Input-Output Tables and Multipliers 2017

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In October 2021, NISRA's Economic Accounts Project published[1] detailed data on the supply and use of commodities, inter-industry flows and the structure of the economy for 2017.

The next stage was the development of experimental NI specific Input-Output Tables (IOTs) for 2017, published in December 2021. These provide a framework for modelling economic impacts and changes to the domestic economy. Furthermore, Input-Output 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 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 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.

This paper provides an update to the DfE Research Bulletin on Input-Output Tables and multipliers published in December 2018[2].

[1] https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2016-and-2017-experimental-results
[2] https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Research-Bulletin-18-9%20Input-Output%20Tables-and-Multipliers.pdf

Contents

1 Introduction

Input-Output 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 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 2017. NISRA has published Gross Value Added (GVA), output and full-time equivalent employment multipliers derived from the 2017 Input-Output tables at the industry level.

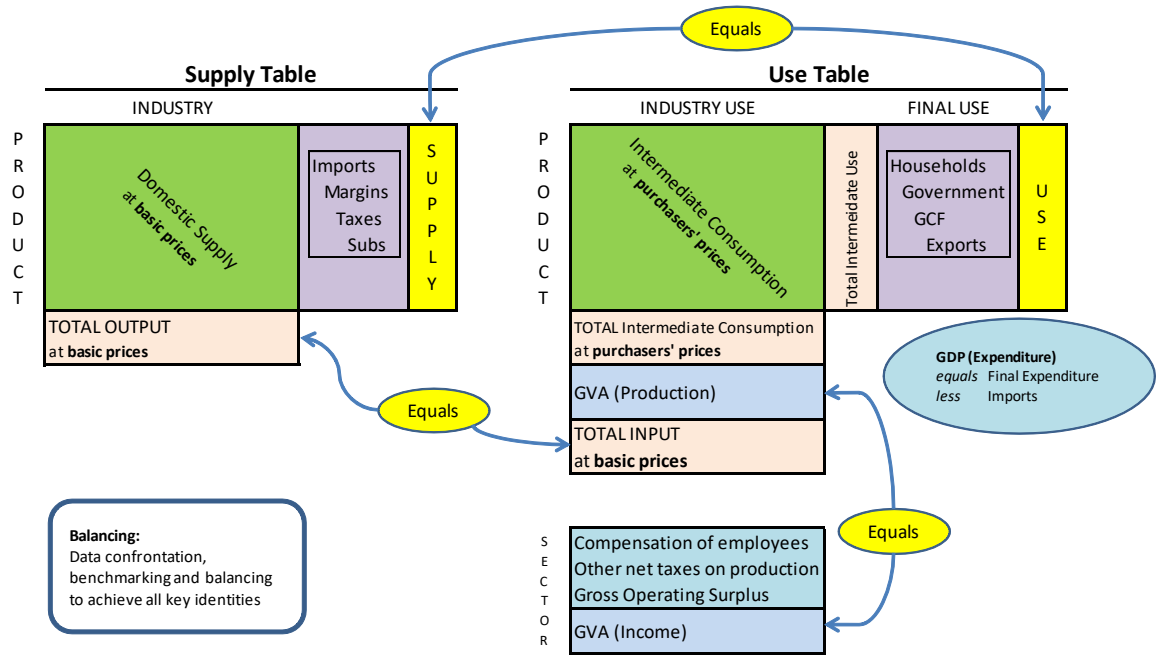
It is important to note that these statistics are designated experimental, to reflect their status as new official statistics undergoing evaluation and are subject to revision. As a result, users should adopt a cautious approach to their use. That said, the methodology is in line with the European System of Accounts 2010[3], 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 Tables[4] 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-2016-and-2017-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 2017 in Table 1 below (the full Supply table can be found on the NISRA website[5]) that £76,211m worth of goods and services were produced by NI businesses in 2017 (Domestic Supply). Of this, reading across the rows in the table, we can see that the total domestic value of rubber and plastic products produced by Northern Ireland businesses was £667m (see column headed domestic supply). In addition rubber and plastic products to the value of £882m were imported in 2017. The total supply of this product equates to £1,647m (after you take into consideration the value of distributors' trading margins and taxes (less subsidies) on products).

Table 1: Excerpt of NI Supply Table 2017

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	549	167	1,769	223	87	2,246	470	1,065	4,329
21	Basic pharmaceutical products and pharmaceutical preparations	987	35	209	25	28	297	203	120	1,608
22	Rubber and plastic products	667	81	566	148	87	882	70	29	1,647
…	…	**…**	…	…	…	…	**…**	**…**	**…**	**…**
	Total Supply at basic prices	**76,211**	**3,185**	**18,225**	**2,970**	**2,374**	**26,754**	**0**	**6,265**	**109,230**

[5] NI Supply 2017 sheet can be found within the NI Supply Use Tables 2016 and 2017 here - https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2016-and-2017-experimental-results

[6] At the level of the total economy the Distributors' trading margins sum to zero

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 2017 table[7] overleaf, the rubber and plastic products industry purchased a total of £442m of goods and services to produce its own product. The main products purchased were coke, refined petroleum and chemicals (£166m). Reading across the row we can see the destination of products and services. The table shows that £808m 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 (£128m). In addition, £75m of rubber and plastic products were used by the household sector and £732m of goods were exported[8].

[7] NI Use 2017 sheet can be found within the NI Supply Use Tables 2016 and 2017 here - https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2016-and-2017-experimental-results

[8] 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-2016-and-2017-experimental-results

Table 2: Excerpt of NI Use Table 2017

INDUSTRY INTERMEDIATE USE at purchaser's prices								FINAL USE at purchasers' prices										
Product	**Product Description**	**...**	**19-20 Coke, refined petroleum and chemicals**	**21 Basic pharmaceutical products and pharmaceutical preparations**	**22 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	...	193	74	166	...	**1,824**	1,754	-	-	-	5	*263*	*329*	*49*	*106*	746	**4,329**
21	Basic pharmaceutical products and pharmaceutical preparations	...	0	382	0	...	**839**	330	-	-	-	3	*44*	*89*	*92*	*210*	435	**1,608**
22	Rubber and plastic products	...	11	55	128	...	**808**	75	-	-	-	33	*195*	*328*	*110*	*100*	732	**1,647**
...	...	...	...	...	...	...	**...**	...	...	...	...	...	...	...	...	...	...	**...**
	Total Intermediate Consumption at purchasers' prices	**...**	**363**	**794**	**442**	**...**	**36,173**	**29,038**	**801**	**11,870**	**652**	**7,082**	***4,336***	***12,180***	***2,240***	***4,858***	**23,614**	**109,230**
PRIMARY INPUTS	Taxes less subsidies on production	...	(7)	(1)	(1)	...	**661**											
	Compensation of employees	...	87	184	205	...	**22,344**											
	Gross operating surplus and mixed income	...	118	104	81	...	**17,033**											
	GVA (at basic prices)	...	198	287	285	...	**40,038**											
	TOTAL OUTPUT (INPUTS) at basic prices	**...**	**560**	**1,081**	**727**	**...**	**76,211**											

5 Input-Output Tables & Multipliers

The Supply-Use tables serve not only statistical but analytical purposes, especially when they are transformed into analytical Input-Output tables[9]. 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 2017 have been published in December 2021.

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.

A multiplier allows users to estimate the impact a small change in demand would have on the whole Northern Ireland economy. The multiplier is calculated as the ratio of the total economic effect on the whole economy to the initial change. So, an output multiplier of 1.66 for example would indicate that if a sector in Northern Ireland were to increase output by £100m then ultimately total output for Northern Ireland would increase by £166m.

There are two main categories of multiplier - Type I & Type II, which between them cover three economic effects

- **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 re-spent on final goods and services.

[9] 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-2016-and-2017-experimental-results

Type I multipliers cover direct and indirect effects only. These multipliers underestimate the effect on the economy as they do not estimate induced effects. Type II Multipliers cover induced effects as well, but due to data availability it has not been possible to produce robust Type II multipliers for Northern Ireland.

Within the Type I category there are different multipliers that can be employed to measure the effect on different policy targets. Two of the more common are Output multipliers and GVA Multipliers. Each sector has a unique multiplier because each has a different pattern of purchases from firms in and outside the region.

6 Industry based Input-Output Tables Multipliers

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

Output Multiplier

Let's take the hypothetical example of an increase in **output** 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.

To estimate the subsequent indirect effects on the industry's suppliers, we multiply the direct impact (£5m) by the Type 1 industry output multiplier[10] for this product grouping (**1.53**) giving **a total of direct plus indirect impact in output of £7.65m**

GVA Multiplier

The direct impact on NIGVA caused by a hypothetical increase of **£10m** in the **GVA** of "**10 Food Products"** Industry group is £10m. To estimate the subsequent indirect effect on this industry's suppliers given the increase in GVA, we multiply the direct impact (£10m) by the GVA multiplier[11] for this Industry grouping (**2.41**) giving **a total of direct plus indirect impact in GVA of £24.14m**.

Employment Multiplier

It is also possible to estimate the subsequent impact a change in employment for a particular industry will have on the NI economy. For example if a firm operating in the **'27 Electrical Equipment'** Industry employed an additional **20 Full Time Employees (FTEs)**. The direct impact on employment will be 20 FTEs.

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 Employment multiplier[12] for the grouping (**1.65**) giving a **total of direct plus indirect employment impact of 33 FTEs**. By subtracting the direct job increase, we can identify the **additional indirect** number of jobs supported throughout the NI economy as **13 (FTEs)**.

It should be again noted that Type 1 Multipliers, underestimate the effect on the economy, as they do not estimate induced effects.

[10] NI Industry based Multipliers are available here - https://www.nisra.gov.uk/publications/ni-economic-accounts-project-2016-and-2017-experimental-results
[11] As above
[12] As above

7 Limitations of Input-Output Table Multipliers

As evidenced in this article, Input-Output tables are a useful tool, which provide a framework for modelling economic impact and changes to the domestic economy. However the Input-Output 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 £7.65m, is based on the structure and composition of the economy in 2017. 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 within the relevant time period.
- **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.

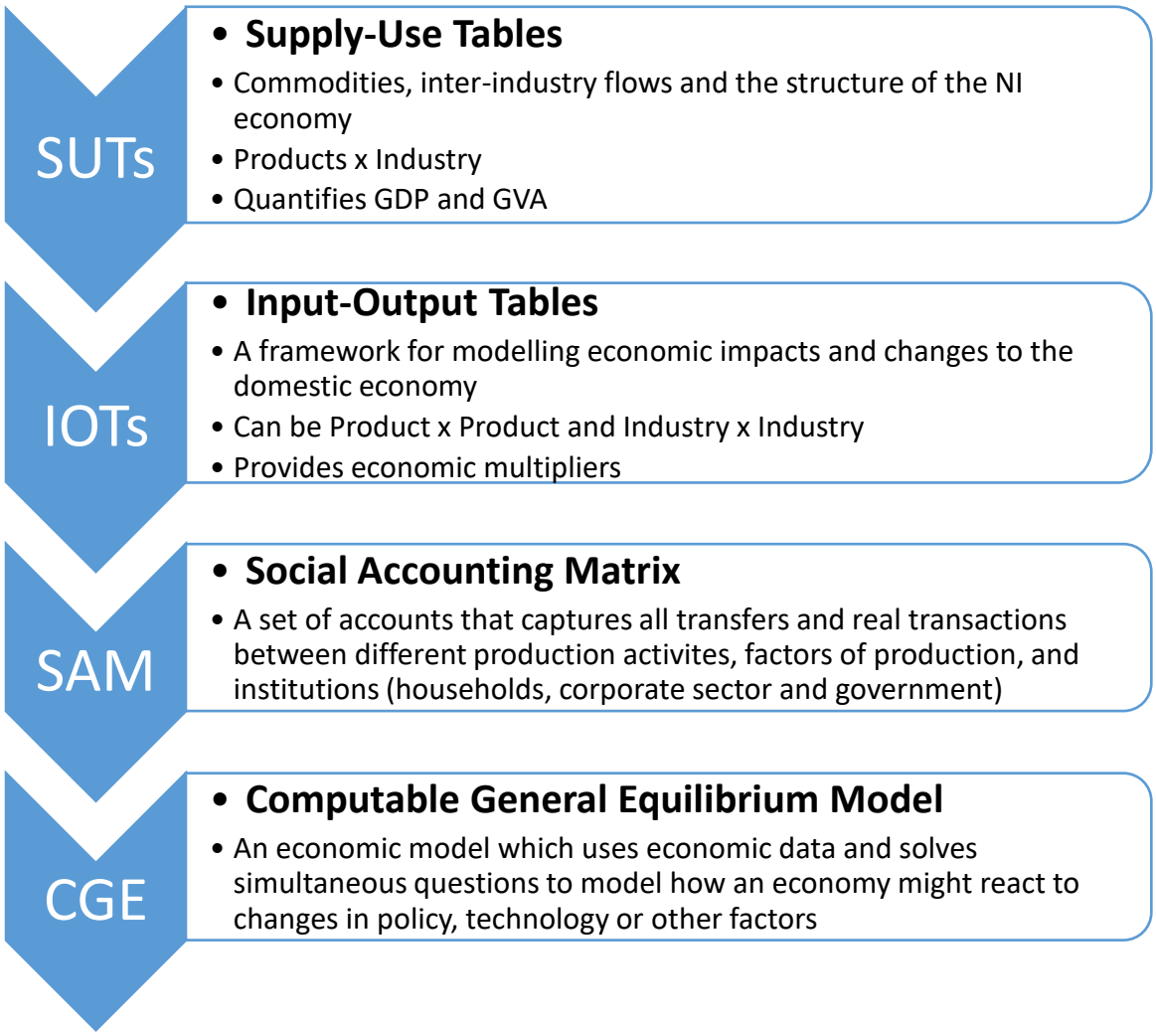
As a result of these assumptions, which reflect the nature of Input-Output tables, Input-Output modelling is not particularly well suited to estimating very large scale changes to the economy or aspects of the economy experiencing significant or rapid changes from the reference year, for example industries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

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

Figure 2: Overview of Economic Accounts production



1. **Department for the Economy (DfE)** – have received detailed unpublished Supply-Use tables data that has been used to inform numerous EU Exit related analyses. In addition, the multipliers derived from the Input-Output tables were used to undertake some 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 tables have been in the development of a Computable General Equilibrium (CGE) model[13] 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.

   - **Hypothetical Extraction Model (HEM)**

     NISRA have provided the required tables from our Input-Output 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 Bulletin[14] 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 have 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 Ireland[15].

[13] https://www.economy-ni.gov.uk/sites/default/files/publications/economy/research-bulletin-19-6-expanding-analytical-toolkit-with-cge-model.pdf
[14] https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Research-Bulletin-20-8-hypothetical-extraction-model-ni.pdf
[15] https://sibni.org/project/circular-economy/

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

- **Investment Levels in Northern Ireland**

  A DFE Research Bulletin[16] 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.

2. **Agri-Food and Biosciences Institute (AFBI) –** have received unpublished Input-Output 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 tables to calculate new multipliers for Industry-by-Industry (IxI) and Product-by-Product (PxP) Input-Output tables for Northern Ireland which are more focussed on agricultural and food products and industries.

   Work is ongoing on evaluating the impact of immigration policy change in NI agri-food sector, and a paper has been produced on the impacts of a reduction in British meat and dairy consumption on Northern Ireland's agri-food sector[17].

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 unpublished Supply-Use tables data that has been used to inform numerous EU Exit related analyses.

5. **HM Treasury (HMT)** - received detailed Supply-Use tables data that has been used to inform EU Exit related analyses.

6. **Nevin Economic Research Institute (NERI)** – used Supply-Use tables data to inform EU-Exit related research.

[16] https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Research-Bulletin-20-4-investment-levels-i-northern-ireland.pdf
[17] https://journals.sagepub.com/doi/10.1177/02690942211032516

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.

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 tables and their multipliers. Notably, the Input-Output tables provide a framework allowing the modelling of economic impacts to NI based on the composition and structure of the economy in 2017. 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 tables and the statistics are designated 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 tables for Northern Ireland is an exciting area for NISRA, we are keen to engage and 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 2018 (and subsequent Input-Output tables) are due to be published in early 2022.

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