



Input-Output Methodology Guide

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¹ ec.europa.eu/eurostat/web/esa-2010

² www.ons.gov.uk/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksic2007

Scottish Input-Output Tables: Methodology Guide

This document describes the methodology employed and data sources used for the construction of the Scottish Government Supply and Use Tables and Analytical Input-Output tables.

At the request of the Chief Statistician, the UK Statistics Authority (UKSA) has re-designated the Scottish Input-Output Tables from National Statistics to Official Statistics. This brings us in line with the UK Input-Output Table re-designation detailed in [UKSA Assessment Report 300](#)³. The report determined that the UK Tables should not carry the National Statistics designation, primarily because a key data source (the Purchase Inquiry) needs to be brought up to date. Our reliance on the same data led us to request that our Tables should also be re-designated. The correspondence between the Chief Statistician and the [UK Statistics Authority is published on the UKSA correspondence pages](#)⁴.

Official statistics are produced by professionally independent statistical staff – more information on the standards of official statistics in Scotland can be accessed on the [Scottish Government Statistics website](#)⁵.

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³ https://uksa.statisticsauthority.gov.uk/wp-content/uploads/2015/11/images-assessmentreport300supplyandusetablesandinputoutputtable_tcm97-44452.pdf

⁴ https://osr.statisticsauthority.gov.uk/wp-content/uploads/2015/11/letterfromedhumphersonatorogerhalliday15061_tcm97-44670.pdf

⁵ www.gov.scot/statistics

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An Overview of the Supply and Use Tables (SUTs)

A modern open economy like that of Scotland engages in four basic economic activities:

- Production involves industries producing goods and services
- Consumption represents purchases of goods and services by both industries and domestic final users comprising mainly households and Central and Local Government
- Accumulation involves all capital transactions including all fixed investment expenditure and stock change
- Trade involves imports from, and exports to, the rest of the UK (RUK) and the rest of the world (RoW).

Measurement of these four activities are captured in the Input-Output framework. The resulting input-output tables and multipliers for Scotland serve a number of purposes, all of which contribute in different ways to understanding the Scottish economy.

The Supply Table

In broad terms, the output and supply table allows the user an appreciation of the absolute monetary values of each industry's output for a given calendar year. Additionally, and possibly more importantly, this table also presents the relationships between the output of products and the output of industries - e.g. key statistics are produced on the extent of diversification within industries and the extent of competition between industries producing the same product.

The Use Table

The combined use matrix shows the consumption of products (goods and services) and primary inputs, in terms of combined domestic and imported goods and services, used in each industry's production process and, in doing so, presents a comprehensive description of the domestic production functions of Scottish industries. This table also gives detailed purchasing information by final consumers.

Supply and Use Tables framework – basic structure (adapted from ONS I-O Analyses 2006 edition⁶)

Supply Table				Use Table											
INDUSTRY				INDUSTRY											
P R O D U C T	DOMESTIC SUPPLY at basic prices	Imports of products	T O T A L S U P P L Y	P R O D U C T	INTERMEDIATE DEMAND at purchasers' prices	FINAL DEMAND (at purchasers' prices)									
						Distributors' trading margins	Taxes (less subsidies) on products	Total intermediate demand	Households FCe	NPISH FCe	Non-Resident Household FCe	Central Government FCe	Local Government FCe	Gross Fixed Capital Formation	Valuables
TOTAL OUTPUT				Total intermediate consumption				GVA at basic prices (Primary inputs)							
				Taxes (less subsidies) on production											
				Compensation of employees											
				Gross operating surplus											
				TOTAL OUTPUT (Inputs)											

FCe - final consumption expenditure
NPISH - Non-profit institutions serving households

⁶ Office for National Statistics (ONS), United Kingdom Input-Output Analyses, 2006 Edition (Mahajan, S): www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/input-output-uk-national-accounts/archive-data/uk-input-output-analyses--2006-edition.pdf

The Supply Table

The primary purpose of the Supply Table is to show the goods and services produced by each industry in Scotland along with the supply of goods and services including imports. The distinction between industries and products is important; individual firms and organisations are classified according to the products they make. If they produce more than one product, they are classified according to whichever product accounts for the largest component part of their output (£). Each industry produces what is termed to be its principal product (shown in the diagonal elements in the table) and many industries also produce a range of other products referred to as secondary production (shown in the off-diagonal cells) or by-products.

The table below shows the main elements of the Supply Table for Scotland for 2017 (the off-diagonal elements are suppressed to prevent disclosure). The supply of products is presented in the rows while the columns show the industries responsible for the output of these products. This table is an aggregate version of the full Supply Table, which shows the output of each of the 98 I-O industry groups by each of the 98 I-O product groups. The full Supply Table is no longer published due to the disclosive nature of the data. However, some information about the levels of supply and market share of each of the 98 industries is available, in summary form, in the Supply Table (available in the downloads section of the [Input-Output website](#)⁷).

The Supply Table also demonstrates the transition from total domestic supply of products at basic prices to total supply at purchasers' prices through the addition of distributors' trading margins and taxes less subsidies on production. The transition from domestic output to total supply is made by the addition of imports and their related taxes and margins.

Aggregate Supply Table 2017

(Output at Basic Prices and Supply at Purchasers' Prices)

£millions

Product	Industry domestic supply at basic prices													Supply = Output + Imports				
	Agriculture, Forestry & Fishing	Mining & quarrying	Manufacturing	Energy supply	Water & waste	Construction	Distribution, hotels & catering	Transport, storage & communication	Financial, insurance & real estate	Professional & support activities	Government, health & education	Other services	Total output	RUK Imports	RoW imports	Distributors' trading margins	Taxes less subsidies on products	Total supply at purchasers' prices
Agriculture, forestry & fishing	5,018	**	**	**	**	**	**	**	**	**	**	**	5,018	634	645	1,092	212	7,601
Mining & quarrying	**	2,794	**	**	**	**	**	**	**	**	**	**	2,822	436	1,069	80	57	4,464
Manufacturing	**	**	34,236	**	**	**	**	**	**	**	**	**	34,493	23,667	22,025	18,809	10,122	109,116
Energy supply	**	**	**	11,699	**	**	**	**	**	**	**	**	11,709	1,689	21	-	679	14,099
Water & waste	**	**	**	**	3,893	**	**	**	**	**	**	**	3,893	359	162	-	189	4,602
Construction	**	**	**	**	**	19,532	**	**	**	**	**	**	21,014	4,184	411	-	611	26,221
Distribution, hotels & catering	**	**	**	**	**	**	28,370	**	**	**	**	**	30,450	4,353	1,138	20,685	1,834	17,089
Transport, storage & communication	**	**	**	**	**	**	**	18,041	**	**	**	**	20,287	10,305	3,224	704	1,510	36,030
Financial, insurance & real estate	**	**	**	**	**	**	**	**	40,908	**	**	**	41,463	4,553	1,029	-	795	47,840
Professional & support activities	**	**	**	**	**	**	**	**	**	21,526	**	**	25,596	9,999	2,075	-	1,077	38,746
Government, health & education	**	**	**	**	**	**	**	**	**	**	47,188	**	47,329	756	158	-	308	48,550
Other services	**	**	**	**	**	**	**	**	**	**	**	6,541	6,882	959	587	-	978	9,406
Total	5,522	3,529	36,567	12,373	4,169	19,760	29,440	19,576	41,666	22,863	48,365	7,124	250,955	61,894	32,544	0	18,370	363,763

Note: This table is for illustrative purposes only. Entries denoted by ** have been suppressed as possibly disclosive. For this reason, the row and column totals do not add up to the sum of the components.

⁷ www.gov.scot/input-output

Interpretation of the Supply Table

Indicators of the diversity of commodities produced by an industry

It can be seen in column 3 of the above table that the Manufacturing industry produced £34,236m of its principal product in 2017, accounting for 94 per cent of this industry's total output (£36,567m). The remaining cells within this column are suppressed to avoid presenting disclosive figures.

This indicator is presented, at 98-industry detail, in the Supply Table as 'Principal Products as a percentage of Total Industry Output'. This statistic shows that for the majority of industries in Scotland in 2017, secondary production of goods and services accounted for less than 20 per cent of their total output.

Indicators of market share

Conversely, to look at the industries that produce Manufacturing products, we consider row 3 of the above table. We find that the manufacturing industry is responsible for the production of virtually all manufacturing commodities (99%). This is an indicator of market share and is presented, at 98-industry detail, in the Supply Table as 'Principal Products as a percentage of Total Output of Products'.

The Use Table

An aggregated combined use matrix at purchasers' prices is presented below. As in the previous table, industries are shown in the columns and products in the rows. Where the Supply Table presented the supply of goods and services for Scottish consumption, the Use Table shows the demand for the goods and services by industries and final demand across the product rows.

Aggregate Combined Use Table 2017 (Purchasers' Prices)

£millions

Product	Industries' intermediate use											Total intermediate use	Final use						Total final use	Total use of products	
	Agriculture, Forestry & Fishing	Mining & quarrying	Manufacturing	Energy supply	Water & waste	Construction	Distribution, hotels & catering	Transport, storage & communication	Financial, insurance & real estate	Professional & support activities	Government, health & education		Other services	Consumers	Government	Gross capital formation	Exports - Non-residents	Exports - RUK			Exports - RoW
Agriculture, forestry & fishing	665	-	1,966	24	-	14	125	2	-	0	12	1	2,810	1,968	-	218	53	1,536	1,015	4,791	7,601
Mining & quarrying	0	404	268	1,178	0	237	34	7	-	2	1	2	2,132	34	-	19	-	1,980	337	2,332	4,464
Manufacturing	1,841	466	13,721	683	322	3,613	3,732	1,527	600	710	5,728	368	33,312	36,344	1,069	6,111	1,661	14,741	15,877	75,804	109,116
Energy supply	82	146	1,022	5,757	47	59	185	110	160	77	396	60	8,100	2,760	-	-	20	216	8	5,999	14,099
Water & waste	29	5	133	48	663	21	39	30	58	42	593	42	1,704	931	723	6	320	364	2,898	4,602	
Construction	114	129	247	112	93	4,665	893	215	1,943	113	628	64	9,235	151	-	14,315	-	2,037	478	16,985	26,221
Distribution, hotels & catering	149	11	220	35	27	146	455	234	519	165	621	36	2,612	10,784	-	-	3,368	314	11	14,477	17,089
Transport, storage & communication	230	200	1,529	163	287	379	2,856	3,297	3,011	1,018	1,848	339	15,157	7,652	780	2,587	570	6,333	2,950	20,873	36,030
Financial, insurance & real estate	185	225	1,124	278	178	439	1,291	521	5,533	677	1,328	125	11,903	24,263	-	471	69	7,392	3,741	35,937	47,840
Professional & support activities	165	316	1,846	358	297	1,502	1,835	1,892	3,523	4,731	2,843	754	20,163	2,797	-	2,683	89	8,150	4,864	18,583	38,746
Government, health & education	11	9	124	18	31	108	73	203	454	601	2,261	46	3,938	6,464	36,439	396	39	559	717	44,612	48,550
Other services	13	8	51	8	11	3	73	143	134	100	541	779	1,862	6,082	709	47	276	296	135	7,544	9,406
Total intermediate use	3,484	1,918	22,252	8,663	1,955	11,201	11,691	8,178	15,934	8,237	16,798	2,616	112,929	100,231	39,720	26,856	6,154	47,374	30,499	250,834	363,763
Taxes less subsidies on production	477	16	218	209	81	107	1,326	253	208	313	90	127	2,470								
Compensation of employees	743	1,122	8,902	988	892	4,902	1,339	7,132	5,645	9,335	24,012	2,581	77,593								
Gross operating surplus	1,772	473	5,195	2,513	1,241	3,550	5,084	4,013	19,879	4,978	7,485	1,800	57,963								
Gross value added at basic prices	2,038	1,611	14,315	3,710	2,213	8,559	17,749	11,398	25,732	14,626	31,567	4,508	138,026								
Total output at basic prices	5,522	3,529	36,567	12,373	4,169	19,760	29,440	19,576	41,666	22,863	48,365	7,124	250,955								

The Use Table can be split into 3 main sections.

- **The intermediate demand (section 1)**, which shows the inputs of products, both domestic and imported, used by Scottish industries in the production of their output.
- **The final demand (section 2)**, which shows the purchases of each product by each category of final demand (e.g. consumers, government, export)
- **The primary inputs (section 3)**, these inputs do not flow through the other industries, they are employees' salaries, taxes less subsidies on production and gross operating surplus, which together constitute Gross Value Added.

The Combined Use matrix is repeated at full 98-industry detail in the downloads section of the [Input-Output website](http://www.gov.scot/input-output)⁸.

⁸ www.gov.scot/input-output

Interpretation of the Use Table

Inputs to the production process

Column 3 of the above table shows the purchases made by the Scottish Manufacturing industry in order to produce its own output. We can see that the main purchases made by this industry comprised: an estimated £13,721 million of its own principal product, £1,966 million of agriculture, forestry and fishing products, £1,846 million of professional and support activities products, and £1,529 million of transport, storage and communication products.

Destination of products

The total demand for manufactured products produced in Scotland is given in the above table as £109,116 million. Row 3 of this table presents the consumption of manufacturing products by both the intermediate and final demand parts of the economy. This row shows that, in addition to the £13,721 million purchased by the manufacturing industry, government, health and education (£5,728m), distribution, hotels and catering (£3,732 m) and construction (£3,613m) were the most significant intermediate destination for these products. Around 28% of the supply of manufactured products are exported to the rest of the UK (£14,741m) and to the rest of the world (£15,877m).

Gross Domestic Product (GDP) and the Supply and Use Tables.

An important feature of the Supply and Use framework is that it presents Gross Domestic Product as measured using three distinct approaches.

GDP measured using the Production approach

GDP at basic prices is also known as Gross Value Added (GVA), that is it is a measure of the gross value added to the economy by each producing unit in Scotland. Broadly speaking, it is simply the sum of each company's outputs (sales) less inputs (purchases).

The output of an organisation will be equal to the total value of sales (turnover) over a given period although account is also taken of goods manufactured but held in inventory and work in progress (which is particularly relevant for industries like ship-building where the outputs are high-value but infrequent). The final component of output includes any items of a capital nature created in-house for the companies own final use - e.g. databases and other computer systems. These are valued and added to the other items to form a figure for the total value of goods and services produced by an organisation - their Gross Output at Basic Prices.

In producing these outputs, an organisation will have to purchase raw materials, energy and other intermediate inputs of goods and services: these are subtracted from the output (including any taxes relating to these purchases) to yield Gross Value Added.

The following shows the calculation of GVA (production approach) for Scotland in 2017:

Total output at basic prices (a)	£251.0 billion
Total intermediate inputs at purchasers' prices (b)	£112.9 billion
Gross Value Added at basic prices (a-b)	£138.0 billion
Taxes less subsidies on products (c)	£18.4 billion
Gross Domestic Product at market prices (a-b+c)	£156.4 billion

GDP measured using the Income approach

Gross Value added (GDP at basic prices) is also equal to the costs of employment (wages, national insurance and pension contributions), any taxes, less subsidies, levied upon production (e.g. business rates, vehicle excise duty) and Gross Operating Surplus (broadly analogous to profit).

The following shows the calculation of GVA (income approach) for Scotland in 2017:

Compensation of Employees (a)	£77.6 billion
Taxes, less subsidies, on production (b)	£2.5 billion
Gross Operating Surplus (c)	£58.0 billion
Gross Value Added at basic prices (a+b+c)	£138.0 billion
Taxes less subsidies on products (d)	£18.4 billion
Gross Domestic Product at market prices (a+b+c+d)	£156.4 billion

GDP measured using the Expenditure approach

GDP (Gross Domestic Product at Market Prices) is usually defined/calculated as the sum of total final demand less total imports.

Total domestic demand comprises purchases (including all taxes that may apply) by: Households, Non-profit institutions, Tourists (or rather expenditure by non-residents), and Government. Gross fixed capital formation, changes in inventories and valuables are also included.

Final demand also includes the value of exports (which from a Scottish perspective include exports or goods and services to the rest of UK). Imports includes goods and services imported from the rest of UK and will also include expenditure by Scottish residents outside Scotland.

The following shows the calculation of GDP (expenditure approach) for Scotland in 2017:

Household final consumption (including NPISH)	£100.2 billion
General Government final consumption	£39.7 billion
Gross capital formation	£26.9 billion
Exports	£84.0 billion
Total final demand (a)	£250.8 billion
Total imports (b)	£94.4 billion
Gross Domestic Product at market prices (a-b)	£156.4 billion

The calculation of GDP in the manner shown above leads to an estimate of GDP in market prices, where the products being bought by final consumers are valued in the prices paid by these consumers – as opposed to the basic prices used in the previous two calculations.

Removing VAT and other taxes and subsidies on products allows us to convert this expenditure estimate of GDP into a basic price measure.

GDP (a) at market prices	£156.4 billion
Taxes, less subsidies, on products (b)	£18.4 billion
Gross Value Added at basic prices (a-b)	£138.0 billion

Note that the figures in the tables above may not sum due to rounding.

All three approaches to measuring GDP result in a figure of £138.0 billion when expressed in basic prices. Achieving consistency between independently derived measures is a key outcome of the balancing process described later in this paper. It is also a key benefit of positioning National Accounts within a Supply and Use framework.

Compilation process for the Supply and Use Tables

An overview and user guide for the Scottish Input-Output Tables are available on the [Input-Output Table website](#)⁹

The compilation of the Supply and Use Tables can be broken down into four broad stages:

1. Compilation of initial Supply and Use Tables
2. Constraining of column totals by industry, incorporating ONS Regional Accounts estimates of Gross Value Added
3. Estimation of the remainder of the Supply table (valuation and imports)
4. Balancing of the tables

The process itself is neither straightforward nor linear. Problems may come to light at a later stage in the process which require revisiting of the earlier stages. More fundamentally, significant changes made during the balancing process can render the tables inconsistent with the tax, margin and subsidy figures estimated in step 3. Re-estimating these can then return the tables to an unbalanced state. An iterative process of re-estimation and rebalancing is therefore applied until the tables converge to a consistent and balanced final estimate.

The process of compiling Supply and Use Tables is extremely data-intensive. For many items, direct estimates for Scotland are not available. While Scottish data are used where they are available and sufficiently robust, in cases where it is not, other data sources may need to be relied upon, especially the UK Supply and Use Tables and associated background datasets. The compilation process for the Scottish tables is therefore a mixture of a top-down apportionment driven approach, and a bottom-up raw data driven approach.

Construction of the initial Supply Table

The first stage of constructing a Supply Table is the generation of the domestic Supply Table at basic prices. This is the part of the Supply Table which shows the mix of products produced by each industry (or, if you prefer, the range of industries which contribute to the domestic production of each product). The row sums of this matrix correspond to the domestic output of each product for the whole economy, and the column sums correspond to the total output of each industry. This matrix is valued at basic prices which means the amount received by the producer for a unit of goods or services excluding any taxes on products and including any subsidies on products. This price includes only taxes on production (such as business rates) and excludes any subsidies on production (such as single farm payment). This price excludes any transport charges invoiced separately by the producer. The remaining columns of the full Supply Table show the transition from domestic product output at basic prices to total supply of products at purchasers' prices, however these are not estimated until later on in the process of compilation.

The main data source used here is the ONS Annual Business Survey (ABS). Although other sources may be used for some industries, the general approach is the same; details of the data sources used are listed in Annex A. A number of adjustments are made to the ABS first to handle known data problems with specific companies, which might otherwise cause distortions in the table due to their size.

Total output at basic prices data by industry are taken from the ABS. These provide the column (industry) totals for the domestic output part of the Supply Table. In the case of manufactured products produced by manufacturing industries, Scotland-specific data from the [European Community Survey \(PRODCOM\) survey](#)¹⁰ are used. Where a sufficient proportion of an industry is covered by data from PRODCOM, proportions derived from it are used to estimate the spread of manufactured products produced by that industry. Where PRODCOM data coverage is not

⁹ www.gov.scot/input-output

¹⁰ <https://ec.europa.eu/eurostat/web/prodcom/overview>

sufficient, the UK Supply Table proportions are used. The distribution of non-manufactured products is also taken from UK Supply Table proportions, with the exception of the Research and Development product, which is estimated using proportions derived from the Business Expenditure on Research and Development (BERD) survey and the ONS Gross Expenditure on Research and Development publication applied to UK Supply of R&D.

The total output and the composition of products which make up that output are estimated separately, consequently it is possible for this approach to generate estimates which are inconsistent with the UK tables (e.g. small sample effects in PRODCOM leading to a particular cell or cells implying an unreasonably large or small proportion of the corresponding cell in the UK Supply Table). Therefore a check of our initial Scottish estimates against the UK Supply Table is made to detect problems, and if necessary, adjustments are made.

Having done this, we are left with an initial estimate of a Scottish Supply Table which is ready to be fed in to the SAS system for further processing.

Market output, output for own final use and non-market output

An important distinction in National Accounts is made between market output, output for own final use, and non-market output. Market output is produced for sale (or intended sale) on the market at economically significant prices. This price information makes it easy to value this sort of output.

However, the economy also produces output which is not sold at market, or is not sold at economically significant prices. This can be broken down further into:

- Output for own final use:
 - Output for own final consumption:
Corporations do not have any final consumption, so only unincorporated enterprises in the household sector may produce this kind of output. It includes for example, farmers who consume a portion of their own produce, housing services provided by owner-occupiers and household services produced by employing paid staff.
 - Output for own gross fixed capital formation:
This can be produced by any kind of enterprise, and includes, for example production of specialised machine tools by a manufacturer, research and development, in-house IT development and extensions to dwellings produced by households
- Non-market output:
This is output produced by NPISHs or government (central or local) which is provided free, or at economically insignificant prices. This includes services such as military defence and the NHS. This is further broken down into:
 - Payments for non-market output
 - Non-market output provided free of charge

Since this output is not sold at market prices, it is difficult to value it appropriately. Conventionally, under ESA 1995, the output has a value equal to the total sum of inputs (both intermediate consumption and primary inputs, with an estimate of capital consumption as the only component of GOS) used in their production. Input costs are estimated during the construction of the Use Table and then combined with the information on market producers in the Supply Table¹¹. However, under ESA 2010 the distinction between paid for and unpaid for other non-market output becomes more significant, and paid for other non-market output is now valued at the payment received. The sum-of-costs valuation with payments for non-market output subtracted off is used for non-market output provided free of charge.

¹¹ For further details of market and non-market producers and estimating their output see Page 189, United Kingdom Input-Output Analyses, 2006 Edition page (Mahajan, S): www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/input-output-uk-national-accounts/archive-data/uk-input-output-analyses--2006-edition.pdf

Construction of the Initial Combined Use Table

Intermediate demand

If the domestic output part of the Supply Table at basic prices is thought of as showing the composition of industries' outputs by product, the left hand side of the Use Table can be thought of as showing the composition of industries' inputs.

The columns shown in the intermediate demand part of the table list the goods and services each industry uses in order to produce its output (as described by the corresponding industry column in the Supply Table). The column totals give the total intermediate consumption of each industry. The row totals give the total Scottish intermediate demand for each product category.

The difference between the value of industry output at basic prices (which are the column totals of the Supply table) and the value of industry intermediate consumption at purchasers' prices is Gross Value Added (GVA), which we treat as an input in the Supply and Use framework. GVA itself can be split into three components: Taxes less Subsidies on Production, Compensation of Employees, and Gross Operating Surplus. These make up the Primary Inputs table, which appears below the intermediate consumption part of the Use Table so that the column totals by industry in the Use Table sum to total output by industry.

When the Use and Supply Tables are balanced by industry then the column totals of the domestic Supply Table at basic prices (outputs by industry) will equal the column totals of the left hand side of the Use Table (inputs by industry). The requirement that these column totals match and thus inputs equal outputs by industry is called the industry balance condition.

When the full tables have been constructed and fully balanced, it will allow a second condition that the product row sums of the Supply and Combined Use tables are equal for each product to hold; this is called the product balance condition, and ensures that total demand for products is equal to total supply (i.e. domestic supply plus imported supply) of products.

Data on total purchases of goods and services (giving us our total intermediate consumption by industry) are available from the ABS, as well as data on GVA and its components (giving us our breakdown of primary inputs by industry). The ABS questions also provide some detail to allow an estimate of the intermediate consumption subtotal for goods and materials.

The next stage is to disaggregate the ABS purchasing categories to the full product level used in the Supply and Use Tables. In future this will be carried out by applying patterns derived from the new UK Purchase Survey, however more time is needed to develop systems to incorporate these data and to QA the results. In the meantime, the industry purchasing patterns used in the construction of the 1998-2016 published tables have been carried forward for one year to 2017.

A final check is made to ensure that the estimated cells in the intermediate consumption part of the Use Table look sensible when compared to the UK (i.e. they do not represent an unreasonably small or large proportion of the corresponding UK cells).

Final Demand

We can now turn our attention to the final demand section of the Use Table.

Final Consumption Expenditure

- by domestic households
- by Non-Profit Institutions Serving Households (NPISHs)
- by Non-resident households (e.g. tourists)
- by Central Government
- by Local Government

Gross Capital Formation

- Gross Fixed Capital Formation
- Valuables
- Change in Inventories

Exports

- to the Rest of the UK (RUK exports)
- to the Rest of the World (RoW exports)

Final Consumption Expenditure

Household Final Consumption Expenditure (HHFCE)

The starting point for this column is a regional split of ONS published UK HHFCE produced by colleagues working on the [Scottish National Accounts Programme \(SNAP\)](#)¹². HHFCE consists of Scottish residents' spending in Scotland, the RUK and abroad (RoW). Estimates of spending in the UK (i.e. Scotland and Rest of UK), split by [COICOP \(Classification of Individual Consumption according to Purpose\)](#)¹³, are derived from the UK Household Final Consumption Expenditure table (listed as Use Table number 3 in the current UK IO publication¹⁴) using expenditure data from the Living Costs and Food Survey (LCFS) and a small number of other sources. We convert this to a classification by product IOC using the same UK table. Scottish resident's spending in the rest of the world (tourist imports) is also derived from the UK HHFCE IO table using expenditure shares derived from the International Passenger Survey (IPS).

Estimates of non-residents' expenditure in Scotland (tourist exports to RUK and RoW residents) are produced in a similar way. For RoW residents, a share of UK tourist exports is derived using IPS data. For RUK residents, estimates of expenditure are based on data from the [GB Tourism Survey](#)¹⁵, [GB Day Visitor Survey](#)¹⁶ and [Northern Ireland Tourism Survey](#)¹⁷. Please note that these expenditures appear as Exports in the Use, PxP and Ixl Tables.

The latest UK IO publication incorporates some significant changes in HHFCE (including non-residents' expenditure) based on Blue Book 2019. The most noticeable changes relate to the split of spending between transport services (air, rail, water and other land transport) and travel and related services. Travel and related services have a much bigger share of the transport and travel combined spend than was the case in previous years' Blue Book publications.

¹² www2.gov.scot/snap

¹³ [https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Classification_of_individual_consumption_by_purpose_\(COICOP\)](https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Classification_of_individual_consumption_by_purpose_(COICOP))

¹⁴ www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/inputoutputsupplyandusetables

¹⁵ www.visitbritain.org/great-britain-tourism-survey-latest-monthly-overnight-data

¹⁶ www.visitbritain.org/gb-day-visits-survey-latest-results

¹⁷ www.nisra.gov.uk/statistics/tourism

Government Final Consumption Expenditure

This is discussed later in the section on 'The treatment of government'.

Non-Profit Institutions Serving Households (NPISH) Final Consumption Expenditure

NPISH includes most universities, charities (including most private schools), religious societies, trade unions and members' clubs. Conceptually, NPISH Final Consumption Expenditure reflects the consumption by the NPISH sector of its own other non-market output, in a similar way to General Government Final Consumption Expenditure.

Data specifically relating to the NPISH sector for Scotland are very limited, however since Universities represent the main part of the NPISH sector, final demand for the education product will be the same as output from Higher Education institutions and private schools. The remainder of NPISH final demand is estimated in line with ONS classifications and using the UK tables.

Gross Capital Formation

Gross Capital Formation comprises three components in the tables:

- Gross Fixed Capital Formation (GFCF)
- Acquisitions less disposals of valuables
- Change in inventories

Gross Fixed Capital Formation (GFCF)

The first step in compiling the GFCF column is to produce a vector of GFCF by industry, GFCF on dwellings and for capitalised transfer costs on land. The main source for this is 'net capital expenditure' data from the ABS. The ABS does not provide complete coverage of Scottish industry, however, so where ABS data are either too sparse or not available (Forestry (SIC 02), Financial Intermediation (SIC 64-66) and Public Sector, Government and Other (SIC 94-97), alternative estimates of GFCF by industry are used instead. In these few industries, we estimate GFCF figures pro rata using the Scotland Gross Operating Surplus (GOS) to the UK GOS.

GFCF spending on New Dwellings estimates are based on Construction Output on new housing and repair and maintenance of housing. This methodology closely matches that used by ONS for the UK as a whole, and is likely to better account for regional price variation over the ONS top-down Regional accounts estimate.

Data for GFCF on transfer costs for are taken from ONS Regional Accounts data.

The estimate for GFCF for the agriculture industry (SIC 01) are now taken directly from the [Total Income from Farming data](#)¹⁸. Previously the Scottish to UK Gross Operating Surplus proportions were applied to UK agriculture estimates of GFCF.

These industry level total GFCF estimates are disaggregated to products using product proportions from the UK GFCF industry by product table. Aggregating by industry then provides us with our GFCF by product final demand column for the Use table.

Valuables

Due to its very small size, data on acquisitions less disposals of valuables are not used for Scotland, so the ratio of net change in valuables to total output for the UK is applied to total output for Scotland. This estimate of overall net change in valuables is then apportioned across products using UK proportions to obtain an acquisitions less disposals of valuables column for Scotland.

¹⁸ www2.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/TrendTiff

Change in Inventories

For manufacturing industries, ABS data provides start year and end year stocks of material and fuels, work in progress and finished goods. It is not currently possible to separate work in progress and finished goods stocks, so UK data (from 2004 - the latest available) is used to calculate this split. For service industries, UK data is used to split all inventory components.

Where inventory deflators are provided by ONS, these are applied to start year and end year stocks to calculate the change in inventories valued consistently in the average prices of the year.

Inventory deflators may be missing for some industries, inventory type or time periods. Where this is the case the average of the available deflators for that industry is used, or average deflators for the IOC which includes the industry. Where there are no Scottish data for an IOC, UK data are used.

Exports

The values of exports by industry group to the Rest of the UK and Rest of World are available from the Global Connections Survey¹⁹. These are apportioned to exports by product IOC using the initial domestic Supply Table at basic prices, and adjusted to separate the margin cost and underlying product cost for the distribution industries; the margin is recorded under the distribution product, whereas the value of the product being distributed is recorded under whichever IOC that product would normally be classified under.

For estimates of non-residents' expenditure in Scotland (tourist exports to RUK and RoW residents), see Household Final Consumption Expenditure (HHFCE) above.

Treatment of government

Most of the output of government is non-market output. Non-market output provided for payment is valued at the value of the payments made. Non-market output provided for free is valued according to the sum of inputs less payments for non-market output, since there are no market prices for such output to use to establish its value (there is assumed to be no net operating surplus on this activity, and so the gross operating surplus entry consists only of consumption of fixed capital). The input costs of government are recorded in the intermediate consumption part of the Use Table under the different service industries of government. Separate matrices are compiled for Central and Local Government and then combined by summation with non-government producers in the final tables.

Under ESA 2010, a new classification of social transfers in kind market production was introduced. This consists of individual goods or services provided by government units²⁰ to individual households which are either purchased by government from market producers, or which government reimburses households for the purchase of from social security funds. Examples include funding for prescription medicines and for NHS dental care. Prior to ESA 2010 these transactions were treated as part of government intermediate consumption (and by the sum-of-costs valuation, of government output). They are now excluded from government IC, and appear instead as part of government final consumption.

¹⁹ www.gov.scot/publications/about-export-statistics-Scotland

²⁰ Social transfers in kind market production can in principle be provided by the NPISH sector, but the amount involved is negligible and therefore treated as zero.

Details of the service industries of government, and which levels of government (central and/or local) contribute to them are detailed in the table below:

Industry SIC	Industry Description	Central Government	Local Government
36, 37	Water and sewerage		✓
49.3-5	Other land transport		✓
52	Support services for transport	✓	
59, 60	Film video & TV etc; broadcasting	✓	
84	Public administration & defence	✓	✓
85	Education	✓	✓
86	Health	✓	✓
87, 88	Residential care and social work	✓	✓
90	Creative services		✓
91	Cultural services		✓
93	Sports & recreation		✓

The inputs to government are compiled from the data sources listed in Annex A and are used to construct the government contribution to the intermediate consumption part of the Use Table. These inputs are also used to value the total output of government. This output can be broken down into market output, output for own final use, and other non-market output. The split between these three categories is estimated by apportioning the total output using proportions derived from the UK tables and used to estimate the central and local government components of the Supply Table.

The sum of government market output and government non-market output for each service industry of government is recorded in the principal product category of each industry column in the government Supply Tables, and the output for own final use split between the construction and computer & related activities products using UK proportions.

These government Supply Tables are then summed with the estimates for non-government activity in each of these industries derived from the ABS to produce single combined government and non-government columns for each of the service industries of government in the Supply Table.

Under the National Accounts framework, government activities are presented in such a way that it appears to be the final consumer of its own non-market output, or put another way, government, on behalf of the people, fund a range of activities across the public services. To reflect this, columns for the final consumption expenditure of central and local government appear in the final demands section of the Use Table. These columns display the total non-market output of government provided for free plus social transfers in kind market production provision by government by product.

Treatment of Financial Services

For an explanation on Financial Intermediation Service Indirectly Measured (FISIM) and the Financial Services Adjustment (FSA), see: [Methodological improvements in the calculation and allocation of FISIM](#)²¹.

Data on use of Financial Intermediation Service Indirectly Measured (FISIM) by industry and market/non-market classification are available for the UK. From these data FISIM Use as a proportion of GVA (for intermediate uses of FISIM) and final consumption category (for final uses of FISIM) are calculated by industry for both market and non-market producers' FISIM demand. These proportions are then applied to Scottish GVA by industry and final demands by sector to obtain Scottish estimates of FISIM use by industry.

Prior to source data already taking into account such FISIM adjustments, in the Use Table, the market FISIM estimates were subtracted from the Gross Operating Surplus component of GVA by industry and the market and non-market FISIM estimates added onto the intermediate consumption of the banking product for each industry and market final demand category (resident and non-resident household expenditure and exports). Non-market industry FISIM estimates were added to their equivalent product within NPISH, Local or Central Government columns. For example R&D FISIM was added to NPISH product 108 and Local Authority education FISIM was added to Local Government final demand product 116. Since these non-market adjustments affect the balance between supply and demand, equivalent offsetting adjustments are made to the Supply Table.

However, as more and more data sources are now compliant with the new FISIM methodology it has become unnecessary to estimate Scottish FISIM and adjust the raw data accordingly.

²¹ <https://www2.gov.scot/Topics/Statistics/Browse/Economy/papers/SES2008A3>

Constraining to Regional Accounts estimates of GVA

Having constructed our initial Supply and Use Tables, the GVA figures are constrained (unless explicitly adjusted; see below) to the raw Regional Accounts²² figures published by ONS. The Gross Value Added (GVA) figures are broadly equivalent to the raw SIC(2007) section level Regional Accounts figures, and on the advice of ONS, we have moved from using the income approach (GVA(I)) to the 'balanced estimate' of Regional Gross Value Added (GVA(B)). For more information please see the [ONS Regional Accounts bulletin](#)²³.

Over the past few years there have been several industries where we have felt Scottish GVA estimates taken from the ONS Annual Business Survey were more accurate than ONS Regional Accounts top down regionalisation of UK estimates. Although expert users recognise the advantages of having a fully UK Regional Accounts constrained set of Scottish Supply and Use Tables, it was agreed by the [Scottish Input Output Expert User Group](#)²⁴ in 2009 that, where other data sources suggest otherwise, it would be preferable for the Scottish estimates to depart from this constraint.

As a result, there has been close working with the Scottish National Accounts Programme (SNAP) and GDP(O) Short Term Indicators teams to enforce consistency between each source to allow triangulation between Regional Accounts and alternative estimates. Constraining to Regional Accounts raw estimates has been the initial and default position, only breaking away from Regional Accounts estimates where it was felt necessary.

Where adjustments have been made which affect the level of GVA for an industry, where possible, a corresponding proportionate adjustment is made to total output (and its components) in order to preserve the ratio of GVA to total output. This ensures that our estimated production functions for each industry are not distorted as a result of the constraining process.

When the constraining process is complete, the Supply Table columns are scaled so that the balance of inputs by industry and outputs by industry is maintained.

²² www.ons.gov.uk/economy/regionalaccounts

²³ <https://www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueaddedbalanceduk/1998to2017>

²⁴ <https://www.gov.scot/groups/input-output-expert-user-group/>

From Domestic Supply at basic prices to Supply at purchasers' prices: Compiling the valuation and imports tables

The Supply Table at basic prices details the domestic output of products at basic prices by industry. The Use Table details the consumption of all products by industry and final consumers at purchasers' prices. In order to bridge this gap, we need information on:

- Imports
 - Distributors' trading margins on products
 - Taxes on products
 - Subsidies on products
- Products used by Scottish consumers which are not domestically produced
- Components of the difference between basic prices and purchasers' prices (i.e. the price paid by the final consumer)

Compiling data on these items allows us to complete the Supply Table but also allow us to construct a domestic Use Table at basic prices to be used in the compilation of the Symmetric I-O Tables.

Distributors' trading margins

Distributors' trading margins form part of the purchasers' price of a product but are not part of the basic price. In the Supply Table at basic prices, distributors' trading margins are recorded against the appropriate distribution product (retail excl. motor vehicles, wholesale excl. motor vehicles, or wholesale and retail of vehicles). In the purchasers' price Use Table, the distribution margins are recorded as part of the price of the product on which they are earned. Therefore, in the Supply Table when we are adding in the components to take domestic output of products at basic prices to total supply at purchasers' prices, the margins component must remove output from the distribution commodities and allocate it to products (note that only physical goods can attract distributors' trading margins). This reallocation should also include margins on imported goods. Since this is a reallocation, the positive entries in the margins column against products will be balanced by negative entries against the distribution products, and the sum of all entries in the margins column will be zero.

Three types of margin are estimated in the process of compiling the tables. They are:

- Wholesale and retail margins on vehicles
- Wholesale excluding vehicles
- Retail excluding vehicles

UK product by industry margin factors (effectively average margin proportions) are applied to the Scottish Use Table (after VAT and other product taxes have been excluded from the prices). These estimates are then scaled so that they match estimates of the total output of each margin for Scotland. The constraining estimates are derived by applying the ratio of total margin to total output of the corresponding distribution product from the UK tables to the total Scottish output of the appropriate distribution product.

The total of each margin by industry is then entered with negative sign against the corresponding margin product to ensure that the column totals sum to zero. The entire matrix of margin estimates is then summed across rows to give a margins column for the supply table.

Taxes on products

Taxes on products are taxes which are levied per unit of quantity or an ad valorem basis. They can be split into three categories:

- Value Added Taxes (VAT)
- Taxes on imports
- Other taxes on products

Due to the way in which we compile information on these items, discussion of the estimation of taxes on imports will be postponed here and described later in the section on imports.

VAT

A VAT matrix for the UK Use Table giving the value of the VAT component of each cell in the Purchasers' Price Use Table is divided through by the corresponding Use cell values to obtain a matrix of rates. These rates are then applied to the Scottish Purchasers' Price Use table to obtain initial Scottish estimates of VAT.

Estimates of total cash VAT receipts attributable to Scotland are obtained from the [Government Expenditure and Revenue Scotland \(GERS\)](#)²⁵. The initial VAT estimates are scaled so that their total matches the GERS estimate.

Other taxes on products

A similar approach to that for VAT is taken for the other product taxes. Rates are derived from the UK Use Table and then constrained to estimated Scottish tax totals taken from GERS (with the exception of protective duty on imports, which is estimated later in the process). The full list of taxes on products within the production boundary is as follows:

- aggregates levy
- agriculture levies
- air passenger duty
- alcohol duties
- betting, gaming and lottery duties
- Channel 4 funding
- climate change levy
- fossil fuel levy
- gas levy
- hydro benefit tax
- hydrocarbon oils duty
- insurance premium tax
- landfill tax
- lottery fund
- protective duty on imports²⁶
- renewable obligation certificates
- stamp duties
- Strategic Rail Authority rail franchise premia
- sugar levy
- tobacco duty

²⁵ www.gov.scot/Topics/Statistics/Browse/Economy/GERS

²⁶ The treatment of import duties differs from that of other product taxes, and is dealt with in the section on imports.

Subsidies on products

Ratios of subsidy to total Use cell value are derived from the UK tables and applied to the estimated Scottish Use Table. In order to move from basic prices to purchasers' prices, subsidies on products are *subtracted* from the basic price, while taxes on products are *added* (and vice versa when moving from purchasers' to basic prices).

Imports and taxes on imports

Imports is one the most difficult parts of the table to get Scottish data for, particularly imports from the rest of the UK, and as a result these columns are the ones which absorb most of the imbalances during the manual balance stage.

Data from HMRC Regional Trade Statistics (RTS), the International Trade in Services survey (ITIS), the International Passenger Survey (IPS) and the Great Britain Tourist Survey are used to provide pre-balance estimates of imports from the Rest of the World (RoW). The import categories are manually matched to product rows to provide initial estimates, which are then compared to latest Blue Book data for the UK to provide an adjustment from raw to Balance of Payments compliant data. Rest of UK (RUK) import estimates as a proportion of total supply from the previous balanced year are used to provide initial estimates of totals for RUK imports, and these are then apportioned to the product level using data from the Global Connections Survey (for RUK) and the UK tables (for RoW).

Some imported products from the Rest of the World attract import duties. UK values for Rest of World imports and protective duty are used to calculate average rates of protective duty by product. These are then applied to the estimated RoW imports for Scotland to obtain estimates of protective duty by product.

Balancing the tables

With initial estimates of the valuation matrices completed, we can construct our first estimate of the full Supply Table at purchasers' prices. At this point industry output at basic prices in both the initial Supply and Use tables are equal. The valuation matrices are presented as columns to the right of the Supply Table at basic prices and show the breakdown of the differences between domestic supply at basic prices and total supply at purchasers' prices by product. The row totals of the Supply Table are therefore at purchasers' prices, as are the row totals of the Use Table. The product level balance requires that these row totals are equal, but since we have used a range of different data sources for each, initially this is not the case.

The Scottish Use Table is manually balanced to the Supply Table at Purchasers' prices by product (i.e. by row). The purpose of the manual balancing process is to adjust the Use Tables to remove these product imbalances. Information in the table itself, from the time series of tables, and any external information which can be brought to bear is used to help inform this process. The matrix nature of the tables means that adjustments to one cell to bring a row into balance can introduce imbalances into other rows and columns. Imbalances identified here can also bring to light problems arising earlier in the compilation process, and require amendments to column totals in order to maintain the industry balance. Within the manual balance system, balancing adjustments are made as much as possible to data items with the least robust data source.

When manual adjustment has brought the tables into an "almost balanced" state by product, the final adjustments to bring the table fully into balance can be carried out automatically through an iterative proportional fitting method known as the RAS procedure (See [Eurostat Manual of Supply, Use and Input-Output Tables](#)²⁷ pp.451-7 for details).

This process leaves us with a fully balanced set of tables. However, changes made as a result of the final RAS balance can require a re-estimation of the valuation tables. If this is not done the estimates can produce inconsistencies when constructing the domestic use table at basic prices required to generate the symmetric tables (e.g. negative estimates of basic price values). In order to minimise these distortions, the valuation tables are re-estimated using the RAS balanced table and a further RAS balance is run to arrive at a set of balanced tables which are consistent with the estimates of taxes, margins and subsidies.

²⁷ ec.europa.eu/eurostat/en/web/products-manuals-and-guidelines/-/KS-RA-07-013

The Analytical I-O Tables

What are the analytical tables?

Supply and Use Tables form a central part of the system of national accounts. Their main use is to act as an integration framework for balancing the national accounts and determining an estimate of GDP.

They are also the starting point for the production of the Input-Output Analytical Tables (also known as symmetric input-output tables). These form a basis from which a wide range of macroeconomic models and impact analyses can be constructed.

The analytical tables present a version of the Use table in either an industry by industry or product by product form, as opposed to the product by industry basis of the Supply and Use tables.

Since the I-O models are generally used to model the impacts of changes on the domestic economy, the first step in generating the symmetric tables is to extract the valuation and imports tables from the combined (i.e. includes imported products) Use Table at purchasers' price. After removing imports, taxes and subsidies, and reallocating margins, we're left with Domestic Supply and Use Tables at basic prices. From here the tables can be transformed to Industry by Industry or Product by Product analytical tables.

In order to construct the analytical tables, some assumptions must be made about secondary production – i.e. the off-diagonal elements shown in the domestic part of the Supply Table. For IxI tables, the assumption relates to the sales structure of secondary production. For PxP tables, the assumption relates to the input structures of secondary production.

Derivation of Industry by Industry analytical tables

The Scottish government industry by industry analytical tables are generated from the Supply and Use tables under a Fixed Product Sales Structure (FPSS) assumption – that the sales structure for a given product is the same regardless of which industry it is produced by. This means that secondary production of a given product is sold to other industries and final demand in the same proportions as production of that product by its principal producing industry.

The details of the construction are provided below:

\mathbf{V}^T = product by industry basic price supply matrix

\mathbf{V} = industry by product make matrix (transposed supply matrix)

\mathbf{U} = intermediate consumption quadrant of the basic price Use table (product by industry)

\mathbf{W} = value added quadrant of the basic price use table (Component of GVA by industry)

\mathbf{Y} = final demand quadrant (product by final demand category)

\mathbf{q} = vector of product outputs

\mathbf{g} = vector of industry outputs

$\hat{\mathbf{q}}$ = matrix with elements of \mathbf{q} on the diagonal and zeroes elsewhere (similarly for $\hat{\mathbf{g}}$)

We create a transformation matrix \mathbf{T} by dividing each column of \mathbf{V} by its column total (i.e. the corresponding element of \mathbf{q}). This gives a matrix of commodity output proportions for each industry (also known as the market shares matrix). In matrix form:

$$\mathbf{T} = \mathbf{V}\hat{\mathbf{q}}^{-1}.$$

In order to create the IxI matrix, we need to obtain the following three matrices:

- Intermediates in the form industry by industry, **B**
- Value added by industry, **W**
- Final demand by industry, **F**

W does not have a product dimension and does not need to be transformed. The rows of **U** and **Y** however refer to products and need to be converted to industries by pre-multiplication by the market shares matrix:

$$\mathbf{B} = \mathbf{T}\mathbf{U}; \mathbf{F} = \mathbf{T}\mathbf{Y}.$$

B, **F** and **W** together make up the Industry by Industry table.

Derivation of Product by Product analytical tables

The Scottish Government product by product symmetric tables are generated using a hybrid technology assumption transformation model in line with that used for the 2005 and 2010 UK Input-Output analytical tables. This combines models based on two possible assumptions relating to secondary production by industries, i.e. the off-diagonal elements of the supply table.

In producing such secondary products, we either assume that there will be no difference in the structure of inputs required from that shown by the industry (an **Industry Technology Assumption**), or, conversely, we can assume that in producing secondary outputs an industry would need to use the inputs typically shown by the main industry producing the product in question (a **Product Technology Assumption**).

A common real-world example relates to the output of animal feed as a by-product of the production of whisky and other spirits. In this case, a distiller will only purchase the inputs required for the production of their principal product and will not purchase the inputs typically bought by dedicated animal feed producers. Consequently, for the production of animal feed by the spirits and wine industry, an industry technology assumption is employed.

Another example relates to the production of hotels and catering output by the agriculture industry. When renting-out holiday accommodation, agricultural producers will generally act as if they were dedicated hoteliers, and buy a typical mix of inputs associated with the provision of accommodation (linen, detergents, food). In this case, the original agriculture column will be altered using the input structure shown in the hotels and catering column – a Product Technology Assumption would be employed.

Details of the product by product transformation models under industry and product technology assumptions are provided first, before continuing to describe the hybrid model.

The Industry Technology Assumption

Here we define the transformation matrix **T** by dividing each row of **V** by its row total (i.e. the corresponding element of **q**). This gives a matrix of industry output proportions for each product (also known as the product mix matrix). In matrix form:

$$\mathbf{T} = \hat{\mathbf{q}}^{-1}\mathbf{V}.$$

In order to create the PxP matrix, we need to obtain the following three matrices:

- Intermediates in the form product by product, **S**
- Value added by product, **E**
- Final demand by product, **Y**

We already have \mathbf{Y} , final demand by product from the Use table. The columns of \mathbf{U} and \mathbf{W} however refer to products and need to be converted to industries by post-multiplying by the product mix matrix:

$$\mathbf{S} = \mathbf{U}\mathbf{T}; \mathbf{E} = \mathbf{W}\mathbf{T}.$$

\mathbf{S} , \mathbf{Y} and \mathbf{E} together make up the product by product table.

The Product Technology Assumption

Here we defined the transformation matrix \mathbf{T} as follows:

$$\mathbf{T} = (\mathbf{V}^T)^{-1} \hat{\mathbf{q}}^{-1}.$$

(Note that this is the transposed inverse of the market shares matrix used for the industry by industry transformation matrix).

We then post-multiply the matrices we wish to convert with the transformation matrix:

$$\begin{aligned} \mathbf{S} &= \mathbf{U} (\mathbf{V}^T)^{-1} \hat{\mathbf{q}}^{-1} = \mathbf{U}\mathbf{T} \\ \mathbf{E} &= \mathbf{W}\mathbf{T}. \end{aligned}$$

Hybrid technology assumptions

The UK and Scottish product by product tables are produced using a hybrid technology assumption which combines both the industry technology assumption and the product technology assumption.

It begins by splitting the make matrix into two matrices; one containing the cells to be processed under a product technology assumption and one containing the cells to be processed under an industry technology assumption. While in principle there is no reason why single cells cannot be split with one part being handled under an industry technology assumption and part handled under a product technology assumption, due to the absence of data needed to make this split the Scottish tables treat each cell as entirely one or the other (note that all diagonal cells in the make matrix must be assumed to use product technology).

\mathbf{V}_1 = Make matrix for product technology
 \mathbf{V}_2 = Make matrix for industry technology
 \mathbf{g}_1 = vector of product technology output by industry
 \mathbf{q}_1 = vector of product technology output by product
 \mathbf{g}_2 = vector of industry technology output by industry
 \mathbf{q}_2 = vector of industry technology output by product

Analogous to the pure product technology model, the transformation matrix for product technology is constructed as:

$$\mathbf{T}_{\text{PTA}} = (\mathbf{V}_1^T)^{-1} \hat{\mathbf{q}}_1,$$

where \mathbf{q}_1 is the vector of column sums of \mathbf{V}_1 (i.e. the total product technology output of each product). And similarly for the transformation matrix for industry technology²⁸:

$$\mathbf{T}_{\text{ITA}} = \hat{\mathbf{g}}_2^{-1} \mathbf{V}_2,$$

where \mathbf{g}_2 is the vector of row sums of \mathbf{V}_2 (i.e. the total industry technology output by each

²⁸ Note that $\hat{\mathbf{g}}_2$ may be singular, and the inverse therefore does not exist. In this case $\hat{\mathbf{g}}_2^+$, formed by replacing each non-zero element on the diagonal of $\hat{\mathbf{g}}$ with its inverse while leaving zeroes in place, can be used instead. Alternatively, \mathbf{T}_H can be written in such a way as to avoid the need to take an inverse of $\hat{\mathbf{g}}_2$:

$$\mathbf{T}_H = \begin{pmatrix} \mathbf{g}_1 \\ \mathbf{g} \end{pmatrix} \mathbf{T}_{\text{PTA}} + \hat{\mathbf{g}}^{-1} \mathbf{V}_2.$$

industry). The rows of the two transformation matrices are then weighted together by output share to form the hybrid transformation matrix:

$$\mathbf{T}_H = \left(\frac{\widehat{\mathbf{g}}_1}{\mathbf{g}} \right) \mathbf{T}_{PTA} + \left(\frac{\widehat{\mathbf{g}} - \widehat{\mathbf{g}}_1}{\mathbf{g}} \right) \mathbf{T}_{ITA}.$$

where $\widehat{\mathbf{g}}_1/\mathbf{g}$ represents the element-wise division of $\widehat{\mathbf{g}}_1$ by \mathbf{g} (i.e. $\widehat{\mathbf{g}}_1 \widehat{\mathbf{g}}^{-1}$). Then we have:

$$\mathbf{S} = \mathbf{U}\mathbf{T}_H; \mathbf{E} = \mathbf{W}\mathbf{T}_H.$$

as before.

Derivation of Leontief inverse matrices (type I and type II)

Leontief type I

The Leontief inverse matrices are derived from the industry-by-industry matrix and show how much of each industry's output is needed, in terms of direct, indirect and, in type II matrices, induced requirements, to produce one unit of a given industry's output. The formula for the type I Leontief is as follows:

$$\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1} \quad \text{Where:}$$

\mathbf{L} = Leontief Inverse matrix

\mathbf{I} = Identity matrix

\mathbf{A} = Direct requirements matrix – each cell of the IxI matrix divided by its column total.

As an example, aggregate type I and type II Leontief tables will be constructed based upon the aggregate IxI table from the 2017 IO table. Unlike the published aggregate tables, the IxI table separately identifies household expenditure; this is necessary for the calculation of the type II Leontief later in this section.

Dividing each cell in the intermediate demand quadrant of the IxI matrix by its column total (Output at basic prices) produces the direct requirements table (\mathbf{A}). This shows the amount (£) purchased by the industries in the columns from the industries in the rows, in order to produce £1.00 of their own output.

Constructing an identity matrix (all zero with 1s on the diagonal) of the same dimensions as the direct requirements table (in this case, 12x12) and subtracting the \mathbf{A} matrix from the identity matrix produces the $(\mathbf{I} - \mathbf{A})$ matrix, the inverse of which is the type I Leontief Inverse matrix.

The IxI, \mathbf{A} matrix and Leontief type I tables are shown over the page.

Aggregate Industry by Industry Matrix 2017 (Basic Prices)

Industry	Input of Industry											Final demand						Total demand for products			
	Agriculture, forestry & fishing (Section A)	Mining and quarrying (Section B)	Manufacturing (Section C)	Energy supply (Section D)	Water and waste (Section E)	Construction (Section F)	Distribution, hotels and catering (Sections G, I)	Transport, storage and communication (Sections H, J)	Financial, insurance and real estate (Sections K, L)	Professional and support activities (Sections M, N)	Government, health and education (Sections O-Q)	Other services (Sections R-T)	Total intermediate consumption	Consumers	Government	Gross capital formation	Exports - Non-residents		Exports - RUK	Exports - RoW	Total final demand
Agriculture, forestry and fishing	439	2	1,257	18	2	35	94	8	14	7	28	4	1,908	1,185	13	204	80	1,272	859	3,613	5,522
Mining and quarrying	9	202	156	3	6	218	71	19	17	29	31	4	765	90	-	26	13	2,149	485	2,764	3,529
Manufacturing	506	194	3,567	127	67	1,366	591	228	159	207	891	82	7,983	3,827	187	1,291	209	9,925	13,145	28,583	36,567
Energy supply	71	108	814	4,576	40	92	187	107	164	102	335	54	6,650	2,138	-	90	33	3,364	98	5,723	12,373
Water and waste	27	6	120	44	440	27	48	27	53	38	421	30	1,282	803	723	62	13	883	403	2,886	4,169
Construction	89	97	194	86	66	3,480	701	163	1,434	92	465	49	6,914	188	0	10,236	19	1,933	471	12,846	19,760
Distribution, hotels and catering	414	56	2,111	92	52	610	834	324	415	230	1,120	103	6,363	13,357	22	654	3,170	3,013	2,861	23,077	29,440
Transport, storage and communication	120	87	681	44	128	225	1,444	1,616	1,265	438	794	107	6,949	3,061	815	383	430	5,336	2,603	12,627	19,576
Financial, insurance and real estate	134	138	725	185	114	314	945	340	3,411	372	984	89	7,752	21,799	-	446	68	7,711	3,891	33,915	41,666
Professional and support activities	113	143	749	149	120	771	843	800	1,354	2,227	1,286	354	8,911	1,282	31	999	79	7,441	4,120	13,952	22,863
Government, health and education	12	9	119	16	29	117	73	193	408	657	1,899	40	3,571	5,769	36,382	760	45	852	986	44,794	48,365
Other services	13	8	67	14	8	15	74	126	128	105	336	503	1,396	4,092	664	45	238	470	218	5,728	7,124
Total domestic consumption	1,946	1,050	10,558	5,355	1,073	7,271	5,903	3,951	8,821	4,504	8,591	1,420	60,444	57,591	38,838	15,196	4,397	44,349	30,141	190,511	250,955
Imports from rest of UK	1,019	565	5,926	1,582	447	2,757	3,803	2,733	4,650	2,851	3,819	667	30,818	21,157	421	7,210	551	1,378	358	31,076	61,894
Imports from rest of world	366	211	5,065	1,255	227	1,090	1,370	1,093	1,198	839	2,670	354	15,737	10,704	453	3,636	385	1,628	-	16,806	32,544
Total intermediate consumption at basic prices	3,331	1,826	21,549	8,192	1,747	11,118	11,076	7,777	14,669	8,194	15,080	2,440	107,000	89,452	39,712	26,042	5,332	47,356	30,499	238,393	345,392
Taxes less subsidies on products	153	92	703	471	209	84	615	402	1,265	43	1,718	175	5,929	10,779	7	814	822	19	-	12,441	18,370
Taxes less subsidies on production	-477	16	218	209	81	107	1,326	253	208	313	90	127	2,470	-	-	-	-	-	-	-	-
Compensation of employees	743	1,122	8,902	988	892	4,902	11,339	7,132	5,645	9,335	24,012	2,581	77,593	-	-	-	-	-	-	-	31,076
Gross operating surplus	1,772	473	5,195	2,513	1,241	3,550	5,084	4,013	19,879	4,978	7,465	1,800	57,963	-	-	-	-	-	-	-	16,806
Gross value added at basic prices	2,038	1,611	14,315	3,710	2,213	8,559	17,749	11,398	25,732	14,626	31,567	4,508	138,026	-	-	-	-	-	-	-	146,724
Total output at basic prices	5,522	3,529	38,567	12,373	4,169	19,760	29,440	19,576	41,666	22,863	48,365	7,124	250,955	146,724	146,724	146,724	146,724	146,724	146,724	146,724	146,724

Direct requirements table (the A matrix)

Industry	Agriculture, forestry & fishing (Section A)	Mining and quarrying (Section B)	Manufacturing (Section C)	Energy supply (Section D)	Water and waste (Section E)	Construction (Section F)	Distribution, hotels and catering (Sections G, I)	Transport, storage and communication (Sections H, J)	Financial, insurance and real estate (Sections K, L)	Professional and support activities (Sections M, N)	Government, health and education (Sections O-Q)	Other services (Sections R-T)
Agriculture, forestry and fishing	0.08	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mining and quarrying	0.00	0.06	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Manufacturing	0.09	0.05	0.10	0.01	0.02	0.07	0.02	0.01	0.00	0.01	0.02	0.01
Energy supply	0.01	0.03	0.02	0.37	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01
Water and waste	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Construction	0.02	0.03	0.01	0.01	0.02	0.18	0.02	0.01	0.03	0.00	0.01	0.01
Distribution, hotels and catering	0.07	0.02	0.06	0.01	0.01	0.03	0.03	0.02	0.01	0.01	0.02	0.01
Transport, storage and communication	0.02	0.02	0.02	0.00	0.03	0.02	0.05	0.08	0.03	0.02	0.02	0.02
Financial, insurance and real estate	0.02	0.04	0.02	0.01	0.03	0.01	0.02	0.02	0.08	0.02	0.02	0.01
Professional and support activities	0.02	0.04	0.02	0.01	0.03	0.04	0.03	0.04	0.03	0.10	0.03	0.05
Government, health and education	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.03	0.04	0.01
Other services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.07

Leontief type I

Industry	Agriculture, forestry & fishing (Section A)	Mining and quarrying (Section B)	Manufacturing (Section C)	Energy supply (Section D)	Water and waste (Section E)	Construction (Section F)	Distribution, hotels and catering (Sections G, I)	Transport, storage and communication (Sections H, J)	Financial, insurance and real estate (Sections K, L)	Professional and support activities (Sections M, N)	Government, health and education (Sections O-Q)	Other services (Sections R-T)
Agriculture, forestry and fishing	1.09	0.00	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Mining and quarrying	0.00	1.06	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Manufacturing	0.12	0.07	1.12	0.02	0.02	0.10	0.03	0.02	0.01	0.01	0.02	0.02
Energy supply	0.03	0.06	0.04	1.59	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Water and waste	0.01	0.00	0.00	0.01	1.12	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Construction	0.03	0.04	0.01	0.02	0.02	1.22	0.03	0.01	0.05	0.01	0.02	0.01
Distribution, hotels and catering	0.09	0.03	0.07	0.02	0.02	0.05	1.03	0.02	0.02	0.01	0.03	0.02
Transport, storage and communication	0.04	0.04	0.03	0.01	0.04	0.02	0.06	1.09	0.04	0.03	0.02	0.02
Financial, insurance and real estate	0.04	0.05	0.03	0.03	0.04	0.03	0.04	0.02	1.09	0.02	0.03	0.02
Professional and support activities	0.04	0.06	0.03	0.02	0.04	0.06	0.04	0.05	0.04	1.11	0.04	0.06
Government, health and education	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.03	1.04	0.01
Other services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	1.08

Leontief type II

The type II Leontief is calculated in the same way as the type I above but, as its purpose is also to estimate the flows of money in and out of households and the effect of these transactions upon industries (i.e. the *induced effect*), it is necessary to endogenise the household sector. Put simply, we treat households as an additional industry by adding an extra row and column into the direct requirements table for 'compensation of employees' and 'household expenditure' coefficients respectively.

The formal notation for this direct requirements table is:

$\mathbf{A} = \begin{bmatrix} \mathbf{A}_{II} & \mathbf{A}_{IH} \\ \mathbf{A}_{HI} & \mathbf{A}_{HH} \end{bmatrix}$	<p>Where:</p> <p>$\mathbf{A}_{II}[i, j]$ = amount of industry i required per unit of industry j; (This is identical to the 12x12 \mathbf{A} matrix used in the calculation of the Type I Leontief above)</p> <p>$\mathbf{A}_{IH}[i, j]$ = amount of industry i required per unit of total household income from all sources (see note below);</p> <p>$\mathbf{A}_{HI}[i, j]$ = income paid to households per unit of output of industry i;</p> <p>$\mathbf{A}_{HH}[i, j]$ = household expenditure per unit of exogenous household income. (This cell is set to zero)</p>
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Total household income from all sources is used as the denominator when calculating household expenditure coefficients (\mathbf{A}_{IH}) even though it may at first seem odd not to use the total household final consumption expenditure figure (HHFCE) from the IxI Table. However, there is a good reason for this: the total HHFCE figure from the IO tables includes household purchases that are bought with unearned income (pensions, dividends, etc.). In other words, not all household expenditure results from 'Income from employment' paid to households. If the HHFCE figure were used as the denominator, the sum of \mathbf{A}_{IH} would equal 1 and the resulting type II Leontief would tend to overestimate the induced effects of changes in the Scottish economy by artificially inflating the effect of earned income in generating further rounds of household spending.

This figure is also used to estimate unearned income (total income from all sources *minus* compensation of employees) which is used later in the calibration stage. For more information on the decision to use total household income from all sources, please see papers and minutes from the [IO Expert Users' Group](#)²⁹. For 2017, the estimate of total household income from all sources used is £146,724m, taken from the June 2020 release of the ONS Regional GDHI publication.

Once coefficients for the household sector have been included in the manner described above, we arrive at the direct requirements table 'A' over the page.

Subtracting matrix \mathbf{A} from an identity matrix of the same dimensions (12x12) and calculating the inverse of the result $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$ yields the type II Leontief inverse.

Since some of the figures are very small, the full Leontief tables have traditionally been multiplied by 1,000 for presentation purposes.

²⁹ www.gov.scot/groups/input-output-expert-user-group/

Direct requirements table (the A matrix)

Industry	Agriculture, forestry & fishing (Section A)	Mining and quarrying (Section B)	Manufacturing (Section C)	Energy supply (Section D)	Water and waste (Section E)	Construction (Section F)	Distribution, hotels and catering (Sections G, I)	Transport, storage and communication (Sections H, J)	Financial, insurance and real estate (Sections K, L)	Professional and support activities (Sections M, N)	Government, health and education (Sections O-Q)	Other services (Sections R-T)	Consumers' expenditure
Agriculture, forestry and fishing	0.08	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Mining and quarrying	0.00	0.06	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manufacturing	0.09	0.05	0.10	0.01	0.02	0.07	0.02	0.01	0.00	0.01	0.02	0.01	0.03
Energy supply	0.01	0.03	0.02	0.37	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01
Water and waste	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
Construction	0.02	0.03	0.01	0.01	0.02	0.18	0.02	0.01	0.03	0.00	0.01	0.01	0.00
Distribution, hotels and catering	0.07	0.02	0.06	0.01	0.01	0.03	0.03	0.02	0.01	0.01	0.02	0.01	0.09
Transport, storage and communication	0.02	0.02	0.02	0.00	0.03	0.01	0.05	0.08	0.03	0.02	0.02	0.02	0.02
Financial, insurance and real estate	0.02	0.04	0.02	0.01	0.03	0.02	0.03	0.02	0.08	0.02	0.02	0.01	0.15
Professional and support activities	0.02	0.04	0.02	0.01	0.03	0.04	0.03	0.04	0.03	0.10	0.03	0.05	0.01
Government, health and education	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.03	0.04	0.01	0.04
Other services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.07	0.03
Compensation of employees	0.13	0.32	0.24	0.08	0.21	0.25	0.39	0.36	0.14	0.41	0.50	0.36	0.00

Leontief type II

Industry	Agriculture, forestry & fishing (Section A)	Mining and quarrying (Section B)	Manufacturing (Section C)	Energy supply (Section D)	Water and waste (Section E)	Construction (Section F)	Distribution, hotels and catering (Sections G, I)	Transport, storage and communication (Sections H, J)	Financial, insurance and real estate (Sections K, L)	Professional and support activities (Sections M, N)	Government, health and education (Sections O-Q)	Other services (Sections R-T)	Consumers' expenditure
Agriculture, forestry and fishing	1.09	0.01	0.05	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01
Mining and quarrying	0.00	1.06	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manufacturing	0.13	0.09	1.13	0.03	0.04	0.11	0.05	0.04	0.02	0.03	0.05	0.04	0.04
Energy supply	0.04	0.07	0.05	1.59	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03
Water and waste	0.01	0.01	0.01	0.01	1.12	0.01	0.01	0.01	0.00	0.01	0.02	0.01	0.01
Construction	0.03	0.05	0.02	0.02	0.03	1.22	0.04	0.02	0.05	0.02	0.02	0.02	0.02
Distribution, hotels and catering	0.12	0.08	0.11	0.03	0.05	0.09	1.09	0.07	0.04	0.07	0.10	0.07	0.12
Transport, storage and communication	0.05	0.05	0.04	0.02	0.05	0.04	0.08	1.11	0.05	0.05	0.05	0.04	0.04
Financial, insurance and real estate	0.09	0.14	0.10	0.06	0.10	0.11	0.13	0.11	1.13	0.12	0.14	0.11	0.20
Professional and support activities	0.04	0.07	0.04	0.03	0.05	0.07	0.05	0.07	0.05	1.13	0.05	0.08	0.03
Government, health and education	0.02	0.03	0.02	0.01	0.03	0.03	0.03	0.04	0.02	0.06	1.07	0.03	0.05
Other services	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.03	1.09	0.04
Compensation of employees	0.30	0.50	0.40	0.19	0.35	0.46	0.54	0.52	0.24	0.58	0.66	0.52	1.16

Derivation of multipliers and effects

The Input-Output publication gives seven different types of aggregate multiplier for both type I and type II effects. The multipliers allow users to make estimates of the whole economy impacts of small changes in the Scottish economy.

Output multiplier $(O_{\text{mult}})_j = \sum_i L_{ij}$

The Type I output multiplier for a particular industry is defined to be the total of all outputs from each domestic industry required in order to produce one additional unit of output: that is, the column sums (\sum_i) from the Type I Leontief inverse matrix (L_{ij}). Similarly, the Type II output multiplier is given from the column sums of Industry rows (i.e. exclude compensation of employees) from the Type II Leontief.

Income multiplier $(I_{\text{mult}})_j = \sum_i v_i L_{ij} / v_j$

The Type I and II income multipliers show the increase in income from employment (IfE) throughout the Scottish economy that results from a change of £1 of income from employment in each industry. In the formula above, 'v' refers to the ratio of IfE/total output for each industry.

Income effects $(I_{\text{eff}})_j = \sum_i v_i L_{ij}$

This statistic calculates the impact upon IfE throughout the Scottish economy arising from a change in final demand for industry j's output of £1.

GVA multiplier $(G_{\text{mult}})_j = \sum_i g_i L_{ij} / g_j$

The Type I and II GVA multipliers show the increase in GVA throughout the Scottish economy that results from a change of £1 of GVA in each industry. In the formula above, 'g' refers to the ratio of GVA/total output for each industry (taken directly from the IxI table).

GVA effects $(G_{\text{eff}})_j = \sum_i g_i L_{ij}$

This statistic calculates the impact upon GVA throughout the Scottish economy arising from a change in final demand for industry j's output of £1.

Employment multiplier $(E_{\text{mult}})_j = \sum_i w_i L_{ij} / w_j$

The employment multipliers show the total increases in employment throughout the Scottish economy which result from an increase in final demand which is enough to create one additional FTE (full-time equivalent) employment in that industry. In the formula above, 'w' is equal to FTE per £ of total output for each industry.

This analysis uses the results of the symmetric table analysis, but additionally requires full-time equivalent employment (FTE) data. This data is required in the format of the number of FTE's by the 98 industry sectors, and is derived using data from NOMIS³⁰. Note these data cover employees only and therefore do not (currently) cover self-employed persons. Care must be taken when interpreting multiplier analysis of industries that contain a large number of self-employed persons.

Employment effects $(E_{\text{eff}})_j = \sum_i w_i L_{ij}$

The employment effects statistic calculates the impact upon employment throughout the Scottish economy arising from a change in final demand for industry j's output of £1.

³⁰ www.nomisweb.co.uk/Default.asp

Consistency testing the Leontief tables and multipliers

The term 'calibration' is used to describe the process whereby the Leontief Inverses are checked by calculating the matrix product of the Leontief and the vector of final demands. The outcome of this calculation (if the Leontief's are correct) is to recreate the base year gross outputs at basic prices.

$O_g = LF_d$ Where:

O_g = Column vector (of size n, where n = number of industries in the Leontief) of gross output at basic prices for each industry. When calibrating the type II matrix, an 'additional' cell I(1, n+1) is output that should equal the figure of total household income from all sources

L = Leontief Inverse Matrix

F_d = Column vector of final demand by industry. When calibrating the type II Leontief, this vector does not include household expenditure and an additional cell (1, n+1) should be included at the bottom of this vector equalling the figure of unearned income (total income from all sources *minus* compensation of employees)

It should be apparent that, as the type II Leontief is equivalent to the type I Leontief but also includes induced (or household spending) effects, each and every cell in the T2 matrix should be of equal or greater value to its T1 equivalent.

An extra check is carried out on the income multipliers. Dividing the type I income multiplier for each industry by the corresponding type II value should lead to a constant ratio across all industries. In 2017, this constant ratio was 0.89.

Annex A: Industry data sources

SIC07	Industry	Supply	Demand
01	Agriculture	Scottish Government; Scottish Agriculture Output, Input and Income Statistics, Components of Total Income From Farming (TIFF), Non-Agriculture spread using UK supply patterns	Scottish Government; Scottish Agriculture Output, Input and Income Statistics, Components of Total Income From Farming (TIFF), Farm Accounts Survey. (Inter-farm, Non-farming and Non-farm based farming estimated from UK data)
02	Forestry planting and harvesting	ABS and Forestry survey 2001	ABS and Forestry survey 2001
03.1	Sea fishing	Marine directorate of the Scottish Government, Scottish based fishing vessel landings, ABS and UK Supply Table	Marine directorate of the Scottish Government, Scottish based fishing vessel landings, ABS and UK Use table
03.2	Fish farming	Marine directorate of the Scottish Government, Scottish Fish Farms Annual Production Survey, ABS and UK Supply Table	Marine directorate of the Scottish Government, Scottish Fish Farms Annual Production Survey, ABS and UK Use table
05-09	Mining	ABS and UK Supply Table	ABS, ABS Purchases Inquiry and UK Use table
10-37	Manufacturing, energy	ABS, Prodcorn and UK Supply table	ABS, ABS Purchases Inquiry and UK Use table
38-39	Waste and remediation and management	Scottish Local Authority Financial Returns, ABS and UK Supply table	Scottish Local Authority Financial Returns, ABS and UK Use table
41-43	Construction	ABS, Prodcorn and UK Supply table	ABS, ABS Purchases Inquiry and UK Use table
45-63	Distribution, catering, transport & communication	ABS and UK Supply table, BBC Annual Accounts	ABS and UK Use table, BBC Annual Accounts
64-68	Banking & Finance, real estate, estate agents	ONS Annual Survey of Hours and Earnings and UK Supply table	ONS Annual Survey of Hours and Earnings and UK Use table
69-82	Professional, scientific and technical activities; administrative and support activities	ABS and UK Supply table	ABS and UK Use table
84	Public administration	Online System for Central Accounting and Reporting (OSCAR) spending database where possible, Government Expenditure and Revenue Scotland, Public Sector Employment statistics, UK Defence Statistics. ABS and UK Supply table	Online System for Central Accounting and Reporting (OSCAR) spending database where possible, Government Expenditure and Revenue Scotland, Public Sector Employment statistics, UK Defence Statistics. ABS and UK Use table
85	Education	Scottish Local Government Financial Statistics, Scottish Funding Council, Higher Education Statistics Agency, Scottish Council of Independent Schools. ABS (Service Trades) and UK Supply table	Scottish Local Government Financial Statistics, Scottish Funding Council, Higher Education Statistics Agency, Scottish Council of Independent Schools. ABS (Service Trades) and UK Use table
86	Human health services	NHS Annual Accounts. ABS and UK Supply table	NHS Annual Accounts. ABS and UK Use table
87-92, 94	Residential care services; social work services; creative and cultural services	Scottish Local Authority Financial Returns, ABS and UK Supply table	Scottish Local Authority Financial Returns, ABS and UK Use table
93	Gambling	ABS and UK Supply table	ABS and UK Use table
95-97	Other service activities	ABS and UK Supply table	ABS and UK Use table
98	Activities of households	ONS Regional Accounts, UK Supply table	ONS Regional Accounts

[ABS - Annual Business Survey](#) ³¹

[Prodcorn - Products of the European Community](#) ³²

³¹ www.ons.gov.uk/businessindustryandtrade/business/businessservices/methodologies/annualbusinesssurveyabs

³² www.ons.gov.uk/surveys/informationforbusinesses/businesssurveys/ukmanufacturerssalesbyproductprodcorn

Annex B: Input-Output Categories

SIC07 Section	Input-Output Classification (SIC2007)		Std. Industrial Classification of Economic Activities 2007					
Agriculture, forestry and fishing	A	01	Agriculture, hunting and related services	01				
		02.1, 02.4	Silviculture and other forestry activities and support services	02.1	02.4			
		02.2-3	Logging and gathering	02.2	02.3			
		03.1	Marine and freshwater fishing	03.1				
		03.2	Marine and freshwater aquaculture	03.2				
Mining and quarrying	B	05	Coal and lignite	05				
		06-08	Crude petroleum, natural gas and metal ores; other mining and quarrying	06	07	08		
		09	Mining support services	09				
Manufacturing	C	10.1	Preserved meat and meat products	10.1				
		10.2-3	Processed and preserved fish, crustaceans, molluscs, fruit and vegetables	10.2	10.3			
		10.4-5	Dairy products, vegetable and animal oils and fats	10.4	10.5			
		10.6	Grain mill products, starches and starch products	10.6				
		10.7	Bakery and farinaceous products	10.7				
		10.8	Other food products	10.8				
		10.9	Prepared animal feeds	10.9				
		11.01-04	Alcoholic beverages - spirits, wines and cider	11.01	11.02	11.03	11.04	
		11.05-06	Alcoholic beverages - beer and malt	11.05	11.06			
		11.07	Soft drinks	11.07				
		12	Tobacco products	12				
		13	Textiles	13				
		14	Wearing apparel	14				
		15	Leather and related products	15				
		16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	16				
		17	Paper and paper products	17				
		18	Printing and recording services	18				
		19, 20B	Coke, refined petroleum products and petrochemicals	19	20.14	20.16	20.17	20.6
		20.3	Paints, varnishes and similar coatings, printing ink and mastics	20.3				
		20.4	Soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	20.4				
		20.5	Other chemical products	20.5				
20AC	Industrial gases, inorganic chemicals, fertilisers, dyestuffs and agrochemicals	20.11	20.12	20.13	20.15	20.2		
21	Basic pharmaceutical products and pharmaceutical preparations	21						

SIC07 Section	Input-Output Classification (SIC2007)		Std. Industrial Classification of Economic Activities 2007						
		22	Rubber and plastic products	22					
		23.5-6	Manufacture of cement, lime, plaster and articles of concrete, cement and plaster	23.5	23.6				
		23OTHER	Glass, refractory, clay, other porcelain and ceramic, stone and abrasive products	23.1	23.2	23.3	23.4	23.7	23.9
		24.1-3	Basic iron and steel	24.1	24.2	24.3			
		24.4-5	Other basic metals and casting	24.4	24.5				
		25	Fabricated metal products, including weapons and ammunition	25					
		26	Computer, electronic and optical products	26					
		27	Electrical equipment	27					
		28	Machinery and equipment not elsewhere classified	28					
		29	Motor vehicles, trailers and semi-trailers	29					
		30	Other transport equipment	30					
		31	Furniture	31					
		32	Other manufactured goods	32					
		33	Repair and installation of machinery and equipment	33					
Electricity, Gas, Steam and Air Conditioning supply	D	35.1	Electricity; generation, transmission, distribution and trade	35.1					
		35.2-3	Gas; distribution of gaseous fuels through mains; steam and air conditioning supply	35.2	35.3				
Water Supply, Sewerage, Waste; Management and Remediation	E	36, 37	Natural water treatment and supply services, sewerage services	36	37				
		38, 39	Waste collection, treatment and disposal; materials recovery; remediation and other waste management	38	39				
Construction	F	41-43	Construction	41	42	43			
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	G	45	Wholesale and retail trade and repair services of motor vehicles and motorcycles	45					
		46	Wholesale trade services, except of motor vehicles and motorcycles	46					
		47	Retail trade services, except of motor vehicles and motorcycles	47					
Transportation and Storage	H	49.1-2	Rail transport services	49.1	49.2				
		49.3-5	Land transport services and transport services via pipelines, excluding rail transport	49.3	49.4	49.5			
		50	Water transport services	50					
		51	Air transport services	51					
		52	Warehousing and support services for transportation	52					
		53	Postal and courier services	53					
Accommodation and Food Service activities	I	55	Accommodation services	55					
		56	Food and beverage serving services	56					
Information and Communication	J	58	Publishing services	58					
		59 & 60	Motion picture, video and TV programme production services, sound recording & music publishing; Programming and broadcasting services	59	60				
		61	Telecommunications services	61					

SIC07 Section		Input-Output Classification (SIC2007)	Std. Industrial Classification of Economic Activities 2007	
		62	Computer programming, consultancy and related services	62
		63	Information services	63
Financial and Insurance activities	K	64	Financial services, except insurance and pension funding	64
		65	Insurance, reinsurance and pension funding services, except compulsory social security and pension funding	65
		66	Services auxiliary to financial services and insurance services	66
Real Estate activities	L	68.1-2	Real estate services, excluding on a fee or contract basis and imputed rent	68.1 68.2
		68.2IMP	Imputed rent services	-
		68.3	Real estate activities on a fee or contract basis	68.3
Professional, Scientific and Technical activities	M	69.1	Legal services	69.1
		69.2	Accounting, bookkeeping and auditing services; tax consulting services	69.2
		70	Services of head offices; management consulting services	70
		71	Architectural and engineering services; technical testing and analysis services	71
		72	Scientific research and development services	72
		73	Advertising and market research services	73
		74	Other professional, scientific and technical services	74
75	Veterinary services	75		
Administrative and Support Service activities	N	77	Rental and leasing services	77
		78	Employment services	78
		79	Travel agency, tour operator and other reservation services and related services	79
		80	Security and investigation services	80
		81	Services to buildings and landscape	81
82	Office administrative, office support and other business support services	82		
Public Administration and Defence	O	84	Public administration and defence services; compulsory social security services	84
Education	P	85	Education services	85
Human Health and Social Work activities	Q	86	Human health services	86
		87, 88	Residential care services; Social work services without accommodation	87 88
Arts, Entertainment and Recreation	R	90	Creative, arts and entertainment services	90
		91	Libraries, archives, museums and other cultural services	91
		92	Gambling and betting services	92
		93	Sports services and amusement and recreation services	93
Other Service activities	S	94	Services furnished by membership organisations	94
		95	Repair services of computers and personal and household goods	95
		96	Other personal services	96
Activities of Households	T	97	Services of households as employers of domestic personnel	97