Department for International Trade

Analysis

Research on Trade in Value Added

Final Research Report

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This is a report of research carried out by Cambridge Econometrics, on behalf of the Department for International Trade.

Cambridge Econometrics' mission is to provide clear insights, based on rigorous and independent economic analysis, to support policy-makers and strategic planners in government, civil society and business in addressing the complex challenges facing society.

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Executive Summary

Conventional trade statistics fail to capture the internationalisation of supply chains.

Gross measures of trade provide an incomplete picture of production and trade activity in the context of global value chains

- Gross measures of trade in conventional statistics are considered insufficient by themselves to inform the implications of trends in modern trade, especially given the fragmentation and internationalisation of supply chains. They over-estimate the last exporting country (or sector) as an exporter; they lead to multiple counting of trade; and distort the true level of trade between countries (bilateral trade balances).
- Coinciding with the latest release of the OECD Trade in Value Added (TiVA) indicators in December 2018, Cambridge Econometrics was commissioned by the Department for International Trade (DIT) to explore UK trade using OECD TiVA indicators. This report outlines the key findings from the analysis.

In contrast, Trade in Value Added (TiVA) indicators decompose exports and final demand into the sources of value added.

TiVA indicators decompose export production into upstream contributions by country and sector

- Trade in value added offers additional insights previously unavailable. Conceptually, measuring trade in value added terms enables the decomposition of the value of exports and final demand into the contribution of upstream suppliers by country and sector of origin. Trade in value added terms also differentiates between exports for use as inputs in a foreign country's export production, and exports for consumption abroad (either directly, or as inputs to the production of goods and services that are consumed without being exported further).
- The OECD publishes a TiVA dataset consisting of a set of indicators focussing on the origins (country and sector) of value added embodied in international trade and in consumption (final demand). The analysis in this report is based on the December 2018 release, covering indicators for 64 economies and 36 sectors over (mostly) 2005-15.

TiVA provides numerous key insights unavailable in gross trade data

- The level of detail available in the TiVA indicators enables an understanding of multiple insights, including:
  - the degree to which a country's exports or domestic consumption are dependent on imported inputs (backward linkages),
  - the degree to which foreign export production or consumption is dependent on domestic production (forward linkages),
  - how domestic value chains are structured to meet the needs of domestic exporting firms, providing a broader view of the drivers of international competitiveness (for example, the importance of services for the exports of the manufacturing sector),
  - 'true' export and import markets, and bilateral balances of a country (i.e. based on the domestic value of trade rather than the gross value of the product crossing the border),
  - the sectors in which a country has a 'true' comparative advantage (based on Revealed Comparative Advantage in value added terms),

- the proportion of employment in the UK supported by exports and the environmental impacts of trade.

TiVA statistics are experimental and should be considered complementary to conventional trade statistics.

The data requirements for measuring trade in value added terms are high

- Currently, the availability of official statistics tailored to measure trade in value added is very limited, especially for developing countries. Measuring trade in value added terms would, in theory, for any given exporter, require data of each individual exporter's production function and the production functions of upstream suppliers. But in reality these data are not observed.

TiVA indicators necessarily rely on imputations and manipulations of national input-output tables and bilateral trade data

- Thus, existing estimates of trade in value added are, by necessity, based on imputations and manipulations of multi-regional input-output tables and bilateral trade in goods and services statistics. Therefore, in their current iteration, TiVA indicators are useful for developing high-level perspectives of cross-country and cross-sector linkages in trade; they should be considered as complements to other measures of trade or to firm-level analyses of supply chains.
- In the future, it is expected that the data underpinning the TiVA indicators will improve. Key initiatives in this domain include, among other developments, improving the timeliness and granularity of the TiVA indicators; reducing bilateral trade asymmetries observed in the underlying gross trade data; and developing extended supply and use tables that differentiate between firm characteristics such as trading status, size class and ownership (country of control).

Multiple factors affect Global Value Chain participation; low participation does not mean an uncompetitive economy.

- The extent of a country's integration in Global Value Chains (GVCs) depends on a number of factors such as the size of the economy, resource endowments, patterns of specialisation (whether a country specialises in activities at the beginning (upstream) or end (downstream) of the value chain), trade and FDI openness, and geography/distance. Care is therefore required when interpreting the TIVA data and the relative performance of a country/sector in terms of GVC integration. Low GVC participation does not mean that the economy is not successful or uncompetitive.

Overall, the UK has become more integrated in GVCs since 2005

- Notwithstanding these caveats, the UK was ranked 49th out of 64 economies in 2015 in terms of overall (backward and forward) GVC participation. UK participation in GVCs has increased since 2005. The level of integration is underpinned by stronger forward linkages than backward linkages, implying that the UK is more integrated in GVCs as a supplier (or seller) of inputs than a user (or buyer) of inputs.

The UK tends to source inputs for its export production domestically rather than from abroad.

Backward linkages for the UK have declined in recent years

- For backward linkages, the UK was ranked 49th out of 64 economies in 2015. The UK's relatively low backward linkages are in part driven by a high share of services in UK exports (for which the value of export production tends to be created in the domestic economy). The import content of UK exports has increased slightly since 2005 – evidence that

the UK has become slightly more integrated in GVCs as a user of foreign inputs for export production. However, the import content of UK exports declined more recently (2011-15) in line with the global downward trend.

- Imported EU inputs used to produce UK exports are sourced predominantly from Germany, France and Italy; in 2015, Germany supplied 11.9% of total imported inputs. For non-EU countries, China and the US dominate, constituting just over 22% of imported inputs.
- UK manufacturing exporters are more import-dependent than services exporters. The UK sectors that are most dependent on imported inputs for their exports are Basic metals, Other transport equipment (which includes aerospace manufacturing and shipbuilding) and Coke and refined petroleum products.
- Sector-level analysis of backward linkages highlights the importance of sourcing inputs from the same sector (within-sector inputs), as well as the importance of services imports for UK manufacturing exports.

A relatively high proportion of UK value added is used as inputs to other countries' exports; this has increased over time.

The UK is a relatively large supplier of inputs to foreign export production

- Forward linkages, in contrast, are much stronger – the UK was ranked 12th out of 64 economies in 2015. The UK's participation in GVCs as a supplier of inputs to foreign exports has increased over 2005-15. In 2015, UK value added embodied in world exports (as a share of UK exports) was 23.7% (totalling $162bn), up from 22.0% in 2005.

Business services in the UK are key supplying sectors to foreign export production

- The UK has strong forward linkages with EU27[1] countries, especially Ireland, Luxembourg and Germany. In non-EU countries, the UK has stronger forward linkages with large economies such as the US and China, and small open economies such as Switzerland, Singapore and South Korea. At the sector level, the highest values for UK value added embodied in foreign exports are observed for service sectors such as Other business sector services (which includes Professional, scientific and technical activities, and Administrative and support service activities), Financial and insurance activities, and Wholesale and retail trade.
- By comparison, UK production embodied in foreign consumption is far greater. In 2015, $570bn of UK value added was exported for consumption abroad, of which almost two-thirds was consumed in non-EU countries.

TiVA indicators yield additional insights on the UK's trade dependencies and consumer markets.

- **The UK's trade surplus with non-EU countries is lower when measured in value added terms.** Correspondingly, the UK's trade deficit with EU countries is lower in value added terms. At the country level, the UK's key export and import markets are the same in value added and gross terms - the US, Germany, France, Ireland and China. However, in value added terms, the importance of the US and China as export and import markets for the UK is amplified, while the importance of France,

[1] 'EU27' in this report is used to refer to the EU (excluding the UK), in instances where it might be ambiguous.

Germany and Ireland is reduced. This should not be taken as an indication of a lower reliance of the UK on demand and supply from these EU countries; these countries act as conduits for a sizeable amount of UK trade with non-EU countries. Similarly, non-EU countries access the UK market via the EU27.

- **Some EU member states export a large amount of UK value added to non-EU final consumers.** Ireland, Germany and Luxembourg export $11bn, $9bn and $7bn of UK value added respectively to non-EU consumers, making these countries the three largest exporters of UK value added to non-EU countries.
- It is considerably less common for non-EU countries to act as a conduit for UK trade to and from the EU than vice versa. Ranking partner countries by UK value added sold to EU consumers, only three of the top 15 economies were non-EU.
- **TIVA highlights that services are integral to the success of UK manufacturing exports and far more important to UK exports than they appear in gross trade statistics.** In value added terms, the share of services in UK exports is approximately 10pp higher than in gross terms. In value added terms, services accounted for around 68.5% of UK exports in 2015. The difference is driven partly by the contribution of service inputs to UK manufacturing exports; 33.7% of value added embodied in UK manufacturing gross exports originated from service sectors in 2015.
- The Revealed Comparative Advantage (RCA) index in value added terms at the sector level yields largely the same results as when measuring the RCA index using gross exports for the UK. Key service sectors in which the UK has an RCA are Arts, entertainment, recreation and other service activities, Telecommunications, Financial and insurance activities and Other business sector services. In manufacturing, the UK has an RCA in Other transport equipment and Other manufacturing (including repair and installation) sectors.
- **Around 21% of existing UK employment (6.6m persons) was supported by exports in 2015.** Of the estimated 6.6m people, just under 70% was supported by the production of service exports. In 2015, 2.9m persons employed were supported by UK exports to the EU (and 3.8m were supported by UK exports to non-EU countries).

1 Introduction

1.1 Background

Over the last 30 years, lowering trade barriers and innovations in transportation, communications and IT have resulted in the globalisation of business activity and the rise of 'Global Value Chains' (GVCs), where different stages of production are carried out in different countries and firms use imports to produce exports. The widespread use of imports to produce exports has resulted in intermediate goods crossing borders many times, before making their way to the final consumer[2].

Against the backdrop of these global economic developments, there has been increased recognition amongst policy-makers and statisticians that traditional ('gross') trade data are inadequate for capturing the complex, multi-dimensional nature of modern trade and production, and therefore data should extend beyond measuring trade flows as a gross concept. A report by Maurer and Degain (2010) noted that '*what you see is not what you get*', alluding to the idea that observed bilateral trade flows in gross terms are perhaps less relevant for understanding global trade than before. With trade in intermediate products rising in importance, the result is the multiple-counting of trade value in terms of the exports' contribution to the national economy.

Initiatives to address these issues have led to the development of multiple sets of 'trade in value added' indicators. Indicators based on trade in value added provide alternative measures of trade (compared to gross measures) by breaking down the value of gross exports into contributions from domestic sectors, as well as contributions from foreign producers. Indicators measuring trade in value added terms therefore enable the consideration of cross-border supply chains and cross-sector dependencies in the production of exports.

1.2 Objectives of the study

The Department for International Trade (DIT) commissioned Cambridge Econometrics (CE) in 2019 to undertake a project researching Trade in Value Added (TiVA).

Specifically, the objectives of this project were as follows:

- to provide an in-depth explanation of trade in value added as a concept, including its advantages and weaknesses as a measure;
- to analyse the OECD TiVA database on the UK's integration in international supply chains to assess:
  - the degree to which UK sectors are dependent on imported inputs for their export production;
  - the degree to which UK value added is embodied in foreign export production;
- to assess the UK's role in GVCs relative to other major economies, at the sector level, and over time;

[2] Johnson (2014)

- to provide estimates of UK jobs supported by exports based on the OECD's Trade in Employment database;
- and assess if/how UK's bilateral trade balances and Revealed Comparative Advantages (RCA) change in value added terms.

1.3 Presentation and structure of the report

Chapter 2 of the report outlines the concept of trade in value added, and provides an overview of the different initiatives to estimate trade in value added terms. The chapter then describes the OECD TiVA database, and in doing so, outlines the strengths and weaknesses of the database.

Chapter 3 explores the importance of foreign inputs to UK exports, that is, 'backward linkages'. The chapter assesses in detail the UK's supply chain dependence on foreign suppliers, disaggregating value added flows by UK exporting sector and by country of origin of value added. Comparisons with other major countries are presented. Brief consideration is also given to non-UK production of inputs for UK final demand.

Chapter 4 provides an in-depth assessment of UK exports used as inputs to other countries' exports, that is, 'forward linkages', and how this compares with other major economies. Consideration is also given to UK production of inputs for non-UK final demand.

Chapter 5 provides additional insights based on TiVA indicators. In particular, it examines how UK's bilateral trade balances change in value added terms and highlights the greater importance of services to UK exports when trade is measured on a value added basis. The chapter also provides a brief overview of UK employment supported by exports, and UK revealed comparative advantage in value added terms.

Chapter 6 provides a brief summary of the key findings from TiVA statistics and their policy implications.

Appendix A presents additional details on trade in value added sources other than the OECD TiVA database. Appendix B comprises of two case studies examining supply and demand-side dependencies of UK gross exports of the Finance & insurance and Motor vehicles sectors.

Throughout the report, full sector names consistent with the TiVA database are presented in figures and tables. For brevity, short sector names are used in the text. The correspondence between the full and short sector names is found in Appendix C.

2 Trade in Value Added: concepts and sources

Key points

- Conventional (gross) trade statistics do not account for the increased fragmentation and internationalisation of supply chains. By allocating the total value of the export to the last exporting country or sector, they over-estimate the last exporting country/sector as an exporter; they lead to multiple counting of trade; and they distort the true level of trade between countries (bilateral trade balances).
- Trade in Value Added (TiVA) estimates correct for these shortcomings by calculating just the value a country or sector *adds* to the production of goods and services that are subsequently exported. TiVA indicators can provide additional insight compared to gross measures of trade. For a given country or sector, TiVA indicators shed light on: the contribution of foreign inputs (by country or sector) to domestic gross exports and consumption (backward linkages); and the contribution of domestic production (value added) to other countries' gross exports and consumption (forward linkages).
- TiVA also enables a better understanding of the role of imports in domestic production and exports (highlighting their often complementary or critical role) and the identification of cross-sector dependencies. In conjunction, TiVA indicators can provide a more realistic picture of bilateral trade balances and the activities/sectors in which countries have a comparative advantage.
- Multi-regional input-output tables (MRIO) underpin the construction of TiVA indicators. Leading MRIO initiatives include the OECD Inter-Country Input-Output tables (ICIO), the World Input-Output Database (WIOD), the UNCTAD-EORA database, as well as the Global Trade Analysis Project (GTAP) and EXIOBASE.
- The OECD has developed a dataset of TiVA indicators based on its own MRIO tables (ICIO). The 2018 TiVA database covers 64 economies and 36 sectors over 2005-15[3].
- Assumptions underpinning TiVA indicators introduce limitations to their interpretation. The proportionality assumption (about the import content of exports) and the production assumption (about the homogeneity of firm production processes) are key limitations and can introduce uncertainty and possible biases in the estimates of trade in value added.
- As a result, the OECD TiVA dataset should be considered as 'experimental' and be used to complement conventional (gross) measures of trade (such as official SUTs, IOTs, Balance of Payments and merchandise trade statistics) rather than replace them.

[3] A limited set of headline indicators is available for 2016.

2.1 Introduction

Unlike conventional trade statistics that record the full (gross) value of a product crossing the border as an export, trade in value added indicators identify the value net of inputs from abroad and other domestic sectors. In other words, they identify the value a country (or a sector) adds to the goods or services that it exports. This has implications in terms of the interpretation of the data, as well as the types of questions that trade in value added measures can answer, relative to gross trade statistics. Sections 2.2 and 2.3 introduce the concept and explore the usefulness of the measure in more detail.

With emerging interest in these measures, a few initiatives have tried to estimate trade in value added using multi-regional input-output tables (MRIO). Section 2.4 provides a brief overview of the key initiatives.

Of these initiatives, the key focus of this project is on the OECD's Trade in Value Added database (TiVA). Sections 2.5-2.7 describe the TiVA database in more detail, outlining the dimensions of the database (Section 2.5), the limitations of the database (2.6), and future development plans for the trade in value added estimates (2.7). Section 2.8 offers concluding remarks.

2.2 What is "trade in value added"?

Trade in value added enables a richer analysis of a country's gross exports and final demand

Conceptually, trade in value added indicators decompose the value of a country's gross exports or final demand (consumption) into the value of constituent upstream inputs, domestic or foreign (henceforth 'domestic value added' and 'foreign value added', respectively). The indicators also identify the contribution that a country/sector makes as a supplier of inputs to foreign consumption and foreign exports.

Identifying the value of upstream activities to export production enables an examination of the mix of sectors supplying the inputs, as well as the country of origin of these inputs. Gross exports can be further decomposed into gross exports for intermediate use and final use[4] by destination country and sector.

The 'country of origin' dimension is particularly important. This detail enables a consideration of the value a country contributes to the production of a good or service in another country that is subsequently exported. In other words, trade in value added enables an examination of export value net of imported inputs to production at the country level.

[4] Final use in this context is used in this report to denote domestic final use, and the term is synonymous to final demand and end use, which includes household, NPISH, government consumption, Gross Capital Formation and direct purchases by non-residents.

Focus - What is 'value added'?

Value added measures are adjusted for the contribution of inputs in the production process. For example, consider a firm that sells computers. To produce a computer, the firm has to buy some inputs (raw materials, components, design services, software engineering etc.), worth, say, £600. It then transforms these inputs into a finished good, the computer, which it sells for £1,000. Thus, the firm takes £600 worth of inputs and, in transforming them into a computer, adds £400 worth of value.

The gross measure of the firm's output would be £1,000, the price the firm sells the computer for. The value added measure of the firm's output would be £400 (the £1,000 sale price less the £600 cost of inputs).

In this way, the gross measure allocates the full value of the sale to the firm that sells the finished good (the computer), whereas, by recognising the contribution of inputs to the final sale value and adjusting for that, the value added measure of output gives the net contribution of the firm (£400) to the final sale (output) value (£1,000).

Similarly, where the firm exports a computer to a customer in another country, gross measures of trade record the full value of the transaction (and thus include the cost of inputs), rather than the contribution made (the 'value added') by the exporting firm to the sale value.

Another perspective to interpret value added is that it represents the "contribution of labour and capital" to the production process (p.103; European Commission et al., 2009); in other words, the compensation to labour and capital for production.

The difference between gross and value added measures of trade

The fundamental difference between value added and gross measures of trade (or economic activity more generally) is the way in which the estimate handles multiple transactions or stages of production.

Focus - Conventional trade statistics: gross measures of trade

Under gross measures (as reported in official statistics such as the System of National Accounts, Balance of Payments, and merchandise trade statistics), whenever goods and services are purchased as inputs to production or otherwise, the *full* value of the transaction is recorded.

At the aggregate level, a gross measure of the exports of a sector in a country provides a measure of the total sale value of the goods and services sold to overseas customers. Under gross measures of trade, import content of the exports is not accounted for. Thus, there is no differentiation between exporters that assemble imported components and exporters that capture (either from producing themselves or purchasing from other domestic producers) a large share of the supply chain domestically.

Value added measures of trade might shed further light on national and regional economies' trade performance

The relevance of measuring the value added content of trade can also be seen in the real world. Russia for instance imports very few inputs for the production of its exports. This means that the difference between the domestic value added content of exports and gross exports is relatively small. This is partly due to the historical context of Russia with regard to trade openness but also partly due to its size (larger economies are typically more able to draw on domestic upstream inputs than smaller economies) and also the fact that a large proportion of Russian exports are in primary sectors (i.e. the extraction of oil, gas and other raw materials).

In contrast, in the case of smaller economies, such as Luxembourg, a far larger proportion of imported components are used to produce goods and service exports. This means that a lower proportion of the revenue generated from gross exports is retained by the national economy. Instead, a considerable proportion is used to pay for imported inputs sourced from abroad. On the other hand, the use of imports to generate exports provides scope for specialisation in tasks that firms and countries have competitive advantages in, which, in turn, could result in higher exports, domestic value added and employment sustained by exports[5]. In short, value added measures of exports account for differences in import intensity of inputs to production, whereas gross measures do not.

How would trade in value added be reflected in the numbers? An illustrative example

The monetary value of a country's exports may look very different when considering only the domestic value added content of gross exports. This is illustrated by a comparison of two stylised instances with differing supply chains underpinning a country's exports.

In the first instance, the entire production process is assumed to rest within the exporting country. In the context of international trade, this means no inputs are imported and there is no international supply chain from the transactions that occur. It also means that all value added derived from exports is retained in the domestic economy because at no stage of the production process are inputs to production imported.

Figure 2-1 outlines the first instance by way of an illustrative example. The country responsible for all production would register an increase in gross exports of £2m and total international trade would also increase by £2m.

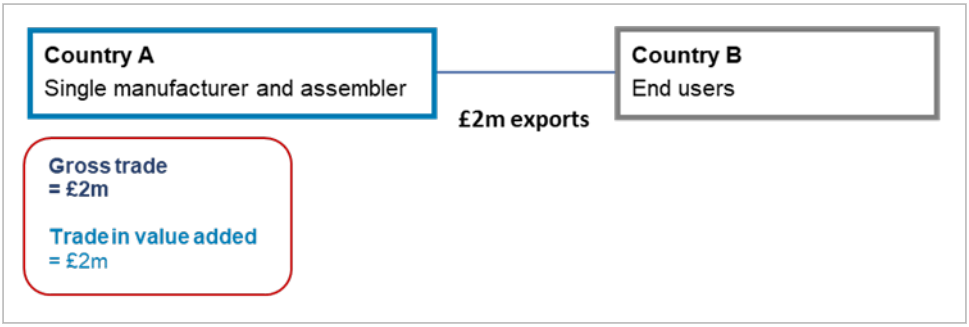
In such an example and at the country level, the monetary value of trade measured in gross terms is identical to the monetary value of trade measured in value added terms; all value added is apportioned to the exporting country.

Even in this case, however, measuring trade in value added terms would still provide additional detail, specifically on the contribution of domestic upstream sectors. Measuring exports in gross terms would attribute the full value of the export to the sector producing and exporting the product; the contribution from domestic upstream suppliers would not be captured. In Figure 2-1, for example, the value of cars crossing the border would be fully attributed to exports of the motor vehicles sector when measured in gross terms. By contrast, value added measures decompose the domestic value of exports into contributions made by the exporting sector itself (car manufacturing in our

[5] Brookings institution (2019)

example), upstream domestic suppliers (e.g. tyre manufacturers) and re-imports – these concepts are discussed in more detail in Chapter 3.

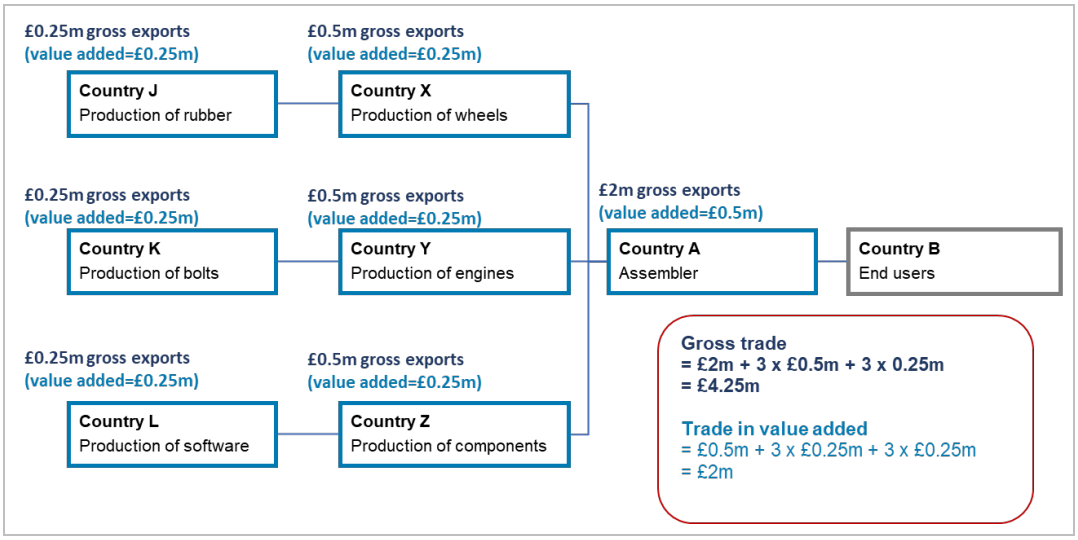
Figure 2-1 Illustrative example: Single manufacturer/assembler of cars



Source: CE illustration.

A second example of production and trade of the same product is illustrated in Figure 2-2. Though still highly simplified, the second example demonstrates the impact of supply-chain fragmentation on international trade. In this example, the same final products are exported by country A and, as a result, the country still registers £2m in gross exports. However, in value added terms, country A records export revenue of just £0.5m, as £1.5m is netted out as it is foreign value added embodied in country A's exports. Crucially, gross measures of trade are unable to differentiate the exports made by the single manufacturer in Figure 2-1 and the assembler in Figure 2-2.

Figure 2-2 Illustrative example: 3-tiered production process of cars



Source: CE illustration.

Measuring trade in value added terms essentially factors out the value of components and, thus, avoids double counting. In Figure 2-2, exports recorded in gross terms associated with the production of final products exported by Country A is £4.25m, over twice that of the sole producer example in Figure 2-1. This is problematic because it means that we do not know whether increases in gross trade measures are being driven by: (1) increasing

quantity/quality of global exports; or (2) increasing fragmentation of global supply chains (and therefore a higher proportion of the product's value is being counted more than once).

2.3 What insights can trade in value added bring?

Insights into the origin of value added in UK gross exports

Trade in value added provides an alternative method to measure trade performance, in that it becomes possible to measure the production value embodied in gross exports by country and sector. By the same token, measuring trade in value added terms enables an alternative calculation of Revealed Comparative Advantage in value added terms[6].

Bilateral trade relationships could look very different

In contrast to gross measures of trade balances, trade balances on a value added basis reflect domestic value added that is consumed by the partner country. As a consequence, a value added trade balance accounts for flows in domestic value added for final use. In contrast, gross measures capture the total value of the goods and services entering and leaving a country, irrespective of the use of the product or the use of inputs originating from other countries in the production of the product. As a result, bilateral trade balances can look very different in value added terms[7]; however, a country's *total* trade balance with the rest of the world in gross terms and in value added terms would be equivalent.

Insights into sector contributions to trade

Another advantage of measuring trade in value added terms is its potential to provide insights into domestic and foreign inputs entering gross exports of a particular sector. Different sectors will naturally have different production processes and are therefore likely to be internationally fragmented to varying degrees. The decomposition of inputs to export production at the sector level also enables an understanding of cross-sector dependencies. By extension, the importance of each sector's contributions to exporting activity can be identified, either directly (exports of that sector's products), or indirectly (as inputs to other sectors' export production), e.g. services embodied in manufacturing exports.

A better understanding of the role of imports

Measuring trade in value added terms can enable a better understanding of the role of imports in the domestic economy. High imports may traditionally be interpreted as firms in the domestic economy failing to compete with firms abroad – imports therefore indicate 'leakage' to the non-domestic economy. However, this ignores that efficient production of exports may require imported inputs (especially for industrialised economies, for relatively higher-value manufacturing or services). In these instances, imports are not in competition with domestic production but are complementary and in some value chains, essential (e.g. countries may have comparative advantages in refineries, despite having no production of crude oil). In the policy environment, a better understanding of the role of imports is especially relevant for trade protectionism-related discussions.

[6] These are calculated and presented in Chapter 5 of this report.

[7] How trade balances differ in practice for the UK is explored further in Chapter 5 of this report.

2.4 Initiatives to estimate trade in value added

There are several initiatives to estimate trade in value added operating in parallel

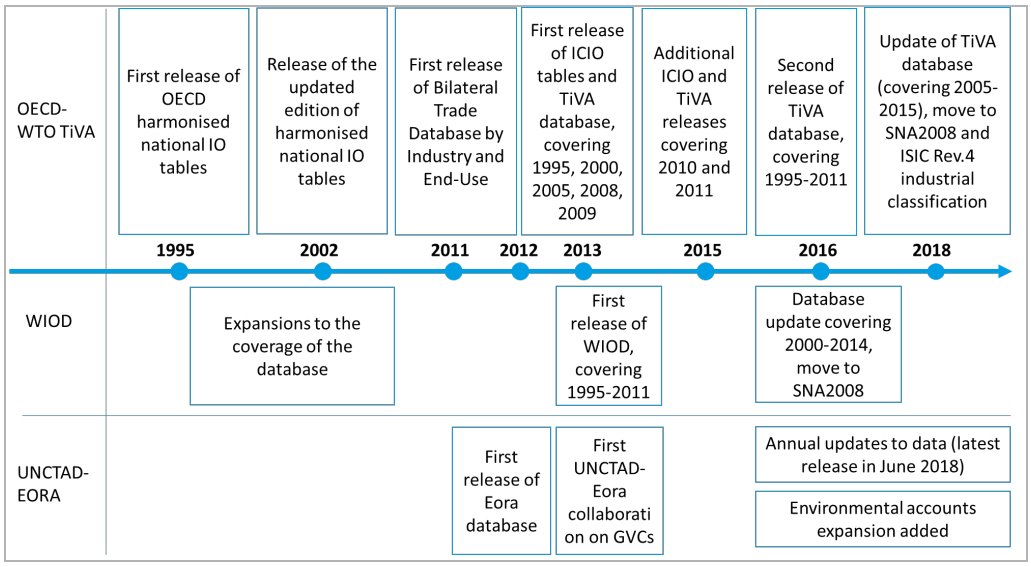
Value added trade statistics and other metrics relating to GVCs have been compiled as part of multiple projects, all of which are based on the manipulation of global input-output tables. The use of input-output analysis to assess the interdependencies between sectors *within a country* dates back to the 1960s. Early attempts to assess the interdependencies between sectors *across countries,* through multi-country input-output analysis, include the 1995 release of the first OECD Input-Output database. This presented a set of 'harmonised' national Input-Output tables for 10 OECD countries developed initially to analyse international technology diffusion.

Three leading initiatives are highlighted as part of this project:

- the OECD's TiVA database;
- the World Input-Output Database (WIOD); and
- the UNCTAD-EORA database.

The timeline of these developments is illustrated in Figure 2-3.

Figure 2-3 Development timeline of global input-output initiatives



Sources: OECD, Timmer, M., KGM Associates.

Other initiatives to estimate trade in value added include region-focused projects, like the EU FIGARO supply and use and input-output tables, the Asia-Pacific Economic Cooperation (APEC) TIVA, and the North American TiVA initiatives.

A summary of the details of the three main initiatives is provided in Table 2-1. In the next section, we describe the OECD TiVA database in more detail. A detailed discussion of the WIOD and UNCTAD-Eora initiatives is available in Appendix A.

Table 2-1 Overview of key trade in value added initiatives

	OECD ICIO (underpinning OECD TiVA indicators)	WIOD	UNCTAD-EORA
Latest release	December 2018	November 2016	2018 rev. 0323
Country coverage	64 economies (plus 'Rest of the World') and 14 supra-national aggregates	43 economies	189 economies (plus 'Rest of the World), fewer for certain indicators
Sector coverage and detail	36 sectors	56 sectors	25 sectors in the UNCTAD-EORA database. Various disaggregation for multi-region input-output tables (511 sectors for the UK)[8].
Accounting framework	Based on SNA 2008 and ISIC Rev. 4.	Based on SNA 2008 and ISIC Rev. 4.	Based on SNA 1993 and proprietary classification mapping to ISIC Rev. 3.
Time coverage	2005-2015	2000-2014	1990-2019 (1990-2015 for sectoral data)
Regularity of updates	Previous releases in 2013, 2015, 2016 and 2018. Regular updates are expected.	Previous releases in 2013 and 2016. Currently, there are no plans for future updates.	First release of the GVC database in 2013. Since then, the GVC database has been updated annually in parallel with Eora database updates.

Sources: OECD, WIOD and KGM Associates.

As Table 2-1 indicates, the greatest level of geographical coverage is available in the UNCTAD-Eora Global Value Chains database. The WIOD database provides the greatest level of sector detail.

Due to differences in coverage and methodology, the indicators obtained from these initiatives are not directly comparable with each other. Differences in coverage and methodology also mean that the latest versions of the OECD TiVA indicators and WIOD (based on SNA 2008 and ISIC Rev. 4) are not comparable with previous releases (based on SNA 1993 and ISIC Rev. 3).

2.5 The OECD-WTO Trade in Value Added (TiVA) initiative

The worldwide collapse in international trade in the wake of the 2008 financial crisis revealed the depth of interconnectedness of the world economy and resulted in many calls for better metrics for analysing GVCs. In response, the World Trade Organization (WTO) and OECD made a commitment to develop

[8] Lenzen et al. (2013)

indicators of trade in value added[9]. Building on its long experience in developing I-O based analytical tools and drawing on the accumulated expertise of a range of institutions such as IDE-Jetro, USITC, as well as specific MRIO-orientated projects such as EORA, EXIOPOL and WIOD, the OECD constructed an Inter-Country Input-Output (ICIO) system. The first edition of the ICIO database was released in 2013 covering 40 countries (all OECD plus BRIICS[10]). Since then, the coverage and the frequency of the updates have increased, allowing for the development of annual ICIOs, as well as trade in value added time-series.

Database contents and coverage

The latest version of the OECD TiVA database (released in December 2018) covers the period 2005-2015 (with preliminary estimates for 2016 for some headline indicators). The 2018 release includes indicators for:

- 64 economies, including all OECD, all EU, all G20 and most East and Southeast Asian economies [11];
- 36 sectors[12], based on the ISIC Rev. 4 classification system.

The database covers a number of indicators[13], which can be accessed using an interactive table builder or in long format as text files using the bulk download facility. The database includes headline statistics on:

- Backward linkages: Domestic and foreign value added as shares of gross exports (coded EXGR_DVASH and EXGR_FVASH)
- Forward linkages: Domestic value added embodied in foreign exports as a share of domestic gross exports (EXGR_DVAFXSH)
- Exports and imports in value added terms: Domestic value added embodied in foreign final demand and foreign value added embodied in domestic final demand (FFD_DVA and DFD_FVA)

A range of other indicators is readily available in the database, providing specific statistics for trade in intermediate, final and investment goods, as well as indicators based on the service content of exports.

2.6 Limitations of the OECD TiVA database

The use of TiVA indicators can benefit from an understanding of some of the assumptions underpinning the database. Most caveats stem from the richness of the statistics required to compile trade in value added indicators, which for many countries are limited or unavailable. Imputations, adjustments and strong assumptions are therefore required, which necessarily weaken the quality of the TiVA estimates and create discrepancies with the traditional gross trade data published by National Statistical Offices (Yamano and Webb, 2018).

[9] OECD and WTO (2012)

[10] Brazil, Russia, India, Indonesia, China and South Africa.

[11] OECD (2018a)

[12] OECD (2018b)

[13] The information on the definition of TiVA 2018 indicators has been obtained from the documentation of the TiVA 2016 database.

The TiVA database is still a work in progress and, in its current form, has significant limitations, the most important of which are[14]:

- Systematic underestimation of the foreign content of exports as a result of the production assumption
- Uncertainty of the estimates as a result of the proportionality assumption
- Limited country, sector and time coverage
- Estimates are only available in nominal terms
- Due to balancing adjustments used in the construction of ICIO tables, gross trade data diverge from the National Statistical Offices' data
- Lack of timely and clear documentation. More detailed metadata and greater transparency would increase confidence in the data and encourage greater use.

These limitations mean that TiVA indicators are best suited for obtaining aggregate-level messages or insights concerning GVCs. They should not be considered as a replacement for firm-level analysis of supply chains, or for using detailed gross trade statistics.

Production assumption

The production assumption outlines that all "*consumers of industries' outputs purchase exactly the same shares of products produced by all of the firms allocated to that industry, and that all firms providing those inputs have, in turn, the same production functions and same intensity in use of imports*" (p.9, OECD, 2018c) .

All firms in a given sector are assumed to have the same input mix

Figure 2-4 demonstrates how the production assumption can be understood in the context of a firm's supply chain. In simple terms, the production assumption assumes that the input mix (by supplying sector and whether domestically produced or imported) for all firms in a given sector is the same. This is a simplification, as firms in the real world differ in their use of inputs – for example some (e.g. exporting firms) may be more reliant on imported inputs than others (e.g. non-exporters), or use inputs from different domestic sectors. This simplification could potentially lead to inaccuracies, if firms with a particular type of production technology are more likely to supply certain other sectors or export more than others.

There might be an under-estimation of the proportion of imported inputs

Based on the example in Figure 2-4, if firm A produces solely for the domestic market and firm B solely for exports, their different technologies cannot be accounted for at the aggregate sector level (on the right hand side of the figure). As data are not available at the firm level, the estimates rely on the aggregate sector X data on the use of domestic and foreign inputs, as well as the sector's value added.

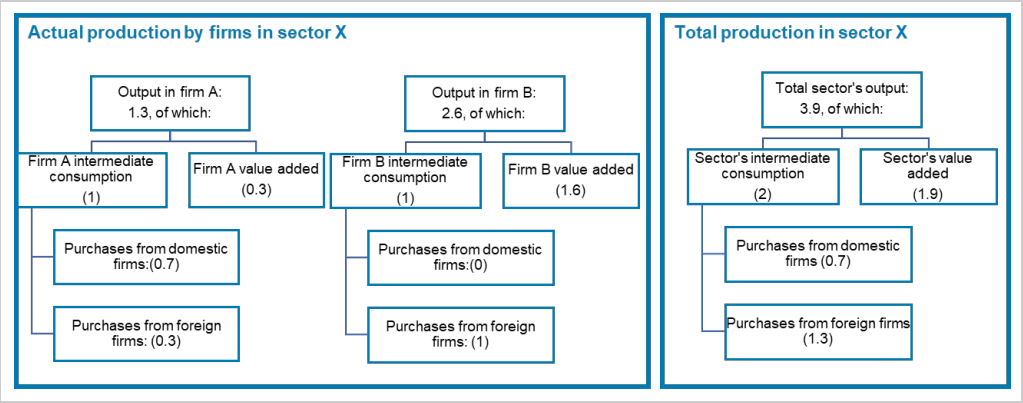
Firms producing to meet foreign (export) demand are typically more integrated in global supply chains and thus, a higher proportion of inputs may be imported[15]. Therefore, suppose that firm B relies entirely on foreign inputs, while the sector-average fraction of foreign inputs used in production is lower, at 1.3 units, out of 2 units of all inputs (which includes inputs used by firm A for

[14] OECD (2017a).

[15] See Ahmad and Ribarsky (2014).

domestic production). In this case, where firm B is a sole exporter and uses only foreign inputs, the production assumption results in an underestimation of the use of foreign inputs in the production of exports in the sector (i.e. foreign value added content in gross exports), and the overestimation of the use of foreign inputs in the sector's production for domestic consumption.

Figure 2-4 Production assumption example



Sources: CE illustration.

Analysis at the country-level may shed more light on the severity of bias stemming from the production assumption, through exploring the presence of firm heterogeneity. An OECD Expert Group on Extended Supply-Use Tables, created in 2014, aimed to tackle this heterogeneity and to mainstream the production of GVC-relevant supply and use tables in the core of national statistical information systems[16]. The current OECD TiVA estimates account for firm heterogeneity for China (with breakdowns by processing status) and Mexico (with breakdowns by whether the firm is a 'global manufacturer') only. That said, many other countries (including Belgium, Canada, Costa Rica, Morocco, the Netherlands, the US[17] and the Nordic region[18]) have recently produced, or begun to produce, extended supply and use tables which will eventually be incorporated into, and improve the quality of, the TiVA data.

The proportionality assumption

The quality of the TiVA estimates can also be affected by the 'proportionality' assumption, which states that "*for a given product, one assumes that the proportion of intermediates that an industry purchases from abroad is equal to the ratio of imports to total domestic demand in that product*" (p.12, OECD, 2015b). A visual interpretation of the proportionality assumption using the example of car engines is outlined in Figure 2-5.

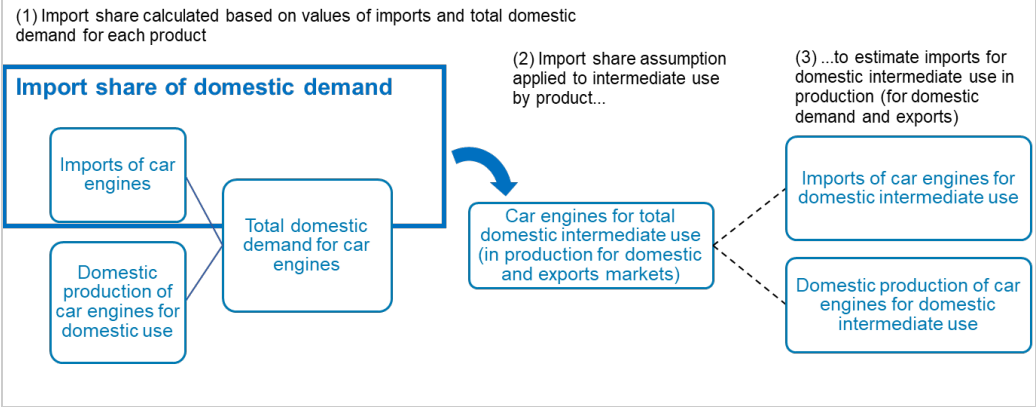
In this example, the assumption would only be accurate if exporting firms use the same mix of imported and domestic engines as inputs to their production as non-exporting firms. In the real world, the import share of inputs for exporting firms is likely higher than the import share for firms producing for the domestic market.

[16] See OECD (2015a).

[17] See OECD (2019c).

[18] See Statistics Denmark (2017).

Figure 2-5 Proportionality assumption example



Sources: CE illustration.

In other words, the import content of domestic demand is used to approximate the import content of inputs to domestic production (intermediate use) to meet both domestic demand and foreign (export) demand. By extension, TiVA indicators also necessarily assume that, for each sector, the share of foreign inputs from each partner country is the same across exporting and non-exporting firms, and the same across firms that export to different markets overseas.

The proportionality assumption could introduce bias into the estimates

As highlighted in the TiVA documentation (OECD, WTO OMC, 2013[19]), this assumption may be questioned on the basis that exporting firms are likely to be more integrated in global supply chains (and therefore have a higher import share of production/exports). The documentation also outlines that this assumption is more critical for developing countries, where the import share for domestic demand is likely much lower than the import share in inputs used for the production of exports (p.15, ibid.). In the same way, the use of the assumption concerning the origin of imports may also create biases in the estimated imported content from particular countries. For example, a German-owned company operating in the UK might source more components from Germany because of its distinct production technology, compared to UK-owned firms in the same sector. At the same time, the German-owned company may export only to certain countries. In this case, the German value added content of UK exports to these countries will be biased downward because the proportionality assumption assumes the same production technology for exports to all countries.

Country, sector and year coverage

A further limitation is the limited country coverage. The current dataset covers 64 economies only, which include all of the OECD and EU countries individually, as well as most of the East and South-East Asian economies. Estimates for most developing economies are not available. The prospect of including more countries depends on the availability and quality of the underlying national statistics.

Information on other countries, especially developing economies, is only partially captured in the "Rest of the World" aggregate as the 65th region. Beyond the general drawback that identification of TiVA activity for these

[19] OECD and WTO OMC (2013).

countries is not possible, a more important consideration in the context of assessing UK performance using TiVA is that the country of origin of value added in UK exports may be grouped into “Rest of the World” and, therefore, hidden. However, to put this into perspective, the 64 economies covered in TiVA account for more than 90% of world GDP and trade.

The sector coverage in the OECD TiVA database is determined by the detail available in national SUTs and I-O tables. The OECD TiVA dataset covers 36 sectors only, based on the ISIC Rev. 4 classification. This could be insufficient detail if specific sectors of interest are not individually identified; for example, Professional, scientific and technical activities (Section M in the ISIC Rev. 4 classification) and Administrative support service activities (Section N) are grouped into one sector in the TiVA database as ‘Other business services’, within which there are a whole range of sectors including Legal and accounting, Advertising, Rental and leasing, and Employment activities. Furthermore, in comparison to merchandise trade statistics such as those available in UN Comtrade, the level of detail in the TiVA database is a lot lower (albeit for products rather than sectors).

By the same token, the latest year TiVA indicators are currently available for is 2015 (in the December 2018 release), with preliminary estimates for 2016 available for a few indicators only. More timely estimates could inform on a more up-to-date basis the structure of trade relationships between economies, as well as changes over time in the magnitudes of, for example, foreign value added content in domestic exports[20]. More up-to-date releases could help policymakers develop timelier responses to changes in trade relationships.

A lack of timely and clear documentation

A further weakness relates to the limited documentation available on the database. The TiVA dataset is complex, partly due to the number of dimensions available in the data (for instance, by exporting country and sector, source country and sector, country and sector of final demand). Therefore, clear documentation on the derivation and interpretation of each indicator would greatly facilitate the use and manipulation of the data. However, at the time of writing there was limited information on the derivation and interpretation of each indicator. Updated documentation is expected to be published in 2020.

2.7 Future development plans for trade in value added statistics

It is expected that in the near future a leading multi-region input-output database will emerge, due to the endorsement and commitment of international economic bodies. The OECD has created an expert group of various TiVA initiatives (including APEC-TIVA, North American TiVA, European TiVA (FIGARO), and South American TiVA), to harmonise sources, methods and standards.

[20] Notwithstanding the limitation that TiVA only provides estimates in nominal terms. While gross measures are also commonly measured in nominal terms, the availability of export and import price data enables the option of deflating gross measures in nominal terms. For trade in value added data, what the relevant price would be is more ambiguous.

Expert groups outline key areas of development for TiVA statistics

The main conclusions from this expert group call for further disaggregation of national supply and use tables to account for: firm heterogeneity by trading status, size of firm and country of control; transparency in balancing methods for international trade; and common approaches to the production and proportionality assumptions (CEPAL, n.d.). Currently, discrepancies between international trade statistics and National Accounts are bridged by statistical methods. In the longer term, better data are expected to be available, in part driven by the OECD's efforts to bring countries together to address bilateral trade asymmetries and through the efforts of the OECD's Working Party on International Trade in Goods and Services Statistics to develop transparent and replicable approaches to producing balanced trade data[21]. Improvements in the reliability of trade in services statistics are also crucial and are an area where the OECD and WTO are making significant efforts[22].

Extensions to TiVA statistics include environmental and employment accounts of trade

High on the agenda are other applications of ICIO tables. The most recent releases included the development of emissions indicators[23] and extensions accounting for employment embodied in trade[24]. In this context, it is important to stress the additional caveats in interpreting indicators derived via ICIOs. Estimates of domestic employment embodied in international trade are, for example, likely upper-bound estimates for two reasons: firstly because, as highlighted above, exporting firms typically have on average a higher import content (and thus lower domestic value added) than non-exporting firms; and secondly because exporting firms also typically have higher labour productivity. Extensive environmental accounts are already prepared as part of WIOD and EORA databases.

2.8 Concluding remarks

Statistics on trade in value added provide additional insight, which is unavailable in gross measures

Compared to conventional trade statistics in gross terms, measuring trade in value added terms provides a complementary picture of trade flows and the importance of trade to the domestic economy. This is driven by the fact that measuring trade in value added terms nets out the purchase of intermediate inputs (domestic or imported) in the production of exports and, in doing so, identifies foreign or cross-sector inputs to produce gross exports and to meet foreign final demand (consumption). In other words, the role that imports play in domestic supply chains and in the production of exports can be better understood using these measures.

There are a few prominent initiatives that provide the necessary tools to develop trade in value added indicators, and these generally differ in terms of geographical and sectoral coverage.

[21] See OECD (2017b).

[22] See OECD (n.d. a).

[23] See OECD (2019a).

[24] See OECD (2019b).

While providing valuable insight, TiVA statistics are experimental and should be interpreted cautiously

A key initiative is the OECD work to develop the ICIO database, from which TiVA indicators are calculated. Limitations in the data required to construct the indicators necessarily weaken the quality of the TiVA estimates**,** and hence, this dataset is best considered as useful for providing broad insights and a complement to conventional (gross) trade statistics. Other trade in value added initiatives are likely to experience the same limitations, given that all initiatives rely on the same types of underpinning data.

For the same reasons, there are a number of limitations associated with the ICIO tables and TiVA indicators that users should be aware of. Assumptions of the homogeneity of firms in any given sector (production assumption) as well as assumptions on the import content of intermediate consumption based on the import share of domestic demand (proportionality assumption) could introduce bias in the estimates. Further limitations relate to the limited sector and geographical detail of the database; most indicators are also only available up to 2015 in the most recent release.

With these caveats in mind, we proceed to explore the insights that the OECD TiVA dataset can yield with respect to analysing UK trade performance in value added terms.

3 Backward linkages: dependence of UK exports and final demand on foreign inputs

Key points

- Backward linkages measure the reliance of a country (or sector) on foreign inputs for the production of exports and to satisfy consumption (final demand). Backward linkages are measured by the foreign value added (import) content of a country's (or sector's) gross exports (and final demand). Several factors affect a country's backward linkages, including the size of the economy; its patterns of specialisation; and its location (geography). Therefore, a relatively low import content should not be interpreted as a lack of global integration or lack of competitiveness.
- The import content of UK exports was 15.4% in 2016, below the OECD average of around 26% and 3.4pp lower than in 2011, but up 1.1pp from 2005. Thus, while the UK was slightly more integrated in GVCs in 2016 than in 2005, in more recent years UK integration in GVCs has fallen, in line with the global downward trend.
- The UK ranks 49th out of 64 economies in the TiVA database in terms of import content in gross exports. The UK's relatively lower import content reflects in part the UK's specialisation in service exports, which tend to have a lower share of imported inputs relative to exports in manufacturing sectors.
- Underpinning the relatively weak UK backward linkages, the UK's largest exporting sectors tend to have low import content; exports of Other business services contained only 7.7% imported content in 2015. Other key UK exporting sectors, such as Finance & insurance and Chemicals, had between 9.1% to 23.3% of import content in their exports in 2015.
- By contrast, the highest import content is observed for UK exports of the Coke, petroleum (42.4% imported content); Other transport (32.5%); and Basic metals (30.4%) sectors.
- UK exports in almost all sectors are more dependent on imported inputs from non-EU countries than the EU. The only UK sectors that depend more on inputs from the EU27 than non-EU countries for their export production are: Motor vehicles; Rubber & plastics; Hotels & restaurants; Paper and printing; Food products; and Wood products.
- In the EU27, UK exporting sectors source their inputs mainly from Germany (which supplies 11.9% of all foreign inputs used in UK exports), France and Italy. Outside of the EU, the largest contributors are the US and China (together supplying 22.2% of all foreign inputs used in UK export production).
- By sector, most UK manufacturing exporters source their foreign inputs mainly from sectors producing the same goods and services.

3.1 Introduction

The structure of the TiVA database enables an exploration of backward and forward linkages of gross exports and final demand[25]. This chapter focusses on understanding backward linkages, and, in doing so, provides an understanding of the importance of imports:

- in the production of UK exports, by UK exporting sector and origin (source) country; and,
- for UK consumption (final demand), by origin (source) country and UK final demand sector[26].

Section 3.2 describes the concept of backward linkages. Section 3.3 provides headline comparisons of UK backward linkages with other economies. Section 3.4 describes the imported (foreign) value added content of UK exports, delineating the domestic, non-EU and EU27 contributions. Section 3.5 describes how domestic value added in gross exports of each sector is composed of direct (exporting sector's), indirect (other domestic sectors') and re-imported contributions. Section 3.6 details how individual countries contribute to UK exports. Section 3.7 describes how individual foreign sectors contribute to UK exports as suppliers of inputs. Section 3.8 gives a brief overview of backward linkages in UK final demand. Section 3.9 provides a summary of findings.

3.2 Understanding backward linkages

What are backward linkages?

In the context of understanding UK trade, TiVA indicators provide insight on the reliance of UK gross exports on inputs sourced from abroad (foreign value added).

Focus - What is meant by 'backward linkages'?

The concept of backward linkages refers to imports being used as inputs to produce exports and to satisfy domestic consumption (final demand).

If a large share of inputs used in the production of exports in a particular sector originates from abroad, this sector has a high share of foreign value added content in its exports, and can be described as having strong backward linkages. Similarly, if a large fraction of domestic demand in a particular sector is satisfied by imported goods and services, the sector of domestic demand can be considered to have strong backward linkages.

A high foreign value added content in UK gross exports (and correspondingly, low UK value added content) indicates that the contribution of UK exports to the UK economy is lower than what conventional (gross) exports data might suggest.

Furthermore, using the TiVA database, it is possible to gain further insight on specific countries' (and sectors') value added contribution to UK gross exports.

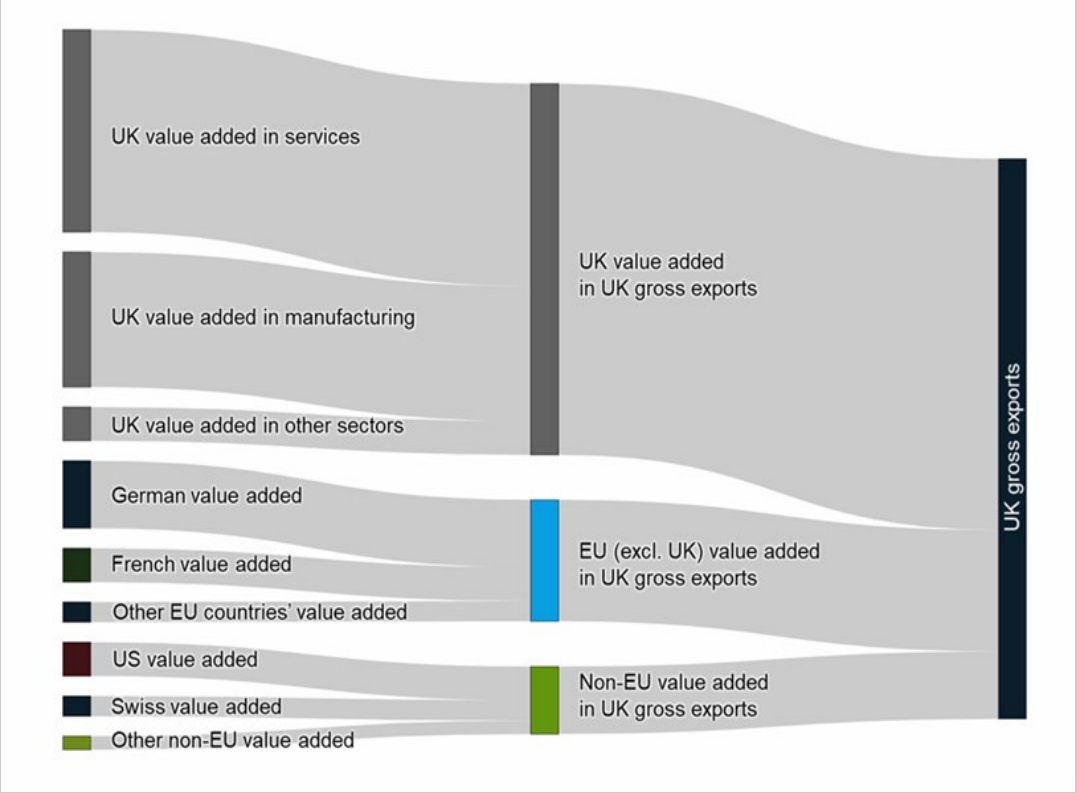
[25] The definition of final demand is discussed in Chapter 2 of this report.

[26] All analysis in this and subsequent chapters are based on the December 2018 release of the TiVA database.

Where the inputs to UK gross exports are imported, this indicates dependence of UK exports on foreign production.

A visual representation of how backward linkages of UK exports can be understood as a concept is outlined in Figure 3-1. UK gross exports are composed of domestic value added generated in multiple UK sectors, as well as foreign value added (which, for simplicity, is not disaggregated by sectors of origin in the figure). A similar figure could be drawn to represent various places of origin for value added consumed in the UK (entering final demand), which is discussed in Section 3.8.

Figure 3-1 Backward linkages: decomposition of UK gross exports into value added components by sector and country of origin



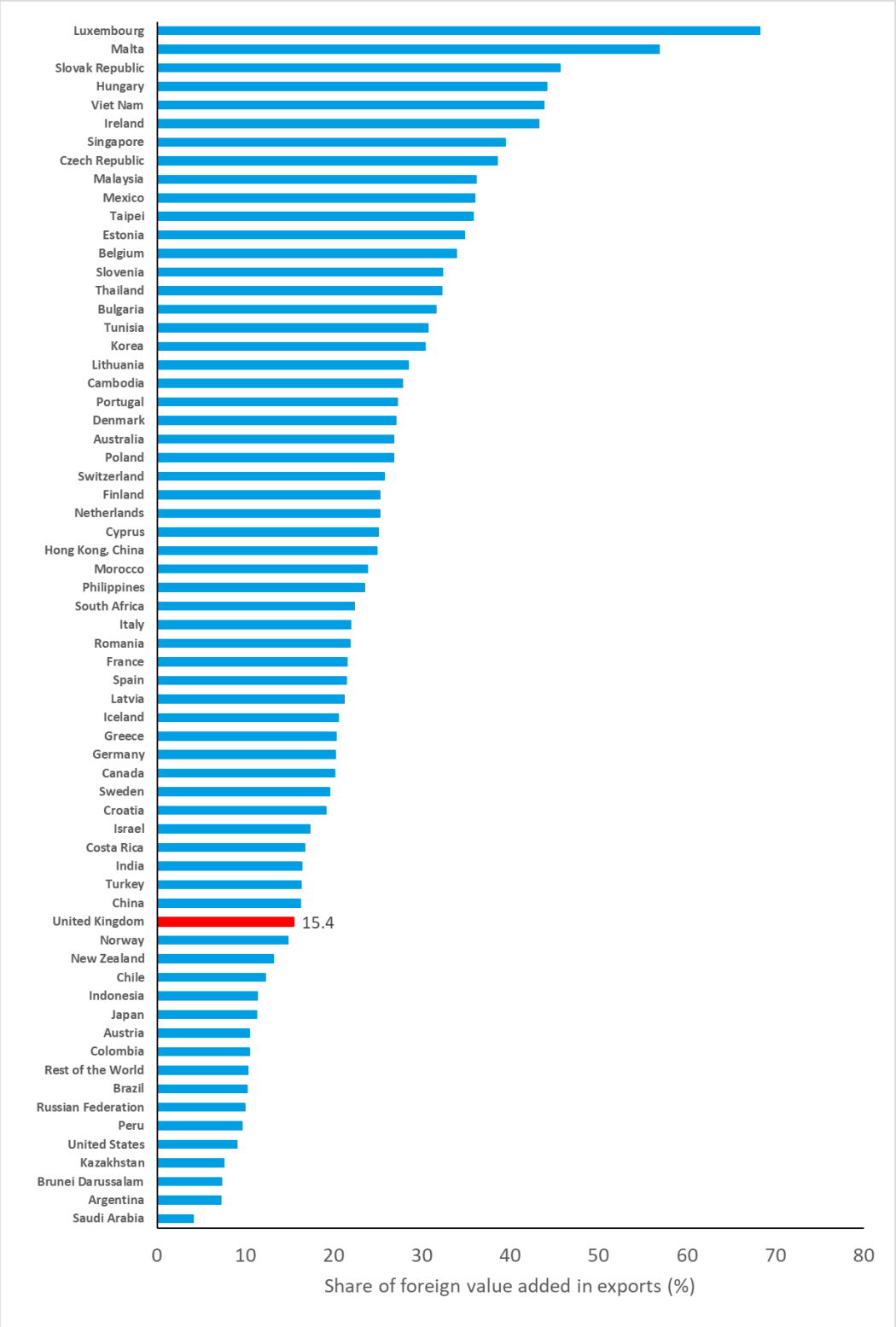
Sources: CE illustration.

3.3 UK dependence relative to other countries and over time

The dependence of a country's exports on imported inputs can be measured by the share of foreign value added embodied in that country's gross exports[27]. As shown in Figure 3-2, the share of foreign value added in UK gross exports stood at 15.4% in 2016, below the OECD average of around 26%, and ranking 49th out of 64 economies in the TiVA database. The UK's relatively low backward linkages partly reflects its specialisation in services exports which tend to have low import content.

[27] Note that a cross-border flow is recorded as import and export only if the ownership changes. In this way, the foreign value added content in UK exports only accounts for the value added that is in UK ownership.

Figure 3-2 Share of foreign value added in gross exports (2016)



Sources: Trade in Value Added (TiVA): Origin of value added in gross exports (EXGR_BSCI).

A relatively low import content should not be interpreted as a sign of lack of integration in GVCs or lack of competitiveness. Several factors affect a country's import content:

- Economies which specialise in upstream activities, such as agriculture and mining, and are rich in natural resources (e.g. Saudi Arabia, Kazakhstan,

Russia) tend to have low foreign value added content in their gross exports as their exports require little intermediate inputs and they can source important inputs (e.g. oil) domestically.

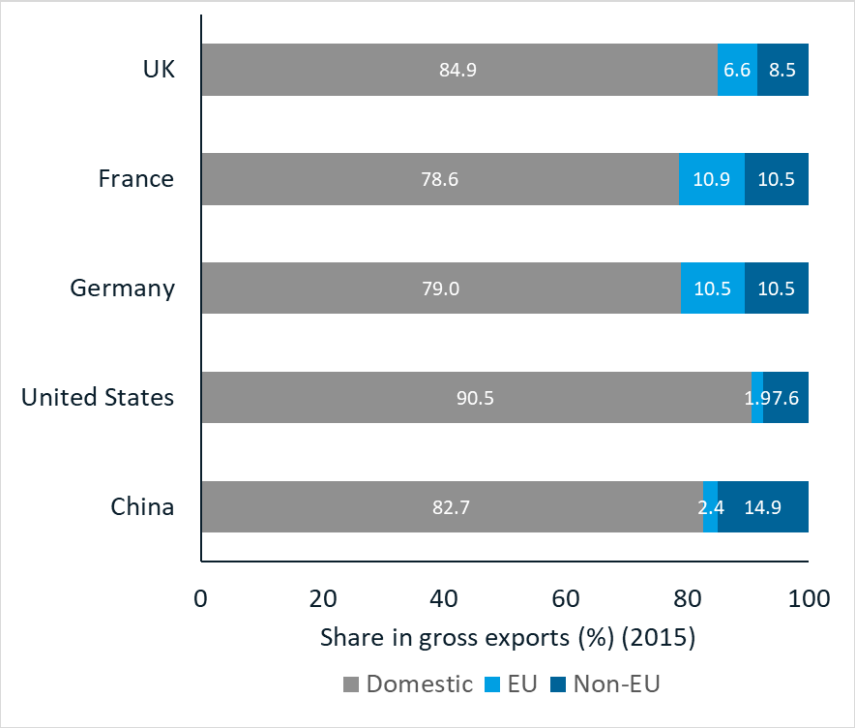
- For smaller economies (e.g. Luxembourg, Malta), the share of foreign value added content in gross exports tends to be higher as their small size limits their ability to produce/source inputs domestically.
- Certain countries specialising in services (e.g. the UK or the US) tend to have lower foreign value added content in their exports. Gross exports of services in general have lower foreign value added content than exports of other sectors such as manufacturing.
- Geography matters. The further a country is from dominant manufacturing hubs (for example in Asia, North America or Central Europe) the greater the challenges to integrate. By contrast, countries that are located near large manufacturing hubs where GVC activity is prevalent rely heavily on imports of intermediate goods and services, and so are more likely to have higher shares of foreign value added in their exports and domestic demand. Singapore, Hong Kong, Vietnam, Hungary and Slovakia are all examples of countries which are located in the proximity of major manufacturing centres (China and Germany).

The share of imported value added in German and French exports is higher than that of the UK

Figure 3-3 presents gross exports decomposed by origin of value added for selected countries in 2015[28]. Foreign value added amounted to 15.1% of UK gross exports, of which 6.6% originated in the EU27 and 8.5% in non-EU countries. In comparison, the shares of foreign value added in German and French gross exports were higher, at 21%, with larger shares of EU value added (10.5% for Germany and 10.9% for France).

[28] Data on foreign value added in gross exports by origin country is not available for 2016, therefore the analysis is based on 2015 figures.

Figure 3-3 Origin of value added in gross exports - selected countries, % of gross exports, 2015



Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

The EU27 makes a larger contribution as a supplier of inputs to UK exports than to US or Chinese exports. This is not surprising given the relative geographic proximity of the UK to EU27 countries and the regulatory alignment as part of the EU Single Market.

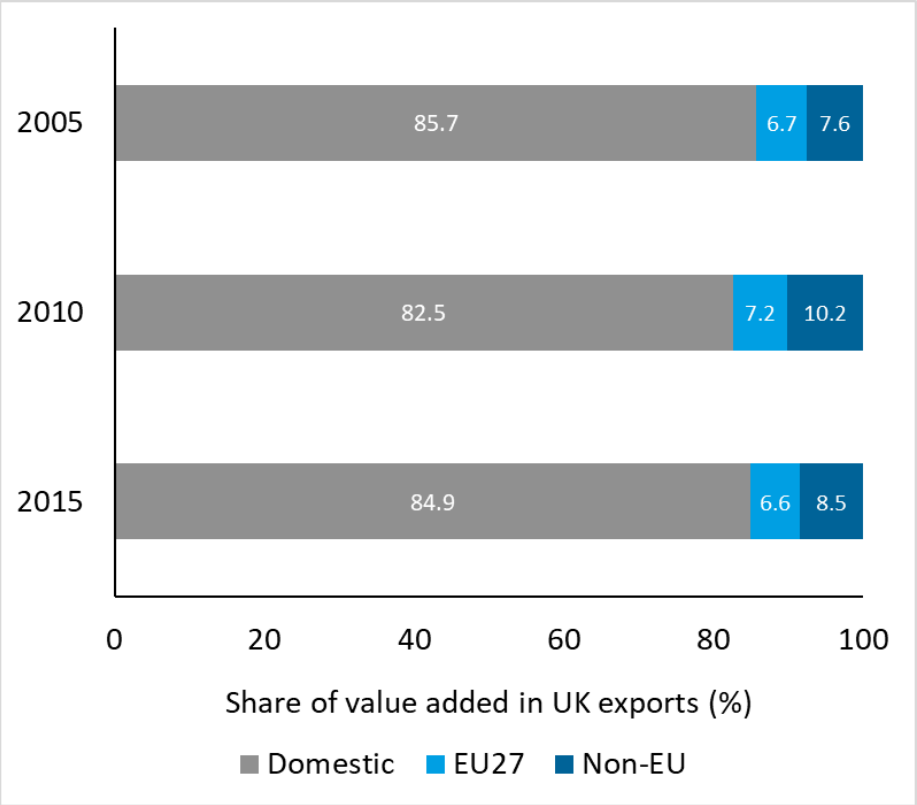
Between 2005 and 2015, the import content of UK exports increased slightly, though it has fallen since 2011

Figure 3-4 presents the composition of UK gross exports in 2005, 2010 and 2015. The import content of UK exports increased slightly in that period (from 14.3% to 15.1%), with the change being entirely driven by an increase in the share of value added sourced from non-EU countries, from 7.6% to 8.5%.

The share of value added sourced from abroad has increased over the 2005-2015 period as a whole, but that is underpinned by a 4.5pp increase between 2005 and 2011 and a 3.7pp decline between 2011 and 2015 (with provisional data for 2016 suggesting foreign value added content is still 3.4pp lower than in 2011). This is in line with the experience of many other major economies and, according to the OECD[29], this trend is a result of a slowdown in the global fragmentation of production in recent years, although fluctuations in commodity prices, such as crude oil, can also have an effect on these trends.

[29] OECD (2018e).

Figure 3-4 Origin of value added in UK gross exports (2005-2015)



Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

3.4 Backward linkages by UK exporting sector

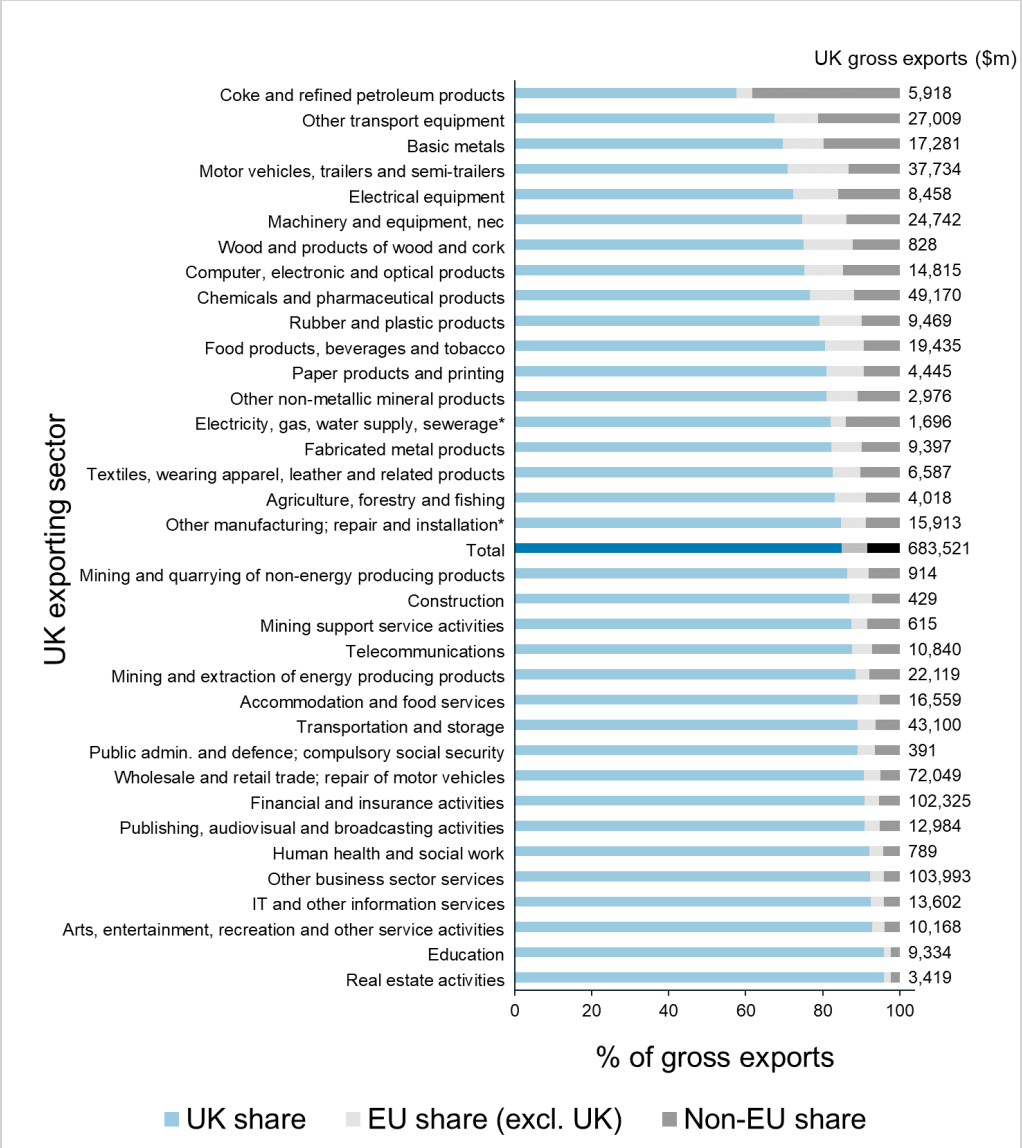
In monetary terms, the sector with the highest import content is Chemicals, partly driven by the magnitude of UK gross exports in this sector ($49bn in 2015) – see Figure 3-5. In the same year, EU27 and non-EU imported value added accounted for 11.4% and 11.9% of gross exports in the Chemicals sector, respectively (or around $11.4bn of import content).

In proportional terms, exports of the UK Coke, petroleum sector are most dependent on imported inputs, with foreign value added content making up 42.4% of gross export value (see Figure 3-5). Other UK sectors that are heavily reliant on foreign inputs for their exports are Other transport equipment (32.5% import content), Basic metals (30.4%) and Motor vehicles (29.2%).

Most UK sectors are more reliant on inputs from outside the EU for their exports

In addition, the majority of UK exporting sectors rely more on non-EU suppliers than EU27 suppliers. Exceptions include the Motor vehicles; Rubber & plastics; Hotels & restaurants; Paper and printing; Food products; and Wood sectors. The UK exporting sector most dependent on inputs from the EU27 is Motor vehicles; EU27 value added content was 15.9% of gross export value in 2015. UK gross exports in services tend to have lower import content compared to exports in manufacturing. Notably, just 4.1% of UK gross exports in Real estate was imported value added content in 2015.

Figure 3-5 Origin of value added in UK gross exports by UK exporting sector, % of UK gross exports, 2015

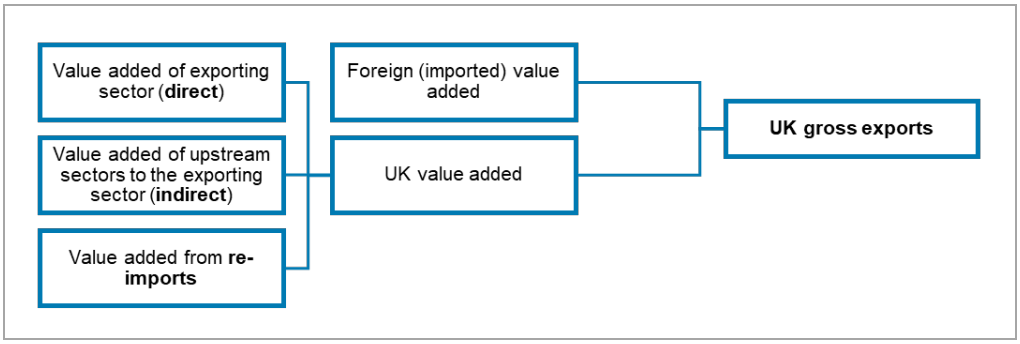


Notes: * Full sector names are: Electricity, gas, water supply, sewerage, waste and remediation service; Other manufacturing; repair and installation of machinery and equipment.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

3.5 Direct, indirect and re-imported value added in UK gross exports

Domestic value added in UK gross exports can be decomposed further into direct, indirect and re-imported value added (Figure 3-6).

Figure 3-6 Decomposition of domestic value added content of UK gross exports



Sources: CE illustration.

The direct domestic value added is exported by the UK sector where it originates, while the indirect domestic value added originates from other upstream UK sectors. Re-imported value added accounts for UK value added which has previously been exported and then imported back into the UK, entering UK exports again.

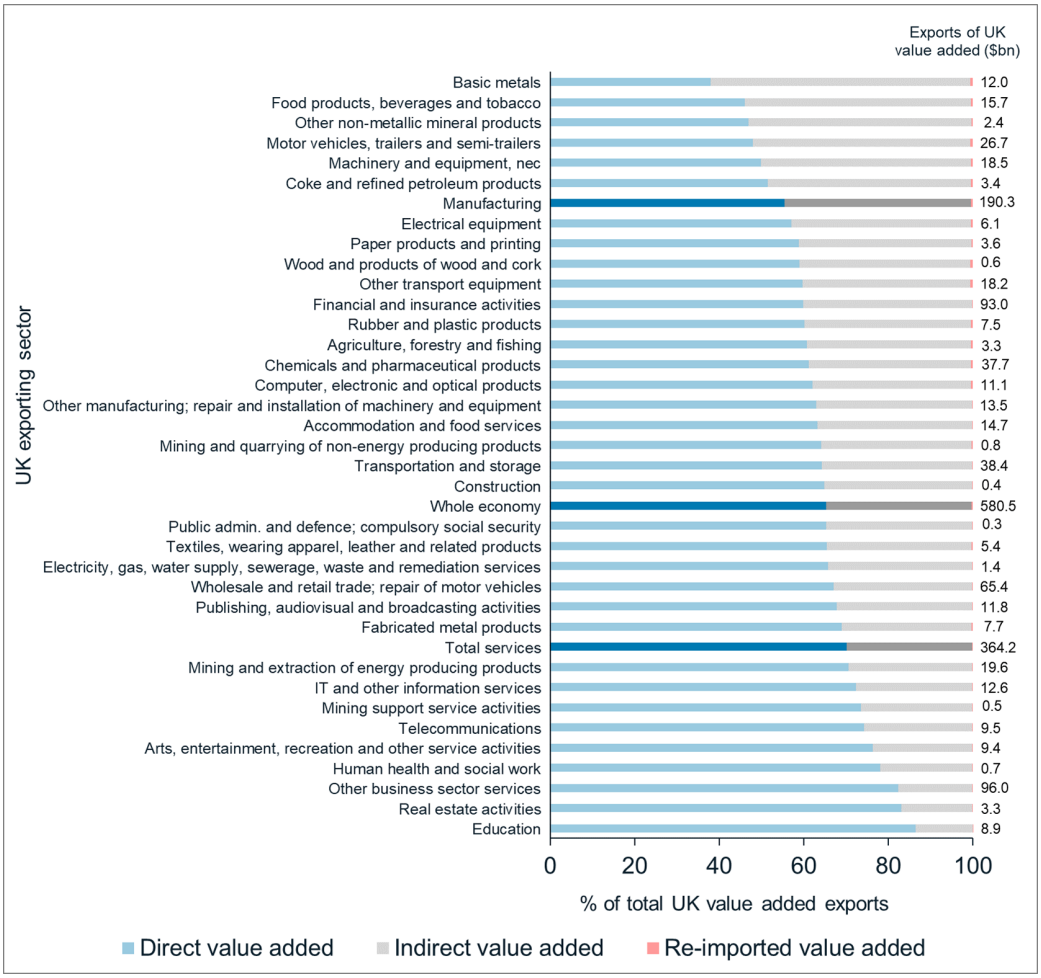
The direct value added content of UK service sectors' exports tends to be high

Figure 3-7 presents the breakdown of UK value added by UK exporting sector. The shares of direct and indirect content vary greatly across sectors; the share of re-imported domestic value added is consistently negligible (below 1% for all sectors). The services sector tends to have a much higher share of direct domestic value added (70.1% of total UK value added exports in 2015), in contrast to the manufacturing sector, where direct domestic value added content is lower (55.4% of total UK value added exports). This reflects the relatively higher level of fragmentation and specialisation of manufacturing supply chains compared to services. These shares remained relatively stable between 2005 and 2015, with both manufacturing and service sectors seeing small increases in the share of direct domestic value added content during that period by 2pp and 1pp, respectively.

Services contributed substantially to UK value added exports of Basic metals and Food products

Among the sectors with the highest share of indirect value added content are Basic metals, Food products and Non-metal minerals. Over 50% of total UK value added exports in these sectors originated from other upstream UK sectors in 2015, with particularly high contributions from Wholesale & retail and Transport & storage. In contrast, nearly all value added (86.5% of total UK value added exports) of the Education sector is direct, with very small contributions from other sectors. Similarly, high shares of direct domestic value added are observed for Other business services (82.4%) and Real estate (83.1%).

Figure 3-7 Direct, indirect and re-imported UK value added exports - % of total UK value added exports (2015)



Sources: CE calculations based on the OECD TiVA Database: Direct domestic value-added content in gross exports (EXGR_DDC), Indirect domestic value-added content in gross exports (EXGR_IDC) and Re-imported domestic value-added content in gross exports (EXGR_RIM).

Focus - Reading heatmaps

Heatmaps are a graphical representation of distribution in which values are represented by colours.

Heatmaps in this report present the distribution of value added across sectors and countries. For example, value added originating in different countries (the x-axis in Figure 3-8) can enter various UK exporting sectors (the y-axis in Figure 3-8). The intersections of countries of origin and UK exporting sectors create unique cells. These cells are filled in with colours corresponding to the country's share of all foreign value added in the exports of the UK sector. The colour scale is provided on the right side of the heatmap with the corresponding percentage values.

3.6 Composition of foreign value added in UK gross exports

Figure 3-8 and Figure 3-9 outline the dependence of UK exports on imported inputs by country of origin using heatmaps.

Among EU27 countries, Germany is the largest supplier of inputs to UK exporting sectors

In the EU, UK exporting sectors source their foreign inputs mainly from large economies such as Germany, France, and Italy. In 2015, Germany supplied 11.9% of all foreign inputs used in UK exports. Notably, German inputs form a high share of foreign value added in exports of the UK Motor vehicles sector. In 2015, UK gross exports in the Motor vehicles sector totalled just under $38bn. Of this, $11bn was foreign value added. Of this $11bn, just under 20% ($2bn) came from Germany.

More generally, for 2015, it is evident that in almost all UK exporting sectors, imported value added from Germany exceeds that of any other EU27 country; German inputs as a proportion of foreign value added in UK gross exports typically range between 5%-20% across sectors. The lowest share of German inputs is observed for the exports of the UK Coke, petroleum sector, at 2% of foreign value added content.

Outside of the EU, the US is a key supplier to UK exports

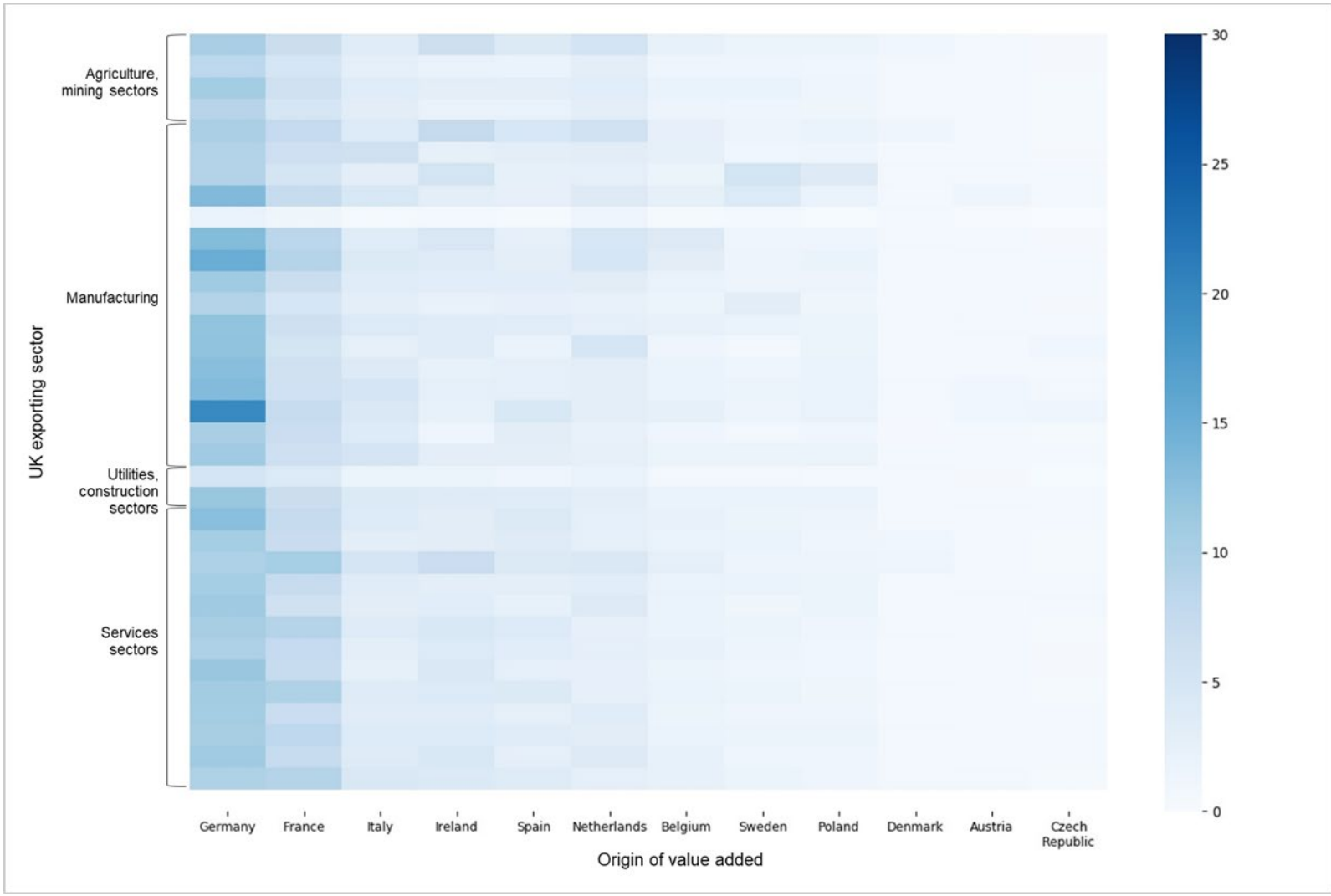
A large proportion of non-EU value added in UK gross exports is sourced from the US and China; together, imported inputs from these economies comprise over 22% of total foreign value added in UK exports in 2015. Underpinning this is a relatively high contribution of US inputs to UK Other transport exports; 30% of foreign value added in the sector's gross exports originates from the US. US inputs are also high for UK exports of Publishing, broadcasting (US inputs comprised 22% of foreign value added in 2015) and Real estate (20%).

Exports in the UK Textiles & apparel and ICT & electronics sectors source a high proportion of their foreign inputs from China (20% and 19% of foreign value added originated from China in 2015 respectively).

The import content of UK gross exports that comes from outside the EU is less concentrated in a small number of economies (Germany being the indicative example in the case of the EU27). Overall, the US and China are the largest suppliers of foreign inputs to UK exports from outside of the EU. Even so, inputs originating from Norway and the Rest of the world[30] exceed that of China and the US for UK exports of the Mining, Utilities and Coke, petroleum sectors. In 2015, inputs sourced from Norway constituted 42.9% and 29.4% of foreign value added in the exports of the UK Coke, petroleum and Utilities sectors respectively, compared to the 5.0% and 11.3% contribution to foreign value added of the US and China combined.

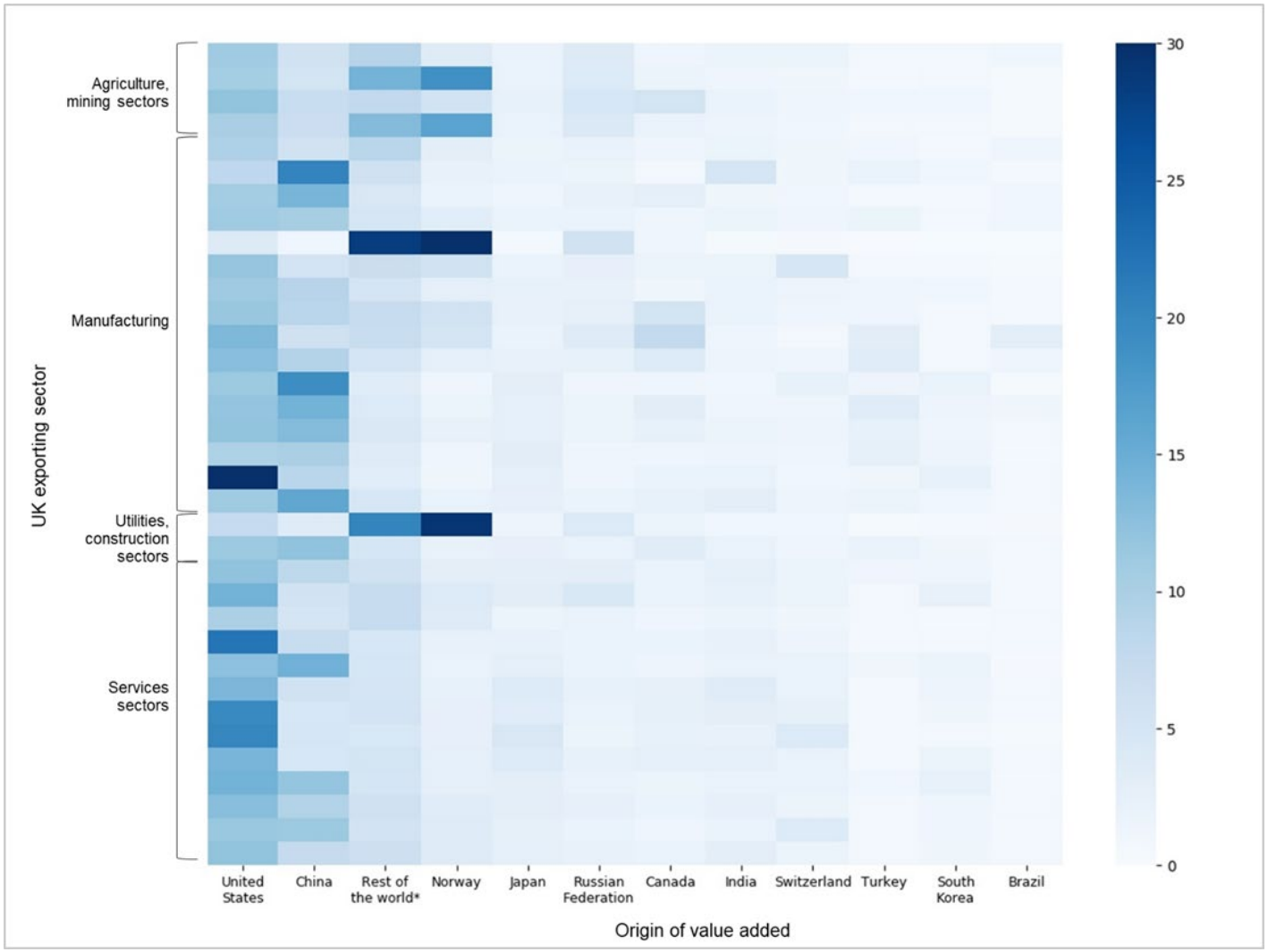
[30] Rest of the world denotes the 65th economy in the TiVA database.

Figure 3-8: Origin of value added in gross exports of selected UK exporting sectors, by EU27 source countries, % of foreign value added, 2015



Notes: Figure presents the 12 largest contributing EU countries.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

Figure 3-9: Origin of value added in gross exports of selected UK exporting sectors, by selected non-EU source countries, % of foreign value added, 2015



Notes: Figure presents the 12 largest contributing non-EU regions. *Rest of the World denotes countries not individually covered within the TiVA database.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

The US and Germany are key suppliers to UK exporters

Table 3-1 presents the value added content of UK gross exports for selected sectors by country of origin. In absolute terms, the US and Germany are the largest suppliers of inputs to UK exporters; in 2015, these countries contributed $8.7bn and $8.1bn respectively to the exports of the UK manufacturing sector. Even so, imported inputs from these countries are small as a share of UK manufacturing gross exports (which totalled $254.2bn in 2015), at 3.4% and 3.2% respectively.

A similar pattern is observed for exports of the UK Finance & insurance sector, for which inputs sourced from the US (at $1.8bn) greatly exceed that of Germany ($907m) and France ($446m) in 2015. Nevertheless, imported inputs are low compared to UK gross exports in the sector ($102bn) in the same year.

In the Motor vehicles sector, inputs from Germany were far higher than contributions from other major economies. In 2015, inputs from Germany ($2.2bn) embodied in exports of the UK Motor vehicles sector was roughly double that imported from the US ($1.0bn) and China ($1.1bn).

Table 3-1 Origin of value added in gross exports of selected UK exporting sectors, by selected source country ($m), 2015

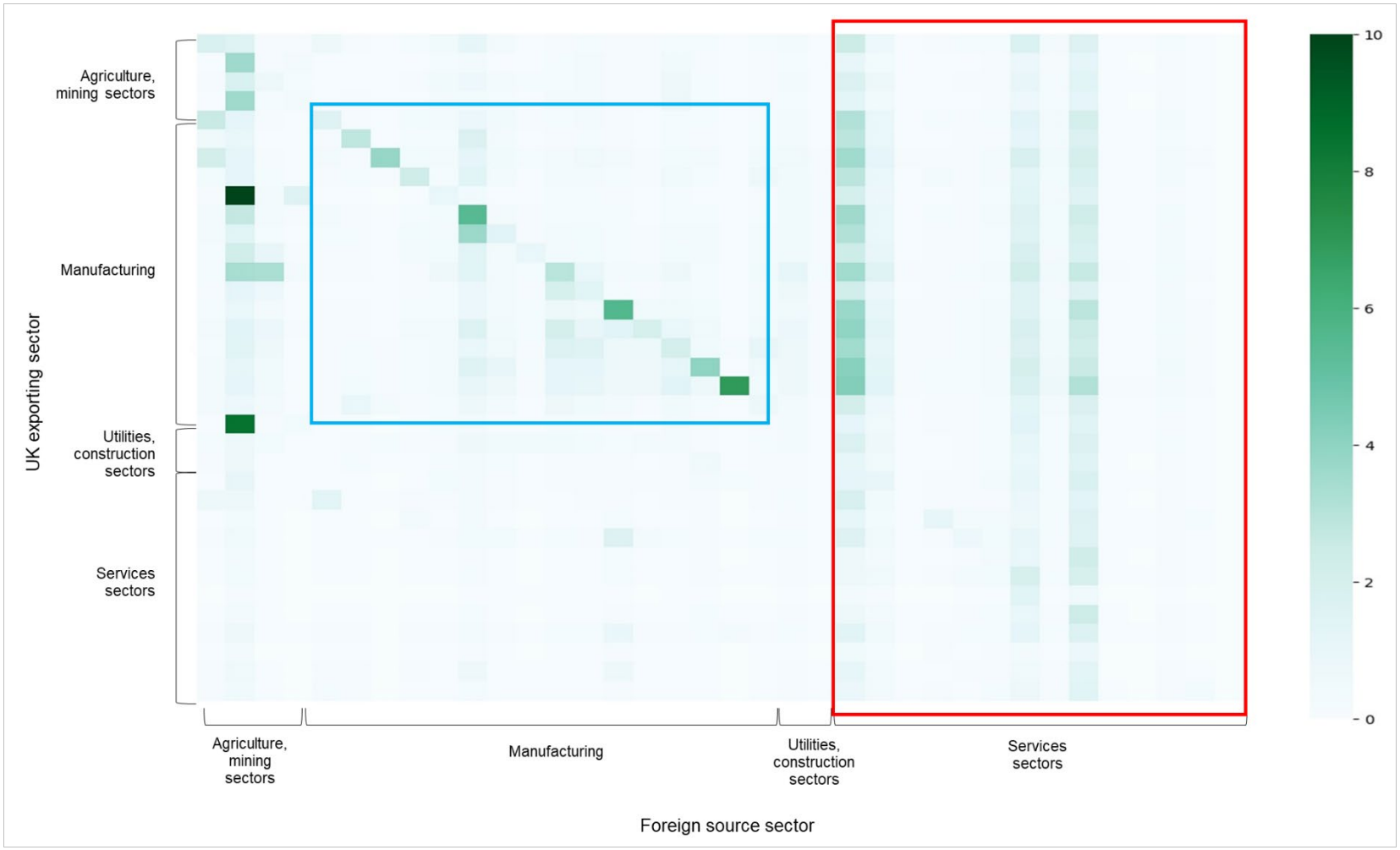
UK exporting sector	United States	Germany	China	Norway	UK gross exports
All sectors	14,433	12,273	8,414	4,541	683,521
Mining and quarrying	291	231	153	493	23,648
Manufacturing	8,670	8,137	6,021	2,893	254,177
Of which: Coke and refined petroleum products	96	47	29	1,077	5,919
Of which: Chemicals and pharmaceutical products	1,360	1,511	613	668	49,170
Of which: Motor vehicles, trailers and semi-trailers	1,047	2,168	1,104	167	37,734
Total business sector services	5,217	3,693	2,081	995	378,871
Of which: Financial and insurance activities	1,831	907	446	231	102,326

Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

3.7 Sector-level dependence of UK exports

Next, we explore the dependence of UK exporting sectors on inputs by source sectors abroad (see Figure 3-10). The darker the square, the higher the contribution of the foreign sector (x-axis) to the gross exports of the UK sector (y-axis).

Figure 3-10 Origin of value added in UK gross exports by UK exporting sector and foreign source sector, % of gross exports of UK exporting sector, 2015



Notes: The upper bound for the colour map is capped at 10%; for the darkest squares, the proportion of foreign value added to gross exports may exceed that of 10%.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

A few key trends are evident from Figure 3-10. UK manufacturing exporters mostly source their foreign inputs from sectors producing the same products (darker squares along the diagonal in the blue box of Figure 3-10). This suggests that within-sector trade is an important characteristic of UK exporters' supply chains. Most notable instances of this are observed in the Chemicals, ICT & electronics, and Other transport sectors.

Imported value added of services contributes to UK exports of all sectors

Figure 3-10 also highlights the importance of services as an input to UK export production. In 2015, imported value added from service sectors abroad is embodied in the supply chains of almost all UK exporting sectors (red rectangle in Figure 3-10). In particular, imported content from Wholesale & retail, Finance & insurance, and Other business services sectors comprised a consistent (and relatively high) proportion of UK gross exports across almost all UK sectors.

Of total UK manufacturing gross exports in 2015, 1.7% is imported Finance & insurance services; imported inputs from the same sector contributed only 1.3% to gross exports of the UK business service sectors. A similar story is observed for imported value added of Other business sector services and Wholesale & retail.

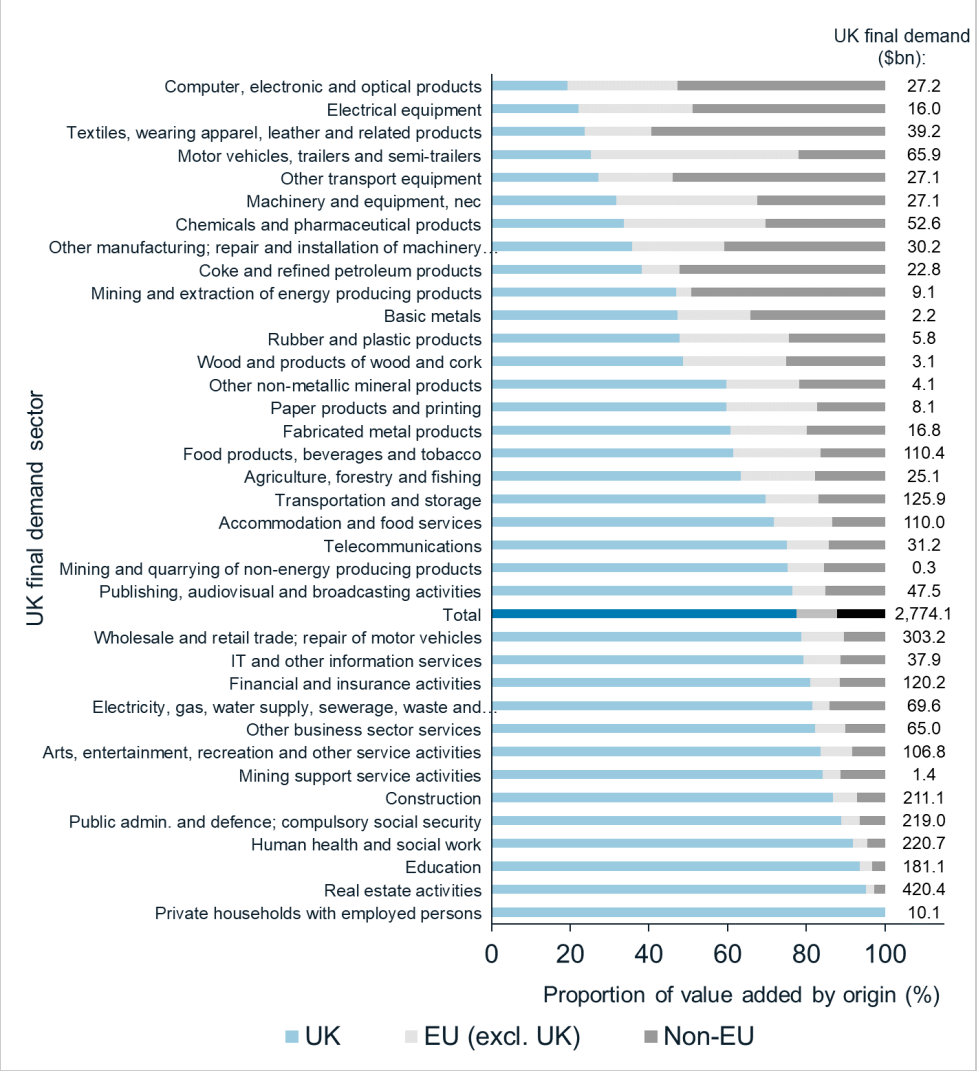
In all of these instances, the foreign source sector's contribution to UK manufacturing gross exports is greater than its contribution to UK gross exports in business service sectors (in percentage terms). This is perhaps not too surprising in the instance of Wholesale & retail, in that the contribution of distribution sectors is often closely aligned with manufacturing activity, and by extension, manufacturing exports.

3.8 Backward linkages of final demand

UK final demand is more dependent on imports

TiVA indicators can be used to explore the dependence of UK consumption (final demand) on imports. The results of the final demand analysis are outlined in Figure 3-11. Compared to backward linkages of gross exports, UK final demand is relatively more import-dependent; foreign content constituted 22.4% of total UK consumption in 2015. This is most notably observed for UK consumption of ICT & electronics, for which 80.8% of the final demand value was imported in the same year.

Figure 3-11 Origin of value added in UK final demand by UK final demand sector, % of UK final demand, 2015



Notes: * Full sector names are: Electricity, gas, water supply, sewerage, waste and remediation service; Other manufacturing; repair and installation of machinery and equipment.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in final demand.

The proportion of foreign value added in UK final demand was 22.4% in 2015, of which 10.2% originated from the EU27. UK final demand for the Motor vehicles, Food products, and Chemicals sectors relies more on EU27 than non-EU suppliers.

In contrast, UK final demand for the Mining of fuels; Coke, petroleum; and Other transport sectors relies more intensively on imports from non-EU than EU27 countries. In these three sectors and as a share of UK final demand by sector, value added imported from non-EU countries was at least 30pp higher than the proportion of value added imported from EU countries in 2015.

3.9 Concluding remarks

Backward linkages measure reliance on foreign inputs for exports and consumption

Backward linkages measure the reliance of the UK on foreign inputs for the production of exports and to meet domestic demand**.** The strength of backward linkages, measured as the share of imported value added content in gross exports, reflects multiple factors, such as the size of the economy, geography and the degree of specialisation in upstream or downstream supply chain activities.

The UK has relatively low backward linkages

In 2016, imported value added content accounted for 15.4% of UK gross exports. This is substantially lower than the OECD average, and partly results from the UK's high level of specialisation in exports of services, which tend to have a low foreign value added content. It therefore should not be interpreted as a sign of trade isolation or a lack of competitiveness of the UK economy. The share of foreign value added content in UK exports remained relatively stable between 2005 and 2016, though it has declined since 2011 as in most developed economies – evidence that the pace of GVC activity has slowed down in recent years, according to the OECD.

Manufacturing sectors are more reliant on foreign inputs

The import content of UK gross exports typically ranged between 5%-15% for service sectors and 15%-30% for manufacturing sectors in 2015. In the same year, the sectors with the highest reliance on foreign inputs included Coke, petroleum (42.4% of imported value added in its exports), Other transport (32.5%), Basic Metals (30.4%) and Motor vehicles (29.2%).

The US and Germany are the largest suppliers to UK exports

The majority of UK exporting sectors rely more on inputs from non-EU than EU27 countries. The relative size of EU27 and non-EU contributions to UK exports remained relatively unchanged between 2005 and 2015, with imported EU value added accounting for close to 7% of UK gross exports, against 8% for non-EU value added.

The slightly higher non-EU share is partly driven by the typically higher contribution of the US in key UK exporting sectors than major EU27 economies such as Germany and France. The only exception to this is imported value added from Germany for UK gross exports of Motor vehicles, for which German value added content (at $2.2bn) was double that of the US ($1.0bn) and China ($1.1bn) in 2015.

UK manufacturing exports are dependent on imported inputs from service sectors

Another finding relates to the dependence of UK manufacturing exports on imported value added from service sectors abroad. In particular, imported inputs from foreign Finance & insurance, Other business services and Wholesale & retail sectors account for a higher share of gross exports in UK manufacturing than of gross exports in UK services. In addition, UK exports in manufacturing sectors are reliant on inputs sourced from the equivalent sectors abroad.

In 2015, 22.4% of UK consumption was met by imported value added. Foreign value added dominates in ICT & electronics and Electrical machinery, accounting for approximately 80% of UK consumption in those sectors. It is, however, less important in the largest service sectors, such as Real estate, Education and Health, where over 90% of consumed value added is sourced domestically.

4 Forward linkages: Foreign exports and consumption of UK value added

Key findings

- Forward linkages measure the contribution that a country/sector makes as a supplier of inputs to other countries'/sectors' exports and consumption. Headline indicators of forward linkages are the domestic value added embodied in foreign exports and the domestic value added embodied in foreign final demand (consumption).
- The UK's role in GVCs as a supplier of inputs has increased over 2005-15. In 2015, UK value added used in foreign exports was 23.7% (as a share of UK gross exports), up from 22.0% in 2005.
- In 2015, the UK ranked as the 12th most forward integrated country, out of 64 economies available in the TiVA database. The UK had stronger forward linkages than backward linkages, indicating its more prominent role as a supplier of inputs than a user of inputs.
- The UK has stronger forward linkages with EU27 countries, especially Ireland, Luxembourg and Germany. UK value added embodied in foreign exports amounted to $162bn in 2015, of which nearly two thirds (64.5%) was embodied in EU27 exports.
- The EU27 as an exporter of UK value added has become more important over time; the EU27 increased its share in foreign exports of UK value added from 61.1% in 2005 to 64.5% in 2015. Outside of the EU, key exporters of UK value added are the US and China.
- The UK source sectors that are most dependent on supplying inputs to EU27 exporters are Mining of fuels, Finance & insurance and Agriculture, while the UK source sectors ICT & electronics, Basic metals, Transport & storage and Machinery are more dependent on supplying inputs to non-EU exporters. In absolute terms, the main suppliers of inputs to foreign exports are UK service sectors such as Other business services, Finance & insurance, and Wholesale & retail.
- UK value added exported for consumption abroad is far greater than UK value added for exports abroad, totalling $570bn in 2015. Of the $570bn, around 37.0% was consumed in the EU27. Other large foreign final demand markets of UK value added include the US and China.
- In terms of GVC participation, UK performance is characterised by lower-than-average backward linkages (foreign value added in domestic exports), and higher-than-average forward linkages (domestic value added in foreign exports).
- A lower-than-average GVC participation is not necessarily an indication of a poor international trade performance. A large domestic market or the relative specialisation in the service sector (which tend to require fewer imported inputs) could lower GVC participation, independent of that country's trade performance.

4.1 Introduction

This chapter provides a detailed account of the UK's forward linkages. Section 4.2 describes the concept of forward linkages with an illustrative example. Cross-country comparisons of forward linkages are presented in Section 4.3; a detailed breakdown of UK value added in foreign exports is presented in Section 4.4. Section 4.5 decomposes UK value added consumed abroad by UK sector of origin and consuming country. Section 4.6 presents cross-country comparisons of the overall GVC participation (based on the strength of backward and forward linkages). Section 4.7 provides a brief summary of the chapter.

4.2 Understanding forward linkages

Focus - What is meant by 'forward linkages'?

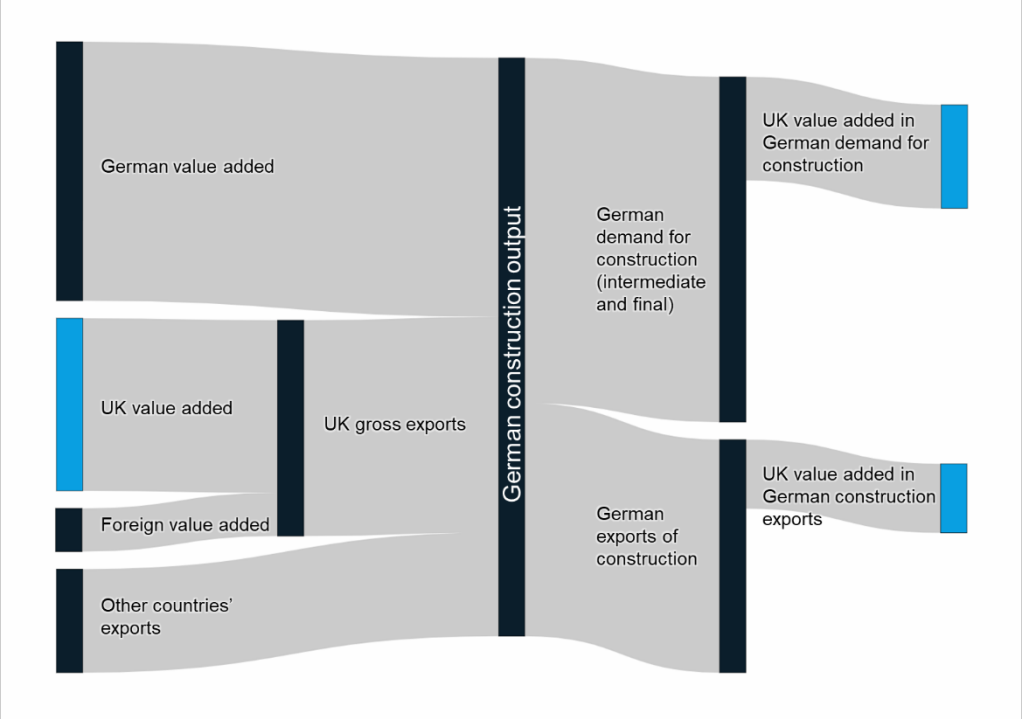
UK forward linkages in Global Value Chains can be measured as UK value added embodied in foreign exports and UK value added embodied in foreign final demand (consumption abroad).

UK value added embodied in foreign exports can provide insight on the reliance of UK suppliers on the export prospects of their trade partners. Similarly, UK value added consumed abroad (embodied in foreign final demand) represents the reliance of UK suppliers on consumption prospects abroad. Another interpretation of forward linkages is the reliance of foreign export and foreign consumption on UK inputs.

Figure 4-1 presents forward linkages in a stylised example of the flow of value added to the German construction sector. The German construction sector uses goods and services imported from the UK (which consist of UK value added and non-UK value added), and goods and services imported from other countries. The total output of the German construction sector (including German value added) goes towards satisfying domestic demand (comprising intermediate demand and end use), and foreign demand (exports), with the UK value added component specifically illustrated for both.

TiVA indicators can also provide insight on forward linkages of individual sectors. UK value added can be disaggregated further by contributing UK sector (not shown in the diagram). For example, in Figure 4-1 some of the UK value added could originate from the financial sector, which provides services to the UK firms that supply building materials to the German construction sector. A contribution from UK financial services to the German construction sector will be captured in trade in value added statistics as UK value added (of financial services) in German construction exports and in German final demand.

Figure 4-1 Stylised example of UK forward linkages with the German construction sector



Sources: CE illustration.

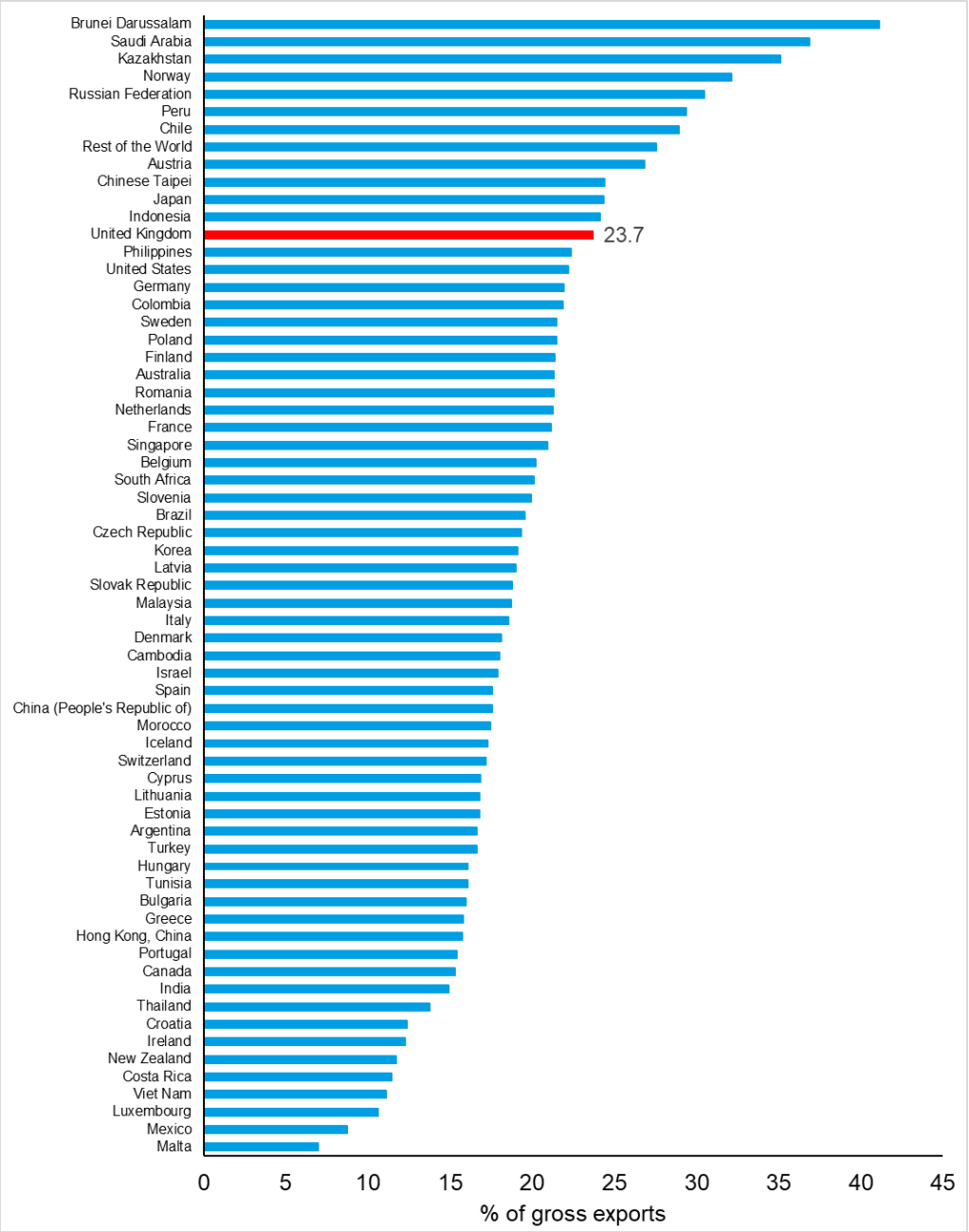
4.3 Forward linkages of exports: dependence on UK relative to other countries

The UK's contribution as a supplier of inputs to other countries' exports ('forward linkages') can be measured as the UK value added embodied in exports of other countries, as a share of total UK gross exports. The higher this ratio, the more integrated the UK is in supply chains of foreign exports (notwithstanding caveats associated with the measure – detailed in Section 4.6). By extension, the stronger the forward linkages, the more important foreign export prospects would be for the UK economy.

The UK's forward linkages are relatively strong

The UK ranks 12th out of the 64 economies in TiVA in terms of domestic value added embodied in foreign exports, expressed as a share of domestic gross exports (Figure 4-2). The top of the chart is dominated by countries whose value added becomes embodied in other countries' exports and crosses many borders before arriving at the final destination. This is especially true for countries with economies specialised in primary inputs (Saudi Arabia, Norway, Chile). Countries with low forward linkages are typically small open economies with high shares of foreign value added content in their gross exports.

Figure 4-2 Domestic value added embodied in foreign exports, as a share of domestic gross exports (2015)

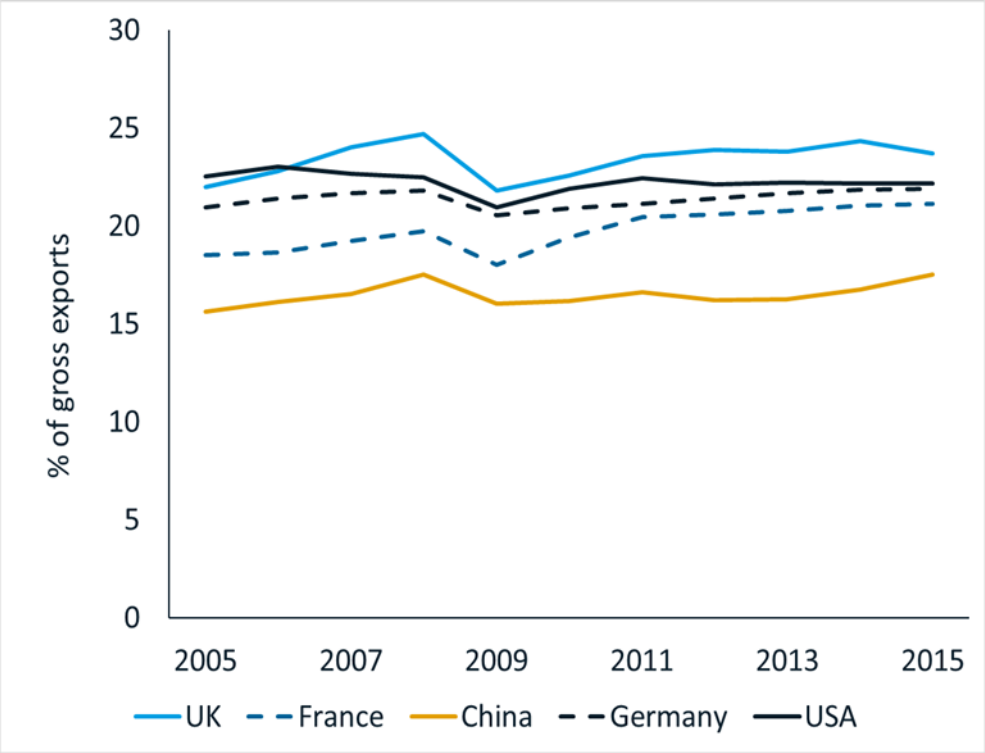


Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

The strength of the UK's forward linkages is similar to that of other major economies

Comparing the UK with other major economies reveals that the UK has a similar level of forward linkages to France, Germany and the US (Figure 4-3). In 2015, UK value added embodied in foreign exports was $162bn, compared to $278bn for Germany and $138bn for France. UK value added in foreign exports as a share of UK gross exports increased slightly from 22.0% in 2005 to 23.7% in 2015. Germany and France experienced a broadly similar trend over the same period, with the share of value added embodied in foreign exports reaching 21.9% and 21.2% of gross exports in 2015, respectively.

Figure 4-3 Domestic value added embodied in foreign exports, as a share of domestic gross exports (2005-2015)



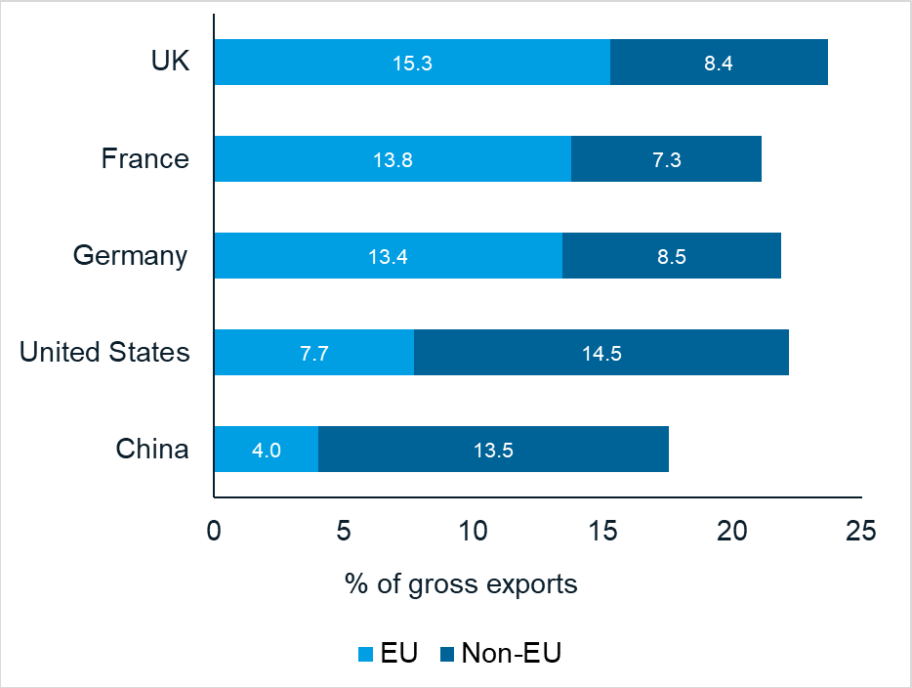
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

The EU27 is the main foreign exporter of UK value added

Figure 4-4 illustrates forward linkages of the UK with EU27 and non-EU partners in 2015. It shows that the UK has stronger forward linkages with the EU27, with nearly two thirds (64.5%) of UK valued added embodied in total foreign exports going to the EU (or, in terms of UK gross exports, 15.3% compared to 8.4% to non-EU countries) – see also Table 4.1. The relative importance of forward linkages with EU and non-EU exporters is similar for France and Germany, which contrasts with the stronger backward linkages with the EU for these countries (compared to the UK).

It should be noted that while EU27 countries account for 64.5% of foreign exports of UK value added (exporting $105bn of UK value added in monetary terms in 2015), the contribution of UK suppliers to EU27 countries' gross exports is small, at only 2% (of those countries' gross exports). Similarly, UK value added in exports of non-EU countries (at $57bn) accounts for only 0.5% of their gross exports.

Figure 4-4 Domestic value added embodied in EU27 and non-EU exports, as a share of domestic gross exports (2015)



Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

Table 4-1 presents the evolution of UK valued added embodied in foreign exports between 2005 and 2015 for the largest exporters of UK value added. Besides the major world economies, the top exporters of UK value added include small and open economies such as Ireland, Luxembourg, Switzerland, Singapore and South Korea. Outside of the EU, the UK has strong forward linkages with the US (which exports 4.2% of total UK value added embodied in foreign exports), China (3.6%), Switzerland (3.2%), Singapore (3.1%), South Korea (2.5%) and Canada (1.3%).

The UK's forward linkages with the EU27 have increased over time

The importance of EU27 countries as foreign exporters of UK value added has increased over 2005-2015, from 61.1% of total UK value added embodied in foreign exports to 64.5%. Increases can also be observed for China and South Korea. The shares of the US, Switzerland and Canada declined over the same period.

Table 4-1 UK value added embodied in foreign exports by exporting country/region, % of total UK value added embodied in foreign exports, 2005, 2010, 2015)

	2005	2010	2015
EU27	**61.1**	**63.8**	**64.5**
Of which: Ireland	8.7	9.4	12.0
Of which: Luxembourg	6.2	8.2	10.9
Of which: Germany	10.7	12.5	9.9
Non-EU	**38.9**	**36.2**	**35.5**
Of which: United States	4.9	4.5	4.2
Of which: China	2.5	2.5	3.6
Of which: Switzerland	3.4	3.4	3.2
Of which: Singapore	3.1	3.1	3.1
Of which: South Korea	1.8	2.1	2.5
Of which: Canada	2.8	2.2	1.3

Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

4.4 UK value added in foreign exports, by UK sector of origin

Figure 4-5 presents UK value added embodied in foreign exports by UK sector of origin. In 2015, UK value added embodied in foreign exports totalled $162bn.

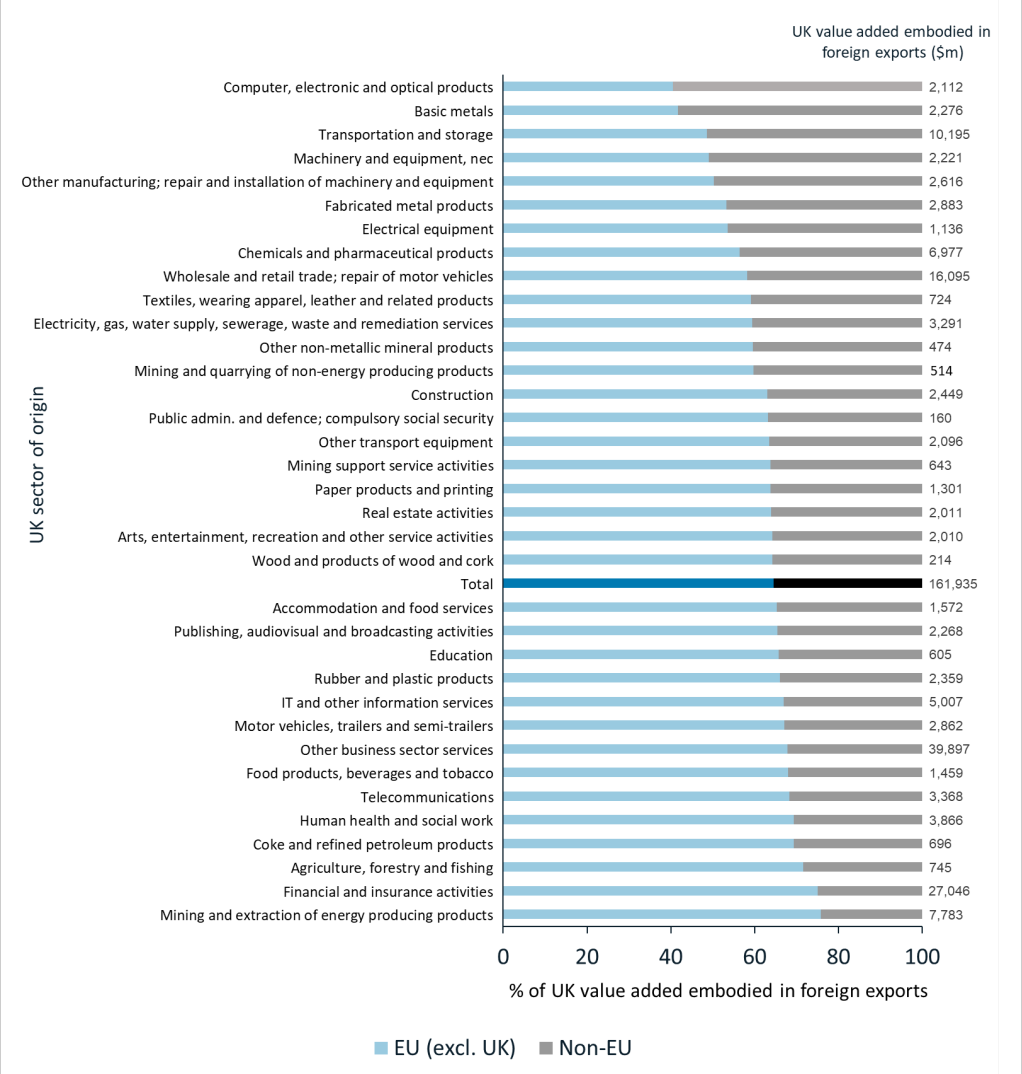
Finance, business and wholesale & retail services dominate as sources of inputs to foreign exporters

The largest contributions of UK value added to foreign exports come from Other business services ($40bn, or 24.6% of total UK value added in foreign exports), Finance & insurance ($27bn, 16.7% of the total) and Wholesale & retail ($16bn, 9.9% of the total).

Figure 4-5 shows that most UK source sectors have stronger forward linkages with the EU27. Exceptions include: Transport & storage, Basic metals, ICT & electronics, and Machinery.

The UK sectors most dependent on supplying inputs to the EU27 are Mining of fuels (76% of the total inputs supplied by this sector abroad are supplied to EU27 exporters), Finance & insurance (75%), and Agriculture (72%).

Figure 4-5 UK value added embodied in world, EU27 and non-EU gross exports, by UK source sector (2015, $m)



Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

A large proportion of UK inputs to EU27 exports originates from the UK Finance & insurance sector

UK value added embodied in foreign exports by UK sector of origin is presented in more detail in Figure 4-6. The distribution of UK value added embodied in foreign exports (by UK sector of origin) varies somewhat across major trading partners, but the main UK source sectors of value added in major trading partners' exports are the same, namely Other business services, Finance & insurance, Wholesale & retail and Transport & storage.

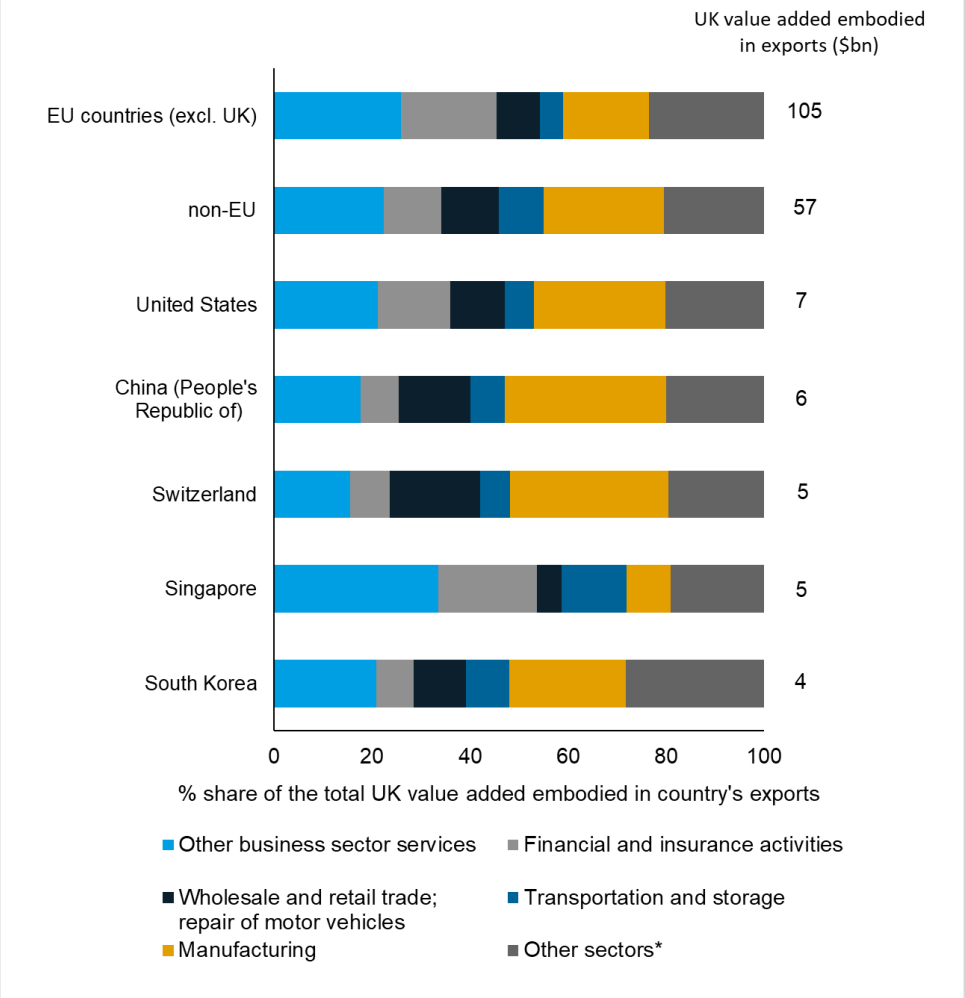
Of these sectors, UK Other business services has a slightly higher share in UK value added supplied to EU exporters compared to its share in UK value added supplied to non-EU exporters. The UK Finance & insurance sector is much more important as a supplier to EU27 exporters – value added in that sector accounts for 19.4% of all UK value added exported by the EU27. This compares to a much lower share the sector has as a supplier of non-EU exporters (at 11.7% of all UK value added supplied to these countries). In contrast, the shares of UK Manufacturing, Transport & storage and Wholesale & retail sectors are greater when considering UK value added in exports of non-EU countries, compared to their shares in total UK value added used by EU exporters.

China and Switzerland have unique linkages with the UK

UK manufacturing sectors, as suppliers of inputs to foreign exporters, play a stronger role in Chinese exports than in most other foreign countries. Closer investigation of manufacturing sectors (not presented individually in the figure) reveals that 7% of UK value added exported by China originated in the UK ICT & electronics sector.

Likewise, Swiss exports of UK value added relied strongly on value added originating from the UK manufacturing sector; in particular, the Chemicals sector (10.3% of total Swiss exports of UK value added). The relatively low importance of the UK Finance & insurance sector in Swiss exports also stands out (accounting for 8.4% of total UK value added in Swiss exports, against an average of 18% for all countries).

Figure 4-6 UK value added embodied in EU27, non-EU and selected countries' exports, by largest UK source sector (% of total UK value added embodied in selected countries' exports), 2015



Notes: *'Other sectors' presents the share of sectors not presented individually.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

Ireland, Luxembourg and Germany are the largest exporters of UK value added in the EU27

A closer look at the EU27 countries' exports of UK value added is presented in Table 4-2. The largest exporters of UK value added include Ireland ($19bn), Luxembourg ($18bn), Germany ($16bn) and France ($10bn). The importance of different UK sectors as suppliers of inputs varies across exporting countries, notwithstanding the universal importance of the UK Other business services and Finance & insurance sectors. In 2015, Luxembourg exported nearly $9bn of UK value added in Finance & insurance; Ireland exported around $7bn of UK value added in Other business services and $3.7bn in Finance & insurance.

Table 4-2 UK value added embodied in EU27 countries' exports, by UK source sector ($m, 2015)

UK source sector	Ireland	Luxem-bourg	Germany	France	Other EU27 countries
Other business sector services	6,995	4,048	3,257	2,915	9,844
Financial and insurance activities	3,669	8,656	2,089	847	5,045
Wholesale and retail trade; repair of motor vehicles	1,509	484	1,931	1,001	4,441
Mining and extraction of energy producing products	694	33	1,222	264	3,689
Transportation and storage	713	575	666	465	2,533
Chemicals and pharmaceutical products	356	43	990	458	2,089
IT and other information services	571	686	460	275	1,357
Human health and social work	515	798	340	180	848
Telecommunications	470	528	256	187	861
Electricity, gas, water supply, sewerage, waste and remediation services	302	175	374	210	898
Motor vehicles, trailers and semi-trailers	50	22	590	139	1,120
Fabricated metal products	195	29	342	183	787
Other sectors	3,377	1,515	3,575	2,405	8,370
Total (whole economy)	**19,415**	**17,590**	**16,092**	**9,528**	**41,881**

Notes: *'Other sectors' comprises of sectors not presented individually.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

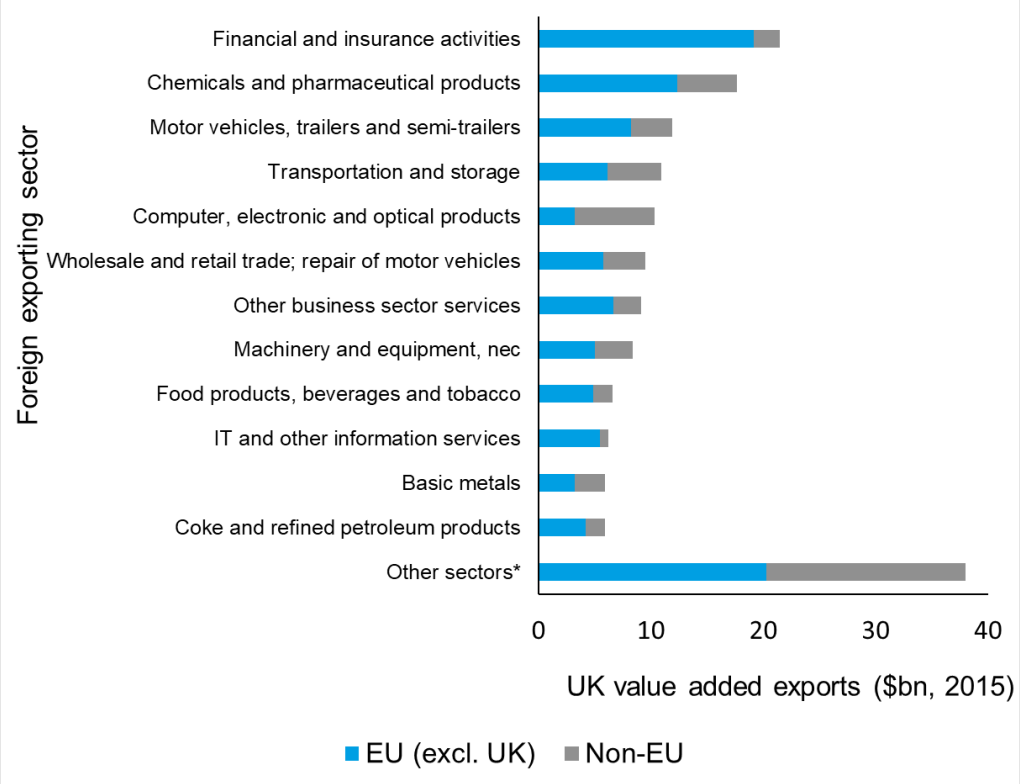
Other particularly strong forward linkages can be observed in German exports of UK value added generated in the Mining of fuels sector. A relatively high proportion of French exports of UK value added originated in UK Other business services and Wholesale & retail sectors.

UK value added in foreign exports, by foreign exporting sector

Figure 4-7 presents total UK value added embodied in EU27 and non-EU exports by foreign exporting sector. There are substantial differences in the sectors that export UK value added in EU and non-EU countries, partly reflecting the different specialisations of these regions.

The largest share of UK value added goes towards exports of the Finance & insurance sector in other countries, at $22bn in 2015. A large proportion of UK inputs to exports of other countries' Finance & insurance sector is supplied to EU exporters (89.1% in 2015). A substantial part of UK value added also ends up in foreign exports of Chemicals ($18bn) and Motor vehicles ($12bn) sectors, where EU exporters are also more important than non-EU exporters. Conversely, non-EU exporters in the ICT & electronics sector source more inputs from the UK than EU exporters in the same sector.

Figure 4-7 UK value added embodied in EU27 and non-EU exports, by foreign exporting sector ($bn, 2015)



Notes: * Other sectors comprises of sectors not presented individually.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

The contributions of UK services to foreign manufacturing exports reflect specialisation in GVCs

Figure 4-8 presents a heatmap of UK value added entering exports of different foreign sectors. As indicated by the dark-shaded cells at the top of the figure, UK service sectors contribute substantial amounts of value added to foreign manufacturing exports.

For example, in 2015, foreign exports in the Chemicals sector contained $18bn of UK value added, of which $12bn originated in UK services, $4bn in UK manufacturing and the remaining $2bn in other UK sectors. This reflects relative specialisation and the way competitive advantage characterises the structure of GVCs; countries specialising in manufacturing purchase UK value added in services (in which the UK specialises) and embed it in their manufacturing exports.

Figure 4-8 UK value added embodied in foreign exports, by UK source and foreign exporting sector ($millions, 2015)

Notes: The upper bound for the colour map is capped at $7,500m for the darkest cells; exports may exceed that level in certain cells.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

4.5 UK value added in foreign final demand

UK value added in foreign final demand, as distinct from UK value added in foreign exports, accounts for foreign purchases of goods and services containing UK value added for the purpose of consumption within the country (not being exported further).

Figure 4-9 presents UK value added in foreign final demand by UK origin sector in 2015. UK value added embodied in foreign final demand amounted to $570bn, compared to $162bn of UK value added embodied in foreign exports[31]. UK value added exported for foreign consumption originated primarily in service sectors such as Other business services ($124bn), Wholesale & retail ($69bn) and Finance & insurance ($68bn). Therefore, the key UK sectors of origin embodied in foreign final demand align with the key sectors of origin of UK value added embodied in foreign exports.

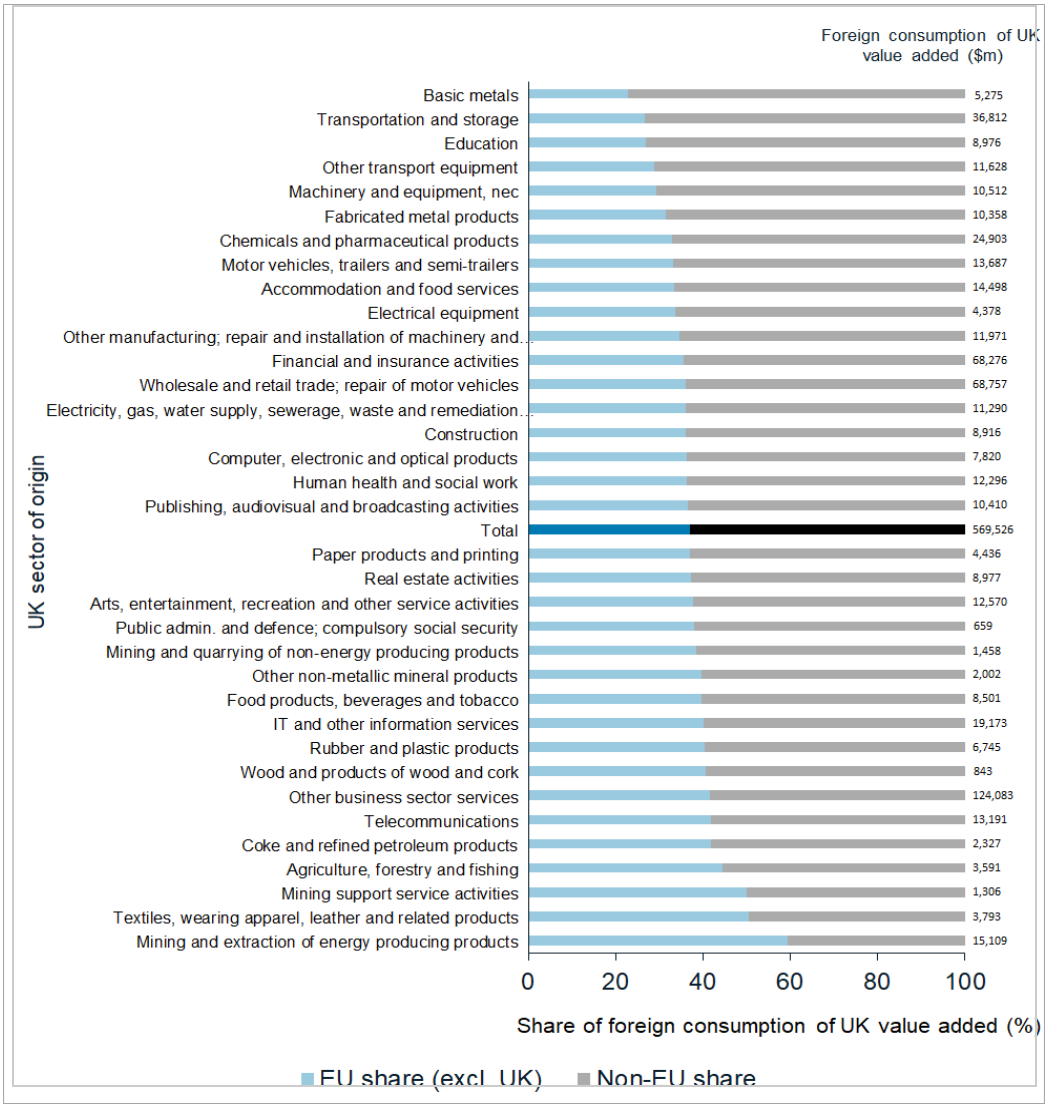
Non-EU countries account for nearly two-thirds of UK value added consumed abroad

Over a third (37%) of UK value added in foreign final demand was consumed in the EU27 in 2015. In Section 4.4, we estimated that the EU27 share in foreign exports of UK value added was 64.5% in the same year. This implies that EU27 countries are more important than non-EU countries as exporters of UK value added, but are less important than non-EU countries as foreign end (or final) consumers of UK value added. Nevertheless, UK value added exports to meet final demand in the EU27 ($211bn) are twice as large as UK inputs to produce EU27 exports ($105bn).

UK sectors that are most dependent on EU27 rather than non-EU final demand include Mining of fuels (59.4% of foreign consumption of UK value added), Other business services (41.5%), IT services (40.2%) and Telecoms (41.8%). In other sectors, the UK has a relatively lower exposure to EU27 demand conditions. This is particularly observed for Transport & storage (26.8% of UK value added consumed abroad is consumed in the EU27), Other transport (28.9%), and Chemicals (33.0%).

[31] It should be noted that UK value added embodied in foreign exports and UK value added in foreign final demand are not mutually exclusive. For example, UK value added in foreign final demand of country A may have arrived there as country B's export of UK value added.

Figure 4-9 UK value added in foreign final demand by UK source sector (2015, $m)



Sources: CE calculations based on the OECD TiVA Database: Origin of value added in final demand (FDVA_BSCI).

The importance of the EU27 as a consumer of UK exports has declined over the years

The EU27 share in foreign consumption of UK value added declined between 2005 and 2015 (from 44.2% to 37.0%), as presented in Table 4-3. In the same period the non-EU share has increased, driven by increasing consumption of UK value added in developing economies such as China. The US remains the largest consumer of UK value added outside the EU27, even though its share has declined over the period.

Table 4-3 UK value added embodied in foreign final demand, by country/region of final demand (% of total UK value added embodied in foreign final demand, 2005-2015)

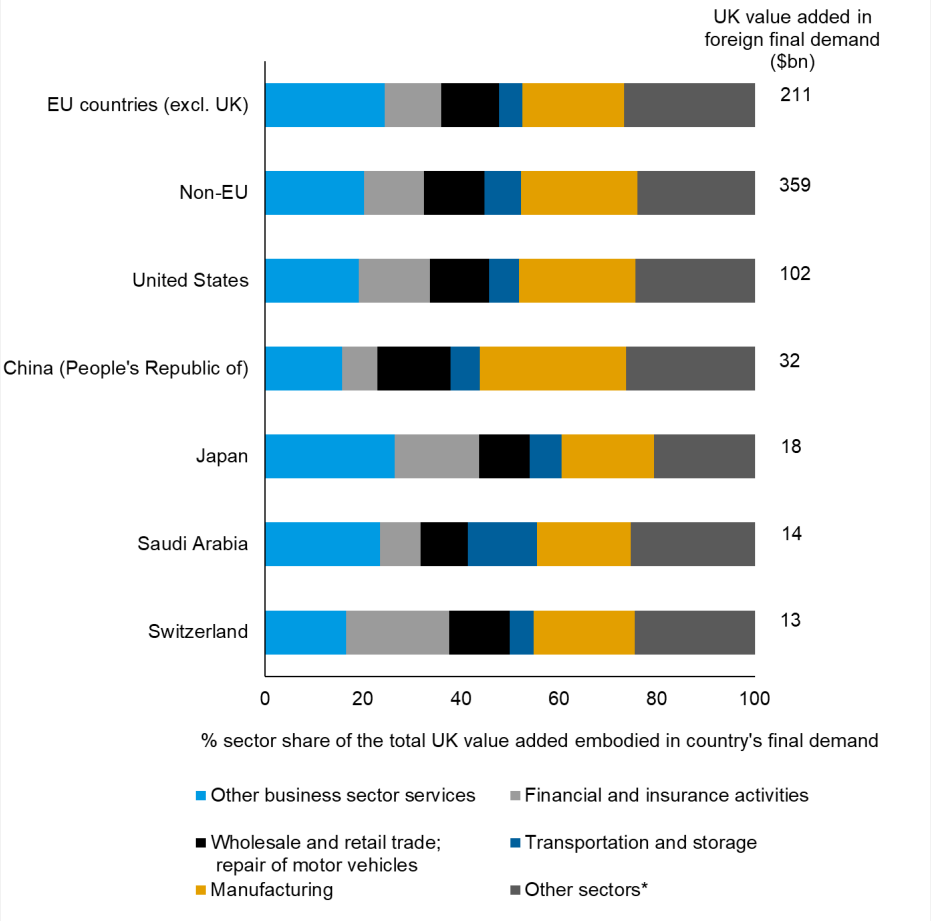
	2005	2010	2015
EU	44.2	42.2	37.0
Non-EU	55.8	57.8	63.0
Of which: United States	20.4	16.5	17.9
Of which: China	1.8	3.0	5.6

Sources: CE calculations based on the OECD TiVA Database: Origin of value added in final demand (FDVA_BSCI).

UK value added in foreign final demand, by UK origin sector

UK value added in EU27 and non-EU final demand and individually for key non-EU partners is presented in Figure 4-10 by UK source sector. The key consumers of UK value added outside the EU27 include the US (17.9% of the total), China (5.6%), Japan (3.1%), Saudi Arabia (2.5%) and Switzerland (2.3%).

Figure 4-10 UK value added embodied in foreign final demand - key UK source sector shares (2015, %) and country totals of UK value added (2015, $bn)



Notes: *Other sectors denotes the sum of sectors not presented individually.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in final demand (FDVA_BSCI).

Most countries primarily consume UK value added originating in the largest UK service sectors

Broadly the same UK origin sectors are important to satisfying foreign final demand in each of the key trading partners.

For all major partners, Other business services, Wholesale & retail and Finance & insurance emerge as the largest sources of UK value added, although with somewhat varying magnitudes. For example, in 2015, EU27 consumption of value added generated by the UK Other business services sector ($52bn) is twice as large as EU27 consumption of value added originating from the UK Finance & insurance sector ($24bn). By contrast, US consumption of UK value added generated by the Other business services sector ($20bn) is much closer to the consumption of value added originating from the UK Finance & insurance sector ($15bn).

Certain other country-specific trade relationships are noteworthy. A relatively high proportion of UK value added embodied in Saudi consumption is generated by the UK Transport & storage sector. Similarly, of UK value added in Swiss final demand, a comparatively high proportion originates from the Finance & insurance sector.

While these sectors account for large proportions of UK trade with Saudi Arabia and Switzerland, in the context of UK value added exported to meet consumption abroad, the importance of these country-specific relationships should not be overstated. For example, in 2015, US consumption of UK Finance & insurance value added ($15bn) is larger than the total UK value added consumed in Switzerland ($13bn).

4.6 Global Value Chain participation rate

The TiVA dataset can be used to estimate the UK's relative participation in GVCs

It is possible to produce a metric that reflects the UK's overall participation in GVCs: the GVC participation rate[32]. The GVC participation is defined as the sum of:

- the share of foreign value added in a country's exports (backward linkages), and;
- domestic (e.g. UK) value added embodied in foreign exports, as a share of total gross exports of the source country (e.g. UK) (forward linkages).

The participation rate is not necessarily an indication of strong or weak trade performance

The degree of integration in global supply chains can be helpful from a policy perspective because GVC participation can create opportunities for growth and development. Nonetheless, the participation rate is driven by various factors and a high or low rate of participation is not necessarily an indication of success or failure in international trade.

For instance, service sectors typically require fewer imported inputs and consequently have weaker backward linkages; likewise for primary extraction sectors. As a result, economies which specialise in service exports tend to have lower GVC participation rates. In addition, countries which are larger economically tend to have lower GVC participation rates because they are more able to source the necessary inputs to production from the domestic economy (e.g. the US versus Luxembourg).

[32] Based on the metric constructed in De Backer and Miroudot (2016).

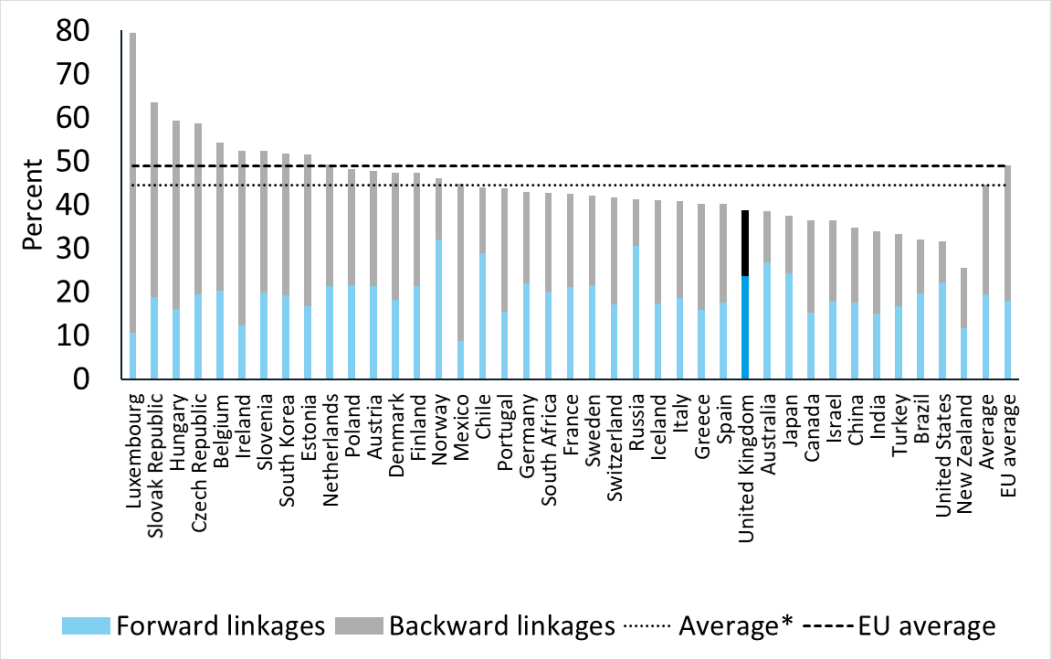
We observe in Figure 4-11 that the UK GVC participation rate in 2015 is fairly low (ranking 49th among 64 TiVA economies). This result is driven in part by low UK backward linkages. UK forward linkages – the share of UK value added in foreign exports – were higher, highlighting the UK's trade position as an exporter of components or intermediate services.

The UK's GVC participation rate is fairly low, largely due to its specialisation in services and the size of the economy

Other large economies such as the US, China and Japan, which all have lower GVC participation rates than the UK, have relatively low backward linkages. On the other hand, the UK GVC participation rate in 2015 was considerably lower than other EU countries. Out of the 20 EU countries included in the country cross-section, the UK has the lowest GVC participation rate, lower than Germany and France.

However, as mentioned above, these differences across countries should not necessarily be taken as an indication of trade performance or competitiveness. Part of the reason for a low overall UK participation rate is its specialisation in services. Service sectors typically demand fewer imported inputs to production and therefore have weaker backward linkages. Weaker backward linkages are also partly explained by the size of the UK economy.

Figure 4-11 Global value chain participation rate among selected countries



Notes: The average is the arithmetic mean of the GVC rate of the selected countries presented in the figure.

Sources: CE calculations based on the OECD TiVA Database: Domestic VA embodied in foreign exports, as a share (%) of total gross exports of the source country (FEXDVAPSH), Foreign value-added share of gross exports (EXGR_FVASH).

Finance & insurance and Other business services have especially strong forward linkages

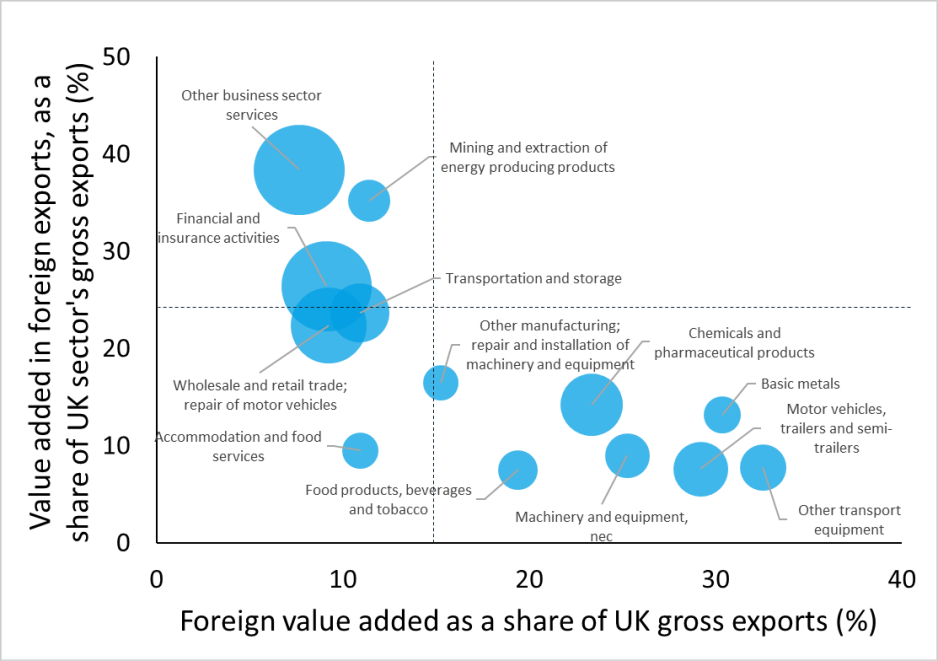
Analysis of sectoral variation in UK GVC participation reveals some interesting features. As represented in Figure 4-12 by a dashed horizontal line, UK forward linkages (UK value added embodied in foreign exports expressed as a share of UK gross exports) stand at around 24% (all sectors average). There are, however, two notable exceptions in which the foreign exports of UK value added make up a substantially higher share of UK gross exports: Other business services and Mining of fuels.

Other transport and Basic metals have strong backward linkages

With regard to backward linkages, as discussed in Chapter 3, the share of foreign value added in UK exports is close to 15% (represented in the figure by a dashed vertical line). The share of foreign value added is much higher in UK manufacturing exports, compared to services. Service sectors such as Finance & insurance, Wholesale & retail and Hotels & restaurants all have lower backward linkages (around 10%). This is, in part, due to the nature of these sectors which commonly require fewer imported components or support services. Manufacturing sectors tend to have higher rates of backward participation with Other transport (e.g. aerospace), Motor vehicles and Basic metals having backward participation rates of around 30%.

For Other transport and Motor vehicles, this is largely due to the fragmented and integrated nature of global supply chains for these sectors. As aerospace and land transport products become more advanced and complex, there is the tendency for supply chains to fragment and countries to specialise in particular technologies. As a result, UK backward GVC participation is high. For Basic metals, the higher foreign value added share is driven in part by the lack of available primary resources (i.e. metal ores). Because unprocessed metal ores typically cannot be sourced from the UK, this means that the UK relies more on international supply chains in the production process.

Figure 4-12 Forward and backward linkages of UK sectors, 2015



Notes: The size of the bubble corresponds to UK gross exports by sector (2015). Figure presents data for 13 UK sectors with the largest gross exports in 2015.
Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross exports (EXGR_BSCI).

4.7 Concluding remarks

Forward linkages measure the dependence of UK production on foreign export prospects

Forward linkages measure the reliance of UK production on foreign countries' export prospects and consumption abroad. UK forward linkages appear to be relatively strong and are at a similar level compared to other major economies: UK value added embodied in foreign exports amounted to 23.7% of UK gross exports in 2015. The UK ranks as the 12th most forward-integrated economy, out of the 64 economies in the TiVA database.

EU27 countries are the main foreign exporters of UK value added

EU27 countries are key foreign exporters of UK value added, accounting for close to two-thirds of the UK value added embodied in foreign exports. At the country level, the largest foreign exporters of UK value added are large economies such as Germany, France and the US, and small, open economies such as Ireland, Luxembourg and South Korea.

Between 2005 and 2015, the importance of EU27 countries as exporters of UK value added increased; the EU27 share in total foreign exports of UK value added increased from 61.1% to 64.5%. Over the same period, increasing shares are also observed for China and South Korea, while the US, Canada and Switzerland saw their shares decline.

UK sectors such as Other business services, Finance & insurance and Wholesale & retail are key suppliers to foreign exports, accounting for approximately half of total UK value added embodied in foreign exports in 2015.

Non-EU countries account for nearly two-thirds of foreign consumption of UK value added

Analysis of UK value added embodied in foreign final demand reveals that besides EU27 countries, the key foreign consumers of UK value added were the US, China and Japan in 2015. In the same year, non-EU countries accounted for nearly two-thirds of UK value added consumed abroad. Trends over time reflect changing demand for UK value added; the shares of UK value added in final demand in China and South Korea increased between 2005 and 2015, while the shares of the EU27 and the US declined.

UK inputs originating from services are as important to foreign consumption as foreign exports

The importance of UK services as inputs to foreign consumption is similar to their importance as inputs to foreign exports. For individual service sectors, however, we observe that UK Finance & insurance and Other business services sectors are more important for foreign exports than for foreign final demand.

Participation in GVCs (based on the strength of backward and forward linkages) varies markedly among countries. The UK's GVC participation rate is lower than all other EU countries included (including Germany and France), but above that of the US, Japan and Canada.

The UK's GVC participation rate is influenced by various contextual factors

The GVC participation rate is driven by multiple factors, such as the size of the economy and the patterns of specialisation in upstream or downstream activities in supply chains, and should therefore be evaluated in the context of each country's economic situation and location. In the case of the UK, a high level of specialisation in services contributes to the overall low backward linkages.

5 Additional insights from TiVA

Key points

- The US is the UK's top single-country trading partner in both gross and value added terms. In value added terms (and as an end user of UK exported value added), the importance of the US as an export market for the UK is amplified. The US is also one of the largest suppliers of inputs from abroad to UK exporters.
- The EU27's importance as an export market for the UK is lower in value added terms, compared to gross terms. Even so, gross exports from the EU27 for final consumption in non-EU economies contain a substantial amount of UK value added. When ranking by the amount of UK value added embodied in individual economies' gross exports to non-EU consumers, nine of the top 15 economies were EU27 countries. Key foreign exporting countries of UK value added to satisfy non-EU final demand include Ireland ($11bn), Germany ($9bn) and Luxembourg ($7bn).
- It is considerably less common for non-EU exports that are ultimately consumed in the EU27 to use inputs from the UK. Ranking by level of UK value added embodied in foreign exports sold to EU consumers indicates that only three of the top 15 economies were non-EU countries (Switzerland, the US and China).
- Bilateral trade balances can be different in value added and gross terms. The UK's trade surplus with non-EU countries is lower when measured in value added terms. Correspondingly, the UK's trade deficit with EU27 countries is lower in value added terms.
- The importance of service sectors to UK export performance is amplified in value added terms. In 2015, 68.5% of total UK exports was value added in services; this is 10pp higher than the share of services in UK exports measured in gross terms. This is driven in part by service sectors supplying inputs to manufacturing exporters.
- The Revealed Comparative Advantage (RCA) index in value added terms by sector provides broadly the same findings as in gross terms. The UK has a comparative advantage in service exports; notably in sectors such as Telecommunications and Finance & insurance. The only manufacturing sectors in which the UK has a comparative advantage are Other transport and Other manufacturing.
- In 2015, the UK ranked 6th out of 64 economies in terms of the highest RCA indices for service exports in value added terms. This places the UK above other major economies specialising in services, such as the US and France.
- In 2015, 6.6m employees in the UK were supported by UK exporting activity, accounting for 21.2% of total UK employment. Of these, 3.8m (57%) were employed in sectors exporting to non-EU countries and 2.9m (43%) in sectors exporting to the EU.

5.1 Introduction

This chapter presents additional insights that can be obtained from the TiVA database. Section 5.2 compares UK exports, imports and bilateral trade balances in gross and value added terms. Section 5.3 uses TiVA indicators to yield additional insight on the UK's key export markets and supply- and demand-side dependencies. Next, value added measures are used to highlight the importance of services in UK exports (Section 5.4). The UK's Revealed Comparative Advantage (RCA) index by sector, based on value added measures of exports, is presented in Section 5.5. Section 5.6 provides a summary of indicators on UK employment[33] supported by exports. Lastly, Section 5.7 provides brief concluding remarks.

5.2 UK bilateral trade balances in gross and TiVA terms

Table 5-1 presents the top destinations of UK exports in gross terms (used in satisfying final demand and in production of exports) and in value added terms (used in final demand) in 2015. Export market rankings change little in value added terms, with the US, Germany and France remaining the UK's top three export destinations. However, in value added terms (i.e. as final consumers of UK exports), the importance of the US and China rises, while the importance of the EU is slightly lower (with a share of 37.0%, compared to 43.5% in gross terms).

The importance of the EU27 as a UK export market is lower in value added terms

The decline in importance of the EU27 as an export market in value added terms is largely driven by lower exports to Ireland, Luxembourg and the Netherlands. The distortion of trade with Luxembourg in gross terms is particularly evident: while UK gross exports to Luxembourg amounted to $20bn (of which £19bn was UK value added), only $2bn of UK value added was consumed there. The difference is due to a very high share of UK value added being exported further by Luxembourg.

[33] For succinctness, employees is used as a synonym for employment in this chapter. Employment, in principle, would include self-employed individuals as well.

Table 5-1 UK exports in gross and value added terms (2015)

Country / Region	Gross exports ($bn)	Country share in gross exports (%)	Value added exports ($bn)	Country share in value added exports (%)
EU27	**297**	**43.5**	**211**	**37.0**
Non-EU	**386**	**56.5**	**359**	**63.0**
United States	108	15.7	102	17.9
Germany	55	8.1	44	7.8
France	45	6.6	37	6.5
Ireland	40	5.9	20	3.4
China (People's Republic of)	32	4.6	32	5.6
Spain	24	3.5	19	3.3
Netherlands	22	3.2	16	2.8
Luxembourg	20	3.0	2	0.4

Notes: Individual countries are presented in order of their share in gross exports.
Sources: CE calculations based on the OECD TiVA Database: Gross exports (EXGR) Domestic value added in foreign final demand (FFD_DVA).

But the EU remains the UK's largest single market for imports and exports

Table 5-2 presents the top sources of UK imports in gross and value added terms in 2015. In value added terms, imports from non-EU countries constituted a higher share of total imports compared to gross imports: 54.5% in value added terms compared to 49.0% in gross terms. Even so, in value added terms the EU27 remains by far the largest single-market source of UK imports.

In gross terms, the UK's top sources of imports in 2015 were Germany (11.9%), the US (11.8%) and China (9.0%). In value added terms, the top sources of imports remain the same, but the US displaces Germany (11.4%) to become the largest source of imports, with a share of 13.4%.

Table 5-2 UK Imports in gross and value added terms (2015)

Country / Region	Gross imports ($bn)	Country share in gross imports (%)	Value added imports ($bn)	Country share in value added imports (%)
EU27	**376**	**51.0**	**283**	**45.5**
Non-EU	**361**	**49.0**	**339**	**54.5**
Germany	88	11.9	71	11.4
United States	87	11.8	83	13.4
China (People's Republic of)	66	9.0	59	9.5
France	52	7.1	43	6.9
Ireland	40	5.4	23	3.6
Spain	35	4.7	27	4.4
Netherlands	29	4.0	21	3.3
Italy	29	4.0	25	4.0

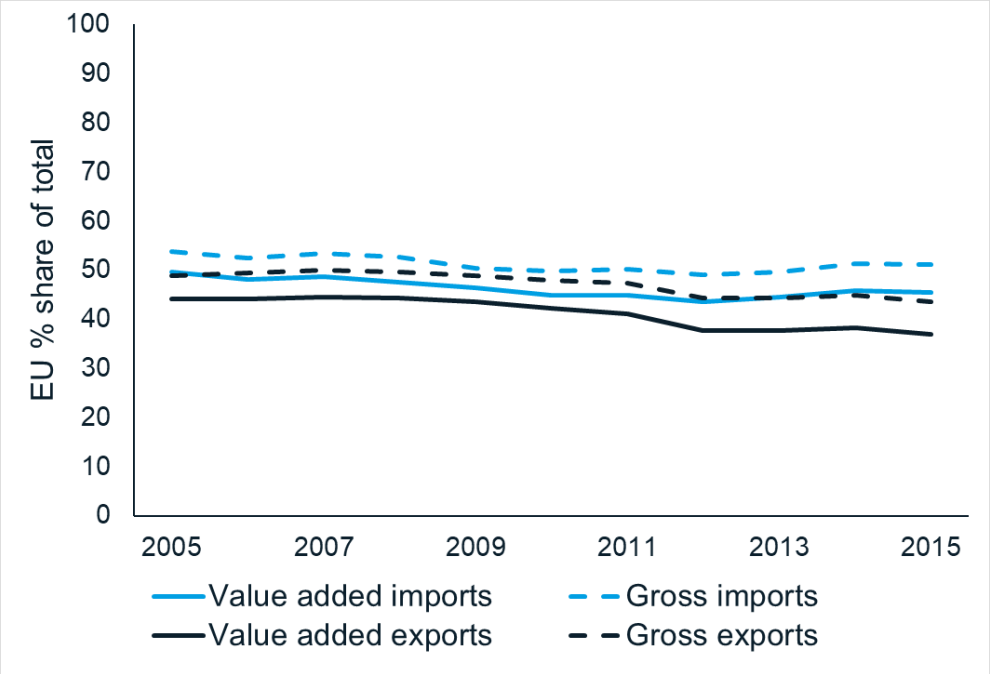
Notes: Individual countries are presented in order of their share of gross imports.
Sources: CE calculations based on the OECD TiVA Database: Gross imports (IMGR) and Foreign value added in domestic final demand (DFD_FVA).

As discussed in Chapter 4, the differences between EU27 shares in UK exports based on gross and value added measures are due to UK value added being embodied in EU27 goods and services that are then exported to non-EU countries (and consumed there). Non-EU value added also enters UK final demand indirectly, through exports of EU27 countries, and this leads to a difference in the EU27 share of total UK imports between the gross and value added measures. The importance of the EU27 market for trade in value added terms therefore takes into consideration that the EU27 serves as a point of access for non-EU exporters to the UK, and as an access point for UK producers exporting to non-EU markets.

The non-EU region is becoming increasingly important as a consumer of UK value added

Figure 5-1 presents exports to and imports from the EU27 as a share of total UK exports and imports, respectively. Shares based on gross and value added terms are presented for comparison. The importance of the EU27 as a consumer of UK value added (UK exports in value added terms) has decreased over time. In 2005, 44.2% of UK exported value added was consumed by the EU27. By 2015, this share decreased to 37.0%. This indicates increasing importance of non-EU economies as consumers of UK value added exports. Similarly, the EU27 share of UK imports has declined from 49.7% to 45.5% in value added terms in the same period. Similar trends are also observed in EU27 shares of UK gross imports and gross exports, represented by dashed lines.

Figure 5-1 EU share of UK exports and imports in gross and value added terms



Sources: CE calculations based on the OECD TiVA Database: Gross exports (EXGR), Gross imports (IMGR), Domestic value added in foreign final demand (FFD_DVA) and Foreign value added in domestic final demand (DFD_FVA).

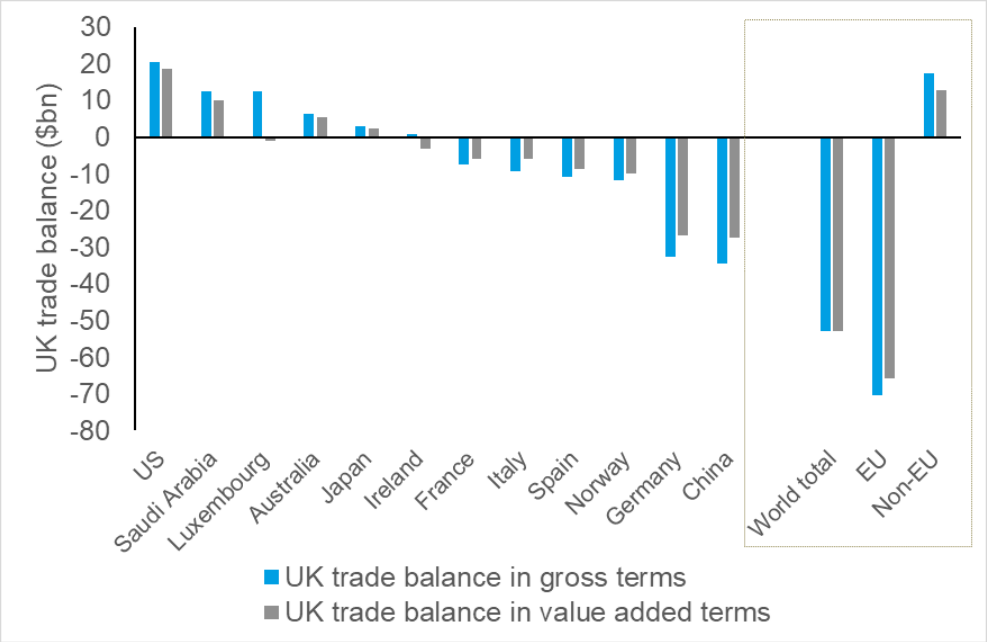
Measuring trade in value added terms does not affect the *overall* trade balance of a country (e.g. UK trade balance with the World). However, bilateral trade balances with *individual* trade partners can look different when measured on a value added basis.

UK trade balances are different when measured in value added terms

Figure 5-2 presents the UK's balance of trade with selected countries in gross and value added terms. The UK's trade surplus with Luxembourg in gross terms turns into a small deficit when measured in value added terms. This is because a large proportion of UK exports to Luxembourg is exported further. A similar picture is observed when looking at the UK's trade balance with Ireland; the UK's trade surplus in gross terms turns into a small deficit in value added terms. In addition, the large trade deficits with Germany and China observed in gross terms are smaller when measured in value added terms. With regard to the UK's largest trading partners, the UK's trade surpluses with the US and the non-EU region are smaller in value added terms than in gross terms, while the UK's trade deficit with the EU is smaller in value added terms.

These differences stem from the widespread use of imported value added in the production of exports and highlight the importance of insights available in TiVA compared with traditional trade measures.

Figure 5-2 UK balance of trade with selected partner countries, in gross and value added terms ($billions, 2015)



Sources: CE calculations based on the OECD TiVA Database: Gross trade balance (BALGR) and Value-added balance (BALVAFD).

5.3 Demand and supply dependencies for UK exporters

Key trading partners and dependencies for UK exporters

This section describes the key supply-side and demand-side relationships for UK exporters, mainly based on Cube 4 of the TiVA database - Gross exports by final destination and origin of value added. These indicators show how individual countries of final demand contribute to UK gross exports.

The analysis in this section differs from the analysis in other sections of the report:

- Section 5.2 (gross export indicators) explores UK gross exports to direct recipients only. Indicators presented in this section break down UK gross exports to the world by country of final demand and by source country of value added.
- Section 5.2 (value added indicators) and Section 4.5 present indicators of final demand decomposed by source of value added (UK value added in foreign final demand). Indicators presented in this section instead decompose gross exports by country of final demand and source of value added.
- Section 3.4 presents origin of value added in UK gross exports to the world. Indicators presented in this section extend the detail by identifying country of final demand.

Distinct from indicators presented in other sections, Cube 4 captures three spatial dimensions simultaneously: the economy where value added originates; the economy which exports the product/service and the economy whose final demand drives the trade. Cube 4 indicators can therefore reveal which economies' final demand drives UK gross exports and, simultaneously, where the value added in these exports originates. They also show how value

added originating in the UK may rely on exporting activities of other countries before it reaches the final demand country.

Cube 5 indicators are also used in this chapter. Cube 5 indicators break down UK gross imports by exporting country and value added source country. This is useful because it provides information about both direct bilateral trade flows to the UK and the origin of production / support services.

Figure 5-3 illustrates the most important sources of value added and final demand markets of UK gross exports. The right-hand side lists the most important end-users of UK gross exports. These are final demand markets which UK exporters rely on and, being such, they illustrate demand-side dependencies in the global supply chain. Importantly, 'end-users' (final demand) of UK exports are not necessarily the same as direct (bilateral) 'purchasers' of UK exports. For example, some UK exports consumed in the US are first purchased by Germany and France before being integrated into a good or service exported to the US market.

The left-hand side of the figure illustrates the most important suppliers to UK exports (destined for the given final consumer country). In representing the key international suppliers to UK exporters, this shows the supply-side dependencies. Crucially, trade frictions with these suppliers could threaten UK exports because they support the provision/production of UK exports.

17.7% of UK gross exports to the world are eventually consumed in the US

At the country level, the US is by far the most important final demand country for UK exports. 17.7% of all UK gross exports is consumed by the US, of which 2.7pp is foreign value added (embodied in UK gross exports). Germany and France follow as the second and third most significant end-users for UK exports (7.6% and 6.3% respectively).

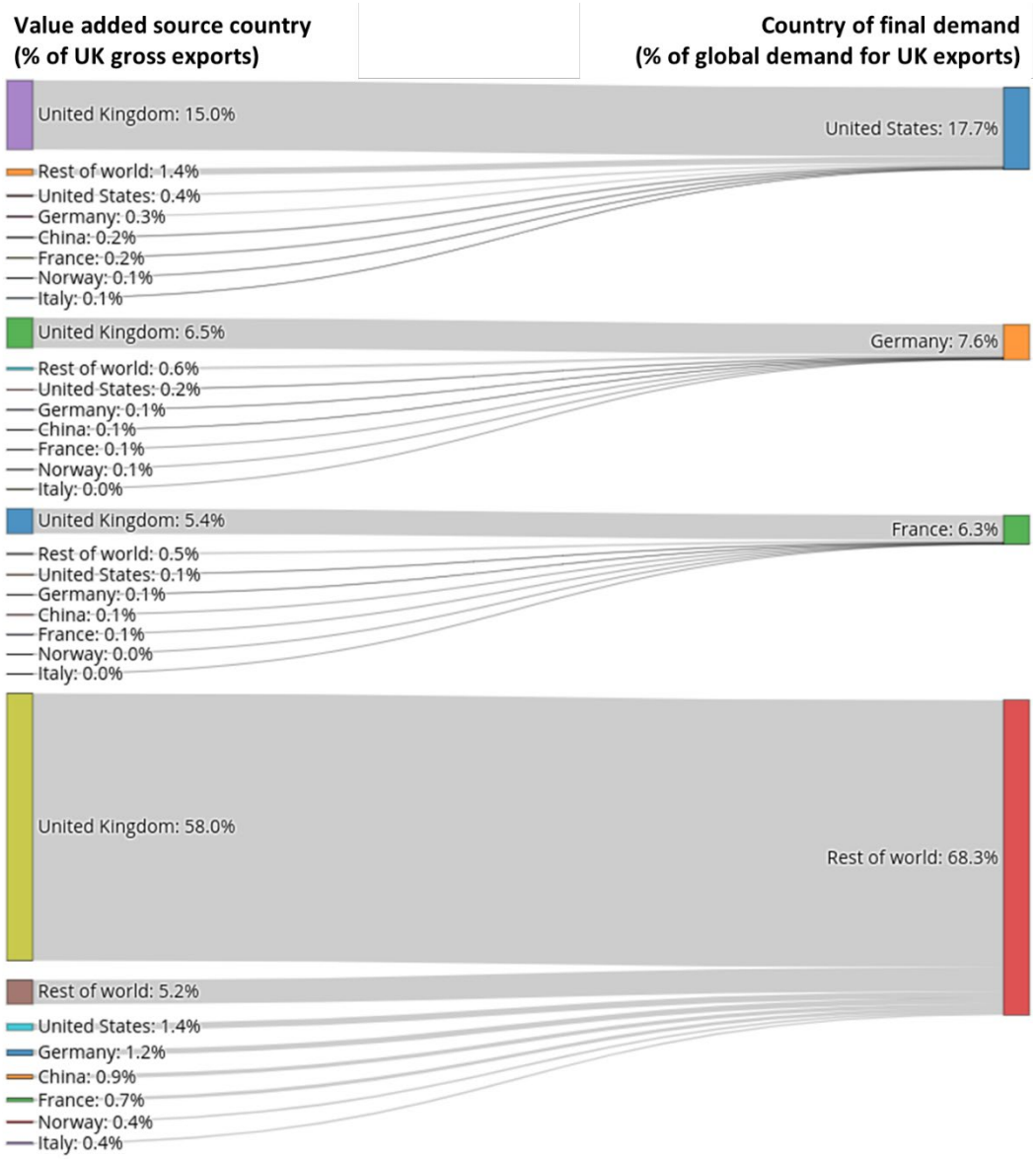
The majority of demand for UK gross exports is not driven by the top three destination countries. Over two-thirds of UK gross exports are consumed in the rest of the world.

The US, Germany and France are prominent suppliers to UK exports

Similar results are observed for foreign value added in UK gross exports. The US, Germany and France all rank highly as the most prominent supply-side contributors to UK gross exports. However, China and Norway also commonly appear as major suppliers to UK gross export production.

The results suggest that trading partners which contribute a high proportion of value added also ultimately consume a substantial share of UK gross exports. Specifically, the same key players appear both as end-users of UK exports and major suppliers for UK provision of exports.

Figure 5-3 Top three final consumers of UK gross exports (broken down by value added source country, 2015)

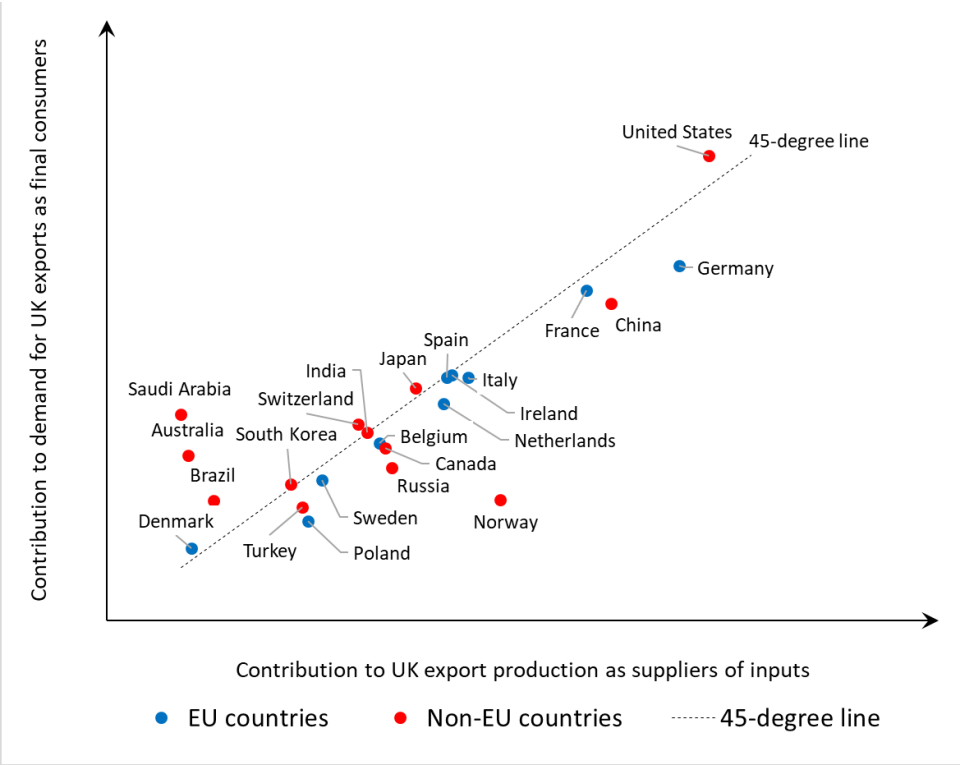


Notes: 'Rest of world' refers to the remainder of countries not listed individually. On the right-hand side this would mean all final demand not stemming from the US, Germany or France. On the left-hand side, Rest of World would refer to total 'world' minus the countries displayed.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

Figure 5-4 examines this in greater detail by contrasting demand and supply-side dependencies for UK exporters. Countries which appear higher on the horizontal axis contribute the most as suppliers of inputs to UK gross exports; countries which are higher on the vertical axis account for the largest shares of final demand of UK gross exports to the world. A 45-degree line is included in the figure which illustrates the points at which a country accounts for the same share of value added in UK exports and final demand.

Figure 5-4 UK gross exports – key supply-side and demand-side dependencies (2015)



Notes: The scale of the axes is logarithmic (base 10). This means that the distance between data-points reflects their relative differences. For instance, China's share of value added in UK exports is roughly three times that of Japan, which is roughly three times that of Denmark. Countries in blue are EU economies and those in red are non-EU economies.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

Countries which contribute a lot of value *added to UK exports tend also to be major end-users, with Germany being one of the key exceptions*

The majority of countries are fairly even in terms of their contribution to UK export production and UK export demand (i.e. many countries appear near the 45-degree line). However, there are a few notable exceptions.

On the supply side, the UK relies more heavily on inputs to export production from Norway, Russia and Germany than on their final demand. For Norway and Russia, this is predominantly driven by supply of raw materials and fuel provided by mining sectors. In absolute terms however, trade with Russia (and, to a lesser extent, Norway) is relatively small. For Germany, the relative dependency on inputs to export production is driven largely by strong backward linkages to the German manufacturing sector. Two-thirds of German value added in UK exports is attributable to the German manufacturing sector.

On the demand side, Saudi Arabia and Australia make up a far higher proportion of demand for UK exports than supply of foreign value added. The UK is therefore relatively more sensitive to demand side shocks to trade with these countries (relative to supply side shocks).

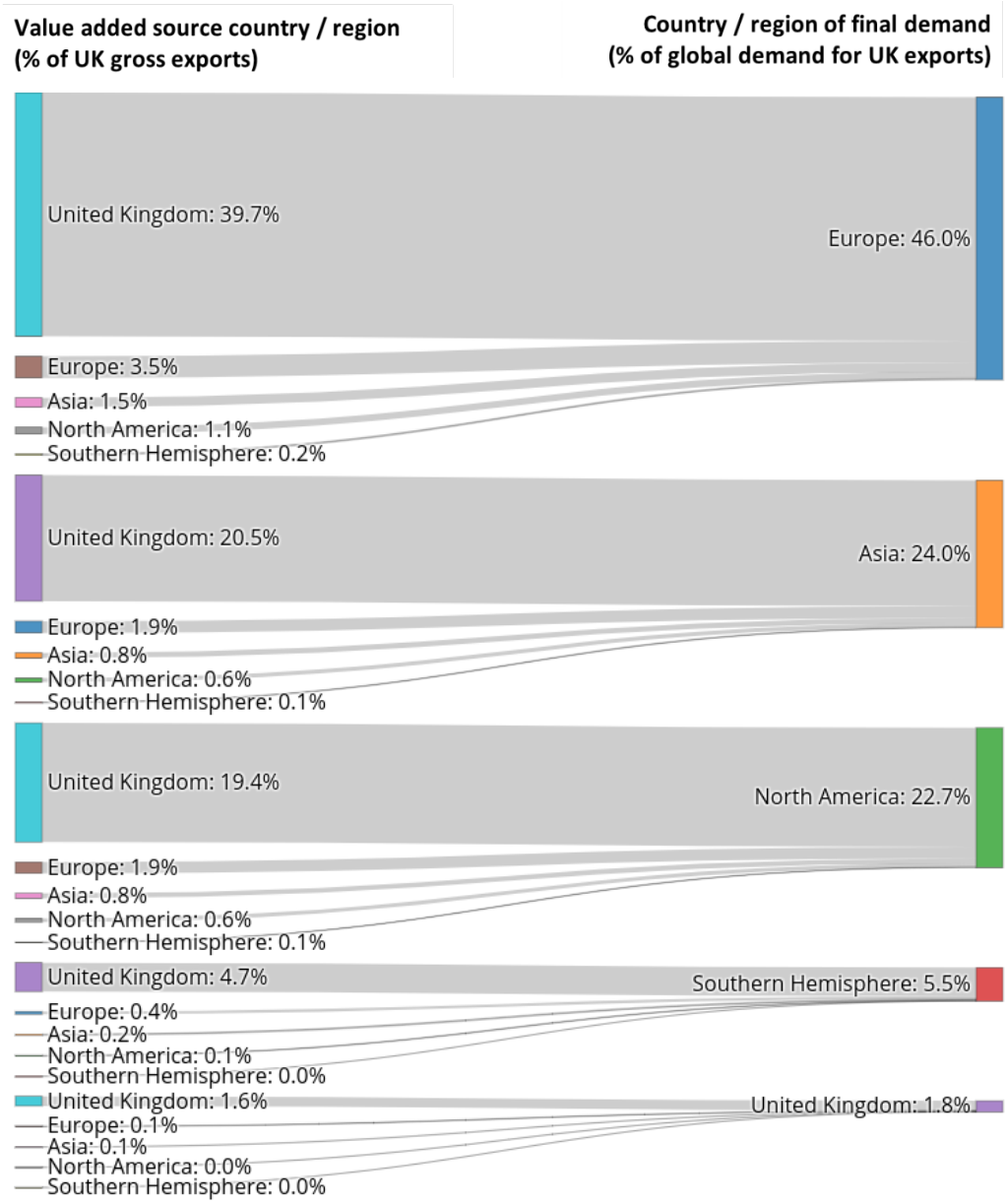
With regard to risk exposure both on the supply-side and demand-side, the most crucial trading partners are the US, Germany, China and France (in that order).

Regional analysis of UK supply chain

Figure 5-5 shows the patterns in major regional blocs as suppliers and consumers of UK gross exports to the world. By far, the most important regional bloc for UK gross exports is Europe. Europe is the end consumer of

over 45% of UK gross exports – 40% due to EU27 countries and 5% due to non-EU European countries. Europe (excluding the UK) is also the largest contributor of value added to UK export production.

Figure 5-5 UK gross exports by regional bloc, by region of final demand and region source of value added, 2015



Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

Key drivers of UK exports

Typically, trade patterns are closely related to 'economic gravity', by which we mean that a country typically trades heavily with economies that are in close proximity or large in size (i.e. high GDP). Figure 5-6 illustrates this feature of the trade data for the UK, mapping consumption of UK exports on the y-axis

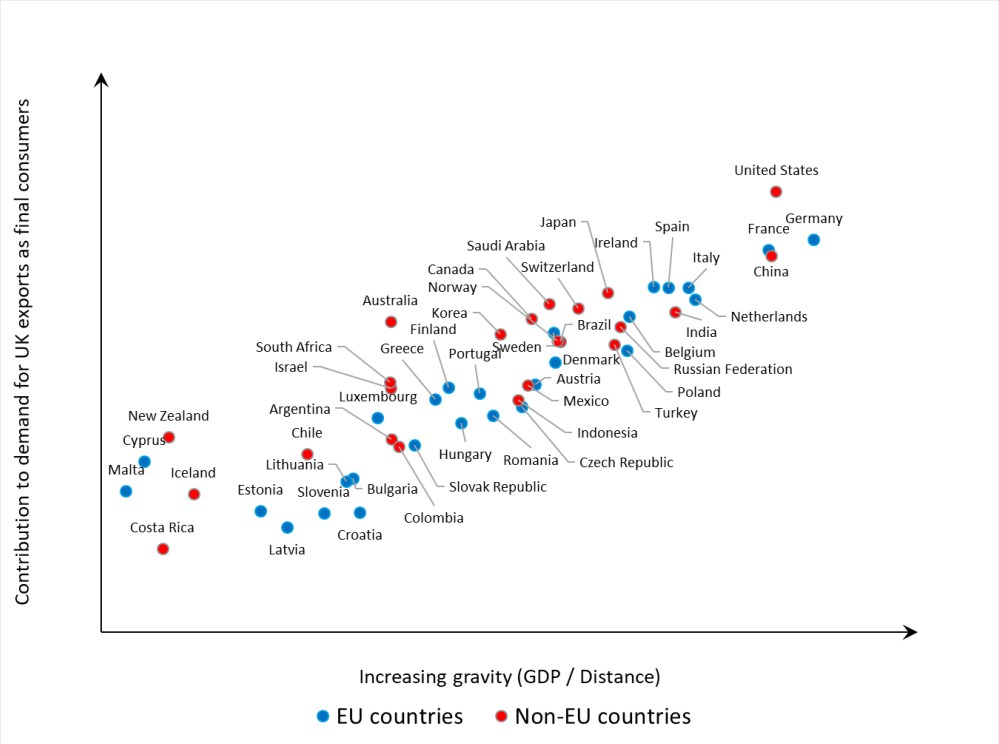
against economic gravity on the x-axis (measured as the size of a country's GDP divided by an estimate of distance[34]).

Analysis of trade gravity reveals other important factors to trade such as cultural / linguistic ties

Deviations from the trend can provide an indication of other factors which influence demand for UK exports. For example, large English-speaking countries such as the US, Australia and New Zealand all appear above the trend in Figure 5-6 (i.e. they consume a greater amount of UK exports than can be explained by gravity). This is likely the result of cultural/linguistic factors which affect barriers to trade and consumer preferences.

Similar deviations from the trend can be observed for small island countries which have close economic/political ties with the UK. This could be, for instance, due to British expatriate communities present in Cyprus and Malta.

Figure 5-6 Final demand for UK gross exports and trade gravity (GDP / distance)



Notes: The scale of the axes is logarithmic (base 10). This means that the distance between data-points reflects their relative differences (see example in the notes section of Figure 5-4). Countries in blue are EU economies and those in red are non-EU economies.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

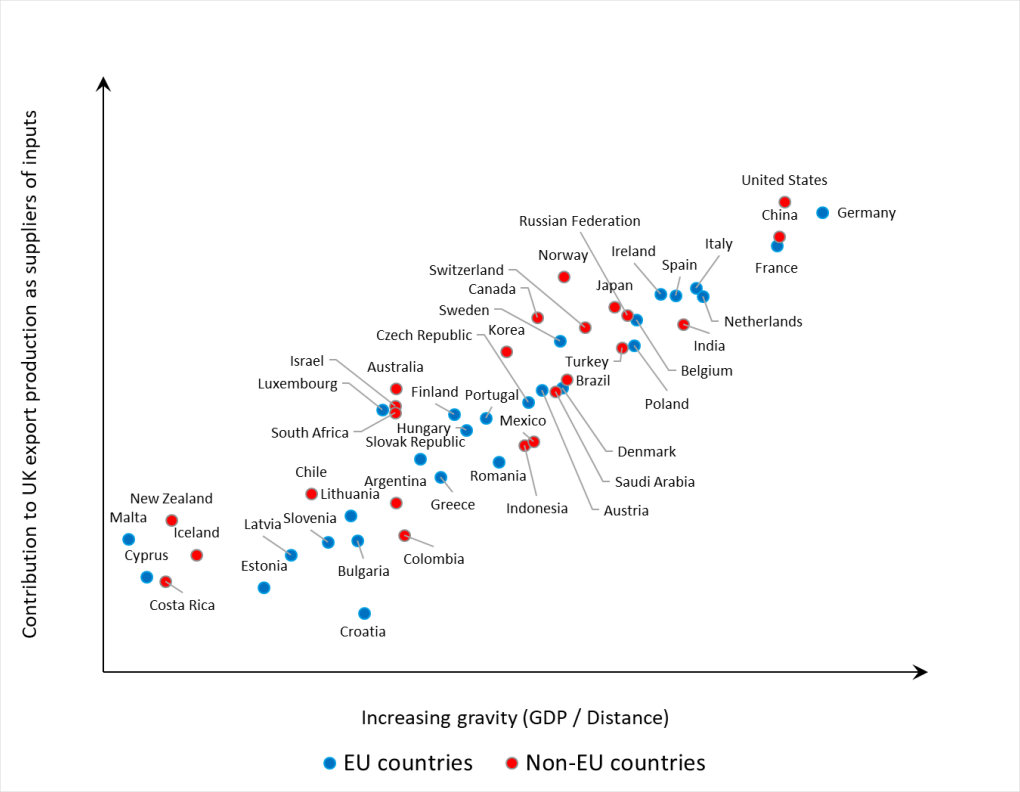
[34] This was done using data from "Distance-from-to" (2019), which uses the distance between the capital cities of countries. This method simplifies geographical proximity as distance is reduced to roughly two points rather than two areas. This simplification is however tolerable, because centres of economic activity are most relevant to international trade. For instance, the distance between London and Moscow is more appropriate than the distance between the UK and eastern Siberia (Russia's geographic centre).

Deviation from the trend could indicate trade competition

Final demand for UK gross exports appears to be slightly lower in the Adriatic region and, to a lesser extent, Baltic countries than would be suggested by economic gravity. This is, in part, due to competition from nearby trading partners, such as Italy and Germany, with which Croatia, Slovenia and Latvia trade intensely.

The corresponding relationship with value added embodied in UK gross exports is shown in Figure 5-7. The origin of foreign suppliers to UK gross exports appears to be explained very well by economic gravity. This is likely due to the fact that UK purchases of intermediate goods and services for production are less affected by consumer preferences and cultural factors than final demand.

Figure 5-7 Value added embodied in UK exports and trade gravity (GDP / distance)



Notes: The scale of the axes is logarithmic (base 10). This means that the distance between data points reflects their relative size (see example in the notes section of Figure 5-4). Countries in blue are EU economies and those in red are non-EU economies.
Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

There are, however, some instances of deviations from the trend. Norway, in particular, supplies a greater amount of value added to UK exports than can be accounted for by gravity. This is consistent with the discussion above regarding the UK's reliance on imports of fuel from Norway. Croatia on the other hand appears to make up a very small proportion of value added, despite being relatively close in proximity to UK. It is likely that Croatia, being a small country very close to Italy and Germany, devotes a large proportion of productive capacity to trade with its nearby trading partners.

Case studies: the UK Finance & insurance and Motor vehicles sectors

Similar analysis was conducted for two key sectors of the UK economy: Finance & insurance and Motor vehicles[35]. For both sectors, the US was found to be the most important individual trading partner (both as a supplier and as a consumer). However, with regard to regional trading blocs, Europe is considerably more important as a supplier to UK exports than North America. Strikingly, North America was found to be only the third most significant final demand market (by continent) for Motor vehicles (behind Europe and Asia), while over 40% of exports was destined for European final consumers in 2015.

Demand for UK Finance & insurance exports is concentrated in a handful of global financial hubs

For the Finance & insurance sector, demand for UK exports is concentrated in a handful of global financial hubs, namely: the US, Germany, Japan and Switzerland. The US and Germany also contributed strongly as suppliers of inputs to UK exports in the same sector. However, France and China played a larger role on the supply side than Japan and Switzerland.

For exports in the UK Motor vehicles sector, final consumers were highly concentrated in the US and China, together accounting for over a third of demand for UK exports in 2015. On the supply side, the UK relied more heavily on European trading partners, most notably Germany and France.

Case studies point further to the integrated and complementary nature of trade

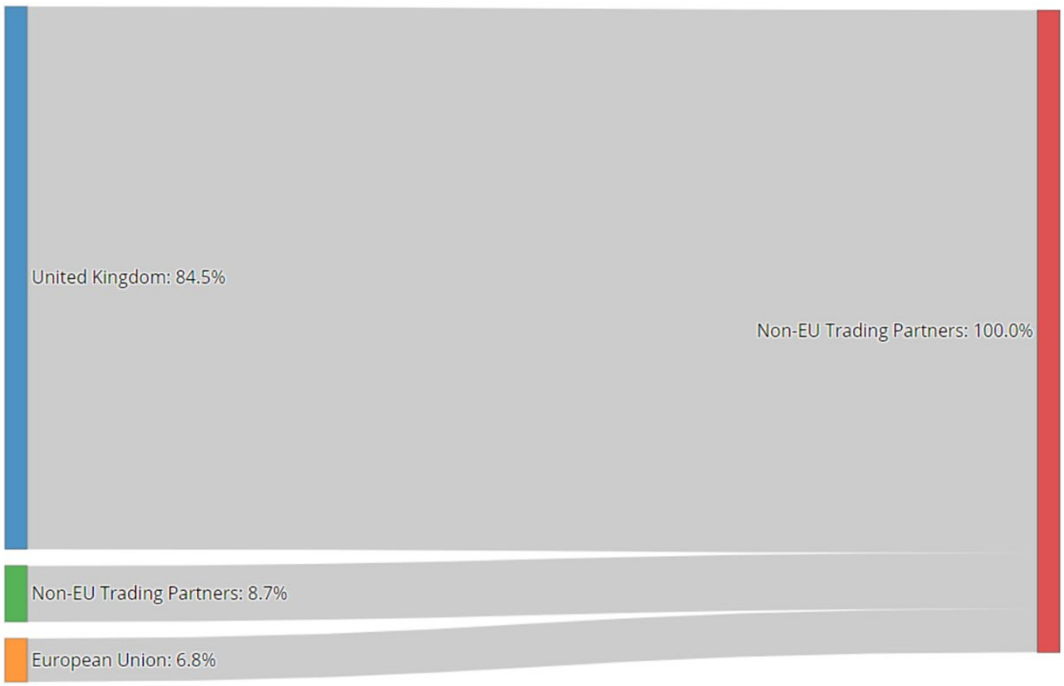
Across the two case studies, the interconnected nature of international markets emerged as a common message. The largest consumers of UK exports tend also to contribute the largest share of foreign value added in the UK's exports. OECD TiVA data also suggest that it is common for trading partners to contribute to value added of goods and services which are destined to return for final consumption. In 2015, the UK was found to be the end consumer of 2.9% of its own exports of financial services. In the same year, Germany accounted for a high share (20%) of the foreign value added in UK exports of Motor vehicles to Germany.

UK trade with non-EU trading partners

Figure 5-8 shows the distribution of UK gross exports which are consumed by non-EU trading partners, broken down by origin of value added. We observe that 15.5% of value added originates from abroad with non-EU trading partners making up 8.7% of value added and EU trading partners making up 6.8% in 2015.

[35] Further details and analysis can be found in Appendix B.

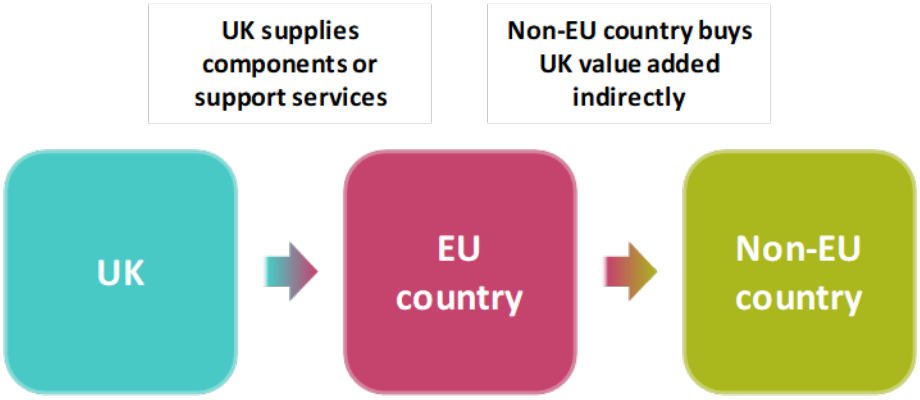
Figure 5-8 Non-EU final demand for UK exports by value added source (2015)



Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

An important point to note about Figure 5-8 is that UK exports which satisfy final demand in non-EU countries are not the same as UK export flows (directly) to non-EU countries. For example, it is possible for the non-EU countries to consume UK value added without purchasing UK exports directly. This could be done by purchasing other countries' exports that contain UK value added (see Figure 5-9). The UK automotive sector, for example, directly exports $7.1bn to the US (gross exports). However, breaking down UK gross exports by end-user, the US accounts for over $8bn in final demand. The US' greater importance as an end-user of UK exports than as a bilateral trade partner is an indication of indirect trade to the US through conduit economies.

Figure 5-9: Illustration of possible indirect exports of UK value added to non-EU final consumers



Sources: CE illustration.

Figure 5-10 shows the foreign exporters with the highest UK value added content embodied in exports ultimately consumed in the non-EU. We observe that EU member states feature prominently among the foreign exporters with the highest UK value added content to satisfy non-EU final demand, with nine of the top 15 countries coming from the EU.

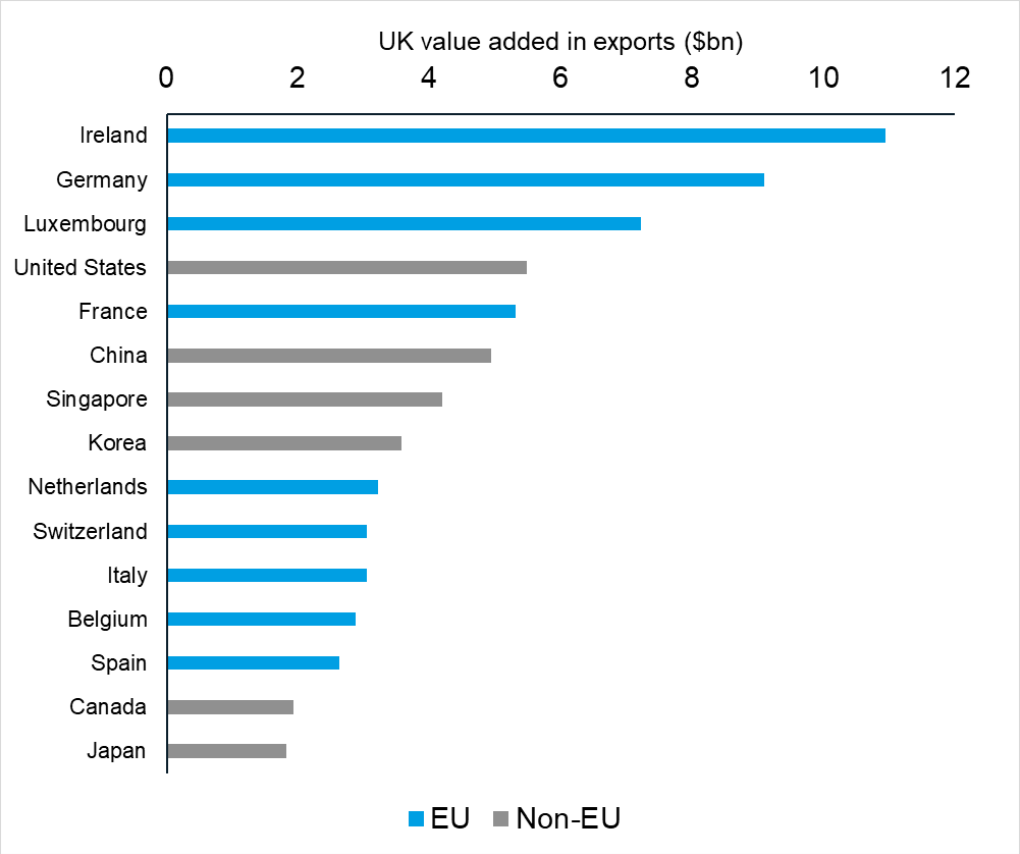
Ireland, Germany and Luxembourg are the most important foreign exporters of UK value added to non-EU consumers

We observe that gross exports from Ireland, Germany and Luxembourg to satisfy non-EU consumption have the highest UK content, with $11bn, $9bn and $7bn of UK value added embodied in these countries' gross exports respectively (in 2015). This provides evidence that there is a high amount of value added embodied in some EU27 country's exports to non-EU consumers, relative to other (non-EU) countries shown in Figure 5-10. With regard to policy significance, this could mean that trade barriers with EU countries might implicitly disrupt the flow of UK value added to non-EU markets, due to restrictions to free trade with UK's key trading partners.

The *manner* in which exporter countries play a role in selling UK value added to non-EU consumers cannot be deduced from the available data. For instance, in the most simplistic case, a country might import UK semi-finished products and then sell this directly to non-EU consumer markets. Alternatively, a country might buy UK semi-finished products, perform a step in the production process, and then resell to the UK, which then exports to non-EU final consumers. Both instances would appear the same in the data because UK value added is still exported and is still destined for non-EU consumers. In both cases, barriers to trade between UK and EU would cause disruption to UK VA exported by EU[36]. However, it illustrates that the dataset is not designed to show all the elements of the international supply chain.

[36] The only instance in which trade barriers between the UK and the EU would not directly affect trade flows would be if (1) the UK exports unfinished products to non-EU countries; (2) these non-EU countries then perform a step in the production process and export to EU countries; (3) EU countries then further process the goods and export to non-EU consumers. This is a very specific case and is unlikely to be representative of trade behaviour.

Figure 5-10 UK value added sold to non-EU markets by exporting economy (2015)



Notes: UK value added among exporting countries is not mutually exclusive and therefore cannot be summed across exporting countries. For instance, UK value added exported to non-EU consumers by Irish and German exporters is not necessarily $11bn + $9bn.
Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

It is less common for non-EU countries to export UK value added for final demand in the EU27

If we consider final consumption in the EU27 , only three of the top 15 exporting countries with the highest UK value added content embodied in their exports were non-EU. These economies were Switzerland, the US and China, who exported $1.8bn, $1.1bn and $0.8bn of UK value added to EU27 consumers in 2015 respectively.

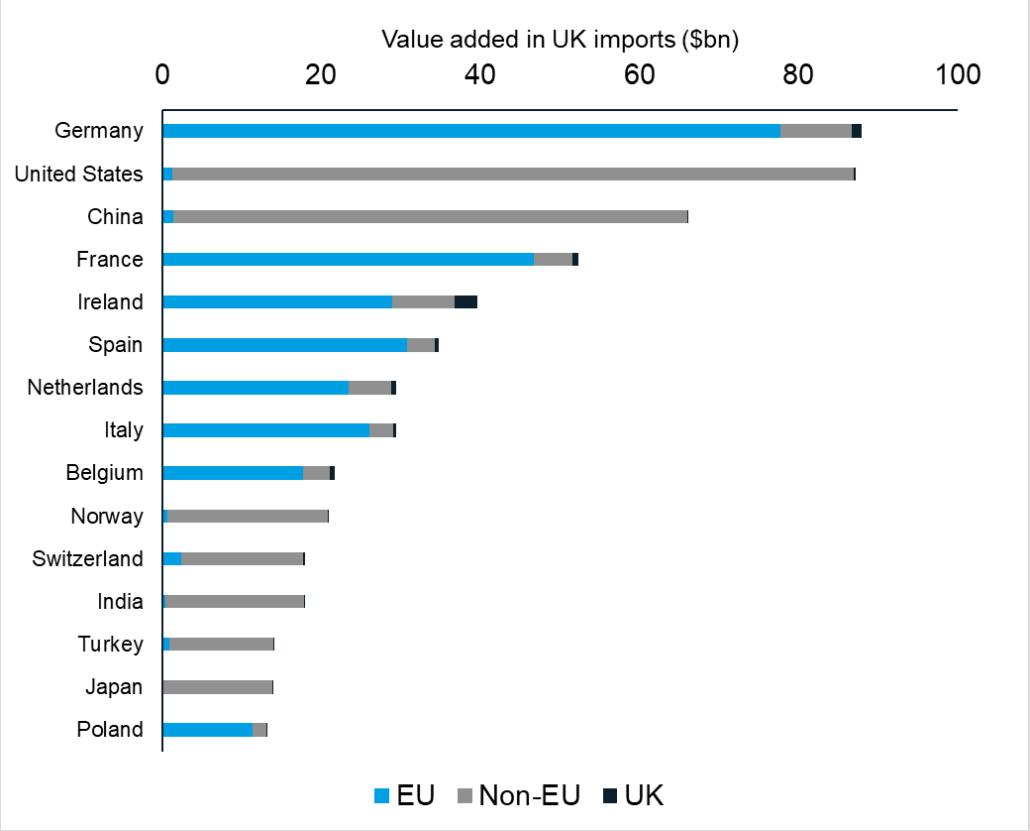
Turning to the channels through which the UK purchases its imports, Figure 5-11 shows the UK's top import partners and the source of value added of these imports broken down into EU27 and non-EU countries. Unsurprisingly, the large majority of value added in exports to the UK is sourced from the exporters' 'home' region – if an exporter is from the EU27, then most of its value added will be sourced there[37]. A more interesting result is that UK imports from EU27 countries tend to also contain a substantial amount of non-EU value added - for instance, around $9bn of UK gross imports from Germany is value added sourced from non-EU countries (around 10% of UK gross imports from Germany).

Another interesting result is that imports from EU countries tend to contain some UK value added, whereas for imports from non-EU countries, UK value added tends to be negligible.

[37] This is mostly because the domestic economy will also belong to that region.

Looking at the top non-EU partner countries for UK imports, a far less prominent share of value added is sourced from the EU27. UK imports from the US, for instance, contain only around $1bn in value added from the EU27 (around 1% of total gross imports from the US).

Figure 5-11 UK imports by top 15 exporting economies, broken down by EU and non-EU value added (2015)



Sources: CE calculations based on the OECD TiVA Database: Origin of value added in gross imports.

5.4 The importance of services to UK exports

One of the attractive features of TiVA indicators is that they allow us to better understand the role of services in trade. In modern GVCs, services are traded either directly between countries or indirectly, embodied in goods exports (e.g. financial services exports bundled with exports of cars). TiVA indicators, unlike conventional ('gross') measures of trade, capture the use of services as inputs to goods production. Additionally, trade in services is often regulated by separate trade agreements and non-tariff barriers, warranting a closer look at the differences between trade in goods and services.

To underline the relative importance of services in exports, Figure 5-12 presents the services value added content in total gross exports of the UK, France, Germany, China and the US in 2015[38]. A common alternative measure of the importance of services based on gross trade statistics is the

[38] Figure 5-12 presents 2015 data for the share of services in value added terms for comparability with the gross-terms data, for which 2016 data is not available.

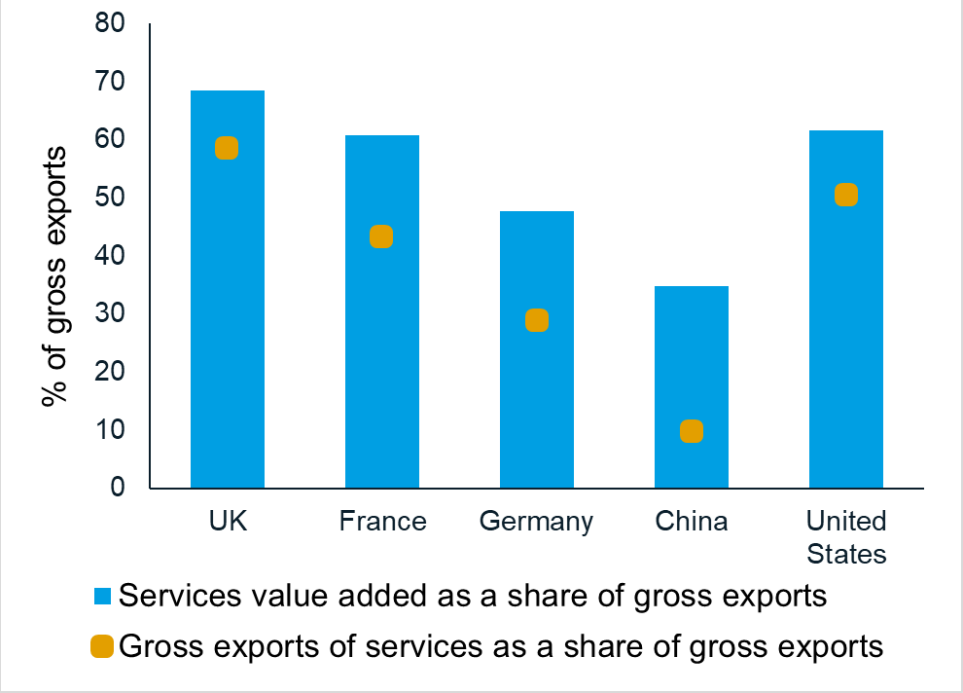
share of gross exports of services in the country's total gross exports – this is represented by the orange marker in the same figure.

In value added terms, services constituted 68.5% of total UK gross exports in 2015,10pp higher than in gross terms

The importance of services in the UK is particularly evident when examining the degree to which value added originating from service sectors is embodied in all UK exports – service sector value added (UK and foreign) accounted for 68.5% of total UK gross exports in 2015.

By contrast, in gross terms, services exports accounted for just 58.5% of UK gross exports in 2015. The differences between value added and gross measures of the share of services are even higher for France, Germany, China and the US, underscoring the point that gross exports statistics tend to underestimate the relative importance of services in international trade.

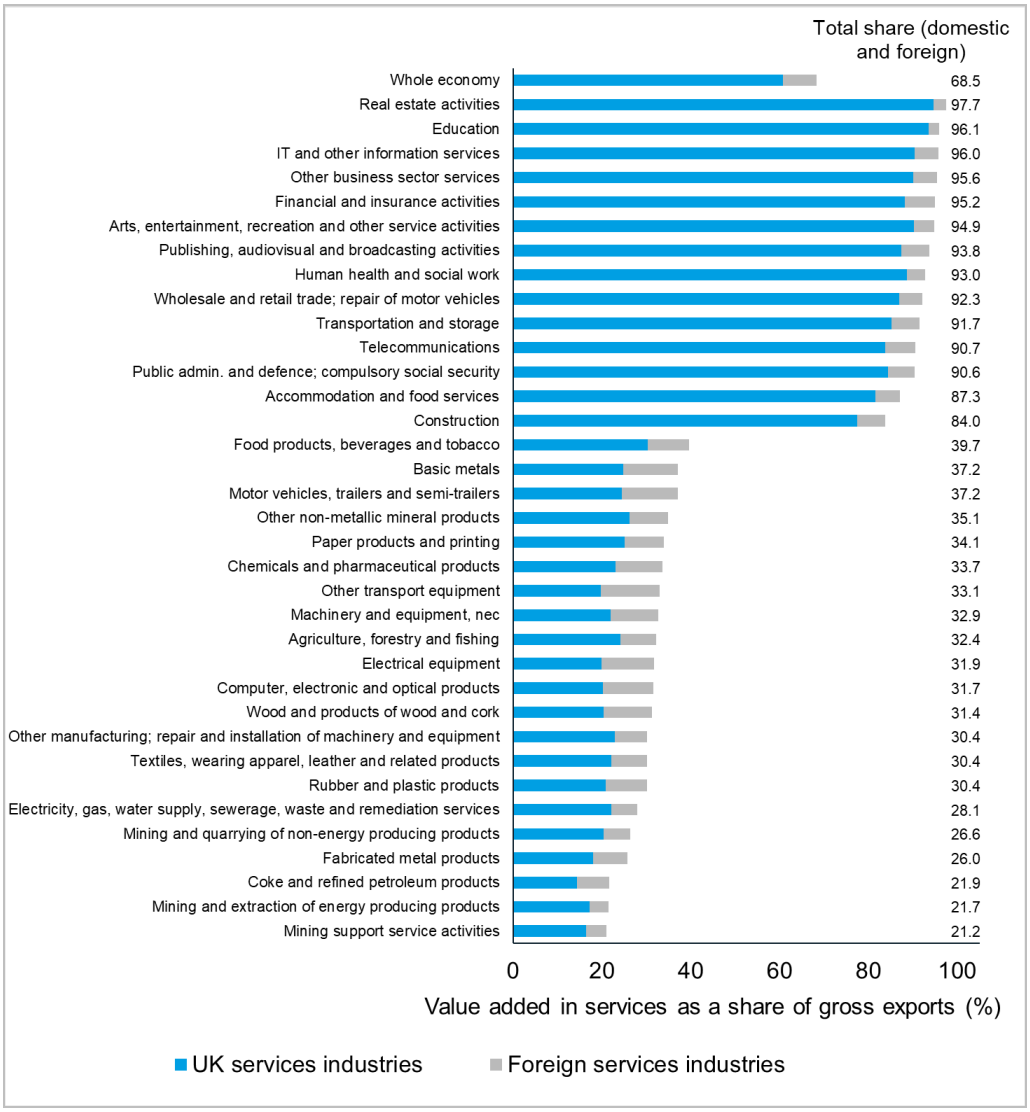
Figure 5-12 Contribution of services to total gross exports, in gross and value added terms, selected countries, 2015



Sources: CE calculations based on OECD Trade in Value Added (TiVA) database: Domestic services value added in gross exports (EXGR_SERV_DVASH), Foreign services value added in gross exports (EXGR_SERV_FVASH) and Gross exports (EXGR).

Figure 5-13 provides further insight into the importance of services in UK exports by presenting services value added as a share of UK gross exports, and whether the services value added is created domestically (in the UK) or abroad.

Figure 5-13 Origin of services value added in UK gross exports, 2015



Sources: CE analysis, based on OECD Trade in Value Added (TiVA) database: Domestic services value added in gross exports (EXGR_SERV_DVASH), Foreign services value added in gross exports (EXGR_SERV_FVASH).

22.8% of value added in UK manufacturing gross exports is created in UK service sectors

The contribution of services value added in UK gross exports of sectors such as Education, IT services and Finance & insurance services is above 95%, with the vast majority of the services value added being sourced domestically.

The share of total (UK and foreign) services value added in UK manufacturing gross exports was 33.7% in 2015; the share of UK services value added in UK manufacturing gross exports was 22.8%.

As a proportion of gross exports, value added from foreign services contributes more to gross exports in the UK manufacturing sector than to gross exports in the UK service sector. This indicates that services inputs are important to the supply chains of UK manufacturing gross exports, and that these inputs are sometimes imported.

5.5 The UK's revealed comparative advantage in value added terms

The concept of Revealed Comparative Advantage (RCA) is based on the relative share a country has in world exports of a particular exported product in comparison to its share of total world exports[39]. It is a measure of relative specialisation in exports of one product relative to other exported products.

Focus - Calculation of the Revealed Comparative Advantage Index in TiVA terms

The equation below presents how the UK's Revealed Comparative Advantage (RCA) index in hypothetical sector $\boldsymbol{X}$ is calculated:

$$RCA\ index(\boldsymbol{X}) = \frac{\left(\frac{UK\ exports\ of\ value\ added\ generated\ in\ sector\ X}{UK\ exports\ of\ value\ added\ generated\ in\ all\ sectors}\right)}{\left(\frac{Sum\ of\ all\ countries\ exports\ of\ value\ added\ generated\ in\ sector\ X}{Sum\ of\ all\ countries\ exports\ of\ value\ added\ generated\ in\ all\ sectors}\right.}$$

Illustrating the calculation with an example, in 2015, exports of UK value added in the Telecoms sector amounted to $13bn, or 2% of total exports of all UK value added ($570bn). At the same time, the sum of all countries' exports of value added in the Telecoms sector amounted to $136bn, which was close to 1% of world exports in all sectors ($13 trillion). Dividing the share of Telecoms in UK exports by the share of Telecoms in world exports (1%/2%), the RCA index for UK Telecoms is approximately 2.

If the country share in world exports of a sector is greater than the overall country share in world exports of all sectors, then the RCA would be greater than 1 and the country can be considered to have a revealed comparative advantage in the sector. Conversely, if the country share of world exports of a sector is lower than the country share of world exports in all sectors (resulting in an RCA less than 1), the country has a comparative disadvantage in the sector.

The concept of comparative advantage therefore refers to advantage in exports of a sector in comparison to other exporting sectors in the same country. It should not be mistaken for absolute advantage of the sector against the same sectors in other countries.

Value added measures can provide an alternative picture of RCA

Conventionally, RCA estimates are calculated from data on gross exports of *products*. One of the attractive features of using value added measures for measuring RCA is that they show the *sectors* in which a country has a 'true' comparative advantage. Using value added measures (domestic value added in foreign final demand by origin sector) can provide a more accurate picture of comparative advantage, as traditional gross trade flows may be distorted by the content of foreign value added embodied in gross exports or value added content embodied in gross exports of another sector.

However, the RCA index in value added terms cannot fully reflect the competitive position of a country in a given sector, especially if the products in that sector are not easily tradable. For example, while a country's exports may

[39] Balassa (1965).

include a substantial share of value added in the domestic transportation[40] sector, this may not be due to the sector's efficiency compared to the transportation sector in other countries, but rather, due to uncompetitive markets or obstacles to importing more competitive transportation services, which might indicate inefficiency. Exports of the transportation sector for the country may also be high if it acts as an upstream supplier to exports of other sectors. In this case, the RCA index for the transportation sector may reflect a high indirect contribution to exports in sectors with a comparative advantage in that country, rather than a comparative advantage in the transportation sector itself. The revealed comparative advantage index should therefore not be mistaken for an efficiency measure.

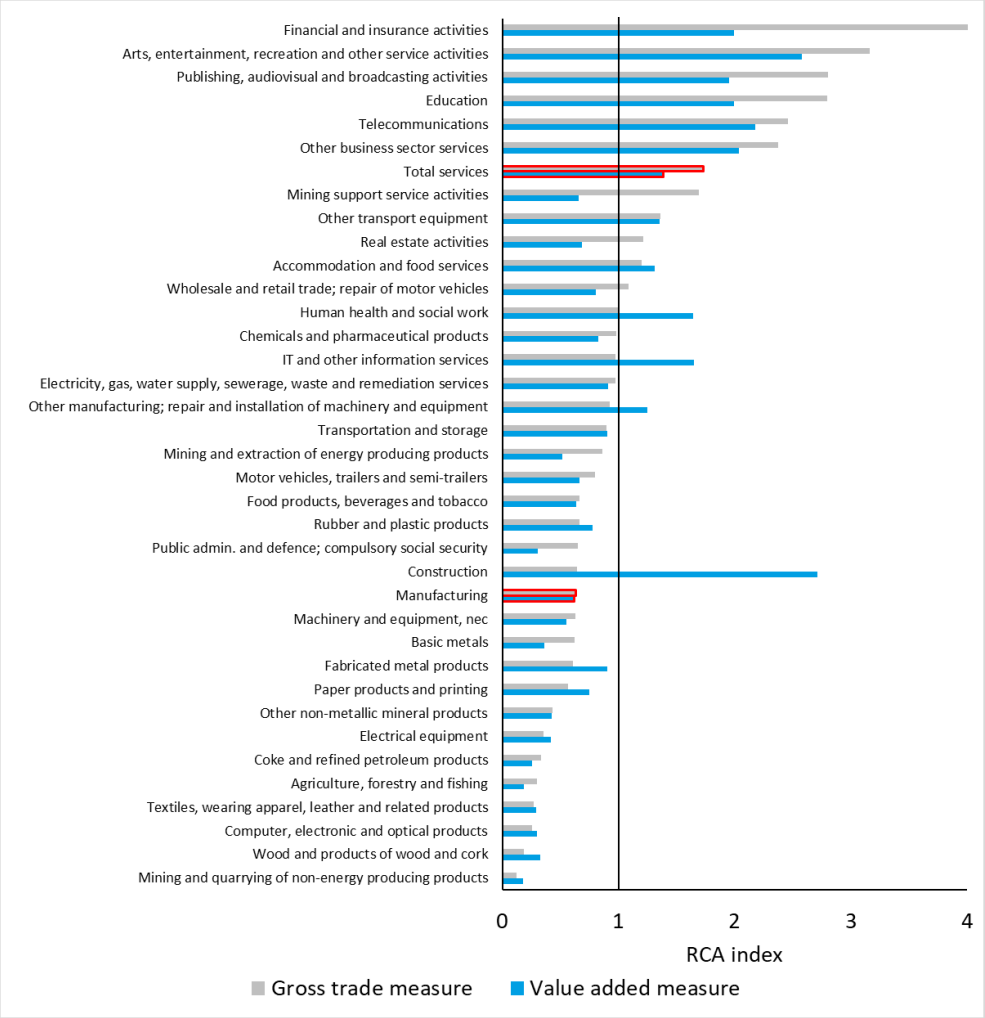
The UK's comparative advantage in services is slightly lower in value added terms

The RCA indices based on 2015 data for gross and value added measures of trade are compared in Figure 5-14. According to both measures, the UK has a comparative advantage in service exports, notably in exports of Other business services, Finance & insurance and Other services. The RCA index in services, however, is lower when measured in value added terms (1.39, compared to the gross exports measure of 1.73). This result may appear counterintuitive at first, as from the analysis in Section 5.3, the share of services in UK exports as measured by gross trade statistics is lower compared to value added measures. However, it should be noted that, for other countries, gross trade statistics underestimate the share of services to an even greater degree. The influence of 'not-easily tradable' sectors (more commonly services than goods, and particularly the transportation sector) is also a contributory factor to the discrepancy between RCA indices in gross and value added terms.

Notable differences between gross and value added measures of RCA include a much lower UK comparative advantage in Finance & insurance when measured in value added terms (RCA: 1.99 compared to a gross terms measure of 4.11), and in Construction (RCA: 2.71, contrasting with RCA: 0.65 in gross terms).

[40] There are additional complexities when considering RCA for the transportation sector using TiVA statistics, given that TIVA indicators are reported in basic price terms. Exports of the transportation sector include distribution margins (of goods exports), and as such, an observed high level of exports in the transportation sector may reflect restrictions of the use of foreign operators, which, while resulting in a high RCA index, does not necessarily reflect comparative advantage. More information on this can be found in WTO et al. (2019).

Figure 5-14 UK revealed comparative advantage index calculations based on value added and gross trade measures, 2015



Sources: CE calculations based on the OECD TiVA Database: Gross exports (EXGR) and Domestic value added embodied in foreign final demand (FFD_DVA).

UK RCA in services was higher in 2015 than in 2005

The estimates of RCA based on value added measures for the UK in 2005 and 2015 are presented in Table 5-3. The estimates are presented for total manufacturing and total services (in bold) and for individual sectors (in italics). The RCA index for total services increased between 2005 and 2015 from 1.34 to 1.39. In comparison, the index for total manufacturing declined from 0.67 to 0.62 in the same period. Change over time has been relatively gradual.

Within services, the sectors with the largest RCA index include Other services (2.58 in 2015), Telecoms (2.17) and Other business services (2.03). All of these sectors had an RCA index comfortably above 1.00 in 2005, but each saw its RCA index increase further in 2015, beyond 2.00. It should be noted that the RCA of the UK's Finance & insurance sector has declined in the same decade, from 2.33 to 1.99. However, with a value well above 1.00 it indicates that the sector is still very competitive compared with other UK sectors.

The only sectors in UK manufacturing that exhibit a comparative advantage are Other transport and Other manufacturing

Within manufacturing, only two sectors exhibited an advantage in 2015: Other transport (1.36) and Other manufacturing (1.25). In both cases, this marked a decrease from the 2005 measure, albeit only just in the case of Other manufacturing. Between 2005 and 2015, the RCA index declined in many manufacturing sectors, notably Chemicals (from 1.00 in 2005 to 0.83 in 2015) and Non-metallic minerals (from 0.61 to 0.43).

Although the RCA estimate for the Construction sector is the highest among all sectors (at 2.71 in 2015), it should be noted that Construction plays a very small role in UK exports of value added, accounting for 1.6% of total UK exports of value added.

Table 5-3 Estimates of UK revealed comparative advantage (RCA) index in selected sectors on a value added basis (2005 and 2015)

Sector	2005	2015
Agriculture, forestry and fishing	0.20	0.19
Mining and extraction of energy producing products	0.70	0.52
Manufacturing	**0.67**	**0.62**
Of which: Chemicals and pharmaceutical products	1.00	0.83
Of which: Rubber and plastic products	0.85	0.78
Of which: Other non-metallic mineral products	0.61	0.43
Of which: Basic metals and fabricated metal products	0.55	0.60
Of which: Computers, electronic and electrical equipment	0.40	0.34
Of which: Motor vehicles, trailers and semi-trailers	0.51	0.67
Of which: Other transport equipment	1.50	1.36
Of which: Other manufacturing; repair and installation of machinery and equipment	1.26	1.25
Electricity, gas, water supply, sewerage, waste and remediation services	0.68	0.91
Total services	**1.34**	**1.39**
Of which: Wholesale and retail trade; repair of motor vehicles	0.85	0.81
Of which: Transportation and storage	0.93	0.90
Of which: Publishing, audiovisual and broadcasting activities	2.31	1.95
Of which: Telecommunications	1.41	2.17
Of which: IT and other information services	2.04	1.65
Of which: Financial and insurance activities	2.33	1.99
Of which: Other business sector services	1.82	2.03
Of which: Education	1.71	1.99
Of which: Human health and social work	1.71	1.64
Of which: Arts, entertainment, recreation and other service activities	1.96	2.58
Construction	**2.59**	**2.71**

Sources: CE calculations based on the OECD TiVA Database: Domestic value added embodied in foreign final demand (FFD_DVA).

Country comparisons of revealed comparative advantage

Based on the TiVA data, the UK is the 6th most specialised region in exports of services and the 50th most specialised in exports of manufacturing (out of the 64 economies in the database). The estimates for the RCA index based on exports of value added data for 2015 are presented in Table 5-4 for selected major world economies.

Table 5-4 Estimates of RCA indices for selected countries on a value added basis (2015)

Sector	UK	France	Germany	United States	China
Agriculture, forestry and fishing	0.19	0.81	0.21	0.65	1.48
Mining and extraction of energy producing products	0.52	0.01	0.02	0.57	0.63
Manufacturing	**0.62**	**0.83**	**1.35**	**0.77**	**1.44**
Of which: Chemicals and pharmaceutical products	0.69	0.91	1.09	0.93	1.26
Of which: Rubber and plastic products	0.78	1.00	1.54	0.60	1.38
Of which: Other non-metallic mineral products	0.43	0.60	1.01	0.55	2.31
Of which: Basic metals and fabricated metal products	0.60	0.70	1.21	0.66	1.64
Of which: Computers, electronic and electrical equipment	0.34	0.52	0.96	0.77	1.91
Of which: Motor vehicles, trailers and semi-trailers	0.67	0.71	3.44	0.43	0.35
Of which: Other transport equipment	1.36	2.77	1.06	2.14	0.74
Of which: Other manufacturing; repair and installation of machinery and equipment	1.25	1.11	1.04	0.46	1.69
Electricity, gas, water supply, sewerage, waste and remediation services	0.91	1.19	0.89	0.44	1.42
Construction	2.71	0.85	1.23	0.06	0.08
Total services	**1.39**	**1.26**	**0.93**	**1.28**	**0.68**
Of which: Wholesale and retail trade; repair of motor vehicles	0.81	1.09	0.84	0.98	0.89
Of which: Transportation and storage	0.90	1.10	0.82	0.87	0.91
Of which: Publishing, audiovisual and broadcasting activities	1.95	0.61	0.77	3.31	0.17
Of which: Telecommunications	2.17	1.06	0.52	1.37	0.81
Of which: IT and other information services	1.65	0.91	1.11	0.81	0.12
Of which: Financial and insurance activities	1.99	0.83	0.63	1.56	1.03
Of which: Other business sector services	2.03	1.70	1.17	1.68	0.36
Of which: Education	1.99	1.68	1.05	2.99	0.09
Of which: Arts, entertainment, recreation and other service activities	2.58	0.94	0.84	0.82	0.85

Sources: CE calculations based on the OECD TiVA Database: Domestic value added embodied in foreign final demand (FFD_DVA).

The RCA index reveals some similarity between the UK's advantage in services (RCA: 1.39) and that observed for the US (1.28) and France (1.26). Likewise, RCA indices below one in manufacturing sectors in these countries are also similar to that for the UK – the RCA index in manufacturing is 0.83 for France and 0.77 for the US (0.62 for the UK). This contrasts with the index of above one for Germany and China in manufacturing (1.35 and 1.44 respectively), and their low RCA index in services (0.93 and 0.68 respectively).

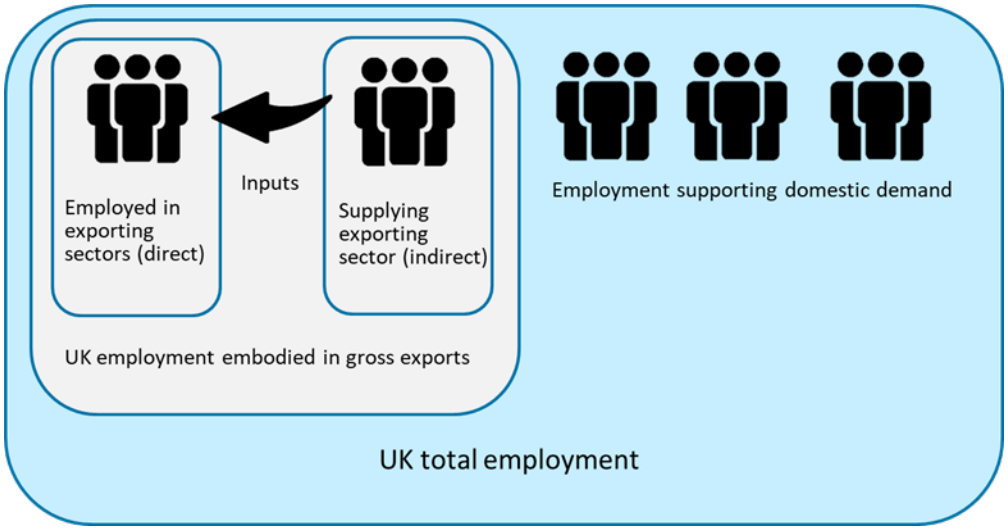
5.6 UK employment embodied in exports

The TIM database provides an insight of UK employment embodied in export production

The related OECD Trade in Employment (TIM) database provides insight on the direct and indirect employment in the UK sustained by exporting activity and foreign final demand.

The diagram in Figure 5-15 presents how UK employment is embodied in exports. UK employment embodied in gross exports comprises of employment in the exporting sector (directly embodied in exports) and employment in UK sectors supplying inputs to the exporting sector (indirectly embodied in exports).

Figure 5-15 Employment embodied in exports



Source: CE illustration.

It should be noted that due to the assumptions underpinning the TIM database, the estimated employment numbers are likely upward-biased. This is due to the assumption of identical foreign value added content and identical productivity for firms producing for domestic and export markets. In reality, exporting firms are better integrated in GVCs than non-exporting firms, meaning that they are likely to have a higher share of foreign value added content and a higher productivity than firms producing for the domestic market.

The estimates of employment embodied in gross exports in the TIM database can also suffer from other biases due to:

- The inability to fully capture the employment in services associated with re-exporting (such as transportation of imported goods across a country before exporting).

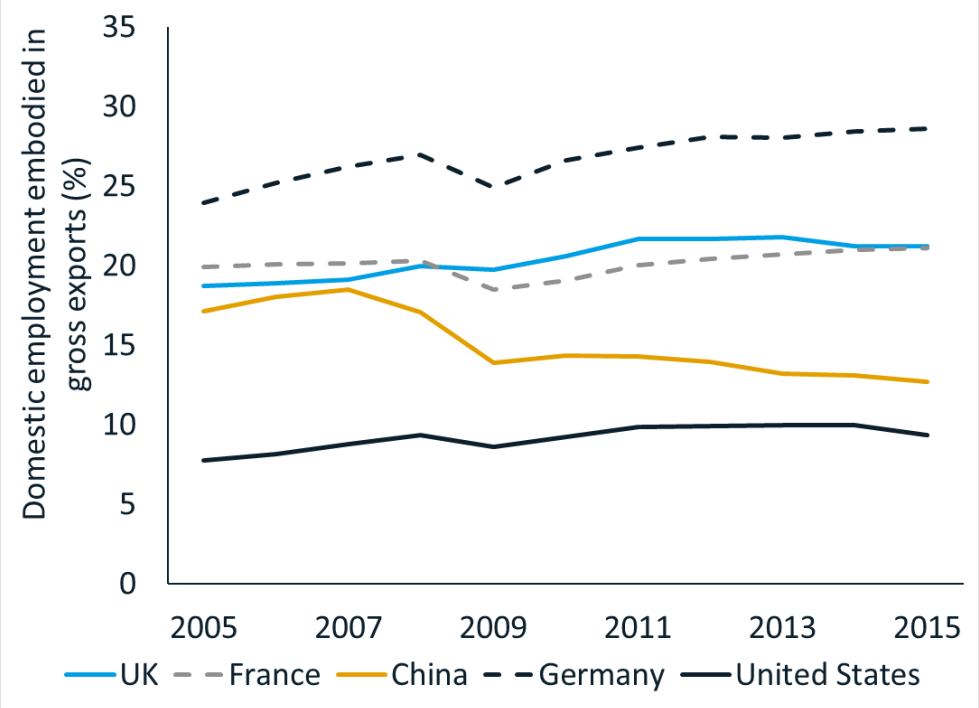
- A lack of differentiation in TIM between employment in market and non-market activities. This is especially important for Agriculture in non-OECD countries.
- Outsourcing of manufacturing/assembly activities by headquarters to a sub-contractor in another country, while retaining the ownership of all inputs and outputs (as there may be high value added with few employees in the headquarter country, and low value added with high employees in the subcontracted company). The bias would be particularly felt in instances where the size of the headquarter company dominates a sector.

Trade in employment indicators estimate the number of employees (rather than full-time equivalents). The figures should be interpreted as employment *supported by* exports, rather than employment *created by* exports. In a hypothetical world without trade, these jobs could potentially still exist, but serve domestic consumers.

UK employment supported by gross exports is similar to that of France but below that of Germany

As presented in Figure 5-16, the share of UK employment supported by gross exports is similar to that of France, but below that of Germany. In the UK, the share increased from 18.7% in 2005 to 21.2% in 2015. Growth in the share of employment supported by exporting activity was also observed in France, Germany and the US.

Figure 5-16 Share of domestic employment supported by gross exports (2005-2015)



Sources: CE analysis, based on OECD Trade in Employment (TIM) database: Share of domestic employment in gross exports (EMPN_EXGRDEM).

Chinese employment supported by exporting activity decreased in that period, likely due to the stronger growth of domestic final demand (compared to foreign final demand) and productivity growth. While a low share of employment embodied in exports might reflect in part low access to export markets, it may also equally reflect a large domestic market.

6.6m employed in the UK were supported by UK exporting activity in 2015

Table 5-5 presents UK employment embodied directly and indirectly in gross exports in the whole economy, manufacturing, services and selected sectors in 2015[41]. Overall, 6.6 million employees were supported by UK exporting activity in 2015. Employment directly embodied in gross exports amounted to 4.1m employees (62% of all employment embodied in gross exports), with an additional 2.5m employees (38%) supported by gross exports indirectly. Indirect employment is relatively higher for manufacturing exports than direct employment (indirect employment was estimated at 1.0m compared with direct employment at 0.8m in 2015). In services, a greater share of employment supported by exporting activity is direct, at 3.2m (compared to 1.4m supported indirectly). These differences reflect the relatively more fragmented nature of manufacturing supply chains.

Approximately 3.8m employees in the UK were supported by UK exports to non-EU countries in 2015, equal to 56.7% of total employment supported by UK export production. The remaining 2.9m employees were supported by UK exports to the EU27.

The relative importance of employment supported by exports to the EU27 compared to employment supported by exports to non-EU countries varies by sector. Of total UK employment supported by UK manufacturing export production, 61.2% of employment is supported by exports to non-EU countries (and 39.8% to the EU27). For exports in services, 51.7% of employment supported by exports reflects exports to non-EU countries. Notable deviations from the manufacturing average include 66.0% of employment supported by exports to non-EU countries in the Other transport sector, and 54.3% in the Food products sector. Within service sectors, the greater importance of UK exports to non-EU countries in supporting employment compared with UK exports to EU27 countries is also notably observed for the UK Hotels & restaurants sector.

[41] Additional component not presented in the table consists of employment embodied in gross exports of re-imported value added, which accounted for 17 thousand employees in the Whole economy in 2015. Table presents selected sub-sectors with the largest employment supported by exports.

Table 5-5 UK employment in selected sectors embodied directly and indirectly in gross exports (thousands of persons, 2015)

	Direct	Indirect	Total*	EU share in total (%)	Non-EU share in total (%)
Whole economy	**4,131**	**2,485**	**6,633**	**43.3**	**56.7**
Manufacturing	**828**	**1,004**	**1,842**	**38.8**	**61.2**
Of which: Chemicals and pharmaceutical products	78	174	254	37.9	62.1
Of which: Motor vehicles, trailers and semi-trailers	82	165	249	38.7	61.3
Of which: Other transport equipment	80	90	171	34.0	66.0
Of which: Food products, beverages and tobacco	66	115	182	45.7	54.3
Services	**3,238**	**1,388**	**4,632**	**44.3**	**55.7**
Of which: Wholesale and retail trade; repair of motor vehicles	705	246	952	41.0	59.0
Of which: Financial and insurance activities	317	510	828	47.8	52.2
Of which: Transportation and storage	278	175	454	24.8	75.2
Of which: Accommodation and food services	235	66	301	31.3	68.7
*Of which: Information and communication***	195	130	325	47.0	53.0
Mining and extraction of energy producing products	**12**	**66**	**78**	**78.6**	**21.4**

Notes: * The total includes employment embodied in re-imports ('re-imported domestic employment embodied in gross exports'). This measures the UK employment used to produce exports of intermediate goods and services embodied in imports that are subsequently used in the production of UK exports. It represents a small fraction of the total and therefore not presented individually in the table.
** Information and communication includes Publishing, broadcasting and Telecoms
Sources: CE analysis, based on OECD Trade in Employment (TIM) database: Direct and indirect domestic employment embodied in gross exports (EXGR_EMD and EXGR_EMI).

5.7 Concluding remarks

Trade in value added better captures the integrated nature of modern trade

Statistics on trade in value added provide a complementary insight to traditional gross trade statistics, beyond backward and forward linkages. The differences between value added and gross measures in many cases present a different picture of UK trade relationships. This is due to:

- Imports to the UK incorporating value added from countries other than the exporting country.
- Imports to the UK being processed and exported further.
- Exports from the UK consisting of a substantial share of foreign value added.
- Exports from the UK being processed in the initial destination country before being exported to the final (third market) destination.

The EU27 acts as a conduit for some UK trade with third countries

These effects lead to noticeable differences between gross and value added measures of trade. For example, the EU share in UK exports (as a destination country) and imports (as a supplier) is 5pp lower when measured in value added terms, compared to gross measures. Conversely, the share of non-EU countries in UK exports and imports increases by a similar amount when measured in value added terms. While this could be taken to indicate a lower reliance of the UK on EU27 demand and supply than that suggested by gross measures, the difference can reflect other factors too. Specifically, destination countries of UK exports reflect final consumers rather than the direct bilateral trade partners; the UK gains access to non-EU markets through some EU27 economies (notably Germany, Ireland and Luxembourg); similarly, non-EU countries access the UK market through EU27 economies.

In value added terms, the contribution of services to total trade is larger

In value added terms, services account for a larger share of world trade compared to gross trade terms. In value added terms, services value added contributed 68.5% to UK gross exports in 2015, compared to just 58.5% in gross terms; this is due to service sectors providing inputs to other sectors, notably manufacturing, for the production of their exports. In the UK, approximately a third of the value of manufacturing gross exports originated in the service sector in 2015.

Europe is by far the largest regional final consumer of UK exports

Tracing UK gross exports by end-user revealed that the most important final consumers of UK gross exports were the US, Germany and France in 2015. Although the US is the largest consumer of UK exports, Europe is by far the most important regional bloc, consuming twice as much UK exports in monetary terms.

With a few exceptions, UK trade flows are in line with countries' gravities

Mapping final demand for UK gross exports against economic gravity provided some insights into key drivers of demand. Large English-speaking countries such as the US, Australia and New Zealand tend to consume a greater amount of UK exports than can be explained by gravity. At the same time, some Adriatic and, to a lesser extent, Baltic countries consume less than would be suggested by economic gravity. This is, in part, because of those countries' strong trade links with Italy and Germany, which are much closer.

Meanwhile, the origin of foreign suppliers to UK export production appears to be explained very well by trade gravity. Exceptions to this were Norway, because of the UK's heavy reliance on fuel imports from Norway; and Croatia, likely because of strong trade links with Italy and Germany.

Nine out of the top 15 exporters of UK value added to non-EU consumers were from the EU

Ranking foreign exports for non-EU consumption by the amount of value added sourced from the UK, nine out of the top 15 economies were from the EU27. Ireland, Germany and Luxembourg were found to be the top three exporters of UK value added to non-EU consumers, exporting $11bn, $9bn and $7bn, respectively. Analysis of UK value added in exports to EU27 consumers revealed that non-EU countries feature less prominently as top exporters of UK value added.

The UK is one of the most services-specialised exporters

In 2015, the UK was the 6th most specialised region in exports of services and the 50th most specialised in exports of manufacturing (out of 64 economies in the TiVA database), based on the revealed comparative advantage (RCA) in value added terms. Between 2005 and 2015, the UK's comparative advantage in services increased slightly. The UK's specialisation at the sector level appears to be similar to the US and France (both highly specialised in

services), but very different to Germany and China (which are more specialised in manufacturing).

The RCA calculations indicate that the UK has a comparative advantage in sectors such as Other services, Telecoms, Other business services and Finance & insurance. However, in a few service sectors, such as Transport & storage[42] and Wholesale & retail, the UK's RCA index is less than 1.00, indicating comparative disadvantage.

While the UK has an RCA score below one in total manufacturing, it does, however, have a comparative advantage in two manufacturing sectors: Other transport (which includes aerospace) and Other manufacturing. RCA of these sectors, however, has not increased since 2005 and in the case of Other transport, it has declined.

Over a fifth of UK employment is supported by exports, most of which is direct employment in export production of services

The share of UK employment that is directly or indirectly supported by UK exports increased from just under 19% in 2005 to over 21% in 2015. A similar increase is observed in other major developed economies. Of the 6.6m employees supported by UK gross exports in 2015, 4.6m were supported by exports in service sectors, while 1.8m were supported by exports in the UK manufacturing sector. Indirect employment (employment in upstream sectors) supported by gross manufacturing exports is slightly larger than direct employment (in the exporting manufacturing sector). In services, the reverse is true: direct employment (3.2m) is nearly two and a half times greater than indirect employment (1.4m).

Exports to non-EU countries account for 57% of UK employment supported by exports

Exports to non-EU countries account for around 57% of UK employment supported by gross exports, translating to 3.8m employees. In the manufacturing sector, 61% of employment supported by gross exports reflects exports to non-EU countries. In several manufacturing sectors, such as Chemicals, or Other transport, this share is even higher. For services, the non-EU share is lower, at 56%. The share varies substantially among individual service sectors: it is much lower in Finance & insurance (52%) and IT services (53%) compared to Transport & storage (75%).

The impact of protectionist policies would be ambiguous and potentially damaging

The insights provided using the TiVA dataset have a number of notable implications for public policy. Firstly, the evidence consulted in this report helps to create a more nuanced picture of the implications of protectionism. The argument for protectionist policies often focusses on competition between comparable products, depicting the landscape of international trade as one of competing interests and winners and losers. In contrast, evidence from the TiVA dataset highlights instances where trade flows complement one another or are dependent on each other. Section 5.3 found that in order to satisfy its key export markets, the UK relied on often substantial flows of imported components and support services. Disrupting such trade flows would therefore likely affect the UK's ability to export. This would suggest that the overall impact of protectionist policies on the UK's net trade position would be ambiguous, and potentially damaging in the short to medium run[43].

[42] The complexities in measuring the RCA of the Transport & storage sector are discussed in Section 5.5.

[43] One consideration is that, in the long-run, barriers to trade will encourage supply chains to change as fewer inputs to production and final products are sourced internationally. Given the difficulties in projecting

Policies focused on just trade in services would impact manufacturing; and vice versa

Analysis of trade in value added also showed that manufacturing sectors rely considerably on support services. Specifically, around 23% of the value of UK manufacturing exports was created in the UK service sector in 2015. This illustrates the interdependence between the manufacturing sector and the services sector and that policies focussing on either area (e.g. liberalisation of services trade) are likely to also impact the other.

Moreover, viewing trade through the lens of gross measures can generate distortions when making comparisons about export performance over time, across sectors or between UK trading partners. For instance, once imported inputs to production are accounted for, the trade surplus with non-EU countries was found to be smaller than in gross terms, while the UK's trade deficit with the EU was also smaller (as seen in Section 5.1). With regard to sectoral distortions, Section 5.4 highlighted the relative importance of services trade to UK exports in value added terms.

such changes and the scope of the available data, we do not consider such long-run developments in this report.

6 Conclusions

6.1 Trade in value added as a concept

Developments and trends observed in trade, such as the fragmentation of supply chains and the increased trade of intermediates, have spurred the need for better measures of trade beyond gross measures. Gross trade statistics measure the total value of the product that crosses the border; but this fails to account for the imported content or the contribution of domestic upstream sectors that went into producing the exported product.

Conceptually, measuring trade in value added terms reveals the supply chains of export production

Conceptually, measuring trade in value added terms enables a consideration of these developments. Crucially, it enables the possibility of analysing questions related to:

- the direct and indirect importance of sectors and countries in the production of exported goods and services,
- the contribution of imports in the production of goods and services for export/final demand,
- the value of gross exports that is generated in the domestic economy;
- the role of trade partners as exporters of UK content to third countries.

From these considerations, it is feasible to explore, among other trends, the dependence of gross exports on foreign inputs (backward linkages) as well as the dependence of foreign exports on UK activity/inputs (forward linkages).

Existing initiatives to estimate trade in value added are built on the construction of multi-regional input-output tables. One such initiative is the OECD Trade in Value Added database (TiVA).

6.2 Insights from an analysis of trade in value added

TiVA indicators can enable an understanding of Global Value Chain (GVC) participation, calculated as the sum of

- foreign value added embodied in domestic exports; and
- domestic value added embodied in foreign exports.

The UK's participation rate is in part driven by its specialisation in services

The GVC participation rate can reveal the country's level of international integration. Decomposing the UK's GVC participation reveals above average forward linkages and lower-than-average backward linkages (foreign value added in domestic exports, as a share of domestic gross exports). That said, the UK's participation rate is also in part driven by the country's high level of specialisation in services, which tend to have a low share of foreign input content in their exports. We therefore caution against interpreting low participation as necessarily a sign of economic isolation. GVC participation is influenced by a range of factors, including the size of the economy, the country's position in value chains, and sectoral specialisation.

Imported inputs account for 15% of UK gross exports

Examining backward linkages more closely, the foreign value added content of UK gross exports constituted 15.1% in 2015, with 8.5% originating from non-EU countries and 6.6% originating from the EU. At the sector level, the highest import content is observed in the exports of: Coke, petroleum; Basic metals (reflecting the absence of relevant primary resources in the UK); and Other transport (reflecting the fragmented and international nature of supply chains in that sector). In 2015, foreign value added accounted for over 30% of the value of exports in these sectors.

UK backward linkages are strongest with large economies such as the US and Germany

Foreign inputs are largely sourced from key economies such as the US and Germany, which together comprised just over a quarter of foreign inputs in UK exports in 2015. UK exporting sectors which source a relatively large proportion of their imported inputs from these countries include Finance & insurance (19.6% of foreign inputs originate from the US) and Motor vehicles (19.7% of foreign inputs originate from Germany). There are exceptions to this; for example, a high value of foreign inputs are sourced from Norway for UK exports of the Coke, petroleum sector.

A closer examination of the sector of origin of imported inputs indicates that imports of inputs from the same sector are important in UK manufacturing exports, and that imported services are more important for UK manufacturing exports than for UK services exports.

The UK's forward linkages are stronger

In contrast, UK forward linkages are much stronger than UK backward linkages, and broadly consistent with the degree of forward linkages observed for France and Germany.

The EU27 has become even more important as an exporter of UK value added over 2005-2015

Foreign exports of UK value added amounted to $162bn in 2015, of which nearly two thirds was exported by EU countries. The share of UK value added exported by the EU27 increased by 3pp between 2005 and 2015, marking an increasing importance of downstream EU27 export value chains to UK production. Even so, UK value added exported for consumption remains the larger component; in 2015, this totalled $570bn, of which just less than two thirds was consumed in non-EU countries.

Services for intermediate use (such as Other business services and Finance & insurance) are the main UK inputs to foreign exports. These inputs enter foreign exports of specific sectors across different countries, often reflecting these countries' relative specialisation.

Other insights from TiVA

The OECD TiVA database reveals further insights into the trade performance of the UK in value added terms, which in many instances differ from insights based solely on gross trade measures.

The proportion of UK exports to the EU is lower in value added terms than when measured in gross terms. While this indicates that non-EU markets are more important as end-users of UK exports than gross measures suggest, it also points to a greater importance of EU partners as conduits for UK exports. UK value added is purchased by EU27 countries and then processed and exported further. Similarly, the UK imports a sizeable amount of non-EU value added that is embodied in imports from the EU27.

Services comprise a higher share of UK exports when measured in value added terms

Relative to gross measures, TiVA provides additional insight on the relative importance of services in international trade. TiVA allows for estimation of the value of services that are traded both directly, and indirectly (as inputs to other services or goods produced for exports). In 2015, 68.5% of UK exports comprised of services measured in value added terms, approximately 10pp higher than in gross terms. Accordingly, a larger proportion of UK employment supported by UK exports is based in service (4.6m employees) rather than manufacturing sectors (1.8m employees).

The UK has a comparative advantage in many services, including Telecoms and Finance & insurance

Measuring Revealed Comparative Advantage (RCA) in value added terms reveals a picture broadly consistent with the same measure in gross terms. The RCA index indicates that the UK's comparative advantage is in services. The RCA index is greater than 1 (indicating comparative advantage) for many service sectors, including Telecoms and Finance & Insurance. In 2015, and within manufacturing, only in Other transport and Other manufacturing does the UK have a comparative advantage when measured in value added terms. It is important to caution that RCA in value added terms may not fully reflect the competitiveness or efficiency of a sector. For example, where an uncompetitive upstream sector is a supplier to a highly competitive exporting sector, this could be reflected as a strong export performance for the uncompetitive sector.

The US, Germany and France are key players as suppliers and end-users to the UK's gross exports

When looking at both the source of inputs to and final consumers of UK exports, UK trade relationships with other partners correlate highly with gravity (notwithstanding exceptions stemming from the influence of key global hubs in specific sectors, such as Switzerland and Japan in Finance & insurance, as well as economies with historical and cultural ties with the UK, such as Cyprus and Malta).

Europe is identified as the most important market for UK exports. Europe is the final consumer of over 45% of UK exports (40% in EU27 countries and 5% in non-EU European countries). Europe is also the largest contributor of value added to UK export production. Specifically, on the supply side, the US, Germany and France all rank highly as contributors to UK exports. On the demand side, the same key players also dominate, although Saudi Arabia and Australia make up a far higher proportion of demand for UK exports than supply of foreign value added.

6.3 Policy implications

The insights and findings gained from the TiVA dataset in this report have a number of implications for public policy.

Protectionist policies can have ambiguous impacts and harm domestic export prospects

The argument for protectionist policies often focusses on competition between comparable products, depicting the landscape of international trade as one of competing interests and winners and losers. In contrast, evidence from the TiVA dataset highlights instances where trade flows complement one another, and the extent to which export production is dependent on inputs sourced from abroad. In light of this, disrupting such trade flows would therefore likely affect the UK's ability to export, especially given that some of the UK's exports to non-EU countries flow through EU27 countries or rely on inputs from the EU27.

The importance of services to UK exports is amplified in value added terms

Analysis of trade in value added also showed that manufacturing sectors buy considerable inputs from service sectors. Specifically, it was found that over 22% of the value of UK manufacturing exports was created in the UK service sectors in 2015. This suggests that the manufacturing sector and service sector are interdependent and policies focussing on either area (e.g. liberalisation of services trade) are likely to also impact the other.

Forward linkages are stronger for the UK than backward linkages

The UK's exporting activity is more dependent on the exporting prospects of key trading partners than on imported inputs for its own trading activity. An exploration of the UK's role in GVCs indicates that the UK's forward linkages are stronger than the UK's backward linkages. In relation to forward linkages, the proportion of the UK's value added embodied in foreign exports (as a share of UK gross exports) has increased between 2005 and 2015, with more UK value added in EU countries' gross exports than non-EU (as a share of UK gross exports). That said, the UK's exported value added for consumption abroad is by far the bigger market, and is more concentrated in non-EU countries than the EU. Arguably then, demand-side conditions and export prospects of the UK's key trading partners are important for UK trade prospects.

Key countries emerge for UK export prospects

The US, Germany and France are key suppliers of imported inputs to UK export activity; these countries are also key consumers of UK exported value added. This may have implications, for example, on trade priorities.

The 'true' trade deficit of the UK is lower than when measured in gross terms at the country level

In value added terms, the trade balance would reflect the surplus or deficit with trading partners that reflects more accurately the domestic activity generated from trading activity. Once imported inputs to production are accounted for, the trade surplus with non-EU countries was found to be smaller than in gross terms, while the UK's trade deficit with EU27 was also smaller.

Appendices

Appendix A Other trade in value added initiatives

A.1 Comparison of Global Input-Output initiatives

An overview of three global input-output initiatives is presented in Table A-1.

- OECD's Inter-Country Input Output (ICIO) database, which underpins its published TiVA and other GVC-related indicators[44];
- the World Input-Output Database (WIOD) maintained by a research consortium led by the Groningen Growth and Development Centre (GGDC)[45]; and,
- the EORA database[46], the source of the UNCTAD-Eora GVC database and related indicators published by UNCTAD[47].

The greatest level of published geographical disaggregation is available in the EORA database, covering 190 economies, compared to 64 covered in OECD's ICIO database and 43 in WIOD. The WIOD database publishes the greatest level of sectoral breakdown, with 56 unique sectors based on ISIC Rev.4, compared to 36 sectors in OECD's ICIO (also based on ISIC Rev.4) and 25 proprietary sectors in the EORA database. This inverse relationship between the level of geographical and sectoral disaggregation in each database partly reflects the availability, coverage and quality of national statistics required as inputs into global I-O construction (such as supply and use tables, input-output tables, National Accounts time series and bilateral trade in goods and services statistics), especially for developing and smaller nations. The underlying assumptions necessary in the construction of global I-O tables and the compromises that database builders are prepared to make are also important factors in determining the level of detail for publishing indicators.

Importantly, the accounting frameworks underpinning the OECD ICIO/TiVA and WIOD initiatives follow the developments in standards of the System of National Accounts[48] (SNA). Both of these initiatives adhere, as far as published national statistics allow, to the recommendations of SNA 2008, the latest version as of 2019. The EORA database currently adheres to SNA 1993 and, thus, due to the significant methodological differences between these SNA frameworks, the indicators based on the UNCTAD-EORA GVC database are not directly comparable with those derived from the latest versions of OECD ICIO (i.e. its TiVA indicators) and WIOD. Similarly, the comparability of

[44] As well as TiVA indicators, OECD also publishes indicators concerning CO2 embodied in international trade (OECD 2019a) and Trade in employment (OECD 2019b).

[45] The original WIOD project was funded by the European Commission, Research Directorate General as part of the 7th Framework Programme.

[46] See Lenzen et al. (2013)

[47] See UNCTAD-Eora Global Value Chain Database (n.d)

[48] System of National Accounts (SNA) is the internationally agreed standard set of recommendations on how to compile measures of economic activity.

the latest versions of OECD TiVA indicators and WIOD with their previous versions, based on older versions of SNA 1993 statistics and with an ISIC Rev.3 industry lists, is also limited.

Other methodological differences between the initiatives stem from the different uses of available international and national statistics; and different vintages of source statistics. When compiling global I-O tables, there are many gaps in the underlying data. SUTs (or IOTs) may not be available for all target years, the level of sector and product detail may not be sufficient for some countries and data may not be available for all the main SNA categories or SNA by sector (e.g. gross output for non-OECD countries). Also, there are significant gaps in bilateral trade statistics, especially trade in services. Even when there is good coverage of bilateral trade statistics, numerous asymmetries need to be reconciled (i.e. Country A reported exports to country B do not match country B reported imports from country A). Official statistics within a country can also be inconsistent, (e.g. differences in exports as reported in SNA, BoP, SUTs and Comtrade). How the different initiatives deal with these issues can be a key source of differences in the TiVA indicators that are eventually produced.

ICIO initiatives use different data sources and assumptions to fill gaps, employ different constraints to align the SUTs and balanced results to latest official SNA time series; and, apply different methods for balancing bilateral trade statistics and ultimately the ICIO tables. The format of the global I-Os may be also different. For example, in OECD ICIO tables non-resident household expenditure is separated from cross-border trade and shown in separate final demand columns. This is not the case in WIOD. Also, in OECD ICIO, country tables for China and Mexico are split to account for heterogeneity in production technology of their “global manufacturers” versus other firms. The treatment of re-exports inherent in official trade statistics and the methods used to construct the “Rest of the World” aggregate region are also sources of differences between the initiatives.

As well as the complexity of the systems used to generate global I-O tables, and the number of countries and sectors to be published, the frequency of the updates of global I-O tables (and hence TiVA indicators) is dependent on the frequency and quality of the input-output and supply and use tables released by national statistical bodies. In recent years, the frequency and quality of national data releases has increased. OECD and UNCTAD-EORA producers anticipate new releases of TiVA indicators on an annual basis. Currently, there are no plans for future releases of the WIOD database, and researchers involved in the project have shifted focus towards sub-national input-output analysis.

Table A-1 Comparison of the coverage of the key Global Input-Output initiatives

	OECD ICIO	WIOD	EORA
Country coverage	64 economies + "Rest of the World" and 14 supra-national region aggregates[49]. Within the ICIO tables, China and Mexico are split to account for heterogeneity within sectors i.e. export-orientated firms versus domestic firms.	43 economies	189 economies + "rest of the World", fewer for certain indicators
Sector detail	36 unique sectors. The TiVA indicators are published in a sector hierarchy, including aggregates for total manufacturing and total business sector services.	56 sectors in WIOT	For UNCTAD-EORA Global Value Chains (GVC) database: 25 sectors Various disaggregation are available for Multi-Region Input-Output (MRIO) tables (511 sectors for the UK).
Accounting framework	Based on SNA 2008 and ISIC Rev. 4	Based on SNA 2008 and ISIC Rev. 4	Based on SNA 1993 and proprietary classification mapping to ISIC Rev. 3
Time coverage	2005-2015	2000-2014	1990-2019 (1990-2015 for sectoral data)
Regularity of updates	Previous releases in 2013, 2015, 2016 and 2018. Annual updates are intended in the future. Next update expected Spring 2020.	Previous releases in 2013 and 2016; currently no plans for future updates.	First release of GVC database in 2013. Since then, the GVC database has been updated annually in parallel with EORA database updates
Measures available *(not exhaustive)*	• A set of "**core" TiVA indicators** including foreign and domestic VA content of exports, domestic VA content of imports, domestic VA in foreign final demand, foreign VA in domestic final demand (incl. GFCF and household consumption) and variations	• Country aggregates for Value-added Exports for Direct Use[52] • Value-added Exports for Final Stage Production • Value-added Exports for Consumption. Sector disaggregated indicators can be obtained on the basis of World Input-Output Table	• Value-added in trade (VA) • Foreign value-added (FVA) • Domestic value-added (DVA) • Indirect value-added (DVX) • Cross-country VA contributions

[49] See OECD (2018a)

[52]Los and Timmer (2018)

Measures available *(not exhaustive)*	revealing partner shares and focussing on services • A set of **4-dimensional data cubes** that allow users to construct their own TiVA indicators without having to manipulate the underlying ICIO tables e.g. – Origin of value-added in gross exports – Origin of value-added in final demand – Origin of value-added in gross imports The OECD also publishes other sets of GVC-related indicators based on the ICIO tables such as "Trade in employment" and "CO_2 emissions embodied in international trade" (see footnote 44 above). OECD AMNE Database, based on ICIO, distinguishes between three types of firms: foreign affiliates domestic MNEs (domestic firms with foreign affiliates) and domestic firms not involved in international investment[50] OECD also publishes a set of harmonised

[50] See OECD (2018d)

	national Input-Output tables generated from the ICIO database.[51]		
Data sources used	The main building blocks for construction of annual ICIO tables are SUTs adjusted to common sector and product classifications, a common format (of rows and columns) and common price valuations. These are constrained to the latest time-series of SNA main aggregates (expenditure accounts) and SNA by sector (from OECD and UNSD databases). Information from national (benchmark) IO tables is exploited when required. Goods and services data are sourced from UNSD (Comtrade) and Trade in Services statistics (from OECD and UNSD) respectively. Balance of Payments statistics and Tourism Satellite Accounts are used to account for expenditure of non-resident households. This improves treatment of trade flows and allows specific analysis of tourism and mode 2 trade in services.	TiVA indicators are derived from the World Input Output tables. Gross imports and exports data sourced from UN Comtrade and UN Service Trade database	EORA MRIO tables are based on national SUTs and IO tables Gross imports and exports data sourced from UN Comtrade and UN Service Trade database
Future development plans	ISIC Rev.4 ICIO tables for earlier years (1995 and 2000 in the first instance) Additional countries. Benefit from outcomes of the OECD's initiative to help countries develop extended supply and use tables (eSUTs) to account for firm heterogeneity within industrial sectors (e.g.	While there are currently no plans to update the database in its current format, future research focuses on sub-national input-output and GVC analysis.	Focus on fixing bugs and accounting inconsistencies.

[51] See OECD (n.d. b)

Future development plans	exporters v. non-exports, SMEs v. large firms) Improvements in accounting for trade and transport margins		
Documentation	OECD (2018f) OECD (2018c) Yamano and Webb (2018)	Timmer et al. (2012) Timmer et al. (2015)	Aslam et al. (2017) Lenzen et al. (2013)

Source: OECD, WIOD and KGM Associates

Trade in value added initiatives also include regional projects, like the EU FIGARO supply and use and input-output tables, the Asia-Pacific Economic Cooperation (APEC) TIVA, and the North American TiVA initiatives.

EU FIGARO is a Eurostat-led attempt aiming to develop regional SUTs and I-O tables for the EU countries[53]. Regional SUTs and I-Os are built using the national SUIOTs and trade data harmonised by Eurostat. These are also linked to employment, capital and environmental accounts. Future development plans aim to tackle inconsistencies in the data and to develop presentation tools.

The APEC TiVA initiative is co-led by the governments of the US and China with participation from international trade bodies of Asia-Pacific Economic Cooperation countries[54]. It aims to build the regional APEC supply and use table and harmonised APEC trade statistics

Similarly, the North American TiVA (NA-TiVA) initiative, led by the statistical bodies of the US, Canada and Mexico, aims to develop value added measures of trade for the region[55]. The NA-TiVA will utilise regional North American supply and use tables and will be based on North American Industry Classification System, allowing for a greater level of compatibility with national accounts and sectoral disaggregation for these countries, compared to other initiatives. The authors are aiming to disseminate an updated methodological paper in 2019.

A.2 The World Input-Output Database (WIOD)

The World Input-Output Database project has been conducted since 2009 by a consortium of European academic and economic policy institutions, with support from national statistical offices and the OECD. The project was a continuation of the earlier EU KLEMS[56] development aiming to further the understanding of competitiveness, trade and the environment in Europe.

The WIOD research comprises of two strands: the development of an accounting framework for measuring trade relationships; and the construction of a global supply and use database.

Accounting framework and assumptions

As with OECD ICIO, the accounting framework used to develop the database is based on national supply and use tables (SUTs) which are supplemented by exports and imports data originating from the National Accounts provided by national statistical offices, and the international trade statistics from UN sources.

The WIOD data are based entirely on SUTs, rather than a combination of SUTs and Input-Output Analytical Tables (IOATs)[57].

According to Timmer et al.[58], SUTs are a more natural way of linking international trade data, as they provide information on both the products and

[53] Eurostat (2019)

[54] APEC (2018)

[55] US Census Bureau et al. (2018)

[56] EU KLEMS (2006)

[57] Timmer et al. (2015)

[58] Timmer et al.(2012)

producing sectors, and obviate the need for additional assumptions used in constructing Multi-Region Input-Output (MRIO) tables from IO tables[59].

For countries where the frequency of releases of national SUTs is lower than annual, the national accounts tables are used to link and interpolate SUTs over time. Time series are generated using a technique called SUT-RAS, which supplements bi-proportional updating RAS method with inputs from National Accounts series with the data on the changes in inventories, exports and imports at the product level.

In the second step, SUT data are combined with international trade data to obtain international SUTs, by making a split between use of domestic and imported products, in accordance with the balancing rules (for each product, the domestic supply equals domestic production, and total imports equal total use of imported products).

SUT data on inputs are broken down into inputs of domestic and imported origin. This is achieved through imputations based on the sector input shares of use category of import (intermediates, final consumption or investment). The proportionality assumption is then applied within each of the three categories of use (intermediates, final consumption or investment). Subsequently, this results in the import use table split by the country of origin, where individual country import shares may differ across use categories, but are restricted to be identical within the categories.

According to WIOD data, the import proportions differ widely across use categories (intermediates, final consumption and investment), which should result in a better accuracy of the WIOD I-O table.

Resulting international SUTs are then transformed into ICIO tables based on product-by-product classification, or sector-by-sector classification, depending on the desired use and the relative importance of the output of secondary products in sectors.

Importantly, all harmonisation procedures used in the latest WIOD (2016) are set with the goal of matching the SNA 2008 conventions[60]. This improves comparability of WIOD and the 2018 OECD ICIO database, due to the same treatment of accounting conventions introduced in SNA 2008, such as capitalisation of R&D, merchanting and treatment of cross-border flows with no change of ownership.

Database contents and coverage

WIOD consists of annual time series covering the following:

- World Tables – International supply and use tables in current and past prices
- National Tables – National supply and use tables in current and past prices
- Socio-Economic Accounts, which include data on indicators such as:
  - output
  - value-added
  - capital stock and investment

[59] Ibid.

[60] WIOD (2016)

  - wages and employment
- Environmental accounts, with data on energy and resource use, emissions

The World Tables data need to be processed by the user to obtain indicators similar to these readily present in the OECD TiVA database. This can be achieved through a series of algebraic transformations, such as those documented by Los, Timmer and de Vries in their analysis of global value chains based on WIOD data[61]. Some calculated indicators data have also been made available by Los and Timmer[62].

The product level of disaggregation in SUTs is largely dependent on the level of detail prescribed by Eurostat for EU countries' statistical offices, and where required, correspondence tables are used, along with imputations for undisclosed data[63]. The import data for all countries covered in WIOD are obtained from the UN Comtrade database at HS 6-digit product level, allocated to three use categories: intermediates, final consumption and investment based on UN Broad Economic Categories[64].

For trade in services, data are collected from various sources[65] and harmonised, before being mapped from Balance of Payments classification to WIOD products. In contrast to goods categories, the breakdown into use categories for services is obtained from existing tables. Due to the overall weaker quality of data, the harmonisation adjustments have to be applied extensively to services data to ensure consistency.

A.3 The UNCTAD-EORA Global Value Chain Database

The UNCTAD-EORA project is a joint effort of the UN and The University of Sydney aimed at compiling global multi-region input-output tables, complemented with environmental accounts and accounts on resource use[66]. The approach is focused on achieving the highest possible level of disaggregation for the longest possible time series. At the same time, the creators aim to remain transparent about the process of compilation through the publication of assumptions, provision of standard deviation estimates and information on constraint violations, highlighting the discrepancies between final MRIO and disparate raw data.

Accounting framework

EORA MRIO tables are constructed using the following data:

- National input-output tables or SUTs constructed by national statistical offices
- UN databases: National Accounts, UN Comtrade and UN Services trade

The accounting framework attempts to harmonise the data sources to standards defined in SNA 1993, resulting in major methodological differences from the latest OECD ICIOs, which are compiled to SNA 2008 standards.

[61] Los et al. (2014)

[62] Los and Timmer (2018)

[63] Erumban et al. (2012)

[64] Timmer et al. (2012)

[65] OECD, Eurostat, IMF and WTO

[66] Lenzen et al. (2013)

For countries where fewer than 25 sectors in national I-O tables are identified, the approach expands the level of detail to 25 sectors. This is contrary to the more common approach used in building MRIO tables, which aggregates sectors to match the lowest level of sector detail available in the relevant data sources. Disaggregation methods are used to construct weights, and, according to the authors, simulations can be used to show that using as much information as possible is beneficial for the accuracy of the resultant I-O table[67].

Valuation of outputs is harmonised to a level distinguishing margins and taxes from basic prices.

Compilation of MRIO tables begins with reconciling all year 2000 accounting constraints[68] (in contrast, accounting constraints are applied for each year in the creation of OECD ICIOs). From there, forecasting and back-casting procedures are applied, scaling all year 2000 solutions with inter-year ratios specific to bilateral transactions and bilateral final demand relationships, as well as value-added and supply tables, derived from country time series data available in UN databases.

Reconciliation approaches to MRIO tables are based on quadratic programming approach or a variant of the RAS (bi-proportional balancing) method. The estimates of the standard deviation for each cell in the MRIO are based on whether the figures were interpolated, estimated or contested by other sources of data[69].

The UNCTAD-EORA Global Value Chain Database is underpinned by the MRIO accounting framework and the simplified EORA26 data (limited to flows in 25 sectors and re-exports/re-imports flow). The sector classification in the EORA26 database is proprietary and a mapping to ISIC Rev. 3 is available. The matrix algebra and GVC concepts are documented in Aslam et al.[70].

Database contents and coverage

The UNCTAD-Eora Global Value Chain Database provides data for the following indicators at the country level:

- value-added in trade (VA)
- foreign value-added (FVA)
- domestic value-added (DVA)
- indirect value-added (DVX)

The above indicators are available for 1990-2019 period for 174 countries.

Additional country and sector breakdowns are available for 1990-2015 for the following indicators:

- for each country-sector combination: VA contribution by each other country
- for each country: VA contribution by each other country-sector tuple

[67] Jensen (1980)

[68] Lenzen (2013)

[69] UNCTAD (2013)

[70] Aslam et al. (2017)

- for each country-sector tuple: the share of foreign value-added in exports (year 2015 only)

The sector classification for these indicators is based on ISIC Rev. 3 and includes 25 sectors.

The authors of the UNCTAD-Eora GVC Database provide direct comparisons of indicators to the counterparts available in the 2016 OECD TiVA database. Comparability with TiVA 2018 is likely to be hindered because the 2018 OECD TiVA database is based on SNA 2008 while EORA is based on SNA 1993. According to calculations[71], the correlation between the two sources of the headline indicator "share of foreign VA in Exports" declines from over 0.8 for 1990s to 0.65 for post 2008 years. A comparison of point-estimates for foreign value-added in exports in 2011 for major economies shows relatively large discrepancies in the data, with UNCTAD-EORA estimates being higher in all compared cases. The difference likely stems from the presence of re-exports in the gross exports of the EORA database (i.e. goods recorded as imports and subsequently exported without further transformation). In the construction of ICIO tables, the OECD adjusts for re-exports by removing them from exports and imports – this adjustment is particularly significant for countries serving as trans-shipment hubs, such as Hong Kong, Singapore or the Netherlands.

[71] Lenzen et al. (2013)

Appendix B UK case studies: financial services and motor vehicles

B.1 Introduction

Appendix B repeats the analysis in Chapter 5, focussing on two sector case studies; namely, UK financial services (Finance & insurance sector) and UK motor vehicles (Motor vehicles sector). The chapter uses the OECD TiVA dataset "Gross exports by origin of value added and final destination" to analyse the global supply chains in which the UK is integrated. In particular, the analysis focusses on the UK's role as a supplier within the global supply chain and notable supply-side and demand-side dependencies/risks.

Section B.2 contains a case study of UK exports of financial services. Section B.3 contains a case study of UK exports of motor vehicles. Section B.4 provides concluding remarks.

B.2 UK exports of financial services

Importance of UK trade in financial services

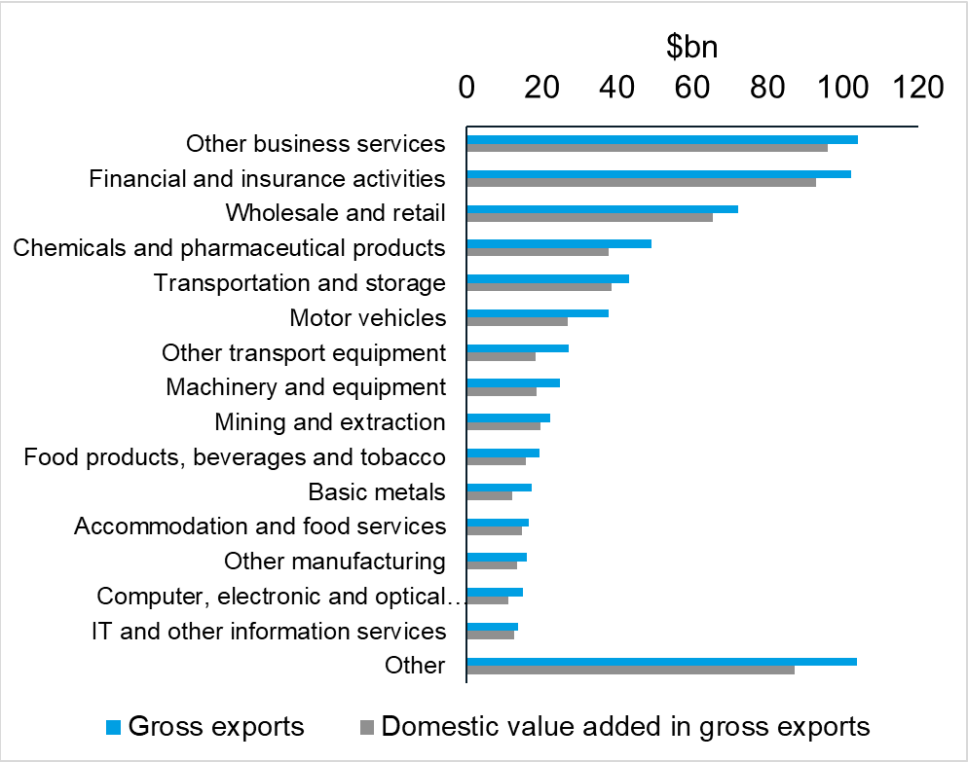
The rationale for examining the financial services sector as a case study is two-fold. Firstly, the sector is especially vital to UK trade. The financial services sector[72] made up $102bn of UK gross exports in 2015 making it one of the largest exporting sectors (15% of total gross exports), second only to Other business services[73] (see Figure B-1). Moreover, due to the relatively high proportion of value added generated domestically, financial services account for an even higher share of total UK value added embodied in UK gross exports (16% or $93bn).

The second reason for examining financial services is the degree to which financial sectors are integrated internationally. Financial markets in key global economies are closely connected – through interactions in capital markets, for instance. This is evident from key events such as the 2007/08 financial crisis. In understanding the UK's relationship with its trading partners and its position in the supply chain, the analysis seeks to provide insight into key risks and dependencies.

[72] For the purpose of Appendix B, the finance sector is defined as capturing all financial and insurance activities (the Finance & insurance sector) and corresponds to Standard Industrial Classification codes 66-68 (see Table C-1 for more details).

[73] Other business services were not examined as a case study because the sector corresponds to a very wide range of economic activities (NACE 69-82) including: Legal and accounting activities; Activities of head offices; management consultancy activities; Architectural and engineering activities; technical testing and analysis; and many others.

Figure B-1 Key UK export sectors 2015



Sources: CE calculations based on the OECD TiVA Database: Gross exports (EXGR) and Domestic value added content of gross exports (EXGR_DVA).

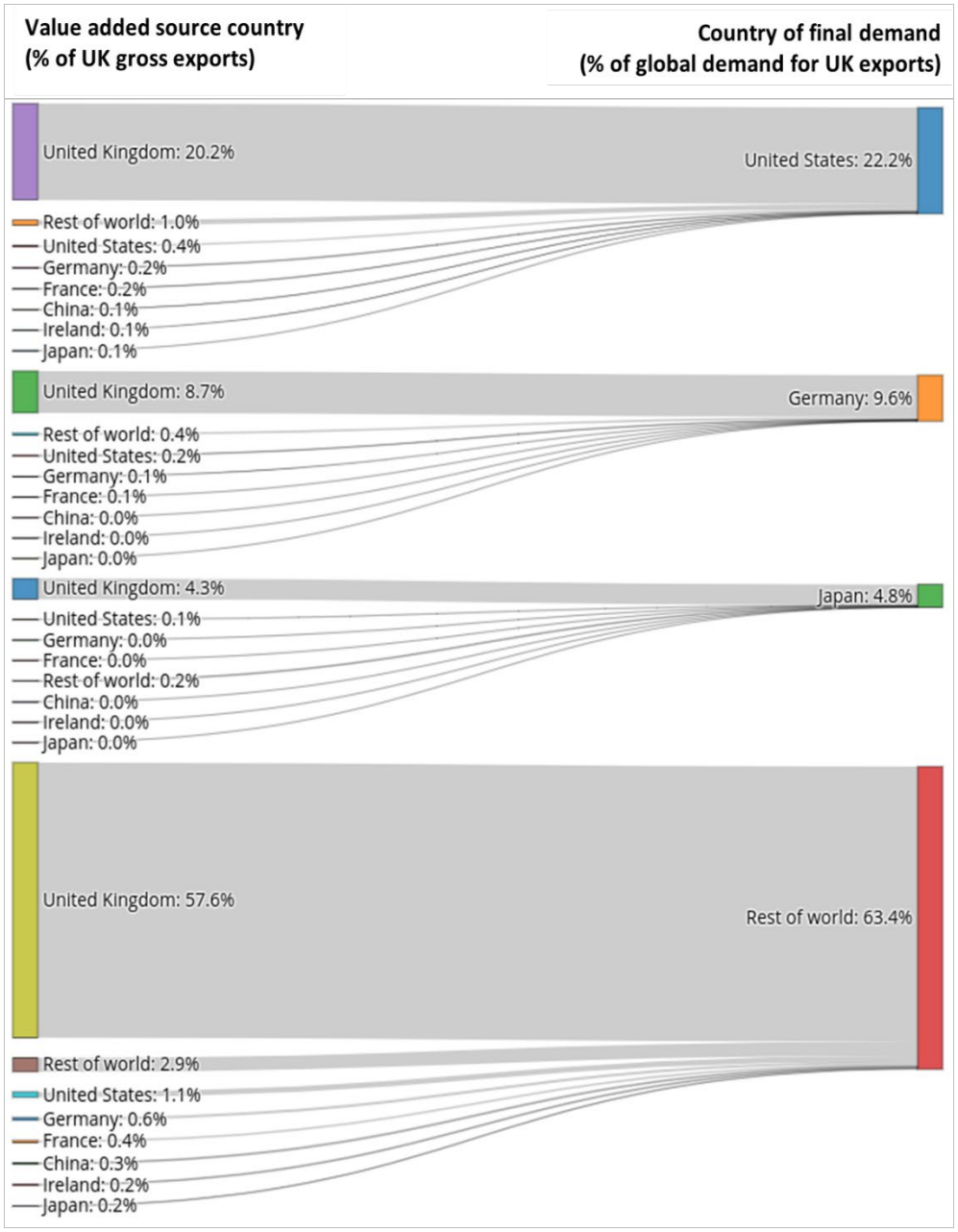
Top trading partners and dependencies

Figure B-2 illustrates the most important markets in which UK exporters of financial services are integrated. The right-hand side lists the most important end-users of UK exports of financial services. These are final demand markets which UK exporters rely on and, being such, they illustrate demand-side dependencies in the global supply chain.

Final demand is not necessarily the result of direct trade between the UK and a given partner country, and therefore is not equivalent to gross exports. Rather, final demand for UK exports can also be indirect if a final demand country consumes exports from a third country which relies on UK value added. In this instance, gross exports in intermediate items are reallocated to the end-user of the final product/service.

The left-hand side of the figure illustrates the most important suppliers to UK exporters of financial services. In representing the key international suppliers to UK exporters, this shows the supply-side dependencies. Crucially, trade frictions with these suppliers could threaten UK exports because they support the provision of UK financial services.

Figure B-2 Top three final consumers of UK exports of financial services (broken down by value added source country, 2015)



Notes: 'Rest of world' refers to the remainder of countries not elsewhere listed. On the right-hand side this would mean all final demand not stemming from the US, Germany or France. On the left-hand side, RoW would refer to total 'world' minus the countries displayed.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

The US economy is the most prominent consumer of UK financial services exports

By far the most important final market for UK financial services exports is the US. US final demand accounted for over $23bn of UK exports of financial services in 2015, more than double that of the second largest market, Germany. This indicates the sensitivity of UK export performance to the US financial sector, and the risks associated with barriers to trade.

When US final demand for UK exports is traced back to the key suppliers, we observe that a large proportion of value added is attributed to the UK (91%, or

20.2pp of the US' 22.2% share of final demand). This means that a large proportion of production for exports to the US, occurs domestically in the UK. The high proportion of domestic value added in exports is a common characteristic of international trade in services.

International supply chains are highly integrated and interdependent

Another key observation relating to UK exports of services to the US is that, of the $23bn of UK exports demanded by the US in 2015, a relatively large amount of value added ($407m) is also *supplied* by the US. This makes US the single largest contributor to foreign value added in UK gross exports to the US. US firms therefore play an important role in supporting the provision of UK financial services which are eventually destined to be consumed by the US economy. This demonstrates the degree of integration of international financial markets and the corresponding interdependence between trading partners.

Germany and France also support UK exports of services to the US, making the second and third largest contributions to UK gross financial services exports. Barriers to trade with Germany and France would thus not only impact the UK's ability to export to French and German markets, but would also have knock-on effects on the UK's ability to provide financial services to the US – the main export market for UK financial services.

The second largest export market for UK financial services is Germany, which accounts for nearly 10% of global demand for UK financial services. A similarly large proportion of production is attributed to the UK domestic economy (91%). From the supply-side perspective, UK exports to Germany are most dependent on imports from the US.

The results presented above suggest that trading partners which contribute the largest proportion of value added in UK exports of financial services also consume a substantial share of UK exports of financial services. Specifically, the same key players appear both as end-users of UK exports and major suppliers for UK provision of exported financial services.

Figure B-3 examines this in greater detail by contrasting UK demand- and supply-side dependencies for financial services exports. Countries which appear higher on the horizontal axis contribute the most to UK *supply* of exports; countries which are higher on the vertical axis contribute the most to *demand* for UK exports. A 45-degree line is also included in the figure which illustrates the points at which a country accounts for the same share of value added and final demand. Countries in blue are EU economies and those in red are non-EU economies.

Major supplier countries to UK exporters tend also to be major consumers of UK exports

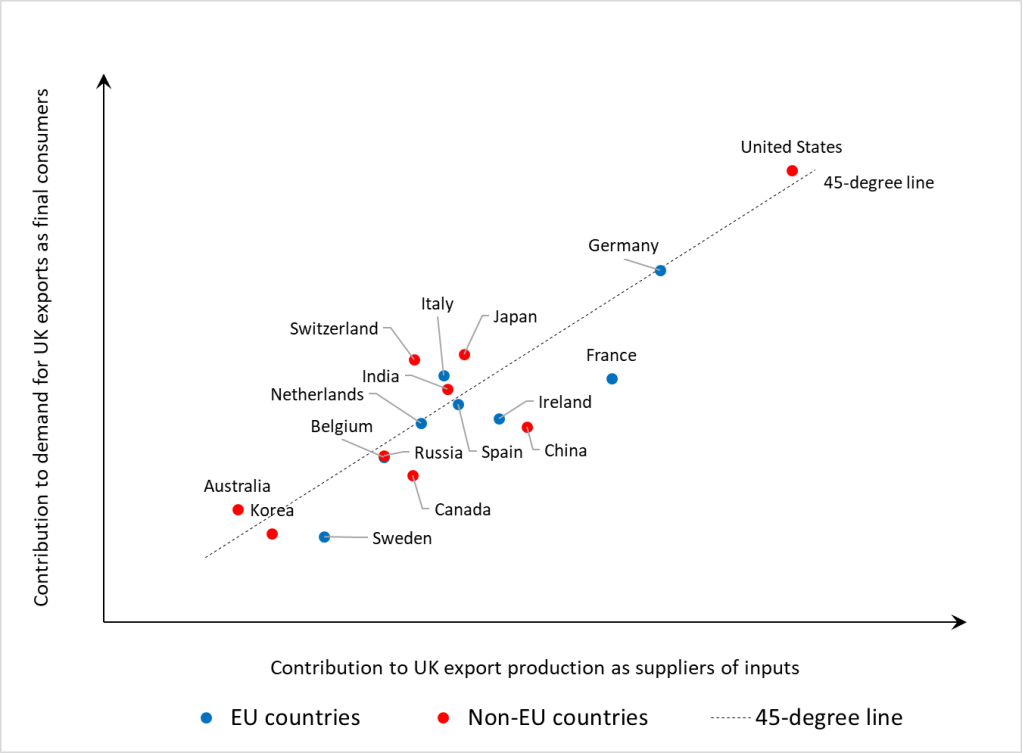
We indeed observe that countries which contribute a high proportion of value added also consume a high percentage of UK exports of financial services. This is notably seen in the case of Germany, which accounts for 10% of demand for UK exports and 10% of foreign sourced value added.

There are, however, several notable exceptions. The UK relies more heavily on supply from France, China and Norway than demand in these markets. France for instance accounts for nearly 8% of foreign value added in UK exports of financial services, but only accounts for 4% of demand for UK exports of financial services in 2015.

In contrast, the US, Japan and Switzerland are relatively more important as destination countries (i.e. purchasers of UK financial services). The US

accounts for 22% of final demand for UK exports of financial services but makes up 20% of foreign value added in UK exports of financial services.

Figure B-3 UK exports of financial services – key supply-side and demand-side dependencies (2015)



Notes: The scale of the axes is logarithmic (base 10). This means that the distance between data-points reflects their relative differences (see example in the notes section of Figure 5-4). Countries in blue are EU economies and those in red are non-EU economies.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

The relative importance of trading partners' supply and demand for financial services exports is similar across EU and non-EU countries. This suggests that there is no prevailing flow of supply and demand between EU and non-EU countries. It appears not to be the case, for instance, that the UK disproportionately purchases intermediate financial services to sell to non-EU countries (or vice versa).

Regional analysis of UK supply chain

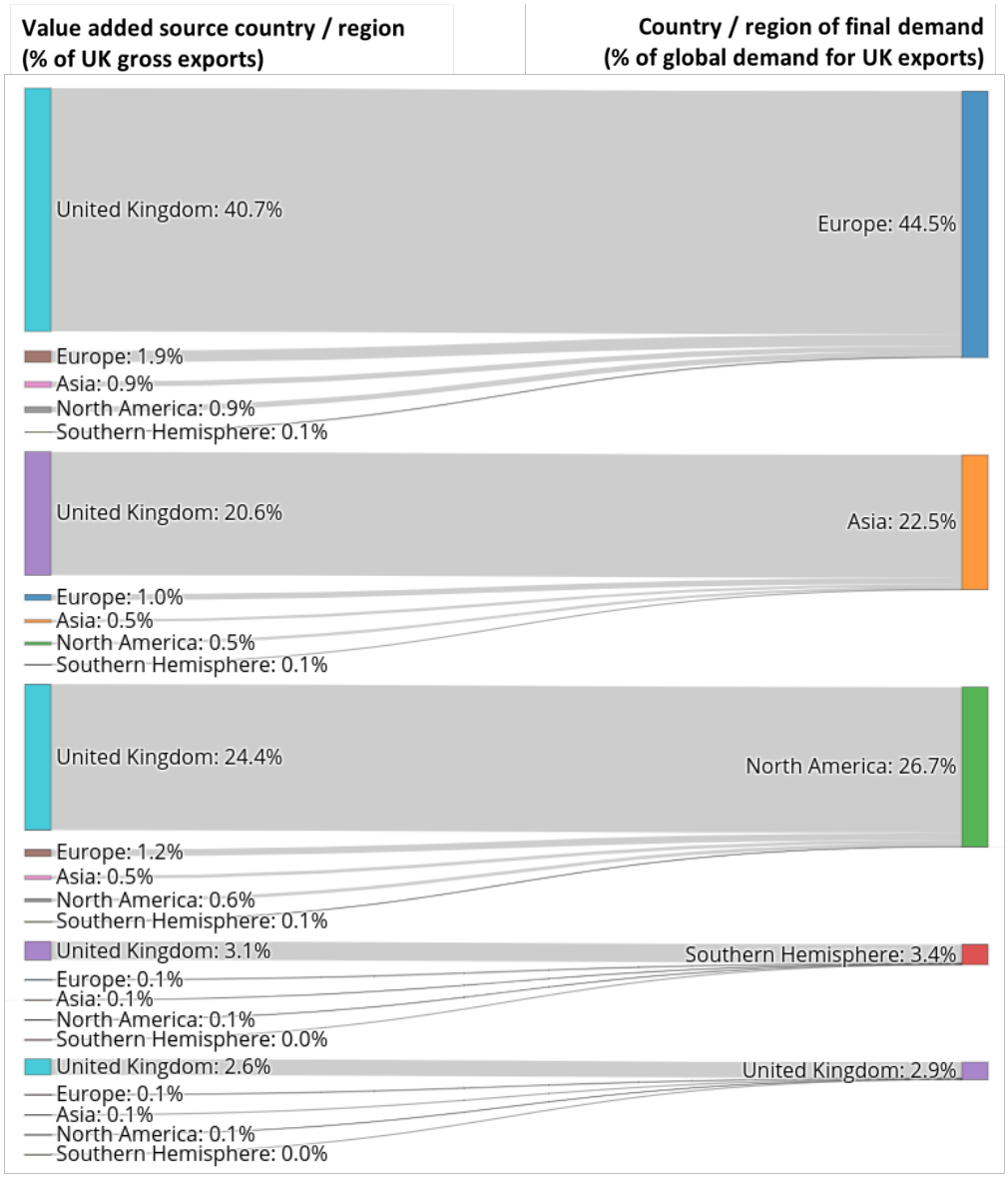
UK exports of financial services depend on a relatively large range of supplier and purchaser countries. This is seen through the large proportion of trade attributed to 'Rest of world' in Figure B-3.

To get around the issue of the significant but uninformative category, "Rest of world", the following analysis characterises trading patterns in terms of regional blocks (Figure B-4). The 64 OECD TiVA economies are therefore categorised as being either in: Europe[74], North America, Asia (incl. Russia)

[74] Europe includes: EU28, Switzerland, Norway, Iceland, and Turkey.

and the Southern Hemisphere (i.e. South America, Africa and Australia/New Zealand)[75].

Figure B-4 UK gross exports by regional bloc, by country/region of final demand and country/region source of value added, 2015



Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

[75] The final group, which covers a very large region geographically, was aggregated due to the modest intensity of trade. Moreover, the nominal reference "Southern Hemisphere" was used because all three continents contain countries which belong to the southern hemisphere. Countries which belong to South America or Africa and belong to the Northern Hemisphere are therefore also included in this group (e.g. Colombia, Tunisia etc.).

Europe is by far the most significant consumer of UK financial services exports.

Although the US is the largest individual consumer of UK exports of financial services, Europe as a whole is a far more important consumer. Around 44% of UK exports of financial services reflects final demand in Europe. This compares to 26.4% from North America and 23.3% from Asia.

Africa, South America and Australia/New Zealand cumulatively account for a very small proportion of UK exports of financial services, either from the perspective of supply (i.e. value added share in UK exports) or demand (i.e. final demand for UK exports). This is likely the result of the size of the economies in this region and the extent to which financial markets and institutions are developed.

The UK is the final consumer for 2.9% of UK financial services exports

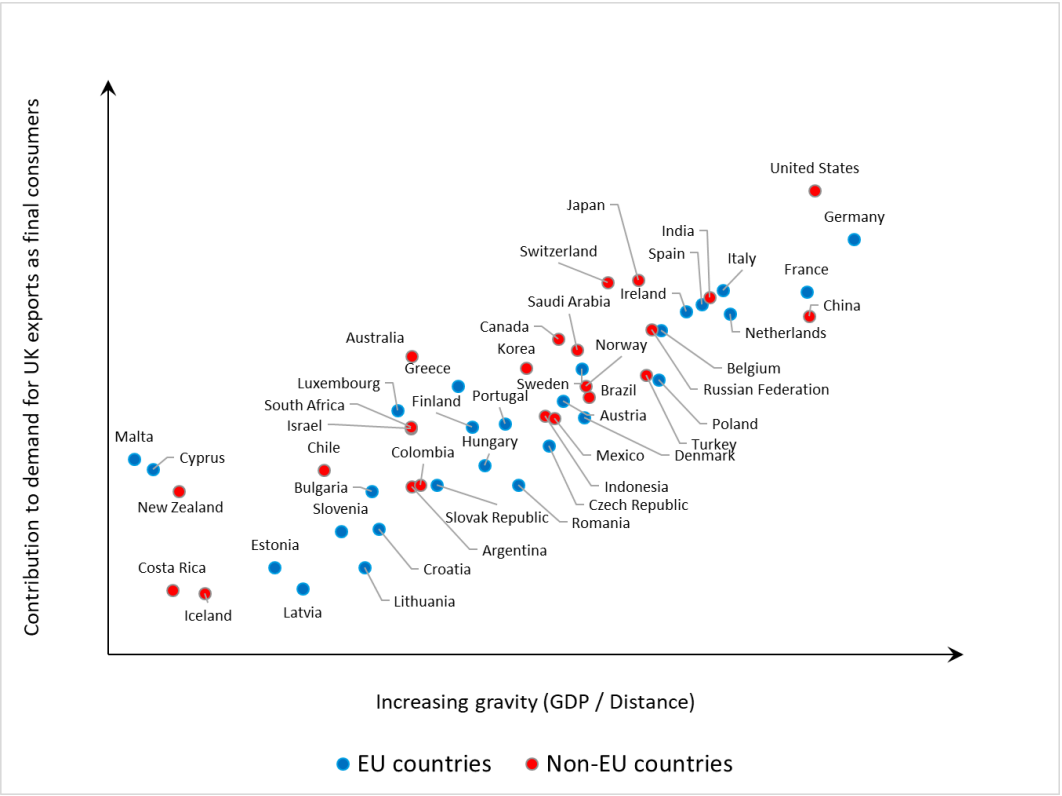
Finally, we observe that around 2.9% of UK exports of financial services are driven by UK demand. This means that the UK drives demand for financial services in the global economy (through imports) and a proportion of these imports is attributable to UK value added. UK final demand of UK exports will therefore be solely intermediate items (by definition).

Key drivers of UK exports of financial services

Observations so far have pointed to the relative importance of European and – to a lesser extent – North American trading blocs in UK exports of financial services. This is seen most prominently when compared to financial services trade to continents which are predominantly in the southern hemisphere (i.e. Africa, South America and Australia). One possible explanation for this is the compound effects of both distance and the size of the economies of the trading partners (i.e. trade 'gravity').

Figure B-5 shows UK exports of financial services by final destination country, plotted against trade gravity which is defined to be GDP / distance. We observe a fairly strong pattern; where countries are relatively larger economically or closer geographically, a higher amount of UK exports of financial services is typically consumed. Countries in blue are EU economies and those in red are non-EU economies.

Figure B-5 Final consumption of UK financial services exports and trade gravity (GDP / distance)



Notes: The scale of the axes is logarithmic (base 10). This means that the distance between data-points reflects their relative differences (see example in the notes section of Figure 5-4). Countries in blue are EU economies and those in red are non-EU economies.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

There are however several notable exceptions to this rule. Some countries appear to account for more final demand for UK financial services exports than can be explained by GDP and distance alone. These exceptions are labelled in the figure and explanations are offered below:

- **Malta and Cyprus:** Strong economic ties with the UK would likely explain some of the variation. Both countries host a high proportion of British expatriates. Moreover, as small open island-economies, these countries rely more heavily on trade.
- **New Zealand, Australia and the US:** Language and historical ties likely play a role in the relatively high demand for UK exports of financial services.
- **Japan and Switzerland:** The size and national significance of the financial sector in these economies would explain why they tend to account for a higher proportion of final demand for UK exports of financial services.

Figure B-6 Value added embodied in UK financial services exports and trade gravity (GDP / distance)

Notes: The scale of the axes is logarithmic (base 10). This means that the distance between data-points reflects their relative differences (see example in the notes section of Figure 5-4). Countries in blue are EU economies and those in red are non-EU economies.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

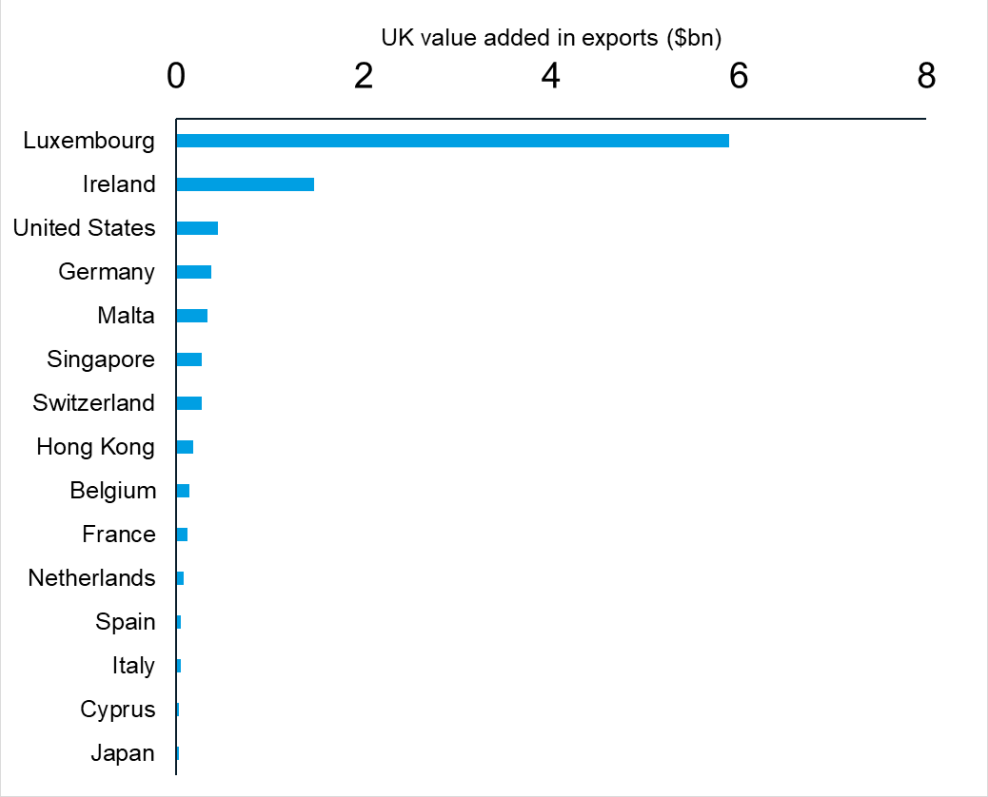
When we conduct the same analysis on foreign-sourced value added in UK financial services exports (i.e. backward linkages), we observe a similar pattern – see Figure B-6. Distance and GDP are correlated with value added shares except for a small group of countries (at the lower left of the figure) who have a similar (low) measure of gravity but a wider range of value added contributions (to UK exports).

Exporters of UK value added to final markets

Figure B-7 ranks countries exporting financial services to non-EU final markets, based on the amount of value added sourced from the UK. Luxembourg and, to a lesser extent, Ireland export a considerable amount of UK value added to final consumers in non-EU markets with $5.9bn and $1.5bn of value added embodied in these countries' exports respectively, in 2015.

With regard to UK value added embodied in foreign exports to EU27 consumers (not shown in Figure B-7), Luxembourg also appears as the top exporter, by a considerable margin (UK value added in exports of the financial services sector from Luxembourg was $6.8bn in 2015). This compares to (UK value added of) $0.7bn and $0.4bn, for Ireland and Malta, who rank second and third.

Figure B-7 UK value added sold to non-EU markets by foreign exporters in the financial services sector (2015)



Notes: UK value added among exporting countries is not mutually exclusive and therefore cannot be summed across exporting countries.
Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

B.3 UK exports of motor vehicles

The UK motor vehicles sector is a key exporter

The UK Motor vehicles ('motor vehicles') sector was selected as a case study because of its contribution to UK exports and its internationally fragmented supply chain. As shown in Figure B-1, the motor vehicles sector exported $38bn worth of goods and services in 2015, making it the second-largest exporter among all UK manufacturing sectors (and sixth overall) next to Chemicals. The sector also exhibits some interesting global trends with a marked shift in final demand towards Chinese consumer markets, although the evidence suggests that this has slowed in recent years (2018 and 2019).

The case study will aim to characterise the UK's role in the global supply chain, identifying key dependencies and risks. Where appropriate, the analysis will also draw comparisons against corresponding results for financial services.

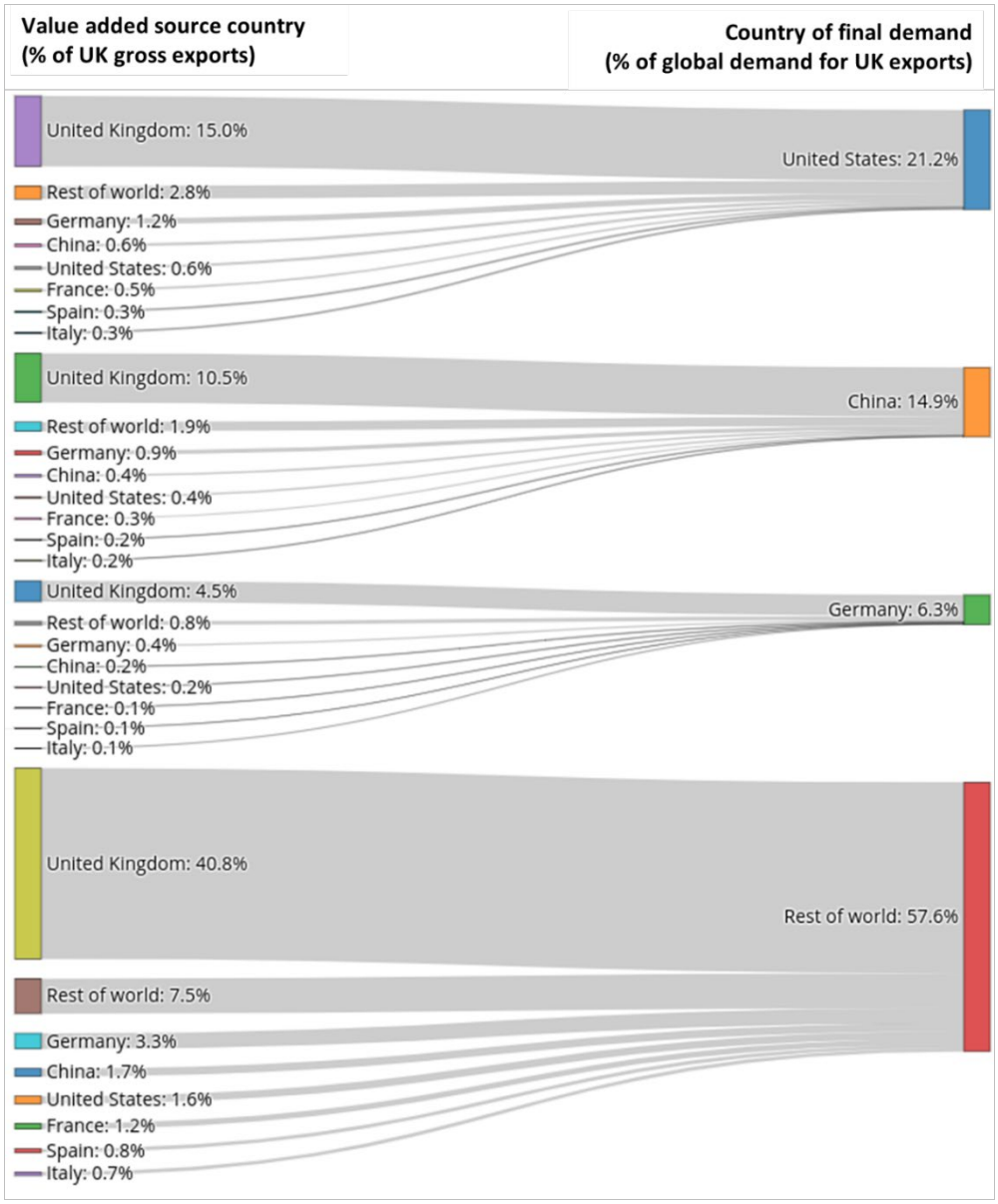
Top trading partners and dependencies

Figure B-8 illustrates the most important markets in which UK exports of motor vehicles are integrated. The right-hand side lists the most important end-users and markets, and indicates the value of final demand in that country that is met by gross exports from the UK. The left-hand side outlines the key suppliers to UK exports of motor vehicles.

US and China make up 36% of total final demand for UK exports of motor vehicles

From the perspective of final consumer markets, the most significant end-users of UK exports of motor vehicles are the US and China, which make up 36% of global final demand (that is met by UK exports).

Figure B-8 Top three final consumers of UK exports of motor vehicles (broken down by value added source country, 2015)



Notes: 'Rest of world' refers to the remainder of countries not elsewhere listed. On the right-hand side this would mean all final demand not stemming from the US, Germany or France. On the left-hand side, RoW would refer to total 'world' minus the countries displayed.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

A relatively high proportion of value added in UK exports of motor vehicles is sourced from abroad

A relatively high proportion of value added in UK gross exports of motor vehicles appears to be sourced from abroad. For example, out of all UK exports of motor vehicles consumed in the US, around 30% of value added comes from foreign suppliers. It is a similar proportion for the other key export markets. The corresponding foreign sourced content of UK exports of financial services to the US was less than 10%.

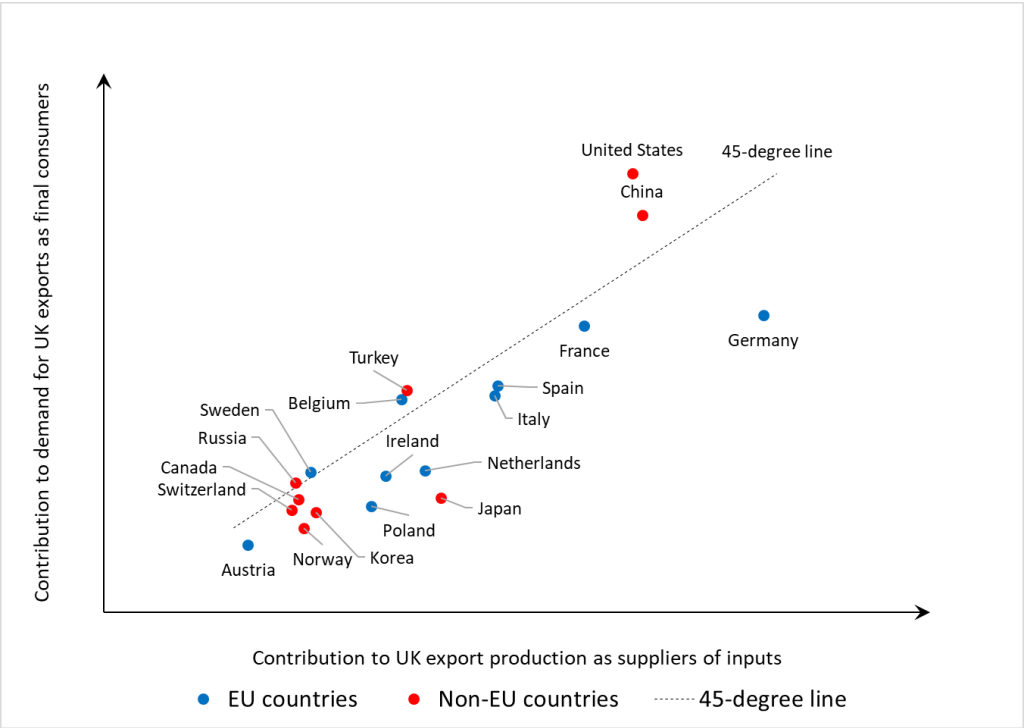
Germany is the most significant supplier in terms of value added, making up around 20% of all foreign sourced value added embodied in UK exports of motor vehicles. Given the magnitude of the German contribution to the production of UK exports of motor vehicles, it is likely that shocks to the supply chain between the UK and Germany would disrupt the UK's ability to manufacture motor vehicles for exporting.

Within UK exports, there is a tendency for value added to flow from EU origin countries to non-EU end-users

Figure B-9 contrasts the key destination and value added origin countries for UK exports of motor vehicles. Again, countries in blue are EU economies and those in red are non-EU economies. Unlike financial services, there is a more evident flow of value added from EU countries to end-users in non-EU countries (notably US and China). In 2015, the US accounted for 22% of final demand for UK exports of motor vehicles but contributes only 9.5% to the foreign value added embodied in UK exports of motor vehicles. Similarly, China accounts for approximately 15% of final demand for UK exports of motor vehicles, while only making up 10% of foreign value added.

This indicates that, on the demand side, UK exports of motor vehicles are highly sensitive to demand side shocks in the US and Chinese markets. Meanwhile, on the supply side, the UK's ability to export to non-EU countries is highly dependent on value added (inputs) sourced from the EU – most notably Germany and France.

Figure B-9 UK exports of motor vehicles – key supply-side and demand-side dependencies (2015)



Notes: The scale of the axes is logarithmic (base 10). This means that the distance between data-points reflects their relative differences (see example in the notes section of Figure 5-4). Countries in blue are EU economies and those in red are non-EU economies.

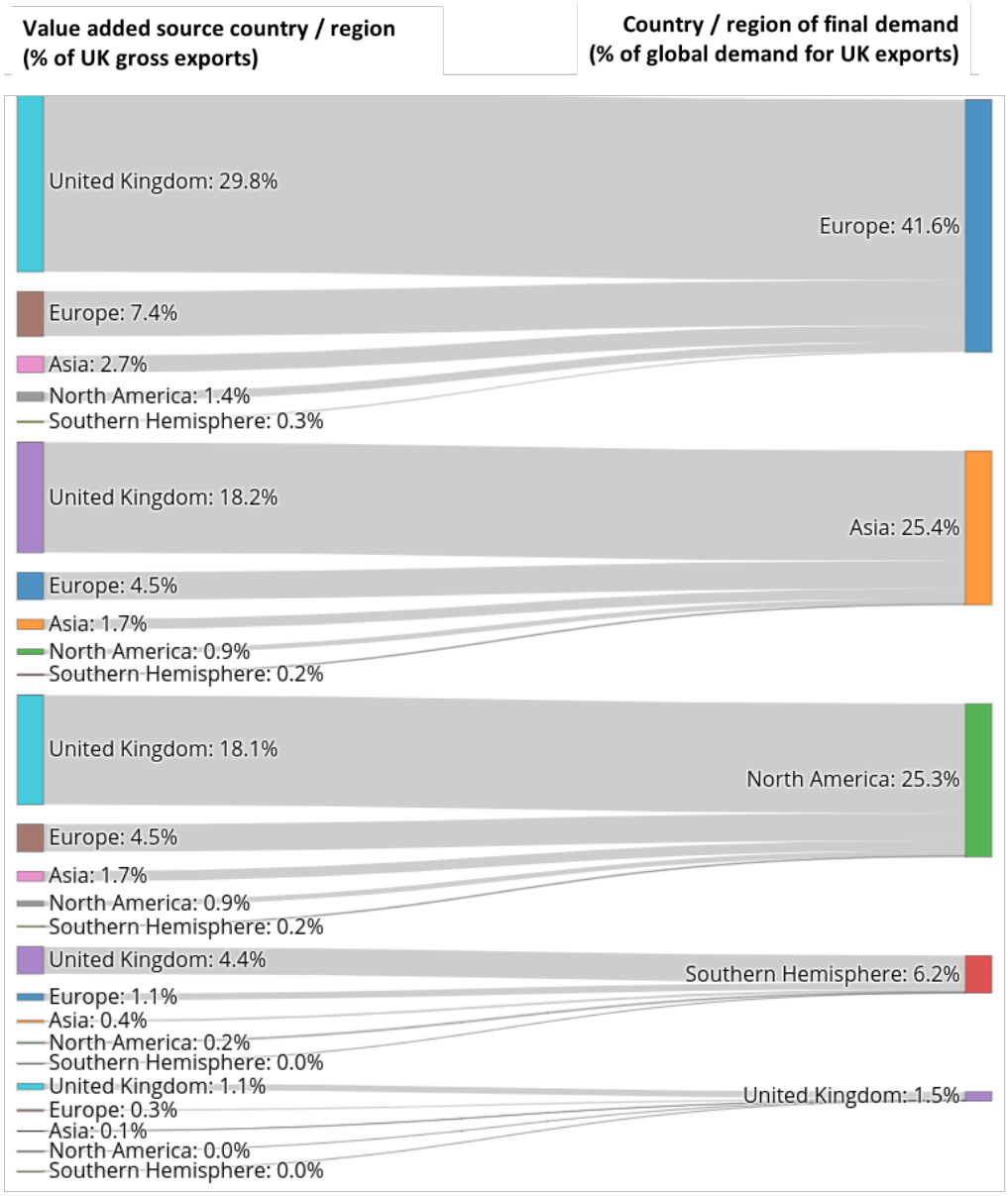
Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

Regional analysis of UK supply chain

Figure B-10 shows the patterns in UK exports of motor vehicles with major regional blocks. From the perspective of supply (i.e. the origin of value added), Europe is by far the most significant trading block. For instance, of the 25.4% of final demand for UK exports from Asia, 4.5pp of value added was sourced from Europe. This compares to 0.9pp from North America.

Europe is also found to be the greatest source of final demand for UK exports of motor vehicles. However, relative to financial services, European end-users appear to make up a slightly smaller proportion of total final demand.

Figure B-10 UK exports of motor vehicles by regional block (final demand and origin of value added, 2015)

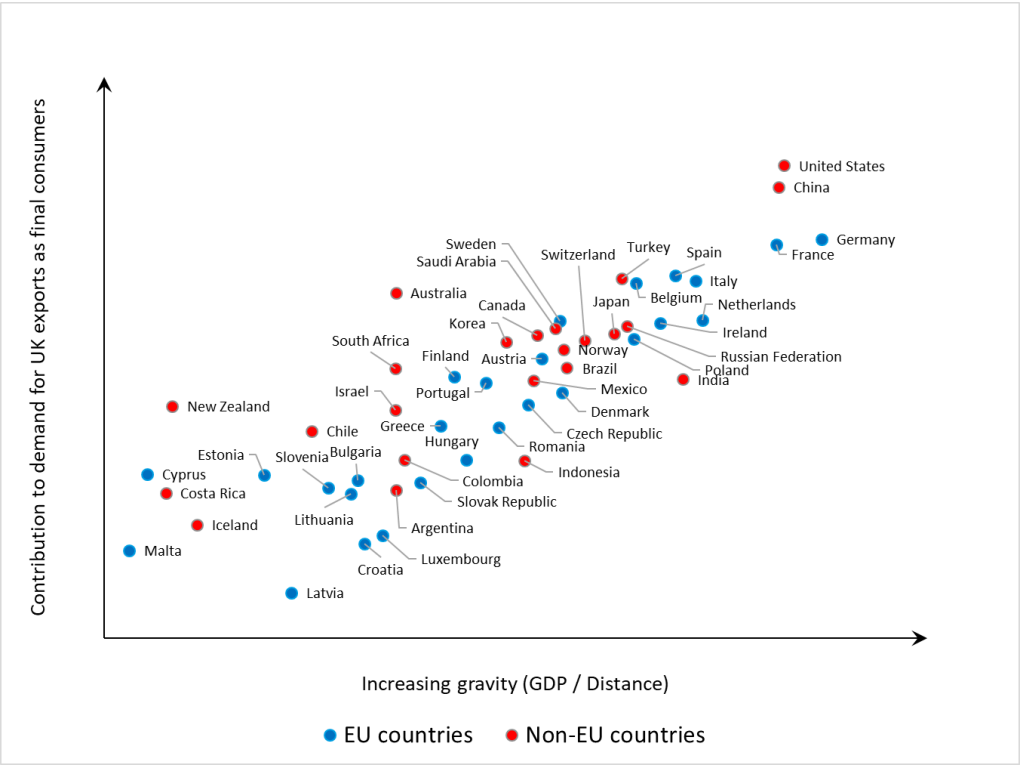


Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

Key drivers

Figure B-11 and Figure B-12 show economic 'gravity' (i.e. GDP over distance) plotted against final demand for UK exports and value added in UK exports of motor vehicles, respectively. Countries in blue are EU economies and those in red are non-EU economies. Similar to financial services, gravity is correlated with final demand across countries.

Figure B-11 Final demand for UK motor vehicle exports and trade gravity (GDP / distance)



Notes: The scale of the axes is logarithmic (base 10). This means that the distance between data-points reflects their relative differences (see example in the notes section of Figure 5-4). Countries in blue are EU economies and those in red are non-EU economies.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

For final demand (Figure B-11), the US, New Zealand and Australia are notable exceptions, all of which appear to consume a higher proportion of UK exports of motor vehicles than can be explained by economic gravity. This is most likely the result of a shared language, cultural similarities and historical ties with the UK. China too consumes a higher share of UK exports than would appear to be explained by economic gravity. This is partly due to a global trend in the automotive sector. China is the third largest importer of motor vehicles globally (behind the US and Germany).

India and Indonesia make up a lower share of final demand for UK exports than implied by economic gravity

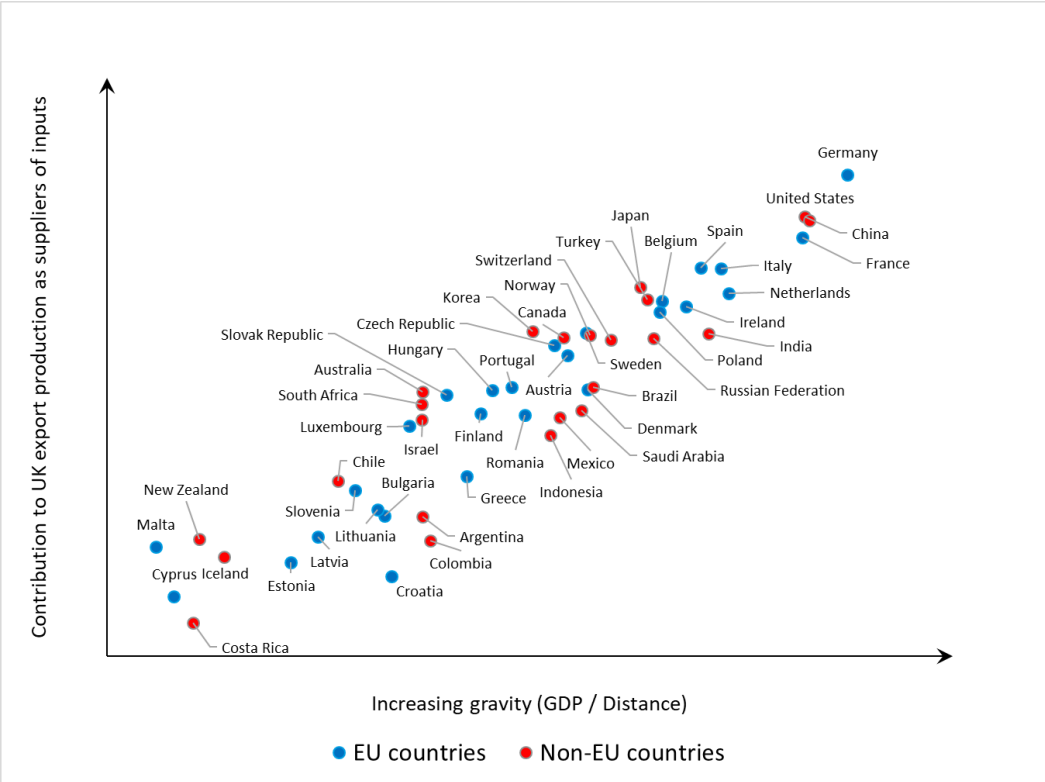
India and Indonesia, on the other hand, consume a lower share of UK exports of motor vehicles than would otherwise be implied by economic gravity. The main reason for this is that a high percentage of value added in final demand for motor vehicles is sourced domestically in Indonesia and India. According to TiVA statistics, in 2015 74% and 68% of final demand for motor vehicles in Indonesia and India is met by domestic value added. This compares to 25% in UK, 27% in France and 53% in the US.

Luxembourg, Croatia and Latvia also appear to make up a relatively low share of final demand for UK exports of motor vehicles, given the size of these economies and the distance from the UK. One possible explanation for this is the intensity of competition with other nearby economies.

As seen in Figure B-12, a correlation exists between economic gravity and the share of foreign value added in UK gross exports of motor vehicles. Countries which deviate most from the trend include:

- countries which typically allocate production of motor vehicles to domestic demand (India and Indonesia);
- countries which have strong cultural, linguistic and historical ties with the UK (New Zealand and Australia);
- small island nations which have ties to the UK through expatriate communities (Malta).

Figure B-12 Value added embodied in UK motor vehicle exports and trade gravity (GDP / distance)



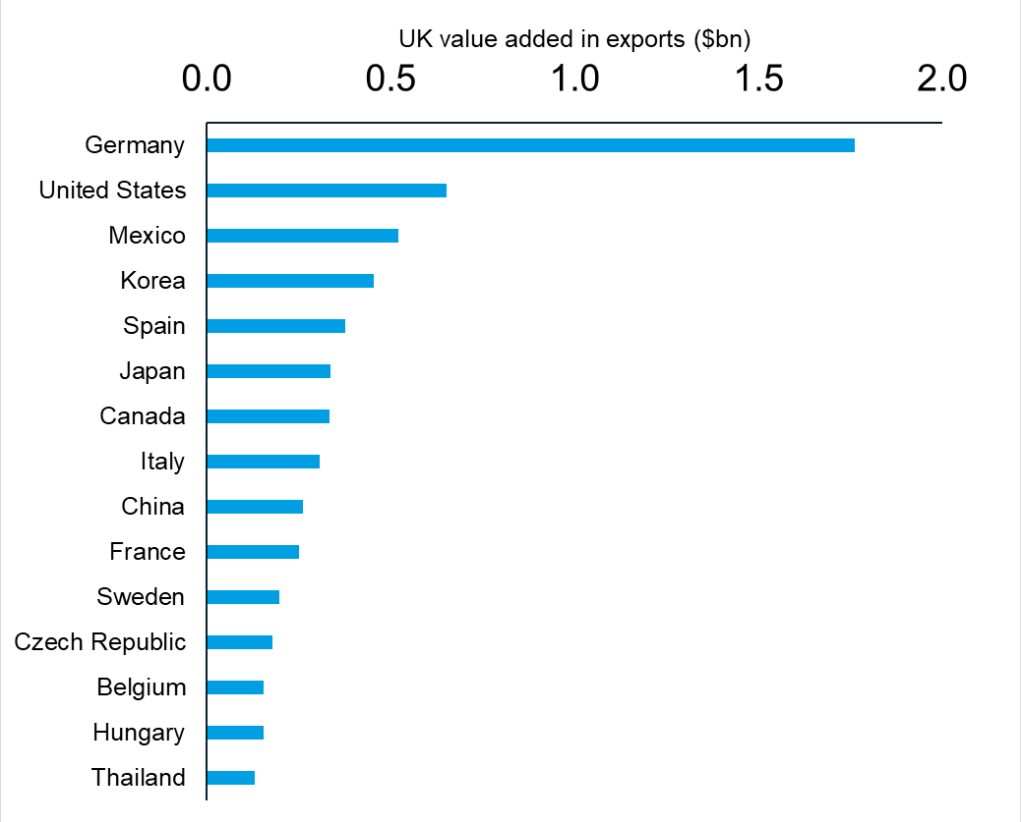
Notes: The scale of the axes is logarithmic (base 10). This means that the distance between data-points reflects their relative differences (see example in the notes section of Figure 5-4). Countries in blue are EU economies and those in red are non-EU economies.

Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

Exporters of UK value added to final markets

In the case of foreign exporters of motor vehicles to non-EU consumers, the countries which source the most from the UK are split relatively evenly between EU and non-EU economies, with 8 of the top 15 coming from the EU (Figure B-13). Gross exports in the motor vehicles sector from Germany had the highest UK value added embodied in its exports in 2015 ($1.8bn). The US, Mexico and Korea also embody a large amount of UK value added relative to other partner countries. With regard to UK value added embodied in foreign motor vehicles exports to EU consumers, 13 out of the top 15 exporters were from the EU.

Figure B-13 UK value added sold to non-EU markets by foreign exporters in the motor vehicles sector (2015)



Notes: UK value added among exporting countries is not mutually exclusive and therefore cannot be summed across exporting countries.
Sources: CE calculations based on the OECD TiVA Database: Gross exports by origin of value added and final destination (FD_EXGR_VA).

B.4 Concluding remarks

This section has examined the role of the UK financial services and motor vehicles sectors in international supply chains. For both financial services and motor vehicles, the US is the largest individual export market. However, with regard to regional trading blocs, Europe is considerably a more important market for UK exports than North America. Strikingly, in 2015 North America was found to be the third most important final demand market (by continent) for motor vehicles, with just 24% of UK exports ultimately consumed there, compared to over 40% of UK gross exports destined for European final consumers.

Demand side and supply side dependencies were also explored for both sectors. For financial services, UK demand is concentrated in a handful of global financial hubs, namely: the US, Germany, Japan and Switzerland. The US and Germany also contributed strongly towards the supply side of UK exports of financial services. However, France and China played a larger role on the supply side than Japan and Switzerland.

For motor vehicles, final consumers of UK motor vehicle exports were highly concentrated in the US and China, together accounting for over a third demand for UK exports. On the supply side, the UK relied more heavily on European trading partners, most notably Germany and France.

Upon tracing the source and destination of UK exports and value added, the interconnected nature of international markets emerged as a common message. The largest consumers of UK exports of financial services and motor vehicles tend also to contribute the largest share of foreign value added in UK gross exports. The TiVA data also suggest that it is common for trading partners to contribute to value added of goods and services which are destined to return for final consumption. The UK was found to be the end consumer of 2.9% of its own exports for financial services. Germany accounts for a high share (20%) of the foreign value added in UK exports of motor vehicles to Germany.

Appendix C OECD TiVA sectoral classification

C.1 OECD TiVA sector names and abbreviated names

Table C-1 OECD TIVA sector names and abbreviated names

ISIC Rev 4 sector code	Sector name	Short sector name
All	TOTAL (All sectors, Whole economy)	Total, all sectors, whole economy
10 to 30	Manufacturing	Manufacturing sector, manufacturing
45 to 98	Total services	Service sector, services
01, 02, 03	Agriculture, forestry and fishing	Agriculture
05, 06	Mining and extraction of energy producing products	Mining of fuels
07, 08	Mining and quarrying of non-energy producing products	Mining, non-energy
09	Mining support service activities	Mining, services
10, 11, 12	Food products, beverages and tobacco	Food products
13, 14, 15	Textiles, wearing apparel, leather and related products	Textiles & apparel
16	Wood and products of wood and cork	Wood
17, 18	Paper products and printing	Paper and printing
19	Coke and refined petroleum products	Coke, petroleum
20, 21	Chemicals and pharmaceutical products	Chemicals
22	Rubber and plastic products	Rubber & plastics
23	Other non-metallic mineral products	Non-metal minerals
24	Basic metals	Basic metals
25	Fabricated metal products	Fabricated metals
26	Computer, Electronic and optical equipment	ICT & electronics
27	Electrical equipment	Electrical machinery
28	Machinery and equipment, nec	Machinery
29	Motor vehicles, trailers and semi-trailers	Motor vehicles
30	Other transport equipment	Other transport
31, 32, 33	Other manufacturing; repair and installation of machinery and equipment	Other manufacturing
35 to 39	Electricity, gas, water supply, sewerage, waste and remediation services	Utilities
41, 42, 43	Construction	Construction
45, 46, 47	Wholesale and retail trade; repair of motor vehicles	Wholesale & retail
49 to 53	Transportation and storage	Transport & storage

55, 56	Accommodation and food services	Hotels & restaurants
58, 59, 60	Publishing, audiovisual and broadcasting activities	Publishing, broadcasting
61	Telecommunications	Telecoms
62, 63	IT and other information services	IT services
64, 65, 66	Financial and insurance activities	Finance & insurance, financial services
68	Real estate activities	Real estate
69 to 82	Other business sector services	Other business services
84	Public admin. and defence; compulsory social security	Public admin
85	Education	Education
86,87,88	Human health and social work	Health
90 to 96	Arts, entertainment, recreation and other service activities	Other services
97, 98	Private households with employed persons	Private households

Sources: Department for International Trade, based on OECD TiVA database.

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