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THE TRUE IMPACT OF UK MANUFACTURING

APRIL 2018

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April 2018

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FOREWORD

If “we don’t make anything anymore”, then how does this sector account for almost half of our exports? How is it that 70 percent of the UK’s Business R&D is in manufacturing?

Because manufacturing is less obviously present in our communities—fewer people work in the sector than in previous generations, and factories are seldom located in town centres any more—there is a tendency to believe it is a sector that has declined to the point of irrelevance. But nothing could be further from the truth: in fact, manufacturing extends to about a quarter of the UK’s economy. That means that the sector is essential to delivering an industrial strategy that can work for the benefit of the country’s prosperity.

The oft repeated “fact” that manufacturing accounts for only a small proportion of UK GDP tells you more about how GDP is calculated than it does about the true impact of manufacturing within the UK economy. This report is an attempt to tell that richer story.

There are three aspects to assessing the impact of manufacturing:

- **The direct impact**: the output of businesses that are traditionally considered as manufacturers for the purposes of the GDP calculation;
- **The indirect impact**: the economic effect supported in the supply chains of those businesses;
- **The induced impact**: the effect of the spending by people employed directly and indirectly in manufacturing.

This report estimates all three of these impacts.

The first gives us the relatively familiar numbers; nine percent of GDP and 2.6 million jobs (still bigger than the UK’s financial services). However, the second and third elements give us real food for thought. Including the indirect impact, manufacturing accounts for 15 percent of the UK economy and over five million jobs. When we incorporate the induced impact, the figures rise still further to 23 percent and seven million jobs.

Those last two sets of numbers give a truer picture of the importance of manufacturing to the UK economy than the first. The reasons are clear: over the last 40 years, manufacturing has increasingly outsourced activities which used to be done in-house—in areas as diverse as logistics and catering. There are also companies, from design houses to accountancy practices, whose activity, or at least a large part of it, is predicated on serving manufacturing businesses. That output and those jobs are not normally considered as manufacturing, but they would not exist if there was no manufacturing. Any assessment of manufacturing’s importance to the UK economy must take those indirect impacts into account—not to do so is to miss half the picture.

The induced impacts are also vital to understanding the full picture of the sector. If manufacturing disappeared overnight, it would leave a huge hole in the economy as the wages of manufacturers disappeared. Over time, other industries might substitute for manufacturing, but simply buying everything from

abroad would not replace the lost wealth that manufacturing creates. The country would be much poorer as a result.

Today, there is an opportunity, through the Industrial Strategy, to help the UK economy grow and boost our exports by fostering manufacturing investment to take advantage of industrial digitalisation and new technologies such as Big Data, AI and Additive Manufacturing. This report is, therefore, a timely one.

With the Government focused on delivering that Strategy and making the changes wrought by Brexit work for, not against, the UK economy, it is vitally important to understand the economic impacts of our industries in the real world. By demonstrating the importance of manufacturing, this report does just that.



James Selka

Chief Executive Officer
Manufacturing Technologies Association
April 2018

EXECUTIVE SUMMARY

Manufacturing is an important part of the UK economic landscape. As conventionally measured in national accounts, the sector directly employs 2.6 million workers across the UK, who collectively generated an estimated £177 billion in GDP during 2016. This means manufacturing companies directly contributed nine percent of GDP and eight percent of employment in that year.

However, the sector's impact on the UK economy extends far more widely than manufacturing companies themselves. In particular, manufacturers rely on a complex network of UK-based supply chains. Purchases from these suppliers generate "indirect" impacts which ripple out across all sectors of the economy. Once these indirect impacts are included within our calculations, we find that manufacturing supported £301 billion of GDP (15 percent of the UK economy) and five million jobs (15 percent of the UK total) in 2016.

There is also a third aspect to the contribution that manufacturing makes to the UK economy. This is the "induced" impact, which arises when those employed by manufacturers and their suppliers spend their wages in the wider economy. **Bringing together the direct, indirect and induced impacts of manufacturing gives us a third way of estimating the impact of the sector.** On this basis, we estimate that the total impact of manufacturing on UK GDP was £446 billion in 2016. For every £1 million that the manufacturing sector contributes to UK GDP itself, a further £1.5 million is supported across the wider economy through indirect and induced multiplier effects. On the same basis, manufacturing supported a total of 7.4 million jobs in 2016. For each job in the manufacturing sector itself, a further 1.8 are supported in other sectors of the UK economy.

Over-and-above the GDP and employment it supports, the manufacturing sector makes an important contribution to the UK economy in other ways. Firstly, manufacturing accounts for a disproportionate share of R&D expenditure: in 2016, more than two-thirds of business R&D investment was made by manufacturers. And secondly, manufacturing is an important source of export revenues: in 2016, manufacturing goods accounted for almost half of UK goods and services exports.

This report also assesses the economic impact of the engineering sub-sector, defined here to include the manufacture of metal products, electronics and electrical equipment, machinery, equipment, vehicles and other transport equipment.

In total, the engineering sub-sector contributed £188 billion to UK GDP and supported 3.1 million jobs in 2016. The GDP figure includes the £67 billion that engineering firms contributed directly, plus £121 billion in indirect and induced multiplier effects. Just over one million people are employed in the UK's engineering firms, with a further two million jobs sustained in the supply chain and as a result of workers' spending.

1. INTRODUCTION

The *size* of the UK's manufacturing sector is closely monitored in official statistics which track the sector's direct contribution to the economy, for example in terms of GDP and employment. But such measures do not reflect the full *impact* of manufacturing on the UK economy, which extends far beyond these headline estimates.

The Manufacturing Technologies Association (MTA), representing companies that design, manufacture and supply the advanced machinery, software and knowhow that manufacturers deploy to create their products, asked Oxford Economics to investigate this, and to estimate the true impact of UK manufacturing. This request follows in the footsteps of the government's 2016 Manufacturing Metrics Review, which highlighted the need for a more comprehensive approach to measuring manufacturing activity.[1]

In response, this report uses an *economic impact assessment* to quantify the full contribution that the manufacturing sector makes to employment and GDP. Crucially, this includes the wider economic "footprint" supported by the industry's domestic supply chains, together with the wage-financed consumption of its workers and those in its supply chain.

The analysis of manufacturers' UK supply-chain purchases is particularly important in understanding the sector's true impact on the economy. Increased outsourcing of support functions means many activities that were traditionally carried out in-house by manufacturers are now classified as "services activity" in national accounts.

Even when UK manufacturers import raw materials, components and equipment from overseas, they may still be supporting activity within the UK—for example, among UK-based distributors and logistics companies who facilitate these imports.[2] Our modelling accounts for these effects to the fullest possible extent using official statistics.

We start our analysis by assessing the manufacturing sector itself, before extending our focus to the supply chain impact, and then worker spending effects.

In Section 6, we take a closer look at the engineering sub-sector, to ascertain its impact on the UK economy, both directly and through supply chain and worker spending multiplier effects. Technical details of our approach and data sources are provided in the appendices.

[1] Manufacturing Metrics Expert Group, "Manufacturing Metrics Review Report" (2016).

[2] The extent to which such activity is captured within our estimates will depend on the structure of contracts and the categorisation of firms. This is discussed further in the appendix.

INTRODUCTION TO OUR ECONOMIC IMPACT ANALYSIS

The impact of manufacturing is assessed using a standard means of analysis called an economic impact assessment. This involves quantifying the sector's impact across three "core" channels:

- ***Direct impact,*** which relates to the manufacturing sector's own activities. It encompasses the economic activity and employment supported directly by firms in the manufacturing sector;
- ***Indirect impact,*** which encapsulates the economic activity and employment supported in the supply chain of the manufacturing sector, as a result of its procurement of goods and services from firms in other sectors. Our analysis estimates the impact of manufacturers' capital investments, as well as that of their day-to-day purchases;
- ***Induced impact,*** which comprises the wider economic benefits that arise when employees within the manufacturing sector, and its supply chain (including that for capital purchases), spend their earnings— for example, in local retail and leisure establishments.

The sum of these channels makes up the manufacturing sector's total economic impact. Two main metrics are used to present a picture of the sector's economic contribution:

- ***GDP,*** or more specifically, the *gross value added (GVA)* contribution to GDP.[3]
- ***Employment,*** measured on a headcount basis.

The modelling is conducted using an Input-Output (I-O) based model of the UK economy. This model was constructed by Oxford Economics, using data published by the ONS.

Note 1: Different studies take different approaches to estimating the total impact of a sector. For example, multiplier estimates published by ONS include supply chain impacts but not worker spending effects (although ONS is seeking to publish multipliers which include induced impacts in future[4]). Induced impacts are, however, cited in academic literature[5] and multiplier values including induced effects are published by the Scottish government, among others.[6]

Note 2: A standard I-O based assessment of the manufacturing industry's supply chain would count its purchases of fuels, consumable parts, tools, utilities, professional services, etc, but would miss out capital spending on machinery, vehicles, or the construction of facilities that are crucial for its activities. Our approach also incorporates information on capital purchases that are made as part of each industry's gross fixed capital formation (GFCF). By including the

[3] GVA measures the contribution to the economy of each individual producer, industry or sector. When aggregated across all industries, GVA approximates to GDP. The latter represents the total value of all goods and services produced in an economy and is the main measure of a country's total economic activity. See Appendix C for further details.

[4] J Howse, "Office for National Statistics", in *Input-output analytical tables: methods and application to UK National Accounts* <https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/articles/inputoutputanalyticaltables/methodsandapplicationtouknationalaccounts> [accessed 19 Mar 2018]

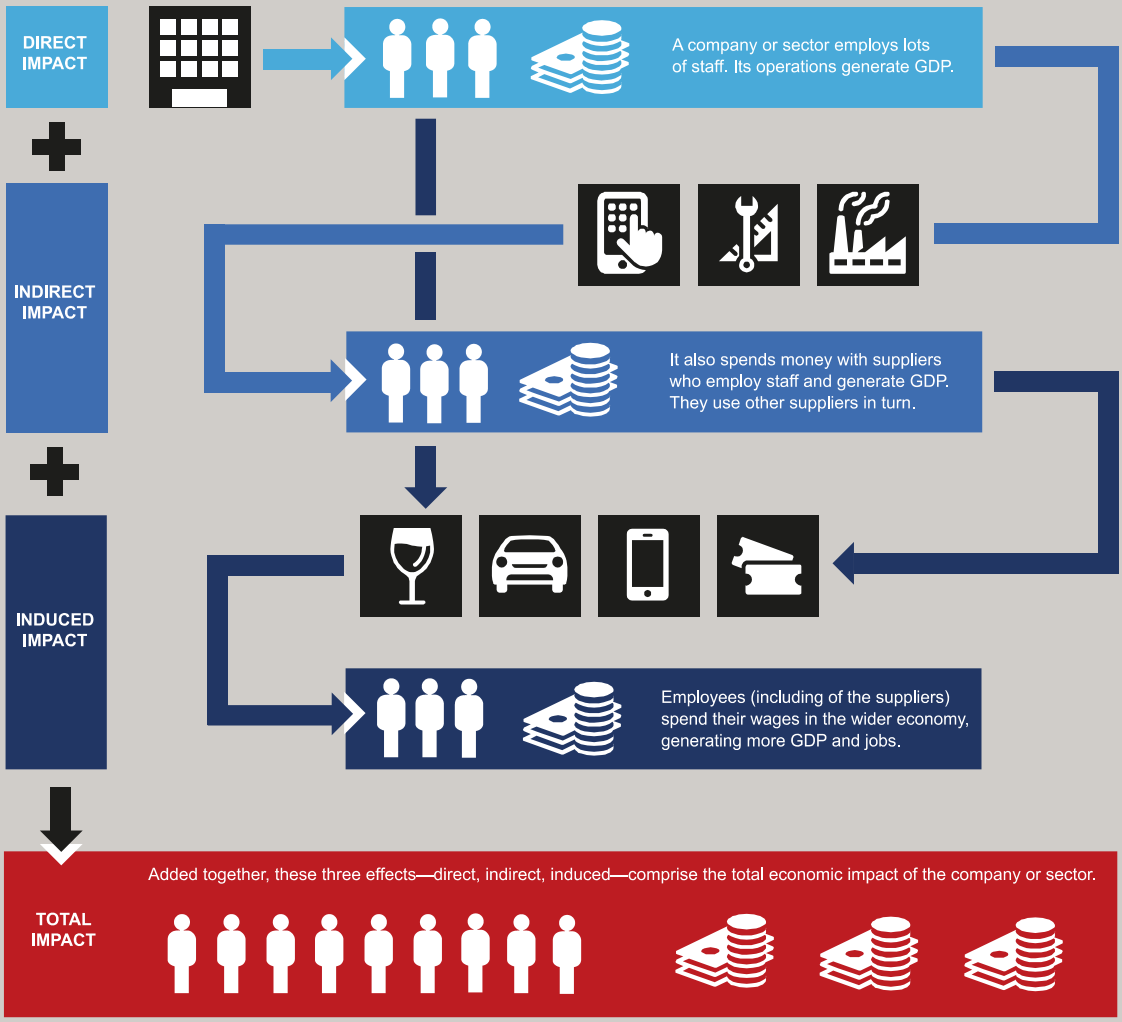
[5] See, for example, Ronald E Miller and Peter D Blair, *Input-Output Analysis: Foundations and Extensions*, 2nd ed. (Cambridge: Cambridge University Press, 2009).

[6] The Scottish Government, "Multipliers - Definitions of Multipliers and Effects", in *www.gov.scot* <http://www.gov.scot/Topics/Statistics/Browse/Economy/Input-Output/Mulitipliers> [accessed March 2018]

average amount of capital spending that is required to sustain a given level of output, we have a more accurate measure of what inputs are required for economic activity to take place.

Further detail about the economic impact methodology is included in Appendix C.

Fig. 1. How we measure the UK manufacturing industry's total impact



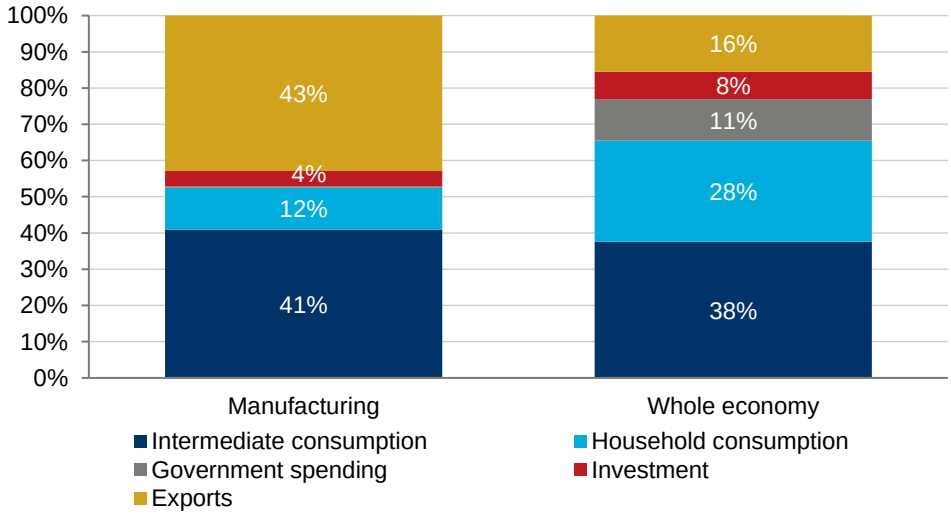
2. THE DIRECT IMPACT OF THE MANUFACTURING SECTOR

2.1 SIZE AND IMPORTANCE OF MANUFACTURING

2.1.1 Sales: how much, and who to?

The manufacturing sector continues to play an important role in the UK economy, selling products worth £546 billion at home and abroad in 2016. The sources of demand for UK manufacturing outputs are shown in Fig. 2.

Fig. 2. Sources of demand: manufacturing versus whole economy, 2016[7]



Source: ONS Input-Output tables, ABS and Oxford Economics

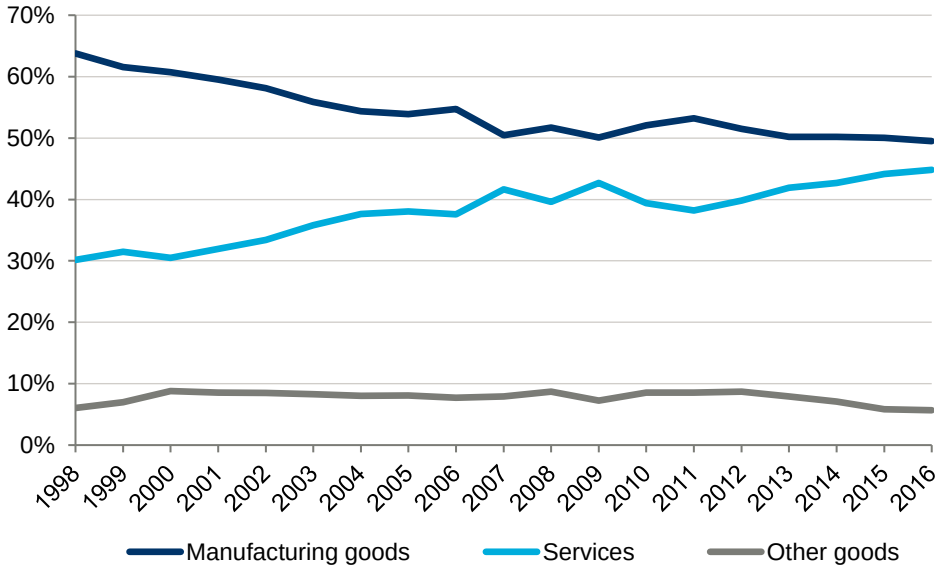
The largest source of demand for the UK manufacturing sector's output is export sales. These accounted for 43 percent of the total—a considerably higher share than the UK average of 16 percent. ONS Input-Output tables suggest that exports have become an increasingly important source of demand for UK manufacturing output over the last two decades: in 1995, overseas sales represented 35 percent of demand for UK manufacturing output, compared to 43 percent in 2013.[8]

The importance of export sales to the UK manufacturing sector also means that it accounts for a disproportionate share of overall UK export sales: since 2007, goods produced by the sector have accounted for around half of UK goods and services exports. This is, however, down from 64 percent in 1998, since stronger growth in services has driven a steady increase in their share of total UK exports.

[7] Manufacturing household consumption only includes direct sales to households. Therefore, if a manufacturer sells a product to a distributor, who then sells to households, the sale would be recorded as intermediate consumption.

[8] The 2013 Input-Output tables were the most recent available at the time of writing.

Fig. 3. Manufacturing goods share of UK goods and services exports, 1998-2016

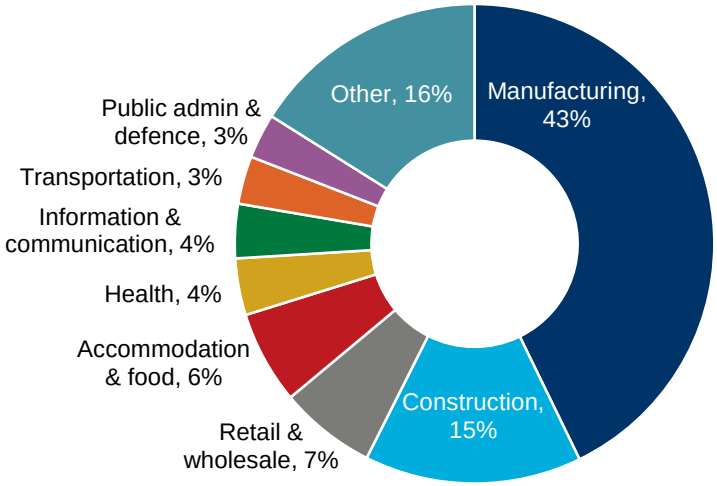


Source: ONS Balance of payments

After exports, Fig. 2 suggested the next largest source of demand for the UK manufacturing sector's outputs was other businesses purchasing goods for use in their production processes (so-called "intermediate consumption"). Using detailed data from 2013 ONS Input-Output tables, we can examine the destination of goods sold to other businesses as intermediate consumption (see Fig. 4).[9] Of the £224 billion of manufacturing products sold for this purpose, 43 percent were sales to other manufacturing companies for use in their production process. A further 15 percent were to the construction sector.

[9] The 2013 Input-Output tables were the most recent available at the time of writing.

Fig. 4. Sectoral mix of sales of manufactured products for intermediate consumption within the UK, 2016



Source: ONS Input-Output table and Oxford Economics

2.1.2 Contribution to GDP and employment

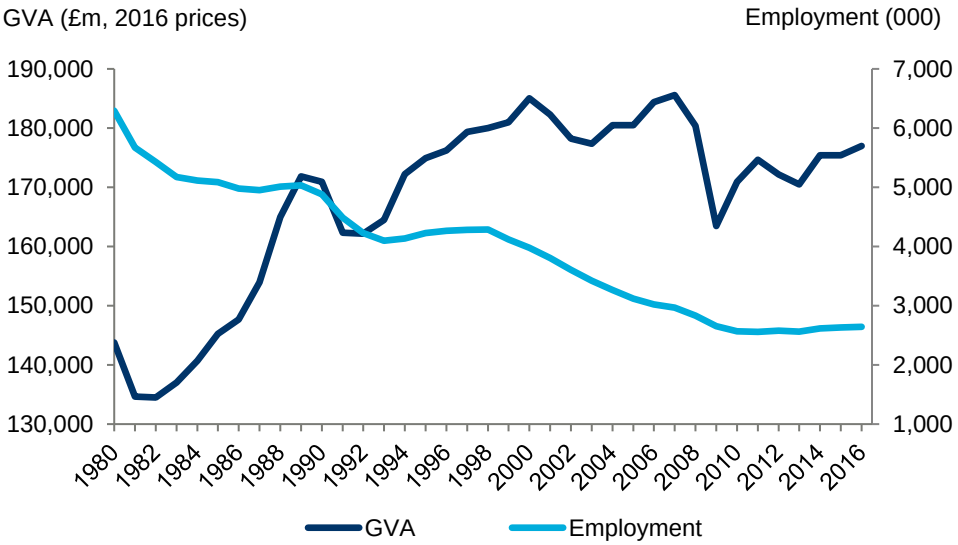
Based on the £546 billion of total sales, the manufacturing sector directly contributed £177 billion in gross value added to UK GDP and supported 2.6 million jobs in 2016.[10] This was equivalent to nine percent of UK GDP, and eight percent of the UK's total employment that year.

The direct GDP contribution of the UK's manufacturing sector grew marginally between 2014 and 2016 (0.9 percent). However, it was over £10 billion higher than in 2009, when the UK's manufacturing sector felt the strongest impact from the global financial crisis.

Direct employment in manufacturing has been stable at around 2.6 million since 2010, following a period of decline from 6.3 million in 1980.

[10] Sources: Office of National Statistics, "Nominal and real regional gross value added (balanced) by industry," *Regional Accounts*, 2017 <https://www.ons.gov.uk/file?uri=/economy/grossvalueaddedgva/datasets/nominalandrealregionalgrossvalueaddedbalancedbyindustry/current/nominalandrealregionalgvabbyindustry.xlsx> [accessed March 2018] and Oxford Economics, "2 Digit SIC Total Employment forecasts," *Regional Model*, 2018

Fig. 5. Manufacturing sector GVA and employment, 1980-2016



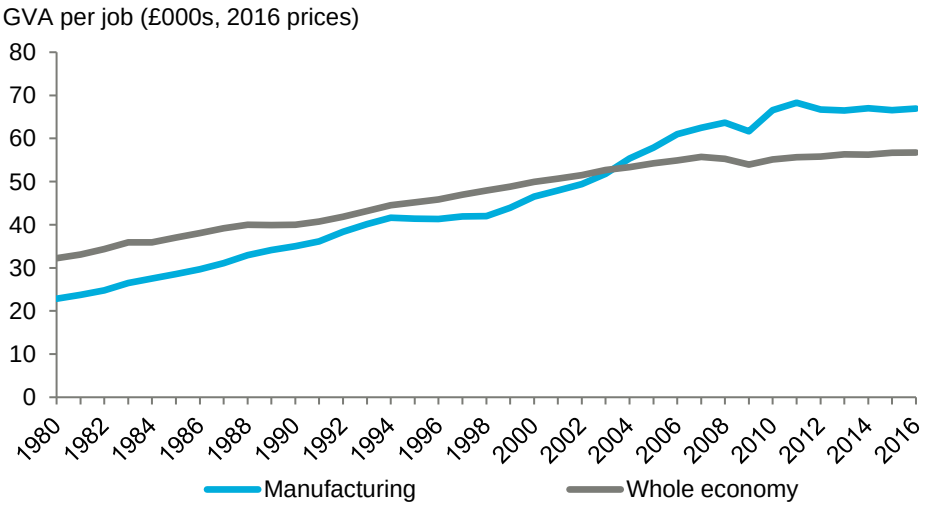
Source: ONS, BRES, and Oxford Economics

2.2 PRODUCTIVITY OF THE MANUFACTURING SECTOR

By combining our estimates of the UK manufacturing sector's direct contribution to GVA and employment, we are able to calculate "GVA per job", a measure of labour productivity for the sector.

This suggests that manufacturing productivity grew more strongly than the UK average during the 10 years from 1998. While the steady upwards trend was interrupted by the financial crisis, manufacturing productivity peaked at £68,000 per job in 2011. Since then it has been stable at around £67,000 per year—higher than the UK average of £56,700 in 2016. Overall UK GVA per job increased by 1.7 percent between 2012 and 2016.

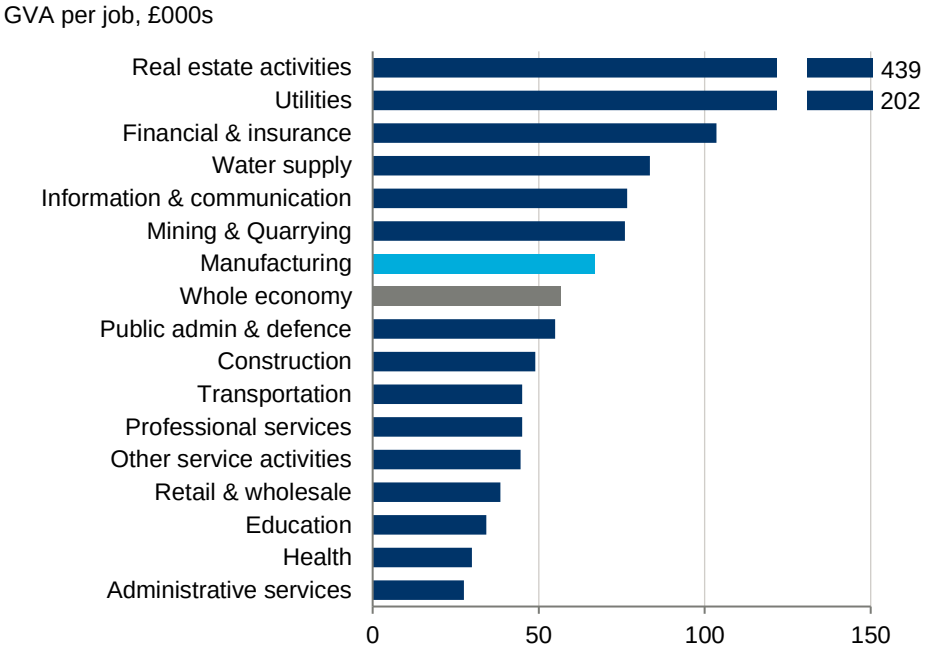
Fig. 6. Labour productivity, 1980-2016



Source: Oxford Economics

While manufacturing productivity has not increased during the last few years, it remains above that of sectors such as construction, transportation, and professional services (see Fig. 7). This above-average productivity partly reflects that manufacturing is more capital intensive than many service activities, which have a greater reliance on labour to produce their outputs.

Fig. 7. UK labour productivity by sector, 2016[11]

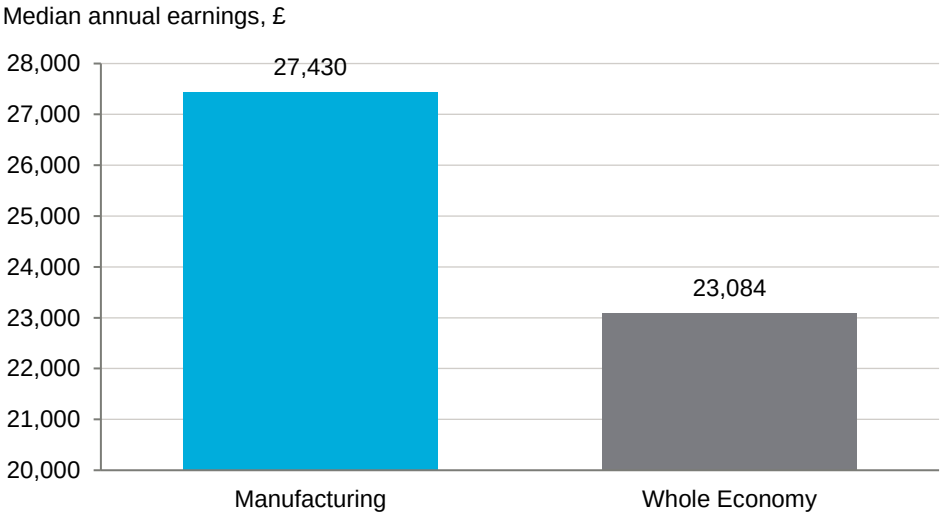


Source: ONS, BRES, Oxford Economics

Consistent with its above-average productivity levels, manufacturing sector wages are also above the UK average. In 2016, the median wage in manufacturing was £27,400, 19 percent higher than the UK's overall median wage (Fig. 8).

[11] Mining & quarrying excludes activity in the UK offshore oil sector. The extra-regio component of GVA is, however, included in the UK average.

Fig. 8. Median wages, 2016[12]



Source: Annual Survey of Hours and Earnings (ASHE)

2.3 DIVERSITY OF THE MANUFACTURING SECTOR

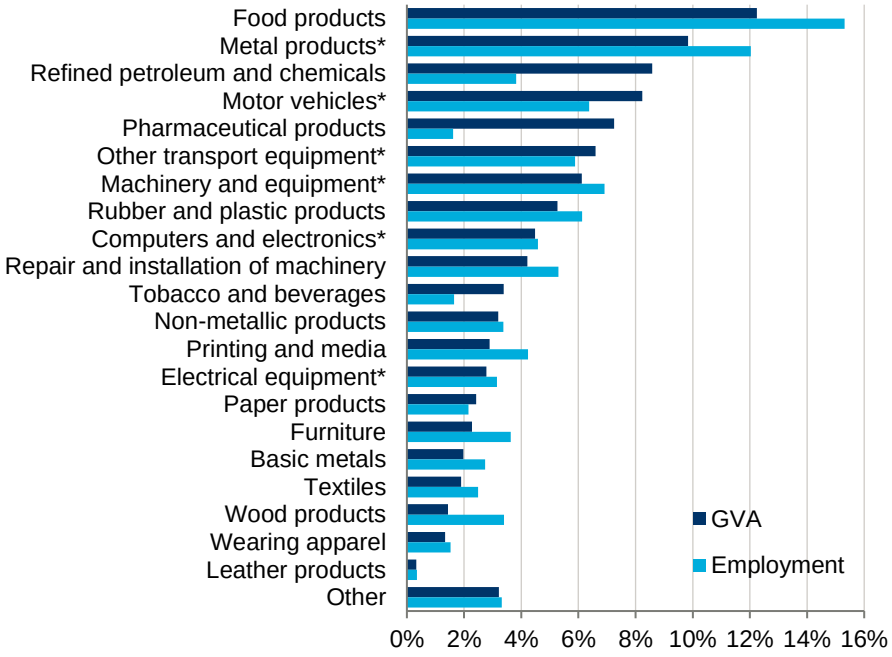
We have so far referred to the UK's manufacturing sector as a single entity. The reality, of course, is that it boasts a huge degree of diversity—not least in the range of goods that are produced.

In terms of both GVA and employment, the largest manufacturing sub-sector is the production of food products, which contributes 12 percent of manufacturing GVA and 15 percent of manufacturing employment (Fig. 9). The importance of this sub-sector reflects that many food products are perishable and closely tailored to local tastes, so need to be manufactured close to where they are consumed.

At the other end of the spectrum, a relatively small share of UK manufacturing GVA is contributed by the production of lower-value goods such as textiles and clothing, which may be most efficiently produced in low-cost locations overseas.

[12] Gross annual pay for all employee jobs

Fig. 9. Share of manufacturing GVA and employment by sub-sector, 2016



Source: ONS, BRES, Oxford Economics

*Engineering sub-sectors—see Chapter 6

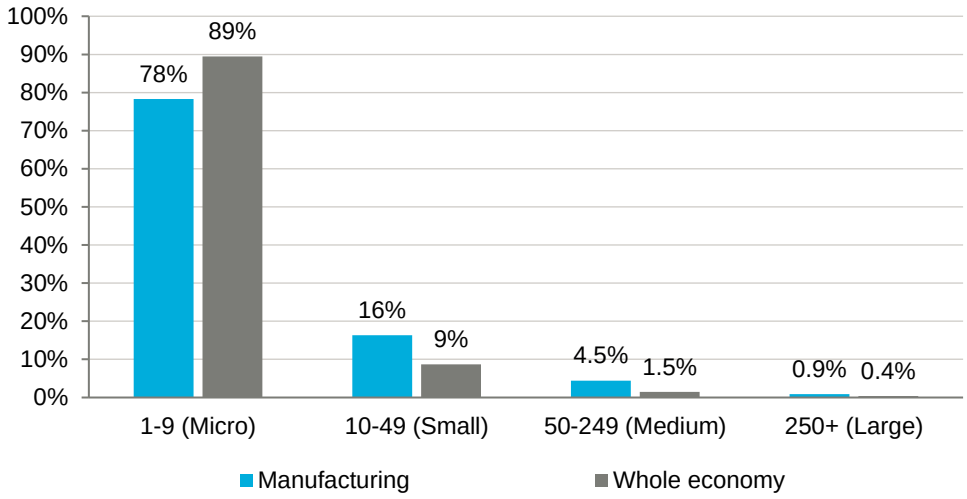
Productivity levels vary considerably between these sub-sectors. Comparing the GVA and employment shares in Fig. 9 illustrates that petrol refining, for example, accounts for a much higher share of manufacturing GVA than employment, reflecting its status as a very capital intensive sub-sector with very high levels of GVA per job (£150,000 per year).

A similar pattern is visible for pharmaceuticals, where GVA per job is £301,000—but in this case, the difference between the two indicators likely reflects high margins on the sale of pharmaceutical products, which are often developed through long periods of research and testing, involving highly skilled workers.

In contrast, sectors that are more labour intensive or produce lower-value goods account for a higher share of manufacturing employment than GVA. Examples include wood products (GVA per job: £28,000), and furniture (£42,000).

Over and above the diversity within the types of products the UK manufacturing sector produces, there is also diversity in the types of business operating in this sector. In 2016, there were over 105,900 micro-sized businesses, 28,100 small-and-medium-sized businesses, and 1,200 large businesses across the manufacturing sector in the UK. These figures suggest that while the proportion of SMEs within manufacturing is similar to the UK average, manufacturing has a greater share of small- and medium-sized firms, and a slightly lower share of micro-enterprises (Fig. 10).

Fig. 10. Business count by number of employees, 2016



Source: ONS BRES

2.4 THE GEOGRAPHIC SPREAD OF UK MANUFACTURING

Manufacturing directly contributes around nine percent of the UK's GDP and eight percent of its employment. However, the sector's importance varies considerably across the regions and countries of the UK. As a proportion of the total economy, manufacturing has the greatest importance in Wales, where it accounts for 18 percent of GVA. In contrast, manufacturing supported just two percent of GVA in London in 2016.

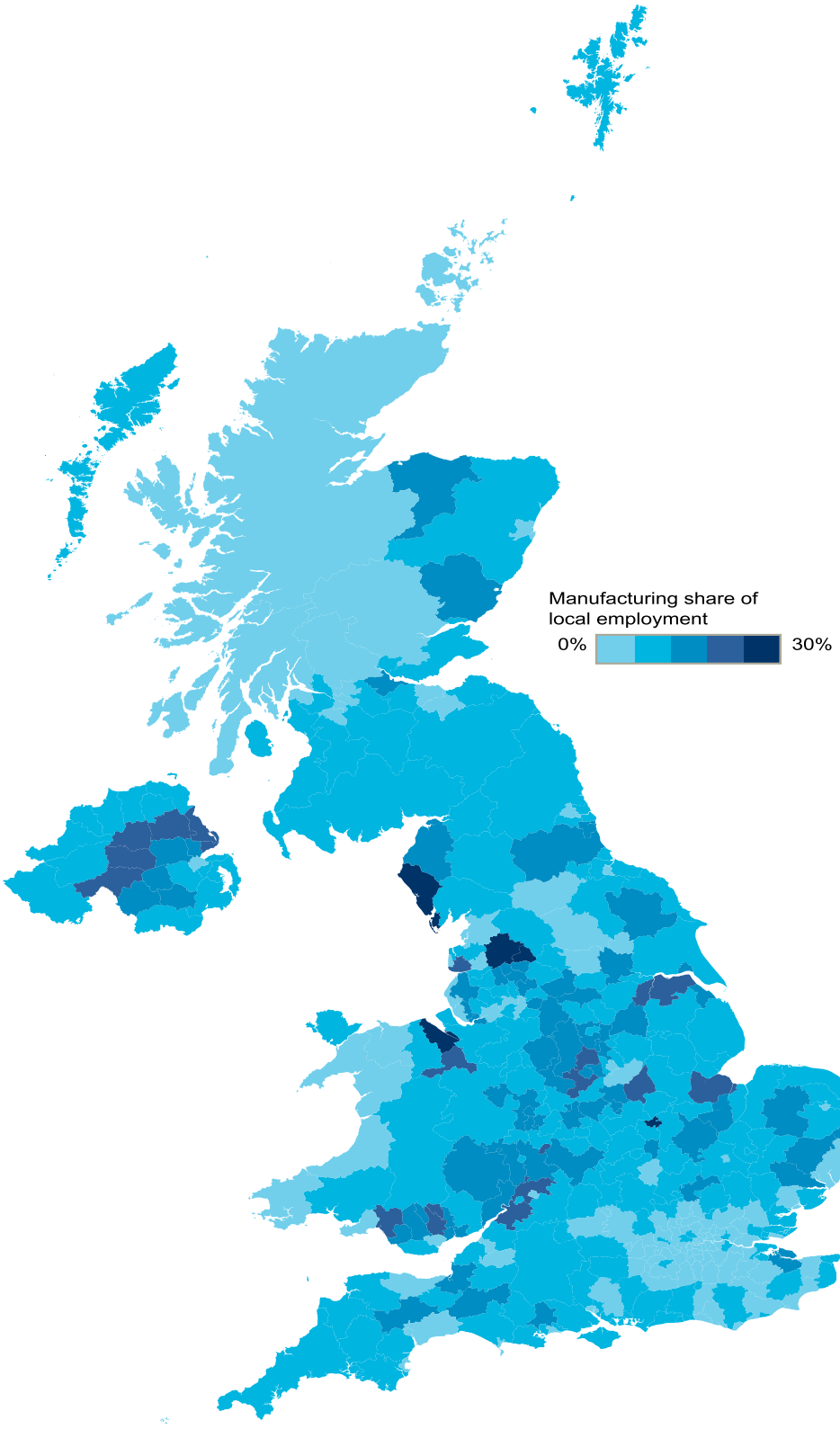
Fig. 11. Contribution of manufacturing to GVA and employment, 2016



Source: ONS, BRES, Oxford Economics

In certain local areas, the direct economic contribution of manufacturing is greater still (see Fig. 12). In some areas, manufacturing can account for 20 percent or more of total employment—for example, in certain districts in the North West, which rely on the aerospace and defence sector; areas in the East Midlands which rely on the manufacture of food, metal and rubber products; and some districts in Wales, where a range of manufacturing activity supports a high share of local employment.

Fig. 12. Manufacturing share of employment in UK local authority districts, 2016



Source: BRES and Oxford Economics

In this chapter we have focused on the manufacturing sector itself, highlighting its direct contribution to the economy, the diversity encompassed within it, and its contribution to UK productivity. However, the sector's impact on the UK economy extends far beyond what it produces itself. We explore this further in the next sections, starting with the activity supported within the supply chain.

3. THE SUPPLY CHAIN IMPACT OF UK MANUFACTURING

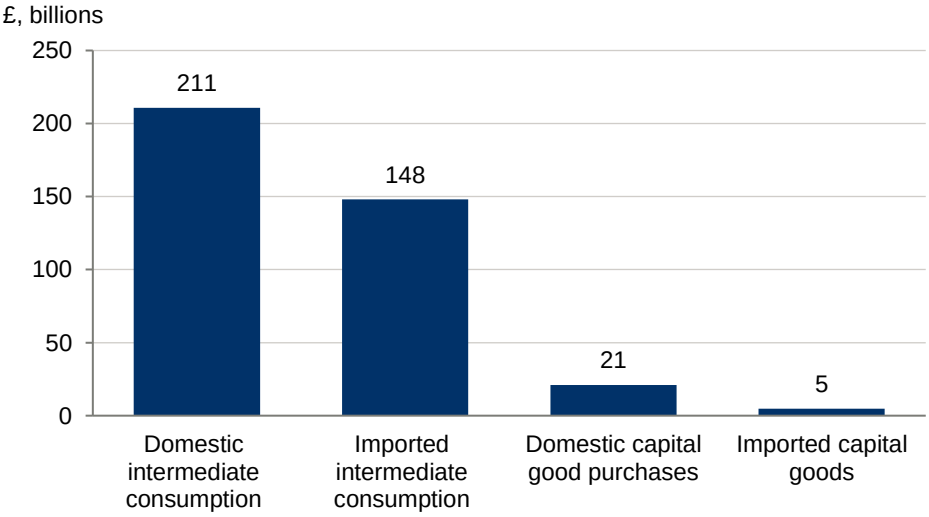
3.1 MANUFACTURERS' PURCHASES OF GOODS AND SERVICES

To analyse the impact of manufacturers' supply chain purchases, we consider two types of expenditure. The first type comprises goods and services which are either transformed, used up or incorporated into other products during the production process. These purchases are known as "intermediate consumption". The second type of purchases are investments in fixed assets, which are typically used over a period of years.

Based on information from the ONS Annual Business Survey and Input-Output tables, we estimate that UK manufacturing companies purchased £385 billion of goods and services in 2016. Fig. 13 categorises this expenditure according to the type of purchase, and whether purchases came from UK or overseas suppliers.

Our analysis suggests 41 percent of intermediate consumption and 19 percent of capital goods purchases were imported, while UK manufacturing companies purchased £232 billion of goods and services from UK suppliers in 2016.[13]

Fig. 13. Estimated operational and capital expenditure by UK manufacturing companies, 2016

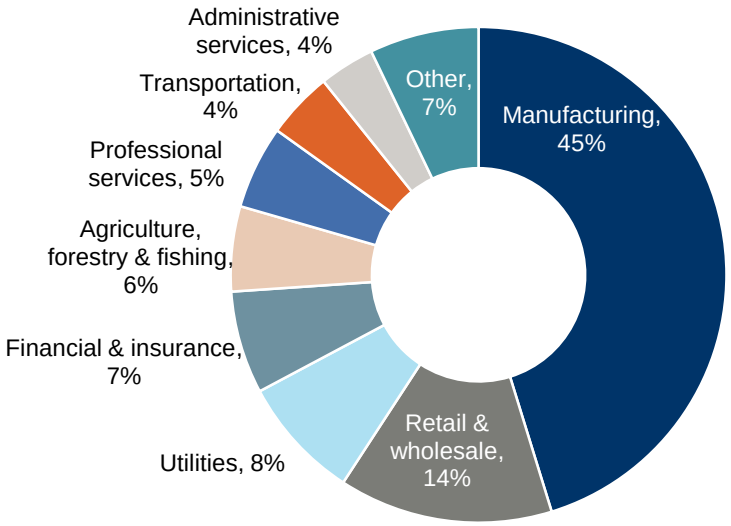


Source: ONS Input-Output tables, Supply-Use tables, ABS and Oxford Economics

[13] Consistent with the underlying datasets, imported goods purchased from a UK distributor are counted as domestic purchases.

Using detailed data from the ONS, we can estimate the UK sectors from which UK manufacturing firms purchased goods and services as part of their intermediate consumption (Fig. 14). Most strikingly, we find that 45 percent of purchases came from within the manufacturing sector itself, reflecting that manufacturing incorporates companies operating at many different stages in the production process.

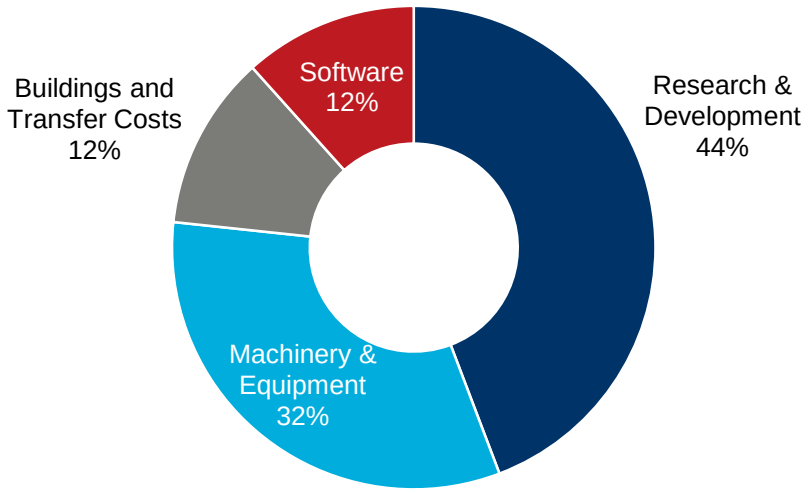
Fig. 14. UK manufacturers' purchases of goods and services from domestic suppliers for use in the production process, 2016 (intermediate consumption)



Source: ONS Input-Output table and Oxford Economics

Using detailed ONS business investment statistics, we can also investigate the types of capital assets purchased by UK manufacturers (Fig. 15). Some 44 percent of capital purchases related to research and development (R&D) activity. Just under one-third of capital expenditure was to purchase machinery and equipment.

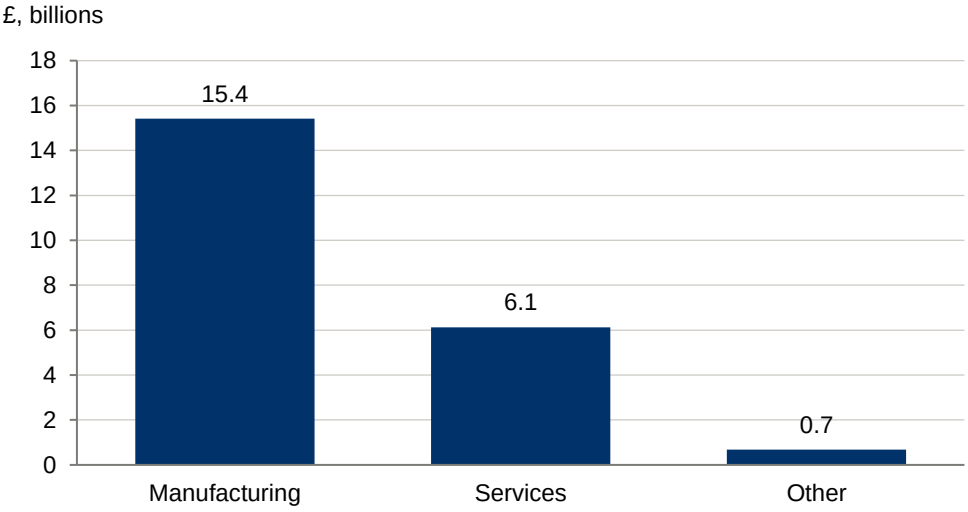
Fig. 15. Capital purchases of the UK manufacturing industry, 2016[14,15,16]



Source: ONS business investment release and Oxford Economics

The strong orientation towards R&D investment means that UK manufacturers punch above their weight in terms of their share of total UK business R&D expenditure. In fact, manufacturing businesses account for more than two-thirds of all R&D expenditure associated with UK businesses.

Fig. 16. Expenditure on R&D performed in UK businesses, 2016[17]



Source: ONS Business Enterprise Research & Development

[14] Includes purchases of both domestic and imported goods and services.

[15] This analysis is based on SIC divisions 20-24 and 26-33, since the necessary data are not available for divisions 10-19 and 25.

[16] Transfer costs, sometimes known as cost of ownership transfer, are the costs associated with buying or selling an asset.

[17] Other includes agriculture, extractive industries, electricity, gas & waste management, and construction

3.2 ACTIVITY SUPPORTED BY MANUFACTURERS' SUPPLY CHAIN PURCHASES

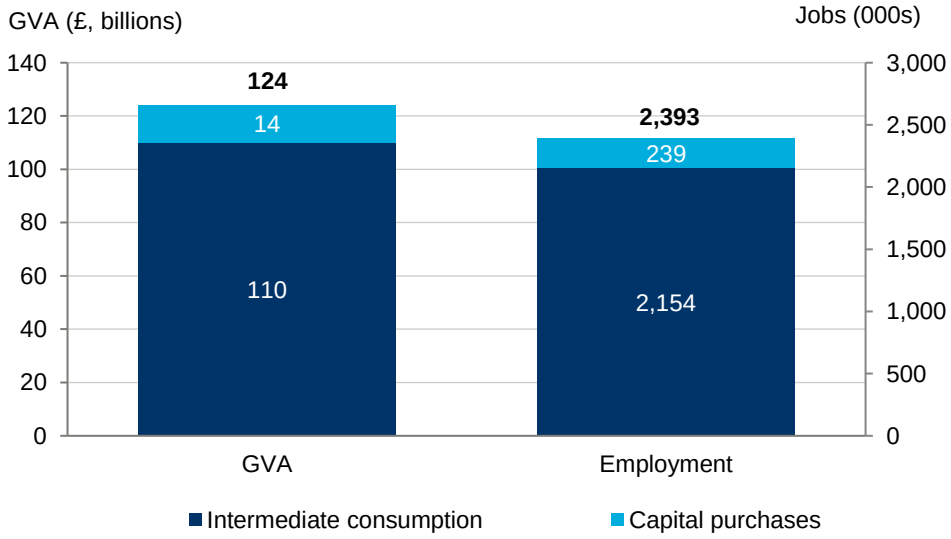
We can now use Input-Output tables to estimate the value of UK GDP supported by manufacturers' purchases from domestic suppliers, as identified in the previous section. This constitutes the manufacturing sector's "indirect contribution" to GDP.

Note: In making this calculation, we must exclude purchases from other UK manufacturing companies, because this activity has already been counted in our estimate of the sector's direct impact. (For example, a manufacturer's purchases of machinery or machine repairs are excluded from the supply chain calculations because are already included in our estimate of the seller's direct contribution to GDP and employment.)

On this basis, we estimate the UK manufacturing industry supported an indirect GDP contribution of £124 billion in 2016 through its intermediate consumption and capital purchases (Fig. 17).

Having calculated this figure for GDP, we can use UK productivity data in each sector to estimate the number of jobs supported in the manufacturing supply chain. This suggests that manufacturing indirectly supported 2.4 million jobs in 2016.

Fig. 17. Indirect contribution of UK manufacturing, 2016



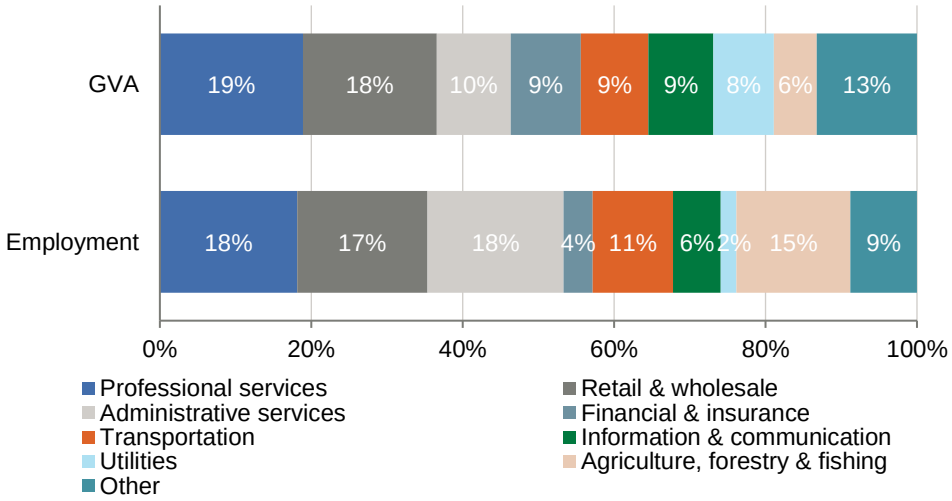
Source: Oxford Economics

Using this analysis, we can also identify which sectors benefit from the indirect GDP contribution supported by the manufacturing industry (see Fig. 18). We find that the indirect impact of manufacturing is broad-based, supporting activity in a range of sectors across the UK economy.

The largest indirect GDP contribution accrues within professional services, which partly reflects that this sector is a substantial recipient of manufacturers' capital purchases, particularly those relating to intellectual property products.

In employment terms, we find that more than two-thirds of the indirect impact of manufacturing falls within four sectors: professional services, retail and wholesale, administrative services, and agriculture. The relatively large share of employment in administrative services partly reflects that this sector includes employment services firms, who are an important source of agency staff for UK manufacturers. We estimate that more than 60 percent of indirect jobs within administrative services fall within the "employment services" category.

Fig. 18. Sectoral share of the indirect contribution of the UK manufacturing industry, 2016[18]



Source: Oxford Economics

[18] Professional services include: legal services, accounting services, tax consulting services, services of head offices, management consulting services, architectural and engineering services, technical testing and analysis services, scientific research and development services, advertising and market research services, other professional, scientific and technical services and veterinary services.

Administrative services include: rental and leasing services, employment services, travel agency, tour operator and other reservation services and related services, security and investigation services, services to buildings and landscape and office administrative, office support and other business support services.

4. WORKER SPENDING IMPACTS

A second type of wider activity supported by manufacturing occurs as workers employed in the manufacturing industry and its UK supply chain spend their wages. These "induced impacts" are mainly felt in sectors serving households such as hotels, restaurants and shops.

In Section 2.2, we highlighted that wage levels in manufacturing are greater than the UK average. To assess the impact of these wage payments, along with those to workers in the supply chain, we estimated the total value of wages payable to workers in manufacturing and its supply chain using the Input-Output model. We then estimated the value of consumer spending supported by those wages, and finally the induced contribution to GDP associated with this expenditure.[19]

On this basis, we estimate that manufacturing supported a £144 billion contribution to UK GDP through workers' spending. The sectoral distribution of this is shown in Fig. 19. Perhaps unsurprisingly, our analysis suggests the largest beneficiaries of the worker spending impact are the real estate (in terms of gross value added) and retail sectors.

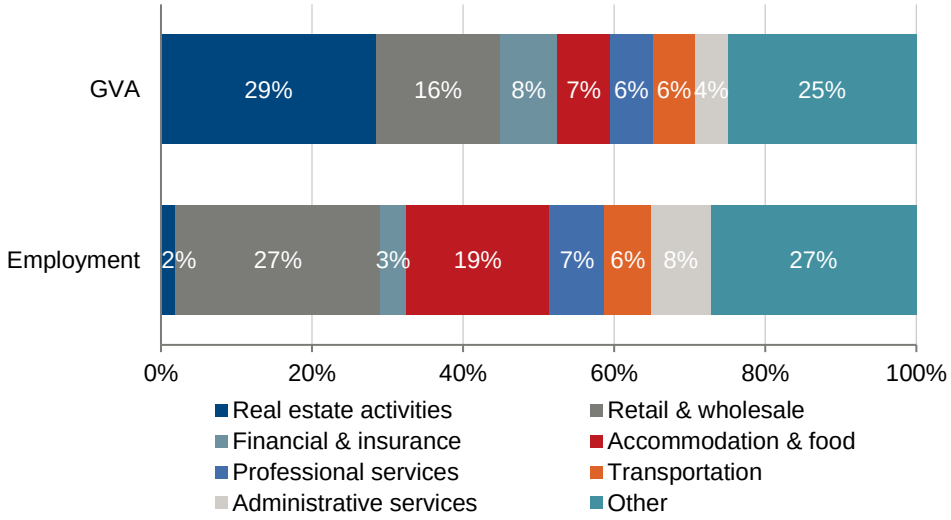
By combining the induced GDP impact in each sector with productivity estimates, we also estimate that manufacturing supported 2.3 million jobs through worker spending multiplier effects in 2016. The breakdown of these jobs by sector is also shown in Fig. 19.

Although real estate was a key contributor to the manufacturing industry's induced GDP contribution, it does not play a substantive role in employment terms.[20] In contrast, the induced impact of retail, and accommodation and food, is much greater when measured in terms of employment than in terms of GDP.

[19] In making these calculations we assume that the pattern of workers' spending is in line with the UK average.

[20] Real estate refers to the value to households of owning their residence, imputed as an equivalent rental value. Within the modelling framework, this imputed spending flows to an 'industry'—one that provides a service (housing) and purchases some, comparatively limited inputs to provide this (e.g. maintenance and upkeep, fees on mortgages). The difference between the output (equivalent to the imputed rent) and inputs means that value-added is generated. However, no employment is associated with this. As such, induced activity in the real estate sector can appear to give rise to lots of GVA and relatively few jobs.

Fig. 19. Sectoral share of the induced contribution of the UK manufacturing industry, 2016



Source: Oxford Economics

5. TOTAL IMPACT OF THE UK MANUFACTURING SECTOR

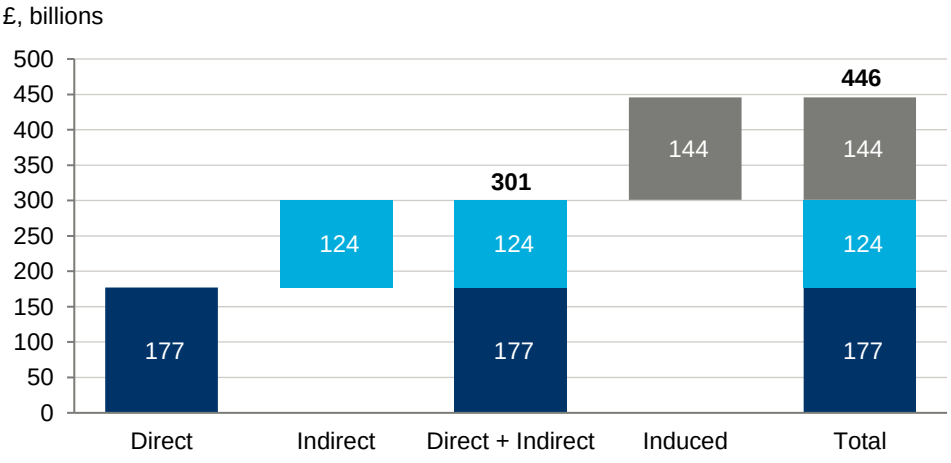
In this chapter, we bring together the findings of the previous sections to present three estimates of how the manufacturing sector impacts on the UK economy.

The first estimate, which we explored in Chapter 2, reflects the size of the manufacturing sector, as conventionally measured in national accounts. On this basis, the direct contribution of manufacturing to UK GDP was estimated to be £177 billion in 2016, or nine percent of the UK economy.

The second estimate adds the supply chain (or indirect) impact of manufacturing to the direct impact. When this is done, the impact of the manufacturing sector increases to £301 billion in 2016, or 15 percent of GDP. By comparing the combined size of the direct and indirect impacts with the direct impact, we can calculate the "Type I GDP multiplier". This is found to be 1.7, suggesting that for every £1 million that manufacturing contributes to UK GDP directly, a further £0.7 million is contributed through the supply chain.

Our third estimate includes not only the direct and indirect impact of manufacturing, but also the induced, worker spending, impact. On this basis, we estimate that in 2016, **the UK manufacturing sector supported a total GDP contribution of £446 billion**—equivalent to 23 percent of the UK's total economy. This means that for every £1 million the manufacturing sector contributes to GDP itself, it creates another £1.5 million elsewhere in the UK economy—giving manufacturing a "Type II GDP multiplier" of 2.5.[21]

Fig. 20. Total GDP contribution of UK manufacturing sector, 2016



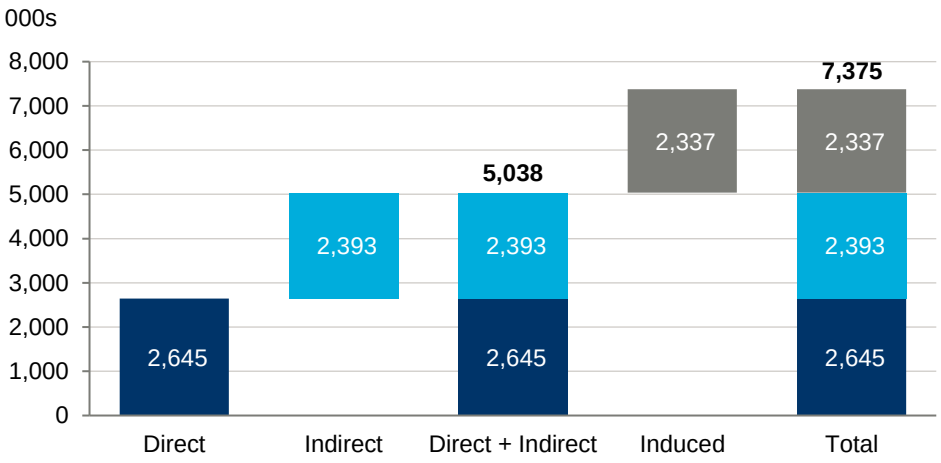
Source: Oxford Economics

[21] The Type II multiplier is calculated as: (Direct GDP + Indirect GDP + Induced GDP) / Direct GDP

We can follow a similar process to assess the contribution of manufacturing to employment. The sector directly supports 2.6 million jobs. A further 2.4 million jobs are supported in the manufacturing supply chain, suggesting that manufacturing and its supply chain together support 15 percent of total UK jobs.

Further extending the employment estimate to also include the induced results suggests that UK manufacturing sector supported a total of 7.4 million jobs in 2016, equivalent to 21 percent of the UK total. This means for every direct job within the sector, another 1.8 are supported elsewhere in the UK economy—giving manufacturing a "Type II employment multiplier" of 2.8.

Fig. 21. Total employment contribution of UK manufacturing sector, 2016



Source: Oxford Economics

HOW DO THE MANUFACTURING SECTOR'S MULTIPLIERS COMPARE TO OTHER SECTORS?

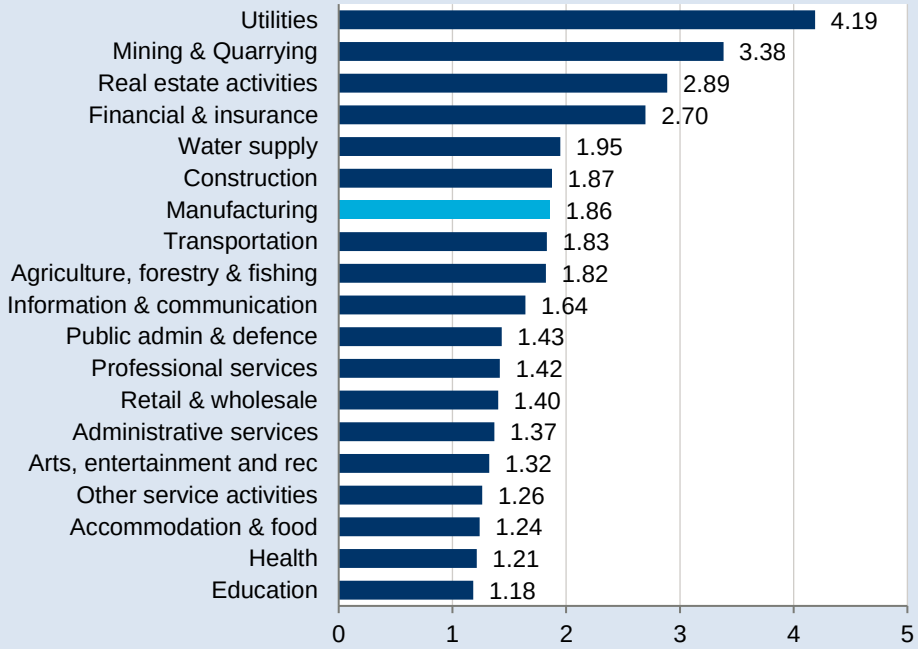
In this section we have presented a series of multipliers which identify the extent to which activity in the manufacturing sector supports wider activity through indirect and induced impacts. A natural extension to this analysis would be to compare the manufacturing sector's multipliers to those for other sectors, to assess whether indirect and induced impacts are proportionately larger for manufacturing than for other parts of the economy. While producing equivalent multipliers for other sectors is beyond the scope of the current study, it is possible to gain insights from published information.

The ONS Input-Output tables, which form the basis for much of our analysis, include estimates of Type I multipliers for output, GVA and employment.[22] These data are presented for 127 product types and do not readily provide a basis for comparing manufacturing to other broad sectors.

[22] Source: Office of National Statistics, "United Kingdom Input-Output Analytical Tables, 2013," *UK Input-Output Analytical Tables*, 2017 <https://www.ons.gov.uk/file?uri=/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesdetailed/2013detailed/ukioanalyticaltables2013.xls> [accessed March 2018]

Nonetheless, the ONS has separately published provisional estimates of Type I employment multipliers for one-digit SIC industry groups, and these are presented below.[23]

Fig. 22. Type I employment multipliers



Source: Input-Output Analytical Tables (2013) supplementary analysis, ONS

Similar to the Type I multipliers mentioned in this report, the ONS multipliers measure the ratio between the direct impact and the direct plus indirect (supply chain) impact of each sector. While these results are not directly comparable with our own results, they do provide an indication of how the manufacturing sector's multiplier compares to other sectors. Of the 19 broad sectors, ONS finds that manufacturing has the seventh largest Type I employment multiplier, coming in above sectors including transportation and information and communication.

The largest difference in methodology between the ONS figures and our own findings is that the former do not remove the supply chain impacts which occur within the same sector. The ONS calculations capture the extent to which activity across the whole economy (including manufacturing) increases in response to a one unit increase in direct manufacturing activity. In contrast, the Oxford Economics calculations measure the impact of the manufacturing sector as a whole, capturing all of the sector's output, GVA and employment. The Oxford Economics estimates of supply chain impacts therefore exclude those which arise within manufacturing, since they have already been counted within the direct impact. A second source of difference is that, unlike our results, the ONS multipliers exclude capital impacts (although estimates of our multipliers excluding capital impacts are presented in Appendix B).

[23] Source: Office of National Statistics, "BB16 Consistent estimates of Type I UK FTE multipliers and effects" <https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/adhocs/008014bb16consistentestimatesoftypeiukftemultipliersandeffects> [accessed March 2018]

6. THE IMPACT OF THE ENGINEERING SECTOR

As well as assessing the economic impact of UK manufacturing as a whole, the MTA is also interested in exploring the impact of a sub-set of manufacturing sectors which together constitute "engineering". In this chapter, we use the same techniques to estimate the full economic impact of those elements of manufacturing which the MTA classes as engineering.

DEFINITION OF THE ENGINEERING SUB-SECTOR

The MTA defines "engineering" to include the following types of manufacturing activity:

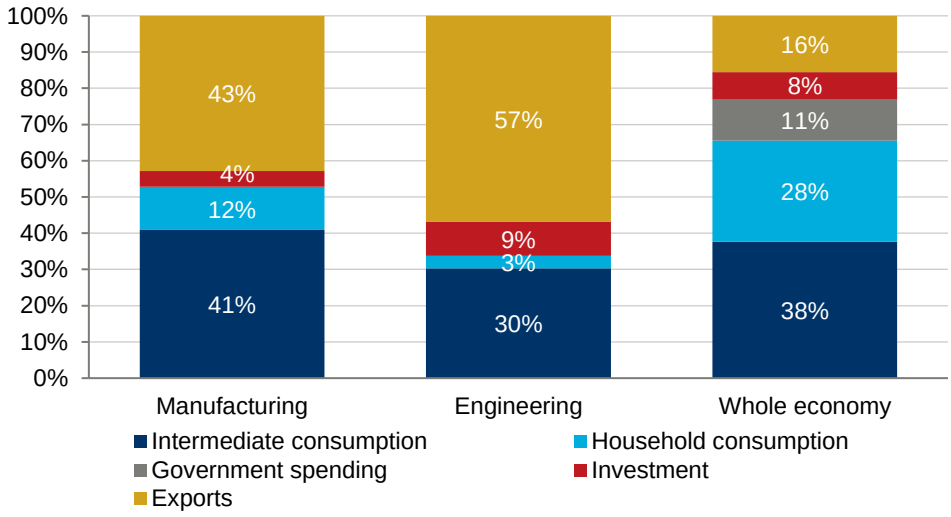
- Fabricated metal products, except machinery and equipment (SIC division 25)
- Computer, electronic and optical products (26)
- Electrical equipment (27)
- Machinery and equipment not elsewhere classified (28)
- Motor vehicles, trailers and semi-trailers (29)
- Other transport equipment (30)

The MTA has noted that some UK companies engaged in the engineering sector may earn a large share of their revenues from the provision of engineering services. However, there is no separate SIC category for engineering services and hence there is no systematic way of identifying such firms within official statistics. To the extent that engineering services firms are assigned to the SIC codes identified above, they will be included in our analysis.

6.1 DIRECT IMPACT OF THE ENGINEERING SUB-SECTOR

In 2016, the UK engineering sub-sector sold products worth £209 billion, or 38 percent of total manufacturing sales. Analysis of Input-Output tables suggests that engineering sales are even more export-orientated than for the manufacturing sector as a whole: some 57 percent of demand comes from customers overseas (Fig. 23).

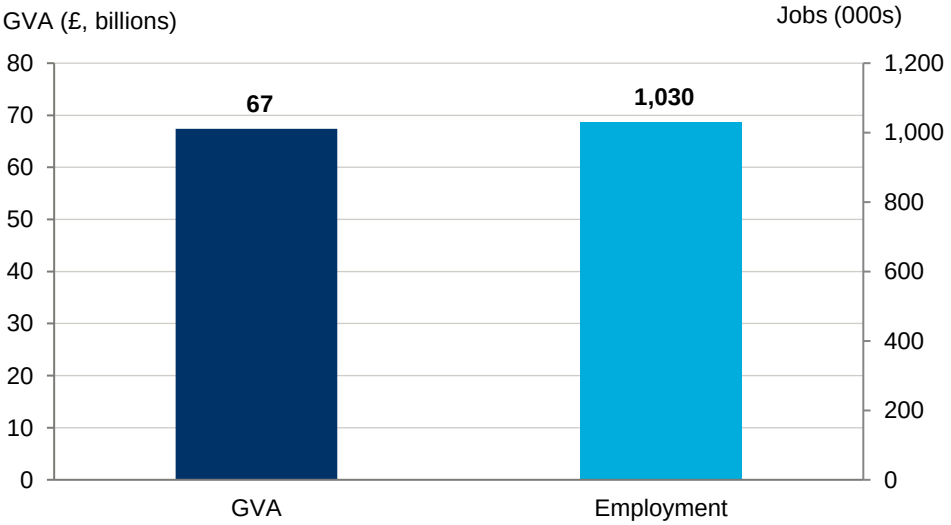
Fig. 23. Sources of demand: engineering, manufacturing and whole economy, 2016



Source: ONS Input-Output tables, ABS and Oxford Economics

Based on these sales, UK engineering firms generated a direct GDP contribution of £67 billion, and supported over one million jobs in 2016.

Fig. 24. Direct contribution of the engineering industry, 2016



Source: ONS balanced regional gross value added estimates, BRES and Oxford Economics

As with the manufacturing sector overall, the importance of engineering to regional economies varies considerably across the UK. The concentration of engineering activity is particularly high in the West Midlands, where the sector accounts for almost 10 percent of regional GVA, and five percent of the region's jobs. The largest contributors to manufacturing employment in the West Midlands are the manufacture of motor vehicles (17 percent) and fabricated materials (14 percent).

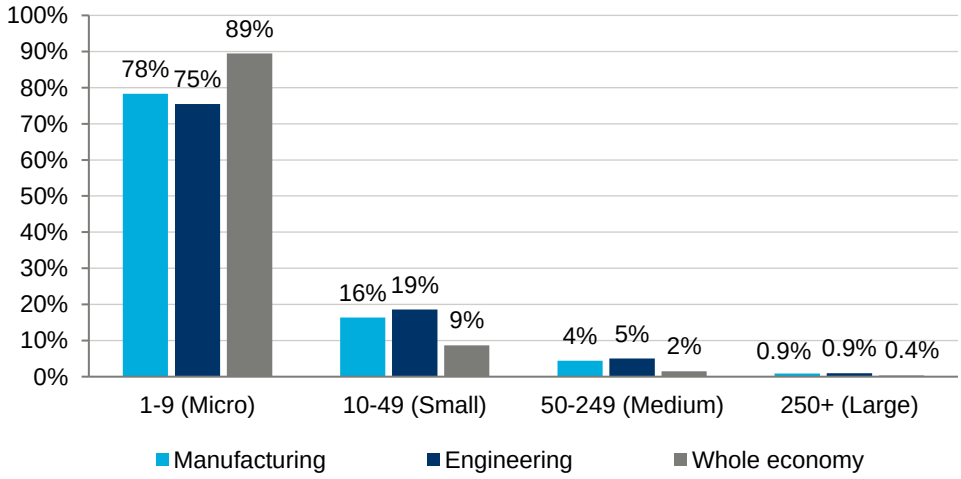
Fig. 25. Direct contribution of the engineering industry in 2016 by region



Source: ONS, BRES, Oxford Economics

There were almost 49,000 firms operating in the engineering sector in 2016. Their distribution is similar to that of the overall manufacturing sector.

Fig. 26. Distribution of firm size in UK engineering by employees



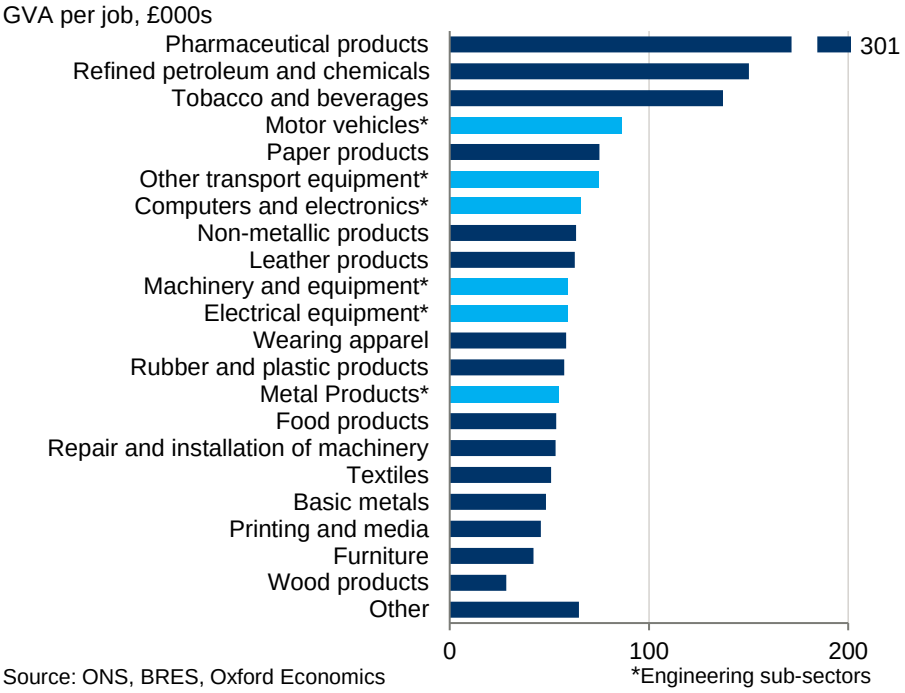
Source: BRES

By bringing together the estimates of direct GVA and employment contributions, we estimate that GVA per job is £65,000 in the engineering sub-sector. This is marginally lower than in the manufacturing sector overall, but still 15 percent higher than the UK average.

The finding that labour productivity in engineering is slightly less than in the broader manufacturing sector may appear counter-intuitive, since engineering incorporates many of the more advanced manufacturing sub-sectors, such as computers and electronics, and motor vehicle production. However, engineering does not include certain manufacturing sub-sectors which have exceptionally high levels of labour productivity: pharmaceuticals, petrol refining,

and tobacco and beverages. If these sub-sectors were excluded from the calculation, engineering would show a higher labour productivity than the manufacturing sector overall.

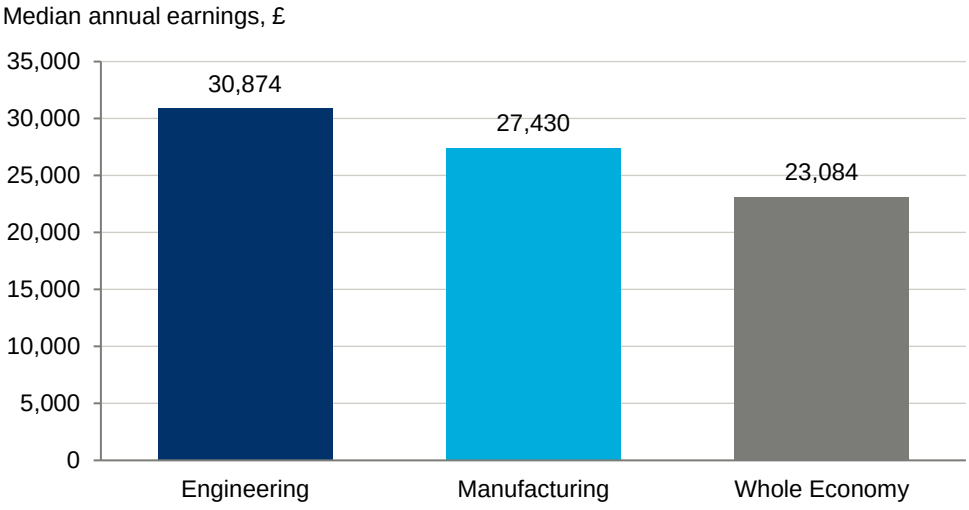
Fig. 27. Labour productivity by manufacturing sub-sector, 2016



Source: ONS, BRES, Oxford Economics

While productivity is lower in engineering than in the manufacturing sector as a whole, the opposite is true of wages. The median wage in engineering was just under £31,000 in 2016, some £8,000 higher than in the economy as a whole.

Fig. 28. Median wages, 2016[24]



Source: Annual Survey of Hours and Earnings (ASHE)

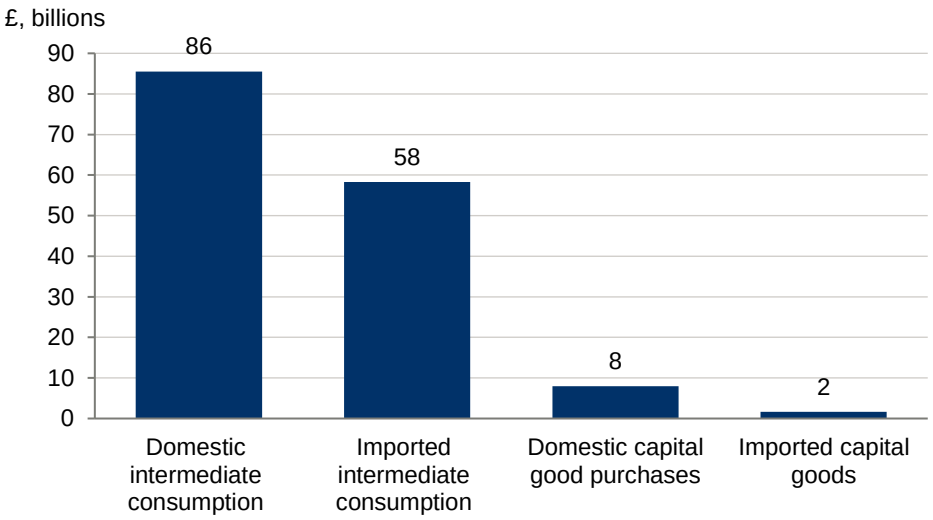
[24] Gross annual pay for all employee jobs

6.2 SUPPLY CHAIN IMPACTS

6.2.1 Engineering companies' purchases of goods and services

As well as the employment and GDP it generates itself, the engineering sub-sector supports further activity through its purchases from UK suppliers. As with the manufacturing sector, we can estimate the value of expenditure that engineering companies make through their intermediate consumption and capital investments (Fig. 29).

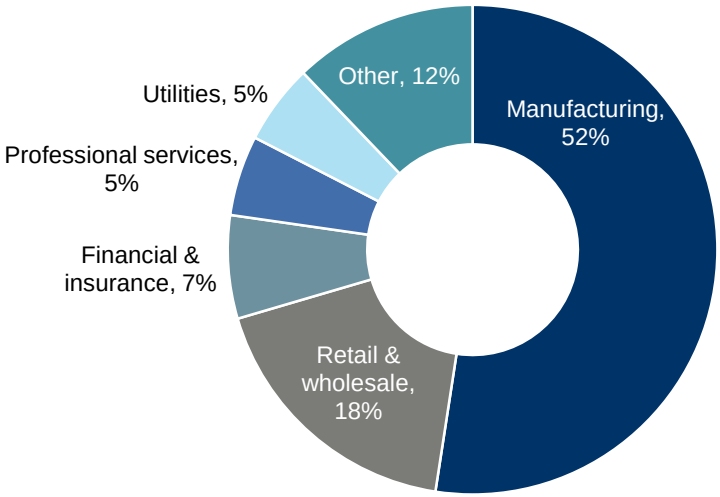
Fig. 29. Estimated operational and capital expenditure by UK engineering companies, 2016



Source: ONS Input-Output tables, Supply-Use table, ABS and Oxford Economics

Based on information from the ONS Annual Business Survey and Input-Output tables, we estimate that UK engineering companies purchased £153 billion of goods and services in 2016. Within this total, we find that 41 percent of intermediate consumption and 17 percent of capital goods purchases were imported. This means UK engineering companies purchased £93 billion of goods and services from UK suppliers in 2016—with just over half of intermediate consumption purchases coming from within the manufacturing sector (Fig. 30).

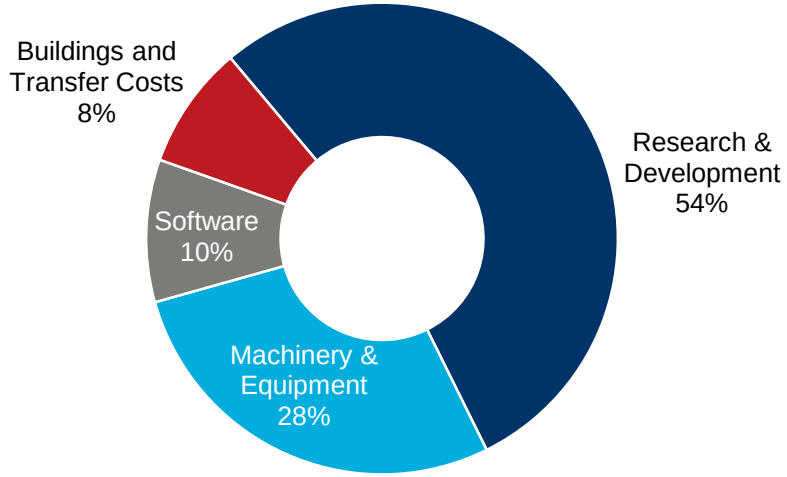
Fig. 30. Domestic intermediate consumption of UK engineering by sector, 2016



Source: ONS Input-Output table and Oxford Economics

As with the manufacturing sector overall, a very large proportion of capital purchases related to R&D activity, with the remainder made up by machinery and equipment, software and buildings (Fig. 31).

Fig. 31. Product share of the capital purchases of UK engineering, 2016



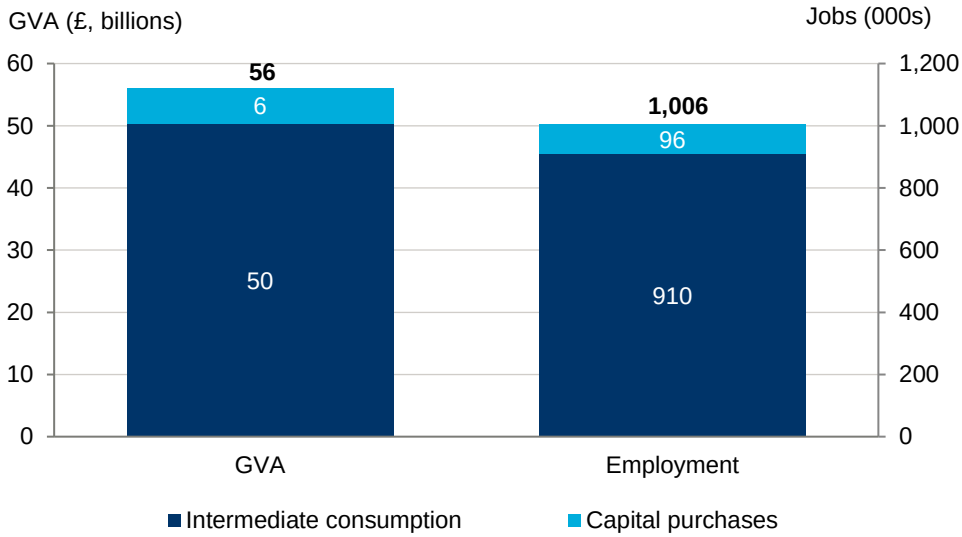
Source: ONS business investment release and Oxford Economics

6.2.2 Activity supported by engineering companies' supply chain purchases

Based on the purchases identified above and ONS Input-Output tables, we can calculate the impact of supply chain spending with UK suppliers. We estimate that in 2016, the engineering sector made an indirect contribution to UK GDP of £56 billion. Of this total, £50 billion resulted from intermediate consumption purchases, and £6 billion from investment purchases (Fig. 32).

Once the indirect impacts have been estimated in GDP terms, data on productivity in each sector can be used to estimate the number of jobs supported in the supply chain. On this basis, we estimate that UK engineering supported just over one million jobs in 2016 through its intermediate consumption and capital purchases.

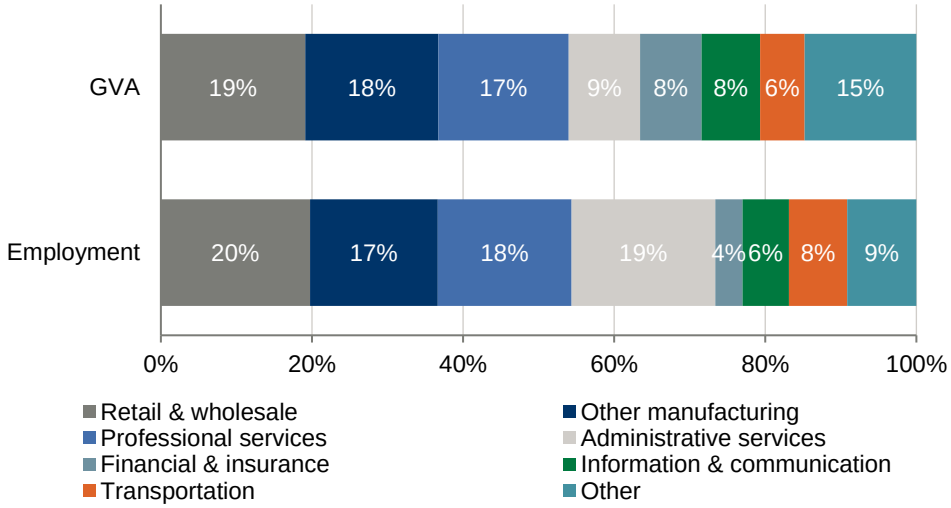
Fig. 32. Indirect contribution of UK engineering, 2016



Source: Oxford Economics

Through its supply chain purchases, UK engineering supports activity across a wide range of other sectors of the economy. In GDP terms, just over half of this impact accrues in three sectors: retail and wholesale, other manufacturing, and professional services. When assessed in terms of the jobs supported, a similar pattern emerges but with administrative services accounting for a much larger share of supply chain activity.

Fig. 33. Indirect GDP contribution of UK engineering by sector, 2016

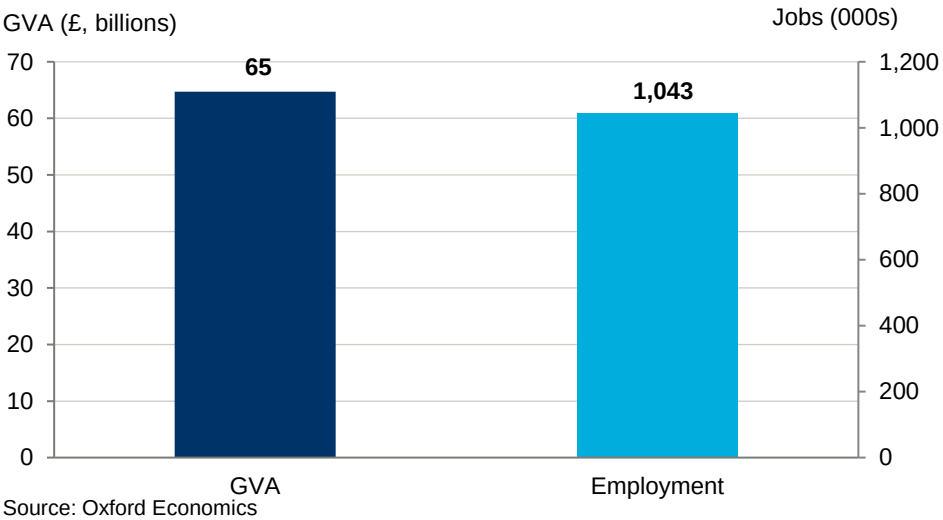


Source: Oxford Economics

6.3 WORKER SPENDING IMPACTS

As workers employed in the engineering sector and its supply chain spend their wages in the wider UK economy, further GDP and employment is supported through the induced channel. As with manufacturing, we can use an Input-Output model to estimate the value of GDP and employment supported in this way. Our analysis suggests that UK engineering supported a £65 billion contribution to GDP and one million jobs through workers' spending in 2016.

Fig. 34. Induced contribution of the UK engineering industry, 2016[25]



Source: Oxford Economics

6.4 TOTAL IMPACT OF THE ENGINEERING SECTOR

As with the manufacturing sector as a whole, the analysis in the preceding sections provides three ways of considering the economic contribution of the engineering sub-sector.

Firstly, engineering directly contributed £67 billion to UK GDP in 2016, equivalent to 3.4 percent of the UK economy.

Secondly, if we broaden the sector's contribution to also include activity in its supply chain, we find that engineering supported £123 billion of GDP in 2016, or six percent of the UK total. Based on these figures, the Type I GDP multiplier for engineering is 1.8.[26]

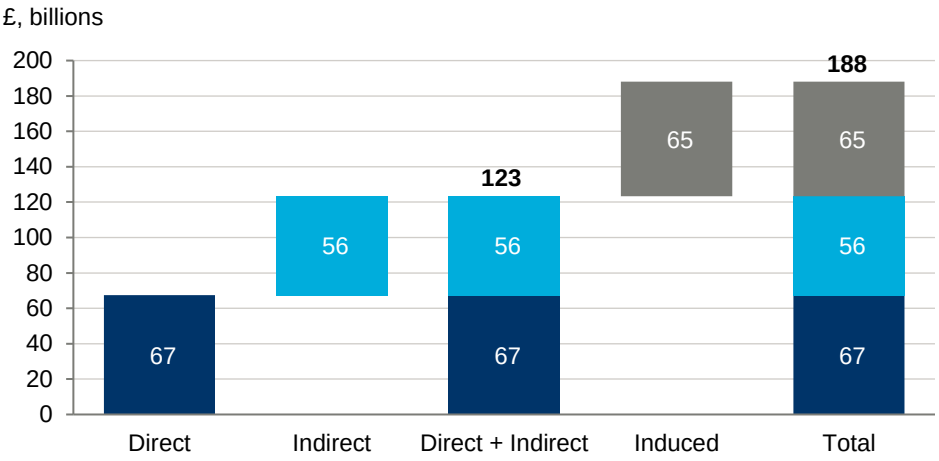
Finally, if we also incorporate the induced, worker spending impacts, we find that engineering supported a total GDP contribution of £188 billion in 2016, equivalent to 10 percent of the UK economy. For every £1 million the engineering sector contributes to GDP itself, it creates another £1.8 million elsewhere in the UK economy. This means that UK engineering's Type II GDP multiplier is 2.8.[27]

[25] Consistent with our analysis of the manufacturing sector as a whole, the pattern of workers' spending is assumed to be in line with the UK average (see Fig. 19).

[26] The Type I multiplier is calculated as (Direct GDP + Indirect GDP) / Direct GDP

[27] The Type II multiplier is calculated as: (Direct GDP + Indirect GDP + Induced GDP) / Direct GDP

Fig. 35. Total GDP contribution of UK engineering, 2016



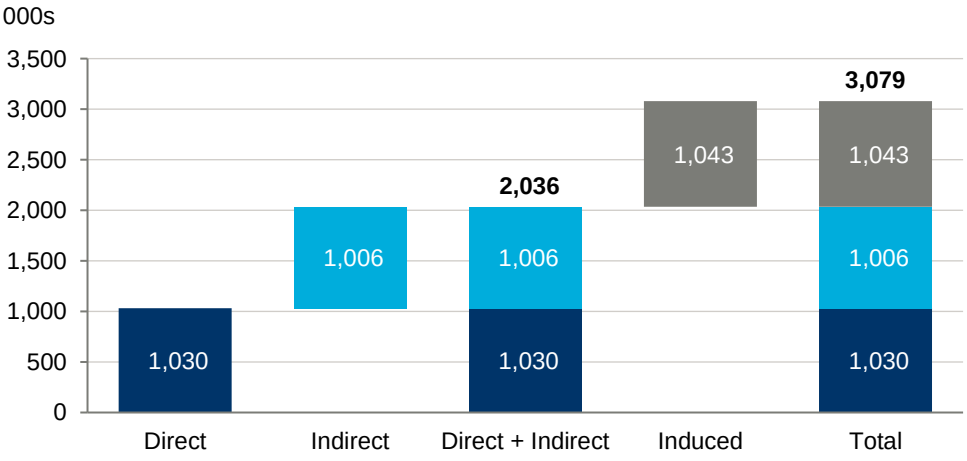
Source: Oxford Economics

UK engineering companies directly provided just over one million jobs in 2016. This doubles to two million once supply chain impacts are included, equivalent to six percent of the UK total.

Further widening the employment contribution of engineering to also include jobs supported through the induced channel increases the sub-sector's impact to 3.1 million. This is equivalent to nine percent of UK jobs in 2016. For every direct job within the industry, another 2 are supported elsewhere in the UK economy, giving a Type II employment multiplier of 3.0.

For both GDP and employment, the Type II multiplier values for engineering are marginally higher than for manufacturing as a whole (the estimated Type II multipliers for manufacturing were 2.5 for GDP, and 2.8 for jobs).

Fig. 36. Total employment contribution of UK engineering, 2016



Source: Oxford Economics

APPENDIX A: DEFINITION OF THE MANUFACTURING AND ENGINEERING SECTORS

DEFINITION OF THE MANUFACTURING SECTOR

For this study we have defined the manufacturing sector in accordance with standard UK Standard Industrial Classifications. As such, our study incorporates the entirety of SIC Section C, and includes the following divisions:

- Manufacture of food products (SIC division 10)
- Manufacture of beverages (11)
- Manufacture of tobacco products (12)
- Manufacture of textiles (13)
- Manufacture of wearing apparel (14)
- Manufacture of leather and related products (15)
- Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (16)
- Manufacture of paper and paper products (17)
- Printing and reproduction of recorded media (18)
- Manufacture of coke and refined petroleum products (19)
- Manufacture of chemicals and chemical products (20)
- Manufacture of basic pharmaceutical products and pharmaceutical preparations (21)
- Manufacture of rubber and plastic products (22)
- Manufacture of other non-metallic mineral products (23)
- Manufacture of basic metals (24)
- Manufacture of fabricated metal products, except machinery and equipment (25)
- Manufacture of computer, electronic and optical products (26)
- Manufacture of electrical equipment (27)
- Manufacture of machinery and equipment not elsewhere classified (28)
- Manufacture of motor vehicles, trailers and semi-trailers (29)
- Manufacture of other transport equipment (30)
- Manufacture of furniture (31)
- Other manufacturing (32)
- Repair and installation of machinery and equipment (33)

DEFINITION OF THE ENGINEERING SECTOR

The engineering sector is defined to include the following divisions:

- Manufacture of fabricated metal products, except machinery and equipment (25)
- Manufacture of computer, electronic and optical products (26)
- Manufacture of electrical equipment (27)
- Manufacture of machinery and equipment n.e.c (28)
- Manufacture of motor vehicles, trailers and semi-trailers (29)
- Manufacture of other transport equipment (30)

APPENDIX B: DETAILED RESULTS

Fig. 37. The economic impact of the manufacturing sector, 2016

Metric	Gross value added (£, millions)	Employment	Turnover (£, millions)
Direct			
Total	176,996	2,645	546,319
Indirect			
Intermediate Consumption	110,237	2,154	228,431
Capital goods	13,898	239	25,759
Total	124,135	2,393	254,189
Induced			
Intermediate Consumption	138,187	2,236	242,263
Capital goods	6,268	101	10,988
Total	144,454	2,337	253,252
Total			
Including capital goods	445,585	7,375	1,053,760
Excluding capital goods	425,419	7,034	1,017,013
Type I multiplier[28]			
Including capital goods	1.7	1.9	1.5
Excluding capital goods	1.6	1.8	1.4
Type II multiplier[29]			
Including capital goods	2.5	2.8	1.9
Excluding capital goods	2.4	2.7	1.9

[28] The Type I multiplier is calculated as (Direct + Indirect) / Direct.

[29] The Type II multiplier is calculated as (Direct + Indirect + Induced) / Direct

Fig. 38. The economic impact of the engineering sector, 2016

Metric	Gross value added (£, millions)	Employment	Turnover (£, millions)
Direct			
Total	67,364	1,030	209,390
Indirect			
Intermediate Consumption	50,390	910	228,431
Capital goods	5,661	96	25,759
Total	56,051	1,006	254,189
Induced			
Intermediate Consumption	62,216	1,003	242,263
Capital goods	2,479	40	10,988
Total	64,695	1,043	253,252
Total			
Including capital goods	188,110	3,079	716,831
Excluding capital goods	179,970	2,943	680,084
Type I multiplier[30]			
Including capital goods	1.8	2.0	2.2
Excluding capital goods	1.7	1.9	2.1
Type II multiplier[31]			
Including capital goods	2.8	3.0	3.4
Excluding capital goods	2.7	2.9	3.2

[30] The Type I multiplier is calculated as (Direct + Indirect) / Direct.

[31] The Type II multiplier is calculated as (Direct + Indirect + Induced) / Direct

APPENDIX C: METHODOLOGY AND DATA SOURCES

MAIN DATA SOURCES

1. Office for National Statistics, "Annual Business Survey - 2016 Provisional Results," *Annual Business Survey*, 9 November 2017 <https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveysectionsas> [accessed March 2018]. *Hereafter referred to as the 'ABS'*.

2. Office of National Statistics, "United Kingdom Input-Output Analytical Tables, 2013," *UK Input-Output Analytical Tables*, 2017 <https://www.ons.gov.uk/file?uri=/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesdetailed/2013detailed/ukioanalyticaltables2013.xls> [accessed March 2018]. *Hereafter referred to as the 'Input-Output tables'*.

3. Office of National Statistics, "Supply and Use Tables, 1997 - 2015," *Input-Output Supply and Use Tables*, 2017 <https://www.ons.gov.uk/file?uri=/economy/nationalaccounts/supplyandusetables/datasets/inputoutputsupplyandusetables/current/tables14finalcorrection.xls> [accessed March 2018]. *Hereafter referred to as the 'Supply and Use tables'*.

4. Office of National Statistics, "Gross fixed capital formation - industry by asset," *Business Investment Statistical Release*, 2018 <https://www.ons.gov.uk/file?uri=/economy/grossdomesticproductgdp/datasets/grossfixedcapitalformationbysectorandasset/current/rftg1tog16from1997forpublication.xls> [accessed March 2018]. *Hereafter referred to as the 'ONS business investment release'*.

5. Office of National Statistics, "Nominal and real regional gross value added (balanced) by industry," *Regional Accounts*, 2017 <https://www.ons.gov.uk/file?uri=/economy/grossvalueaddedgva/datasets/nominalandrealregionalgrossvalueaddedbalancedbyindustry/current/nominalandrealregionalgvabbyindustry.xlsx> [accessed March 2018]. *Hereafter referred to as the 'balanced regional GVA dataset'*.

6. Oxford Economics, "2 Digit SIC Total Employment forecasts," *Regional Model*, 2018. *Hereafter referred to as the 'Oxford Economics' regional forecasts'*.

HOW WE CALCULATED THE DIRECT IMPACT

Sources of demand

- Intermediate consumption includes demand from market organisations, non-market organisations and non-profit institutions serving households. Market organisations comprise all private sector activity including demand from retailers and wholesalers. Non-market organisations refer to publicly funded activities delivered by public services e.g. the National Health Service. Non-profit institutions serving households (NPISH) are institutions that provide goods and services, either free or below the market prices, mainly derive their income from grants and donations, and are not controlled by government. Examples include charities, trade unions, and the majority of universities.[32]
- Government includes demand from central government and local authorities.
- Household consumption includes demand from households.
- Investment includes the following sub-categories: gross fixed capital formation, acquisitions less disposals of valuables, and changes in inventories.
- Exports includes all goods and services that are exported from the UK.

Gross value added

The gross value added (GVA) estimate for the manufacturing sector was taken from the balanced regional GVA dataset published by the ONS on 20 December 2017. This provides GVA estimates at 2-digit SIC level for the UK and its regions, derived by balancing the income and production approaches to measuring GVA.

"The income approach sums the components of income (compensation of employees, mixed income, rental income, gross trading profit and surplus, non-market capital consumption, holding gains, taxes less subsidies on production) to give a measure of GVA. In the production approach, GVA is calculated as total output of goods and services less the value of goods and services used up in the production process (intermediate consumption)."[33]

"Both income and production approaches seek to measure the same quantity, but using different conceptual methods and different data sources. The balanced approach seeks to make use of the relative strengths of the two measures to come up with the best possible single estimate of GVA."[34]

The measure of direct GVA forms the cornerstone of the analysis. All other variables (with the exception of capital expenditure and employment) have been scaled to it. We chose this approach because we consider the GVA estimate to be the most robust data point we use in this analysis.

Employment

Taken from Oxford Economics' regional forecasts. These are based on detailed UK Business Register and Employment Survey (BRES) data which have been adjusted to align with the four-quarter average of UK workforce employee jobs and to incorporate estimates of self-employment.[35]

Turnover / total sales

To calculate turnover, we developed a turnover to GVA ratio from the ABS and applied it to our estimate for GVA.

We used Input-Output tables to estimate the destination of sales of manufacturing products, by estimating the value of the various components of final demand (i.e. intermediate demand, household consumption, investment and exports) of each manufacturing product produced in the UK.

HOW WE CALCULATED THE INDIRECT IMPACT

We define the indirect impact to include the economic activity supported within the UK as a result of the UK's manufacturing industry's purchases of goods and services from UK suppliers.

To calculate the indirect impact of the manufacturing industry, it is necessary to identify the value of intermediate consumption and capital expenditure of the companies within the industry, and determine how these purchases stimulate further economic activity through the UK supply chain.

Even when UK manufacturers import raw materials, components and equipment from overseas, they may still support activity within the UK— for example, among UK-based distributors and logistics companies who facilitate these imports. However, the extent to which these effects are captured within our results will depend on the structure of contracts. For example, where a UK manufacturer has a contract with a UK distribution company, the activity supported in the distribution sector is likely to be captured in our supply chain analysis. If, on the other hand, the UK manufacturer is purchasing from an overseas supplier and the overseas supplier commissions the UK leg of distribution activity, the activity with the UK distributor may not be captured in the supply chain.

A second example concerns the repair and maintenance of imported equipment by a UK-based company. In this case the associated activity would be expected to fall within the direct impact of the manufacturing sector, although whether this is the case will depend on the SIC code assigned to the company undertaking the work.

Intermediate consumption

To calculate total intermediate consumption purchases, we developed an intermediate consumption to GVA ratio from the ABS and applied to it our estimate for GVA.[36] The sectors where the manufacturing industry made its purchases and the value these purchases created in the economy were estimated using ONS 2013 domestic Input-Output tables.

[32] Source: Office of National Statistics, "Households and non-profit institutions serving households" <https://www.ons.gov.uk/economy/grossdomesticproductgdp/compendium/unitedkingdomnationalaccountstheblueebook/2016edition/householdsandnonprofitinstitutionsservinghouseholds> [accessed March 2018]

[33] Office of National Statistics, "Development of a balanced measure of regional gross value added", in *www.ons.gov.uk* <https://consultations.ons.gov.uk/national-accounts/consultation-on-balanced-estimates-of-regional-gva/supporting_documents/Development%20of%20a%20balanced%20measure%20of%20regional%20gross%20value%20added.pdf> [accessed March 2018]

[34] Ibid.

[35] The use of this dataset is consistent with Oxford Economics' approach for its Global and Industry models.

[36] The metric name for intermediate consumption within the ABS is 'total purchases of goods, materials and services'

Capital purchases

A standard I-O based assessment of the supply chain of the manufacturing industry would count its purchases of fuels, consumable parts and tools, utilities, professional services, etc. But it would miss out capital spending on machinery, vehicles or the construction of facilities that are crucial for its activities and represent a significant part of its interaction with the wider economy.

Our approach also incorporates information on capital purchases, that are made as part of each industry's gross fixed capital formation (GFCF). By including the amount of capital spending that is required to sustain a given level of output, we have a more accurate measure of what inputs are in fact required for economic activity to take place. The total value of capital purchases was taken directly from the ABS 'Total net capital expenditure' metric.[37]

The actual products purchased by the manufacturing industry were estimated using the ONS business investment release. Using this release, it is possible to map the various asset purchases the manufacturing industry made in 2016. The composition of each asset class is summarised in the table below.

Description of assets categories[38]

Published Asset	Includes	Definition	Examples (N.B. not exhaustive)
Machinery & Equipment	ICT	This mainly consists of computer hardware and telecommunications equipment such as computers and mobile phones	Computers, laptops, mobile phones and gaming consoles
	Other machinery and equipment	Other machinery and equipment consists of all equipment and machinery that is for general or special use. General use machinery includes engines, turbines, ovens, etc. Special use machinery includes machinery for mining, domestic appliances, agricultural equipment, etc	Typically large electronic equipment (e.g. equipment used in the production of goods and services)
	Transport equipment	Transport equipment consists of any equipment used to move people and objects.	Motor vehicles, trailers, ships, trains, trams, aircraft, motorcycles, and bicycles
Intellectual property products (IPP)	Research and development	This is the value of expenditure on creative work to increase the stock of knowledge, which developers can market or use for their own benefit when producing goods and services.	Development of software programs or design for a new aircraft
	Software and databases	Software consists of computer programs and supporting systems for both systems and application software.	Packages such as Microsoft Office
Other buildings and structures and transfer costs	Other buildings	Other buildings are buildings that are not dwellings, industrial buildings, commercial buildings, educational buildings and health buildings.	Schools, hospitals, prisons, religious, sport, amusement and community buildings
	Transfer costs	Transfer costs, sometimes known as cost of ownership transfer, are the costs associated with buying or selling an asset.	Transportation costs, legal fees and stamp duty.

Source: ONS business investment release

The sectors where the manufacturing industry made their capital purchases and the value these purchases created in the economy were estimated using the gross fixed capital formation by industry matrix from ONS Supply and Use tables.[39]

Having identified the product categories where capital purchases were made, we also used ONS Supply and Use tables to estimate what proportion of capital goods were imported. To do this, we used the "supply of products" table to see what proportion of products were imported within those product categories where capital goods were purchased. We then applied these ratios to our estimates for capital purchases. Therefore, we have made the assumption that the proportion of capital goods that were imported within each product category is the same as all goods within that category.

Input-Output modelling

The modelling for this study was based on UK Input-Output tables published by the ONS (see above). These set out the goods and services that UK industries purchase from one another in order to produce their output (as well as their purchases from abroad). These tables also provide detail on the spending patterns of UK households, and indicate whether this demand is met by UK production, or imported products. In essence, the tables show who buys what from whom. Using details of these linkages from the Input-Output tables, Oxford Economics constructed a bespoke UK impact model, which traces the intermediate consumption and capital good consumption impacts attributable to the manufacturing industry (this is known as the Leontief manipulation).

Oxford Economics' impact model quantifies all rounds of subsequent purchases along the supply chain. These transactions are translated into GDP contributions, using UK-specific ratios of GVA to gross output, sourced from the UK input-output table.

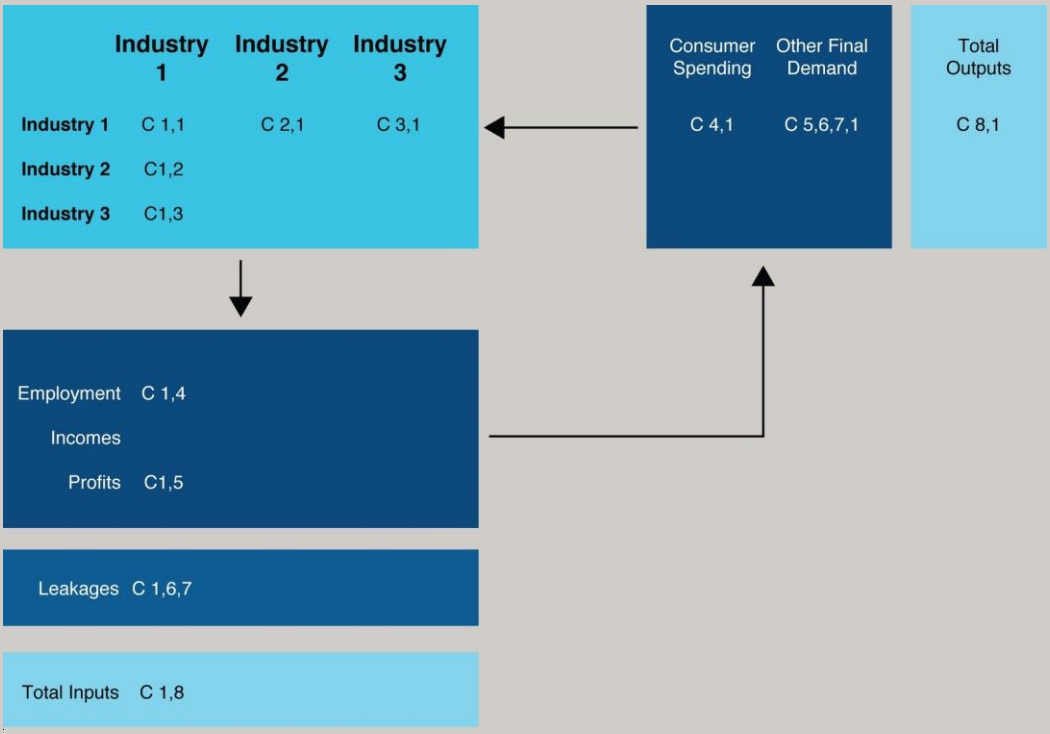
Once we have obtained results for output and GVA, we estimate employment using productivity estimates.

[37] Total net capital expenditure by businesses excludes expenditure on dwellings and the costs associated with the transfer of ownership of non-produced assets, and capital expenditure by local and central government.

[38] Office of National Statistics, "A short guide to gross fixed capital formation and business investment", in *www.ons.gov.uk* <https://www.ons.gov.uk/economy/grossdomesticproductgdp/articles/ashortguidetogrossfixedcapitalformationandbusinessinvestment/2017-05-25> [accessed March 2018]

[39] Both the supply and use tables and the ONS business investment release are consistent with the UK National Accounts Blue Book 2016 & UK Balance of Payments Pink Book 2016.

Fig. 39. A stylised Input-Output table structure



HOW WE CALCUALTED THE INDUCED IMPACT

The induced impact is modelled using a similar method to the indirect impact. Using employment and wage data calculated as part of the direct impact, Oxford Economics used household spending data to model the typical consumption patterns of UK households, making an allowance for 'leakages' in the form of imports and savings.

For workers within the manufacturing industry's supply chain, we used industry-specific ratios of employee compensation per unit of output to estimate the value of household wages supported among the suppliers' workers.

Both of these spending streams were then fed into our Input-Output model, to calculate the total impact of this spending on GDP. As with the indirect impact, employment impacts were derived using productivity estimates for each sector of the economy.



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