Department for International Trade

Analysis

Estimating the relationship between exports and the labour market in the UK

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This is a report of research carried out by the Fraser of Allander Institute at the University of Strathclyde, on behalf of the Department for International Trade.

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Executive Summary

Economic theory tells us that trade can help boost employment outcomes in the long run. However, the benefits of trade are not necessarily experienced equally, or at all. Evidence suggests that some sectors do better than others and that the impact on labour can differ by gender and skill group. Given the different sectoral and skill mixture of age groups and regions, it is also highly likely that the impacts also differ across these dimensions.

Organisations such as the Organisation for Economic Co-operation and Development (OECD) and the European Commission have produced estimates for some of the impacts of trade on the labour market. While these estimates can capture cross-border supply chain interactions, they are often very aggregate and do not explore the distributional impacts across different labour market characteristics and regions.

Some countries, such as the United States and Canada have sought to improve their understanding of the distributional impact of trade by estimating these various impacts. However, a gap in existing statistics exists for the United Kingdom, particularly when looking at distributional impacts.

This project, commissioned by the Department for International Trade (DIT), produces for the first time a comprehensive set of indicators to estimate the aggregate and various distributional impacts of UK exports on the labour market. This allows for an in-depth understanding of the relationship between exports and the labour market in the UK. The indicators are highly detailed and include a large number of sectors, a yearly time series covering the years 2014-16, a large number of trading partners, breakdowns by gender, occupation group, age group, qualifications, and UK NUTS1 region.

The estimates are based on combining data from the Office for National Statistics (ONS) UK input-output (IO) tables and other ONS sources, including Workforce Jobs, the Annual Survey of Hours and Earnings, the Annual Population Survey and Trade in Goods and Services by Industry data. IO modelling provides a useful framework for estimating the impact of exports on the labour market if augmented with additional economic and labour market data. To our knowledge, this is the first attempt internationally to quantify such a comprehensive range of impacts using an IO approach at this level of granularity.

The analysis produces a number of novel insights:

- We estimate that UK export production supported around 6.5 million full-time equivalent (FTE) jobs, or 23% of total UK FTE jobs, in 2016[1].

[1] The report focuses on the '*direct*' and '*indirect*' effects of exporting on UK jobs. However, the analysis also enables estimation of jobs supported due to the wage spending of those employed directly and indirectly in UK exporting sectors and their UK supply chains. When adding in these '*induced*' effects, the number of FTE jobs supported by exports rises to 11.3 million, or 39% of FTE jobs in the UK.

- Around 58% (3.8 million) of these jobs were in exporting industries (jobs supported '*directly*' by exports) and 42% (2.7 million) were in the UK supply chain of exporting industries (jobs supported '*indirectly*' by exports).
- The number of jobs directly and indirectly supported by exports is estimated to have increased between 2014 and 2016 by around 387,000.
- The sector whose exports support the largest number of jobs is Manufacturing.
- The sectors most dependent on exports (in terms of absolute number of jobs) are the 'Professional, scientific and technical services' and 'Admin and support services' sectors.
- The country which supports the largest number of jobs through exports is the United States (US); UK exports to the US supported directly and indirectly around 1.3 million UK jobs (or 4% of all UK FTE jobs). Over the same period, exports to the EU and the RoW supported 2.8 million and 3.7 million UK FTE jobs, respectively.
- Over a quarter of FTE jobs directly and indirectly supported by UK exports are estimated to be in London.
- Given the sectoral make up of exporting sectors, we estimate that the median wages are on average higher for both direct and indirect jobs: showing the importance of exporting for supporting high wage paying sectors.
- Further estimates are derived for personal characteristics to provide insights into the challenges and opportunities that a change in exporting may have for particular parts of the population. For example, our estimates suggest that men benefit disproportionately from UK exporting activity: of all the UK FTE jobs that are directly and indirectly supported by exports, 36% are held by women and 64% by men. Similar estimates are derived for people with different qualifications, occupations and ages.

It should be noted that all estimates relate to existing UK-based jobs (that is, 'supported') rather than newly created jobs ('created').

Our estimates differ from other exercises that use the same framework as a building block for producing similar estimates (see, for example, OECD (2019b)) due to differences in methods and the underlying data used. Despite methodological and data differences, our aggregate results come close to the OECD (2019b) estimates.

Our 'single-nation' IO framework has a number of advantages over other exercises that attempt to quantify the impact of exports on the labour market using 'multi-nation' IO tables. Single-nation tables require fewer assumptions; are consistent with National Accounts; can be relatively easily augmented with additional data to examine further indicators of interest; and should provide the most robust results. However, international comparisons and analysis of Global Value Chains (GVCs) can only be performed with multi-nation IO tables.

As with any modelling framework, there are a number of assumptions underpinning the results. The modelling relies on industry averages as we do not have enough information at the firm-level to separate exporting firms from non-exporting firms within an industry. However, evidence suggests that exporting firms are different to non-

exporting firms. On average, they have higher labour productivity and are more import intensive. This will result in the estimates of jobs supported by exports being overestimated. On average, they also pay higher wages which will result in the income supported by exports being underestimated.

Sensitivity analysis carried out by the OECD (2020) found that, even when labour productivity varies significantly among firms, the overall impact on the estimates is reasonably small. However, it is best practice to view the results as having moderately broad confidence intervals, rather than providing point estimates.

There are a number of ways that the analysis/estimates presented in this report could be improved and extended:

A large amount of data is incorporated into the modelling to produce the results of this report. Improving the underlying data would significantly improve the quality of the estimates.

- The most critical data source for this report is the ONS Industry by Industry (IxI) IO table. Currently, only a single IxI IO table exists for the UK and this covers the year 2016. Development of more IxI IO tables by the ONS would allow for significantly better time series analysis and the relaxation of several assumptions. Continuous updating of IxI IO tables, say on an annual basis, is a key recommendation of this report.
- Another critical piece of data is exports by sector. Annual IxI IO tables would resolve the issue of not having a time series of exports by sector in basic prices. However, we have also found several consistency issues of the ONS trade by industry datasets, used in the estimates covering exports to specific nations, with National Accounts. Consistency between these data sources and the UK IxI IO table is another key recommendation.
- Estimates for the nations and regions of the UK could also be significantly improved with a time series of exports by industry for each NUTS1 region. At present, we have prioritised transparency in our NUTS1 regional estimates as this data is unavailable in a complete or compatible format.

As has been highlighted in this report, a caveat of the modelling is that it looks at sector averages. However, firms can vary within sectors, particularly by trading status, ownership status and size. A clear extension to this project is therefore to start separating sectors by these characteristics. This would require the development by the ONS of more granular ('Extended') Supply Use Tables (SUTs) that take into account heterogeneity between firms. The construction of such tables would enable a substantial step forward in our understanding of how exporting impacts the UK economy and its labour force.

We have provided a proof of concept for analysing how exporting can differentially impact on people with different characteristics, such as gender, age group, occupation and qualifications. This can be extended further to identify groups that are particularly at-risk to export shocks, or groups that may have been left behind in globalisation.

In addition, the analysis could be extended to cover more years, either prior to 2014 or (using nowcasting techniques) post-2016. The quality of these estimates will however depend on the quality and availability of IxI IO tables.

1 Background

Trade is crucial to the success of any modern and open economy. Trade can provide opportunities for firms as new markets are opened up, but it can also provide risks as firms in less competitive industries are exposed to international competition, so that the gains from trade may not be evenly spread across society. It is therefore important to understand the impact that trade could have on different parts of the workforce, whether that is by region, sector or personal characteristic. In this study, we focus on the impact of one component of trade – exports – on the labour market.

For the UK Government, a crucial part of understanding the relationship between exports and the labour market will be good quality data based on robust economic modelling. In countries such as Canada and the United States, estimates of the number of jobs supported by exports are produced regularly and broken down by province/state and sector. For the UK, while some estimates have been published by organisations such as the OECD and the European Commission, a gap in statistics exists when looking at aggregate jobs supported by UK exports, as well as specific population groups, sectors and regions.

As will be demonstrated through the literature review of the various projects in this field, it is widely accepted that the benefits of trade are not evenly spread. At this important time in UK trade policy making, it is important that this evidence gap is filled. This is not only to understand which sectors benefit differentially from trade, but also (crucially) to explore the characteristics of the parts of society which benefit, or have the potential to benefit, from increased or more diverse trade.

This project will help understand the relationship between UK exports and the labour force, by sector, gender, partner country and UK region, which will build the evidence base for policy making in this area. In addition, it will explore the extent to which impacts can be estimated for other groups in the population, such as those with different qualifications, ages and occupations.

A key objective of this project is to carry out the analysis so that it is replicable, uses publicly available sources, and is completely transparent. This enables the estimates to be extended to cover further years or other indicators over time, to capture the evolution of policy and/or the changing nature of the labour market.

The project was commissioned by the Department for International Trade (DIT) in 2020. The aims of the project as set out in the original tender document were as follows:

- review the evidence base of the impact of exports on employment and labour incomes; and
- develop a methodology for estimating the number of UK workers, and their associated incomes, that are directly and indirectly supported by exports – both at an aggregate level and by UK industry, export destination, UK NUTS1 region and gender.

As has been set out above, this report has also sought to explore the impact of exports on characteristics that go beyond the original scope of the project such as age, occupation and qualifications.

Underpinning our work in this project are Input-Output (IO) tables. IO tables describe the monetary flows of goods and services in the economy, and the relationships between industries, types of final demand (such as household consumption, exports etc.) and inputs (such as labour).

The Fraser of Allander Institute (FAI) has extensive experience of research into trade and the labour market, and regularly comments on the releases of relevant statistics. In addition, the FAI has an international reputation for expertise in IO and Computable General Equilibrium (CGE) modelling. It produced the first Scottish IO table in 1979, has undertaken a huge number of IO projects and hosted the latest International Input-Output Association conference.

The structure of the report is as follows:

- We first provide an overview of the economic theory that links trade to labour market outcomes.
- Following this is a review of the methodologies of various international and national initiatives to estimate the impact of exporting on jobs and incomes, along with a summary of existing estimates for the UK.
- In Chapter 3, we provide an understanding of IO modelling, the assumptions underpinning the modelling and the choice of IO tables.
- Chapter 4 covers the data underpinning the modelling and explains in detail any assumptions that have been made and relevant caveats.
- In Chapter 5, we provide the results of the modelling and compare these to OECD estimates.
- Finally, we conclude and suggest opportunities for future research to refine the estimates and offer further understanding of the relationship between trade and the labour market.

2 Literature review

Key points:

- Economic theory tells us that trade can help boost employment outcomes in the long run. This is not just limited to exporting. Importing can also provide benefits to an economy. Imports are often used to help produce exports and, in many countries, a significant proportion of employment is supported by Global Value Chains (GVCs).
- But the benefits of trade are not necessarily experienced equally, or at all. Evidence suggests that some sectors do better than others and that the impact on labour can differ by gender and skill group. Given the different sectoral and skill mixture of age groups and regions, it is likely that the impacts also differ across these dimensions.
- This study focuses on the impact of one component of trade - exports - on the labour market. The typical methodology for estimating the number of jobs supported by exports is IO modelling. Existing estimates based on IO modelling differ due to differences in methodology, definitions, coverage and the underlying data used.
- The choice of using a multi-nation IO table or a single-nation IO table is important. Single-nation tables (such as those used in the present study) require fewer assumptions; are more coherent with National Accounts; can be relatively easily augmented with additional data to examine further indicators of interest; and should provide the most robust results. However, they do not enable analysis of GVCs (including the impact of imports on employment) and international comparisons. Such analyses can only be performed with multi-nation IO tables.
- To date, no single study on the relationship between exports and the labour market covers the full range of sectoral, regional, trading partner and personal characteristic indicators.
- This project, for the first time, provides estimates of the number of jobs, and associated incomes, supported by exporting activity for all of these indicators in a format consistent with UK National Accounts. This allows for an in-depth understanding of the impact of exports on the UK labour market. Estimates are produced for a range of UK sectors and trading partners for the years 2014-16, and a number of dimensions are explored, including gender, age, qualifications and occupation.

2.1 The link between trade and labour market outcomes

A significant body of literature analyses the theoretical and empirical link between trade and the labour market. Economic theory teaches that trade and the gains from specialisation can boost aggregate incomes and employment in the long term (Myint, 1958), but that the resulting restructuring in economic activity and “reshuffling” of

capital and labour towards more productive industries can result in short term job losses within industries at a comparative disadvantage.

When engaging in trade, countries specialise because of comparative advantage: a country has comparative advantage if the opportunity cost of producing an additional unit of a good or service is lower than the equivalent costs of their trading partner (The Core Team, 2017). This implies that industries at a comparative disadvantage that become exposed to more efficient competition through trade liberalisation are likely to lose out, as capital and labour are redirected to more productive sectors.

Several major international studies have tested this theory and analysed the different factors that affect the relationship between trade and labour market outcomes. It is clear throughout that the effects of trade on the labour market are not uniform and depend on many country specific factors.

The OECD (2019b) currently estimates that gross UK exports supported 6.6 million employment and $325 billion compensation of employees in the UK in 2015 (latest year available). Analysis by the OECD (2016), based on older data for 2011, found that trade supports a significant portion of employment across OECD countries through GVCs. The share of the workforce involved in producing goods and services for final consumption abroad has increased over time and is greater for smaller nations, ranging between 10%-15% for large advanced economies such as the United States, Brazil and China and 45%-65% for small open economies like Ireland and Luxembourg.

Analysing GVCs and their impact on employment, rather than just considering imports and exports of finished products, can provide a useful understanding of the importance of international supply chains. This is particularly useful when jobs are created in industries that use imported goods to produce exports. In the UK, Ijtsma et al (2018) found that industries that export more also tend to source a higher portion of inputs through imports, most notably manufacturing industries. However, compared with other EU countries, the study found that the UK is less integrated in GVCs.

A recent study by Cambridge Econometrics (2020) on behalf of DIT, based on OECD Trade in Value Added (TiVA) data, found similar evidence in terms of UK's integration in GVCs, attributing the relatively low level of UK's participation in GVCs to its specialisation in services and size of the economy; the production of services is not 'sliced up' to the same extent as production of manufacturing goods, and the larger the economy, the greater its ability to source inputs domestically. This explains why the import content of exports – a key indicator of GVC participation – is relatively low for the UK.

Whilst trade supports a significant number of jobs, it also creates job losses in less productive sectors exposed to higher competition. A major study conducted by the International Collaborative Initiative on Trade and Employment (OECD, 2012) found that "*employment gains in exporting sectors often lag or do not fully compensate for employment losses in import-competing sectors, sometimes ushering periods of higher unemployment*". This shows that whilst the overall result might be increased employment, the (perhaps short-term) impact on individuals of redirecting labour to more productive sectors can be severe.

Employment tends to shift towards more productive industries, which in turn has driven productivity growth. Cline (2004) estimated that an increase in the trade to GDP ratio

by 10 percentage points will on average produce a long-term increase in labour productivity of between 1.4 and 9.6%.

Due to the competitive behaviour of firms in a free market, firms that fail to adopt new technology, minimise their costs, etc. will be competed out of the market, "*leaving more dynamic firms facilitating technological advancement*", productivity growth and hence economic growth (The Core Team, 2017).

This productivity growth results in long term wage increases and is the main way in which trade liberalisation boosts incomes. A study on trade policy by the OECD (2018a) found that opening economies to trade could boost wages by up to 4%, with developing countries benefiting the most. However, the study also finds that trade's impact on wages varies from industry to industry, which is in line with economic theory.

There is ambiguity about the impact that trade has on wage inequality. A joint study by the International Labour Organisation and World Trade Organisation (WTO and ILO, 2007) argued that developed countries tend to trade more with other developed countries than with developing countries. This ('intra-industry') trade between similar countries can raise wage inequality within countries and within sectors.

Slaughter (2001) studied the price elasticity of demand for United States labour and found that manufacturing industries have experienced a particularly significant increase in elasticity, from around -0.5 in the mid-1970s to around -1.0 in 1991. This ties in with the theory that labour demand in open economies is more sensitive to changes in wages because domestic workers are more substitutable. The result would be increased wage inequality between those whose work is easily outsourced and those whose skills are not, that is, between skilled and unskilled labour.

Ethier (2005) models the impact of globalisation on the skill premium and the presence of skill-biased technological change. The study finds that decreasing costs of outsourcing can increase the skill premium by depressing wages of unskilled workers in developed countries.

This effect might be exacerbated by diminishing workers' bargaining power in the face of increased competition from unskilled labour abroad. Spector (2001) argues that trade liberalisation reduces a government's ability to control wages and therefore redistribute wealth, resulting in a further increase in wage inequality.

Quantifying the impact that trade has had on wage inequality is difficult and there are varying estimates. For example, Wood (1994) finds that 70% of the rise in skill differentials is due to trade liberalisation, whereas Lawrence and Slaughter (1993) attribute almost no role at all to trade.

Furthermore, the OECD (2012) found "*virtually no evidence that trade has played a major and/or systematic role across countries in increasing household income inequality*". The study concluded that trade can generate more inclusive growth when supporting policies are in place, suggesting that the specifications of trade agreements and supporting policies are as crucial to labour market outcomes as trade itself.

The International Monetary Fund (2007) found that trade liberalisation and export growth tend to be associated with lower income inequality in both developed and developing economies but financial openness and Foreign Direct Investment (FDI) may have the opposite effect.

The literature presents evidence that the benefits and costs of trade are not shared equally within societies and that this divide is across more elements of society than skilled and unskilled labour. A recent study by the ILO (2016) concluded that trade agreements that specifically provide for labour market provisions increased labour force participation rates amongst females more than males. Many other studies have found that the effects of trade are felt differently according to gender. Gunluk-Senesen & Senesen (2011) examine the impact of final demand on male and female employment across different sectors in Turkey using a single-region IO table of the Turkish economy. For instance, they find that the transportation and services sector, when indirect effects are taken into account, generates a significant amount of employment for men, but not for women.

In a separate OECD report (2018b), the gender split of employment supported by exports was examined. The study found that, in the UK, around 19% of female and 26% of male employment was supported by exports in 2014. However, female employment is primarily in indirect channels while male employment is mainly in direct channels. This is primarily due to more female employment being related to service rather than manufacturing industries, relative to male employment. It should be noted that similar estimates for more recent years are not available - a gap that the present study attempts to fill.

Shaw and Jobes (2019) noted that trade and open borders can work to increase or decrease employment for men and women depending on the sector. "*Occupational segregation*" can concentrate genders into certain industries. With this in mind, it is crucial to understand the sectors that are more male employment-intensive or female employment-intensive to analyse the gender-differences in outcomes following changes to trade. In the UK, manufacturing sectors typically have a high propensity to export and are more male employment intensive, 13% of male employment is in manufacturing compared to 5% of female employment (ONS, 2020b). Services sectors, which are typically involved more in the supply chain of exports than in direct exporting, are usually more female employment intensive. Approximately 71% of male employment and 92% of female employment is in services sectors. Shaw and Jobes state that "*trade may shift … the gender composition of the labour force and working conditions, earnings and labour market segmentation*".

To conclude, the literature shows that there is a causal effect of trade on the labour market and that these effects manifest themselves in a variety of ways. Furthermore, the gains and losses from trade liberalisation are not shared evenly, for example outcomes can differ depending on gender, the location of industry clusters and whether labour is skilled or unskilled. The literature also highlights that limitations in data availability and quality make it difficult to quantify precisely the impact of trade on the labour market.

2.2 Initiatives to estimate the number of jobs supported by exports

In this section, we first provide a brief overview of the typical modelling framework for estimating jobs supported by exports – IO modelling. We follow this with a discussion of the existing multi-nation and single nation initiatives, their methodologies and their relative advantages and disadvantages. Finally, we compile the latest estimates for the UK and other large economies.

The OECD, European Commission, World Bank, HM Treasury, Statistics Canada, Statistics Finland and the US Department of Commerce all use IO as a building block to produce estimates of employment or jobs supported by exports. IO tables describe the monetary flows of goods and services in the economy, and the relationships between industries, types of final demand (such as household consumption, exports etc.) and inputs (such as labour).

Because IO tables account for all these flows in one system, the tables lend themselves extremely well to exploring the use of labour inputs, such as wage income and jobs, in the production of exports. As IO tables are also multi-sectoral (showing the structure of production and consumption of goods produced in a highly detailed number of different industrial activities), they permit a high degree of sectoral analysis. The main reason for their usefulness comes from being able to separately identify those sectors which themselves directly export, and those (upstream) sectors which 'indirectly' export by supplying goods and services to exporting sectors. In other words, IO tables take into account exporting sectors linked with other sectors in the economy, and so capture the full activity in an economy underpinned by exporting activities. For this reason, the IO framework is a widely used method for exploring the relationships between exports and labour incomes/jobs.

The results from IO analysis are typically presented with the '*direct effects*' of exporting as well as the wider spill-over effects, which typically includes either '*indirect effects*' on its own or combined with '*induced effects*'. These can be described as follows:

- *Direct effects* relate to the labour used by exporting firms to produce the exported goods and services;
- *Indirect effects* relate to the labour supported in firms that are within the domestic supply chain of exporting firms;
- *Induced effects* relate to the labour supported by the wage spending on goods and services in the economy of those employed directly and indirectly in exporting sectors and their domestic supply chains.

These estimates relate to existing UK based jobs ('supported') rather than newly created jobs ('created').

2.2.1 Multi-nation initiatives

As mentioned in the previous section, a number of organisations, such as the OECD, the European Commission and the World Bank, produce estimates of the relationship between trade and the labour market for many countries. These estimates are based on multi-nation or multi-regional IO (MRIO) tables.

A leading MRIO initiative is the OECD's Inter-Country Input-Output (ICIO) tables. This has been developed to produce TiVA and Trade in Employment (TiE) indicators. TiE indicators provide estimates of employment supported by exports and foreign sources of final demand. That is, they explore the employment supported across countries by the complex trading relationships arising from GVCs. The ICIO presently covers 36 industries, 64 countries and the years 2005 – 2015. Updated TiVA estimates, covering the period 1995-2018, are expected to be published in Q1 2021.

The Labour Content of Exports (LACEX) and Jobs Content of Exports (JOCEX) databases, maintained by the World Bank, provide indicators for the compensation of employees and number of jobs, respectively, which are supported by a country's exports (Cali, et al., 2016). They are based on the Global Trade Analysis Project (GTAP), a set of IO tables. The JOCEX database includes 11 sectors and covers up to 88 countries for the years 1997, 2001, 2004 and 2011.

The European Commission (2018) uses the World Input-Output Database (WIOD) to produce indicators on the relationship between exporting and employment. The latest WIOD release covers 43 countries, 56 sectors and spans from 2000 – 2014.

The OECD and Statistics Finland (2020) extended the OECD TiVA to 80 sectors using linked data and National Accounts data. They found that this more granular approach showed a significantly higher dependency on GVCs – 10% higher than the OECD TiVA initially suggested. This is due to the more granular tables better capturing the highly trade oriented sub-sectors.

While there are many MRIO initiatives, we concentrate here on three – JOCEX, ICIO and WIOD. The primary advantage of the MRIO tables is their geographical coverage and resulting ability to capture employment or jobs linked to GVC activity. They could answer questions such as "*how many jobs in the UK are supported by the exports of other countries?*" and "*which sectors in other countries use the exports of UK sectors?*". All these datasets have a track record of being used by large organisations and in academic papers.

However, in constructing the tables, data producers necessarily rely on a number of strong assumptions, imputations and adjustments to reconcile data from different sources that are not always coherent with each other. This is particularly the case for bilateral trade statistics which are notoriously inconsistent ('asymmetric') and often incomplete. The harmonisation ('balancing') required to deal with the inconsistencies in the data, inevitably leads to estimates that may diverge from official statistics. In addition, it often leads to compromises on sectoral or geographical coverage, or availability across years. For instance, JOCEX has a good geographical coverage but the information for the UK is limited to four specific years and 11 sectors only. Since this project aims to examine impacts on specific sectors, we suggest that JOCEX is not the best fit for this analysis.

The ICIO and WIOD both have a good coverage of geographies (64 and 43 respectively), sectors (36 and 56) and years (2005-2015 and 2000-2014). They also both take a similar approach to building and balancing their tables, treating National Accounts as the most accurate source of information, albeit with adjustments made for consistency where necessary.

However, there are some key differences between the WIOD and ICIO tables. One key difference is in the frequency and regularity of produced tables. The WIOD is primarily an academic initiative that requires obtaining funding to produce new estimates and is therefore not necessarily produced regularly. On the other hand, ICIO tables are produced on a regular basis by the OECD. In addition, the OECD's MRIO initiative is considered the most viable in the long-run; the OECD has created an expert group to "*harmonise sources, methods and standards*" (Cambridge Econometrics, 2020, p. 26) across different current MRIO initiatives and it is "*reasonable to expect that over the coming years...a 'gold standard' MRIO will emerge*" (Yamano & Webb,

2018) based on the OECD methodology that will be a permanent feature of the international statistical system.

Another difference lies in the data behind the tables. WIOD UK tables are based on benchmark use tables and estimated supply tables for specific available years and the remaining years are estimated using trends in National Accounts. ICIO tables are built using a combination of supply tables, use tables and IO tables. There are also differences in data sources for trade data. In addition, the ICIO is based on the latest System of National Accounts (SNA 2008) whereas WIOD is still constructed on SNA 1993 basis. This can have a big impact on estimates. One of the reasons behind this is because R&D expenditure was reclassified from intermediate consumption to a source of final demand – Gross Fixed Capital Formation (OECD, 2015). Another is the change in treatment of goods or services moving across borders without a change of economic ownership.

Comparing the approaches, the ICIO has wider geographical coverage which produces additional challenges when harmonising this large amount of international data. In general, the more countries and sectors that are included as part of these international databases, the more imputations and manipulations are required to ensure internal consistency, which inevitably weakens the quality of the estimates. However, this is an issue that applies to all MRIO initiatives. The ICIO may be preferential due to its better access to data, ongoing improvements to data quality and documentation, and continuing production of tables.

2.2.2 Single nation initiatives

A number of estimates have been produced for a single nation only. These include estimates by the FAI for Scotland (2019), HM Treasury (2016) for the UK and its regions/countries, Statistics Canada (2020), the US Department of Commerce (2017b) and Trade Partnership Worldwide for the US (2019).

The FAI and Statistics Canada follow a similar methodology – that is, the industry-by-industry (IxI) IO tables are used to construct Leontief inverses which enable estimation of the employment or jobs in the supply chain supported by exports. The FAI's IO modelling framework was based on the Scottish Government's IO tables. These tables currently cover the years 1998 to 2016 and include 98 industries. They represent the Scottish economy only, rather than being a multi-regional IO table.

Statistics Canada publish IO tables which, at the detailed level, include 234 industries and cover every province in Canada individually. While these are MRIO tables, they have been included in this section as they produce results for a single nation only, and are not faced with the difficult task of harmonising international data. This makes their implementation similar to methodologies using a single region IO table. The advantages and disadvantages of both these methodologies primarily relate to their use of single-nation, rather than multi-nation IO tables.

The advantages of using a single-nation table are primarily in the additional sectoral detail available, the recentness of the tables, the quality of the data and the consistency with other national data that is included in the modelling. For instance, the Scottish Government IO table has 98 industries and Statistics Canada has up to 234 industries. This compares with 56, 36 and 11 for WIOD, ICIO and JOCEX tables respectively. In addition, the large amount of international data harmonisation seen for

MRIO tables is not required for single-nation tables. This results in less compromise around data quality.

A comparison between the headline results produced by Statistics Canada and by the OECD's Trade in Employment data show broadly similar results for aggregate figures. It is important to note that Statistics Canada estimates measure jobs, while the OECD estimates measure employment. The difference being that a person can hold more than one job and, less commonly, one job can be shared between two people. As the results are broken down, for example by trading partner, the differences between the use of single-nation tables and MRIO tables will grow.

Table 1: Employment (OECD) or jobs (Statistics Canada) supported by exports of Canada, 2012-2015

Source	2012	2013	2014	2015
Statistics Canada	2,990,004	3,041,197	3,121,115	3,236,824
OECD Trade in Employment	3,627,500	3,744,100	3,769,000	3,697,000

Sources: Statistics Canada (2020), OECD Trade in Employment database (OECD, 2019b)

There are also disadvantages in using single-nation IO tables. Comparisons with other countries are not available on a consistent basis and the tables are unsuitable for analysing the impact of GVCs.

In summary, the methodology used by the FAI and Statistics Canada emphasises the quality of data and the level of detail, but as a result loses the ability to analyse international trade flows and GVCs.

In a one-off exercise, HM Treasury (2016) analysed the number of jobs in the UK, and its regions and nations, supported by UK exports. To estimate this they used output multipliers, generated from ONS IO and jobs data. The results were provided by NUTS1 region by using regional shares of UK GVA. While using the multipliers derived from IO tables (rather than the IO tables themselves) is suitable for generating aggregate jobs numbers, further analysis is very limited. It is not possible to incorporate labour characteristics, such as gender, skills and age groups. This is because the multipliers show the jobs supported by a sector's exports, but not which other sectors the indirectly supported jobs are in. In summary, it would not be possible to meet the objectives of this project by using this methodology.

The US Department of Commerce uses the IO framework to provide estimates of jobs supported by US exports at the national level (2017a) and by US state (2017b). The estimates at the national level cover exports of both goods and services while the estimates by state cover goods exports only. They do not break down by sector or other characteristics, although previous releases covering the year 2014 (US Department of Commerce, 2016b) and 2015 (US Department of Commerce, 2016a) are more comprehensive considering impacts by exports destination, product and industry.

Trade Partnership Worldwide (2019) use a Computable General Equilibrium (CGE) model, based on Global Trade Analysis Project (GTAP) tables to estimate the jobs supported by US exports. A CGE model is in some ways similar to an IO model but uses a huge number of equations (and underpinning assumptions) to add supply-side responses to the modelling. Using this model, they hypothetically remove all US exports and imports by imposing sufficiently high tariff costs for the US. CGE models can provide useful analysis, however, due primarily to their complexity and the high degree of data required, particularly when a detailed sectoral breakdown is required, they are not as suitable as IO analysis for meeting the objectives of this project.

2.2.3 Comparison of estimates

It is important to understand that definitional differences can impact the estimates. In the existing estimates below, some are measured in terms of jobs while others are measured in terms of employment - the key difference is that a person can hold multiple jobs. Our estimates count full-time equivalent (FTE) jobs. We explain the definitional differences in full in section 4.2.1.

Table 2: Overview of initiatives with UK estimates of employment or jobs supported by exports

Source	Years available for UK estimates	Reporting countries available
OECD Trade in Employment (2019b)	2005-2015	All OECD countries and a selection of non-OECD countries
OECD Women in GVCs (2018b)	2014	All OECD countries and a selection of non-OECD countries
World Bank – JOCEX/LACEX (Cali, et al., 2016)	2001, 2004, 2007, 2011	120 countries
European Commission (2018)	2000-2014	43 countries
HM Treasury (2016)	2015 (base year 2010)	UK and UK regions/nations

Table 3: Employment/jobs supported by exports sources - dimensions available

Source	Sectors	Time series	Income	Trading partners	Sub-national	Gender	Skill group	Age group	JSE‡	ESJ‡‡
OECD Trade in Employment	✓ (36)	✓	✓	✓	✗	✗	✗	✗	✓	✗
OECD Women in GVCs*	✓ (3)	✗	✗	✗	✗	✓	✗	✗	✓	✗
World Bank – JOCEX/LACEX**	✓ (11)	✓†	✓	✗	✗	✗	✓††	✗	✓	✓
European Commission***	✓ (10)	✓†††	✗	✓	✗	✓	✓	✓	✓	✓
HM Treasury****	✗	✗	✗	✗	✓	✗	✗	✗	✓	✗

* Data currently available in chart format only. This is a one-off report.
** Several key results are not provided in the online database
*** Only includes impact of UK exports to non-EU or total EU exports to non-EU
**** Only includes impact of UK exports to EU
† 2001, 2004, 2007, 2011
†† Only for labour compensation
††† Latest report has 2000, 2007, 2014, 2017
‡ "Jobs Supported by Exports of each sector" (JSE): Allocating the jobs supported by exports to the exporting sector, no matter which sectors these jobs lie within.
‡‡ "Export Supported Jobs within each sector" (ESJ): Allocating the jobs supported by exports to the sector the jobs lie within, no matter the exporting sector.

Table 4: Estimates of employment, jobs and wages supported by exports for the G7 countries by international initiative

Source	No. of employment/ jobs supported	Share of jobs supported by exports	Share of compensation of employees supported by exports
OECD Trade in Employment Latest data: 2015	**Canada:** 3.7m **France:** 5.8m **Germany:** 12.3m **Italy:** 5.6m **Japan:** 8.9m **UK:** 6.6m **US:** 14.8m (headcount employment supported by domestic gross exports, direct + indirect)	**Canada:** 20.2% **France:** 21.1% **Germany:** 28.6% **Italy:** 22.7% **Japan:** 13.5% **UK:** 21.2% **US:** 9.4%	**Canada:** 37.1% **France:** 43.9% **Germany:** 42.5% **Italy:** 33.5% **Japan:** 43.8% **UK:** 47.6% **US:** 48.1% (share of compensation of employees supported by domestic gross exports, direct + indirect)
OECD Women in GVCs Latest data: 2014	N/A	**UK:** around 19% female, 26% male (share of male and female labour hours embodied in exports)	N/A

Source	No. of employment / jobs supported	Share of jobs supported by exports	Share of compensation of employees supported by exports
World Bank – JOCEX/LACEX Latest data: 2011	**Canada:** 2.8m **France:** 4.5m **Germany:** 10.9m (headcount employment embodied in exports, direct + indirect) The indirect figures are only provided for a subset of nations in the report – direct figures available for some in the database: **Canada:** 1.4m **France:** 2.4m **Germany:** 5.6m **Italy:** 2.0m **UK:** 2.6m	**Canada:** 16% **France:** 17% **Germany:** 27% (as a % of the job content of domestic production) These figures are only provided for a subset of nations in the report	Not shown
European Commission Latest data: 2014	**France:** 2.8m / 0.5m **Germany:** 6.8m / 1.1m **Italy:** 2.7m / 0.5m **UK:** 3.75m / 0.65m (headcount employment supported by domestic exports to countries outside the EU / by the exports of other EU countries to countries outside the EU, direct + indirect)	**France:** 12% **Germany:** 18% **Italy:** 13% **UK:** 14%	N/A
HM Treasury Latest data: 2015	**UK:** 3.25m (Jobs supported by domestic exports to EU countries, direct + indirect)	**UK:** 10%	N/A

It is important to note that no single initiative covers the full range of sectoral, regional, trading partner and personal characteristic indicators. Given that each initiative uses different underlying data and, in some cases, very different methodologies, it is not possible to mix and match the results of interest as they will not be comparable.

The results of this project will, for the first time, provide all of these indicators as comparably as possible while making use of the benefits of single-nation IO tables, such as data quality, data consistency and sectoral disaggregation. This will allow for an in-depth understanding of the impact of exports on the UK labour market.

These indicators will be extended further than in the initiatives above. For example, income will be examined on a median wage basis, along with a total change in compensation in the economy, and results will be produced for a large number of trading partners, UK sectors and labour market characteristics.

Estimates will also be more up-to-date, with the latest IO table relating to 2016. Estimates will cover the years 2014-16 to both ensure that they are representative, and to provide a framework for producing a larger time series. The methodology will enable regular updating of these estimates, for instance on an annual basis. Finally, the estimates will be in line with UK National Accounts to ensure that they are as robust as possible.

3 Methodology

Key points:

- IO modelling provides a useful framework for estimating the impact of exports on the labour market when augmenting these estimates with additional economic and labour market data.
- Three 'effects' are crucial to interpreting results from IO modelling. *Direct effects* relate to the labour used by exporting firms to produce the exported goods and services. *Indirect effects* relate to the labour supported in firms that are within the supply chain of exporting firms. *Induced effects* relate to the labour supported by the wage spending on goods and services in the economy of those employed directly and indirectly in exporting sectors and their domestic supply chains.
- The primary methodology for producing our estimates is to calculate Leontief matrices, then use these to estimate the output supported by exports, and finally combine this with data on how output relates to FTE jobs, compensation of employees and other indicators of interest.
- As with any modelling there are a number of assumptions underpinning the results. The results should therefore be treated with care. IO modelling examines the impact on industries. We do not have enough information to separate exporting firms from non-exporting firms within an industry. Therefore, the modelling relies on industry averages. However, if exporting firms are significantly different to non-exporting firms, this could bias the results.
- Evidence suggests that exporting firms differ. On average, they have higher labour productivity and are more import intensive. There is also evidence that larger and foreign-owned businesses are more productive and more likely to export than smaller and domestic-owned businesses. This finding is not specific to the UK and is seen in other countries also. These will result in overestimating jobs supported by exports. Exporting firms also pay higher wages on average which results in an underestimation of income supported by exports.
- When looking at firm heterogeneity within sectors, the OECD has undertaken sensitivity analysis and found that, even when varying labour productivity significantly, the overall impact on their estimates was reasonably low. However, it is best practice to view the results as having moderately broad confidence intervals, rather than providing point estimates.
- The choice of IO tables is important. It dictates the quality of the estimates and the potential outputs from the modelling. To meet the objectives of this report, we use the ONS' UK IxI IO table. This provides the most reliable data; will be in line with UK National Accounts; can be combined with other sources of ONS data to provide further insight into personal characteristics; provide good sectoral detail; and are presently the most up-to-date tables. However, given that the ONS tables only cover one region – the UK – they are not appropriate for modelling GVCs, nor are international comparisons possible.

3.1 Input-output modelling

IO modelling is a common method for attributing labour to a type of domestic demand and exports. IO tables describe the monetary flows of goods and services in the economy, and the relationships between industries, types of final demand (household consumption, exports etc) and inputs (such as labour).

Because IO tables account for all these flows in one system, the tables lend themselves extremely well to exploring the use of labour inputs, such as wage income and jobs, in the production of exports. As IO tables also show the structure of production and consumption of goods produced in a highly detailed number of different industrial activities, they permit a high degree of sectoral analysis.

They are able to account for exporting sectors' links with other sectors in the economy, and so capture the full activity in an economy underpinned by exporting activities. For this reason, the IO framework is a widely used method for exploring the relationships between exports and labour incomes/jobs.

3.2 Direct, indirect and induced effects

The *'direct effects*' of exporting are simply the activity (exports) generated by exporting UK firms as they respond to demand from other countries.

However, the exporting firm does not produce its goods or services in isolation. To produce its goods or services, it purchases inputs (for example, raw materials or business support services) from other domestic (UK) firms. And, in turn, these suppliers will have their own suppliers. The external demand placed on the exporting firm has led to activity being generated through the whole of its domestic supply chain. This is termed the *'indirect effect*'.

Throughout the whole supply chain, people are employed to help produce these additional goods or services, whether the goods or services are inputs to another firm in the supply chain or the final product. These employees spend their wages on other goods and services across the economy such as housing and groceries. This generates further economic activity and is named the *'induced effect*'. The indirect and induced effects are often known as *'spill-over effects*'.

Throughout this report we have placed more emphasis on the direct and indirect effects. Firms involved in the direct and indirect effects are part of the exporting supply chain. While the spending of the wages seen in the induced effect are supported by exports, the pattern of wage spending is more of an economy-wide effect.

3.3 Understanding the IO methodology

First, we start with the IO table. This will form the basis of the relationships between sectors, inputs and sources of final demand. That is, it details the purchases and sales of each sector to every other sector, as well as exports and compensation of employees by sector.

Relationships can be drawn from these data which show how, on average, sectors buy inputs from other sectors so that they can meet demand (from households,

government, foreign customers) for their products. These relationships can be shown using the Leontief matrices.

This project uses two Leontief matrices - a Type I Leontief matrix and a Type II Leontief matrix. The former includes only direct and indirect relationships while the latter includes direct, indirect and induced relationships.

The Type I Leontief matrix is calculated as

$$L = (I - A)^{-1}$$

where A is the matrix of technical coefficients and I is the identity matrix.

The matrix of technical coefficients can be explained most simply by looking at a single column. That column represents the purchases of one sector as a proportion of its output. For instance, if the second element is 0.1 then the sector in question purchases inputs from the second sector (for example, forestry and logging) worth 10% of its total output. Part of its inputs will also be made up of compensation of employees and imports. The identity matrix is a matrix of ones along the diagonal and zeroes elsewhere.

The Leontief matrix is also used to extract multipliers. Summing all the elements of a given column provides the Type I output multiplier for a given sector. That is, the ratio of direct and indirect output change to the direct output change resulting from a one unit (£1m) increase in final use.

While some work, such as the HM Treasury (2016), use output multipliers to generate their estimates, we use the full Leontief matrix instead. While multipliers will produce the same aggregate result, they are a single number and so information on which other sectors the spill-over effects occur in is lost. This means, therefore, that multipliers will not be able to explain the amount of jobs supported *within* each sector by UK exports. They will only be able to explain the amount of supported jobs *by* each individual sector's exports (but not how the jobs supported indirectly are spread over the sectors of the economy). We discuss this further in our results section and, in addition, produce a number of results for the multiplier method. Using the Leontief matrix enables us to allocate the spill-over jobs to sectors and so incorporate further data, allowing for analysis of characteristics such as gender, median wages, age group and occupation.

The Type II Leontief matrix endogenises households so that the relationship between output and compensation of employees can be explored. It is calculated as

$$L^* = (I^* - A^*)^{-1}$$

where A* is the matrix of technical coefficients and I* is the identity matrix, both with an additional row and column relating to households.

Similar to the matrix of technical coefficients for the Type I Leontief, a single column in the matrix of technical coefficients for the Type II Leontief shows the purchases of one sector as a proportion of all its inputs.

For the household column, this shows the purchases of households (household and non-profit institutions serving households final demand) for each sector, as a proportion of all household output (total compensation of employees).

The IxI IO table shows how much each sector directly exported in 2016. However, in order to be able to produce the goods and services they export, firms within these directly exporting sectors purchase inputs (goods and services) from firms within other sectors. Firms within these other sectors gain from (support) exporting. And of course, firms within these sectors have their own suppliers in turn. These supply chain effects are the 'indirect effects' discussed previously, and we can use the purchase and sale relationships detailed in the Leontief to understand which sectors are part of the exporting supply chain.

We also know that firms pay compensation to employees to produce their goods and services. And this compensation is then used to purchase goods and services across the whole economy. The IxI IO table shows how much compensation of employees each sector uses as well as how much households buy from each sector. The induced effect captures the impact of this household spending which arises from paying compensation to employees, both from the activity occurring in the direct effect as well as in the indirect effect.

The output supported by exports, in terms of different effects, is calculated as follows:

- The *direct* effect of exporting is simply the exports of each sector.
- The *indirect* effect of exporting can be found by multiplying the Type I Leontief by the vector of total exports by sector. This shows the direct and indirect output supported by exports for each sector. Since this is in Type I terms (direct plus indirect), the direct effect should be subtracted to find the indirect effect on its own.
- The *induced* effect of exporting can be similarly found by multiplying the Type II Leontief by the exports of each sector. This shows the direct, indirect and induced output supported by exports for each sector. Since this is in Type II terms (direct plus indirect plus induced), the direct and indirect effects should be subtracted to find the induced effect on its own.

This process can be shown mathematically as follows. Output in the economy x can be estimated by multiplying the Type I Leontief Inverse (L) by the vector of final demand (y),

$$x = Ly$$

This vector of final demand is made up of domestic sources of final demand (for example, household and government consumption) and of external sources of final demand (exports). We can therefore separate out these components to attribute the output supported in each sector by exports. A more complete description of IO analysis can be found in Miller & Blair (2009).

The methodology above provides estimates for output supported by exports. This output can be used to estimate the impact on other indicators, such as FTE jobs, using fixed coefficients.

Examples of fixed coefficients include FTE jobs-output coefficients. These are calculated by dividing FTE jobs in each sector by their total output (in £m). This shows the amount of FTE jobs in a given sector associated with a million pounds of output in that sector. For instance, in 2016, every million pounds of output in electrical equipment is, on average, associated with 6 FTE jobs.

Knowing the relationship between jobs and output and also the output supported by exports, we can estimate the jobs supported by exports.

This same process of translating output to FTE jobs using FTE jobs-output coefficients can be extended to other indicators by using the relevant coefficient. For instance, female/male jobs coefficients and compensation of employees coefficients can be used.

And we can change more than just the choice of the coefficient. We have shown above how to relate the output supported by total exports to FTE jobs. However, this can be done for exports to a single country by simply replacing the vector of total exports by sector in the methodology with a vector of exports by sector for an individual country. Using the same coefficients, we can then understand how output supported by exports to a specific country can support FTE jobs in the UK.

3.4 Relevant assumptions

As with any modelling framework, there are a number of assumptions underpinning the results so estimates should be taken with caution. For instance, all firms are assigned to a sector and all firms in a given sector are aggregated into the 64 sectors given in the UK IO table. As noted in the previous section, therefore, when we examine how industries provide inputs in order for a given industry to increase its output by a unit, we are looking at industry averages of firms, weighted by the size of those firms.

Without further information, the necessary (strong) assumption for this project is therefore that exporting firms are similar to other firms within the same industry. This means that exporting firms, for each £1m of outputs, are assumed to purchase the same proportions of inputs from other industries, the same amount of labour, imports etc. as non-exporting firms within the same industry. This is an important drawback of the methodology as exporting firms within a sector are not separated from non-exporting firms. This drawback, reflecting the inability of existing IO tables to account for firm-level idiosyncrasies (heterogeneity), is not limited to the present study only and can impact on the results.

It is therefore important to understand how well this assumption holds. Evidence suggests that exporting firms are more productive than non-exporting firms, and that this productivity premium increases as the length of time a firm has been exporting increases, see for example (Berthou, et al., 2015). The ONS examined the relationship between goods exporting and productivity for firms in the UK (ONS, 2018). They found that, when controlling for firm size, industry and foreign ownership status, firms which declare goods exports have a labour productivity premium of 21%. This premium is much lower for trade with the EU (4.3%), attributed to the lower barriers to EU goods trade enabling less productive firms to access the markets.

Given that the exporting firms are assumed to have the same labour productivity as other firms in the same industry, this produces an upward bias to the direct FTE jobs estimates. This upward bias to the direct FTE jobs estimates may be lower for sectors which proportionately export more to the EU.

There is also evidence that larger and foreign-owned businesses are more productive and more likely to export than smaller and UK-owned businesses (ONS, 2018). Therefore, the estimates of jobs supported by exports may be overestimated not only

because IO tables fail to distinguish firms by trading status (exporters vs non-exporters) but also by size (large vs small) and ownership (foreign vs domestic owned). The OECD is working collaboratively to encourage countries to develop 'Extended' Supply Use Tables (SUTs) to improve the underlying statistics. This includes separating firms within sectors by trading status, ownership status and size. We outline this as a further extension at the end of this report.

The OECD (2020) performed sensitivity analysis around firm heterogeneity within sectors. They divided firms into two groups – one group, "global manufacturers" that consisted of manufacturing firms who only exported and provided no domestic supply, and the other group made up the remainder of firms. They then estimated the difference between their results and scenarios where global manufacturers had higher to significantly higher labour productivity (10%, 25%, 50%, 100% and 2000% higher). They found that there is little change for non-manufacturing industries and that even in the most extreme scenario, the average maximum change is less than 10% from their baseline estimates. For manufacturing industries only, the average difference from baseline is 10% for 100% higher labour productivity.

Evidence also suggests that exporting firms are more import intensive (ONS, 2018). This implies that there may also be an upward bias to the indirect estimates.

Temouri et al. (2013) find that exporters in the UK, Germany and France pay higher wages on average than non-exporters. The US Department of Commerce (2010) find that, when controlling for workers' education and other demographic characteristics, exports are associated with 18% higher wages in the US manufacturing sector. This varies by industry and is highest for industries with high propensities for exporting. If this is the case then it implies a downward bias on estimated induced impacts (the impact of wage spending arising from the FTE jobs supported by exporting) and a downward bias on estimated salaries.

The likely differences between exporting firms and non-exporting firms mean that the estimates produced in this project should be seen as central estimates with moderately broad confidence intervals, and not as highly accurate point estimates. Future extensions to analyse the impact of this assumption, or attempt to separate non-exporting from exporting firms, has been laid out in the final section of the report.

IO assumptions can briefly be explained as: fixed technical coefficients, fully demand driven, a passive supply side, static information (a snapshot of the economy at one point in time) and the inability to determine legacy effects (if demand expenditures ever hypothetically stopped, there would still be changes in prices, wages and labour supply). Other assumptions are also made in the construction of IO tables. However, presently there is no methodology document for the selected ONS IxI IO table, and so it is difficult to examine these in depth. Further discussion of these assumptions can be found in (Miller & Blair, 2009).

It should be noted that the limitations above are not specific to the present study - they apply to all studies that utilise IO tables. Despite these drawbacks to the IO framework, it provides by far the best basis for meeting the objectives of this project.

3.5 Choice of input-output tables

With IO modelling as the chosen framework, an IO table that provides the basis for the analysis must be selected. A summary of four IO tables – three multi-region and one single-nation – are shown in the table below. The first three IO tables provide the basis for the JOCEX, OECD and European Commission initiatives covered earlier. The final table is an industry-by-industry (IxI) IO table produced by the ONS this year. It is worth noting that, while the ONS have published many product-by-product IO tables, an IxI format is required for analysis of industrial sectors and the effects on FTE jobs.

Table 5: Summary of Input-Output Tables

Table	Sectors	Economies	Years
JOCEX (GTAP)	11	88	2001, 2004, 2007, 2011
ICIO (TiVA)	36	64	2005-2015
WIOD	56	43	2000-2014
ONS UK IxI IO table	64	1	2016

The advantages of using a single-region table are primarily in the additional detail available, the recentness of the tables, the quality of the data and the consistency with other national data that will be included in the modelling. For instance, the ONS IxI IO tables for 2016 cover 64 sectors. This is as few as 8 more sectors than covered by WIOD, and as many as 53 more than JOCEX.

The ONS' IO table is consistent with UK National Accounts and uses a great deal of data to provide the most accurate picture of the UK economy possible. There stands to be a significant improvement in the quality of the data in this table over some multi-regional input-output tables, as in order to create their UK IO tables, often MRIO tables rely either on very old UK IO tables or on estimating the UK supply table. For instance, the WIOD takes the UK use table, which is fully disclosed, and the UK supply table, which only has its diagonal elements disclosed, and estimates the non-diagonal elements of the supply table. It then uses these to build an industry-by-industry IO table. While this is the best that could be done with the available data at the time, the quality of the tables will nevertheless suffer from this estimation procedure.

The relationships between products and sectors in older ONS SUTs (and therefore the data that feed into MRIO tables) are based on the ONS' Purchases Inquiry survey from 2004. The survey (rebranded Annual Purchases Survey) has been relaunched in the past few years, covering the years 2015 – 2017. Our understanding is that the ONS IO table published in 2020 incorporates this new data. There are of course challenges in utilising the survey in conjunction with historical data to produce a consistent time series.

There can also often be significant differences in bilateral trade statistics reported by countries – see ONS (2020a) for more detail. These differences, which are also known as 'trade asymmetries', need to be reconciled in the construction of MRIO tables, using

a number of balancing procedures, assumptions and imputations. These adjustments inevitably affect the quality of the MRIO estimates. By contrast, the ONS' IO tables do not suffer from the same limitation as they rely solely on trade data reported by the UK.

The ONS tables relate to 2016 and are the most recently updated. However, there are no recent prior ONS industry-by-industry tables and there is currently no certainty around the regular production of future tables.

For this piece of work, we use the 2016 tables to produce estimates for 2014 – 2016. For the years 2014 and 2015, the relationships between sectors, final demand and inputs are kept constant from 2016. However, the remaining data used reflects the year of interest. This means, for instance, that for every £1m of output by the agriculture sector in 2014, the sector will buy the same proportion of inputs from each other industry as in 2016. However, the output, exports and other indicators for the agriculture sector will reflect 2014. There is of course some loss of data quality when fixing the relationships for prior years but, given that IxI IO tables are not available for these years, we believe that combining the 2016 IO tables with National Accounts data will offer the best alternative for examining impacts across time. It is also worth noting that other MRIO tables also face this issue of estimating years when a table is unavailable.

Because the ONS tables are consistent with UK National Accounts, they are particularly suited to being combined with other ONS data, such as jobs and wage data.

The ONS tables do have some disadvantages. For instance, other countries' IO tables are not included, and so international comparisons are not available. You will also be unable to study any GVCs between countries. For example, the amount of UK jobs supported by the exports of other countries, that is, where UK producers are part of the supply chain for those countries' exports, and other questions of interest.

Finally, it is worth noting that, while estimates could be made, none of these tables will be able to replicate the provincial split produced by Statistics Canada, as they produce annual IO tables for each province and territory and at a very granular level.

To best meet the objectives of this project, we used the ONS IxI IO tables along with a similar methodology to FAI (2019) and Statistics Canada (2020). This will provide the most robust source of data, will be in line with UK National Accounts, can be combined with other sources of ONS data, provide good sectoral detail and are presently the most up-to-date UK tables.

Our results will also look in further detail at the gender split of FTE jobs, by sector, by supported income, by export partner country and regionalise the estimates. While some of the reports listed previously have explored a few of these issues, this project will be the first piece of work covering all of these aspects using a consistent methodology and will provide an important understanding of the relationship between exports and the UK labour market.

4 Data

Key points:

- This project produces estimates for the number of UK jobs, and related incomes, which are directly and indirectly supported by exports. These results are examined in terms of export destination, sector, UK region/nation and other characteristics such as gender, age, occupation and qualifications.
- A number of ONS data sources (with varying levels of quality and detail) and assumptions have been used to arrive at the estimates.
- The estimates by export destination use ONS data from the IxI IO table, the UK Trade in Goods by Industry, the UK Trade in Services by Industry and the UK Balance of Payments (The Pink Book) releases. Estimates are constructed for 24 destination countries, the EU and the Rest of the World for the period 2014-16. Data for 2014 and 2015 are estimated using 2016 proportions.
- There are a number of caveats around the experimental Trade in Goods and Services by industry data used to produce estimates of jobs supported by exports by destination country. It is clear that these products have been developed separately to the ONS IxI IO and have not, to date, been designed to be consistent. Ensuring consistency is a key recommendation of this report.
- The jobs estimates use ONS Workforce Jobs data. Unlike other studies (OECD (2019b)), this report uses an FTE jobs definition. This definition covers jobs, rather than employment; includes self-employed and part-time jobs; and weights part-time jobs to be worth half of a full-time job. This enables comparisons across sectors where there may be very different levels of part-time work.
- Compensation of employees and median wage data are incorporated into the modelling, based on data from the ONS Supply Use tables (SUTs) and the Annual Survey of Hours and Earnings (ASHE). The former indicator is simple to incorporate in a format consistent with the modelling, however it cannot provide an insight into the "typical" compensation for an employee in a given sector. Median wage is more difficult to implement and has some caveats around interpretation, however it supports a better understanding of the compensation of a typical employee.
- The estimates have been regionalised to a NUTS1 level using GVA shares. This regionalisation has purposefully been kept simple to promote transparency, as consistent data on the exports of the UK regions/nations are unavailable.
- The report also studies labour market characteristics, including age group, occupation group and qualification. These were provided primarily as a proof of concept and are given for 2016 only. These data were sourced from the ONS Annual Population Survey and provided at section level due to the sample sizes.
- As the modelling does not separate firms within a sector by exporting status, size or ownership, nor does it track individual firms across time, any differences in the results should not be interpreted as a causal effect of exporting.

4.1 Introduction

Section 3 above describes the methodology employed to estimate the impact of UK exports on labour. In the following sections, we explain which data we use, alongside the IO IxI table mentioned previously, to produce these estimates.

4.2 Exports

Data on how much the UK exports and which sectors are exporting are crucial to produce the estimates for this report. Understanding where the UK exports to also enables analysis by destination country.

4.2.1 Total, EU and Rest of World Exports

The ONS IxI IO table includes total exports by sector for 2016. Ideally, we would have data on exports by sector for 2014 and 2015, however these are either not available in an industry format or have consistency issues with the IxI IO table.

The partner country data in the ONS Trade in Goods TIG (2020e) and Trade in Services TIS (2020f) publications explained in section 4.2.2 could have been used, however we have concerns over the consistency of these data with National Accounts. Instead, we decided on a simple approach to estimating exports by sector that would provide transparency, as well as being consistent with trends in National Accounts. This issue is again raised in the data recommendation section of this report.

To create time series by sector for 2014 and 2015, we first took output for each sector from the Combined Use matrix for 2016. We used this along with exports by sector from the ONS IxI IO table to calculate exports as a percentage of output for each sector. Using data on output from the Combined Use matrix for the years 2014 and 2015, we applied the 2016 proportions to obtain our first estimate of exports by sector for 2014 and 2015.

One issue with this is that exports may not have changed in line with these fixed coefficients. We therefore adjusted the first estimates using export growth rates from the ONS UK Balance of Payments, The Pink Book (ONS, 2019a) release (henceforth ‘Pink Book’ for brevity) to ensure that the trend matches National Accounts.

The same process is repeated separately for both exports to the European Union (EU) and to the rest of the world (RoW), which also have exports by sector readily available in the 2016 IO table.

There are some further caveats around this methodology. One of the steps assumes that exports as a percentage of a sector's output stays constant and each sector is then adjusted so that the total matches the Pink Book. However, since the adjustment has been applied proportionately across all sectors, the trend in individual sectors will not be completely accurate. Improving the underlying data is a clear extension to this piece of work.

4.2.2 Individual country exports

We used two highly detailed datasets to allow for export destination analysis. The datasets are the ONS TIG (2020e) and TIS (2020f) by industry. These datasets show

UK goods and services exports by sector to 176 countries and for up to 84 sectors. We also used the ONS Pink Book (2019a), giving geographical breakdown of total trade in goods and services across 235 countries.

Presently, the TIG data covers 2008 to 2018 and the TIS data covers 2016 to 2018. This meant that the estimates prior to 2016 required some assumptions.

We selected a number of countries to examine. These include: France, Germany, Ireland, Netherlands, Spain, Belgium, Italy, Sweden, Poland, Denmark, Switzerland, Japan, Singapore, South Korea, Australia, New Zealand, South Africa, Mexico, Hong Kong, United States, Canada, China, India and Saudi Arabia.

Our methodology involved aggregating 2016 TIG and TIS data into the UK IO Classifications (IOCs) and combining the goods and services data into total exports by country and by sector.

As mentioned, the TIG and TIS data contain suppressed and rounded data. To ensure that the country totals matched with National Accounts, we took the proportion of each sector's exports as a percentage of total exports to the given country for both goods and services. Then using the Pink Book totals for goods and services exports we applied these proportions; this meant that our aggregated totals for each sector now matched the Pink Book. Finally, to scale our data to the prior calculated EU and RoW export data, we took our sectoral figures as a percentage of total EU or RoW exports by sector, as calculated in section 4.2.1.

Replicating this methodology for 2014 and 2015 was slightly more challenging given that the ONS TIS data only cover 2016-18. First, we used the 2016 TIS data to determine each sector's service exports as a percentage of total service exports to each country. Then, using the ONS Pink Book, we found the total exports of services to our selected countries for 2014 and 2015. Finally, we applied the 2016 sectoral proportions to these totals to estimate the sector breakdown for each country for 2014 and 2015. The goods data for 2014 and 2015 followed the same process as that of 2016 to provide country by sector export estimates.

This resulted in a time series of exports by each sector for all the countries of interest as a percentage of total exports to the EU or RoW within the destination data. These percentages were applied to the total EU and RoW export time series from section 4.2.1 to apportion these data to individual countries.

There are, however, a number of caveats around these destination data. It is first important to note that the ONS UK TIG and TIS data are experimental (their methodology is still under development). Moreover, we have had a number of issues in using these data in conjunction with the IxI IO table. The sectoral totals for trade are very different to those in the IxI IO table.

After discussion with the ONS, it is clear that these products have been developed separately and have not, to date, been designed to be consistent with each other. There is a definitional difference, the IxI table is in basic prices while the TIS and TIG data are in purchasers' prices, but this does not explain the differences we have seen in total exports by sector.

Ensuring these data are consistent with National Accounts is a key recommendation we set out at the end of this report.

4.3 Jobs

The primary estimates of this report examine the relationship between FTE jobs and UK exports. Jobs can have multiple definitions and we lay out the various indicators that this report explores using the different definitions.

4.3.1 Important definitions

The first difference is between employees and employment where the latter includes self-employment.

The second definitional difference is between jobs headcounts and FTE jobs. Jobs headcounts show the total number of jobs supported and has a simple interpretation. However, the economic gain from one additional part-time job is not the same as one additional full-time job. FTE jobs instead translates the headcount numbers into a consistent format where each FTE job works a similar number of hours. FTE jobs has the drawback of a more difficult interpretation. However, it enables easier comparisons across sectors where there may be vastly different proportions of part-time work. Section 4.3.2 explains how we calculate FTE jobs.

The third definitional difference is between jobs and employment. The difference is that a person can hold multiple jobs and so jobs estimates would be expected to be greater than like-for-like employment estimates. It is important to note that our estimates are of FTE jobs and so part-time jobs have a lower weight. This will result in lower estimates than headcount jobs and somewhat reduce the difference between employment and FTE jobs estimates. While a person can hold multiple jobs, it is important to reiterate that one FTE job is equivalent to working full-time and therefore the chance of someone working multiple FTE jobs is considerably smaller.

The fourth and more obvious difference is between full-time and part-time.

This report primarily looks at FTE jobs, covering both employee jobs and self-employment jobs. However, headline estimates are also produced for full-time and part-time employee job headcounts and full-time and part-time self-employment jobs.

4.3.2 FTE and headcount jobs

The Employee Jobs (2020c) and Self-employment Jobs (2020d) data by sector, split into full-time/part-time and female/male, are sourced from the ONS Workforce Jobs (WFJ) release. The ONS states that WFJ provides a more reliable sectoral breakdown than other sources of labour data.

Female employee and self-employment jobs data are combined to produce Female FTE jobs by sector, and the same process is followed for Male FTE jobs.

As is standard, FTEs are calculated on the basis that one FTE equals one full-time job and one FTE also equals two part-time jobs. The FTE calculation, therefore, assumes that the average part-time job in each sector works half the hours of a full-time job. Headcounts are calculated for each gender by adding full-time and part-time jobs together.

Finally, we have FTE jobs and headcount jobs by sector for each year. These series are used to produce the FTE jobs-output coefficients mentioned in section 3.3. Using

these, we can estimate the number of FTE jobs (both directly and indirectly) supported by UK exports.

The large number of sectors provided in the ONS IO tables will allow for detailed sectoral reporting of the relationship between the UK labour market and exports, and can be segmented by gender, export destination and so on. This could answer questions such as: "*How many UK jobs are estimated to be supported by exports of the pharmaceutical sector?*" and "*How many jobs in the construction sector only are supported by UK exports?*".

4.4 Labour income

We have produced estimates for two indicators of labour income – compensation of employees and median wages, each allowing for a different interpretation.

Compensation of employees incorporates all employee associated costs – wages and salaries in cash, wages and salaries in kind and employers' social contributions. A major advantage of this indicator is that it is included in the IO table and therefore is readily consistent with the IO methodology. It also provides a minimum to how much domestic value added remains in the economy as profits may be repatriated abroad.

However, an important drawback is that it is provided as an aggregate of total compensation for each sector. This provides little usefulness in understanding either a 'typical' (median) salary in a sector or understanding the distribution of salaries. For instance, if a small number of jobs within the sector had very large salaries, this will put a large upwards bias on the compensation of employees in that sector. Compensation of employees supported by exports has been analysed before by the OECD (2019b) and the World Bank (2016).

We have also produced estimates for the median salaries of jobs supported by exports. The major advantage of the median measure is that large outliers will not change the interpretation. However, the drawback is that the data are not as readily consistent, and the methodology required some assumptions. Using median gross wages represents a unique, innovative contribution to this body of literature.

It is also important to again note a crucial IO assumption and how this impacts on interpretation. The analysis compares the median wage income of employees in sectors with either a high propensity to export or a high propensity to being involved in the export supply chain, to the median wages in the UK. It uses industry-wide median salaries. It would not detect, for instance, if exporting firms paid higher wages than non-exporting firms in the same sector. Nor does it detect a change in median salaries as a firm changes from being a non-exporter to an exporter or vice versa. It is therefore important to be careful around interpretation, and avoid drawing causal relationships from any differences in median earnings.

4.4.1 Compensation of employees

Compensation of employees is taken from the ONS SUTs and aggregated into IO Classifications (IOCs). This results in a time series of compensation of employees by sector.

These series are then used to produce compensation of employee-output coefficients.

4.4.2 Median wages

Median gross earnings were obtained from the ONS' Annual Survey of Hours and Earnings (ASHE). ASHE provides earnings data on employee jobs. Self-employment earnings data have not been included in the median wage analysis as they are less reliable.

The ASHE data were first aggregated into IOCs for the years of interest. Assumptions were made for the few sectors that had suppressed data. If a suppressed sector's median wage was available in the year prior, the prior year's median wage for that sector was increased by the national median wage growth. If a suppressed sector's median wage was not available in prior years, the mean salary for the sector was adjusted. This adjustment takes the national median wage as a proportion of the mean and applies it to the sector's mean wage.

While these adjustments are not ideal, they are inevitable and should not greatly impact the analysis. The first reason for this is that only a very small number of sectors had suppressed data at the IOC level. The second reason is that, since the methodology only looks at the median of the median wages by sector, inaccuracies in a few sectors would only affect the results if they are the median of all sectors, or switch from being above the national median wage to below (or vice versa).

After collecting median wage data by sector for the years of interest, the next step is to find the employee midpoint. For instance, there were 29,966,000 employees in the UK in 2016, so the midpoint would be employee 14,983,000.

These midpoints were calculated for employees supported directly and indirectly by exports. For instance, exports directly supported 3,889,640 employees in the UK in 2016. The midpoint for these is therefore employee 1,944,820. For each year, sectors were then ordered from lowest median wage to highest median wage. The corresponding employee estimate for each sector (for instance, employees directly supported by exports) was then cumulatively added until it reached the midpoint figure.

For instance, employees supported directly by exports in 2016 were added until they cumulatively met the midpoint of employee 1,944,820. This employee sits within a sector with median gross earnings of £23,508. This process was repeated for all years and for both employees and full-time employees only.

A caveat of this methodology is that it represents a 'median of medians' rather than a true median as we do not have publicly available information on the distribution of wages within each sector. For instance, the median wage published by ASHE for 2016, looking across all employees in the economy, was £23,084. Whereas using the 'median of medians' methodology, we find this to be £22,849. Although some of this difference may be due to the assumptions made around the suppressed data, some of this will be due to the ‘median of medians’ issue.

To reiterate the crucial point around interpretation, it does not tell us that exporting itself drives these wage differences. Instead, it tells us that sectors which are likely to either directly export or be involved in export supply chains pay higher median wages than are paid in the economy as a whole.

4.5 National and regional estimates

One of the project's objectives is to examine the impact of exporting on labour in different regions and nations of the UK. This section describes the methodology and data sources used to produce relevant estimates.

4.5.1 Apportionment to nations and regions

Existing estimates of UK exports by NUTS 1 region/nation, published by the ONS (for services) and HMRC (for goods), are on a different basis and incompatible with the sector-based model required to produce the results of this project.

For example, HMRC publishes estimates of UK exports by region on a merchandise (physical movement) and product (SITC) basis. ONS, on the other hand, publishes estimates of regional exports of services on a change of ownership (Balance of Payments) and sectoral basis in its International Exports of Services from Subnational Areas of the UK (IESSA) publication. Unfortunately, at this time, no subnational export data are available on the same basis for both goods and services and the sectoral breakdown of the goods data includes only 13 industry groups. In addition, the IESSA data are experimental with the latest data relating to 2018 and a prior series running from 2011-2016, albeit not entirely consistent with the latest release. The IESSA is consistent, at the levels provided, with the ONS TIS dataset. Given our concerns raised in section 4.2.2 around the consistency of the TIS with National Accounts (and the IxI IO table), and given the partial coverage of the product (IESSA only covers services, not goods), we have not used these data to inform our regional estimates.

Instead, our approach was to use ONS Regional GVA by Industry data to calculate GVA shares by industry and NUTS1 region. This is similar to the approach that the HM Treasury (2016) used to apportion exports to NUTS1 regions. The dataset provides a sectoral breakdown of GVA in £ millions by NUTS1 region for the period 2005-2018.

GVA data are readily available for the NUTS1 regions and are consistent with National Accounts. These data can be used to understand the relative size of value added that each sector produces in each region or nation of the UK. Using GVA to apportion the export figures can therefore capture when a specific industry in a NUTS1 region adds relatively more value than in other regions. The assumption is therefore that this region exports relatively more. This provides a simple, transparent way to apportion UK exports to NUTS1 regions. It is important to caveat that there will be many cases when relative GVA does not wholly represent the spread of exports. However, we have chosen to prioritise transparency until the issues with consistency of subnational trade data have been resolved.

Employment could also be used to apportion UK exports. This would resolve the issue of apportioning Extra-regio, covered in section 4.5.2. However, it would not capture many of the relative differences in value added. For instance, a sector in a specific NUTS1 region may have relatively high value-added but low employment. Employment sources such as the Business Register and Employment Survey (BRES) also do not collect data on certain sectors.

Using the regional GVA data, we aggregated sectoral GVA figures for each of the 13 NUTS1 regions – this includes Scotland, Northern Ireland, Wales and the 9 regions of

England; as well as the total UK and Extra-regio figures – into the UK IOCs. This involved aggregating the 102-sector format of the ONS regional GVA data to our 64 sector IOCs.

In conducting the above methodology, we incurred a number of small issues regarding the sectoral breakdown of the ONS data and the format of the UK IO. In particular, in the ONS regional data, some sectors were more aggregate than the format we required. For example, 'Manufacture of coke, refined petroleum and chemicals' is aggregated into a single value covering SIC 19-20 in the GVA data; however, our IO format separates SIC 19 and SIC 20 as individual sectors. We used the UK IO table to separate the GVA figure, where GVA figures are available for each individual sector. We used the relative size of SIC 19 and 20 in terms of GVA in the UK IO to split the ONS data on the single sector SIC 19-20 into the two sectors.

The same issue occurred when looking at sectors SIC 36 to 39. In the regional GVA data, SIC 36-37 are grouped, with SIC 38 and 39 separate; however, in our IO format, SIC 36 is an individual sector, with SIC 37-39 grouped. Similarly, to do this, we used the UK IO table to find the GVA figure for sector SIC 36 and deducted this from the SIC 36-37 total in the regional GVA data to attain the GVA figure for sector SIC 37. Then, as before we aggregated these figures and took proportions, applying these to our regional data when aggregating up to our IO format.

4.5.2 Allocation of Extra-regio

One issue with using GVA to apportion the estimates is that some of this is apportioned to the Extra-regio NUTS1 region. This is primarily offshore oil and gas extraction but a small portion of Extra-regio GVA is accounted for by overseas embassies and military bases.

Using GVA to apportion UK FTE jobs supported by exports to regions and nations of the UK therefore results in allocating jobs to the Extra-regio NUTS1 region in the Mining and Quarrying and Public Admin sectors. We reallocated these jobs to the other regions and nations of the UK.

Mining and Quarrying jobs were allocated to UK nations and regions using ONS data on offshore corporation tax (ONS, 2019b), using a geographic split. This results in Scotland being allocated the majority of the jobs, with the remainder allocated to different English regions. A three-year average was taken of this series to reduce volatility in the series.

The Extra-regio Public Admin jobs were allocated to regions and nations using population shares of the UK.

4.6 Labour characteristics

In order to use a similar methodology to the aggregate FTE jobs estimate, we first had to decide upon the appropriate data source. The ONS Annual Population Survey (APS) was selected as it provides information on employment by sector for age groups, occupation groups and qualifications. The APS is a continuous household survey conducted within the UK with themes including the labour market, housing, personal characteristics, health and education.

APS data for 2016 consists of over 500 variables and around 290,000 individual observations. These observations can be weighted to represent the entire country.

The APS data were used to find the percentage of employment in each sector by age group, occupation group and qualification. These percentages were used to apportion the FTE jobs results for 2016. While there are definitional issues in using FTE employment to apportion FTE jobs, the purpose of these results is only to provide both a proof of concept and the latest snapshot. We set out potential further extensions in the final section of the report.

4.6.1 Age group

To understand age breakdown, we calculated the employment in each sector of the UK economy by different age bands. We first calculated the aggregated representative weightings for those aged 16-64 in employment. As aforementioned, one major concern within this analysis, particularly when looking at any personal characteristics was the robustness of the survey data used. Given the small sample sizes in this case we decided to use the more aggregate section level data.

Age bands were chosen in line with ONS labour market breakdown with 4 groups chosen: 16-24, 25-34, 35-49 and 50-64-year olds. We then calculated aggregated full-time and part-time employment numbers for each of these age groups. Using our FTE definition, we used these age groups to calculate FTE employment by age group at section level. To scale these numbers to our main FTE jobs estimates, we took, for each sector, the FTE employment by age band as a proportion of the sector's total FTE employment.

4.6.2 Occupation group

Using the APS data for 2016 we obtained the full-time and part-time employment numbers within each occupation group at section level. The Standard Occupation Classifications (SOC) 2010 include:

- Managers, directors and senior officials
- Professional occupations
- Associate professional and technical occupations
- Administrative and secretarial occupations
- Skilled trades occupations
- Caring, leisure and other service occupations
- Sales and customer service occupations
- Process, plant and machine operatives
- Elementary occupations

We then used the same method as in section 4.6.1 for both full-time and part-time employment to calculate FTE employment numbers per occupation group at section level. This was then used to calculate, for each sector, FTE employment by occupation group as a proportion of a sector's total FTE employment.

4.6.3 Qualifications

Finally, we looked at FTE employment by qualification. Again, given the sample sizes it was decided to look at this at a section level.

Given the crossover with many of the qualification categories, for example, if you have an undergraduate degree you may fall into 2 categories – those with higher than high school education and those with a degree, for example – it was decided to look at FTE employment for those with an undergraduate degree and above, and those with qualifications less than a degree. This can be extended into more groups in further analysis.

Similar to our analysis of age groups, we aggregated full-time and part-time employment by the chosen qualifications at section level. Again, using the FTE definition, we calculated total FTE employment for both levels of education. Finally, we calculated proportions of total FTE employment for each sector.

4.6.4 APS Issues

A number of assumptions were made in order to use the APS to produce estimates for the personal characteristics discussed above.

The first obvious issue surrounds sample sizes. As already discussed, more aggregate (section level) information was used to produce estimates for the characteristics due to the improvement this provides in sample size. However, some of the sample sizes were still relatively small, particularly for the occupational breakdown by industry: for instance, for obvious reasons, there were very few people with caring occupations in the Electricity, gas, steam and air conditioning supply sector.

As already discussed in the methodology section, it is also important to note that the characteristics we are deriving from the APS for each section are sectoral averages, and not necessarily the characteristics of employees in exporting firms.

A further caveat to bear in mind is that the industrial classification in the APS may not be as accurate as that produced through a source like WFJs, so there is the possibility of misclassification of employees. However, given the apportionment is carried out at a section level, the risk of this is fairly minimal.

5 Results

Key points:

- We estimate that 3.8 million UK FTE jobs were *directly* supported by exports in 2016, representing around 13% of all UK FTE jobs. When adding in the supply chain (or *indirect*) effects, this rises to 6.5 million FTE jobs (23% of UK FTE jobs). Including the wage spending (*induced*) effects of those employed directly and indirectly in UK exporting sectors and their UK supply chains, the estimate rises further to 11.3 million FTE jobs (or 39% of UK FTE jobs).
- The number of jobs supported directly and indirectly by exports is estimated to have increased between 2014 and 2016 by around 387,000.
- The sector whose exports support the largest number of jobs is Manufacturing.
- The sectors most dependent on exports (in terms of absolute number of jobs) are the 'Professional, scientific and technical services' and 'Admin and support services' sectors.
- The country supporting the largest number of UK jobs through exports is the US: 1.3 million UK FTE jobs (or 4% of UK FTE jobs) were supported directly and indirectly by exports to the US in 2016.
- Exports to the EU and RoW supported 2.8 million and 3.7 million UK FTE jobs, respectively, in 2016.
- Over a quarter of FTE jobs directly and indirectly supported by exports are estimated to be in London.
- Further estimates are also provided by personal characteristics (gender, age group, occupation and qualifications) to provide insights into the challenges and opportunities that a change in exporting may have for particular parts of the population. For example, it is estimated that around 64% (4.2 million) of the FTE jobs directly and indirectly supported by exports are held by men, with the remaining 36% (2.4 million) FTE jobs filled by women.
- Given the sectoral make up of exporting sectors, we estimate that the median wages are on average higher for both direct and indirect jobs: showing the importance of exporting for supporting high wage paying sectors.
- We compare our results with the results of the OECD. It is important to bear in mind with these comparisons that there are differences in how we define jobs/employment, as well as data and methodological differences.
- Our aggregate results are close to the OECD estimates. There are some differences when looking across sectors, with the largest differences seen in the Manufacturing, Other business services and Education sectors. These appear to be driven by differences in the underlying export data by sector. This may be, in part, due to the requirement of the OECD IO tables to harmonise the trade data of many countries. The compatibility with UK National Accounts is a key advantage of the methodology used in this report.

5.1 Headline Results

In 2016, we estimate that 3.8 million FTE jobs are *directly* supported by exports in the UK, which represents around 13% of employment in the UK. When adding in the supply chain effects, or *indirect effects*, this rises to 6.5 million FTE jobs, or 23% of FTE jobs in the UK.

The report focuses on the *direct* and *indirect* effects of exporting on UK jobs:

- *Direct effects* relate to the labour used by exporting firms to produce the exported goods and services
- *Indirect effects* relate to the labour supported in firms that are within the supply chain of exporting firms

However, the analysis also enables estimation of jobs supported due to the wage spending of those employed directly and indirectly in UK exporting sectors and their UK supply chains. When adding in these *induced* effects, the number of FTE jobs supported by exports rises to 11.3 million, or 39% of FTE jobs in the UK.

Table 6: UK FTE jobs (Direct, Indirect and Induced) supported by exports, number of FTE jobs and as % of total FTE jobs, 2014 - 2016

Effect	Number of UK FTE jobs supported by exports			% of total UK FTE jobs		
	2014	2015	2016	2014	2015	2016
Direct	3,551,000	3,569,000	3,795,000	12.7%	12.6%	13.2%
Indirect	2,589,000	2,563,000	2,732,000	9.3%	9.0%	9.5%
Induced	4,582,000	4,555,000	4,794,000	16.4%	16.1%	16.6%
Direct + Indirect ("Type I")	***6,140,000***	***6,132,000***	***6,528,000***	***22.0%***	***21.6%***	***22.6%***
Direct + Indirect + Induced ("Type II")	**10,722,000**	**10,688,000**	**11,321,000**	**38.4%**	**37.7%**	**39.3%**

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

In the remainder of this section, unless otherwise stated, we focus principally on the combination of direct and indirect effects. However, the detail of all figures is available in the accompanying spreadsheets.

As set out in the methodology section, the basis of our analysis was the 2016 UK IxI IO table. As set out in the section 4, data for 2014 and 2015 were estimated by first assuming that sectors exported the same proportionate amounts across years, and then adjusting the total to match trends in National Accounts.

Therefore, the figures for 2014 and 2015 should be used with caution, and these limitations also mean the production of figures for earlier years becomes more difficult: the further away we get from the year that the IO table has been produced for, the

more problematic the assumption that the structure of the economy is the same as in 2016.

For the rest of the results section, we will focus on 2016 results, but the spreadsheets that accompany the main report also contain estimates for 2014 and 2015.

5.2 Sectoral results

It is worth emphasising that there are two ways to think about the number of jobs supported by exports in different sectors.

For both of these methods, the jobs supported directly by a given sector's exports are both allocated to the same sector (and therefore the direct effects do not differ between methods). The approaches instead differ on how the spill over (indirect and induced) effects are allocated to sectors.

These 2 approaches are:

- Allocating the jobs supported by exports to the exporting sector, no matter which sectors these jobs lie within. We term this definition **"*Jobs supported by exports of each sector*" (JSE)**. This interpretation can also be understood by simply examining a sector's multipliers along with the amount it exports. This can be thought of as how important the exports of a sector are for jobs in the whole economy.

- Allocating the jobs supported by exports to the sector the jobs lie within, no matter the exporting sector. We term this definition ***"export supported jobs within each sector"* (ESJ)**. This can be thought of as how dependent (directly or indirectly) jobs within a sector are on exporting.

The Manufacturing sector provides a useful example. In 2016, exports of the Manufacturing sector directly supported around 645,000 UK FTE jobs in manufacturing. In both the JSE and ESJ definition, these are allocated to the Manufacturing sector. The exports of the sector also indirectly supported around 863,000 jobs in the whole economy. Combining these two figures gives the JSE definition – the number of jobs supported across the whole economy by exports of the Manufacturing sector. It is important to note that manufacturing jobs can also be indirectly supported by the exports of manufacturing. This is because manufacturing firms that are directly involved in exporting purchase goods and services from other manufacturing firms. Firms within a sector buying a large proportion of their inputs from other firms within the same sector is a common characteristic of many parts of the economy.

Of the 863,000 jobs supported indirectly by the exports of Manufacturing, only 195,000 of these are jobs within the Manufacturing industry. 206,000 of the jobs supported by manufacturing exports are within the Retail & wholesale sectors, 18,000 are within Construction and so on. And the exports of other sectors support jobs in the UK economy too, with some of these allocated to Manufacturing. For instance, under the JSE definition, the exports of the Mining and quarrying sector support 29,000 jobs directly and 94,000 jobs indirectly. Of these 94,000 jobs, 20,000 lie within Manufacturing sectors.

The ESJ definition allocates all the jobs that lie within the Manufacturing sector to manufacturing. Here, that means the 195,000 jobs indirectly supported by manufacturing exports that lie in Manufacturing, the 20,000 jobs indirectly supported by Mining and quarrying that lie within Manufacturing and the jobs supported indirectly by all other sectors that lie in manufacturing are all allocated to the Manufacturing sector.

Both of these definitions are useful for policy-making, and both are required to understand the dependence of the economy on exports.

As would be expected, those sectors which have a higher propensity to export (such as Manufacturing) have a higher number of jobs dependent on them under the JSE definition: and those sectors which are more likely to be in the supply chain of exporters have a higher number of jobs under the ESJ definition.

Table 7 below shows the comparison of the 2 approaches at section level.

On one extreme is manufacturing. Manufacturing exports support a large number of jobs in the UK economy (1.5 million). However, of the jobs supported by total UK exports, around 1 million lie in Manufacturing. The exports of Manufacturing therefore support many jobs in other sectors of the economy. This is unsurprising given the large amount of exports by the manufacturing sectors.

On the other extreme is Administrative and support services. Exports of the sector support 731,000 jobs in the UK economy. However, of the jobs supported by total UK exports, around 1 million lie in the Administrative and support services sector. This is because the sector is heavily involved in the supply chains of exporting industries (such as Manufacturing).

An understanding of both definitions is key to understanding the impact of exporting on jobs across the UK economy. On the one hand, it is important to understand which sectors are supporting jobs across the economy with their exports. On the other hand, it is important to understand where these jobs lie, or which sectors may be heavily impacted by export shocks without that sector necessarily producing a large amount of exports itself.

Table 7: Number of UK FTE jobs supported (directly and indirectly) by exports by sector, JSE vs ESJ definition, 2016

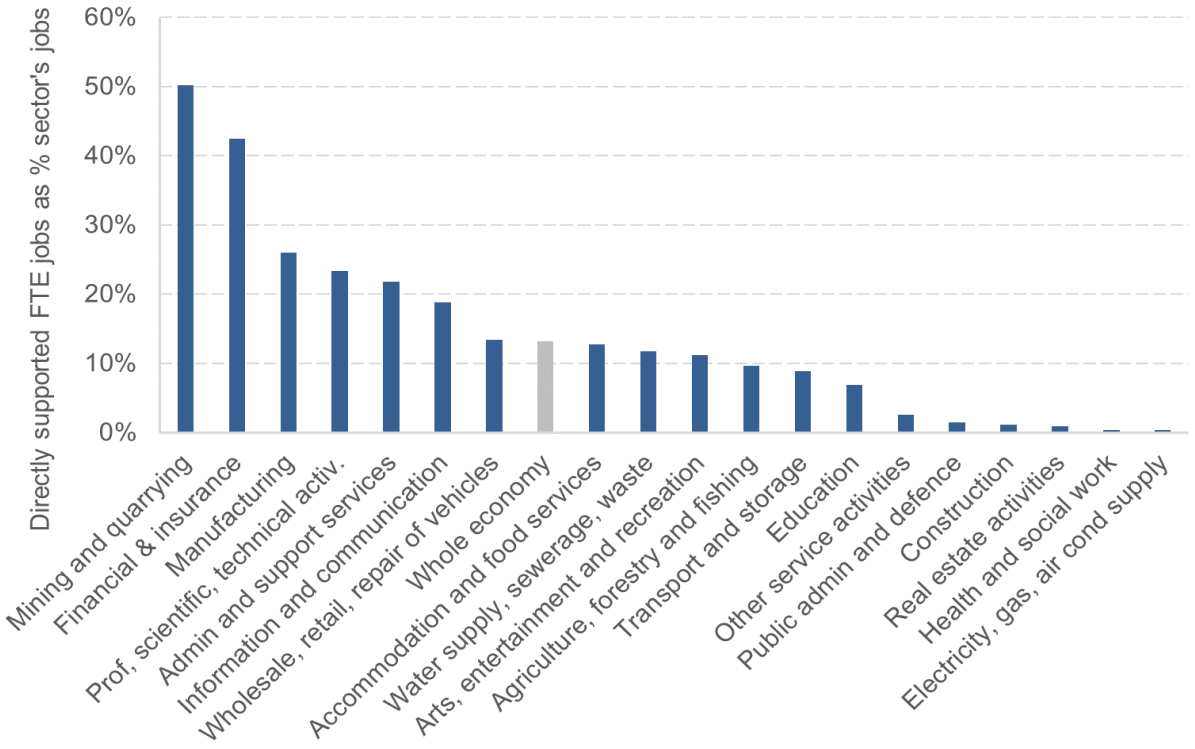
Sector	JSE	*ESJ*
Agriculture, forestry and fishing	**59,700**	*89,100*
Mining and quarrying	**123,300**	*40,300*
Manufacturing	**1,507,900**	*997,500*
Electricity, gas, air cond. supply	**3,100**	*17,000*
Water supply, sewerage, waste	**44,900**	*42,700*
Construction	**48,500**	*112,100*
Wholesale, retail, repair of vehicles	**832,800**	*892,200*
Transport and storage	**273,900**	*491,500*
Accommodation and food services	**293,100**	*291,000*
Information and communication	**425,700**	*418,300*
Financial and insurance activities	**870,200**	*551,900*
Real estate activities	**9,100**	*35,900*
Prof, scientific, technical activities	**911,900**	*1,110,400*
Admin and support services	**731,300**	*1,008,100*
Public admin and defence	**28,500**	*38,100*
Education	**198,500**	*216,300*
Health and social work	**18,400**	*24,800*
Arts, entertainment and recreation	**123,800**	*112,000*
Other service activities	**22,800**	*38,600*
Total	**6,527,700**	*6,527,700*

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

As discussed above, the largest differences can be seen in those sectors with the largest percentage of jobs supported by exports: particularly for sectors like Mining & quarrying, Financial and insurance services and Manufacturing. Chart 1 summarises the percentage of FTE jobs that are *directly* supported by exports in each sector; note that due to the methodologies, the values for jobs supported directly by exports will be the same for both ESJ and JSE measures. In addition, the economy-wide aggregate

level estimates are the same across both methods, as the distribution across sectors does not affect this figure.

Chart 1: Directly supported UK FTE jobs as a % of jobs within a sector, 2016



The discussion above suggests that we need to be very clear on which basis the sectoral results are being produced.

We produce the destinations data in the next section on a JSE basis, and then compare the results with those on an ESJ basis.

For the characteristics below, results by sector have been determined on the ESJ basis only. This is because the characteristics of each sector are required to produce these results. In order to produce results on the JSE basis for these characteristics, an algorithmic approach would have to be adopted to reassign, one by one, the sectoral indirect jobs back to the original sector of export. This is the approach taken by the OECD in the results they have produced by gender. This is beyond the scope of this project but could be done in further work.

ESJ analysis includes:

- Gender
- Age
- Occupation
- Qualification
- Export destination (results by export destination are also provided on the JSE basis)
- UK NUTS1 region
- Median wage

5.3 Export Destinations

The single destination country which supported the largest number of UK jobs in 2016 was the United States, which supported almost a fifth of the direct and indirect jobs which are reliant on exports. For comparison, over the same period exports to the Non-EU as a whole supported 3.7 million UK FTE jobs (or 13.0% of total UK FTE jobs) and exports to the EU supported 2.8 million FTE jobs (9.7% of total UK FTE jobs).

Table 8 below shows the numbers of FTE jobs for selected EU and Non-EU countries.

Table 8: UK FTE jobs supported (directly and indirectly) by exports to broad destination and selected EU and Non-EU countries, number of FTE jobs and as % of total FTE jobs and FTE jobs supported by exports, 2016

Export destination	UK FTE jobs (direct + indirect)	% of total UK FTE jobs supported by exports	% of total UK FTE jobs
World	6,528,000	100%	22.6%
EU	2,790,000	42.7%	9.7%
Non-EU	3,737,000	57.3%	13.0%
United States	1,254,000	19.2%	4.3%
Germany	519,000	8.0%	1.8%
France	375,000	5.7%	1.3%
Ireland	372,000	5.7%	1.3%
Netherlands	360,000	5.5%	1.2%
Switzerland	266,000	4.1%	0.9%
China	190,000	2.9%	0.7%
Italy	190,000	2.9%	0.7%
Spain	166,000	2.6%	0.6%
Belgium	146,000	2.2%	0.5%
Saudi Arabia	129,000	2.0%	0.4%
Japan	126,000	1.9%	0.4%
Canada	111,000	1.7%	0.4%
Hong Kong	107,000	1.6%	0.4%

Export destination	UK FTE jobs (direct + indirect)	% of total UK FTE jobs supported by exports	% of total UK FTE jobs
Australia	106,000	1.6%	0.4%
Singapore	97,000	1.5%	0.3%
Sweden	95,000	1.5%	0.3%
South Korea	71,000	1.1%	0.2%
Denmark	70,000	1.1%	0.2%
Poland	68,000	1.0%	0.2%
India	63,000	1.0%	0.2%
South Africa	54,000	0.8%	0.2%
Mexico	25,000	0.4%	0.1%
New Zealand	16,000	0.2%	0.1%

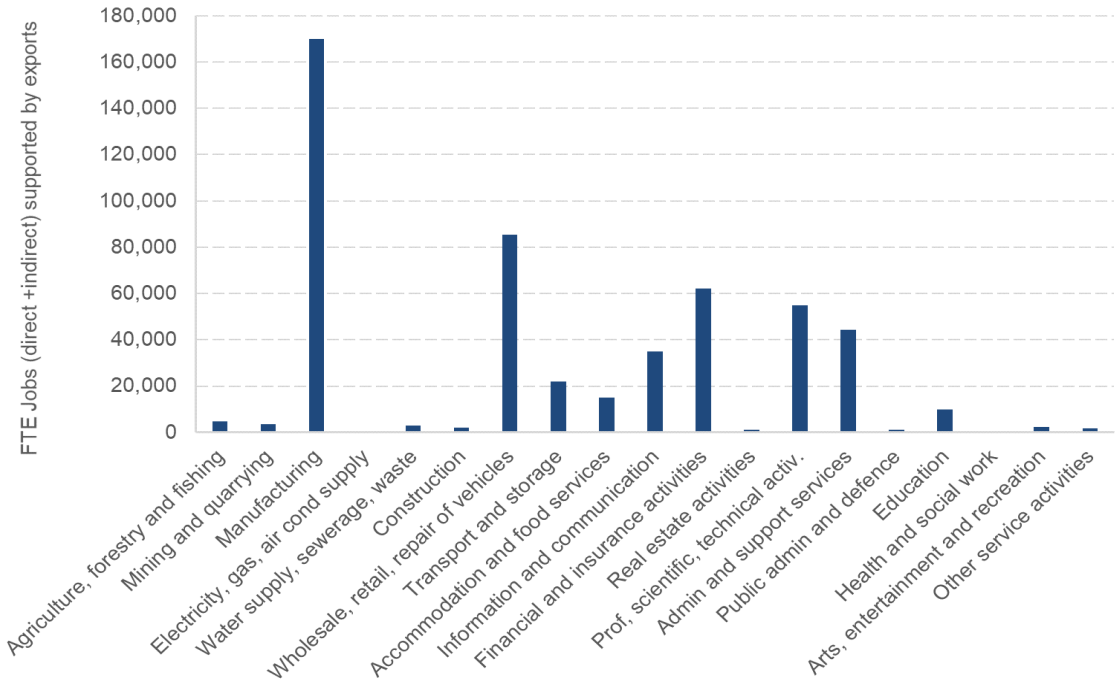
* Data rounded to the nearest thousand. As a result, column totals may not match the sum of elements.

The selected countries include many of the UK's largest export destinations as well as some countries of particular interest. The countries included are the United States, Germany, France, Netherlands, Ireland, China, Switzerland, Italy, Belgium, Spain, Japan, Hong Kong, Sweden, Australia, Canada, Singapore, South Korea, India, Poland, Denmark, Saudi Arabia, South Africa, Mexico and New Zealand.

We can also analyse the particular sectors of the economy where jobs are supported by exports, both directly and in the supply chain. When doing this, we consider the JSE definition in the first instance, as described in section 5.2 above.

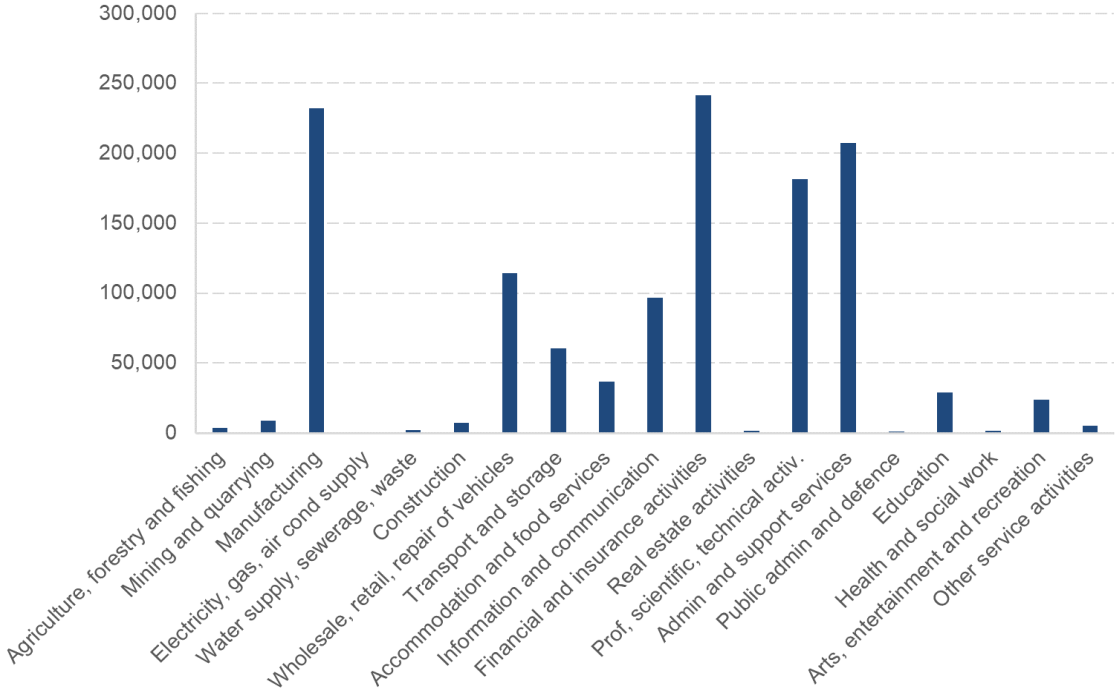
Exports to Germany support the largest number of UK jobs of all countries in the EU with the largest number of these jobs being in Manufacturing.

Chart 2: UK FTE jobs supported (directly and indirectly) by exports to Germany, by sector, JSE basis, 2016



In contrast, the largest numbers of jobs supported by exports to the US are in either Financial and insurance services or Administrative and support services, dependent on the basis of the calculation. Of course, given the dominance of manufactured goods in exporting in general, there are still significant numbers of FTE jobs that are reliant on Manufacturing.

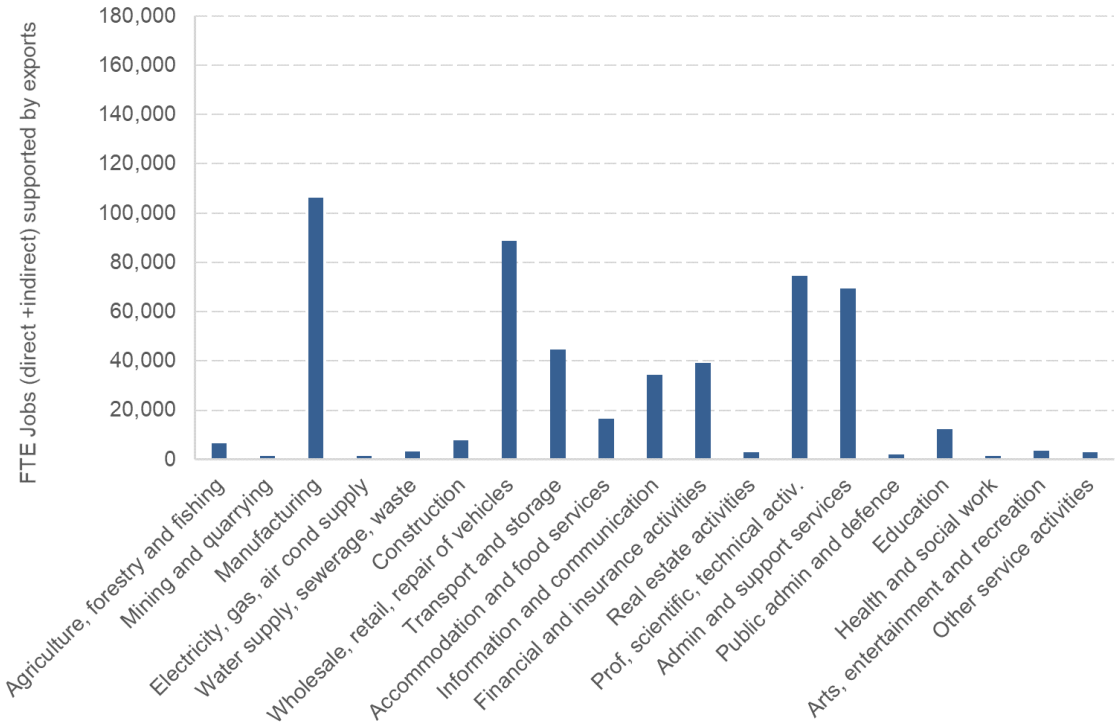
Chart 3: UK FTE jobs supported (directly and indirectly) by exports to the USA, by sector, JSE basis, 2016



5.3.1 Considering the ESJ definition

The sectoral pattern changes when we consider the sector these supporting jobs are actually in, on the ESJ definition. As we would expect, when looking at Germany for instance, many of the jobs supported by exports from the Manufacturing sector are actually in other sectors, such as Wholesale and retail, and Professional, scientific and technical services.

Chart 4: UK FTE jobs supported (directly and indirectly) by exports to Germany, by sector, ESJ basis, 2016



As mentioned above, both of these definitions are useful for policy makers: ESJ gives you an idea of which sectors supply chain jobs are actually likely to be in if there was increasing exports of particular goods and services to a particular country.

For the characteristics sections below, results by sector have been determined on the ESJ basis only. This is because the characteristics of each sector are required to produce these results. This is explained in more detail in section 5.2 above.

5.4 Gender (ESJ basis)

We use the characteristics of the employees in different sectors of the economy to estimate the gender disaggregation of FTE jobs supported by exports.

The share of female employment is often used as a determinant of gender equality within the labour market and has been a topic of discussion for many years now. In 2016, the UK labour market had around 57% (or 16.4 million) FTE jobs filled by men and the remaining 43% (12.5 million) filled by women.

As well as holding more jobs than women, men also benefit disproportionately from exporting activity in the UK. Table 9 shows that male jobs account for two thirds (64%) of all jobs supported directly and indirectly by exports in 2016. Put differently, the share of female jobs that are supported by exports is much lower than that of male jobs; our estimates show that around 19% (2.4 million) of all female jobs are supported directly and indirectly by exports, compared to 25% (4.2 million) of male jobs.

These estimates come very close to experimental estimates published by the OECD (2018b), using a different methodology, which show that, in 2014, 19% of female employment in the UK was dependent (either directly or indirectly) on exports compared to 26% for male employment.

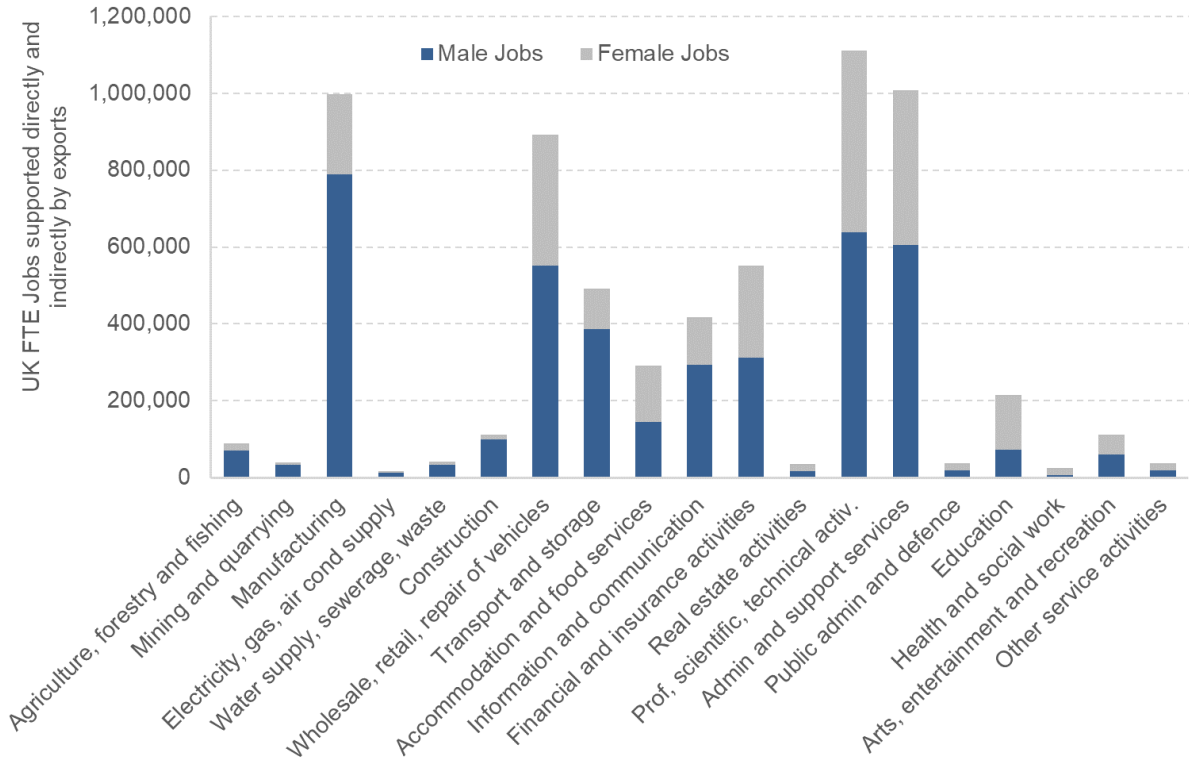
Table 9: UK FTE jobs supported (directly and indirectly) by exports, by gender, number of FTE jobs and % of total FTE jobs supported by exports, 2016

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

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

Part of the reason why there are more men than women supported by exports is that, in general, the sectors which have higher export propensity are more likely to be dominated by men. For example, industries that tend to have a higher concentration of male workers such as Manufacturing and Mining and quarrying have a much higher export propensity. Manufacturing accounted for around 9% of total FTE jobs in 2016, with 77% of these filled by men. In contrast, in industries with a much higher female concentration of FTE workers, such as Education or Health and social work, export propensity is far lower.

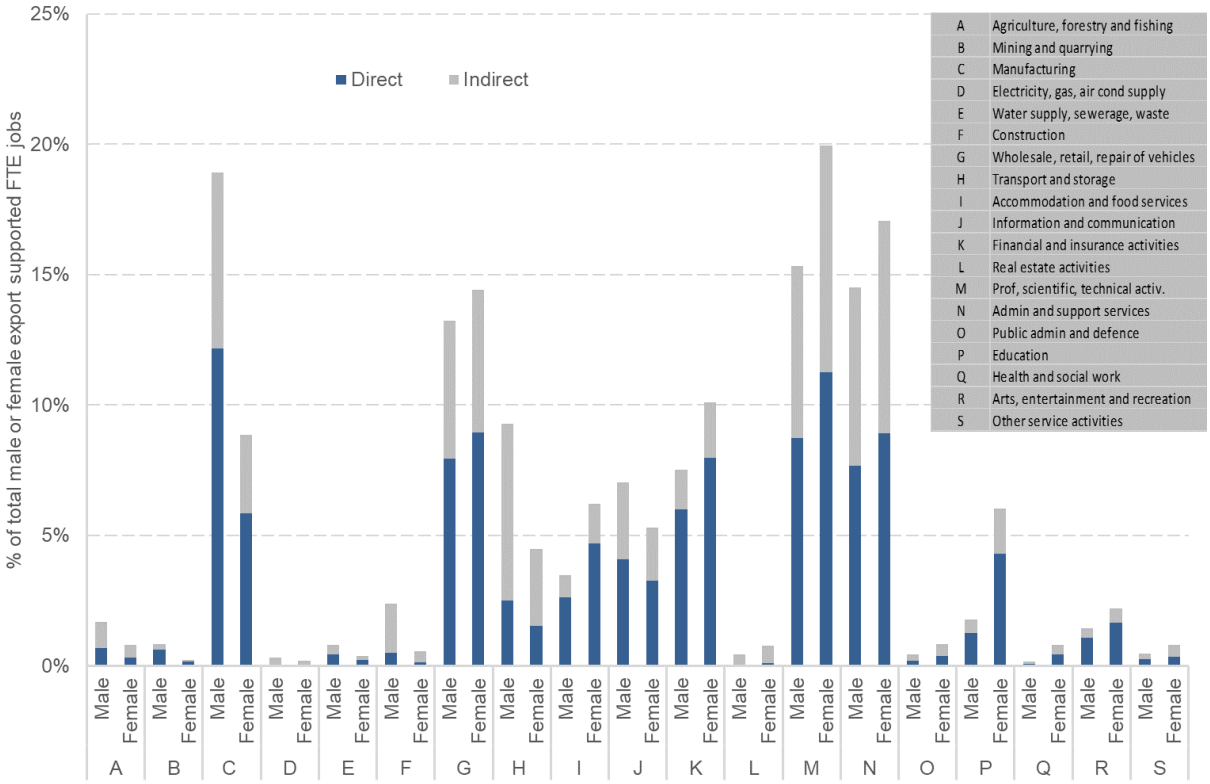
Chart 4: UK FTE jobs supported directly and indirectly by exports in each sector, by gender, ESJ basis, 2016



The estimates above show that the distribution of male and female employment supported by exports differs across sectors of the UK economy. The spread across sectors also varies significantly by sector when considering direct jobs vs indirect jobs, as we would expect. In the majority of sectors, direct employment is higher than indirect employment for both genders, a perhaps unsurprising result.

However, there is a small number of sectors that have a higher indirect employment share of total employment for both males and females, including Construction, Transport and storage and Real estate. There are also two sectors in which female indirect employment is higher than male indirect employment. Women account for 16,200 indirect FTE jobs in the Real estate industry, or 51%, with 15,600 indirect male FTE jobs. Similarly, in the Public admin and defence industry, females account for 52% of indirect FTE employment.

Chart 5: UK FTE jobs supported (directly and indirectly) by exports in each sector, as % of each gender's total FTE jobs supported by exports, ESJ basis, 2016



When comparing our results to those of the OECD (2019a), we see that the UK falls in line (43%) with the average of 46% across the OECD for share of female employment. The results in our analysis will differ slightly from that of the OECD due to definitional differences, which we discuss in more depth in Section 5.10.

The OECD (2019a) highlights the fact that across all EU member states in 2015, male employment is higher than female employment embodied in total gross exports, arguing that industry composition may have a role to play for this result. When looking at a similar sectoral breakdown to our analysis, the OECD yields similar results. Industries with much higher export propensity, such as those mentioned previously, are more dominated by male employees.

We are also able to further breakdown our analysis of gender balance in export supported jobs. When looking at the split by gender of jobs supported directly and indirectly by exports to the EU and RoW, we estimate that in 2016:

- UK exports to the EU supported around 1.8 million male FTE jobs and 1 million female FTE jobs, equivalent to 6.2% and 3.5% of total FTE jobs, respectively.
- UK exports to the RoW supported around 2.4 million male FTE jobs and 1.4 million female FTE jobs. These equate to 8.2% and 4.7% of total FTE jobs, respectively.

5.5 Age (ESJ basis)

We extend the analysis using the 2016 Annual Population Survey to consider how jobs are spread amongst other characteristics, including: age, occupation and qualification level. As we have already set out above, it should be remembered that this analysis reflects the characteristics of the sector under consideration, rather than exporting firms specifically: but this analysis can give an insight into the challenges or opportunities which may face different groups if exporting behaviour was to change.

Combining data on jobs by age groups with jobs supported by exports in each sector, we have estimated the jobs supported by exports in each age group. Table 10 shows these results.

The age group with the most jobs supported by exports are those aged 35-49. This is unsurprising given that this age group holds more jobs than any other.

Looking at an age group on its own, we can examine how the jobs supported by exporting of a sector (direct effects), or through involvement in exporting supply chains (indirect effects), are distributed across sectors. Looking at both direct and indirect effects, the largest positive effect is seen in the Admin and support services sector. For instance, around 4.9% of 16-24 year olds' jobs are in this sector. However, of all 16-24 year olds' jobs supported directly by exports, 14.0% are within Admin and support services, and indirectly this figure is 18.8%. These figures are reasonably consistent across age groups.

Table 10: UK FTE jobs supported (directly and indirectly) by exports by age group and sector, ESJ basis, 2016

Sector	16-24	25-34	35-49	50-64
Agriculture, forestry and fishing	10,000	17,000	28,000	33,000
Mining and quarrying	2,000	9,000	18,000	11,000
Manufacturing	91,000	239,000	363,000	305,000
Electricity, gas, air cond. supply	2,000	5,000	6,000	5,000
Water supply, sewerage, waste	4,000	8,000	16,000	14,000
Construction	11,000	28,000	40,000	33,000
Wholesale, retail, repair of vehicles	176,000	223,000	278,000	216,000
Transport and storage	31,000	106,000	186,000	170,000
Accommodation and food services	90,000	83,000	73,000	45,000
Information and communication	35,000	120,000	176,000	86,000
Financial and insurance activities	53,000	163,000	224,000	112,000

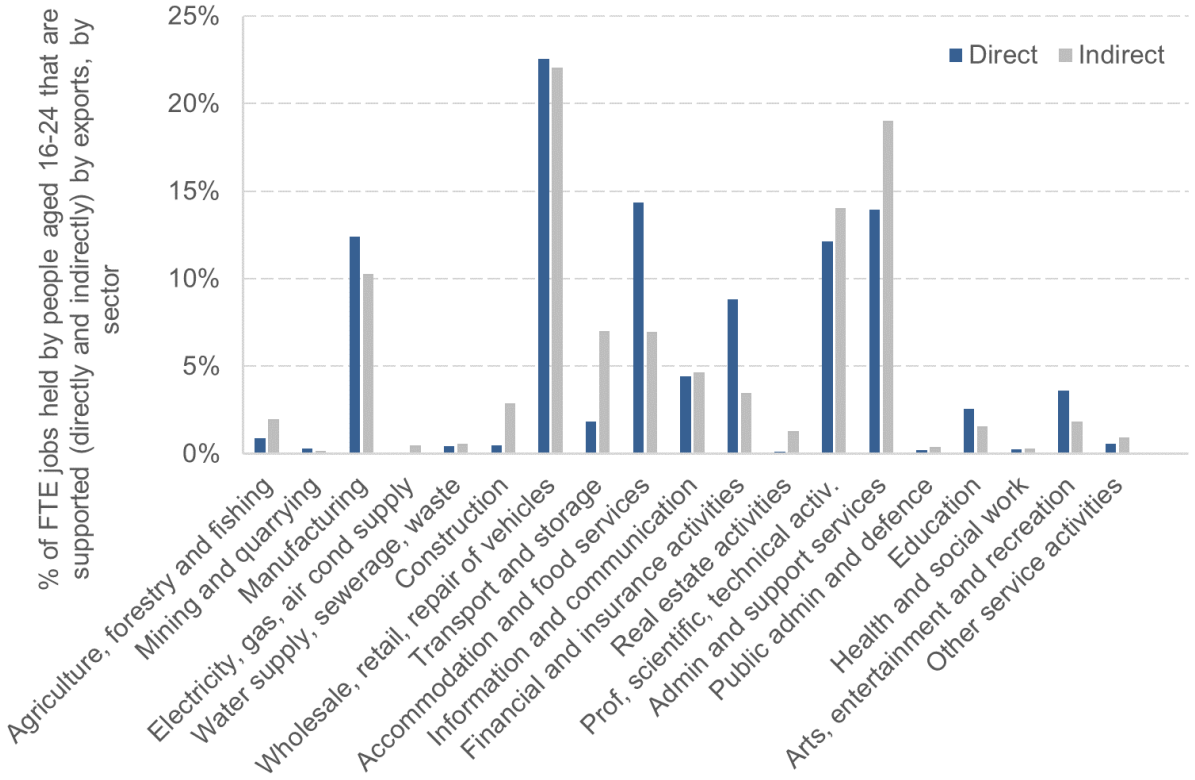
Sector	16-24	25-34	35-49	50-64
Real estate activities	5,000	8,000	13,000	11,000
Prof, scientific, technical activ.	101,000	305,000	413,000	291,000
Admin and support services	125,000	260,000	352,000	271,000
Public admin and defence	2,000	9,000	16,000	11,000
Education	17,000	50,000	83,000	66,000
Health and social work	2,000	6,000	9,000	8,000
Arts, entertainment and recreation	23,000	30,000	33,000	27,000
Other service activities	6,000	10,000	12,000	11,000
Total	**786,000**	**1,677,000**	**2,340,000**	**1,725,000**
% of Age Group's FTE jobs	**23.4%**	**23.5%**	**22.6%**	**21.6%**

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

We may also be interested in how a change in exporting behaviour could impact directly and indirectly on certain age groups, such as young people aged 16-24.

Chart 6 shows that almost a quarter of the jobs carried out by young people, directly and indirectly supported by exports, are in the Retail and wholesale sector. The Accommodation and food services sector also supports directly a significant number of jobs, which means that young people may be affected by any change in tourism behaviour. In addition, we can see that a significant proportion of the indirect jobs carried out by young people are in Administrative and support services.

Chart 6: % of FTE jobs held by people aged 16-24 that are supported (directly and indirectly) by exports, by sector, ESJ basis, 2016



5.6 Occupation (ESJ basis)

We adopt a similar approach to estimate the number of FTE jobs supported by exports for the nine Standard Occupational Classifications (SOCs).

In 2016, the SOC with the highest proportion of UK FTE jobs supported (directly and indirectly) by exports was elementary occupations, with 28.6% of all Elementary FTE jobs supported by exports. This estimate was similarly high for Process, plant & machine and Sales & customer service jobs. Including the impact of wage spending (the induced effect), over one in every two jobs classified as Elementary and Sales & customer service was supported by exports.

The SOC with the lowest proportion of UK FTE jobs supported by exports was Caring & leisure, at 8.2%.

Table 11: UK FTE jobs supported (directly and indirectly) by exports, by occupation type, ESJ basis, 2016

SOC	UK FTE jobs (direct + indirect)	% of occupation FTE jobs supported by exports
Managers & Directors	834,000	25.9%
Professional Occupations	1,158,000	18.9%
Professional & Technical	1,104,000	25.5%
Admin & Sec	642,000	23.2%
Skilled Trade	699,000	21.4%
Caring & Leisure	200,000	8.2%
Sales & Customer Service	535,000	28.1%
Process, Plant & Machine	565,000	28.2%
Elementary	791,000	28.6%
Total	**6,527,000**	**22.6%**

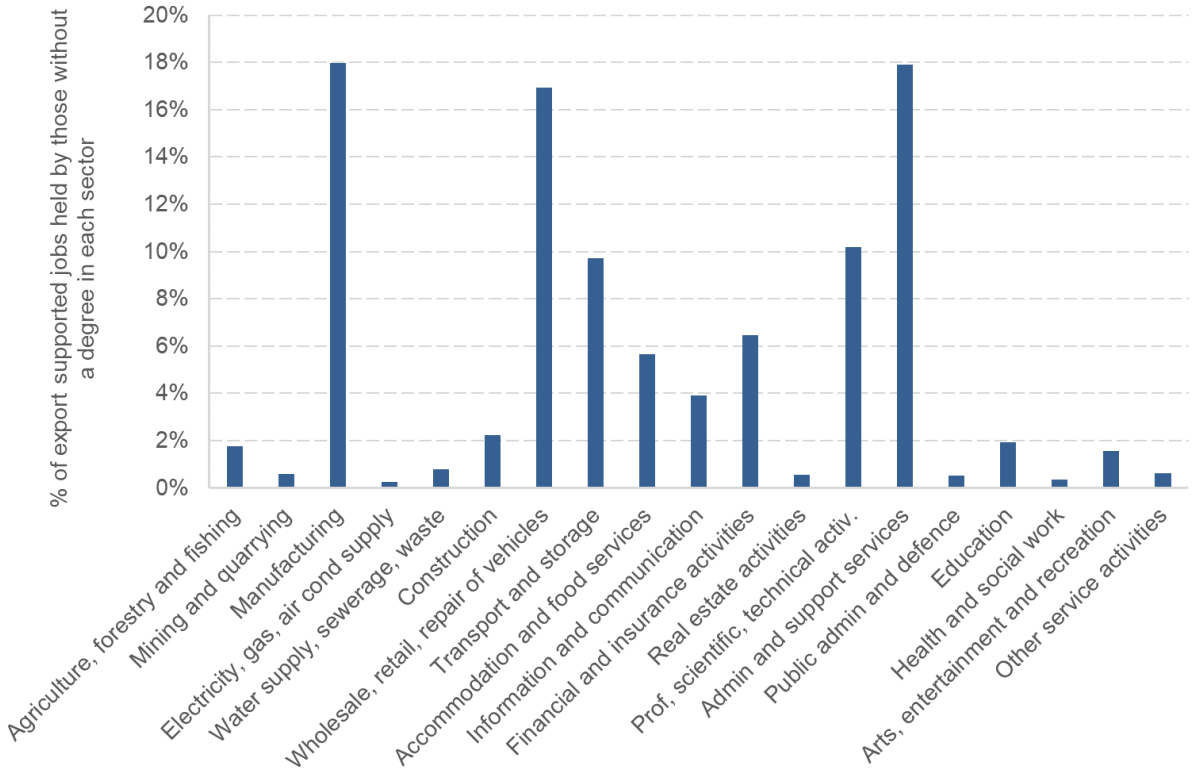
* Data rounded to the nearest thousand. As a result, column totals may not match the sum of elements.

5.7 Qualifications (ESJ basis)

We can also examine the qualification level of the population whose jobs are supported by exports. Chart 8 below shows that of those whose jobs are supported (directly and indirectly) and do not have a degree or higher qualification, around 18% are in the Admin and support services sector, another 18% are in Manufacturing and a further 17% in the Wholesale & retail sector.

Of those whose jobs are supported and have a degree or higher, around 30% are in the Professional, scientific and technical sector, with a further 12% in the Financial and insurance sector.

Chart 8: % of all UK FTE jobs held by people without a degree or higher qualification that are supported (directly and indirectly) by exports, by sector, ESJ basis, 2016



5.8 Country and Regional Breakdowns (ESJ basis)

GVA data were used to apportion FTE jobs to the countries and regions of the UK. Given the dominance of London in the GVA data, it is not surprising that this region comes out top in this table, with over a quarter (26.3%) of all supported jobs estimated to be in London. Even when correcting for population (see third column in Table 12), the propensity of London exports to support jobs is still significantly higher than the other regions.

Table 12: UK FTE jobs supported (directly and indirectly) by exports by NUTS 1 countries/regions, as % of NUTS1 population and % of all FTE jobs supported by exports, ESJ basis, 2016

NUTS1	UK FTE jobs supported by exports	FTE jobs supported by exports as a % of NUTS1 population	% of all FTE jobs supported by exports
North East	168,000	6.4%	2.6%
North West	630,000	8.7%	9.7%
Yorkshire and The Humber	418,00	7.7%	6.4%
East Midlands	384,000	8.1%	5.9%
West Midlands	511,000	8.8%	7.8%
East of England	563,000	9.2%	8.6%
London	1,717,000	19.6%	26.3%
South East	914,000	10.1%	14.0%
South West	430,000	7.8%	6.6%
Wales	196,000	6.3%	3.0%
Scotland	468,000	8.7%	7.2%
Northern Ireland	129,000	6.9%	2.0%
Total*	**6,528,000**	**9.9%**	**100%**

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

GVA is a workplace–based measure, and therefore GVA in London will be supported by residents from other regions commuting to the area, which should be borne in mind when interpreting figures such as this.

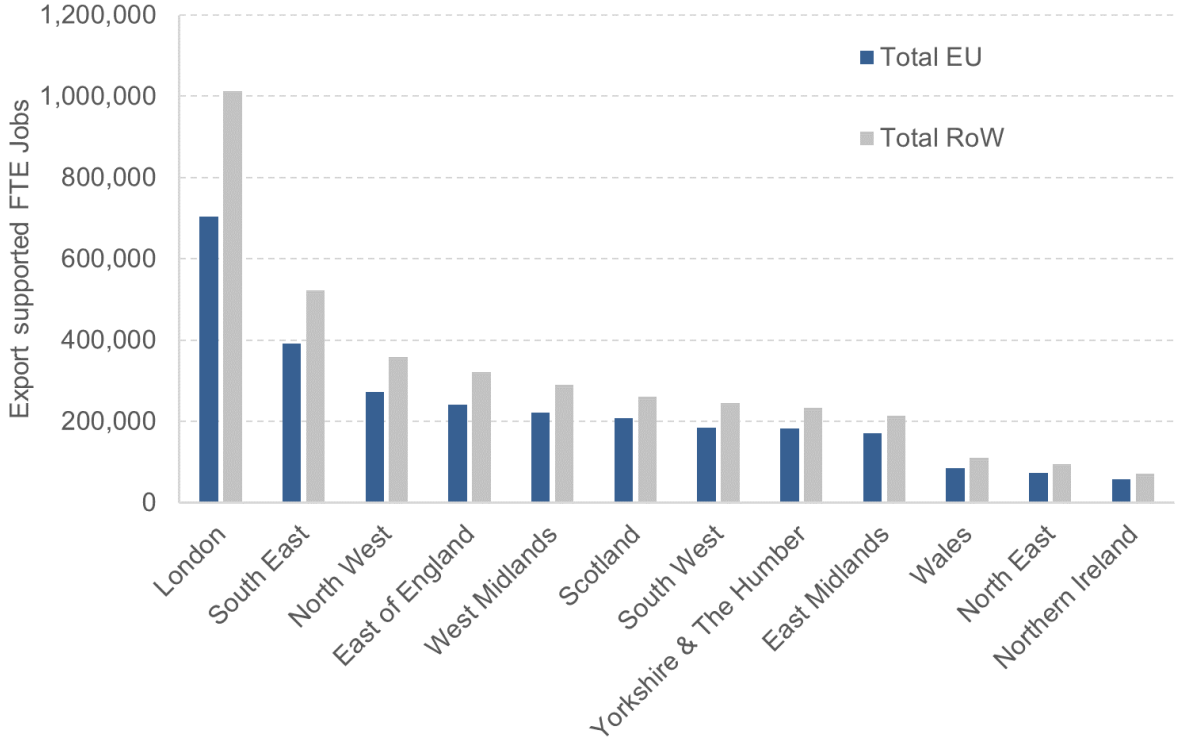
After London and the South East, the region with the next greatest number of FTE jobs supported directly and indirectly by exports is the North West, which reflects its relatively high proportion of manufacturing industries.

The impact on jobs in the regions and nations of the UK is shown in Chart 9 below. The region that has the most jobs supported by exports to both the EU and RoW is London. Based on its industrial mix, it also has the highest proportion of jobs supported by exports to the rest of the world (59% of jobs supported by exports are supported by exports to RoW). The North West and East Midlands are second and third both with 57.2% of all the jobs supported by exports being supported by exports to the RoW.

In proportional terms, the regions and countries which have the most FTE jobs supported by exports to the EU are Northern Ireland, East Midlands and Scotland with 44.5%, 44.4% and 44.3% respectively. However, it is important to bear in mind that

GVA is used to allocate these jobs to regions. Some regions and nations may have stronger or weaker export profiles than this suggests and may also have a different pattern of exports to the EU and RoW.

Chart 9: UK FTE jobs supported (directly and indirectly) by exports, by broad destination and NUTS 1 regions, ESJ basis, 2016



In the accompanying spreadsheet, there are breakdowns by NUTS 1 region by sector, gender, and broad destination. Given the methods required to produce these estimates, these should be interpreted with caution.

5.9 Median wages (ESJ basis)

The characteristics of each sector were used to estimate the median wages of jobs supported by exports. We need to be clear that this median wage reflects the relative wages that sectors who have a high propensity to export tend to pay. We do not have information on the wages of exporting vs non-exporting firms. However, it does give us a feel for the importance of exporting activity for helping sustain high pay occupations and industries.

Table 13 shows that jobs directly and indirectly supported by exports have higher than national median wages. As we move to the induced spending, jobs are primarily supported in sectors involved heavily in consumer spending, such as Retail & wholesale, Accommodation & food services, Education and Health and social work activities. Many of these sectors have low median wages compared to the national median wage which lowers the median wages supported by the induced effects of exporting below the national median.

Table 13: Annual UK Median Wages* for export-supported jobs, against national median, ESJ basis, 2016

Effect	All FTE jobs (£)	Full-Time only (£)
Direct	24,462	30,350
Indirect	24,462	29,936
Induced	18,991	27,416
National median	*22,849*	*28,171*

* Numbers may match in some cells since data is only publicly available at a sector level.

5.10 Comparisons with OECD Trade in Employment

In this section we compare our results with the results of the OECD (2019b).

It is important to note that our estimates will differ from the OECD's due to definitional differences. Firstly, there is a major difference in how jobs/employment by sector is reported. This is laid out in the sectoral comparisons below. The measure of employment we use is FTE jobs, unlike the OECD which consider any persons involved in production; our understanding therefore is that a full-time employee and part-time employee are treated by the OECD as equivalent employment. Furthermore, the OECD also account for re-imported employment within their final employment figures, which for the purpose of comparison we have deducted from the total. However, this represents a very small amount of employment so should not affect the results much.

So that we could accurately compare both sets of results, we analysed the OECD's domestic employment embodied in gross exports with our FTE jobs, as well as our jobs headcount, estimates.

It is important to bear in mind the differences laid out in section 4.3.1 between headcounts and FTEs, and between jobs and employment. That is, a person can hold multiple jobs and so jobs estimates would be expected to be greater than like-for-like employment estimates. For example, in table 14 our headcount jobs figures are generally higher than the OECD's headcount employment figures.

In our estimates of FTE jobs, part-time jobs have a lower weight as each FTE job is equivalent to a job with full-time hours. Therefore, the chance of someone working multiple FTE jobs is considerably lower. As shown in table 14, this will result in lower estimates than headcount jobs and may also be lower than (direct) headcount employment.

Table 14: Fraser of Allander Institute (FAI) FTE and headcount jobs supported by exports vs OECD domestic employment embodied in gross exports, 2014-2015, rounded to the nearest 100

	2014			2015		
	Direct	Indirect	Total	Direct	Indirect	Total
FAI (FTE Jobs)	3,550,800	2,589,400	6,140,200	3,569,100	2,563,300	6,132,300
FAI (Headcount Jobs)	4,113,800	2,978,500	7,092,400	4,128,500	2,941,100	7,069,600
OECD (Headcount Employment)	4,005,700	2,507,400	6,513,100	4,130,600	2,485,300	6,615,900
Headcount Difference	108,100	471,100	579,300	2,100	455,800	453,700

Sources: FAI Analysis, OECD Trade in Employment database (2019b)

Our aggregate results are close to the OECD estimates. The difference in results can be explained by differences in data sources and definitions. We have already laid out above the impact of different jobs/employment definitions. Data differences include differences in the underlying IO tables, trade data and employment/jobs data. These will affect the analysis greatly and explain why the multiplier effects (as seen in the indirect effects) in table 14 differ between our analysis and the OECD's.

Table 15: UK FTE jobs/employment directly and indirectly supported by total exports of each sector (JSE), by industry groups, 2015, rounded to the nearest 100

Sector	FAI	OECD
Agriculture and Mining	194,600	143,800
Manufacturing	1,420,700	1,832,300
Utilities	43,800	9,300
Construction	45,200	4,600
Retail & Wholesale	775,200	951,000
Transport & Storage	255,900	453,200
Accommodation & Food	271,600	300,200
Information & Comms	389,900	324,400

Sector	FAI	OECD
Finance & Insurance	816,700	826,300
Real estate	8,745	9,900
Other business services	1,537,600	1,446,400
Public admin, defence, education & health	236,400	161,000
Arts, entertainment, recreation and other	136,000	153,200
Total	**6,132,300**	**6,615,900**

Sources: Fraser of Allander, OECD Trade in Employment database (OECD, 2019b)

Our estimates included in Table 15 are on a JSE basis to be comparable to the OECD. In general, our estimates by sector are relatively close to those of the OECD. The sector groups in which differences are most noticeable are in the Manufacturing, Transport & storage and Public admin, defence, education & health sectors.

The differences in Manufacturing are primarily driven by the manufacture of chemicals and chemical products, basic metals, machinery and equipment and transport equipment sectors. There are similar differences in Public admin, defence, education & health. Differences could not be explored for Transport & storage as these are aggregated in the OECD data.

To reiterate, the estimates are not entirely consistent as our estimates use FTE jobs while the OECD use headcount employment. However, the differences appear to be primarily driven by the underlying export data by sector. This may be, in part, due to the requirement of the OECD IO tables to harmonise the trade data of many countries, however, more research is needed to understand these differences. The compatibility with UK National Accounts is a key advantage of the methodology used in this report.

6 Conclusion and further research

This report first reviews the evidence base of the impact of exports on employment outcomes. While exports and trade can help improve employment outcomes, the benefits of trade are not necessarily evenly spread.

Some countries, such as the United States and Canada, have sought to improve their understanding of the impact of exports by estimating these various impacts. However, there is a gap in existing statistics when looking at the jobs supported by UK exports, particularly when looking at distributional impacts on gender, regions, wages and labour characteristics.

This project provides some insight into the relationship between exports, the different sectors of the UK economy and the labour force – by gender, partner country and region – which will build the evidence base for better policy making in this area. In addition, it explores the extent to which impacts can be estimated for other groups in the population, such as different age groups, occupation groups and qualifications.

The report discusses the initiatives which aim to estimate the labour market impacts of exports and reviews their methodologies. We then outline a methodology for estimating the number of UK jobs, and the associated incomes, that are directly and indirectly supported by exports. The report discusses the data, and the required assumptions, underlying this methodology.

Finally, the report provides, for the first time, a detailed set of estimates for the UK covering a wide range of indicators while prioritising consistency with UK National Accounts.

6.1 Further research and data improvements

A large amount of data is incorporated into the modelling to produce the results of this report. Good and fit-for-purpose underlying data are critical to any estimates. In this section, we lay out how these data could be improved. In addition, we discuss potential extensions to the work that could provide useful insight into the impact of exporting.

6.1.1 IO tables, extended IO tables and trade data

The first developments we suggest relate to the ONS IxI IO tables. The IxI table is the most critical data source for this report, as it describes the relationships between different sectors, labour and exports. Currently, only one IxI IO table exists and covers the year 2016. A detailed methodology document outlining the assumptions and data underpinning this IxI IO, along with any caveats, would be useful for better understanding the quality of any modelling built on top of this table.

IxI IO tables covering the years 2014 and 2015 would allow us to use the relationships between sectors in those years and relax the assumption of fixed 2016 relationships. Ideally, tables would be produced for the whole time series of analytical tables, from 1997. Continuous updating of IxI IO tables, say on an annual basis, would also have several benefits. Firstly, it would allow for these relationships to be updated annually and reflect the latest information. Secondly, data on exports by sector in basic prices

would be included. This information is presently not available and, as a result, requires the adoption of several assumptions to produce estimates in the years before or after 2016.

As has been highlighted in this report, an important caveat of the modelling is that it looks at sector averages. However, there is evidence that firms can vary within sectors, particularly by trade status, ownership status and size. A clear extension to this project is therefore to start separating sectors by these characteristics. This would require the development by the ONS of more granular ('Extended') Supply Use Tables (SUTs) that take into account heterogeneity between firms. Extended SUTs would enable more accurate estimates and develop our understanding of how different types of firms interact.

Another critical piece of data that could be developed to further insights, is exports by sector. As mentioned, IxI IO tables would resolve the issue of not having exports by sector in basic prices for other years. This would make time series analysis considerably easier. We have also stated in this report that there are several consistency issues between the ONS TIG and TIS datasets and the National Accounts. These data are important for estimates which include exports to individual countries. Consistency between the TIG, TIS and UK IxI IO table would be important for ensuring accurate estimates in the future.

Greater confidence in these data may also allow multiple indicators to be analysed at once, for instance, regionalising the impact of trade with specific countries. Also, the analysis could be extended to cover a larger set of countries, although care should be taken around the level of suppression that the data may have. Another thing to note is that our estimates for 2014 and 2015 rely on additional assumptions as TIS data are only available after 2016. A longer time series of these data, covering estimates prior to 2016, would better reflect the changing nature of the trading relationship with individual countries.

6.1.2 Median wages

Median wages are likely to differ greatly based on a firm's trading status, ownership status and size. Segmenting both the data in the IxI IO table and median wage data by these firm characteristics would provide a great deal of insight into how exporting is associated with incomes. Microdata, rather than publicly available data, could be used to understand the distribution of wages across sectors and the economy and provide a true median wage, rather than a 'median of medians'.

6.1.3 Regional data

A time series of exports by industry for each NUTS1 region would bring significant improvement in the accuracy of the regional estimates. It is important that these regional estimates are consistent with the UK National Accounts, to allow them to be used for the production of regional accounts where this is required. This could be combined with NUTS1 based jobs-output coefficients to better reflect the relationship between jobs and output within specific regions.

A smaller intermediate step would be to incorporate SUTs data for Scotland, Northern Ireland and Wales (soon to be published). This is of course tricky due to the partial nature of the coverage of these tables, and would mean that the English regions would

be adjusted in line with the trade set out in these separately produced tables. The separate data sources, approaches, and definitional differences adopted for these tables may cause issues in particular industries.

6.1.4 Labour Market Characteristics

We include three labour characteristics in the report – age, occupation group and qualifications. These can be extended to include any characteristic, although this characteristic should causally differ across sectors. For instance, jobs supported by exports for people with specific protected characteristics could be examined as some sectors may have a higher or lower propensity to employ people with these characteristics. The report also only includes 2016 for these characteristics and this could be extended to examine longer term trends.

6.1.5 Additional Extensions

The analysis can be extended and improved in several ways. The time series can be extended to include more years. However, the accuracy of this data will depend on the availability of IxI IO tables. In general, the further away the estimates get from the year of the existing IxI IO table, the less accurate the results may be. The time series could also be brought forward to much more recent quarters by making use of nowcasting techniques. This would allow for earlier recognition of changes in trends.

The analysis can be cut in multiple ways. For instance, median wages could be analysed for jobs supported by exports in a specific region or by gender. The jobs supported by exports for each gender could be analysed by age, occupation and qualifications. The jobs supported by exports in each region could be segmented by individual export destinations. In addition, further indicators can be introduced to provide key insights into the UK labour market.

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Department for International Trade

Analysis

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