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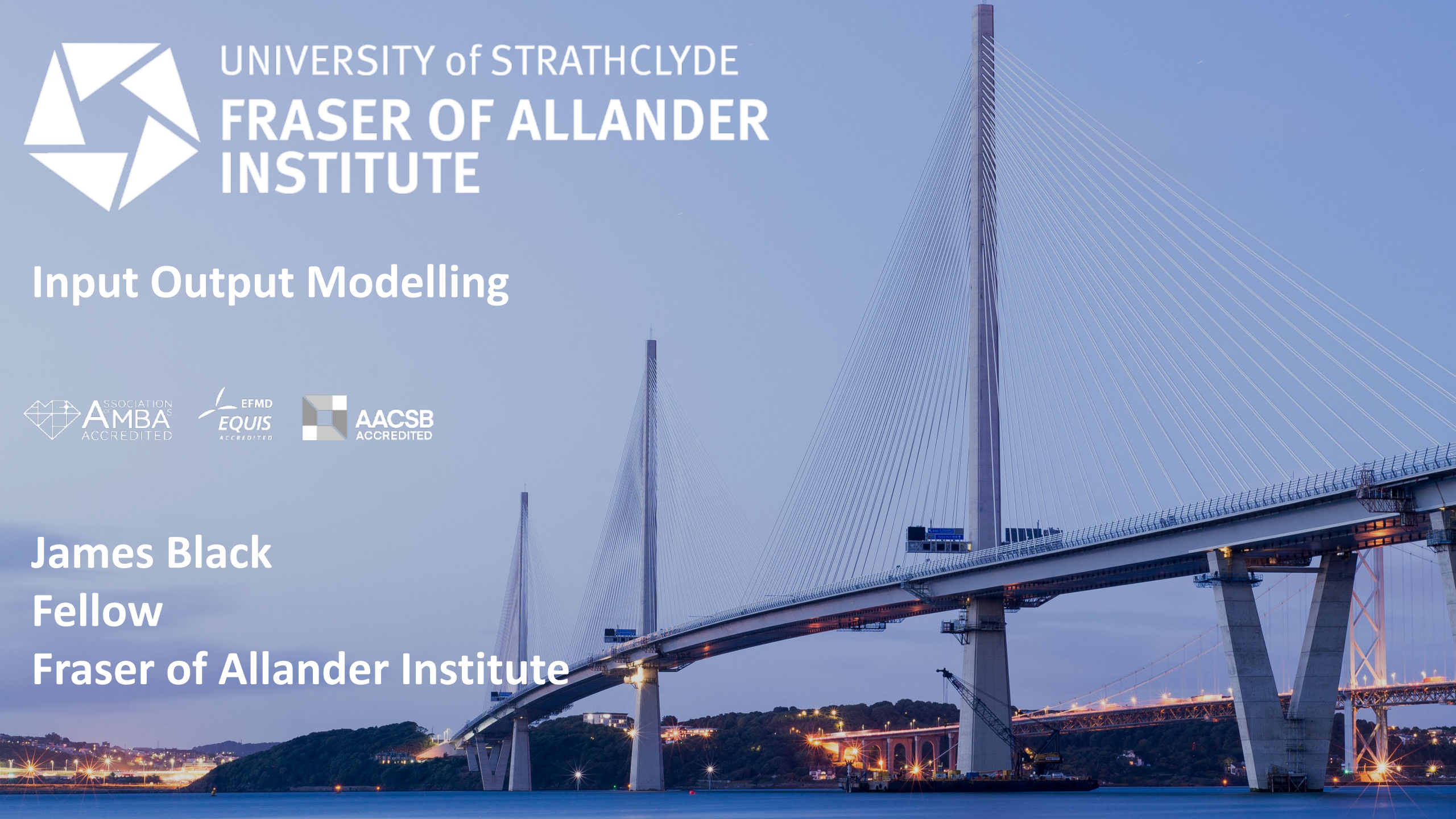
Input Output Modelling



James Black

Fellow

Fraser of Allander Institute

Overview

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- The main focus of this lecture is to develop your skills in input-output (IO) modelling.
- IO modelling is one of the most popular macroeconomic tools and is commonly used across Government, academia and consultancy.
- Wassily Leontief is credited with the creation of IO tables and this won him the Noble Prize in Economics.
- A huge amount of data underpins IO models. This gives rise to the main attractiveness of the tool – it can produce a large amount of interesting information quickly with quite basic inputs.

What we'll be discussing today

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- What sorts of questions can IO modelling answer?
- An introduction to Supply and Use Tables (SUTS)– the data that IO tables are based on
- What are IO multipliers and how can they be used?
- IO modelling + extensions, with examples of real world use
- What IO modelling shouldn't be used for + example of misuse

The lab

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- This will be followed up by a lab session later this summer
- This will be a practical session where you will learn how to undertake IO modelling and interpret the results
- We'll discuss in more detail where it is most appropriate to use IO modelling and to use Computable General Equilibrium (CGE) modelling
  - Both of these NI has access to
- The aim is for you to come out of these sessions ready to apply IO modelling in your day-to-day work. This means we will learn IO from a practical standpoint and not an academic one.

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What sorts of questions can IO answer?

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Number of regional jobs linked to EU exports

1.1 Analysis by HM Treasury estimates that around 3.3 million jobs, out of a total of 33.8 million across the United Kingdom, are linked to exports from the UK to other EU countries. The analysis also estimates how many jobs in each region are linked to exports to the EU.

	Number of jobs related to EU exports (rounded to nearest 50,000)	Workforce jobs December 2015
UK	**3,250,000**	**33,783,000**
North East	100,000	1,172,000
North West	350,000	3,542,000
Yorkshire and the Humber	250,000	2,635,000
East Midlands	200,000	2,343,000
West Midlands	250,000	2,800,000
East of England	300,000	3,068,000
London	650,000	5,576,000
South East	450,000	4,693,000
South West	250,000	2,944,000
Wales	100,000	1,452,000
Scotland	250,000	2,697,000
Northern Ireland	50,000	849,000
Extra-regio[1]	50,000	-

HM Treasury, 2016

- Airbus supported a £5.6 billion contribution to UK GDP, supported 86,400 jobs across the country, and raised more than £1.4 billion in tax revenues in 2020, according to research by Oxford Economics.

Our new report, commissioned by Airbus, highlights that despite the well-documented impact of the COVID-19 pandemic on the global aviation sector, Airbus continues to be a significant contributor to the UK's economy. When looking at Airbus' contribution from the start of 2019 to the end of 2020, it found that, in terms of GDP, employment, tax, and investment, Airbus continues to play a crucial role in the UK's wider economic performance.

The report takes stock of the company's economic, social, and environmental impact in

Oxford Economics

1.2. Key Results

13. Following the approach set out in section 1.1, it is estimated that total emissions attributed to the 2022-23 Budget amount to 9.9 million tonnes carbon dioxide equivalent (MtCO2e). Applying the updated model to last year's 2021-22 Budget leads to a downward revision from the published 10.2 MtCO2e to 9.8 MtCO2e.

[Carbon Assessment of the Scottish Budget, Scottish Government]

Table 2: Portfolio expenditure[4] (TME excluding non-cash items) and emissions

Portfolio	Spend £m	Estimated GHG emissions (thousands of tonnes of CO_2 equivalent)			
		Domestic		Imported	Total
		Direct	Indirect		
Health and Social Care	£17,670	415.8	513.6	1,010.9	**1,940.4**
Social Justice, Housing and Local Government	£15,964	1,017.9	588.0	1,590.7	**3,196.6**
Finance and the Economy	£8,172	68.3	203.3	686.7	**958.3**
Education and Skills	£4,531	108.3	110.4	358.1	**576.9**
Justice and Veterans	£3,081	81.9	94.7	197.8	**374.5**
Net Zero, Energy and Transport	£4,168	531.1	185.0	656.9	**1,373.0**
Rural Affairs and Islands	£958	993.1	160.7	248.3	**1,402.1**
Constitution, External Affairs and Culture	£354	5.9	17.1	23.9	**46.9**
Deputy First Minister and Covid Recovery	£43	1.1	1.3	2.6	**5.0**
Crown Office and Procurator Fiscal	£175	4.8	5.4	11.2	**21.5**
Scottish Parliament and Audit Scotland	£124	3.5	3.4	9.7	**16.7**
Total	**£55,239**	**3,232.0**	**1,883.0**	**4,796.9**	**9,911.9**

UKEF provided a record level of financial support to UK exporters in 2020/21 – £12.3 billion of new loans, insurance and guarantees. Our analysis shows that:

- Our financial support in turn backed £11.3 billion of UK economic output (including amounts subsequently reinsured by other export credit agencies and private insurers)
- This consequently supported up to 107,000 UK Full-Time Equivalent (FTE) jobs.
- Of the total 107,000 jobs supported in 2020-21, 58,000 were directly employed by exporters and 49,000 employed by their supply chain.

UK Export Finance

Economic legacy

- Preparation for, and delivery of, the Games supported a substantial amount of economic activity. Overall the Games is estimated to have contributed, in gross terms, approximately £740 million to Scotland's GVA, and approximately £390 million to Glasgow's GVA specifically, over the period 2007-2014. An estimated average of 2,100 jobs per year nationally, and 1,200 jobs per year in Glasgow specifically, were supported over this time period, peaking in 2014.

An Evaluation of Legacy from the Glasgow 2014 Commonwealth Games, The Scottish Government

When planned benefits are fully rolled out, Social Security Scotland is expected to make payments to 1.8 million children and adults – around one in three people in Scotland. This will include benefits for families on low incomes, people who need help paying for a funeral, disabled people, carers, young people entering the workplace and to help people heat their homes.

Using the latest Scottish Government Input-Output model of the economy, it is estimated that 3,500 full time equivalent public sector jobs in 2022 will directly support around £280m in GVA (Gross Value Added).

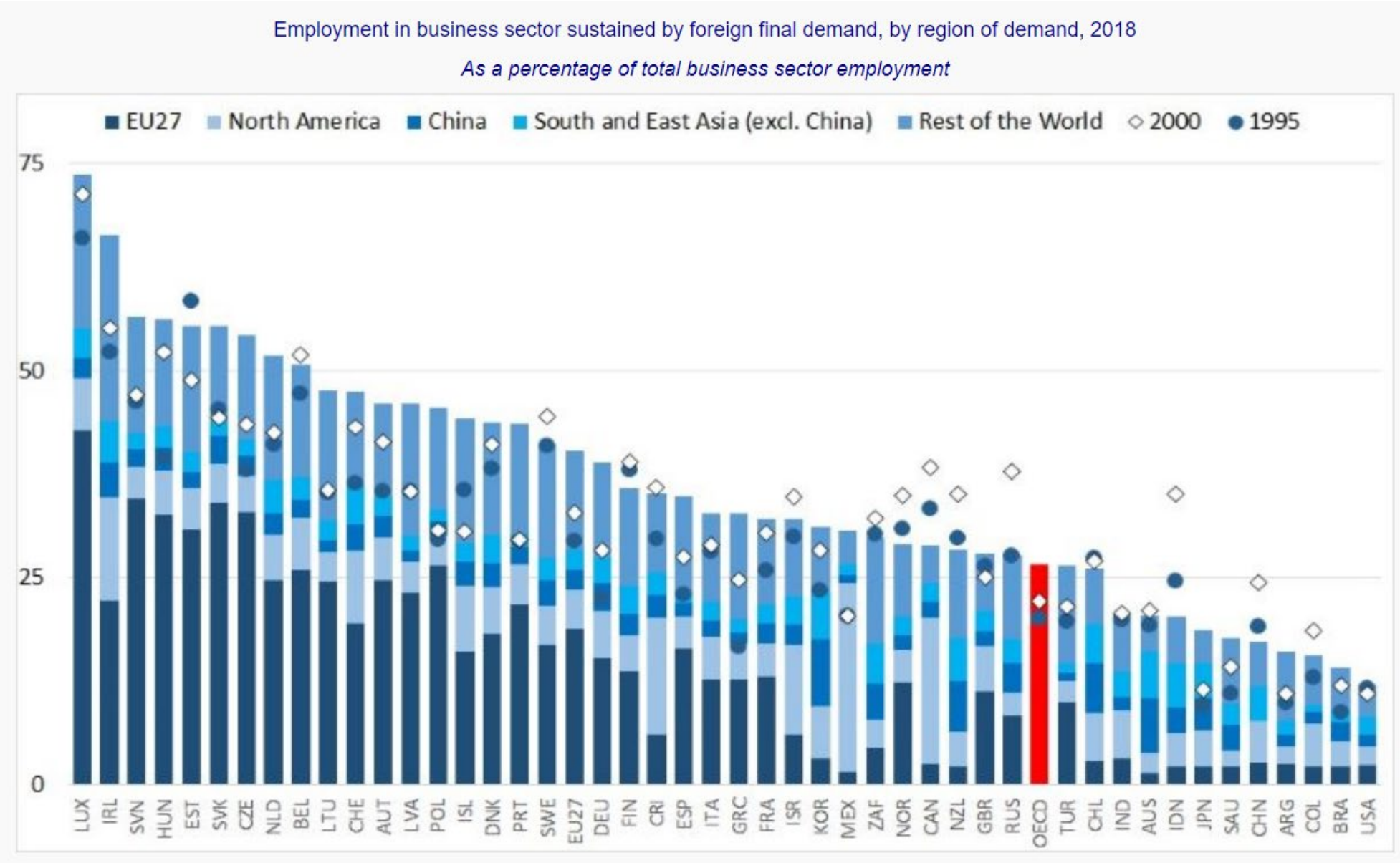
Social Security Scotland

Table 9: UK FTE jobs supported (directly and indirectly) by exports, by gender, number of FTE jobs and % of total FTE jobs supported by exports, 2016

	UK FTE jobs (direct + indirect)		% of total UK FTE jobs supported by exports	
	Male	Female	Male	Female
Direct	2,366,000	1,429,000	62%	38%
Indirect	1,796,000	936,000	66%	34%
Induced	2,642,000	2,151,000	55%	45%
Direct + Indirect ("Type I")	*4,163,000*	*2,365,000*	*64%*	*36%*
Direct + Indirect + Induced ("Type II")	6,805,000	4,516,000	60%	40%

* Data rounded to the nearest thousand. As a result, column totals may not match the sum of elements.

[Estimating the relationship between exports and the labour market in the UK, Department for International Trade (UK)]



[Employment and Global Value Chains (GVCs), OECD]

Common uses

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- Consultancies:
  - Economic impact of a firm or industries
- Government:
  - Economic impact of project
  - Impact of closure of major firm/industry
  - Linking policy to wider outcomes – e.g. how trade impacts on employment for younger people
  - Examining supply chain shocks

Common uses

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- Government:
  - Understanding relationships between industries
  - Modelling how shocks to the economy might impact employment – and which industries could be hit the hardest
- CGE modelling:
  - Different trading relationships with tariff/non-tariff barriers, e.g. Brexit
  - Differing migration scenarios
- Etc

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Supply and Use Tables

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Supply and Use Tables

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- They are also used, along with an important assumption, to create IO tables.
- SUTS include a Supply Table and a Use Table.
- The two tables are “balanced” with each other so that a couple of mathematical identities hold true.
  - Brings together an understanding of the economy that is consistent with all major data sources.
- SUTS are therefore the cornerstone of National Accounts. It is recommended that a supply and use framework is used as the basis for all national accounts data.

Supply and Use Tables

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- Supply Table: Describes how products (goods and services) in Northern Ireland are supplied
  - Domestic production by firms in NI sectors
  - Imports of products
  - Often not fully publicly available due to disclosure issues
- Use Table: Describes how products in Northern Ireland are used
  - Domestic use by firms in NI sectors
  - Exports (i.e. use by non-NI sectors)
  - Use by households, government, gross capital formation

Supply Tables

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	Product		Domestic Supply	*Imports from IE*	*Imports from GB*	*Imports from REU*	*Imports from ROW*	Total Imports	Distributors' Trading Margins	Taxes (less subsidies) on products	Total Supply
5	01	Products of agriculture, hunting and related services	**1 909**	*181*	*430*	*84*	*45*	*741*	*254*	*80*	**2 983**
6	02&03	Products of forestry and fishing	**77**	*28*	*40*	*0*	*0*	*69*	*35*	*0*	**182**
7	B	Mining and quarrying products	**204**	*38*	*419*	*37*	*99*	*593*	*65*	*25*	**886**
8	10	Food products	**4 891**	*858*	*1 243*	*315*	*138*	*2 555*	*1 533*	*259*	**9 238**
9	11-12	Beverages and tobacco products	**315**	*138*	*342*	*133*	*34*	*646*	*725*	*1 110*	**2 795**
10	13	Textiles	**463**	*27*	*67*	*34*	*105*	*233*	*372*	*83*	**1 150**
11	14-15	Wearing apparel and leather products	**113**	*154*	*327*	*139*	*313*	*933*	*983*	*274*	**2 303**
12	16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	**425**	*64*	*107*	*108*	*53*	*333*	*73*	*8*	**839**
13	17	Paper and paper products	**239**	*41*	*308*	*50*	*11*	*409*	*150*	*24*	**822**
14	18	Printing and recording services	**134**	*-*	*82*	*-*	*-*	*82*	*-*	*16*	**232**
15	19-20	Coke, refined petroleum and chemicals	**549**	*167*	*1 769*	*223*	*87*	*2 246*	*470*	*1 065*	**4 329**
16	21	Basic pharmaceutical products and pharmaceutical preparations	**987**	*35*	*209*	*25*	*28*	*297*	*203*	*120*	**1 608**

Use Tables

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NI USE Table 2017

All in £ millions

			A01	A02&03	B	10	11-12	13	14-15	16							Exports of Goods & Services						
	Product		Crop And Animal Production, Hunting And Related Service Activities	Forestry and fishing	Mining and quarrying activities	Manufacture of food products	Manufacture of beverages and tobacco products	Manufacture Of Textiles	Manufacture of wearing apparel and leather products	Manufacture Of Wood & Products Of Wood & Cork, Except Furniture; Manuf. Of Articles Of Straw	Total Intermediate Use	HHFCE	NPISH FCE	CG FCE	LG FCE	Gross Capital Formation	*Exports to IE*	*External Sales to GB*	*Exports to REU*	*Exports to ROW*	Total Exports	Total Use
4	01	Products of agriculture, hunting and related services	117	0	0	1,623	3	2	0	-	1,781	533	-	-	-	97	367	182	20	3	572	**2,983**
5	02&03	Products of forestry and fishing	18	2	-	64	-	-	-	34	152	13	-	-	-	0	6	9	1	0	16	**182**
6	B	Mining and quarrying products	-	0	18	22	0	0	0	0	632	82	-	-	-	(1)	65	90	17	1	173	**886**
7	10	Food products	621	0	0	1,354	18	1	0	1	2,525	2,603	-	-	-	36	871	2,654	293	257	4,075	**9,238**
8	11-12	Beverages and tobacco products	-	-	-	0	10	-	-	-	243	1,851	-	-	-	8	173	490	18	13	694	**2,795**
9	13	Textiles	-	0	-	0	-	112	66	0	336	356	-	-	-	20	46	159	48	185	438	**1,150**
10	14-15	Wearing apparel and leather products	-	-	-	0	-	0	3	-	155	1,868	-	-	-	2	75	157	17	29	277	**2,303**
11	16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	-	-	-	1	-	0	-	136	496	43	-	-	-	(2)	112	184	6	1	303	**839**
12	17	Paper and paper products	4	0	0	68	3	2	1	4	478	148	-	-	-	1	81	94	12	8	195	**822**
13	18	Printing and recording services	-	-	-	0	-	0	-	-	196	29	-	-	-	1	3	1	0	0	6	**232**
14	19-20	Coke, refined petroleum and chemicals	151	9	23	88	2	29	1	23	1,824	1,754	-	-	-	5	263	329	49	106	746	**4,329**
15	21	Basic pharmaceutical products and pharmaceutical preparations	7	-	-	21	-	-	-	-	839	330	-	-	-	3	44	89	92	210	435	**1,608**
16	22	Rubber and plastic products	30	0	0	113	6	11	0	3	808	75	-	-	-	33	195	328	110	100	732	**1,647**
17	23	Other non-metallic mineral products	-	-	8	0	8	-	-	2	820	110	-	-	-	13	75	361	2	5	443	**1,386**
18	24	Basic metals	-	-	0	-	-	-	-	-	944	0	-	-	-	2	93	152	1	7	254	**1,200**
19	25	Fabricated metal products	66	0	0	4	2	2	0	5	1,142	155	-	-	-	128	174	369	33	29	604	**2,029**

Exploring relationships

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- These tables are excellent for relating products to industries
- For example …
  - What products does the accommodation and food services industry purchase? A useful question to ask in a pandemic!
  - Which industries purchase the most fabricated metal?

Supply = Use

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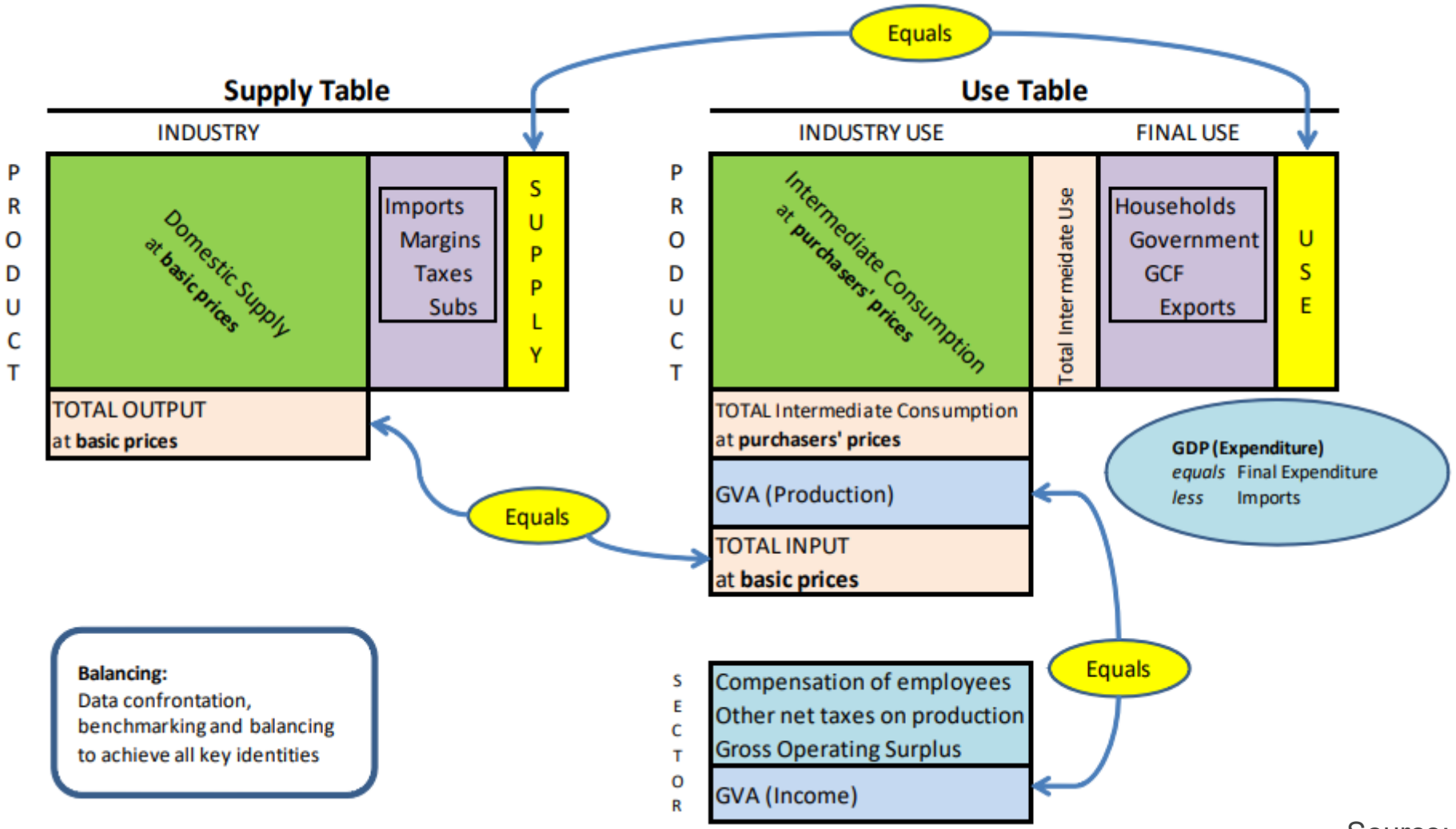
- Two key relationships for SUTS:
  - Total Supply of a product = Total Use of that product
  - Total Output of a sector = Total Input of that sector
- The second one can take people by surprise… but remember that we're including labour costs, taxes and GOS (including profits) in "Total Input"
- These equations provide useful hints as to where different data sources do not align. They are used for "balancing" the data.

Figure 1. Framework for a coherent picture of the economy



Source: NISRA

Underlying data

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- SUTS are based on a huge amount of underlying data.
- Major data sources used across the UK include ABI/ABS, Purchases Survey, PRODCOM, HMT OSCAR, Trade stats, etc.
- SUTS for devolved nations also typically use UK SUTS and ONS Regional Accounts.
- They draw together lots of data sources, measured in many different ways, in a single coherent framework.
- SUTS are therefore an incredibly robust source of data. This is why they are seen as the cornerstone of National Accounts.

Useful outside of IO

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- SUTS are very much not just there to produce IO tables. They have a huge number of uses. SUTS should be the first dataset to check for many economic questions.
- Chiefly, they are commonly used in the production of GDP.
- They allow you to measure GDP in each of the three approaches:
  - Income approach
  - Expenditure approach
  - Production approach
- Due to the earlier equations … each of these should equal to create balanced GDP

Income approach

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GDP Income approach 2017 (£ billion)	**NI**
Compensation of employees (a)	22.3
Taxes, less subsidies, on **production** (b)	0.7
Gross operating surplus (c)	17.0
Gross Value Added at current basic prices (a+b+c)	**40.0**
Taxes less subsidies on **products** (d)	6.3
Gross Domestic Product at current market prices (a+b+c+d)	**46.3**

Source: NISRA

Expenditure approach

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GDP Expenditure approach 2017 (£ billion)	NI
Household final consumption (including NPISH)	29.8
Government final consumption (GGFCE)	12.5
Gross capital formation (GCF)	7.1
Exports (including sales to GB)	23.6
Total final use (a)	**73.1**
Total imports (b) (including purchases from GB)	26.8
Gross Domestic Product at current market prices (a-b)	**46.3**

Source: NISRA

Production approach

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GDP Production approach 2017 (£ billion)	**NI**
Total output at basic prices (a)	76.2
Total intermediate inputs at purchasers' prices (b)	36.2
Gross Value Added at current basic prices (a-b)	**40.0**
Taxes less subsidies on **products** (c)	6.3
Gross Domestic Product at current market prices (a-b+c)	**46.3**

Source: NISRA

Quick note

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- Watch out for a common pitfall when examining SUTS. Different values may be recorded in different prices
  - **Basic prices:** Amount receivable by the producer. Excludes tax on products, includes subsidies on products.
  - **Producer prices:** Basic prices + taxes on products – subsidies on products.
  - **Purchasers' prices:** Amount payable by the purchaser. Producer prices + trade and transport margins + non-deductible VAT. Basic -> Purch transformation in RHS of Supply table.
- I won't get into these for now. But you should directly compare numbers in different price systems.

Converting into IO tables

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- SUTS are in a Product by Industry format.
- With use of an assumption can convert the two tables into an “Industry by Industry” or “Product by Product” input output table.
- We mostly use industry by industry input output tables and so we focus on these. This is because you can match any data that is collected by industry to IxI IO tables … e.g. employment.
- The conversion of SUTS to IO table does require an assumption. For IxI tables, the assumption focuses on the sales structure

Converting into IO tables

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- **Fixed industry sales structure assumption:** Each industry has its own specific sales structure, irrespective of its product mix.
- **Fixed product sales structure assumption:** Each product has its own specific sales structure, irrespective of the industry where it is produced.
- NISRA follows a hybrid methodology.
- You don’t need to remember this for using IO tables. Only need to remember that there is an assumption involved.

Key takeaways

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- SUTS describe industry inputs and outputs in a given year.
- SUTS are the cornerstone of national accounts.
- They are produced for NI by NISRA.
- They can be used to calculate GDP and, using an assumption, to produce input-output tables.
- Industry by industry IOTs are typically more useful than product by product IOTs as you can match any data measured by industry to the data
- Industries and product groups are different concepts – so be careful not to mix these.

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What are input output tables?

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Input Output table overview

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- Input output tables (sometimes called “Analytical Input Output Tables”) describe the flows of goods and services between industries.
- In general they describe interactions between:
  - Intermediate use: Purchases and sales between industries
  - Primary inputs: Compensation of employees (i.e. employee costs), gross operating surplus, taxes
  - Final demand: Households, Government, gross fixed capital, exports, etc
- IO tables describe almost the entire economy in a single spreadsheet
- Produced for Northern Ireland by NISRA

Northern Ireland 2x2 – reading an IOT

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IOT 2017, £ million				Final consumption expenditure				Capital Formation		Exports			
	Production & Agriculture	Construction & Services	**Total intermediate use**	HHFCE	NPISH FCE	CG FCE	LG FCE	Gross Fixed Capital Formation	Valuables	Changes in inventories	Total export of goods	Exports of travel services	Total use for Industry Output
Production & Agriculture	5,157	3,688	**8,846**	2,965	2	297	210	678	0	148	8,717	76	21,940
Construction & Services	3,135	11,226	**14,361**	15,471	781	11,431	422	3,773	0	10	7,526	495	54,271
Total domestic use	**8,292**	**14,915**	**23,207**	18,436	783	11,728	632	4,451	0	159	16,243	572	76,211
Total Use of Imports	5,873	5,691	**11,564**	7,078	4	49	0	1,607	0	13	6,347	92	26,754
Taxes less subsidies on products	349	1,053	**1,402**	3,524	14	94	20	806	0	45	348	12	6,265
Total	6,222	6,744	**12,966**	29,038	801	11,870	652	6,864	0	217	22,938	676	109,230
Taxes less subsidies on production	-122	783	**661**										
Compensation of Employees	4,297	18,047	**22,344**										
Gross operating surplus	3,251	13,782	**17,033**										
GVA at basic prices (Income)	7,426	32,613	**40,038**										
Total output at BASIC PRICES	21,940	54,271	**76,211**										

Standard NI IOT is 63x63 sectors

Relationships

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- The important concept to take from a first look is that IO tables provide a way to relate businesses to labour to final demand and so on
- We can use these relationships to understand some basic information … and then build on this
- To build this intuition, lets start with a question:
  - Without any information other than the input output table, what would you expect to happen if Central Government decided to buy an additional £100m of services?

Reading the IOT #2

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Row = Sales of Services

Column = Purchases of Services

Services sells £11,431 to Central Govt

IOT 2017, £ million				Final consumption expenditure				Capital Formation		Exports			
	Production & Agriculture	Construction & Services	**Total intermediate use**	HHFCE	NPISH FCE	CG FCE	LG FCE	Gross Fixed Capital Formation	Valuables	Changes in inventories	Total export of goods	Exports of travel services	Total use for Industry Output
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- So £11,431m goes to £11,531. What else has to change?

+£1m services purchases by Govt

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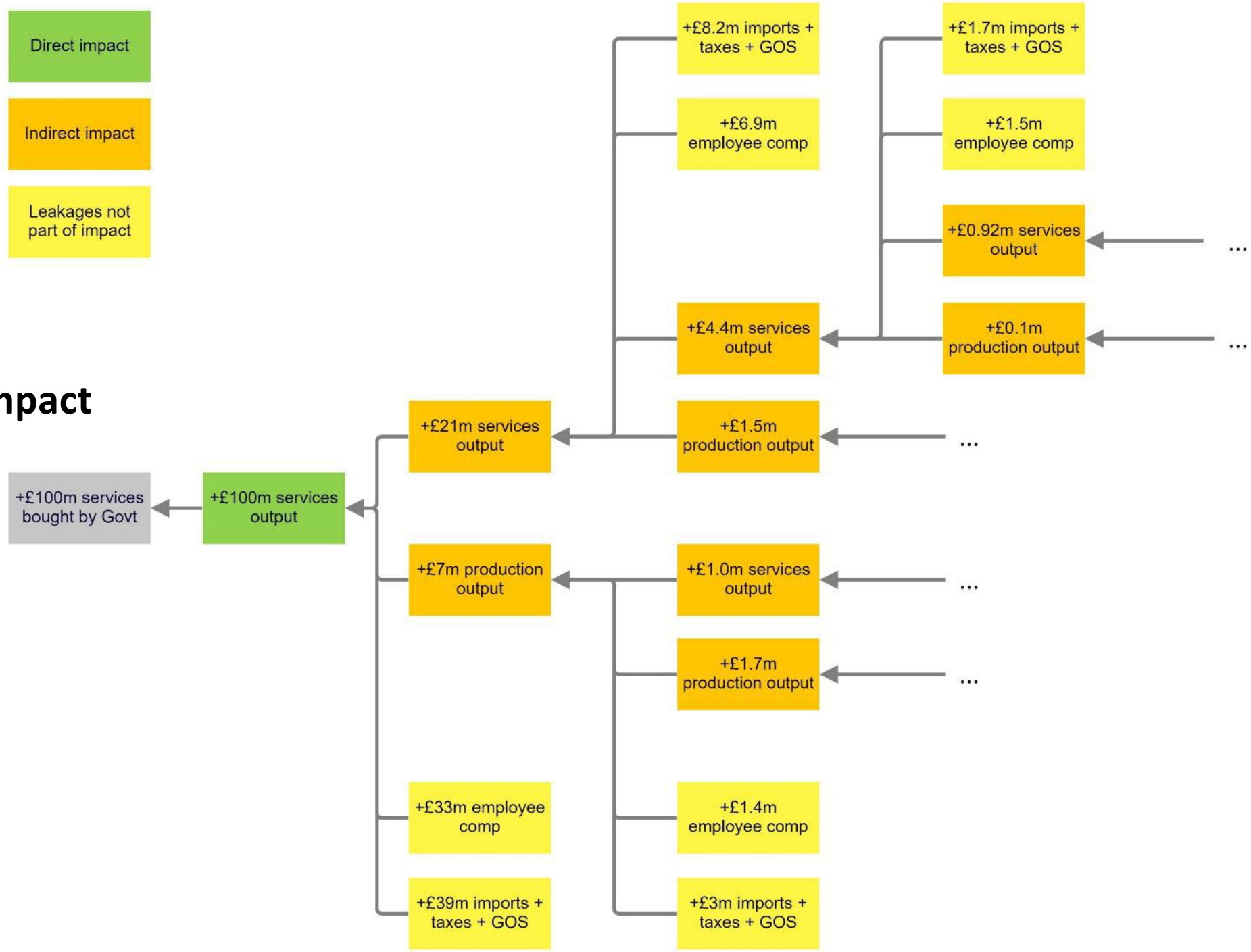
	Production & Agriculture	Construction & Services
Production & Agriculture	24%	7%
Construction & Services	14%	21%
Total domestic use	**38%**	**27%**
Total Use of Imports	27%	10%
Taxes less subsidies on products	2%	2%
Total	**28%**	**12%**
Taxes less subsidies on production	-1%	1%
Compensation of Employees	20%	33%
Gross operating surplus	15%	25%
GVA at basic prices (Income)	**34%**	**60%**
Total output at BASIC PRICES	**100%**	**100%**

- So, without more information, our best guess is that £100m more services leads to the services industry purchasing:
  - £7m from Production
  - £21m from Services
  - £10m imports
  - £33m CoE
  - Etc…

Type I impact



Type I and Type II

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- The direct effect (green) plus the indirect effect (orange) are together called the ‘Type I impact’.
- But some of the yellow parts will surely also have an impact too? E.g. employees don’t just earn wages in a vacuum, they spend these on groceries, utilities, restaurants etc.
- We can also include these wage spending impacts, this is called the ‘induced effect’.
- Type II = direct + indirect + induced
- In fact, there are many “types”. But type I and type II are the most commonly used.

Type I and Type II

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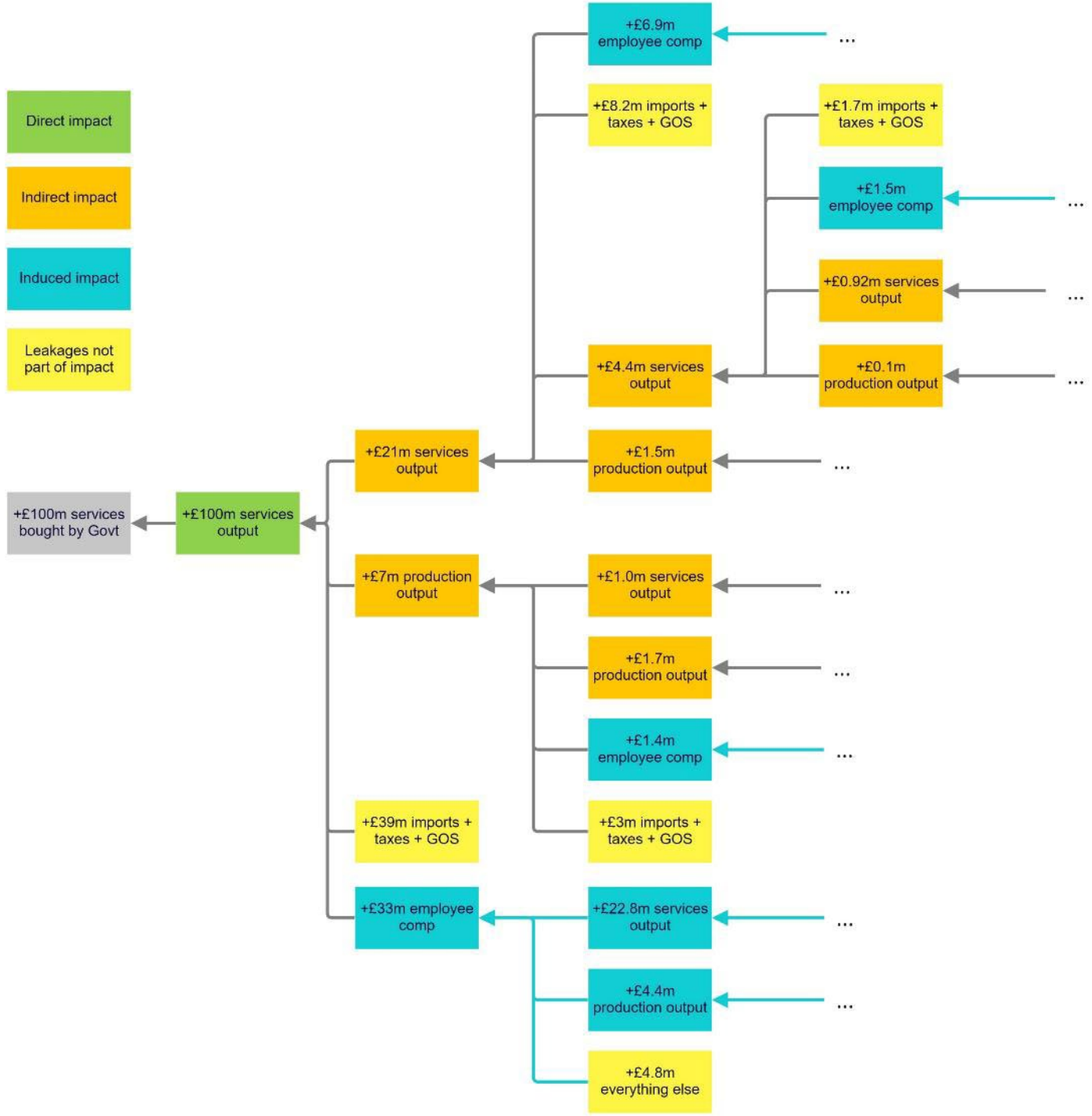
- Household inputs = household final consumption expenditure column
- Household outputs = compensation of employees row (i.e. labour output)
- The calculations to undertake type II analysis effectively move the household column and compensation of employees row into the intermediate part of the table and turn households into an industry

Type II impact

Blue parts are the added induced effect



The core concept

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- This is the core concept of IO modelling from a simplistic standpoint. You can use the structure of an IO table to model changes in final demand.
- This is why IO models are called **demand-side models**.
- That is, you can estimate the impact of a change in final demand.
- We'll cover a range of extensions and different applications later that enhance this process somewhat. But the key concept to remember is that IO modelling is (as default) driven by the underlying structure of the IO table.

Types of effects

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- Three common ways to describe the impact.
- **The direct effect:** £1m increase in Govt purchases of services results in firms in the services sector increasing output by £1m to fulfil the demand
- **The indirect effect:** Increase in output by firms in the services sector requires these firms to purchase inputs from firms in their supply chain. Firms in the supply chain, in turn, purchase from their own supply chain.
- **The induced effect:** All of the additional output due to the direct and indirect effect leads to additional employment. More employment = more wages. More wages = more spending by households = increase in output by firms.

Easy way to remember it

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- **The direct effect:** the industry in question
- **The indirect effect:** supply chain impacts
- **The induced effect:** wage spending impacts
- Not every study includes the induced effect – depends on what you're trying to measure!

Takeaways

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- Input output modelling can estimate the impact of a change in final demand.
- It does this by relying on industry averages in the input output tables (see limitations later).
- Modelling typically examines ‘direct’, ‘indirect’ and sometimes ‘induced’ impacts.
- This is the strength of IO modelling – examining impacts on supply chains.

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Multipliers

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Why calculate multipliers?

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- I showed earlier how you can calculate the economic impact of a £100m increase in government demand for services by turning the IO table into proportions and then following the money along the supply chains.
- But it would be a lot of work to have to do this for multiple sectors. Particularly when we consider that the IO table for Northern Ireland includes 62 sectors.
- Thankfully, Leontief has rescued us with a mathematical approach to calculating what are called “multipliers”.
- If you’re not familiar with matrix algebra, the maths on this doesn’t look very appealing. However, it’s pretty easy to do it in Excel so we’ll keep it for the Lab session.

What are multipliers?

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- Multipliers describe the total economic impact resulting from a change in final demand for a sector.
- Terminology differ between countries which can confuse things.

- We have “type I” and “type II” multipliers:
  - “type I” includes both direct and indirect impacts
  - “type II” includes direct, indirect and induced impacts
- Type II makes more economic sense, but isn’t always the thing of interest.

What are multipliers?

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- We have “effects” and “multipliers”:
  - Type I GVA effects: the change in direct and indirect GVA resulting from a £1m increase in final demand for a sector
  - Type I GVA multiplier: the ratio of the change in direct + indirect GVA to the change in direct GVA, which has arisen due to a £1m increase in final demand for a sector
- This terminology can change a lot… be careful which one you’re using

What are multipliers?

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- And we can create multipliers and effects for any indicator that we have data by industry on:
  - Employment
  - GVA
  - Output
  - Income
  - Carbon emissions
  - Female / Male employment
  - 16-24 employment
  - Employment of people with protected characteristics

What are multipliers?

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- The practical implication of this is that if you have some basic data … you can use multipliers to estimate the size of impacts. For example:
  - Say the Type I employment effects for the services sector is 25
  - This means that an increase in £1m of final demand (e.g. exports) for the services sector is estimated to support 25 jobs across the economy. This includes:
    - X employment directly by the exporting firms in the services sector
    - Y employment indirectly by firms in the supply chain

What are multipliers?

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- The various definitions may be fairly confusing at this stage. These will become clearer in the practical session.
- For now, the key takeaways are:
  - There is a mathematical way to easily calculate multipliers
  - Type I multipliers include direct and supply chain impacts. Type II also add wage spending impacts.
  - You can create multipliers for (almost) any indicator which is measured by sector
  - Multipliers are the most simple form of IO analysis, but let you produce pretty powerful results simply by multiplying numbers together

NI multipliers 2017

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- Type I NI multipliers included in the download from NISRA

4	SIC	Industry Group	NI GVA multiplier	NI Output multiplier	NI FTE Employment multiplier
26	31	Furniture	1.4	1.36	1.3
27	32	Other manufactured goods	1.2	1.20	1.2
28	33	Repair and installation of machinery and equipment	1.1	1.18	1.1
29	35	Electricity transmission and distribution, gas distribution, steam and air conditioning distributionsupply	2.0	1.67	~
30	E	Water supply; sewerage and waste management	1.7	1.66	2.1
31	F	Construction	1.9	1.78	~
32	45	Wholesale and retail trade and repair services of motor vehicles and motorcycles	1.7	1.65	1.7
33	46	Wholesale trade services, except of motor vehicles and motorcycles	1.3	1.36	1.4
34	47	Retail trade services, except of motor vehicles and motorcycles	1.2	1.29	1.2
35	49	Land transport	1.2	1.27	1.3
36	50	Water transport services	1.6	1.44	3.0
37	51	Air transport services	1.2	1.17	1.4
38	52	Warehousing and support services for transportation	1.6	1.57	1.6
39	53	Postal and courier services	1.3	1.34	1.3

Takeaways

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- Want to model the impact of £100m more furniture exports?
  - Multiply 100 by NI output effects to get total output impact
  - Multiply 100 by NI employment effects to get total employment impact
  - Multiply 100 by NI GVA effects to get total GVA impact
- Heard that the new exports added 1,000 new jobs to the companies but don't know how much the exports were?
  - Multiply 1000 by NI employment multiplier

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Modelling based on IOTs

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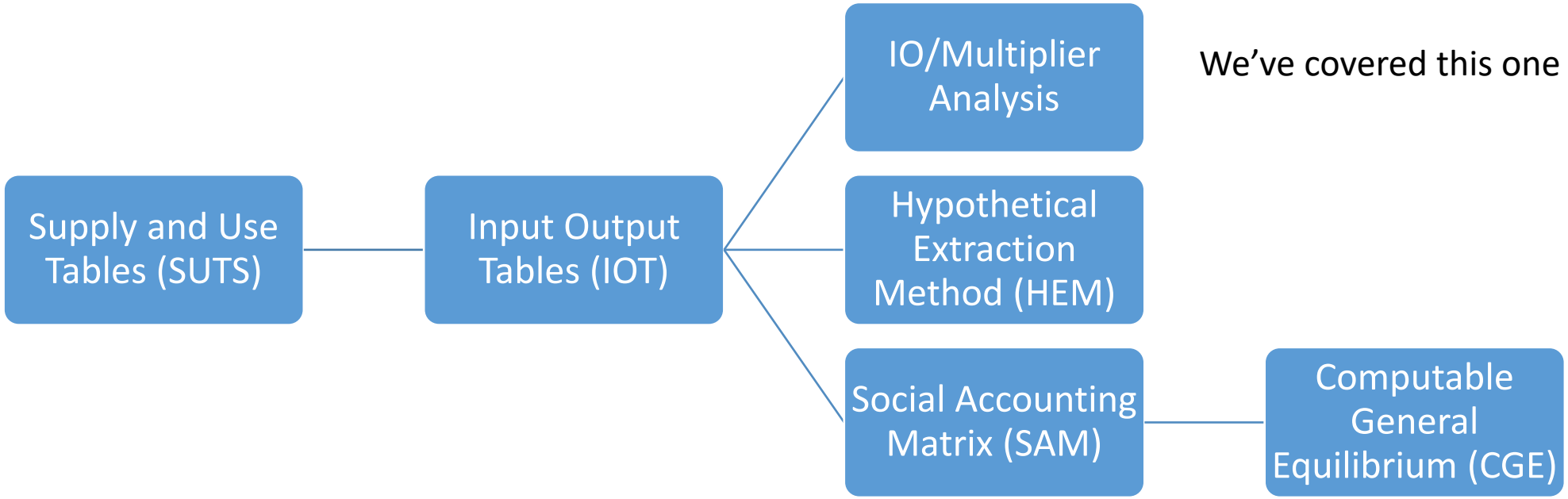
Relationship between modelling & SUTS



IO Modelling Assumptions

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- IO modelling provides a way to think about different scenarios. There are, of course, assumptions and limitations.
- Relies on sector averages
  - Can reduce impact of this assumption by specifying more information
  - Don’t use it in Green Book appraisal – it won’t capture specific differences
- Assumes no substitution between goods and services used as inputs. E.g. construction firms won’t switch from concrete to wood due to an action.
  - Can specify substitution using CGE modelling

IO Modelling Assumptions

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- Passive supply side. There are no limits on supply (of goods, labour etc). Prices do not change.
  - Can't model supply side impacts + IO becomes less accurate in very large impacts.
  - Prices will usually mitigate the true impact of a shock
  - Can look at supply side using CGE modelling
- Standard IO models are static – looking at a single snapshot in time.
  - CGE models are dynamic.
  - IOTs do therefore not attempt to predict the future. They look at current structure.

IO Modelling Assumptions

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- By default, IO modelling provides gross estimates not net estimates.
  - If the money wasn't used for X, it could be used for Y.
  - A company moving to Belfast has "created" Z jobs. But are these jobs truly new or are they mostly just displacing workers from other roles?
  - In general, the same things we need to consider for an economic appraisal.

IO Modelling Assumptions

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- **Takeaways**:
  - IO is good for modelling most demand shocks quickly. But don't expect a high degree of accuracy if you're just multiplying a shock with a multiplier.
  - IO enhanced with extra data can provide additional accuracy. IO multipliers are mostly a best guesstimate.
  - When you're looking at supply side impacts, use a CGE model.

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What to watch out for

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IO gone wrong

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- IO modelling is simple and can produce big jobs numbers (who doesn't love those?).
- But this also brings risk. In my time, I have seen a number of accidental mistakes and some which appear … less accidental.
- We'll cover some of these mistakes now so that you:
  - Can avoid making these mistakes
  - Can spot when an external report trying to influence government doesn't pass the sniff test

Report #1

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- Report looking at the impact of cutting VAT on UK housing repair and renovation from 20% to 5%
- Through various assumptions, assumes this leads to a 5% uplift in demand for housing repair and renovation = +£536m construction output.
- Claims the direct impact of this is 31,949 jobs.
  - That's 59 jobs per £1m of direct impact? Err…
- Then claims construction has a type I output multiplier of 2.98
  - Err… can check the construction product (not sector) output multiplier for 2015 easily as this is published by ONS … it's 1.92

Report #1

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- Using this mult, they say +£536m leads to a total impact of £1.6bn.
- They then divide £1.6bn by the average salary of a full-time construction worker (~40.8k) and say this supports 39,140 full-time equivalent jobs.
  - Err… so none of that £1.6bn is spent on materials, services, profits etc?
  - Weird way to calculate it – could just use employment effects!
- Next they add the results together. Total impact of £536m+£1600m = £2.1bn. Total impact of 31,949 jobs + 39,140 jobs = 71,089 jobs
  - Err… the direct has been double counted here. £536 and 31,949 are both embodied in the other numbers.

Report #1

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- **They claim +£2.1bn and +71,089 jobs.**
- Some quick maths using actual figures calculated from UK IOT 2016:
  - Type I Output mult = 2.05.
    - So, 539 x 2.05 = +£1.1bn
  - Type I Employment effects = 16.37.
    - So, 539 x 16.37 = +8,823 jobs
- **I claim +£1.1bn and +8,823 jobs.**
- I haven't even considered whether the starting assumption of £539m is correct and compatible with multiplier analysis.

Report #1

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- Lessons for undertaking IO modelling:
  - Avoid double counting. E.g. direct is already included in type I multiplier.
  - Understand that you can use employment effects or employment multipliers to calculate jobs impacts.
- Lessons for interpreting IO modelling:
  - Very unlikely to see output multipliers approaching 3 or bigger (especially true in tables for smaller geographical areas, e.g. NI or Scotland).
  - Highest type I output mult for 63 sectors of NI is 1.81. Much above this should = alarm bells.

Report #2

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Employment

- The industry supported some 450,000 jobs, many highly skilled and well paid, across the whole economy, with:
  - 36,000 employed by operating companies
  - 200,000 employed in the supply chain
  - 112,000 in jobs induced by the economic activity of the above employees
  - 100,000 in the export of goods and services

Oil and Gas UK, Economic Report 2014

Takeaways

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- In general, IO is a very powerful methodology.
  - You can specify very little and get a lot of data. But results should be treated as illustrative.
  - Or you can specify a lot and get even more data. But more effort in collecting data and adjusting IOT.
- But with the power of this methodology comes an opportunity for misuse. Clients with big multipliers are the happiest and, at times, it can feel that some consultancies are competing to provide the biggest multipliers …
- Being able to undertake your own modelling can help to quickly sense check these results

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Extensions

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Quick note on sectors

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- While the NI IOT has 63 sectors, you are not fixed to using this number.
- In many cases you may be interested in different sectors which don't fit into standard classifications e.g.
  - Renewable activities
  - Tourism activities
  - A specific (large) firm
- All you have to do is add a row and column in the IOT and fill in the gaps. Then make sure that everything you add into the new sector, you remove from existing sectors so that the totals match.

Hypothetical Extraction Method

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- This is a method to understand the ‘importance’ of an industry, as defined through the ‘interconnectness’ with other industries.
- A HEM poses a hypothetical question – what happens if we shut down an industry? E.g. NI fabricated metal industry.
- Other industries still need to use fabricated metal, so they import it. (Note the implications for this assumption can mean conservative estimates)
- But all the domestic supply chains that feed into the NI fabricated metal industry are severed. The industry now has no demand and no purchases.

Hypothetical Extraction Method

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- This is exactly what the modelling does: sets the final demand to zero and the purchases to zero.
- You then estimate the size of the hypothetical new economy
- Total impact of shutdown = Actual economy minus hypothetical new economy
- This is a useful modelling methodology for:
  - Seeing supply chain impacts of sector shutdown (pandemic?)
  - Seeing supply chain impacts of major firm closing down

Computable General Equilibrium

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- Lots of the above assumptions are removed or softened by using a CGE model.
- In basic terms, a CGE model is based on a social accounting matrix, which is just an IOT with a few bits of data added.
- CGE models can be thought of as IO models with a supply side added.
- They allow you to specify relationships. E.g. how firms substitute between labour and capital.

Computable General Equilibrium

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- They can be very powerful BUT they're also significantly more complex.
- Our base CGE model solves 400,000+ equations.
- DFE NI has a CGE model – you'll need them to run simulations.
- CGE is where you go for any supply side impacts or complex modelling, e.g. labour market productivity, tariff barriers, energy price shocks etc.
- But this can't be done rapidly and results can be more complex to understand.

Computable General Equilibrium

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- Example: The impact of the new Northern Ireland Protocol, 2021

Table 7. Long-term economic impact on key macroeconomic indicators in the FTA scenario.

GDP	CPI	Consumption	Real wage
−2.6%	2.3%	−2.5%	−3.9%

Employment	Investment	Imports	Exports
−1.2%	−3.3%	−4.4%	−7.4%

Exports		Intermediate imports	
Great Britain	Rest of the world	Great Britain	Rest of the world
−6.1%	−8.6%	−5.9%	0.5%

Note: Results from simulations. CPI, consumer price index; and GDP, gross domestic product.