Identifying clusters of industries

18 December 2019

There is a standard hierarchy of industries which groups together parts of the economy that make the same general types of goods or services. However, these industries aren't necessarily affected by the same factors, meaning that the standard hierarchy may not pick up underlying trends which affect Gross Domestic Product (GDP).

Taking advantage of recent developments in data science, we undertook network analyses on the Scottish economy to identify clusters (or groups) of industries that use each others' output. We then looked to see if these clusters of industries explained cross-cutting changes in Scottish GDP.
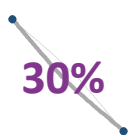
Headline results

83% The analysis produced 18 clusters of industries which between them account for 83% of the economy. The industries in the remaining 17% were too distinct to be included in a cluster.

20% The largest cluster of industries is the business support and development cluster, which contains 11 industries and makes up 20% of the economy.

30% Since 2016 the finance & estate agents cluster contributed the most to total GDP (positively or negatively) relative to its size in the economy. It accounts for 4% of the economy, but has contributed 30% to GDP change since 2016 quarter 1.

Additional information

A methodology guide and detailed tables on this analysis are available at www.gov.scot/gdp.

We welcome feedback from users on this analysis. Please contact gdp_stats@gov.scot if you have any comments on the clusters generated, how you might like this analysis to be improved or developed, or any other comments on this work.

Scottish Government
Riaghaltas na h-Alba
gov.scot

Contents

Why identify clusters of industries?

Published hierarchy of industries in GDP

In order to calculate GDP, industries are assigned within an internationally agreed system (the Standard Industrial Classification, or SIC). The hierarchy that this classification creates allows GDP data to be meaningfully compared across countries. When applied to the Scottish economy, the SIC has around 100 low level industries which nest into larger levels of industries (see chart below). Because of the risk of publishing disclosive information data are only published on the larger groups of industries

Agriculture, Forestry & Fishing — **A**

Production — **P**
- Mining & Quarrying Industries
- Manufacturing
- Electricity & Gas Supply
- Water Supply & Waste Management

Construction — **C**

Services — **S**
- Distribution, Hotels & Catering
- Transport, Storage & Communication
- Business Services & Finance
- Government & Other Services
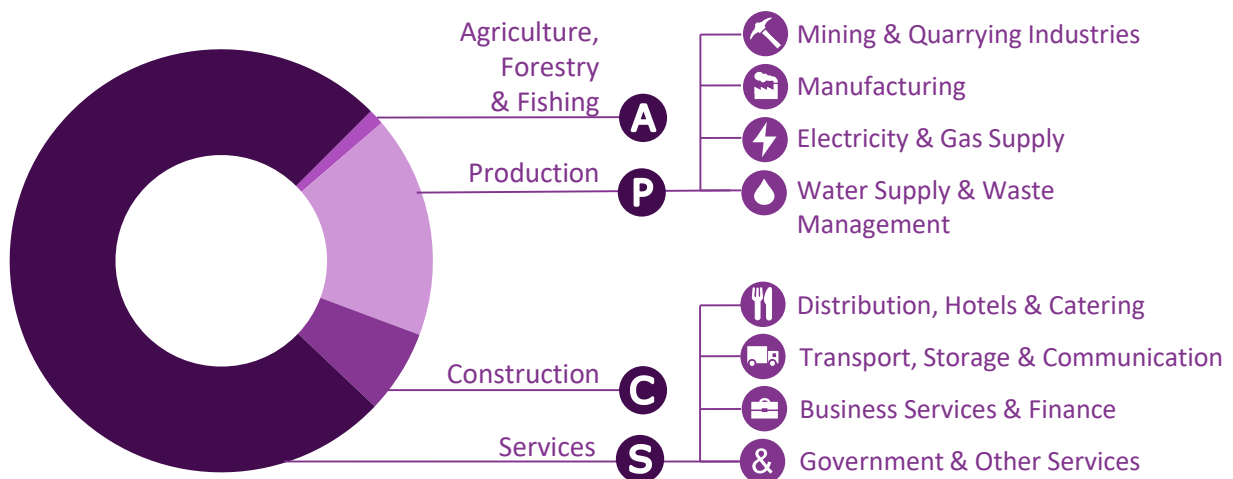
Limitations of what is currently published

The standard hierarchy of industries groups together parts of the economy that make the same general types of goods or services. However, these industries aren't necessarily buying the same things, feeding into the same industries or affected by the same factors. As a result the standard hierarchy does not always pick up cross-cutting trends in GDP.

To try to identify clusters (or groups) of similar industries, which may explain some changes in Scottish GDP, we undertook network analyses on the Scottish economy.

Scottish Government
Riaghaltas na h-Alba
gov.scot

How did we identify linked groups of industries?

What is network analysis?

Cluster 2

Cluster 1
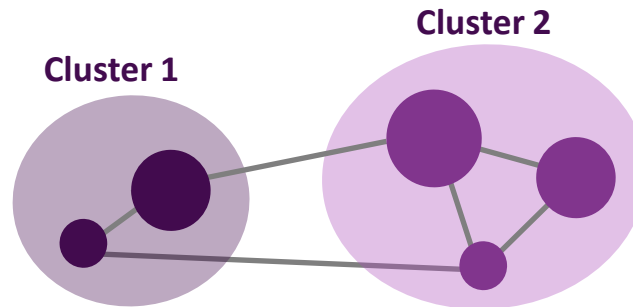
Network analysis measures the web of relationships between groups. It can be applied to social groups or, as in this case, to connected parts of the Scottish economy. Network analysis takes the information on the economy and uses it to generate a number of 'clusters', or groups, of industries which have more in common with each other than they do with other industries.

Data source

Sub-industries

Amount of money flowing between sub-industries
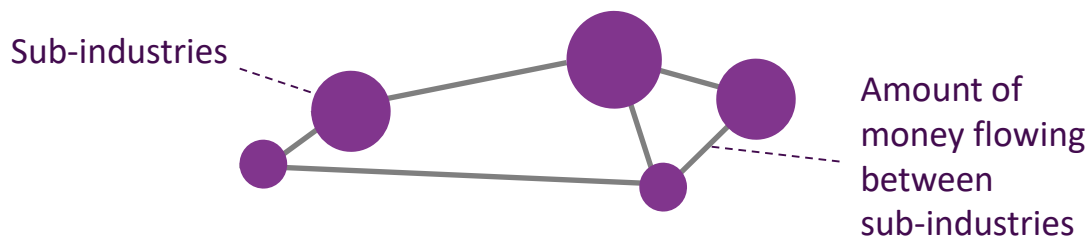
To undertake network analyses we used data on the amount of money flowing between the lowest published level sub industries of the Scottish economy, from the 2016 Input-Output tables. This is the most recent currently available data, but we produced very similar results from other years.

Within the Input-Ouput tables we used the Leontief Type 1 table, which shows how what proportion of input comes from different parts of the economy to produce 1000 units of output of each industry. Because it shows the strength of inter-industry relationships relative to the size of each industry (rather than the total amount of money moving) it helps retain smaller industries in clusters.
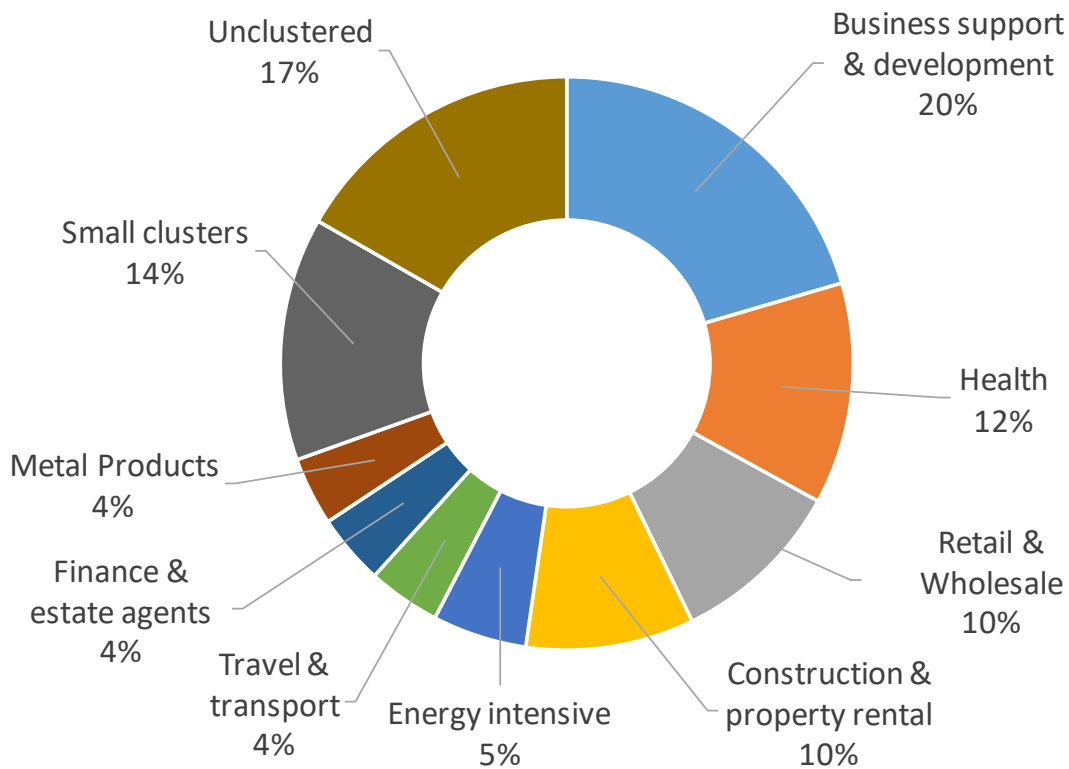
If you want more detailed information on the methodology and approach, please go to the **Methodology Guide** available via www.gov.scot/gdp.

www.gov.scot/gdp   4   Scottish Government
Riaghaltas na h-Alba
gov.scot

What clusters were produced?

The network analysis assigned 83% of the economy to a cluster, with the remaining 17% of industries being 'unclustered' (e.g. too distinct to be clustered with other industries).

The network analysis identified eight large clusters of industries (those that account for at least 4% of the economy each) plus ten small clusters, which in combination account for 14% of the economy.

Clusters of industries by weight in the economy

Unclustered
17%

Business support
& development
20%

Small clusters
14%

Health
12%

Metal Products
4%

Retail &
Wholesale
10%

Finance &
estate agents
4%

Travel &
transport
4%

Energy intensive
5%

Construction &
property rental
10%

Clusters of industries with a small weight

The ten clusters of industries which account for less than 4% of the economy each are:

- Chemicals
- Clothing
- Communications
- Fishing
- Food production

- Legal & accounting
- Leisure activities
- Printing
- Water & waste
- Wood products

Scottish Government
Riaghaltas na h-Alba
gov.scot

What clusters were produced?

Unclustered industries

There are 11 'unclustered' industries which are not assigned to a cluster, or were initially assigned to a cluster that they only had a very weak association with. These 11 industries, which account for 17% of the economy, are:

1. **Households as employers** covers groups like gardeners, window cleaners and babysitters.

2. **Imputed rent** is a theoretical measure which helps account for the fact that countries have different rates of people renting property. If only income from rent is being counted towards GDP then countries with higher levels of owner occupancy (like Scotland) would have lower levels of GDP.

3. **Insurance & pensions**

4. **Manufacture of ships & boats**

5. **Manufacture of spirits & wines**

6. **Mining of coal & lignite**

7. **Mining support** covers exploratory services, such as test drilling as well as cleaning and maintaining gas wells and mines.

8. **Other mining** which includes mining and quarrying of stone and fertiliser

9. **Rental & leasing services** is dominated by companies who rent large equipment used in offshore production.

10. **Repairs (personal & household)** includes the repair of computers, electronics and other household goods.

11. **Security & investigation** includes things like detective and patrol services and remote monitoring of burglar and fire alarms.

Scottish Government
Riaghaltas na h-Alba
gov.scot

## Contribution to GDP: clusters vs standard hierarchy

We compared the contribution to GDP using the standard definitions currently published and using our new definitions from the network analysis. The charts below show change between 2018 Q3 and 2019 Q3. As can be seen, the different categorisation of industries creates a different narrative around which sectors have been driving growth over the past year.

Under standard definitions (chart 1) it appears that many sectors of the economy are contributing towards growth. However, under our new definition, it's clearer to see that over the past year, there have been a small cluster of sectors really driving all of the growth - with many other sectors providing little support - or even acting negatively. Finance & Estate Agents in particular appear to have been a key contributor to economic growth over the past year.

Industry groups in standard hierarchy with largest contribution
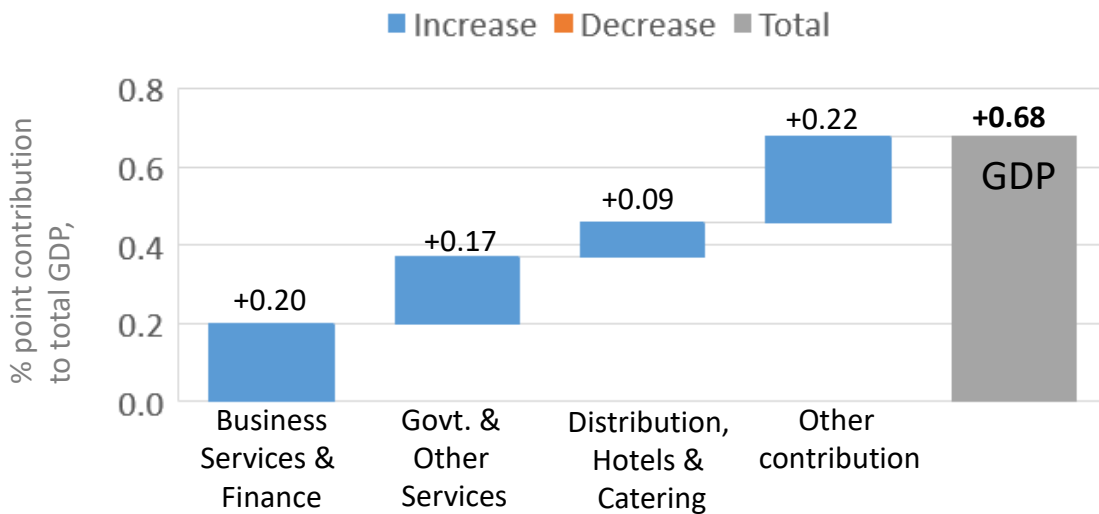
Clusters with the largest contribution

Scottish Government
Riaghaltas na h-Alba
gov.scot
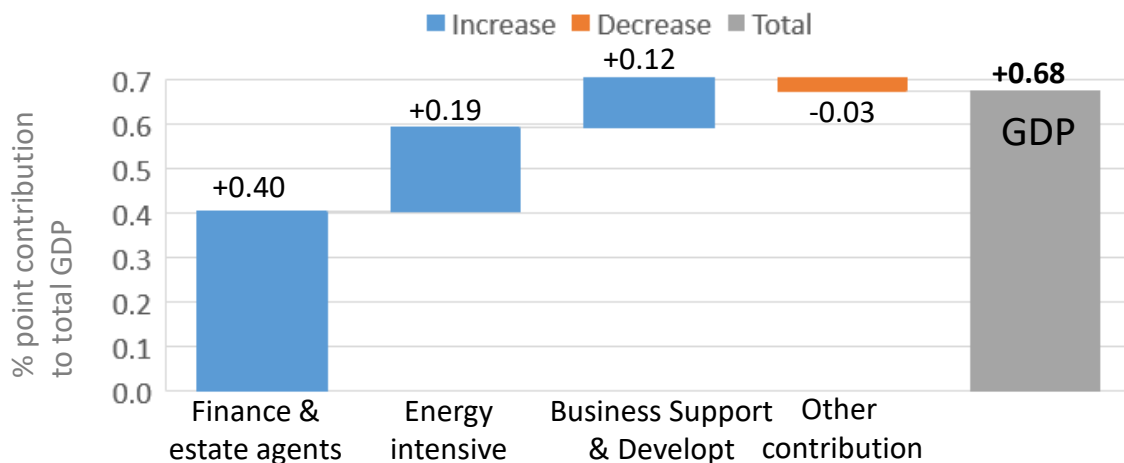
Annex: Detailed information on clusters

The following section contains detailed information on the eight clusters of industries with the largest weights, including:
- the industries they contain and any explanation for their inclusion
- the relative strength of the relationships between these industries
- the long term growth of these clusters
- the contribution of each large cluster to overall GDP

Following that, there is a short summary of the industries included in the ten clusters with the smaller weights.

Strength of relationships between industries
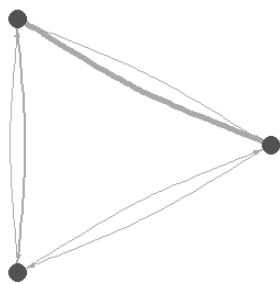
The network graph shows the strength of relationship between the industries in this cluster. The thicker the line, the larger the proportion of an industry's money comes from or goes to the linked industry. The network graph shows at a glance what the strongest relationships in a cluster are, but it is not always clear what direction which industries are buying from which.

To clarify this, in complex clusters we have also provided a heat map showing the strength of relationships between the industries.

The heat map shows where money or output is coming from (down the side) and where it is going (along the top). Darker squares represent stronger connections. In the example heat map, the outputs from Industry 3 are being used in the production of Industry 1. Industry 2 uses the output of Industry 1, but the relationship is less strong.
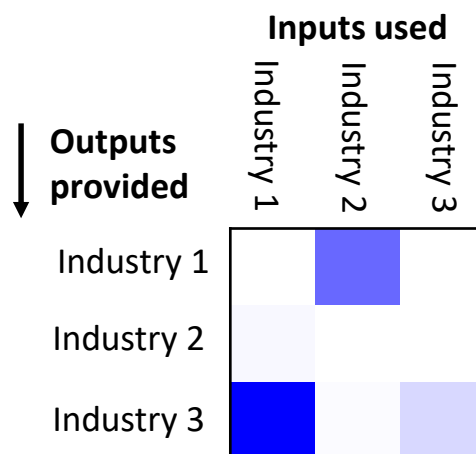
In general, where industries tend to be net users of the outputs of other industries in the cluster their columns will have darker squares. Where industries are more producers of outputs used by other industries in the cluster their rows will have darker squares.

1. Business support & development cluster

The largest cluster is the business support & development. It covers service industries which support businesses as well as public administration & defence, which covers most of the non NHS part of the public sector.

Size and composition of cluster

This cluster contains 11 sub-industries and makes up 20% of the Scottish economy (rounded up to 20.5% in the table). The table below shows the relative size of industries in the cluster and in the overall economy.

Industry	% of Scottish economy	% of cluster
Public administration & defence	6.5%	32%
Education	5.7%	28%
Architectural services	2.3%	11%
Computer services	1.6%	8%
Head office & consulting services	1.2%	6%
Employment services	1.0%	5%
Research & development	0.7%	4%
Business support services	0.7%	3%
Other professional services	0.4%	2%
Advertising & market research	0.2%	1%
Information services	0.1%	1%
Total	**20.5%**	**100%**

1. Business support & development cluster

Links within the cluster
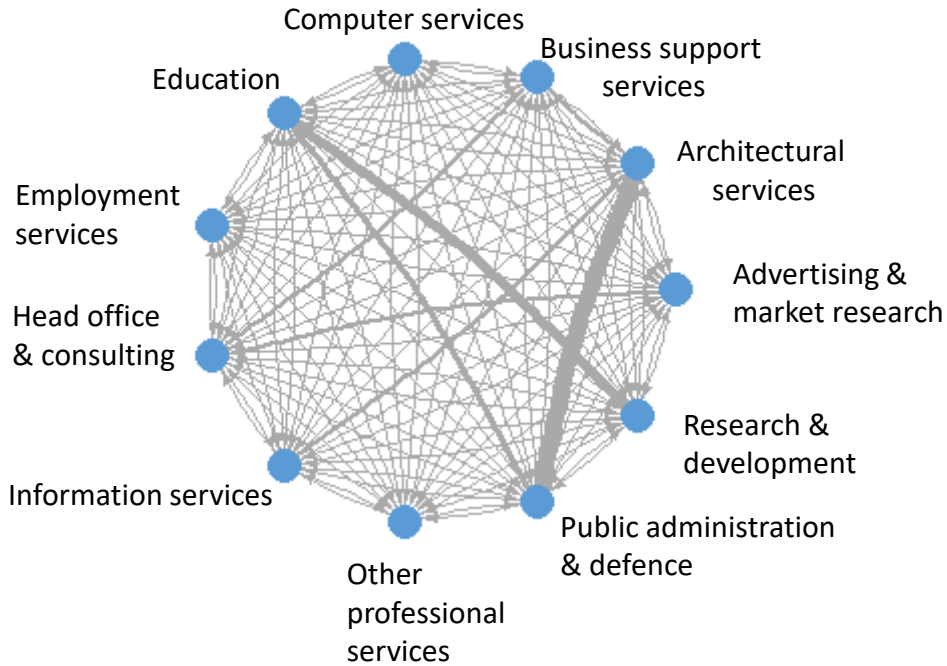
The strongest link in this cluster is from architectural services to the public administration & defence industry, most likely reflecting architects paying for things like planning fees. The next strongest link is from the education industry to the research & development industry.
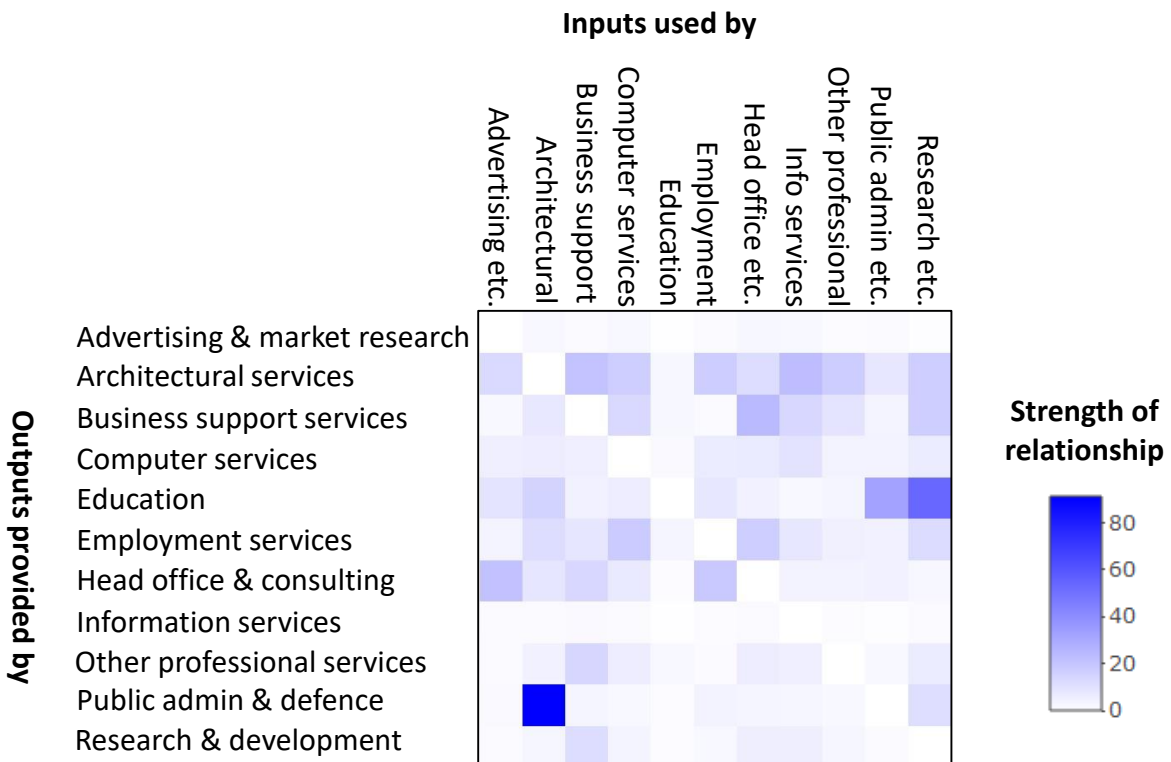
## 1. Business support & development cluster

Since 1998

The output of the business support and development cluster historically grew in line with, or slightly above total GDP. The average annual growth in this cluster since 1998 is 1.5%, compared to 1.4% for GDP as a whole.
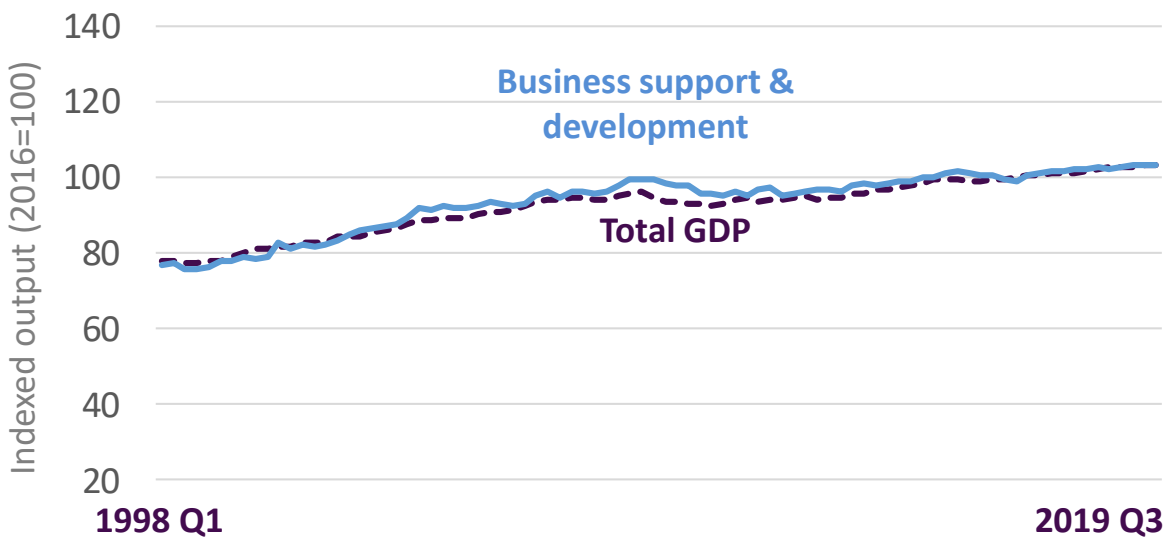
Contribution to quarterly GDP growth

The business support and development cluster accounts for 20% of the economy. Between 2016 Q1 and 2019 Q3 growth or contraction in the business support services cluster contributed an average of 35% of total GDP change over the same period.
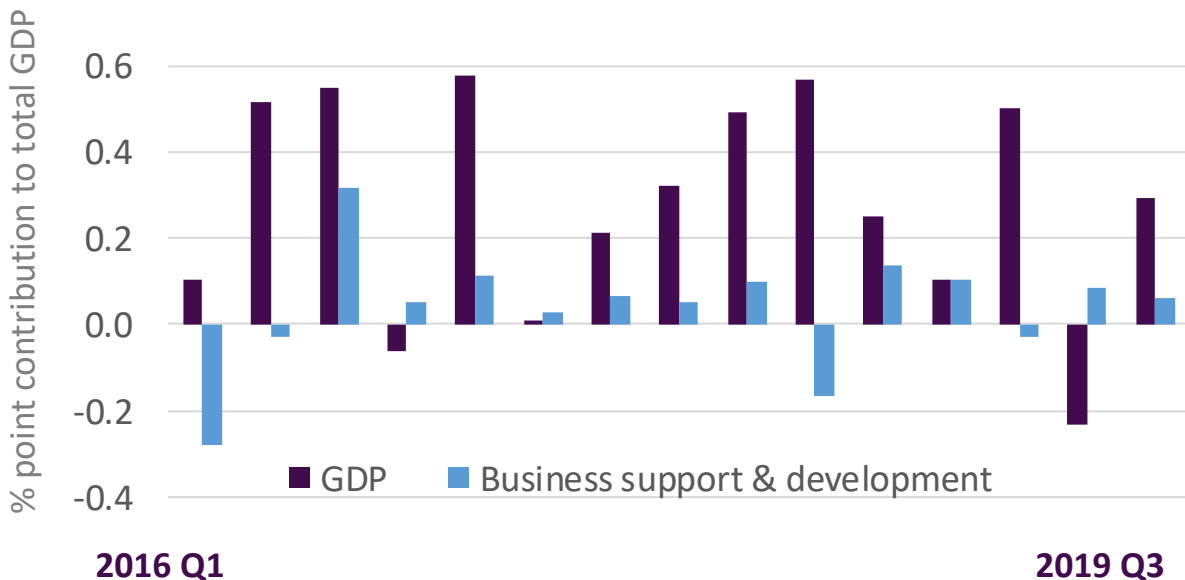
2. Health cluster

Size and composition of cluster

This cluster contains five sub-industries which cover medical and social care and makes up 12.5% of the Scottish economy. The table below shows the relative size of industries in the cluster and in overall GDP.

Industry	% of total GDP	% of cluster
Health	6.2%	50%
Residential care and social work	3.5%	28%
Food & beverage services	2.0%	16%
Pharmaceuticals	0.7%	6%
Veterinary services	0.1%	1%
Total	**12.5%**	**100%**

Links within the cluster
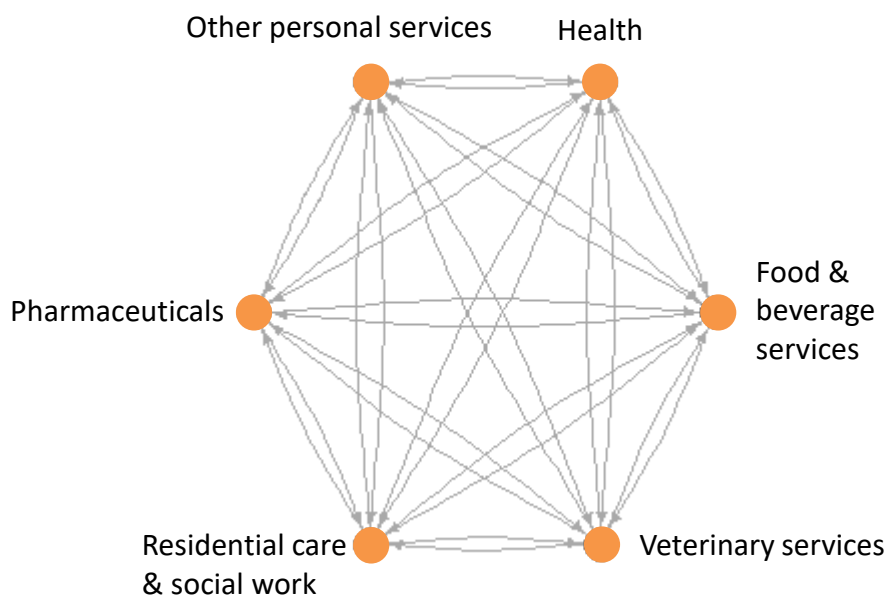
2. Health cluster

Strength of relationships within the cluster
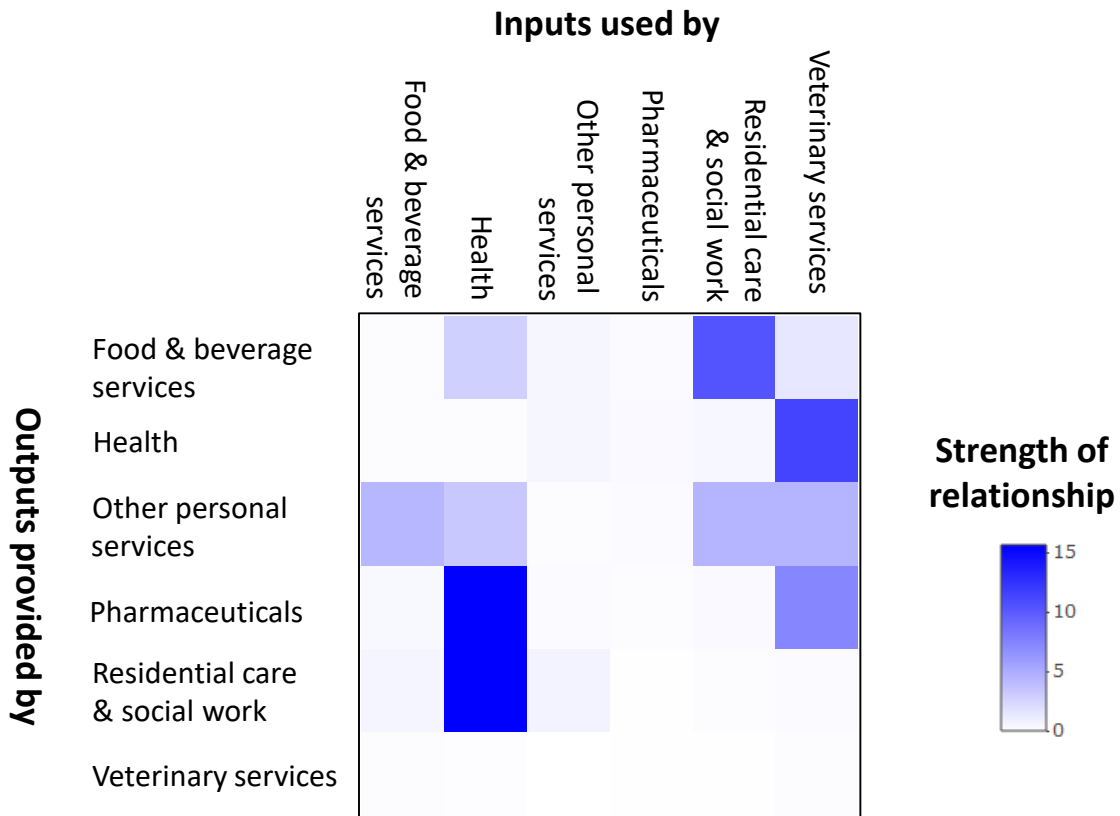
The lines in the network chart are all the same thickness, meaning that there are no dominant relationships in this cluster. The heat map above shows the relative strength of relationships within this narrow range.

The strongest relationships from pharmaceuticals and residential care to health. The heat chart also shows that health and veterinary services are users of the products of the other industries in this cluster.

2. Health cluster

Since 1998

The output of health cluster has historically been in line with total GDP but has slowed in recent years.
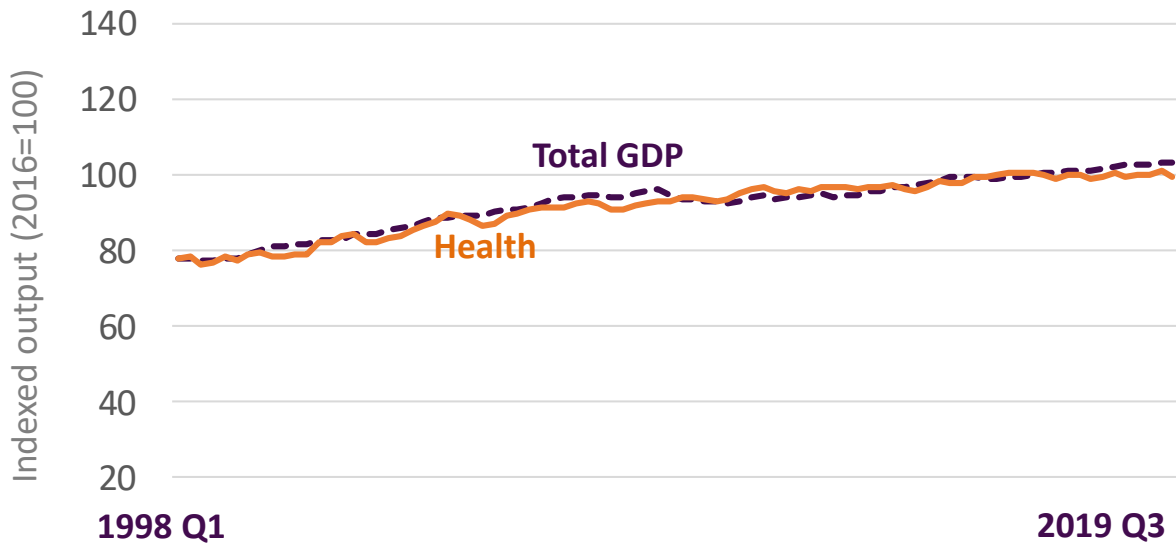
Contribution to quarterly GDP growth

The health cluster accounts for 12% of the economy. Between 2016 Q1 and 2019 Q3 growth or contraction in the health cluster contributed an average of 26% of total GDP change over the same period.

www.gov.scot/gdp   14   Scottish Government
Riaghaltas na h-Alba
gov.scot
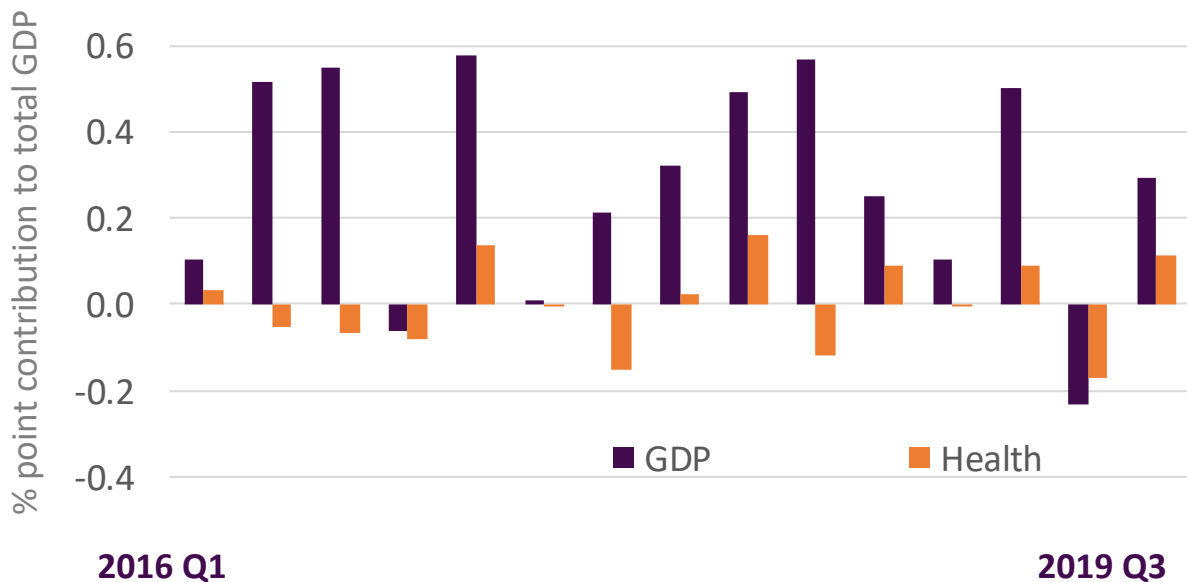
3. Retail & wholesale cluster

Size and composition of cluster

This cluster contains three sub-industries and makes up 10% of the Scottish economy. The table below shows the relative size of industries in the cluster and in overall GDP.

Industry	% of total GDP	% of cluster
Retail	4.9%	50%
Wholesale	3.4%	34%
Motor vehicles (sales & repair)	1.6%	16%
Total	**9.8%**	**100%**

Links within the cluster
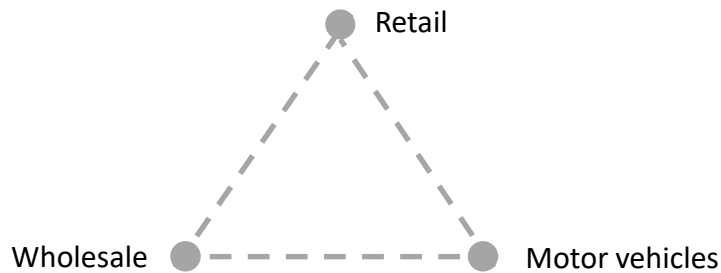
This cluster was not generated by the Network Analysis. Because of the data available, the input-output tables do not represent the connections between the retail, wholesale and sale of motor vehicle industries, which we know exist.

Retail, wholesale and sale of motor vehicle industries buy a large amount of products from each other (and are bought by households) but the scale of these transactions are not well represented in the Input-Output data. Based on sector knowledge and the Input-Output team's advice, we created an amalgamated cluster of these three industries.

3. Retail & wholesale cluster

Since 1998

The output of the retail & wholesale cluster has historically been in line with or below GDP as a whole. Since 2016 this cluster has grown in line with GDP.
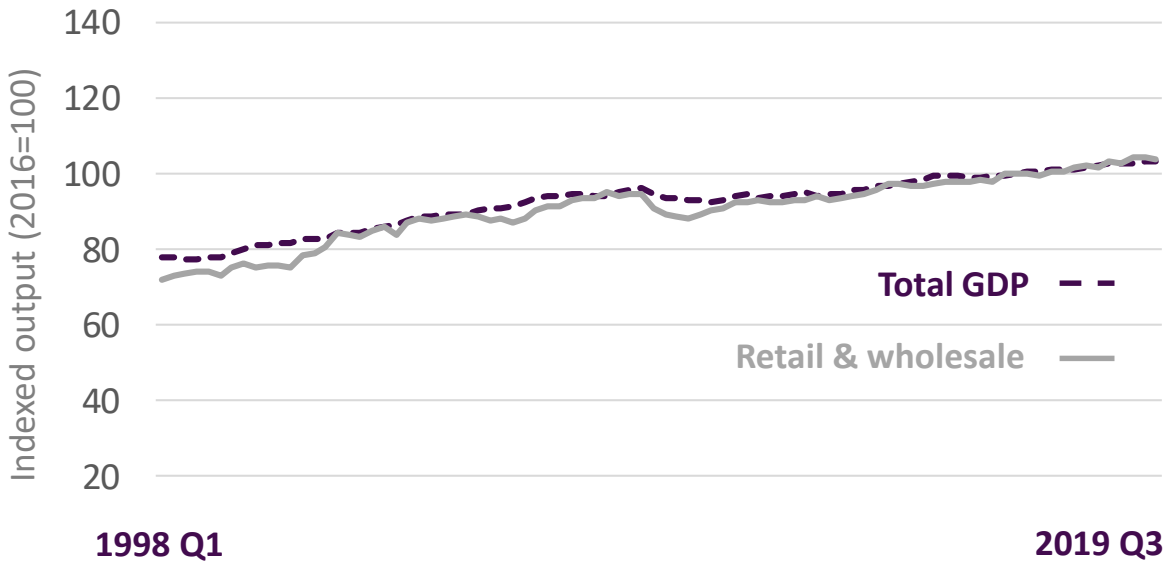
Contribution to quarterly GDP growth

The retail & wholesale cluster accounts for 10% of the economy. Between 2016 Q1 and 2019 Q3 growth or contraction in the retail & wholesale cluster contributed an average of 22% of total GDP change over the same period.

Scottish Government
Riaghaltas na h-Alba
gov.scot

4. Construction & property rental cluster

## Size and composition of cluster

This cluster contains two sub-industries and makes up 10% of the Scottish economy. The table below shows the relative size of industries in the cluster and in overall GDP.

Industry	% of total GDP	% of cluster
Construction	5.8%	61%
Property rental*	3.7%	39%
Total	**9.5%**	**100%**

*categorised as Real estate (own) in the Standard Industrial Classification

Links within the cluster
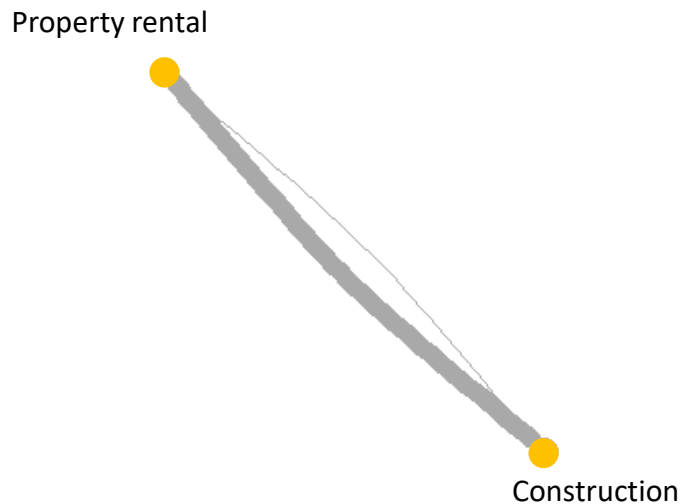
This cluster is centred around construction. As can be seen by the thickness of the lines above, there is much more money moving from construction to property rental than from property rental to construction.

4. Construction & property rental

Since 1998

The output of construction & property rental cluster was historically below the rate of total GDP. Since 2016 this cluster has grown in line with GDP.
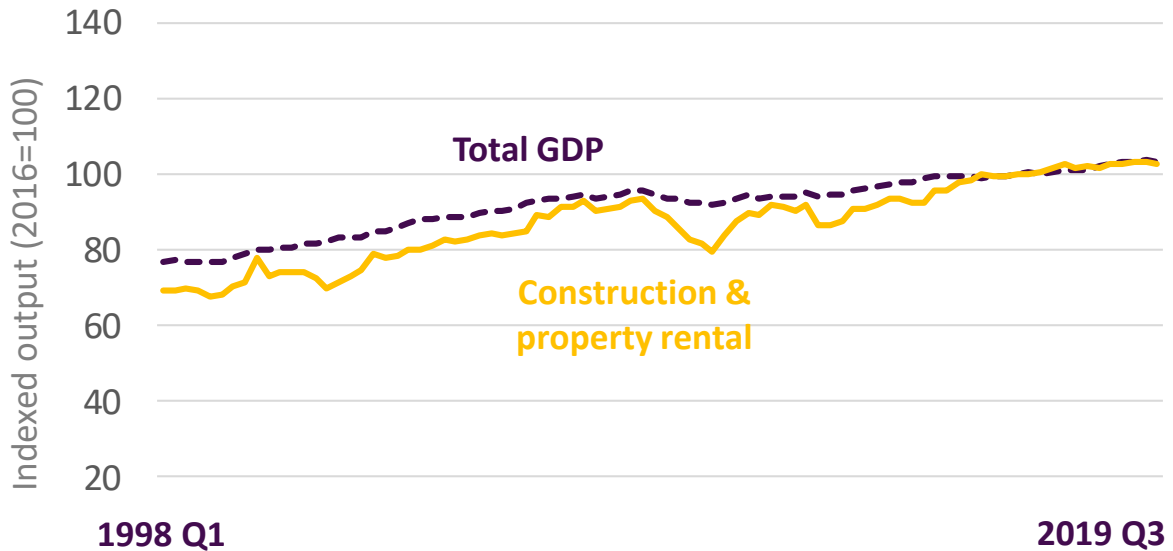
Contribution to quarterly GDP growth

The construction & property rental cluster accounts for 10% of the economy. Between 2016 Q1 and 2019 Q3 growth or contraction in the construction & property rental cluster contributed an average of 18% of total GDP change over the same period.
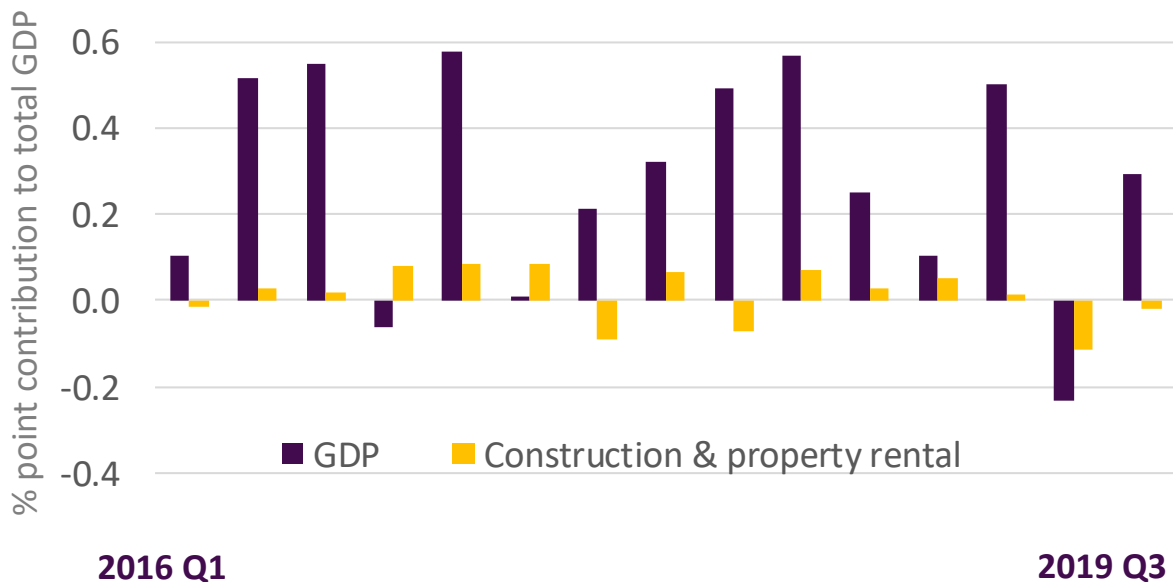
5. Energy intensive cluster

Size and composition of cluster

The energy intensive cluster covers the energy-generating industries, industries which input to them and key coal and chemical industries that use a lot of electricity.

This cluster contains 8 sub-industries and makes up 5% of the Scottish economy. The table below shows the relative size of industries in the cluster and in overall GDP. The electricity and passenger land transport industries account for more than three quarters of the energy intensive cluster. Passenger land transport includes buses and taxis. It also includes pipeline services for gas and electricity, which may include its inclusion in this cluster.

Industry	% of total GDP	% of cluster
Electricity	2.7%	51%
Passenger land transport	1.4%	26%
Gas	0.6%	11%
Coke, petroleum & petrochemicals	0.3%	6%
Glass, clay & stone	0.1%	2%
Cement, lime & plaster	0.1%	2%
Oil & gas extraction, metal ores & other	0.1%	1%
Inorganic chemicals, dyestuffs & agrochemicals	0.0%	0%
Total	**5.3%**	**100%**

There are very strong links between the electricity and gas industries, in part due to the fact that they both buy from each other in order to sell electricity and gas on to consumers. The strength of the link between electricity and gas overwhelms other connections and makes it difficult to identify any other links either industry might have. To account for this, we removed the data linking electricity and gas. The strength of connections between industries which use a large amount of energy meant that electricity and gas remained in the same cluster even without a direct link between them, however.

5. Energy intensive cluster

Links within the cluster
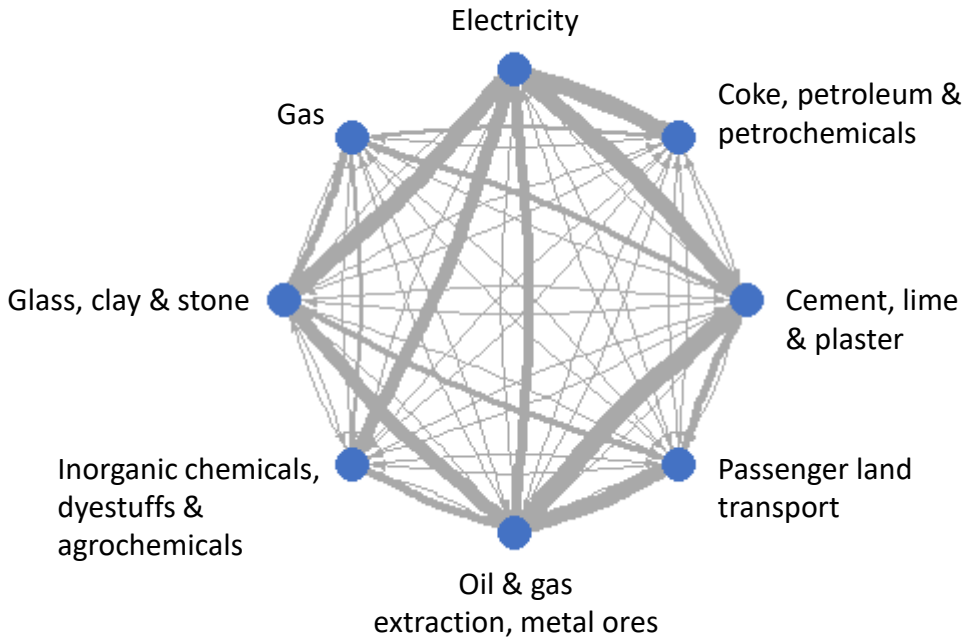
As can be seen by the thickness of the lines above and the darker squares below, many of the strongest relationships in this cluster come from electricity, as it is a key component of all other industries in this cluster.
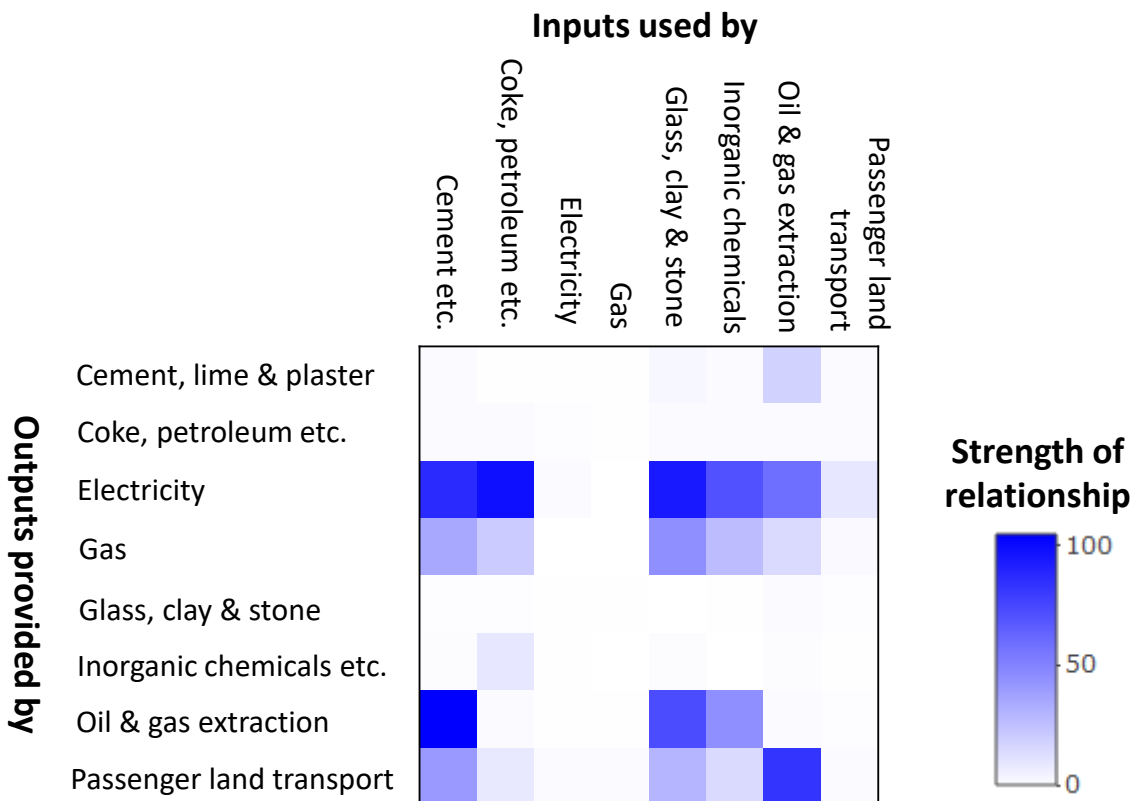
5. Energy intensive cluster

Since 1998

The output of energy intensive cluster was historically much higher than total GDP, but growth has tended to be lower. This cluster is also very volatile quarter-on-quarter.
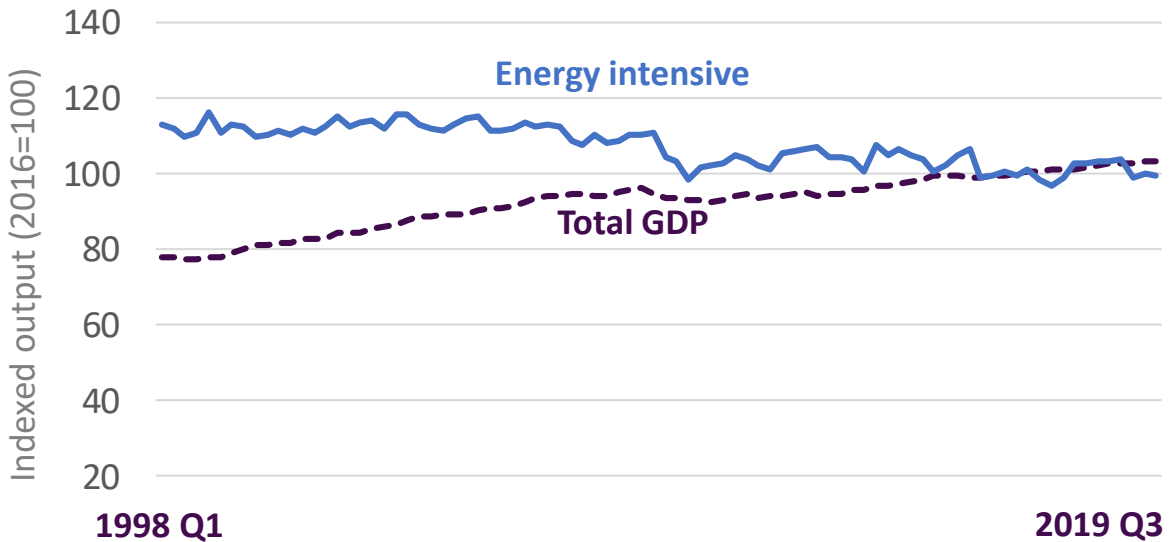
Contribution to quarterly GDP growth

The energy intensive cluster accounts for 5% of the economy. Between 2016 Q1 and 2019 Q3 growth or contraction in the energy intensive cluster contributed an average of 25% of total GDP change over the same period (primarily due to a large negative contribution in 2018 Q4).
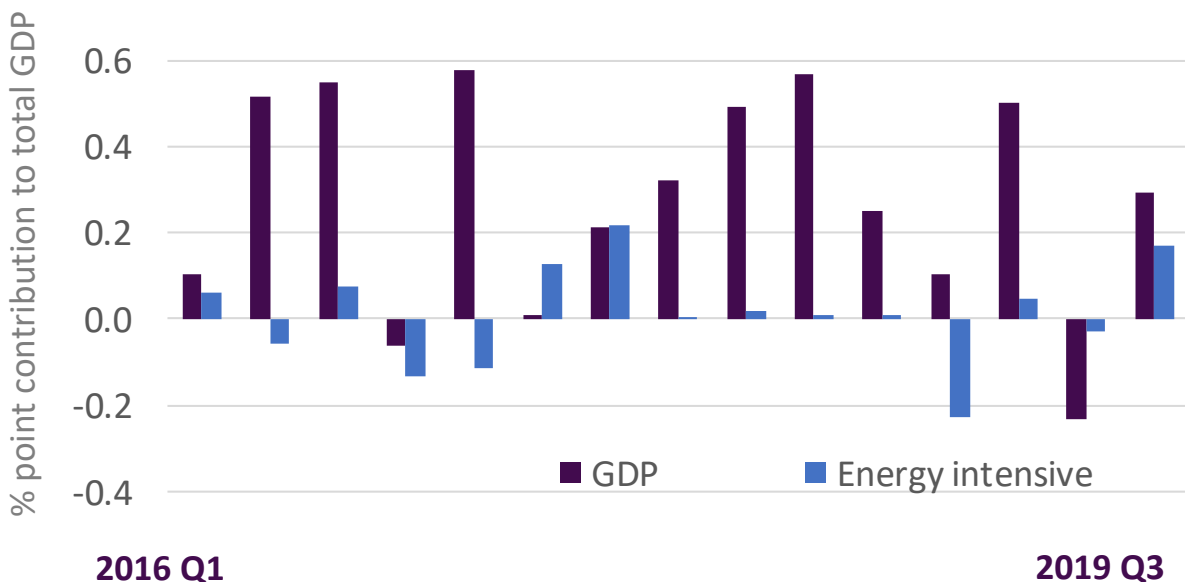
6. Travel and transport cluster

Size and composition of cluster

This cluster contains six sub-industries covering travel and accommodation which make up 4% of the Scottish economy. The table below shows the relative size of industries in the cluster and in overall GDP.

Industry	% of total GDP	% of cluster
Support services for transport	1.6%	39%
Accommodation	1.3%	33%
Travel & related services	0.4%	10%
Air transport	0.3%	8%
Rail transport	0.3%	7%
Water transport	0.2%	4%
Total	**4.1%**	**100%**

Between them, support services for transport and accommodation account for more than two thirds of the weight of this cluster of industries.

Support services for transport includes warehousing and other infrastructure such as airports and harbours. Travel and related services includes travel agents and tour operators.

6. Travel and transport cluster

Links within the cluster
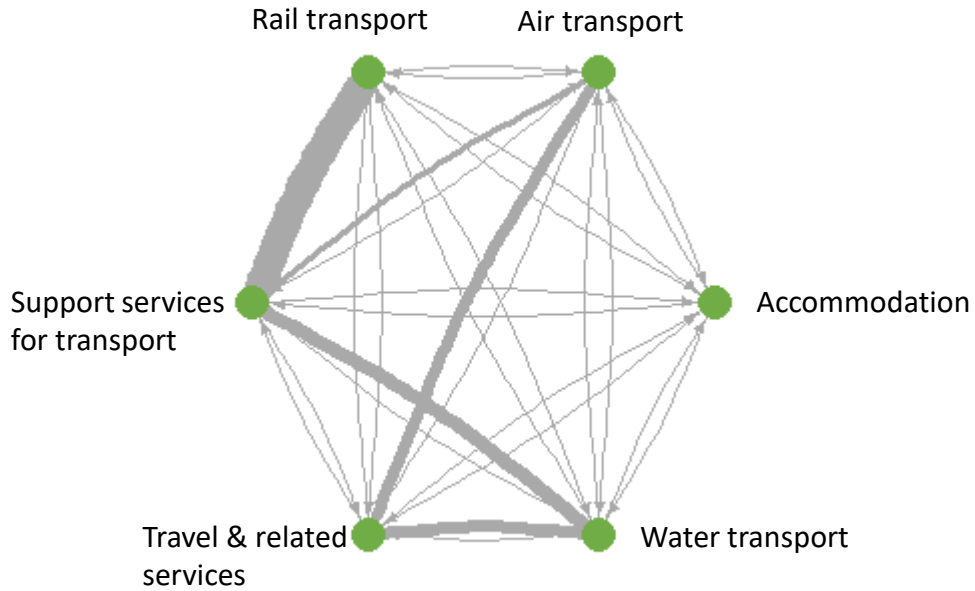
The strongest relationships in this cluster is from the support services for transport industry to the rail transport and water transport industries.
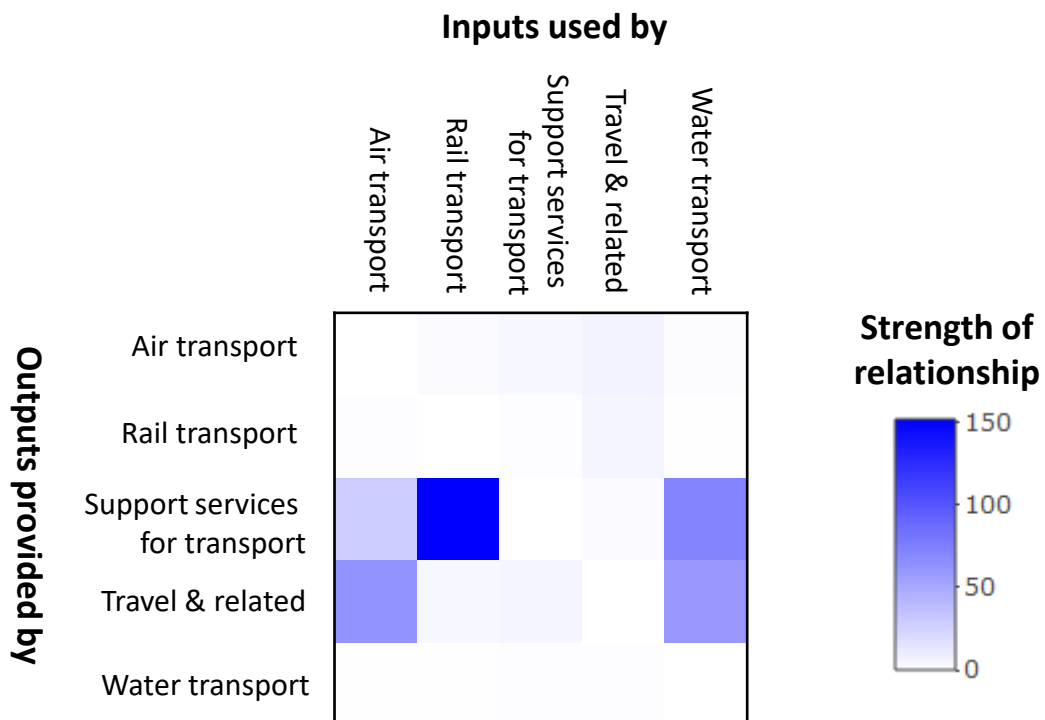
6. Travel and transport cluster

Since 1998

The output of the travel and transport cluster is historically lower than total GDP but with greater short-term fluctuation.
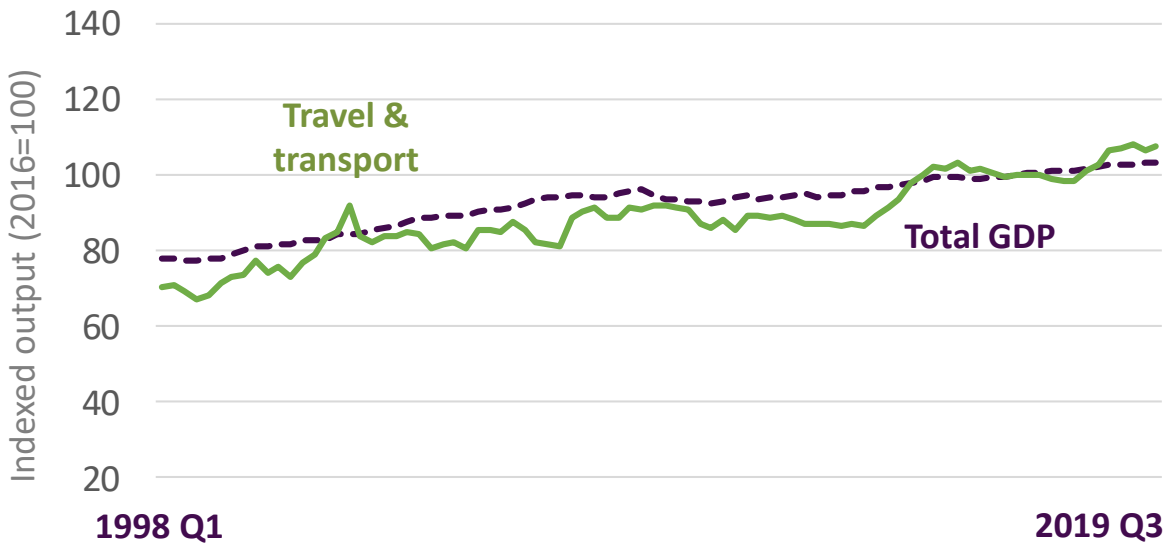
Contribution to quarterly GDP growth

The travel and transport cluster accounts for 4% of the economy. Between 2016 Q1 and 2019 Q3 growth or contraction in the transport cluster contributed an average of 14% of total GDP change over the same period.

7. Finance & estate agents cluster

Size and composition of cluster

This cluster contains two sub-industries and makes up 4% of the Scottish economy. The table below shows the relative size of industries in the cluster and in overall GDP. Estate agents includes real estate and rent collecting agencies. Financial services includes the outputs of banks and building societies.

Industry	% of total GDP	% of cluster
Financial services	3.7%	93%
Estate agents*	0.3%	7%
Total	**4.0%**	**100%**

*categorised as Real estate (fee or contract) in the Standard Industrial Classification

Links within the cluster

Estate agents

Financial services
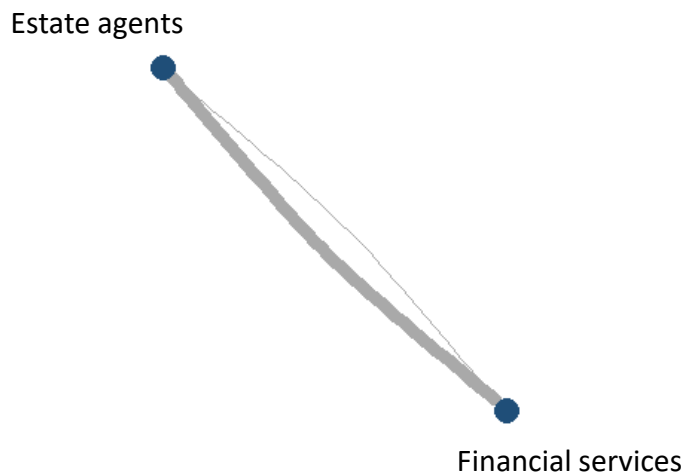
As can be seen by the thickness of the lines above, there is a much more significant flow of money moving from financial services to real estate than flowing back. This reflects the degree to which the work of real estate agents and rent collecting agents requires input from banks and building societies.

Scottish Government
Riaghaltas na h-Alba
gov.scot

7. Finance & estate agents – trends over time

Since 1998

The output of the finance & estate agents cluster was historically much higher than total GDP but with a faster growth rate.
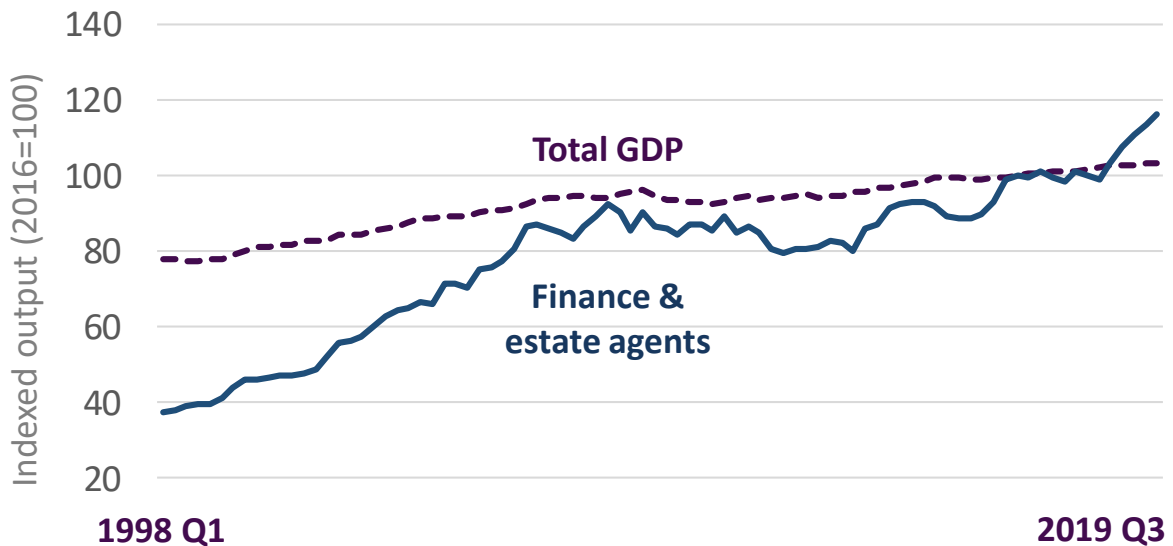
Contribution to quarterly GDP growth

The finance & estate agents cluster accounts for 4% of the economy. Between 2016 Q1 and 2019 Q3 growth or contraction in the finance & real estate cluster contributed an average of 30% of total GDP change over the same period.
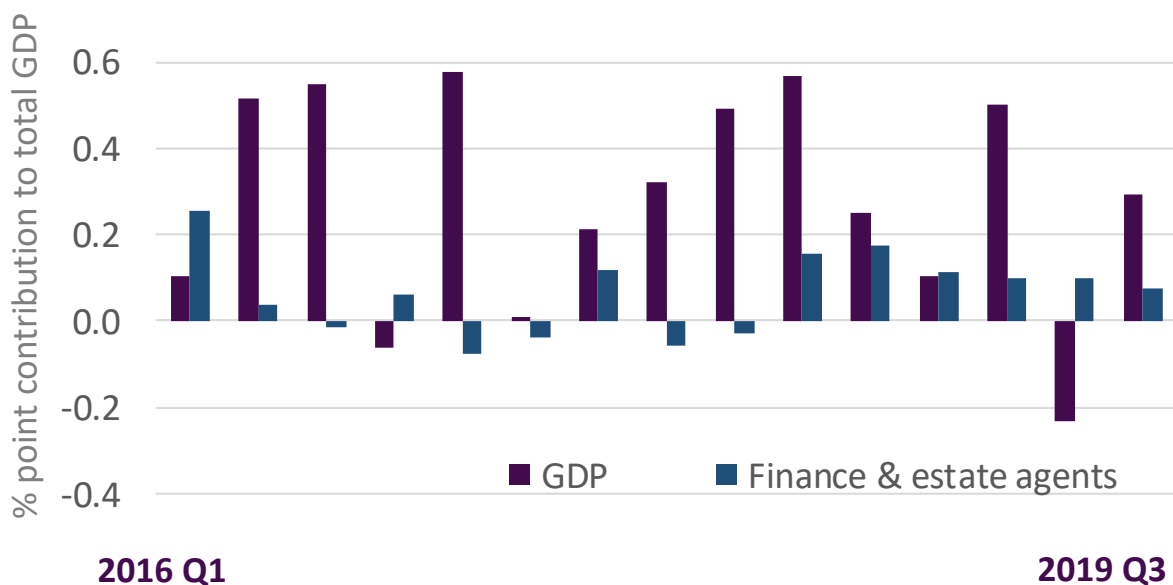
8. Metal products cluster

Size and composition of cluster

This cluster contains ten sub-industries and makes up 4% of the Scottish economy. It can be interpreted as metal production and the industries which primarily use them (car manufacture, machinery).

The table below shows the relative size of industries in the cluster and in overall GDP.

Industry	% of total GDP	% of cluster
Fabricated metal	0.9	24%
Repair & maintenance of machinery	0.9	24%
Manufacture of machinery & equipment	0.6	16%
Computers, electronics & opticals	0.6	15%
Other manufacturing	0.2	6%
Electrical equipment	0.2	6%
Motor vehicles	0.1	4%
Beer & malt	0.1	2%
Iron & steel	0.1	2%
Other metals & casting	0.0	1%
Total	**3.9%**	**100%**

Fabricated metals includes the manufacture of metal frameworks or skeletons for construction. Other manufacturing includes striking of coins and production of metals for jewellery, which most likely explains its inclusion in this cluster. Other metals & casting includes the manufacture of aluminium and other metals used to produce cans.

Scottish Government
Riaghaltas na h-Alba
gov.scot

8: Metal products cluster

What are the relationships within this cluster?
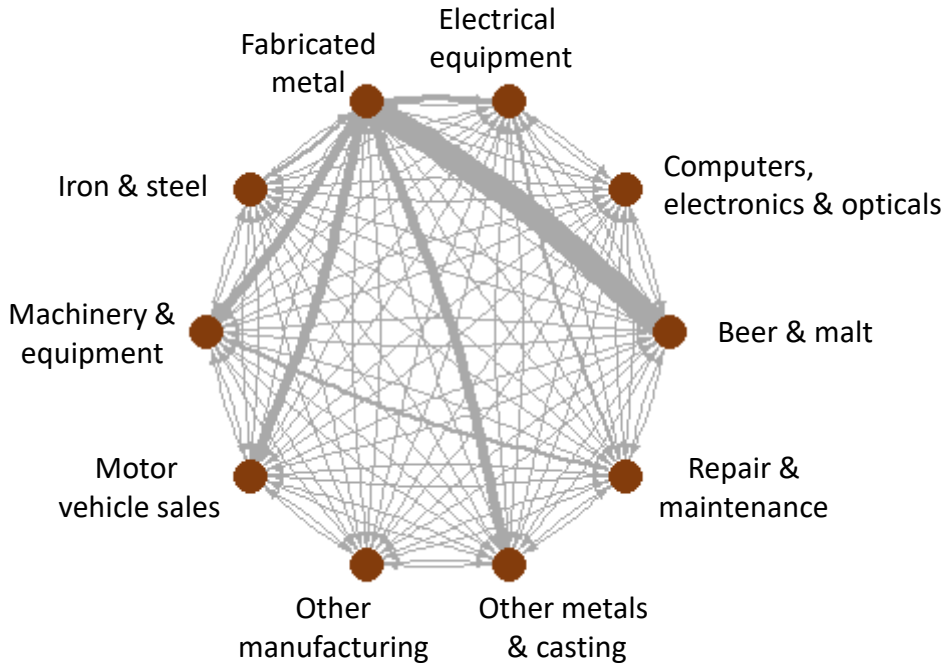
The strongest relationships in this cluster are from the fabricated metals to the beer & malt industries (as beer and malt production uses a lot of fabricated metals to produce beer cans and the tanks and boilers used in beer production).
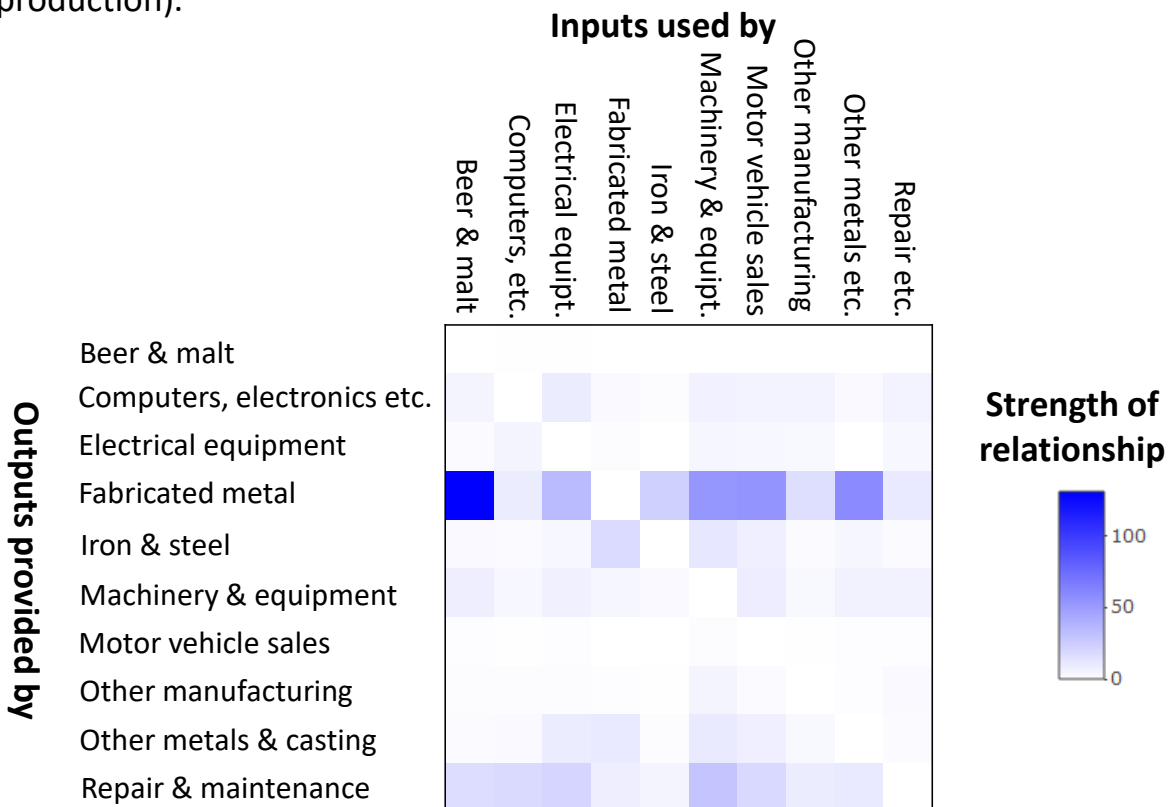
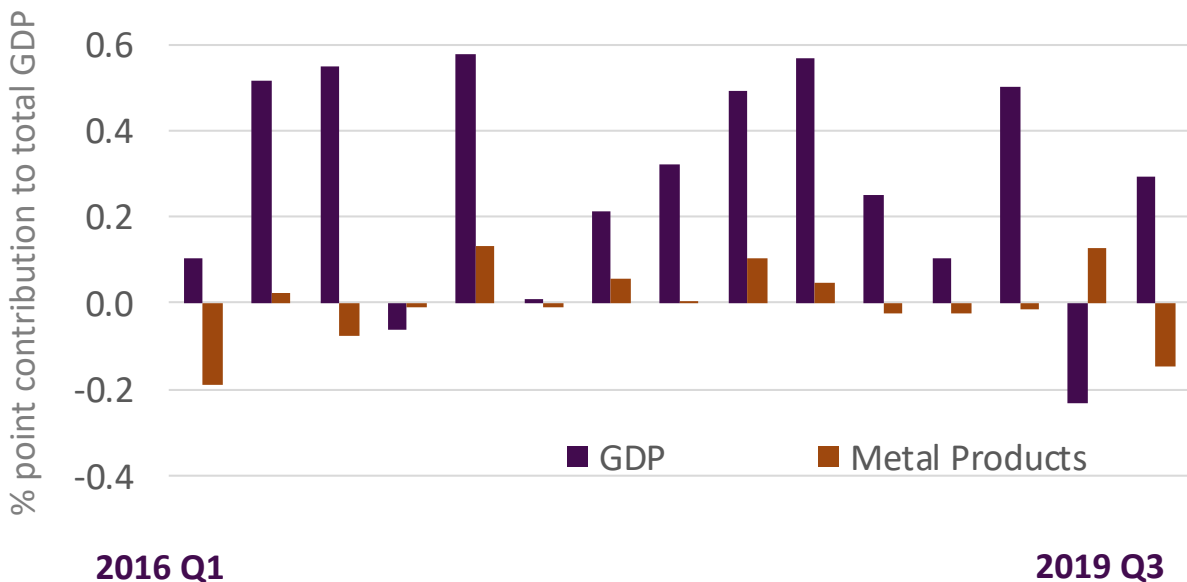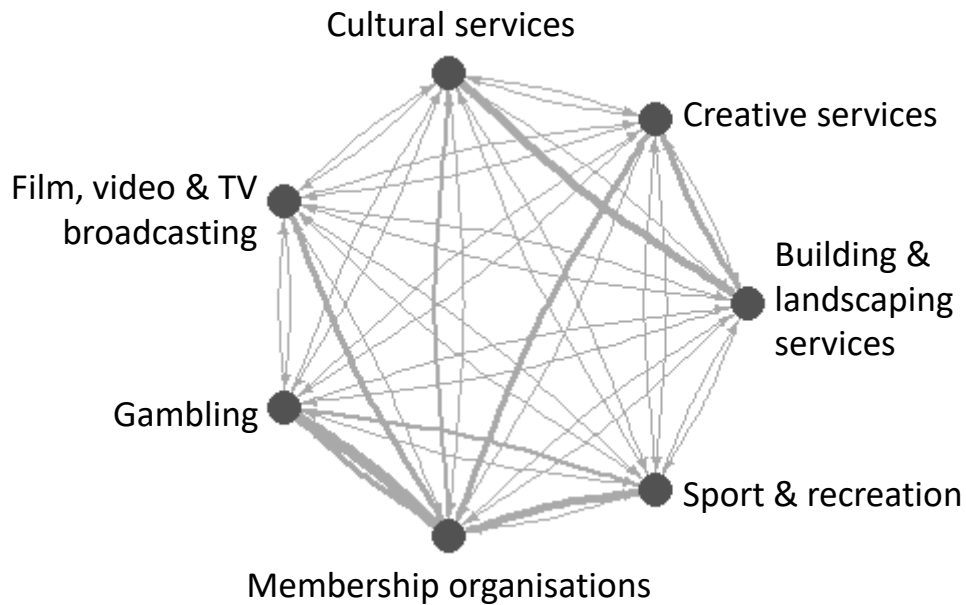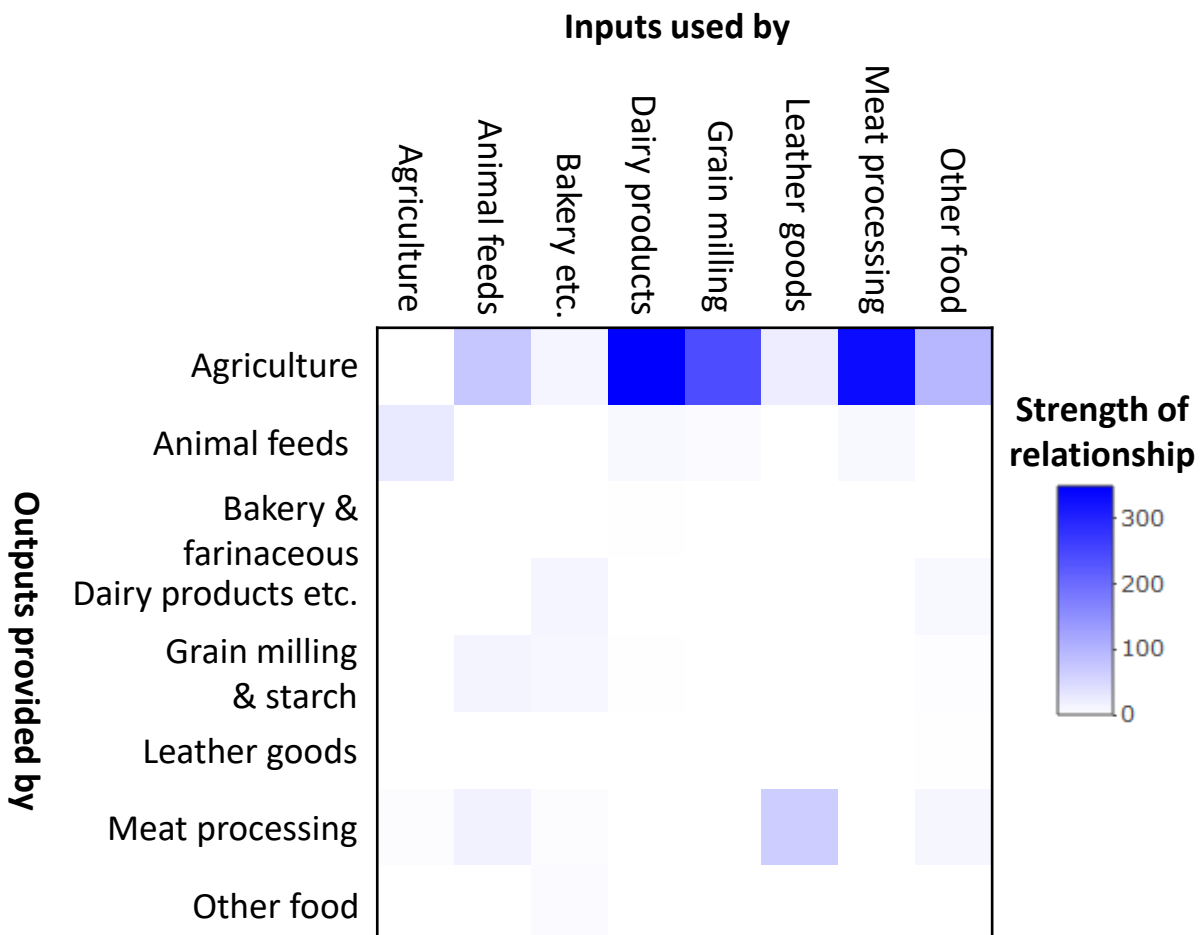## 8. Metal products cluster – trends over time

Since 1998

The output of the metal products cluster was historically lower than total GDP. Growth has fallen since 2018 but growth in this cluster has been volatile.
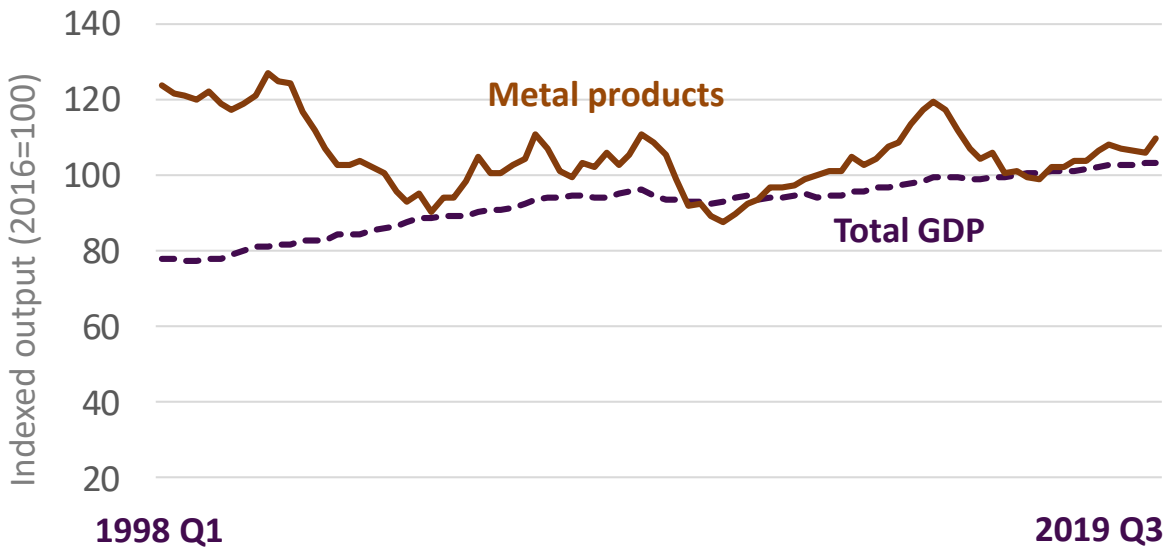
Contribution to quarterly GDP growth

The metal products cluster accounts for 4% of the economy. Between 2016 Q1 and 2019 Q3 growth or contraction in the metal products cluster contributed an average of 19% of the total GDP change over the same period.
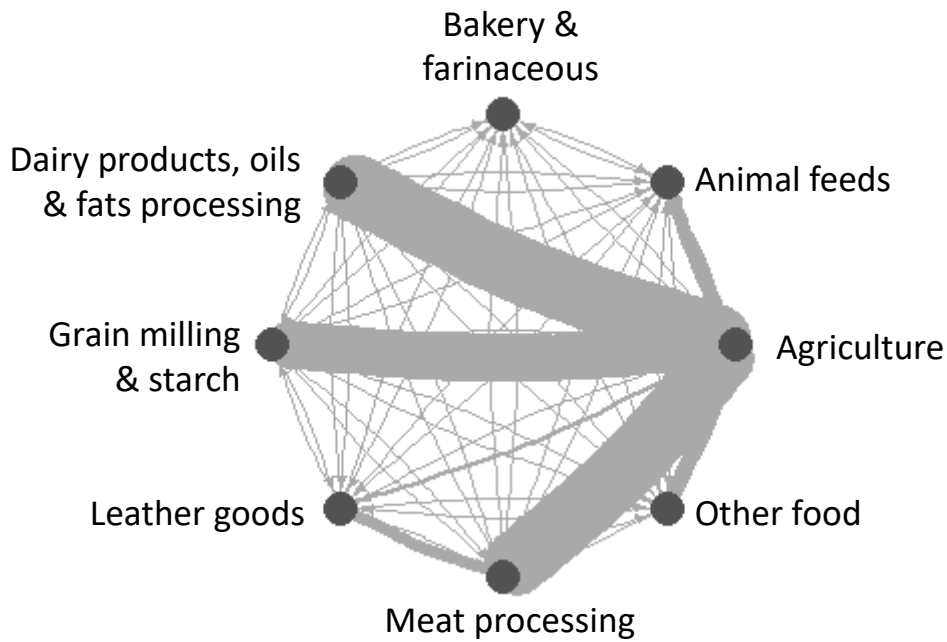
www.gov.scot/gdp   29   Scottish Government
                                                          Riaghaltas na h-Alba
                                                          gov.scot

9. Leisure activities cluster (3.1% of Scottish economy)

Scottish Government
Riaghaltas na h-Alba
gov.scot
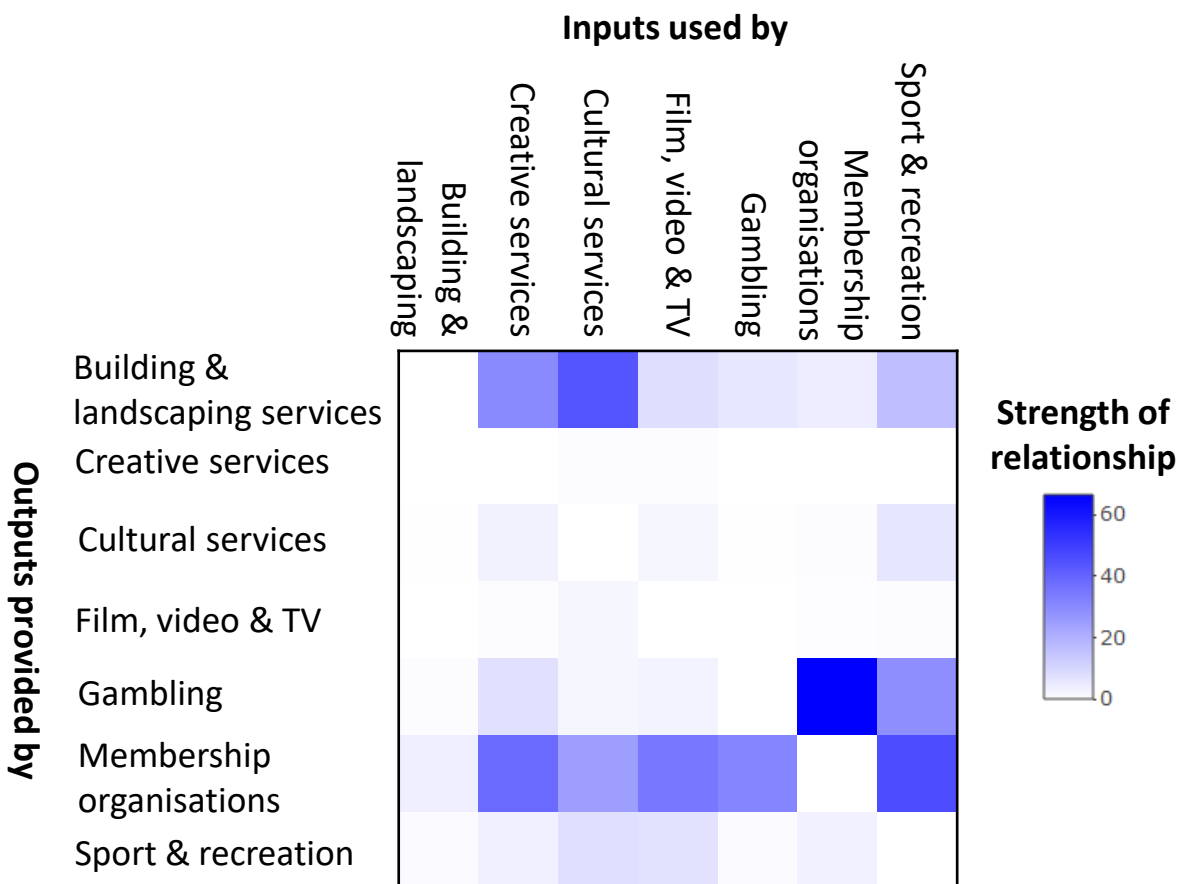
10. Communications cluster (2.8% of economy)
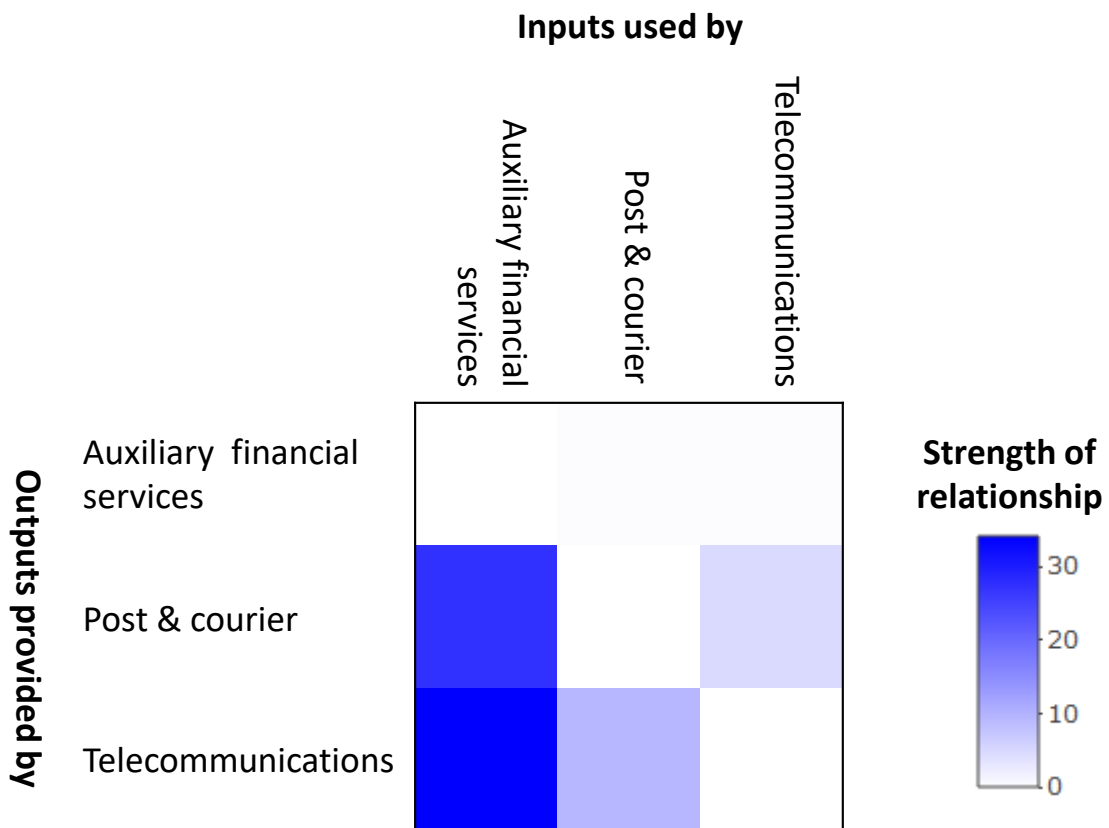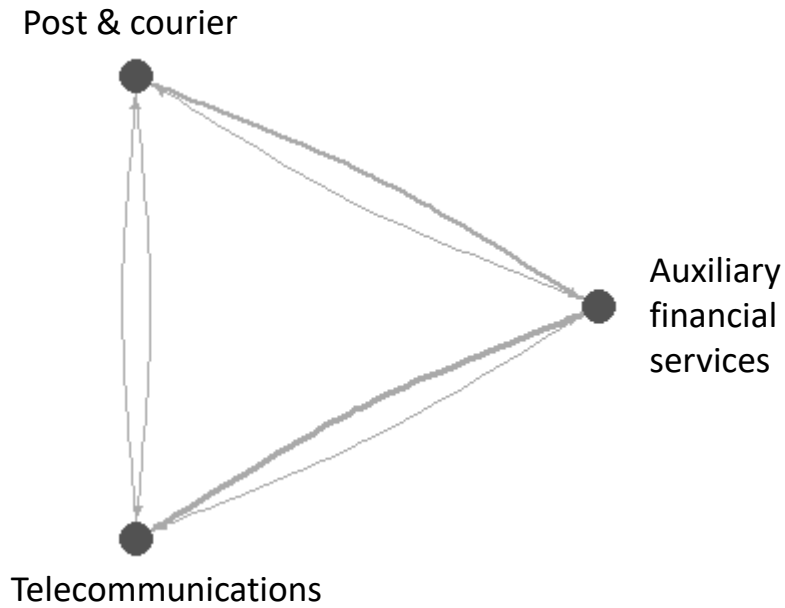
11. Food production cluster (1.7% of economy)

12. Water & waste cluster (1.4% of economy)

Waste, remediation
& management

Water & sewerage
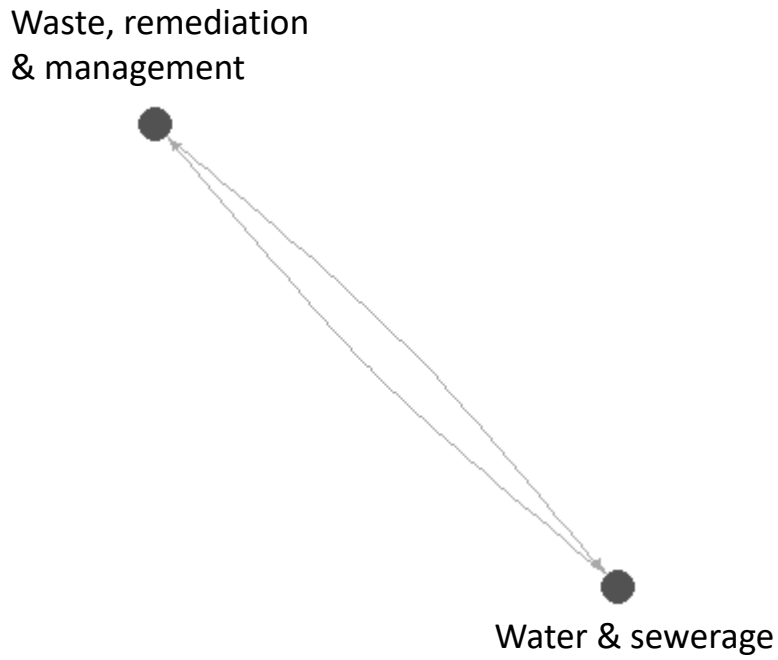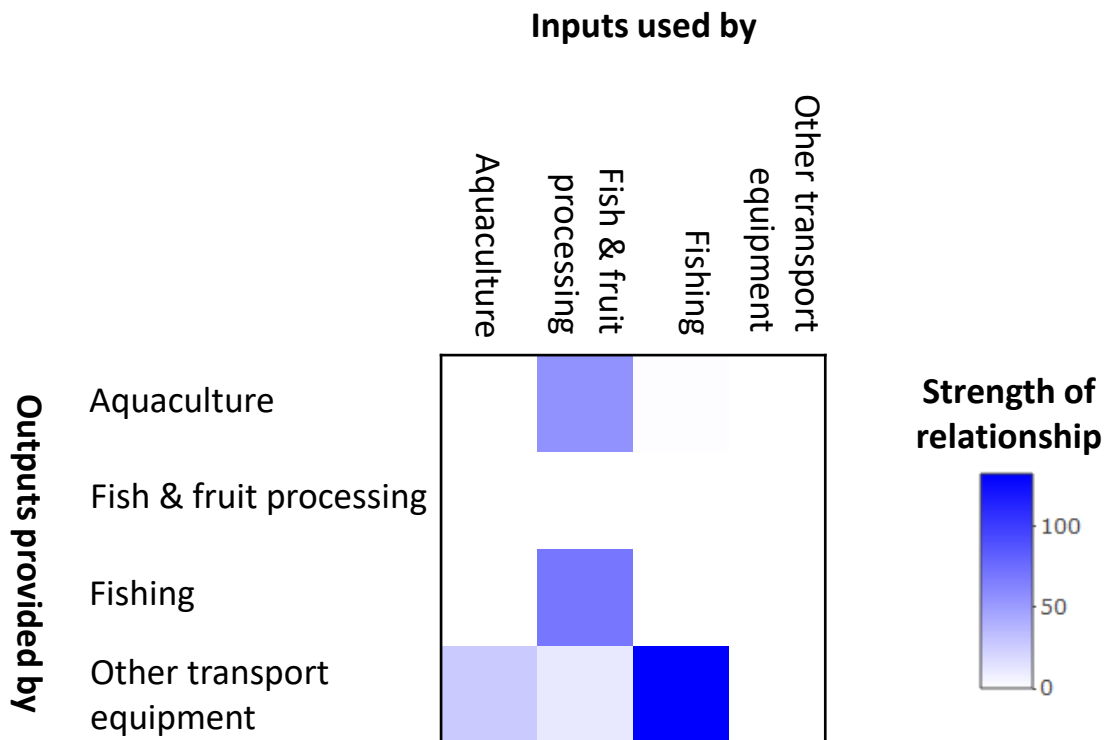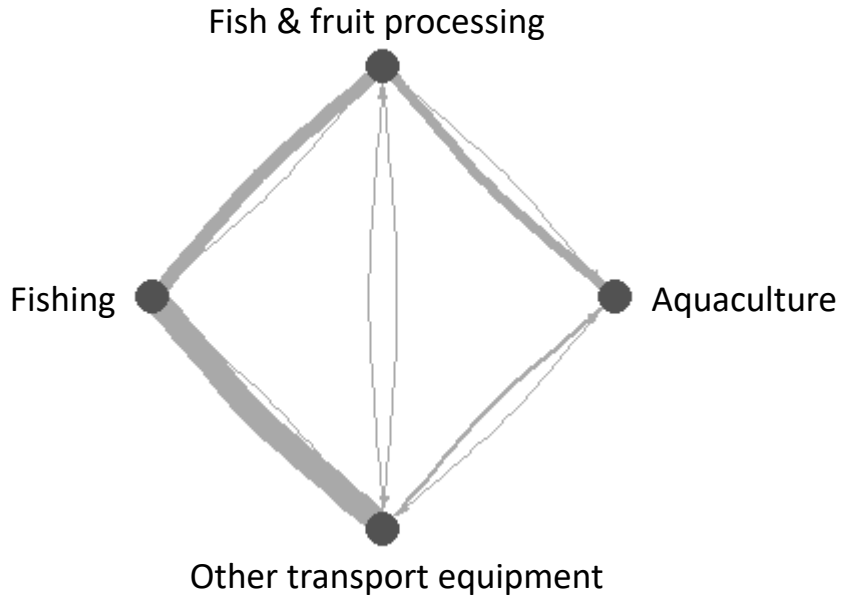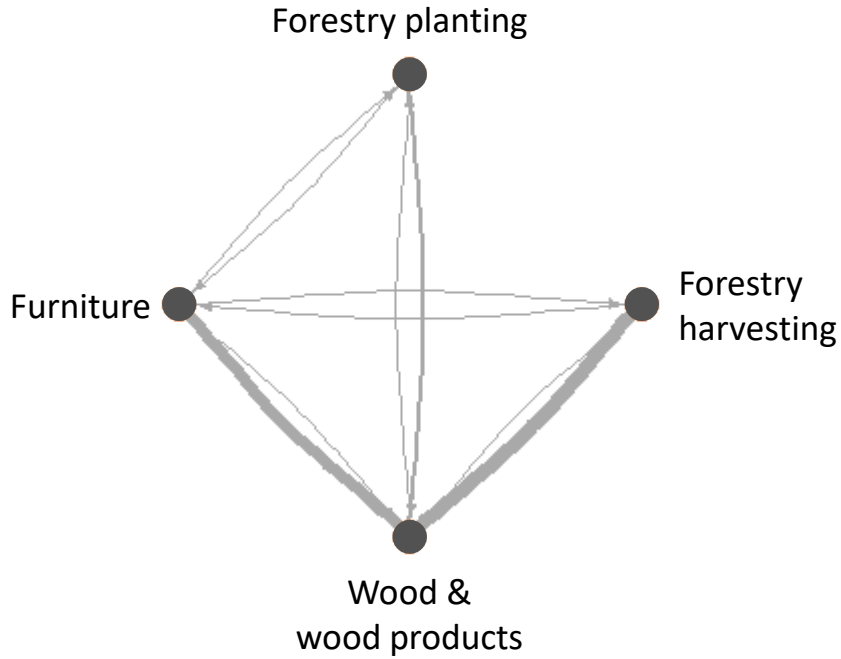
13. Legal & accounting cluster (1.4% of economy)

Accounting & tax
services

Legal activities

Scottish Government
Riaghaltas na h-Alba
gov.scot

14. Chemicals cluster (0.9% of economy)

www.gov.scot/gdp   34   Scottish Government
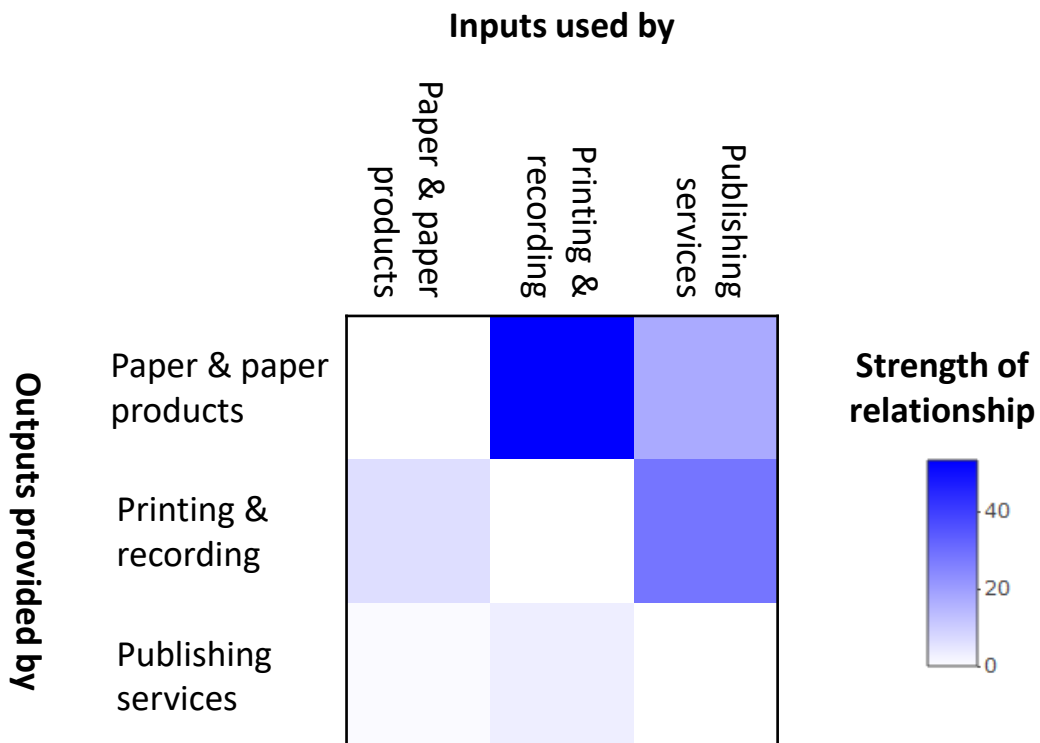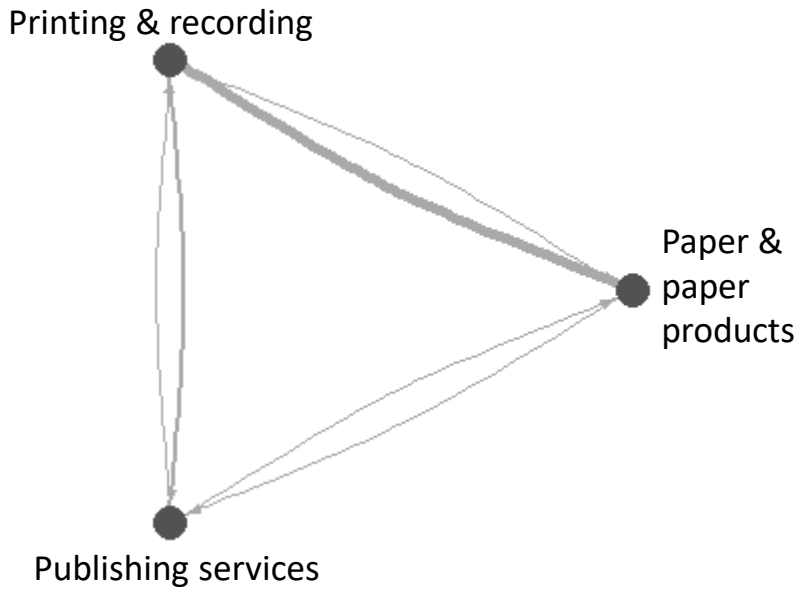Riaghaltas na h-Alba
gov.scot
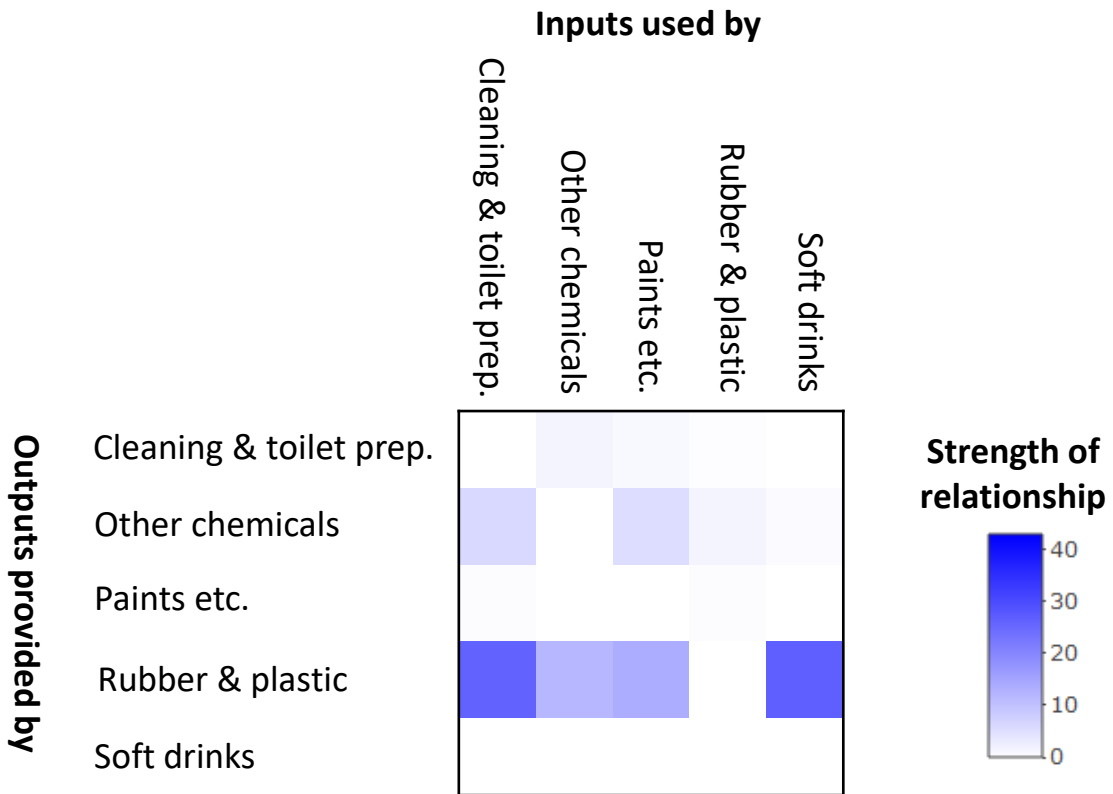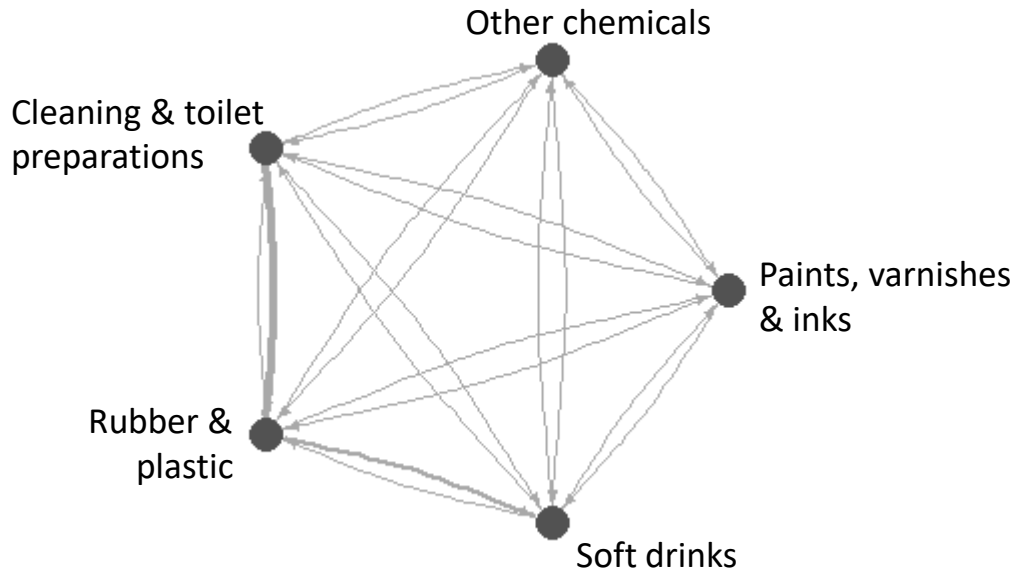
15. Fishing cluster (0.8% of economy)

16. Wood products cluster (0.8% of economy)
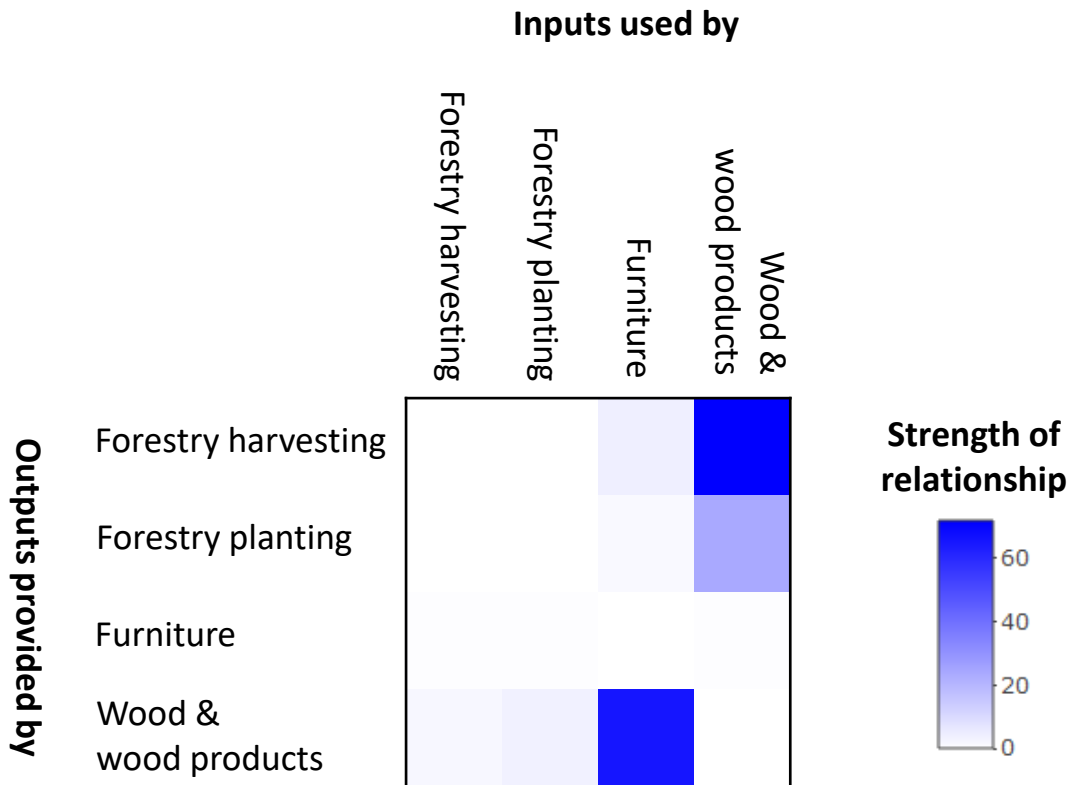
17. Printing cluster (0.5% of economy)

18. Clothing & textiles cluster (0.4% of economy)

Textiles

Wearing apparel