

Input-Output Analytical Tables and Multipliers 2018

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In November 2022, NISRA's Economic Accounts Team published¹ detailed data on the supply and use of commodities, inter-industry flows and the structure of the NI Economy for 2018.

The next stage was the development of experimental NI specific Input-Output Analytical Tables (IOATs) for 2018², published in December 2022. These provide a framework for modelling economic impacts and changes to the domestic economy. Furthermore, Input-Output Analytical tables allow the derivation of economic multipliers which can be used for economic planning, analysis and forecasting.

This bulletin provides a brief overview of Supply-Use Tables (SUTs) before focusing in on Input-Output Analytical tables and their associated multipliers, along with examples to help the reader understand how to use them. It discusses how the information within Input-Output Analytical tables can be used to inform economic analysis, how to interpret the results of that analysis, the limitations of this approach and how the information can be used in further economic accounts production.

¹ NI Supply-Use Tables 2017 and 2018 can be found here: <https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

² NI Input-Output Analytical Tables 2017 and 2018 can be found here: <https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

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1 Introduction

Input-Output Analytical tables describe and quantify the interdependent relationship between inputs and outputs within an economy irrespective of whether the products have been produced by the primary industry or by other industries as their secondary output. The Input-Output Analytical tables show separately the consumption of domestically produced and imported goods and services, providing a theoretical framework for further analysis of the structure of the economy, its composition and the effect changes in demand will have on the economy.

This means from an analytical perspective, users can estimate the impact on the economy of an increase or decrease in spending in one sector and the subsequent impact on the NI economy over the reference period, which in this article is 2018. NISRA has published Gross Value Added (GVA), output and full-time equivalent employment multipliers derived from the 2018 Input-Output Analytical tables at the industry level.

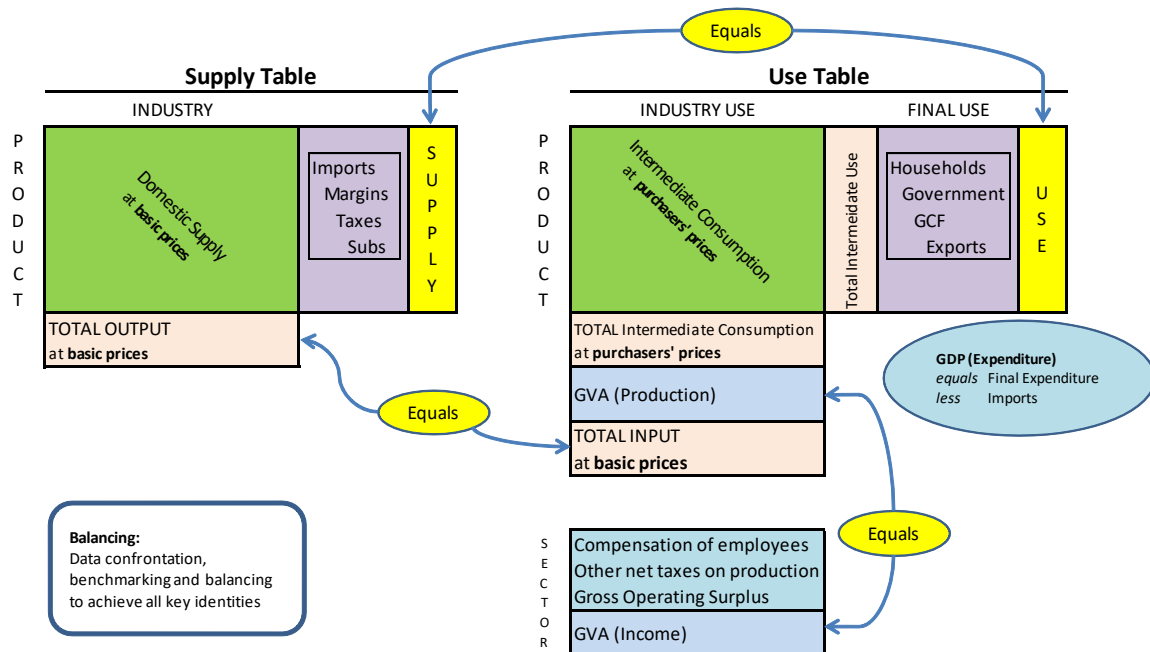
It is important to note that these statistics are designated experimental, to reflect their status as new official statistics that are undergoing evaluation and are subject to revision. As a result, users should adopt a cautious approach to their use. That said, the methodology is in line with the European System of Accounts 2010³, thereby allowing comparison with other countries adhering to the same standard.

³ <https://ec.europa.eu/eurostat/esa2010/chapter/view/1/#h1>

2 Overview of the Supply-Use framework

Supply-Use Tables⁴ are the starting point for the production of the Input-Output Analytical Tables. All other Input-Output analyses are derived from them. The Supply-Use tables provide a picture of the flows of products and services in the economy for a single year and are used to set the level of annual current Gross Domestic Product (GDP). They show the composition of uses and resources across institutional sectors and the inter-dependence of industries.

Figure 1: Supply and Use framework for a coherent picture of the economy



⁴ More detail on the key outputs from the Economic Accounts project, including a methodology guide and results bulletin, is available here - <https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

3 Interpretation of the Supply Table

The primary purpose of the Supply Table is to show the goods and services produced by each industry in Northern Ireland along with the supply of goods and services including imports. The supply of products is presented in the rows while the columns show the industries responsible for the output of these products.

We can see from the excerpt of NI Supply 2018 in Table 1 below (the full Supply table can be found on the NISRA website⁵) that £79,505m worth of goods and services were produced by NI businesses in 2018 (Domestic Supply). Of this, reading across the Product ‘22’ row in the table, we can see that the total value of rubber and plastic products produced domestically by Northern Ireland businesses was £650m (see column headed domestic supply). In addition, rubber and plastic products to the value of £868m were imported in 2018. The total supply of this product in the NI economy equates to £1,634m (after you take into consideration the value of distributors’ trading margins and taxes (less subsidies) on products).

Table 1: Excerpt of NI Supply Table 2018

Product	Product Description	Domestic Supply	Imports from IE	Imports from GB	Imports from REU	Imports from ROW	Total Imports	Distributors' Trading Margins ⁶	Taxes (less subsidies) on products	Total Supply
...
19-20	Coke, refined petroleum and chemicals	458	252	2,034	300	137	2,723	494	1,087	4,762
21	Basic pharmaceutical products and pharmaceutical preparations	1,150	48	170	34	41	293	274	137	1,854
22	Rubber and plastic products	650	88	530	145	106	868	85	30	1,634
...
	Total Supply at basic prices	79,505	3,323	16,484	3,648	2,699	26,155	0	6,262	111,921

⁵ NI Supply 2018 sheet can be found within the NI Supply-Use Tables 2017 and 2018 here - <https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

4 Interpretation of the Use Table

Where the Supply Table presented the supply of goods and services for consumption in Northern Ireland, the Use table shows the demand for goods and services by industries and final demand across the product rows.

The Use Table can be split into 3 main sections.

- **The intermediate use (section 1)**, which shows the inputs of products, both domestic and imported, used by Northern Ireland industries in the production of their output.
- **The final use (section 2)**, which shows the purchases of each product by each category of final use (e.g. Household Final Consumption Expenditure (HHFCE), Non-Profit Institutions Serving Households (NPISH), Central Government (CG), Local Government (LG) and Exports).
- **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.

Reading down the columns of the first section of the Use table we can see the range of products used by each industry to produce goods and services. For example, in the excerpt of the NI Use 2018 table⁶ overleaf, the rubber and plastic products industry purchased a total of £453m of goods and services to produce its own product. The main products purchased were coke, refined petroleum and chemicals (£149m). Reading across the row we can see the destination of products and services. The table shows that £876m of rubber and plastic products were used by industries in the production of their products. The main industry using these products was the rubber and plastics industry (£118m). In addition, £85m of rubber and plastic products were used by the household sector and £665m of goods were exported⁷.

⁶ NI Use 2018 sheet can be found within the NI Supply-Use Tables 2017 and 2018 here -

<https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

⁷ Each of the components of the Supply-Use Tables are based on detailed analysis of a wide range of data sources covering the whole of the Northern Ireland economy. Where direct estimates for NI are not available UK datasets are used to estimate NI values. The range of data sources can be accessed here -

<https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

Table 2: Excerpt of NI Use Table 2018

INDUSTRY INTERMEDIATE USE at purchaser's prices							FINAL USE at purchasers' prices												
Product	Product Description	...	19-20 Manufacture of coke, refined petroleum and chemicals	21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	22 Manufacture of rubber and plastic products	...	Total Intermediate Use	HHFCE	NPISH FFCE	CG FCE	LG FCE	Gross Capital Formation	Exports to IE	External Sales to GB	Exports to REU	Exports to ROW	Total Exports	Total Use	
...
19-20	Coke, refined petroleum and chemicals	...	127	84	149	...	1,995	1,763	0	0	0	7	341	240	187	230	997	4,762	
21	Basic pharmaceutical products and pharmaceutical preparations	...	0	451	0	...	927	335	0	0	0	6	56	110	139	282	586	1,854	
22	Rubber and plastic products	...	6	51	118	...	876	85	0	0	0	7	182	311	112	60	665	1,634	
...
	Total Intermediate Consumption at purchasers' prices	...	220	880	453	...	37,502	30,252	818	11,736	692	6,547	4,498	11,862	2,774	5,241	24,375	111,921	
PRIMARY INPUTS	Taxes less subsidies on production	...	-8	-1	2	...	664												
	Compensation of employees	...	105	182	181	...	23,082												
	Gross operating surplus and mixed income	...	112	139	65	...	18,256												
	GVA (at basic prices)	...	210	319	248	...	42,002												
	TOTAL OUTPUT (INPUTS) at basic prices	...	429	1,199	701	...	79,505												

5 Input-Output Analytical Tables, Multipliers & Effects

The Supply-Use tables serve not only statistical but analytical purposes, especially when they are transformed into analytical Input-Output tables⁸. The analytical tables present a version of the Use table in either an industry by industry or product by product format, as opposed to the product by industry basis of the Supply-Use tables. Industry multipliers for 2018 have been published in December 2022.

The representation of the Supply-Use tables in the Input-Output framework allows the interdependence of industries to be formally analysed as each industry is shown as intermediate purchasers of their own and other industries output. A key output from this analysis is the production of multipliers which help to analyse direct relationships within the economy.

Multipliers capture the idea that a change in the economy does not act in isolation, it ripples through other parts of the economy. Multipliers can help us understand the total size of that ripple. Some industries are clearly more “interconnected” than others.

There are three main types of impacts on the economy.

- **Direct effect (Type I):** This is the immediate effect caused directly by the change in final demand e.g. if there is an increase in final use for a particular product, we can assume that there will be an increase in the output of that product, as producers react to meet the increased demand;
- **Indirect effect (Type I):** This is the subsequent effect caused by the consequent changes in intermediate demand i.e. as producers increase their output, there will also be an increase in demand on their suppliers and so on down the supply chain; and
- **Induced effect (Type II):** This is the effect attributable to the ensuing change in compensation of employees and other incomes, which may cause further spending and hence further changes in final demand e.g. as a result of the direct and indirect effects the level of household income throughout the economy will increase as a result of increased employment. A proportion of this increased income will be spent on final goods and services.

Type I multipliers cover direct and indirect effects only. These multipliers can potentially underestimate the effect on the economy as they do not estimate induced effects.

⁸ Further discussion on this transformation process is available within the NI Economic Accounts Methodology Guide - <https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

In addition to direct and indirect effects, Type II Multipliers also cover induced effects. Type II multipliers for Northern Ireland have been produced for the first time for reference years 2017 and 2018.

Multiple methodologies can be used to calculate Type II multipliers, however the approach we have used is the Miller and Blair Type II methodology⁹.

An example of how these effects flow through the economy is shown in Figure 2 overleaf. This shows what would be expected to happen if Central Government decided to buy an additional £100m of services, based on an aggregated 2x2 2018 Input-Output Analytical table¹⁰.

⁹ Miller, R., & Blair, P. (2022). *Input-Output Analysis: Foundations and Extensions* (3rd ed.). Cambridge: Cambridge University Press. doi:10.1017/9781108676212

¹⁰ The figures in this example were updated on 14th December 2022, based on an aggregated 2x2 2018 Input-Output Analytical table. Previously the example was hypothetical.

6 Industry based Input-Output Analytical Tables & Multipliers

The NI Industry multipliers can be used to estimate the effect a direct change in Output, GVA, or Employment for a particular industry will have on the NI economy as a whole due to a change in final demand. It is important to note multipliers are subject to a number of limitations, some of which are identified on the following page.

Output

The **output multiplier** is the ratio of direct plus indirect output changes (and induced if Type II multipliers are used) to the direct output change.

Using 2018 figures, for an increase in final demand of **£5m** for the **'59-60 Motion Picture, Video & TV Programme Production, Sound Recording & Music Publishing Activities & Programming And Broadcasting Activities'** Industry, the direct impact on this industry will be a requirement to increase its total output by £5m, to meet the additional final demand. A change in final demand will always equal the change in direct output as goods and services must be produced in order to be sold.

To estimate the subsequent indirect effects on the industry's suppliers, we multiply the direct impact (£5m) by the Type I industry output multiplier¹¹ for this industry grouping (**1.49**) giving a **total of direct plus indirect impact on output of £7.43m**.

Using the Type II industry output multiplier for this industry grouping (**2.07**), we can estimate the **total of the direct, indirect and induced impacts on output by multiplying it by the direct impact (£5m) to give £10.33m**. We can then work out the induced impact on output by subtracting the direct plus indirect impact worked out using the Type I multiplier above (£7.43m) from the total of the direct, indirect and induced impacts using the Type II multiplier (£10.33m), **resulting in an induced impact on output of £2.90m**.

The **output effects** is the direct plus indirect (and induced if Type II effects are used) output impact for every £1m change in final demand for that sector.

This means that an increase in **£5m** of final demand for the **"59-60 Motion Picture, Video & TV Programme Production, Sound Recording & Music Publishing Activities & Programming And Broadcasting Activities"** Industry is estimated to support **£7.43m of output** using Type I effects (Direct & Indirect), and **£10.33m of output** using Type II effects (Direct, Indirect & Induced).

For output, these two definitions (multipliers and effects) produce the same numbers, because a £1m increase in final demand always leads to a £1m increase in output.

¹¹ NI Industry based output Multipliers are available here - <https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

GVA

The **GVA multiplier** is expressed as the ratio of the direct and indirect (and induced if Type II multipliers are used) GVA changes to the direct GVA change. In other words, if you have the change in GVA for the industry, the GVA multiplier can be used to calculate the change in GVA for the economy as a whole. This multiplier should therefore be multiplied with the £ change in GVA.

A hypothetical change in demand for the “**10 Food Products**” industry group that leads to a £10m increase in GVA for that industry therefore has a direct impact of £10m. Using 2018 figures, to estimate the subsequent indirect effect on this industry’s suppliers given the increase in GVA, we multiply the direct GVA impact (£10m) by the Type I GVA multiplier¹² for this industry grouping (**2.45**) giving a **total of direct plus indirect impact on GVA of £24.51m**.

Using the Type II industry GVA multiplier for this industry grouping (**3.84**), we can estimate the **total of the direct, indirect and induced impacts on GVA by multiplying it by the direct impact (£10m) to give £38.41m**. We can then work out the induced impact on GVA by subtracting the direct plus indirect impact worked out using the Type I multiplier above (£24.51m) from the total of the direct, indirect and induced impacts using the Type II multiplier (£38.41m), **resulting in an induced impact on GVA of £13.90m**.

The **GVA effects** describes the amount of GVA directly and indirectly (and induced if Type II effects are used) supported in Northern Ireland due to a **£1m** increase in final demand. This multiplier should therefore be multiplied with the £ change in final demand.

This means that an increase in **£1m** of final demand for the “**10 Food Products**” Industry is estimated to support **£0.58m of GVA** using Type I effects (Direct & Indirect), and **£0.92m of GVA** using Type II effects (Direct, Indirect & Induced).

¹² NI Industry based GVA Multipliers are available here - <https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

Employment Multiplier

The employment multiplier is the ratio of direct plus indirect (and induced if Type II multipliers are used) employment changes to the direct employment change.

For example if an increase in final demand for a firm operating in the '**27 Electrical Equipment**' Industry led to the firm employing an additional **20 Full Time Equivalent Employees (FTEs)**, the direct impact on employment will be 20 FTEs.

Using 2018 figures, to estimate the indirect employment effects i.e. the effects on suppliers of that industry to the economy, we multiply the direct employment impact (20 FTEs) by the Type I industry employment multiplier¹³ for the grouping (**1.88**) giving a **total of direct plus indirect employment impact of 37.5 FTEs**. By subtracting the direct FTE increase, we can identify the **additional indirect** number of FTEs supported throughout the NI economy as **17.5**.

Using the Type II industry employment multiplier for this industry grouping (**3.00**), we can estimate the **total of the direct, indirect and induced employment impacts in FTEs** by multiplying it by the direct impact (20) to give **60.1 FTEs**. We can then work out the induced employment impacts in FTEs by subtracting the direct plus indirect impact worked out using the Type I multiplier above (37.5) from the total of the direct, indirect and induced impacts using the Type II multiplier (60.1), **resulting in an induced employment impact of 22.6 FTEs** supported throughout the NI economy.

The **employment effects** is the direct plus indirect (and induced if Type II effects are used) employment impact for every £1m change in final demand for that sector.

This means that an increase in £1m of final demand for the '**27 Electrical Equipment**' Industry is estimated to support **7.2 FTEs** across the economy using Type I effects (Direct & Indirect), and **11.6 FTEs** across the economy using Type II effects (Direct, Indirect & Induced).

Generally, you will most likely see multipliers rather than effects used for employment due to data availability.

¹³ NI Industry based employment Multipliers are available here - <https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2017-and-2018-experimental-results>

7 Limitations of Input-Output Analytical Table & Multipliers

As evidenced in this article, Input-Output Analytical tables are a useful tool, which provide a framework for modelling economic impact and changes to the domestic economy. However the Input-Output Analytical tables are based on a strict set of assumptions, which for the purposes of estimating any subsequent economic impacts, are assumed to remain constant.

The overarching assumption is that interdependency between input and outputs over the relevant period remains constant. Referring back to the previous Industry multiplier example, an increase in output of £5m in the '**59-60 Motion Picture, Video & TV Programme Production, Sound Recording & Music Publishing Activities & Programming And Broadcasting Activities**' industry results in a total direct plus indirect impact of £7.43m, is based on the structure and composition of the economy in 2018. This estimate makes a number of assumptions. Including:

- **Responsive Supply Chain** – relevant industries in the supply chain will vary their own production to meet the variance in demand for their outputs.
- **Fixed Price Supply Chain** - it is assumed there will be no price adjustment or supply constraints.
- **Industry Homogeneity** - any additional increase/decrease in production for an industry/product classification is based on the characteristics of all production within that classification.
- **Fixed Production patterns** – assumes input proportions are fixed in the production process.
- **Local Supply Conditions** – does not make an adjustment for local industries who may purchase inputs from outside the region.

As a result of these assumptions, which reflect the nature of Input-Output Analytical tables, Input-Output modelling is not particularly well suited to estimating very large scale changes to the economy or aspects of the economy experiencing significant or rapid changes from the reference year, for example industries in new or emerging areas (or in sudden decline) or in industries which implement new production methods. Input-Output modelling is also not suited to assessing supply side shocks (for example, changes in labour productivity).

8 Uses of project outputs

The Economic Accounts project has produced data that was never previously available for Northern Ireland. Specifically the detailed Supply-Use tables, Input-Output Analytical tables and associated multipliers have been welcomed by users. The tables provide a detailed insight into the structure and interlinkages of the NI economy and provide users with NI specific data, whereas before users would have relied upon the use of Scottish or UK level data to undertake economic modelling or research projects.

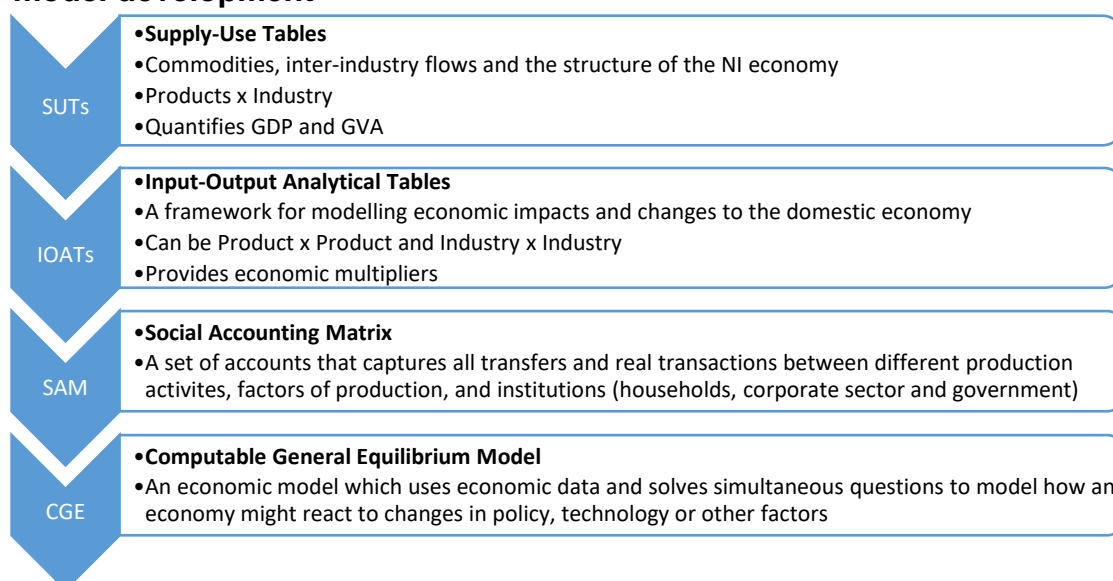
This data stemming from the project has been used by a number of organisations to inform their work.

1. Department for the Economy (DfE) – have received detailed Supply-Use tables data that has been used to inform numerous EU Exit related analyses. In addition, the multipliers derived from the Input-Output Analytical tables were used to undertake modelling work around EU Exit analysis with a focus on how changes in tariffs might impact the NI economy.

- **Computable General Equilibrium (CGE) Model**

The Input-Output Analytical tables have been used in the development of a Computable General Equilibrium (CGE) model¹⁴ by the Department for the Economy (DFE) NI. The CGE model is being used to enhance the economic modelling capabilities and has been used to assess the potential impacts of EU Exit on the NI economy amongst other things. Figure 3 below shows how the Supply-Use and Input-Output Analytical tables informed this work.

Figure 3: Overview of Economic Accounts production informing CGE model development



¹⁴ <https://www.economy-ni.gov.uk/sites/default/files/publications/economy/research-bulletin-19-6-expanding-analytical-toolkit-with-cge-model.pdf>

- **Hypothetical Extraction Model (HEM)**

NISRA have provided the required tables from our Input-Output Analytical tables to facilitate the development of a HEM on behalf of DfE by the Fraser of Allander Institute (FAI).

The HEM is useful for examining the knock-on effects of demand shocks to sectors, sub-sectors, economic activities or companies. It is envisaged that this will be an important tool for DfE economists going forward to allow them to undertake economic analyses of various shocks to the economy.

Further information is provided in the DFE Research Bulletin¹⁵ published in December 2020.

- **Partial Equilibrium Model**

In March 2020 DfE commissioned the University of Sussex to undertake a modelling project to evaluate the possible impact of the UK's departure from the EU on Northern Ireland through the application of a (state of the art) partial equilibrium model. Economic accounts data along with other data produced by ELMS is currently being used to progress this project.

- **Circularity Gap Report**

DFE has commissioned the Strategic Investment Board (SIB) to produce a Circularity Gap report for Northern Ireland for the first time. The purpose of the project is to develop a strategic policy options framework for the Circular Economy (CE) in Northern Ireland¹⁶.

A key component of this is the Input-output Analytical tables which are a pivotal dataset feeding into their work.

- **Investment Levels in Northern Ireland**

A DFE Research Bulletin¹⁷ published in December 2020 looked at the investment levels in Northern Ireland compared to other countries. Investment levels within an economy are measured using a statistic called Gross Fixed Capital Formation (GFCF). GFCF is a net investment concept used within national accounts, which measures expenditure on non-financial assets from both the public and private sectors. GFCF is an internationally recognised standard that is comparable with other countries and is often recorded as a percentage of GDP. GFCF data for NI is sourced from the Economic Accounts project.

¹⁵ <https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Research-Bulletin-20-8-hypothetical-extraction-model-ni.pdf>

¹⁶ <https://sibni.org/project/circular-economy/>

¹⁷ <https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Research-Bulletin-20-4-investment-levels-i-northern-ireland.pdf>

2. **Agri-Food and Biosciences Institute (AFBI)** – have received Input-Output Analytical tables data to inform modelling around the importance of the agri-food sector.

The Systems Modelling unit at AFBI has been able to expand agriculture and food sectors within the Input-Output Analytical tables to calculate new multipliers for Industry-by-Industry (Ixl) and Product-by-Product (PxP) Input-Output Analytical tables for Northern Ireland which are more focussed on agricultural and food products and industries.

A paper has been produced on the impacts of a reduction in British meat and dairy consumption on Northern Ireland's agri-food sector¹⁸.

3. **Economic Statistics Centre of Excellence (ESCOE)** – have received detailed Supply-Use tables data that has been used to inform a project investigating inter-regional UK trade.
4. **Department for Exiting the EU (DExEU)** - received detailed Supply-Use tables data that was used to inform numerous EU Exit related analyses.
5. **HM Treasury (HMT)** - received detailed Supply-Use tables data that was used to inform EU Exit related analyses.
6. **Nevin Economic Research Institute (NERI)** – used Supply-Use tables data to inform EU-Exit related research.
7. **Other** – Supply-Use tables data has been provided to numerous independent economists and academics to inform research projects requiring detailed information on the NI economy.

¹⁸ <https://journals.sagepub.com/doi/10.1177/02690942211032516>

9 Conclusion

The purpose of this bulletin is to provide a brief overview of the outputs of NISRA's Economic Accounts Project, in particular Input-Output Analytical tables and their multipliers. Notably, the Input-Output Analytical tables provide a framework allowing the modelling of economic impacts to NI based on the composition and structure of the economy in 2018. This may be of particular interest to policy colleagues, as it allows the straightforward quantification of the economic impact to NI as a result of variances in demand across industries and products. Furthermore, as the methodology is in line with the European System of Accounts 2010, it is possible to compare Northern Ireland with other countries or regions adhering to the same standard.

This bulletin identified some of the limitations to the impact of Input-Output Analytical tables and the statistics, which users are advised to bear in mind when using them. It is also noted that these are designated as experimental, reflecting their status as new official statistics undergoing evaluation and are subject to revision. Nevertheless, this type of economic analysis, if used responsibly, is a very powerful addition to the analytical toolkit. The Input-Output Analytical tables for Northern Ireland is an exciting area for NISRA, we continue to engage on and are happy to advise any users interested in learning more about the outputs of the Economic Accounts Project and their application.

The Supply-Use tables for 2019 are due to be published in early 2023. The related Input-Output Analytical tables for 2019 will follow a couple of weeks after the Supply-Use tables are published.

10 Further Information

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Additional Reading

Further information on the background to the NISRA project to develop the Supply-Use tables can be found on our [website](#).

Other useful sources of information relating to National Accounts and the Supply-Use framework include:

- [Eurostat Manual of Supply, Use and Input-Output Tables](#)
- [European System of National and Economic Accounts \(ESA 2010\)](#)
- [ONS Series of National Accounts articles](#)
- [Scottish Government Input-Output Methodology Guide](#)
- [UN Handbook on Supply and Use Tables and Input Output-Tables with Extensions and Application](#)