From SUTs to IOTs

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Supply Table

	Industries	Output	Imports	Supply
Products	V	x	m	q
Output	g^r			

Domestic Use Table

	Industries	Final use	Use
Domestic products	U_d	Y_d	x
Imported products	U_m	Y_m	m
Gross value added	W		w
Output	g^r	Y	

– empty

Usage table supply and domestic use work

	Domestic products	Industries	Final use	Total
Domestic products		U_d	Y_d	x
Imported products		U_m	Y_m	m
Industries	V			g
Gross value added		W		w
Total	x^r	g^r	Y	

Input-Output Table - product by product

	Products	Final use	Use
Domestic products	S_d	Y_d	x
Imported products	S_m	Y_m	m
Gross value added	E		w
Output	x^r	Y	

Input-Output Table - industry by industry

	Industries	Final use	Output
Domestic industries	B_d	F_d	g
Imports from industries	B_m	F_m	m
Gross value added	W		w
Output	g^r	Y	

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From SUTs to IOTs

- SUTs are a central part of national accounts itself. The SUT-framework brings together data from many sources. Balancing usually reveals errors and inconsistencies caused by basic data itself or its treatment, for instance grossing up. In the end inconsistencies are dealt with and removed.

- While SUTs are primarily a kind of statistics, IOTs are compiled for analytical purposes based on models that depend on a set of simplifying assumptions.

- However, it should be admitted that assumptions and modelling also plays a role in compilation of the SUTs themselves:
  - The cost structures of some industries are more or less constructed using assumptions.
  - The valuation layers require modelling of margins, taxes and VAT.
  - Some production costs are typically only found in statistics by enterprises and will have been distributed by establishments based on assumptions.
  - Some redefinition of industries may already have taken place during compilation of the SUTs.

IOT product by product, hybrid technology assumption (From IO-handbook)

Input-Output Table

		Products			Final use			Output
		Agriculture	Manufacturing and construction	Services	Final consumption expenditure	Gross capital formation	Exports	
Products	Agriculture	0.03	0.98	13.22	13.18	0.08	10.47	37.96
	Manufacturing and construction	2.30	98.31	61.55	32.04	73.94	175.94	444.08
	Services	10.50	79.51	187.90	344.77	20.75	112.95	756.37
Prim	Imports	3.89	128.74	71.95	75.33	36.50	244.82	561.23
	GVA	21.25	136.53	421.76				579.54
Input		37.96	444.08	756.37	465.33	131.27	544.17	2,379.18

Input Table of Imports

		Products			Final use			Total
		Agriculture	Manufacturing and construction	Services	Final consumption expenditure	Gross capital formation	Exports	
Products	Agriculture	0.02	5.02	2.61	1.25	0.03	6.45	15.38
	Manufacturing and construction	1.75	102.16	33.01	61.07	31.49	171.55	401.04
	Services	2.11	21.56	36.33	13.02	4.98	66.81	144.81
Total		3.89	128.74	71.95	75.33	36.50	244.82	561.23

Input-Output Table with net exports

		Products			Final use			Output
		Agriculture	Manufacturing and construction	Services	Final consumption expenditure	Gross capital formation	Net exports	
Products	Agriculture	0.05	6.00	15.83	14.43	0.10	1.54	37.96
	Manufacturing and construction	4.05	200.47	94.56	93.11	105.44	-53.55	444.08
	Services	12.61	101.07	224.23	357.79	25.73	34.95	756.37
	GVA	21.25	136.53	421.76				579.54
Input		37.96	444.08	756.37	465.33	131.27	-17.05	1,817.96

Terminology.

- The names ”Product by Product” and ”Industry by industry” are commonly used and understood, but they are somewhat misleading. It would be more correct to name these tables:
  - ”Product” by “product adjusted industries” and
  - ”Industry adjusted products” by “industry” -tables.
- In the first case columns represent redefined industries whose secondary production has been moved to the industries, where they are characteristic outputs.
- In the second case the rows are “redefined” so each row becomes a mix of the primary and secondary outputs of each corresponding industry.
- While “Product technology” or “Industry technology” are the names used for alternative methods for compilation of “product by product” –tables,
- “Fixed industry sales structures” or “Fixed product sales structures” are the correct names for methods that can be chosen for “industry by industry” tables.

Objective for the transformation from SUTs to IOTs

- The output matrix shall be transformed into a “diagonal” matrix (that will then be superfluous)
- either by moving those parts of industry columns that produce secondary products and their related inputs and GVA to those (product adjusted) industries where the secondary outputs belong. This will result in a **“product by product”** IOT
- or by rearranging the products by distributing each product to the (industry adjusted) products corresponding to the industries where it is actually produced. This will result in an **“industry by industry”** IOT.
- If an industry by industry table is compiled using the “fixed product sales structure” it is not necessary to aggregate the SUT’s rows to form square matrices for supply and intermediate consumption before the transformation.

SUTs that fulfil the needs for IOTs

- It is useful to consider the needs for compilation of IOTs when planning the SUTs framework.
- Classifications of products should as far as possible separate products that are used for input from products that are output from the same industry e.g. raw milk and processed milk.
- According to SNA 2008, industries in the SUTs should not have secondary production that belongs to other sections of ISIC. Where this is the case, such establishments ought to be further broken down for national accounts purposes.
- These redefinitions may already have taken place in the compilation of the SUTs. It may be necessary to avoid double counting of production, for instance when agriculture contains all produced agricultural products and the accounts for other industries includes secondary production of agricultural products.

Redefinition of industries

- If some of the SUTs' industries still include (significant) secondary production belonging to other sections, it can be appropriate to use a two-step procedure for compilation of IOTs.
- In the first step the secondary production should be moved to the correct industries. Its associated inputs and GVA should be estimated and moved as well. Estimation can here typically be done manually, preferably based on actual knowledge. This redefinition is appropriate for "product by product" as well as "industry by industry" IOTs.
- As the second step in compilation of a "product by product" IOT, further redefinition of industries can be done automatically using a technology assumption.

Manual redefinition of all industries.

- In some countries redefinition is carried on until all production of secondary products has been moved to the industries where they are characteristic. Used in France, Ukraine (at least some years ago)
- It leaves the supply table as diagonal matrix, in fact it makes it superfluous. After the transformation, the use-table becomes the IOT.
- It can be done before data is entered into the SUT environment. It will require sufficient staff with technical insight, and may produce more realistic input structures based on actual observations.
- Manual replacing of parts of industries assures that no values are left negative.
- However the method still has an element of arbitrariness because some input and GVA within an establishment cannot be distributed by output-products in an objective way. Here it is necessary to follow some rules of thumb.
- Drawback: Lack of mathematical beauty

Mathematical solutions

- When the SUTs' industries – after redefinitions – contain secondary production the IOT will have to be compiled using assumptions.

- According to classical IO theory:
- "Product by product" tables can be compiled using
  - a "product technology" assumption. The distribution of inputs and GVA of the product that is moved from a column to another is assumed to follow the structure in the column <u>to</u> which the product is moved. This may produce negative entries in the table.
  - an "industry technology" assumption. The distribution of inputs and GVA of the product that is moved from a column to another is assumed to follow the structure in the column <u>from</u> which the product is moved.
- The word "technology" shall not be taken literally. It refers to cost structures for production of product groups that each cover numerous different products that are produced using different techniques.

Mathematical solutions II

- "Industry by industry" tables can be compiled using
  - a "fixed industry sales structure assumption". The distribution of each product that is moved from a row to another is assumed to be the same as in the row to which the product is moved. This may create negative entries in the table.
  - a "fixed product sales structure" assumption. The distribution of each product that is moved from a row to another is assumed to be the same as in the row from which the product is moved.

- The four methods are shown in the diagram below. It is copied from the "Handbook on Supply, Use and Input-Output tables with Extensions and Applications". (It should be noticed that the sequence of methods is different from SNA 2008. Model "C" and "D" are called "d" and "c" in SNA)

Figure 12.2 Basic transformation models

		Product by Product Input-Output Table	Industry by Industry Input-Output Table
Technology	Product technology	**Model A** Each product is produced in its own specific way, irrespective of the industry where it is produced. *Negative elements may occur*	
	Industry technology	**Model B** Each industry has its own specific way of production, irrespective of its product mix. *No negative elements*	
Sales structure	Fixed industry sales structure		**Model C** Each industry has its own specific sales structure, irrespective of its product mix. *Negative elements may occur*
	Fixed product sales structure		**Model D** Each product has its own specific sales structure, irrespective of the industry where it is produced. *No negative elements*

Matrix representation of the IO-framwork

Integrated input-output framework

	Domestic products	Imported products	Industries	Final use	Total
Domestic products			U_d	Y_d	x
Imported products			U_m	Y_m	m
Industries	V				g
Gross value added			W		w
Total	x^T	m^T	g^T	y	

- The input-output framework can be show in the single table shown above. The V-matrix is the transposed supply table for domestic production from the SUT. Domestic use is split into domestic and imported products.
- The IOT is usually compiled in basic prices. The use table in basic prices can be seen as a first step in the compilation of the IOT.

The import table

- The imports table may be constructed using information collected from the businesses that have imported the products.
- Import statistics may contain information on the purchasers of imported products. It is, however, necessary to distinguish between products used for intermediate consumption, GFCF and goods for trade.
- Countries with restrictions on imports may have detailed information that can be used in compilation of the table.
- In a country with an open economy where a considerable share of imported goods is imported by wholesale trade, it is, however, difficult to identify the users of each product.
- Otherwise the imports table will have to be constructed using the assumption that imports are used in the same proportion across all inputs and final uses, the imported share being equal to domestic supply of imports (allowing for reexports) divided by total domestic supply for each product. A detailed product classification is helpful here.

The “product by product” table

- It may here seem most appropriate to use model A that assumes a product technology for “product by product” IOTs.
- Model A requires that SUTs must be aggregated to the same number of rows as the number of columns in the V and U -matrices.
- The use of model A does usually result in a number of negative entries in the IOT.
- A number of explanations are usually given for negative values:
  - There may be multiple technologies for production of a product
  - The economic transactions may not fully record technological relations
  - The products may represent heterogeneous elements
  - There may be data-errors in the SUT

“Product by product” table, mathematics

$C = V^T(\hat{g})^{-1}$ Product-mix matrix (share of each product in output of an industry)

$D = V(\hat{x})^{-1}$ Market shares matrix (contribution of each industry to the output of a product)

Model A: Product by Product IOTs based on product technology assumption **Negatives possible**

Each product is produced in its own specific way, irrespective of the industry where it is produced.

$T = (D^T)^{-1}$	Transformation matrix
$S_d = U_d T$	Domestic intermediates
$S_m = U_m T$	Imported intermediates
$E = W T$	Gross value added
$Y_d = Y_d$	Final use of domestic products
$Y_m = Y_m$	Final use of imported products

Model B: Product by Product IOTs based on industry technology assumption **No negatives**

Each industry has its own specific way of production, irrespective of its product mix.

$T = C^T$	Transformation matrix
$S_d = U_d T$	Domestic intermediates
$S_m = U_m T$	Imported intermediates
$E = W T$	Gross value added
$Y_d = Y_d$	Final use of domestic products
$Y_m = Y_m$	Final use of imported products

How to avoid negative entries

- Investigate large negative entries. Find an explanation and adjust the SUT. This may, however affect positive elements leaving them with implausible values.
- Review the results and change, if necessary.
- Other ways to deal with negatives:
  - Merging of industries
  - Changing the primary producer
  - Applying industry technology within the product technology framework
  - Introduce new products
  - Correct errors in the SUTs
  - Make manual corrections to the IOTs
  - Use the Almon Method to remove small negative entries
- It may be appropriate to use a “mixed” technology, model E. here the supply table is divided in two parts, one with product technology and another with industry technology assumption.

Hybrid technology, mathematics

Model E: Product by Product IOTs based on a hybrid of technologies chosen to avoid negatives **Negatives possible**

Products are produced with product technology assumption or industry technology assumption.

$V_1 = V \# H$	Matrix for product technology
$V_2 = V - V_1$	Matrix for industry technology
$C_1 = V_1^T (\hat{g})^{-1}$	Product mix matrix for product technology
$D_2 = V_2 (\hat{x})^{-1}$	Market share matrix for industry technology
$R = C_1^{-1} * (I - \mathrm{diag}(D_2^T * i)) + D_2$	Hybrid technology transformation matrix
$A = Z R$	Input coefficients intermediates
$R = L R$	Input coefficients value added
$x = (I - Z R)^{-1} y$	Output
$S = Z R \hat{x}$	Intermediates
$Y = Y$	Final use
$E = L R \hat{x}$	Gross value added

V_1 = Matrix for product technology

V_2 = Matrix for industry technology ($V - V_1$)

g_1 = Vector of industry output with product technology

i = Unit vector

H = Matrix for hybrid technology

The “industry by industry” table

- Model C that uses a “fixed industry sales structure” assumption seems less plausible than model D that assumes a “fixed product sales structure”. Furthermore model C results in negative values. For these reasons it is not considered here.

- The use of model D is relatively simple. The transformation matrix is identical to the market-share matrix, D, that shows the contribution of each industry to the output of a product.

- The transformation can be directly derived from the rectangular SUT-tables without aggregation of the rows to the number of industries.

- The “Handbook on Supply, Use and Input-Output Tables with Extensions and Applications” contains an example that shows the loss of information when the SUTs are aggregated before the transformation.

“Industry by Industry” table, mathematics

$C = V^T(\hat{g})^{-1}$ Product-mix matrix (share of each product in output of an industry)

$D = V(\hat{x})^{-1}$ Market shares matrix (contribution of each industry to the output of a product)

Model C: Industry by Industry IOTs based on fixed industry sales structure assumption **Negatives possible**

Each industry has its own specific sales structure, irrespective of its product mix.

$T = C^{-1}$	Transformation matrix
$B_d = T\,U_d$	Domestic intermediates
$B_m = T\,U_m$	Imported intermediates
$W = W$	Gross value added
$F_d = TY_d$	Final use of domestic products
$F_m = TY_m$	Final use of imported products

Model D: Industry by Industry IOTs based on fixed product sales structure assumption **No negatives**

Each product has its own specific sales structure, irrespective of the industry where it is produced.

$T = D$	Transformation matrix
$B_d = T\,U_d$	Domestic intermediates
$B_m = T\,U_m$	Imported intermediates
$W = W$	Gross value added
$F_d = T\,Y_d$	Final use of domestic products
$F_m = T\,Y_m$	Final use of imported products

“Product by product” or “industry by industry”

- Both types of tables may be produced.
- For specific purposes “product by product” IOTs can be appropriate, specifically for study of price movements.
- Compilation of “product by product” tables are more demanding because of the need to eliminate negative entries.
- It should be remembered that each “product” represents a mix of a large number of products that have different requirements for input and GVA. This mix will probably also differ depending of the industry that has produced the product.
- The “industry adjusted products” of a “industry by industry” IOT share characteristics with the “products” mentioned above.

“Product by product” or “industry by industry”, some private points of view.

- “Industry by industry” tables are closer to statistical sources and national accounts figures. The use of national accounts concepts and redefinitions of industries will, however, cause differences to the data that can be found in primary statistics.

- Compilation of IOTs directly from the rectangular SUTs ensures utilization of the full detail of the SUTs in the compilation.

- The compilation of “industry by industry” IOTs do not require as many resources as “product by product” tables. The production is considerably less time consuming.

- An IOT can be finished a short time after balanced SUTs has become available, and it is comparatively easy to produce annual IOTs with limited resources.

“Provisional” or up-to-date IO tables

- In October 2018 newest Danish tables will still be from 2014.
- Therefore, many users have requested more up-to-date IO-tables.
- Standard IO tables is published at T-3 and the updated version at T-1.
- The updated version is based only on the T-3 version and new column and row totals. There are no SUTs ready to support this.

Procedure for compilation of up-to-date IO tables, 2015 + 2016