Llywodraeth Cymru
Welsh Government

YSTADEGAU, DOGFENNU

Lluosyddion economaidd dangosol (tablau mewnbwn-allbwn): 2019

Mae'r erthygl ystadegol hon yn cyflwyno'r cysyniad o luosyddion cynnyrch, gwerth ychwanegol gros a chyflogaeth sy'n deillio o'r tablau mewnbwn-allbwn ar gyfer Cymru. Mae'r erthygl hefyd yn cynnwys rhybuddion pwysig am sut i'w dehongli a'u defnyddio. Saesneg yn unig.

Cyhoeddwyd gyntaf: 15 Hydref 2025

Diweddarwyd ddiwethaf: 15 Hydref 2025

Cynnwys

Introduction

In March 2025, the Welsh Government published its first **supply-use and input-output table for Wales** (/tablau-cyflenwad-defnydd-thablau-mewnbwn-allbwn-2019). These tables provide a snapshot of the Welsh economy in 2019, detailing the buying and selling relationships of goods and services between its component parts, the rest of the UK, and the world.

Input-output tables are used to calculate economic multipliers and indirect economic effects, which estimate how changes in final demand for one industry's output can affect other industries across the Welsh economy. The Welsh Government has now published indicative effects and multipliers for economic output, gross value added (GVA), and employment. These are **available on StatsWales** (https://stats.gov.wales/en-GB/3e1adeb5-de50-4dd6-abc8-5b9e7164739b), along with additional Leontief matrices – used to support input-output modelling – **published in a supporting spreadsheet** (/lluosyddion-economaidd-dangosol-tablau-mewnbwn-allbwn-2019).

Users should carefully consider the assumptions that underpin the data, as outlined in this article. Worked examples are provided to show how effects and multipliers can be applied, along with guidance on appropriate use.

These effects and multipliers are based on the input-output tables for Wales, which are designated **as official statistics in development (Office for Statistics Regulation)** (https://osr.statisticsauthority.gov.uk/policies/official-statistics-policies/official-statistics-in-development/). This designation reflects the fact that the methodology is still being refined and that some known data quality issues remain. Further detail on data sources, methods and limitations is available in the **methodology article** (/tablau-cyflenwad-defnydd-thablau-mewnbwn-allbwn-2019-ar-gyfer-cymru-methodoleg-amlinellol-html) published alongside the original release.

To support analysis, the Welsh Government's Data Science Unit has developed an interactive tool for input-output modelling. Those interested in **reviewing or**

installing the tool can do so via GitHub (https://github.com/wgdsu/InputOutputAnalysisTool). This tool makes it easier to explore and visualise the direct and indirect effects of changes in industry output.

Definitions of effects and multipliers

The Welsh Government has published effects and multipliers for output, GVA and employment to accompany the 2019 input-output tables for Wales.

A brief description of the three measures is provided below.

Output

The total value of goods and services produced by an industry during the year. This is similar to turnover, but it also includes changes in inventories (including work in progress) and own-account production. When valued at basic prices (as in the input-output table), output excludes taxes on products (such as VAT, excise duties and import duties) and trade and transport margins.

Gross Value Added (GVA)

A measure of economic output that excludes the value of intermediate goods and services used in production. For example, if a furniture store sells a chair for £200 and the inputs cost £50, its contribution to GVA is £150. Statistically, GVA comprises the total of payments to labour, other value added, and taxes-less-subsidies on production, but (as with Output) excludes taxes on products.

Full-time equivalent (FTE) employment

FTE employment refers to the total number of jobs, adjusted for part-time working patterns. It expresses employment in terms of full-time units, allowing for consistent comparison across industries.

In practice, multipliers can be calculated for a wide range of measures. For example, if greenhouse gas emission estimates are available for each sector in an input-output table, it would be possible to derive multipliers to estimate the total impact of changes in domestic emissions across all industries should one industry experience a change in final demand and output.

Direct, indirect and induced effects

When final use of a particular industry's output increases, the input-output model assumes that the industry will respond by increasing its economic output to meet the higher demand.

This response, and the wider impacts it triggers, can be grouped into three types of effect.

Direct effects

The immediate increase in output for an industry resulting from a change in final use. For example, if demand for manufactured products increases by £100 million, we expect a directly corresponding increase in output from the manufacturing industry.

Indirect effects

The increase in output from industries that supply inputs to the industry experiencing higher demand. For example, increased manufacturing output leads to greater demand for raw materials, energy and transport services, boosting output in those sectors further up the supply chain.

Induced effects

The direct and indirect effects lead to more employment and higher household income in both manufacturing and supplying industries in Wales. A portion of

this income is re-spent across the economy, generating further demand. These additional rounds of spending are known as the induced effect.

Effects are a way of quantifying how a change in final use impacts the wider economy. For instance, an employment effect shows the impact that every £1 million spent on an industry's final products has on full-time equivalent (FTE) employment across the Welsh economy.

- Type I effects capture direct and indirect effects only.
- Type II effects capture direct, indirect and induced effects.

Example: GVA effects

In 2019, the Welsh agricultural sector had a Type II GVA effect of 0.47. This implies that if the sector's output increased by £1 million, Welsh GVA might be expected to increase by up to £0.47 million. As this is the Type II effect, this includes the direct, indirect, and induced effects of additional rounds of spending triggered by higher household income resulting from increased employment.

Multipliers

Multipliers offer another way to express these effects. They show the ratio of total effects (direct, indirect and, for Type II multipliers, induced effects) to direct effects for a given metric.

Example: employment multipliers

Suppose a new plant opens in the basic metals manufacturing sector, employing 100 full-time workers. This represents the direct impact on employment.

Using the sector's 2019 employment multipliers (Type I: 1.59, Type II: 1.80), we might expect the net potential impact on employment in Wales to be 180 (100 * 1.80) full-time equivalent (FTE) jobs. This includes:

- 100 FTE new jobs resulting directly from the new plant opening
- 59 FTE jobs from indirect effects (i.e. increased demand in supply chains)
- 21 FTE jobs from induced effects (i.e. additional household spending resulting from higher income)

Users should note that basic input-output analysis does not model changes in the structure of the supply side of the economy. This has important implications when interpreting the results. Crucially, the effects and multipliers may overstate indirect impacts, although the extent of this will be unknown. Input-output multiplier analysis works best when the originating economic shock and estimated impacts are relatively small compared to the size of the relevant supplying industries and their workforces.

Further discussion of the limitations of input-output analysis is provided in the following section.

Limitations of input-output analysis

Input-output multipliers are useful tools for estimating how changes in final demand might affect different parts of the economy. However, they rely on several simplifying assumptions that users should understand before applying the results in analysis.

Assumptions underpinning the input-output model

Input-output modelling is a form of partial equilibrium analysis. It estimates the impact of changes in final demand but does not account for changes in the structure or capacity of the supply side.

The model assumes a fixed, linear relationship between inputs and outputs, meaning a 10% increase in demand leads to a 10% increase in supply. This is a simplification, because it does not take into account how prices might adjust, the impact of economies of scale, or the practical limits on the supply side such as labour shortages or production bottlenecks.

In reality, these factors can mean that increases in demand do not translate directly into equal increases in output. For example, firms in the supply chain may already be running at full capacity and would need to expand to larger facilities before they could produce more. Similarly, finding and training new staff with the right skills can take time, so even if businesses want to respond to higher demand, they may not be able to do so immediately. As a result, while the model assumes that demand and supply rise together, in practice the supply side can act as a constraint – especially in the short term. Over the longer term, however, these barriers are more likely to ease, making it easier for output to adjust to higher demand.

Industries are assumed to use inputs in fixed proportions, with no substitution between labour, capital or materials. For example, a factory that uses 10 workers and 5 machines to produce 100 units will still use the same ratio if output increases to 200 units. The model does not allow for switching to more machines and fewer workers, even if that would be more efficient in practice.

Wages and prices are also fixed, so income and tax effects remain constant regardless of changes in demand. This means that even if demand increases significantly, the model assumes no change in wage levels or the cost of goods.

In an input-output table with a single household sector (as for Wales), household spending patterns are assumed to stay the same, even when income and spending rises. For instance, if household income increases due to higher employment, the model assumes people will continue to spend in the same way and in the same locations, without shifting preferences or shopping habits.

The model also assumes that Welsh industries can always meet increased demand, regardless of scale. For example, if demand for construction materials doubles, the model assumes the ratio of imported goods remains constant and therefore Welsh suppliers can scale production to meet demand without delay.

It does not account for investment, innovation, or behavioural changes over time. For example, it cannot easily model a scenario where a business invests in automation to meet future demand, or where consumers reduce spending in the short term to save for long-term goals.

An implicit assumption in the Type II multiplier method is that labour income earned in Wales goes to Welsh-resident households. This means the model does not account for commuting – for example, individuals living outside Wales who travel in for work.

Implications for input-output analysis

Because of these assumptions, input-output multipliers typically tend to overestimate the wider economic impact of changes to final demand, especially in smaller economies or sectors with limited capacity. The model works best for small changes in demand. Larger shocks may produce unrealistic results, as the model assumes regional industries can always respond proportionately.

Results from input-output analysis should be treated as indicative, not definitive. They show the potential scale and direction of impacts, but not exact outcomes. For robust analysis, input-output modelling should be used alongside other techniques, for example combined with richer qualitative information about the nature and capacity of relevant regional industrial sectors and workforces.

Data sources and methods

The published effects and multipliers are based on the input-output table for Wales.

As official statistics in development, there are areas in the compilation process where the data is less robust. A separate **methodology article** (/tablau-cyflenwad-defnydd-thablau-mewnbwn-allbwn-2019-ar-gyfer-cymru-methodoleg-amlinellol-html) explains in detail how this table is built and the associated data limitations.

Calculating Type I effects and multipliers

The method used to calculate Type I multipliers follows the approach described in **Miller and Blair (Cambridge University Press, 2019)**

(https://www.cambridge.org/core/books/inputoutput-analysis/69827DA658E766CD1E17B1A47BA2B9C3).

A broad outline of the steps to achieve an Output multiplier is provided below:

1. A ‘matrix of technical coefficients’ is constructed by dividing each entry in the input-output transaction matrix by the total output of the corresponding industry (i.e. the column total). This shows the proportion of inputs required from each industry to produce one unit of that industry’s output.
2. Next, the Leontief inverse matrix is derived. This is done by subtracting the technical coefficient matrix from its identity matrix and taking the inverse of the result.
3. The Type I effect for each industry is calculated by summing the values in each column of the Leontief inverse matrix. For output, the effect is equivalent to the multiplier.

The Welsh Government uses **a custom R package called iot-leontief-r (GitHub)** (https://github.com/wgdsu/iot-leontief-r) to perform these calculations.

Calculating Type II effects and multipliers

Type II multipliers are calculated using a similar approach to Type I multipliers, but with an important extension to capture induced effects.

To do this, the technical coefficient matrix is augmented in two ways:

1. An additional row is added at the bottom. This is derived by dividing the compensation of employees row from the input-output table by the total output vector.
2. An additional column is added on the right. This is calculated by dividing household final consumption expenditure by a constant, representing total household income from all sources.

The resulting matrix is then transposed and used to calculate the Type II Leontief inverse, as described above.

An important detail in the Type II methodology is the way household expenditure coefficients are calculated. Instead of dividing household consumption expenditure by the column total, we divide it by total household income from all sources.

For 2019, the denominator used was £77,606 million, which is the sum of primary and secondary resources from the **ONS Regional Gross Disposable Household Income publication** (https://www.ons.gov.uk/economy/regionalaccounts/grossdisposablehouseholdincome/bulletins/regionalgrossdisposablehouseholdincomegdhi/latest) (Table 7: Components of total GDHI at current basic prices, 1997 to 2022 edition). This is consistent with the **approach used by the Scottish Government** (https://www.gov.scot/publications/input-output-latest/).

This adjustment reflects the fact that not all household consumption is funded by earned income. A significant share comes from unearned income such as pensions, dividends, and other transfers. Including these sources in the feedback loop would artificially inflate the effect of earned income in generating further rounds of household spending.

FTE employment estimates

The full-time equivalent (FTE) employment estimates used in this analysis are bespoke and intended specifically for input-output modelling. They do not replace any existing employment estimates published by the Welsh Government or the Office for National Statistics (ONS).

Data on employees is sourced from the **Business Register and Employment Survey (BRES)** (https://www.nomisweb.co.uk/sources/bres). This is supplemented with data on self-employment and HM Forces employment in Wales from the **Workforce Jobs (WFJ)** (https://www.nomisweb.co.uk/sources/wfj)release published via Nomis. Employment in agriculture is sourced directly from the Welsh Government's **Survey of Agriculture and Horticulture** (/arolwg-or-cyfrifiad-amaethyddol-garddwrol-mehefin-2024).

WFJ data for Wales is available only at the industry section level (21 sections). However, more detailed division-level estimates are required to produce

employment figures for each of the 55 published input-output sectors in Wales.

To achieve this, self-employment figures are apportioned to industry divisions using GB-wide Labour Force Survey (LFS) data at the two-digit SIC code level. Specifically, we apply the GB ratio of **FTE employee jobs (ONS)** (https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/employeejobsbyindustryjobs03) to **FTE self-employed jobs (ONS)** (https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/selfemploymentjobsbyindustryjobs04) for each division. These estimates are then aggregated to match the published input-output sectors for Wales.

In effect, self-employment totals are constrained to the WFJ Wales-level figures at the 21-industry section level, but we still rely on GB data to apportion Welsh self-employment estimates within divisions, due to the limitations of survey data. This broadly follows the approach employed by the Scottish Government.

Users should carefully consult the quality information associated with the underlying data sources, **including the LFS, as documented by the ONS** (https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/methodologies/labourforcesurveyperformanceandqualitymonitoringreports).

A simple weighting is applied to part-time workers, with each counted as 0.5 FTE. This does not fully capture variation in actual hours worked across industries.

The simplifying assumption on hours worked by part-time workers may be particularly problematic in sectors with a higher proportion of contractors and casual labour. This might include the agricultural sector (A01), where the 0.5 FTE weight applied to part-time principal farmers – including, directors, business partners and their spouses – and casual workers may overstate their hours worked. Conversely, the 1 FTE weight applied to full-time principal farmers does not account for additional hours worked beyond the standard week. This is particularly relevant given that the Survey of Agriculture and Horticulture defines full-time farmers as those working at least 39 hours per week.

Note that self-employed contractors serving agricultural businesses are not captured in the Survey of Agriculture and Horticulture, meaning that these will not be captured in the employment estimate. Moreover, the survey provides only a snapshot of the workforce in June, which may not accurately reflect the average size of the casual workforce throughout the year.

We welcome feedback on the methods used to produce these input-output multipliers. Please contact us at **InputOutputTables@gov.wales** (mailto:InputOutputTables@gov.wales)

Notes on the use of statistical articles

Statistical articles generally relate to one-off analyses for which there are no updates planned, at least in the short-term, and serve to make such analyses available to a wider audience than might otherwise be the case. They are mainly used to publish analyses that are exploratory in some way, for example:

- introducing a new experimental series of data
- a partial analysis of an issue which provides a useful starting point for further research but that nevertheless is a useful analysis in its own right
- drawing attention to research undertaken by other organisations, either commissioned by the Welsh Government or otherwise, where it is useful to highlight the conclusions, or to build further upon the research
- an analysis where the results may not be of as high quality as those in our routine statistical releases and bulletins, but where meaningful conclusions can still be drawn from the results.

Where quality is an issue, this may arise in one or more of the following ways:

- being unable to accurately specify the timeframe used (as can be the case when using an administrative source)
- the quality of the data source or data used
- other specified reasons

However, the level of quality will be such that it does not significantly impact

upon the conclusions. For example, the exact timeframe may not be central to the conclusions that can be drawn, or it is the order of magnitude of the results, rather than the exact results, that are of interest to the audience.

The analysis presented does not constitute an official statistic, but may be based on official statistics outputs, and we have applied the principles of the Code of Practice for Statistics as far as possible during development. An assessment of the strengths and weaknesses in the analysis will be included in the article, for example comparisons with other sources, along with guidance on how the analysis might be used, and a description of the methodology applied.

Articles are subject to the release practices as defined by the **release practices protocol** (/ystadegau-ac-ymchwil-datganiad-ar-arferion-cyhoeddi-protocol), and so, for example, are published on a pre-announced date in the same way as other statistical outputs.

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> Drllenwch ein **datganiad hygyrchedd** (/datganiad-hygyrchedd-llywcymru) i gael rhagor o wybodaeth.