in analysing given economic problems.

Input-Output Model (continued)

– However, it lacks several features of economic models:

- No money supply
- No variation in prices
- No supply constraints
- No economic behaviour responding to scarce or limited resources
- Does not capture economies of scale, technological spin-offs, environmental pollution, etc.

Models based on I-O Tables

1. Output Models

   a) The Open Model

   b) Closed Models

   c) Interprovincial Model:
      Requires (a) input-output tables for each province.
      (b) a matrix of commodity flows between provinces.

2. Price model: cost push model.

Exercise 3 (To be done with the participants)

1. Use the table below to calculate the Market Share Matrix

MAKE (OUTPUT) MATRIX

	MANUFACTURED GOODS	OTHER GOODS	SERVICES	TOTAL
GOODS INDUSTRY	100	200	0	300
SERVICES INDUSTRY	0	0	150	150
TOTAL	100	200	150	450

2. Calculate the Matrix of input coefficients using the table below.

USE (INPUT) AND FINAL DEMAND MATRICES

	INTERMEDIATE			FINAL DEMAND				
	GOODS	SERVICES	TOTAL	DOMESTIC FINAL DEMAND	EXPORTS	IMPORTS	FINAL USE	TOTAL
MANUFACTURED GOODS 0	0	70	70	20	20	-10	30	100
OTHER GOODS	30	35	65	145	40	-50	135	200
SERVICES	0	70	70	70	50	-40	80	150
LABOUR INCOME	40	105	145	30	0	0	30	175
CAPITAL	30	70	100	10	0	0	10	110
TOTAL	100	350	450	275	110	-100	285	735

3. Using the tables above, calculate the import share of domestic supply of each commodity.

4. Calculate the labour cost (direct and indirect) of producing $100 million of services.

MAKE (OUTPUT) MATRIX

	MANUFAC-TURED GOODS	OTHER GOODS	SERVICES	TOTAL
GOODS INDUSTRY	100	200	0	300
SERVICES INDUSTRY	0	0	150	150
TOTAL	100	200	150	450

USE (INPUT) AND FINAL DEMAND MATRICES

	INTERMEDIATE			FINAL DEMAND				
	GOODS	SERVICES	TOTAL	DOMESTIC FINAL DEMAND	EXPORTS	IMPORTS	TOTAL FINAL USE	TOTAL USE
MANUF. GOODS	0	70	70	20	20	-10	30	100
OTHER GOODS	30	35	65	145	40	-50	135	200
SERVICES	0	70	70	70	50	-40	80	150
LABOUR INCOME	40	105	145	30	0	0	30	175
CAPITAL	30	70	100	10	0	0	10	110
TOTAL	100	350	450	275	110	-100	285	735

IMPACT MATRIX: DIRECT AND INDIRECT EFFECTS PER $ COM. OUTPUT: $[I-D(I-\mu)B]^{-1} D$

	MANUFACTURED GOODS	OTHER GOODS	SERVICES
GOODS INDUSTRY	1.290	1.290	0.376
SERVICES INDUSTRY	0.000	0.000	1.154
TOTAL	1.290	1.290	1.530

Exercise 3 (Answer key)

1. MAKE (OUTPUT) MATRIX

	MANUFACTURED GOODS	OTHER GOODS	SERVICES	TOTAL
GOODS INDUSTRY	1.0	1.0		
SERVICES INDUSTRY			1.0	
TOTAL				

2. USE (INPUT) AND FINAL DEMAND MATRICES

	INTERMEDIATE			FINAL DEMAND				
	GOODS	SERVICES	TOTAL	DOMESTIC FINAL DEMAND	EXPORTS	IMPORTS	TOTAL FINAL USE	TOTAL USE
MANUFACTURED GOODS		.2						
OTHER GOODS	.3	.1						
SERVICES		.2						
LABOUR INCOME	.4	.3						
CAPITAL	.3	.2						
TOTAL								

3. IMPORT SHARES:

MANUFACTURED GOODS:

$$\frac{10}{100 + 10 - 20} = .1111$$

OTHER GOODS:

$$\frac{50}{200 + 50 - 40} = .238$$

SERVICES:

$$\frac{40}{150 + 40 - 50} = .286$$

Exercise 3 (Answer key) (continued)

4. Market Share Matrix:
   See answer to question 1

Use Matrix:
   See answer to question 2

Import Shares:
   See answer to question 3

Domestic Shares:

1 - import shares:	Com. 1:	.889
	Com. 2:	.762
	Com. 3:	.714

<u>ASSUMING NO IMPORT LEAKAGE</u>

For simplicity of computation, we can asume that there are no imports.

Using the market share matrix we can see that all 10 dollars of output of commodity 3 is produced by industry 2.

Exercise 3 (Answer key) (continued)

Round 1

Using the matrix of input coefficients, the requirements to produce $10 output of industry 3 are:

Commodity 1: $2
Commodity 2: $1
Commodity 3: $2

From the market share matrix:

Industry 1 produces: $3 (all of commodities 1 and 2)
Industry 2 produces: $2 (all of commodity 3)

At the end of round 1,

Production of industry 1: $3
Production of industry 2: $12 (10 + 2)

Round 2

Input requirements:

For $3 output of industry 1:

Exercise 3 (Answer key) (continued)

Commodity 2: 90 cents

For $2 output of industry 2:

Commodity 1: 40 cents
Commodity 2: 20 cents
Commodity 3: 40 cents

From market share matrix, the industries producing these commodities are:

Industry 1: $1.50 (90 + 40 + 20)
Industry 2: $.40

Industry output after two rounds:

Industry 1: $4.50 (3 + 1.50)
Industry 2: $12.40 (10 + 2 + .40)

WITH IMPORT LEAKAGE'S

In a system with imports we must adjust the input coefficients by multiplying them by the domestic shares to obtain domestic effect on gross output.

5 of 8

Exercise 3 (Answer key) (continued)

input coefficients:

	INDUSTRY 1	INDUSTRY 2
Commodity 1	0	.178
Commodity 2	.229	.076
Commodity 3	0	.143

Again, using the market share matrix we can see that all 10 dollars of output of commodity 3 is produced by industry 2.

<u>Round 1</u>

Using the matrix of input coefficients, the requirements to produce $10 output of industry 3 are:

Commodity 1: $1.78
Commodity 2: $0.76
Commodity 3: $1.43

From the market share matrix:

Industry 1 produces: $2.54 (all of commodities 1 and 2)

Industry 2 produces: $1.43 (all of commodity 3)

At the end of round 1,

Production of industry 1: $ 2.54
Production of industry 2: $11.43 (10 + 1.43)

<u>Round 2</u>

Input requirements:

For $2.54 output of industry 1:
Commodity 2: 58 cents

For $1.43 output of industry 2:
Commodity 1: 25 cents
Commodity 2: 11 cents
Commodity 3: 20 cents

From market share matrix, the industries producing these commodities are:

Industry 1: \$0.94 (.58+.25+.11)
Industry 2: \$0.20

Exercise 3 (Answer key) (continued)

Industry output after two rounds:

Industry 1: \$ 3.48 (2.54 + .94)
Industry 2: \$11.63 (11.43+ . 20)

5. Direct labour cost per \$ of industry output is derived from the Use Matrix.

In this exercise

$$\text{Goods} = \frac{40}{100} = .4$$

$$\text{Service} = \frac{105}{350} = .3$$

Impact matrix shows direct + indirect output per \$ of commodity output.

Therefore, for $1 of service output, the impact matrix says that

(i) the Goods industry produces $0.348 dollars

(ii) the Service industry produces $1.163 dollars

Exercise 3 (Answer key) (continued)

To get the labour input required for the goods industry to produce its $0.348 dollars, multiply the labour coefficient (.4) by the output (.348) coefficient:

= .4 x .348
= .1392

and to obtain the labour input required to produce $1.163 in the service industry, multiply the labour coef (.3) by the output 1.163:

= .3 x 1.163
= .3489

Sum the labour requirements of the goods + service industry and you get

.1392+ .3489 = .4881

For $100 of services: .4881 * 100 = <u>48.81</u>

100 x [(.4)(.348) + (.3)(1.163)] = 48.81

DEFLATION OF THE ACCOUNTS AND DERIVATION OF BENCHMARK ESTIMATES OF REAL GDP BY INDUSTRY

BASE YEARS

– Canadian System: 4 base years:

- 1961 - applicable to the period 1961 to 1971
- 1971 - applicable to the period 1971 to 1981
- 1981 - applicable to the period 1981 to 1986
- 1986 - applicable to the period since 1986

– Reasons for frequent rebasing:

- Relative prices change over time.
- Structure of the economy can be distorted.

ADVANTAGES OF CONSTANT PRICE TABLES

- Allow measurement of real growth of :
  - a commodity,
  - an industry.
- Allow the calculation of multifactor productivity.
- Allow the reconciliation of real Domestic Product with constant price expenditure on GDP.
- Allow the evaluation of the price indexes.

Deflator

– Definition: A measure of price change appropriate to a particular commodity.

Input-Output Tables are in producer prices.
Prices should be measured in producer prices also.
Producer prices subject to less variation than purchaser prices.

SUMMARY OF DEFLATION PROCEDURE

– Output matrix: is deflated with output price indexes.

– Imports: import prices (where available) otherwise output Prices.

– Domestic exports: output price indexes generally
but
special export deflators for certain commodities.

– Re-exports: import price indexes.

– A special procedure for M and E commodities is used.

– The **Use Matrix** and other categories of the **Final Demand** are deflated with implicit price indexes based on:

Output + Imports - Domestic Exports - Re-Exports = Intermediate Use + Domestic Final Demand.

– Commodity indirect taxes
subsidies } Base year rates

– Trade Margins: Average of current and base year rates.

– Commodities with more than one price: special . adjustment procedures.

– In the **Use Matrix** primary inputs are not deflated: obtained as a residual.

DEFLATORS

1. **Goods**
   a) Primary or unmanufactured goods:
      (i) Unit value index.

   b) Manufactured goods:
      (i) Industrial Product Price Indexes (IPPI).
      (ii) Machinery and Equipment Price Indexes.
      (iii) Export Price Indexes of the U.S. Bureau of Labour Statistics.
      (iv) Import Price Indexes developed by International Trade Division
      (v) Others.
         e.g. Hedonic Price Indexes for computer.

2. **Services**
   a) Price indexes (CPI where appropriate).
   b) Unit value indexes.
   c) Various rates (indexes of average weekly earnings).
   d) Trade margins (base year and current year rates).

3. **Commodity taxes and subsidies:**
   Base year rates.

GROSS DOMESTIC PRODUCT

a) **Business Sector**

– This consists of :

Labour and Capital input which are not directly deflated, derived as difference between Gross Output and Intermediate Inputs (including net indirect taxes). (This is called **Double Deflation**)

When the residual (GDP) is a small proportion of gross output or total intermediate input, small variations in the latter may result in large fluctuations in GDP.

b) **Non-Business Sector**

– Labour Income and other operating surplus (capital cost allowances) deflated directly.

PUBLISHED GROSS DOMESTIC PRODUCT

- Tables of Gross Domestic Product (GDP) in 1986 prices published for period 1961 to 1988.
- Tables before 1986 published originally in prices of other base years.
- Estimates prior to 1986 re-scaled to 1986 prices (original rates of growth of aggregates were retained).
- Estimates obtained are not additive.

USES OF INPUT-OUTPUT ACCOUNTS

– Benchmarks for GDP by industry.

– Measurement of real growth of:
  (i) industry output
  (ii) commodity output or use
  (iii) final demand

– Development of measures of multi-factor productivity.

– Impact analyses:
  (I) Output.
  (ii) Intensity studies,
    - energy
    - employment
    - taxes, etc.

– Analysis of the industrial structure of the economy..

– Effective tariff studies.

– Studies of price movements.

– Other.

SOME DEFINITIONS

Gross Output: The value of all commodities produced by an industry over a specified time period.

Intermediate Inputs: Goods and services purchased by producers and used as inputs to produce other goods. Intermediate goods are produced by other producers or imported and should be distinguished from primary inputs.

Primary inputs are payments for the use of labour and capital. Such payments are recorded in the Input-Output Tables as:

- Net Indirect Taxes
- Wages and Salaries
- Supplementary Labour Income
- Net Income of Unincorporated Business
- Other Operating Surplus

Other operating surplus includes:

- Profits generated by corporations and government business enterprises before taxes and dividends.
- Capital consumption allowances for both the corporate and unincorporated sectors.
- Inventory valuation adjustment of non-farm inventories.
- Interest and miscellaneous investment income.

CS 005
STATISTICS CANADA LIBRARY
BIBLIOTHÈQUE STATISTIQUE CANADA
1010297728
c.3