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UK trade in goods and productivity: New findings

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Abstract

Despite a large international literature on the relationship between firm-level trading behaviour and productivity, evidence on this link for the UK has been hampered by long-standing data issues. This paper addresses this data gap, introducing a new dataset which combines information from the ONS' Annual Business Survey (ABS) and HM Revenue & Customs' (HMRC) trade in goods declarations. We apply this new dataset to examine the prevalence of trading behaviour among businesses of different sizes, ownership types and in different industries; and to analyse the link between productivity and trader status for British businesses in the non-financial business economy.

The results of this analysis show that large businesses and those which are foreign-owned are most likely to declare international trade in goods. Among businesses with more than 10 employees, only around one-in-five firms report trade in goods to HMRC, but businesses which declare trade in goods accounted for around 40% of all employment in 2016. Most direct trade in goods is undertaken by the Manufacturing and Wholesale & Retail industries. Our analysis also suggests that trade in goods is strikingly concentrated: 38% of the value of UK goods exports was accounted for by the top 50 exporters in 2016, while the top 50 importers accounted for 34% of the value of imports over the same period.

Our productivity analysis suggests that the productivity of British businesses which declare international trade in goods was around 70% higher on average than for businesses which did not in 2016. After controlling for their size, industry and foreign ownership status, businesses which declare goods exports or imports have labour productivity premia relative to non-traders of around 21% and 20% respectively. These premia are notably lower for trade with the EU: consistent with lower barriers to EU goods trade enabling relatively less productive businesses to access these markets. Analysis of the link between labour productivity and the intensive margin of trade suggests businesses which source a large proportion of their inputs abroad, which export more products (particularly to non-EU nations), or which export to more countries (particularly within the EU) tend to be more productive than businesses which have less internationalised supply chains, which import a wider variety of products and which have a more limited geographical reach within the EU. Although these results are not necessarily causal, they provide a detailed overview of the link between productivity and trade in goods in the UK context.

Key words: Productivity, trade in goods, administrative data

JEL classification: F1, J2

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UK trade in goods and productivity: New findings

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Main points

- A new dataset – linking business-level financial data with administrative trade data – suggests that British businesses which declare international trade in goods were 70% more productive on average than non-traders in 2016
- Businesses which trade in goods internationally are large: only around one-in-five UK businesses with more than 10 employees made trade in goods declarations in 2016, but trading businesses accounted for around 40% of all employment.
- Most direct trade in goods is undertaken by the Manufacturing industry – which exported (imported) £149bn (£112bn) of goods in 2016 – and the Wholesale & Retail industry – which exported (imported) £84bn (£222bn) over the same period; businesses in these industries trade a large number of products and have the greatest geographical reach.
- Businesses which report goods exports or imports were around 21% and 20% more productive respectively than businesses which do not trade after controlling for their size, industry and ownership status; among traders, more productive businesses export more products and export to more destinations than less productive traders.
- These effects appear to differ between the EU and non-EU markets: the productivity premia associated with trading with non-EU markets are considerably larger than those associated with EU trade, consistent that lower productivity businesses finding it easier to access EU than non-EU markets.

1 Introduction

Despite a large international literature examining the link between business performance and trade in goods status at the firm-level (see Wagner 2007, 2012 for surveys), evidence of these relationships in the UK context has been hampered by data constraints. Information on businesses' financial performance is collected by the UK's large, structural business surveys such as the Annual Business Survey (ABS), conducted by the Office for National Statistics (ONS), and is gathered for distinct units within enterprises known as reporting units. Data on trade in goods is collected for administrative purposes by HMRC, and is linked to VAT units which – for large businesses in particular – often do not align with the reporting unit structure of businesses. These differences have hampered the linking of these datasets, and have constrained analysis of the association between business performance and trade in goods in the UK.

Our paper addresses this data issue directly. We use a new feed of HMRC's trade in goods declarations provided to ONS and data from the UK's Inter-Departmental Business Register (IDBR), as well as information from the ABS, to create a new, linked dataset which carries financial and trade in goods data for a large sample of UK businesses for the 2008 to 2016 period. Building on ONS' recent efforts to improve trade in goods statistics and drawing on methods used by ONS to incorporate VAT data in the UK's National Accounts, we devise and implement a strategy which apportions the trade reported by a business' VAT units to its reporting unit structure. For a majority of businesses, this is a simple aggregation exercise. For more complex businesses – responsible for a large proportion of UK business turnover, employment and trade – this involves more complex apportionment between their VAT entities and their reporting unit structures.

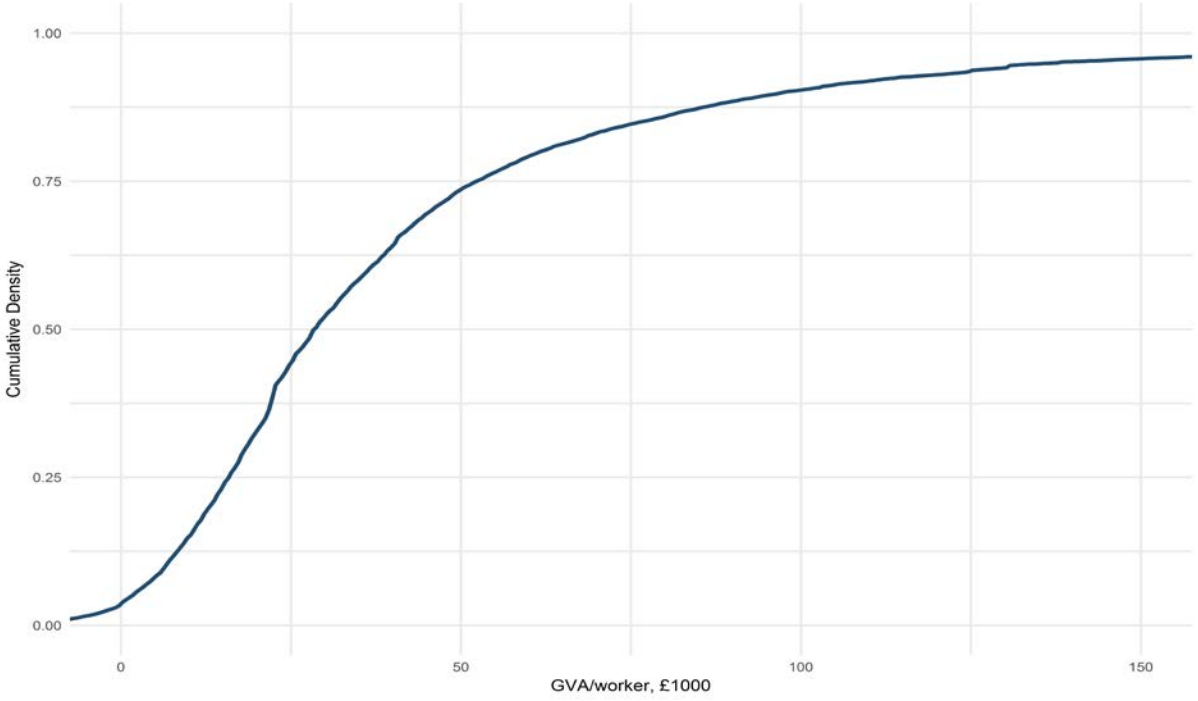
The resulting dataset is the first contribution of this paper. Although it is limited to direct trade in goods alone (and therefore does not capture trade in services, or the onward shipping of traded content through supply chains) and only covers EU trade collected on the Intrastat survey, to our knowledge it is the first large dataset for the UK combining transaction level trade in goods data with business-level financial information. The details of the datasets we used and the matching and linking methodology are set out below.

We apply these data to produce statistics and analysis of relevance to existing policy debates. To support policy-makers following the UK's decision to leave the European Union and wider debates about trade policy, we set out statistics on the prevalence of trade in goods behaviour for different types of businesses. We examine the value of trade in goods for different industries, the average number of products traded and the geographical reach of UK trade in goods, as well as the degree of

concentration of trade in goods flows among businesses, using data for a large proportion of the UK business population.

Secondly, we apply these new data to the UK's productivity performance: examining the link between trade in goods behaviour and labour productivity at the business level. This work – drawing on recent ONS work to examine the drivers of productivity at the micro-level (ONS 2016, 2017a, 2017b, 2017c, 2017d, 2018) – seeks to explain differences in labour productivity across businesses (Figure 1) in relation to their trade in goods behaviour. We examine the link between productivity and trade at the extensive margin – whether a business trades or not – and the intensive margin – how much a business trades – using data for a sample of businesses in the non-financial business economy in Great Britain.

Figure 1: Distribution of labour productivity across businesses, Great Britain, 2016



Source(s): ONS

Note(s): (1) Approximate Gross Value Added (aGVA) per worker from the Annual Business Survey. (2) Excludes businesses which report zero turnover for 2016. (3) Weighted by sample and grossing weights as well as employment: Consequently the cumulative density function aggregates over employment, as well as businesses.

The results of this analysis show that large businesses and those which are foreign-owned are most likely to trade goods directly. Among businesses with more than 10 workers, only around one-in-five firms report trade in goods to HMRC, but trading businesses accounted for around 40% of all employment in 2016. Most direct trade in goods is undertaken by the Manufacturing industry – which exported (imported) goods worth £149bn (£112bn) in 2016 – and the Wholesale & Retail industry –

which exported (imported) goods worth £84bn (£222bn) over the same period. Large businesses in the Wholesale & Retail industry also appear to trade a very large number of products on average, and have some of the greatest geographical reach. Our analysis suggests that trade in goods is strikingly concentrated: 38% of the value of UK goods exports was accounted for by the top 50 exporters in 2016, while the top 50 importers accounted for 34% of the value of imports over the same period.

Our productivity analysis suggests that the productivity of British businesses which declare trade in goods was around 70% higher on average than for businesses which did not in 2016. After controlling for their size, industry and foreign ownership status, businesses which declare goods exports and imports have labour productivity premia relative to non-traders of around 21% and 20% respectively. These extensive margin effects also appear to vary by geography: the labour productivity premia associated with EU trade (4.3% and 1.7% for EU exports and imports respectively) are notably smaller than those associated with non-EU trade (19% and 18% for exports and imports respectively). These results may partly reflect reporting thresholds, but are consistent with lower barriers to EU goods trade enabling relatively less productive businesses to access these markets, while only a considerable productivity advantage enables access to wider markets.

Our analysis of the link between labour productivity and the intensive margin – how much a business trades, how many products, and with how many markets – suggests a highly varied picture. Traders which source a large proportion of their inputs abroad, which export more products (particularly to non-EU nations), or which export to more countries (particularly within the EU) tend to be more productive than traders which have less internationalised supply chains, which import a wider variety of products and which have a more limited geographical reach within the EU. However, these initial findings suggest that how much a business trades can have quite a complicated relationship with their productivity, and will be subject of future work. While these results are not necessarily causal – they cannot say whether these businesses are more productive because they trade or whether they trade because they are more productive – they provide some first evidence of the link between productivity and trade in goods in the UK context.

The rest of this paper is set out as follows. Section two offers a brief overview of the existing literature on the association between trade and productivity. Section three presents our data, while section four provides a guide to our methods and approach. These are elaborated further in the appendix. Sections five and six present our results and a discussion of the limitations of our analysis respectively, while section seven offers some conclusions and direction for future research.

2 Literature Review

There is a large literature focusing on trading behaviour and business performance at the firm-level, of which only a summary is provided here. To date, there has been limited micro-based evidence for the UK that quantifies the link between trade and productivity (notable exceptions include Girma et al., 2004, Greenaway and Kneller, 2004, Kneller and Pisu, 2010, and Harris and Li, 2012[2]). This can largely be explained by data limitations and, in particular, the lack of business-level data which contain information about both financial performance and trading behaviour. Consequently, a large proportion of the existing literature in this field is focussed on countries other than the UK.

Access to data on both firm characteristics and trading behaviour has enabled a large micro-level literature analysing the nature of trade links. These papers examine both how many businesses trade – the extensive margin – and how much these companies trade – the intensive margin. Surveys of these kinds suggest that trade is relatively concentrated in a small number of large firms (see, for example, for the US, Bernard et al., 2009, 2018, and for Europe, Mayer and Ottaviano, 2007, and Berthou et al., 2015).

Existing research on the link between trade and productivity mostly shows that trade is positively associated with firm performance: businesses which export, import or both tend to have higher productivity than businesses which trade only with other domestic firms. However, whether the export- and import-premia estimated by researchers reflects the causal impact of trade is a matter of debate. Specifically, whether high productivity businesses choose to trade – the 'self-selection' hypothesis – or whether trading causes business productivity to rise – the 'learning-by-exporting' hypothesis – or whether causation runs in both directions, remains unclear.

With respect to labour productivity, most studies show that traders are more productive than non-traders. Examining the association between productivity and trader status, after controlling for a range of other, business-level characteristics, researchers have found a positive and significant export productivity premium in the USA (Bernard and Jensen 1995, 1999, 2004), Germany (Bernard and Wagner, 1997 and Vogel, 2011), Slovenia (De Loecker, 2007), Italy (Grazzi, 2012), Spain (Farinas and Martin-Marcos, 2007), Portugal (Tavares-Lehmann and Costa, 2015) and other European countries (Berthou et al., 2015). By contrast, studies for Ireland (Girma et al., 2004) and Sweden (Greenaway et al., 2005) find no productivity differences between exporters and non-exporters. Wagner (2007, 2012) and Tavares-Lehmann and Costa (2015) provide further surveys of the relevant

[2] Previous research is generally limited to databases such as FAME and ORBIS.

literature[3]. Businesses which import are also found to have higher productivity than business which do not. Research on Belgian data (Muuls and Pisu, 2009) and on data from Germany (Vogel and Wagner, 2010) also find that firms who engage in exporting and importing simultaneously are stronger performers compared to those who engage in exporting or importing alone.

On whether these effects are causal, the literature is divided – reflecting both the considerable data constraints and the empirical challenge of identification – although the weight of studies suggests self-selection is very important. For instance, Bernard and Jensen (2004) studied the productivity paths of exporters and non-exporters groups in the USA during a period of five years. For continuous exporters, productivity remained steady over time, meaning that exporting did not seem to influence their productivity level. In more than 30 studies reviewed by Greenaway and Kneller (2007), covering a wide range of countries, 'self-selection' is generally found to be important and other evidence, such as that of learning-by-exporting is found to be less conclusive. Wagner's (2007) review concludes that there is evidence in favour of self-selection for more productive firms into exports markets but almost no evidence in favour of the learning by exporting hypothesis.

However, some researchers have detected evidence of a dynamic effect of exporter status on firm-level productivity. De Loecker (2007) finds that exporting firms become on average 8.8% more productive due to exporting using propensity score matching, which gives support to learning-by-exporting hypothesis. Using more robust econometric methods, further studies, for example, Manjon et al. (2013) and De Loecker (2013), have also found evidence for learning-by-exporting. Manjon et al. (2013) find that although the productivity effects of exporting may work initially through the extensive margin, rather than the intensive margin, for firms that continue exporting it is the intensive margin which determines the extent of their productivity gains. De Loecker (2013) shows that current methods used to test for learning-by-exporting are biased towards rejecting the learning-by-exporting hypothesis since most studies do not account for the fact that past export experience may affect firms' productivity.

In this paper, we do not address these issues of causality, and we restrict ourselves to considering the relative levels of productivity in trading and non-trading businesses. While this does not permit analysis of the importance of trade for productivity growth, it does enable us to establish whether some of the high-level patterns that are observed in the international hold true for the UK. Work on these causal questions – and a range of other applications of these data – we defer to future research[4].

[3] One further notable finding is Collard-Wexler and De Loecker (2016), who report that while Slovenian exporters have relatively higher labour productivity, this is due to having more capital, rather than more Total Factor Productivity (TFP).
[4] See our concluding section for a discussion of potential further work.

3 Data

Data from several different sources are used in this analysis. Business-level data on employment and financial performance were taken from the Annual Business Survey (ABS). Transaction level data on trade in goods was taken from HMRC's customs and Intrastat declarations, and data from the Inter-Departmental Business Register (IDBR) is used to link these sources together. This section provides a brief overview of these data.

3.1 Annual Business Survey (ABS)

The Annual Business Survey (ABS) is the main structural business survey conducted by the Office for National Statistics. It surveys around 65,000 businesses per year to collect financial information on firms in the production, construction, distribution and services industries, representing around two-thirds of the UK economy. The ABS provides the data for the labour productivity estimates used in this paper. These data include business-level turnover, intermediate consumption and 'approximate gross value added[5]' (aGVA) at basic prices. As the ABS has limited coverage of the agricultural and financial industries – as well as the public sector – we exclude these industries from our productivity analysis, and as equivalent historical data for Northern Ireland are not available at time of writing, the ABS analysis presented here only considers firms based in Great Britain[6]. The resulting dataset contains between 45,000 and 50,000 business-level observations of value added per year.

Estimates of employment at the business level are not collected on the ABS. Consistent with our earlier work with the ABS (ONS 2016, 2017a, 2017b, 2017c, 2017d, 2018), the estimate of labour input which we use in this analysis is total employment at the business – including both employees and working proprietors – taken from the Inter-Departmental Business Register (IDBR) at the time of their selection into the ABS. Employment information from the IDBR is derived from a number of different sources (including the Business Register Employment Survey (BRES), HM Revenue and Customs' (HMRC) records and some imputation) and some of the employment information – especially for small businesses – may be several years old. This forms the denominator for our estimate of firm level labour productivity. Our measure of labour productivity (GVA per worker) is therefore calculated as approximate value added at basic prices divided by employment.

[5] GVA from the ABS is referred to as aGVA to differentiate it from the national accounts measure, of which aGVA is a component. The differences between aGVA and the national accounts measure of GVA is discussed in Ayoubkhani (2014).

[6] Northern Ireland is included in our analysis of the trade in goods datasets, but excluded from the analysis of the association between productivity and trader status. An upcoming article will examine the trading patterns of businesses based in Northern Ireland as detailed in HMRC's trade in goods records.

While the ABS provides detailed financial data on the performance of businesses, it offers limited information on their trade in goods behaviour. This omission makes analysis of the link between trader status and productivity challenging, and largely reflects the primary purpose of the ABS: to produce data for the National Accounts. As ONS collects aggregate data on trade in goods from HMRC, there is no need to survey businesses for it directly. Binary ('yes' or 'no') questions on whether a business imports or export goods were added to the ABS in 2011, but no information on the value of trade in goods is collected.

Finally, in common with most ONS surveys, the ABS asks for information at the reporting unit level of the corporate hierarchy. This feature and a range of other issues which accompany the use of these data impose some limitations on our analysis and are explored further below.

3.2 **Inter-departmental Business Register (IDBR)**

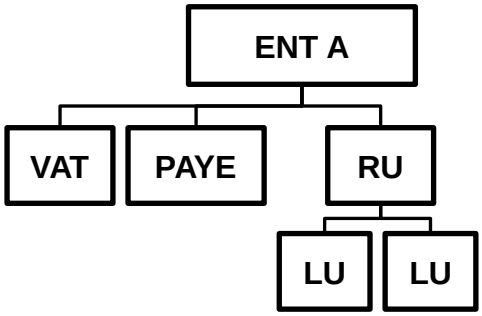
The Inter-Departmental Business Register (IDBR) is a comprehensive register of UK businesses. It is maintained by ONS as the sampling frame for UK business surveys, and covers around 2.8m businesses across all the industries of the economy. The primary source data used to maintain the IDBR is provided by HMRC. It includes all businesses registered with HMRC either for Value Added Tax (VAT), or for the operation of the UK's payroll tax system – Pay as You Earn (PAYE). Additional information comes from Companies House, Dun and Bradstreet and ONS' business surveys. As a consequence, the IDBR contains records on a large proportion of the UK's business population, excluding only those which do not have employees and those with turnover below the VAT registration threshold. To mirror changes in the structure of businesses – including enterprise births, deaths and merger and acquisition activity – as closely as possible, we use quarterly snapshots of the IDBR.

At the core of the IDBR are a set of relational data or look up tables which link various firm-level identifiers together. These identifiers include a business' VAT registration and PAYE scheme registration numbers, as well as the reference numbers of units which ONS constructs to facilitate data collection: In most instances, 'Local units' closely approximate the establishments of businesses, while 'Reporting units' mostly comprise collections of local units which undertake similar activities. Most UK businesses have a structure on the IDBR which resembles that in Panel A of Figure 2: a single Enterprise (ENT) comprised of one VAT (VAT), PAYE (PAYE) and Reporting Unit (RU), with a number of local units (LU). However, larger businesses and those which undertake several kinds of activity are more complex and might appear more like the example in Panel B. In this case, a

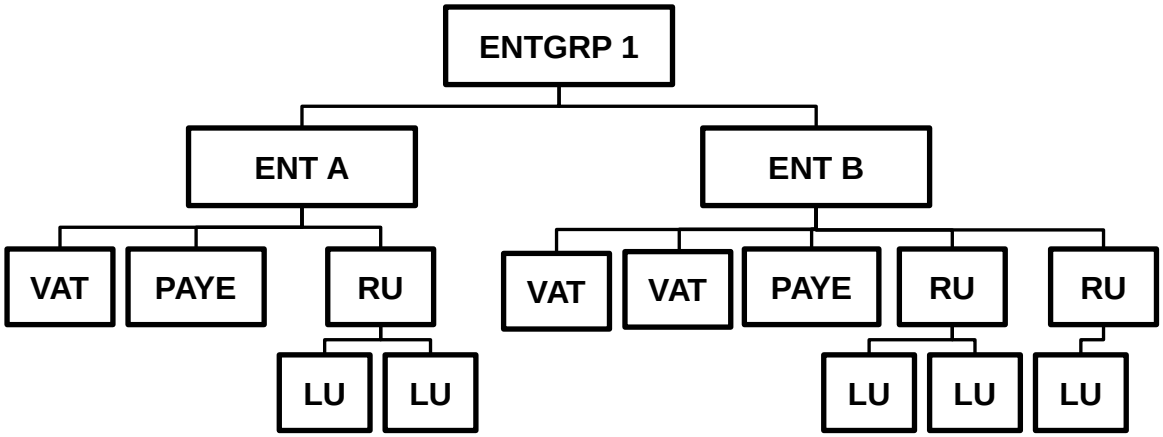
single Enterprise group (ENTGRP) comprises two distinct enterprises, with multiple reporting units to capture information in a granular form[7].

Figure 2: Relational information on the IDBR

Panel A: 'Simple' businesses



Panel B: 'Complex' businesses



Source(s): ONS

These relational data provide the link between VAT units – for which we have information about trade in goods from HMRC – and reporting units – for which we have information about productivity from the ABS. Specifically, we apportion the trade reported by each VAT unit to all the reporting units which appear within the same enterprise group. The details of this process are set out below.

3.3 Trade in Goods

The third dataset used in this analysis is provided by HMRC, and contains transaction level information on trade in goods. These data are collected for administration and tax purposes, and form the basis of HMRC's 'Overseas Trade Statistics' (OTS) publications. ONS Trade in Goods statistics

[7] Throughout, we will refer to 'simple' enterprises as those which have only a single reporting unit (one ENT corresponds to one RU). Multi-reporting unit enterprises will be referred to as 'complex' businesses.

release is derived from these data, with adjustments for consistency with National Accounts[8]. These substantial datasets cover a large proportion of UK trade in goods transactions, between 2008 and 2016 and cover three distinct types of transaction.

- Transactions between businesses based in the UK and the European Union (EU): Information on the total value of trade in goods transactions of UK businesses is collected through the VAT returns of businesses. If the monthly value of this trade crosses an administrative threshold, the business is included in the monthly 'Intrastat' survey for the following twelve months. By law, this survey is currently required to cover at least 93% of UK imports from the EU ('arrivals') and 97% of UK exports to the EU ('dispatches'). As the value of trade has changed, this threshold has also moved – as shown in Table 1. These threshold changes take place on a calendar year basis. Those included in the survey must provide returns by the 21st day of the month following the transaction, and can be subject to criminal proceedings if they fail to make the appropriate submissions.
- Transactions between UK based businesses and those outside the EU: These data are collected through the UK customs import and export declarations made by the importing or exporting businesses, predominantly through the Customs Handling of Import and Export Freight (CHIEF) system. These data are administrative and are consequently not collected through a survey, and cover a large proportion of UK trade with non-EU nations.
- Estimates of aggregate trade missing from the above sources: aggregate estimates for businesses operating below the Intrastat reporting threshold, estimates for missing or incomplete returns from businesses and estimates which account for Missing Trade Intra Community (MTIC) VAT fraud.

Table 1: Threshold for inclusion of VAT unit in Intrastat survey

	Imports from EU	Exports to EU

[8] HMRC's statistical releases are published on an 'overseas trade statistics' basis, set out in the United Nation's International Merchandise Trade Statistics Concepts and Definitions (IMTS), while ONS' trade data are published on a 'Balance of Payments' basis, which are based on the International Monetary Fund's Balance of Payments and International Investment Position Manual. The differences between these two measurement bases include differences in coverage, time of recording, valuation and classification. The main conceptual difference is that the OTS data are designed to record all transactions of goods which add to or subtract from the stock of material resources of a country by entering (imports) or leaving (exports) the country's economic territory, while the Balance of Payments data are based around the change in ownership principle. More information is available on the HMRC and ONS websites.

2007	£260,000	£260,000
2008	£260,000	£260,000
2009	£270,000	£270,000
2010	£600,000	£250,000
2011	£600,000	£250,000
2012	£600,000	£250,000
2013	£600,000	£250,000
2014	£1,200,000	£250,000
2015	£1,500,000	£250,000
2016	£1,500,000	£250,000

Source(s): HMRC

These data are very rich in detail. For each observed shipment across the UK's territorial border, we observe the value of the trade; the type of commodity; the country of dispatch or destination; and – for non-EU trade – the flag of the ship transporting the goods. For a selection of trades we have volumetric estimates of a specific trade flow (mass), information on whether the trader used a third party to complete the trade and the reason for the trade. We also observe some information on the terms of delivery – including the currency of invoice (for non-EU trade), ancillary costs and delivery charges (for EU trade) – and on the reporting process, including whether a business made an amendment to their original submission. Declarations from the same business with all fields in common are aggregated in the HMRC dataset; while not strictly transaction level data, there is no other loss of information.

Critically, for our purposes, we also almost always observe the VAT registration number of the UK based trading company. The exceptions – data collected directly (electricity and gas imports) and non-EU declarations made by businesses not registered for VAT – are a relatively small fraction of total trade in goods.

3.3.1 **Number of observations**

As the use of these trade in goods data is one of the analytical innovations of this paper, this section provides some high-level descriptive statistics. Even by modern standards, the trade in goods dataset is substantial. Table 2 sets out the number of export and import observations recorded in these data, divided into EU and non-EU trade, for the 2008 to 2016 period. The number of export and import observations has risen steadily over this period for both EU and non-EU trade. Changes in the Intrastat survey threshold – in particular, the significant changes in the imports thresholds between 2009 and 2010, and between 2013 and 2014, appear to have a notable, if temporary impact on the number of observations. Taken together, our initial dataset contains around 227m trade in goods observations.

Table 2: Trade in goods observations, 2008 to 2016, millions

	2008	2009	2010*	2011	2012	2013	2014*	2015*	2016
Exports									
EU	6.4	6.4	7.0	7.6	9.5	10.1	8.9	10.6	10.8
Non-EU	3.8	3.6	4.1	4.0	4.2	4.6	4.7	4.8	5.2
Total	10.2	10.1	11.1	11.5	13.8	14.7	13.6	15.4	16.1
Imports									
EU	4.6	4.5	4.4	4.7	5.8	6.1	5.1	5.9	6.1
Non-EU	6.4	6.2	6.9	6.3	6.4	7.2	7.6	7.9	8.5
Total	11.0	10.7	11.4	11.0	12.3	13.3	12.6	13.8	14.5
Total	21.2	20.7	22.4	22.5	26.0	28.0	26.3	29.2	30.6

Source(s): HMRC, authors calculations. Figures may not sum due to rounding

Note(s): (1) Includes original, revision and amended submissions. (2) Years are starred when there is a significant increase in the Intrastat threshold on EU imports and a reduction in the number of firms in the Intrastat survey, which likely explains the falls in the number of importers and employment at importers in these years.

3.3.2 **Aggregate trade in goods: exports, imports, balance**

The total value of the trades recorded in these data is close to the corresponding total UK trade flow in ONS' headline statistics. Figure 3 shows the total value of UK goods exports to the EU and the non-EU, alongside the equivalent trade in goods data from ONS[9]. Exports to the EU amounted to around £35.5bn per quarter in the HMRC data between 2008 and 2016: falling slightly during the economic downturn, recovering in 2010, and then stalling again from 2012 onwards. Exports to the non-EU averaged £31.9bn per quarter over the full period, although this average masks movement over time. In particular, exports to the non-EU climbed between 2008 and 2011, before stalling from 2011 onwards. The ONS Balance of Payments measures of exports are closely aligned with the HMRC Overseas Trade Statistics equivalents[10].

The correspondence between ONS and HMRC exports data is equivalently close for imports (Figure 4). Imports from the EU averaged £51.1bn per quarter between 2008 and 2016 (£51.4bn in the ONS Balance of Payments series), while imports from outside the EU averaged around £49.7bn per quarter over the same period (£46.3bn in the equivalent ONS aggregate). The profiles of the value of trade appear quite different for imports than for exports. Imports from both the EU and the non-EU fell during the economic downturn, but while the value of imports from the EU followed a broadly

[9] Note that both totals exclude transactions in unspecified goods (SITC 9) and are non-seasonally adjusted. These data are consistent with Pink Book 2017. Data revisions since this date mean that the current published position may differ.

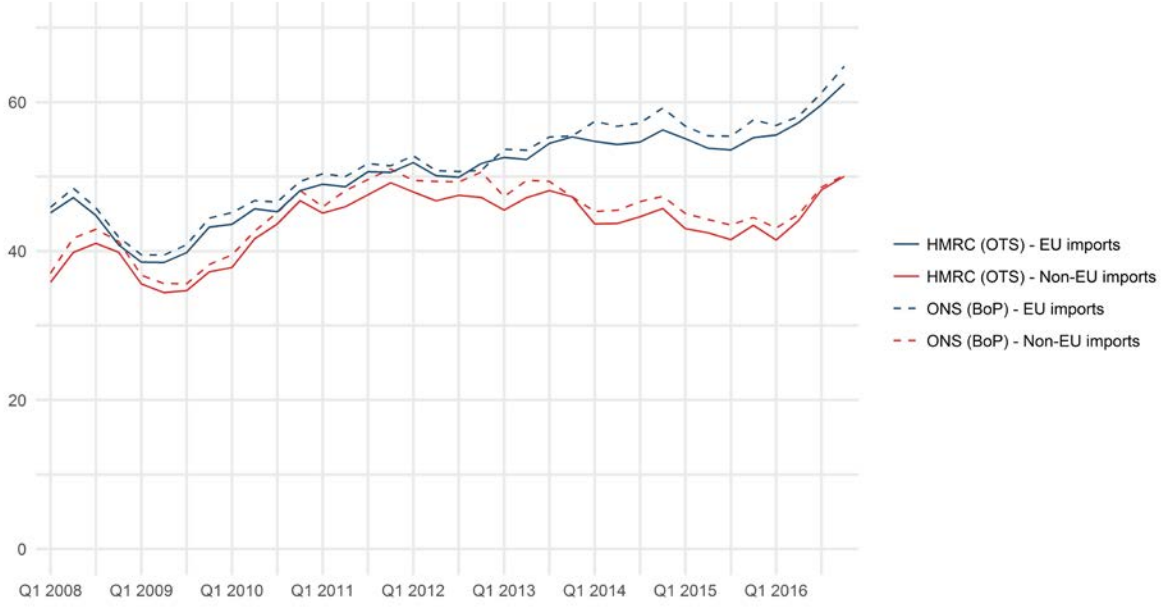
[10] See Data section for more details on the difference between Overseas Trade Statistics and Balance of Payments statistical regulations

upwards trajectory over much of the post-downturn period, the value of imports from the non-EU grew until 2013 and then stabilised – only returning to growth during 2016. As a result, the value of imports from the non-EU was no higher at the end of 2016 than five years earlier.

Figure 3: UK exports, EU and Non-EU, HMRC OTS and ONS BOP, special trade, £bn, NSA

Source(s): ONS, HMRC, authors calculations
Note(s): Excludes Unspecified goods (SITC 9).

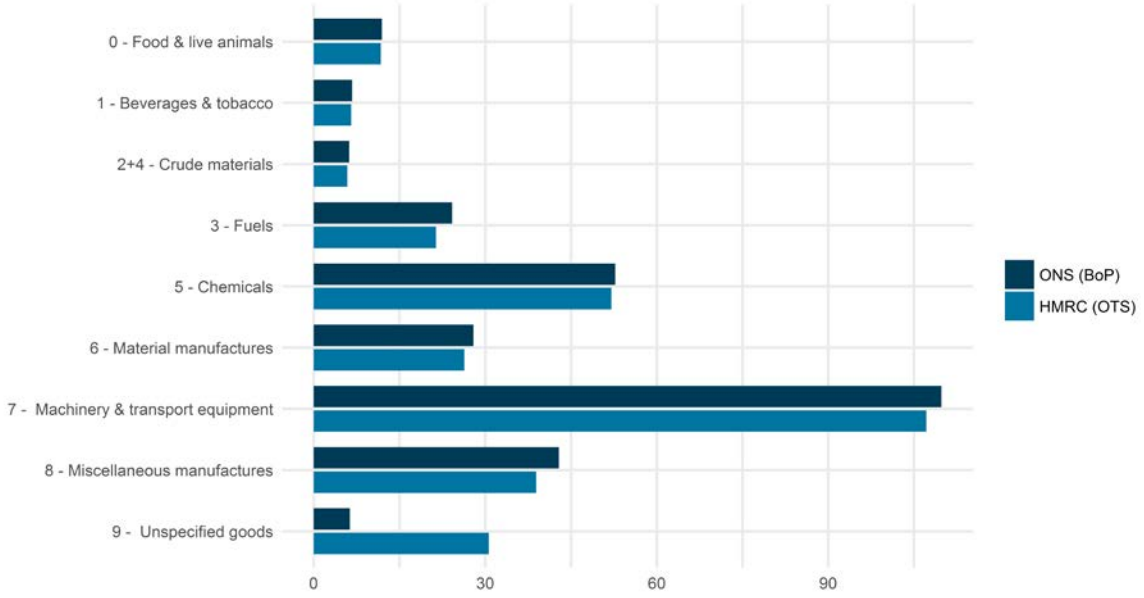
Figure 4: UK imports, EU and Non-EU, HMRC OTS and ONS BOP, special trade, £bn, NSA



Source(s): ONS, HMRC, authors calculations
Note(s): Excludes Unspecified goods (SITC 9).

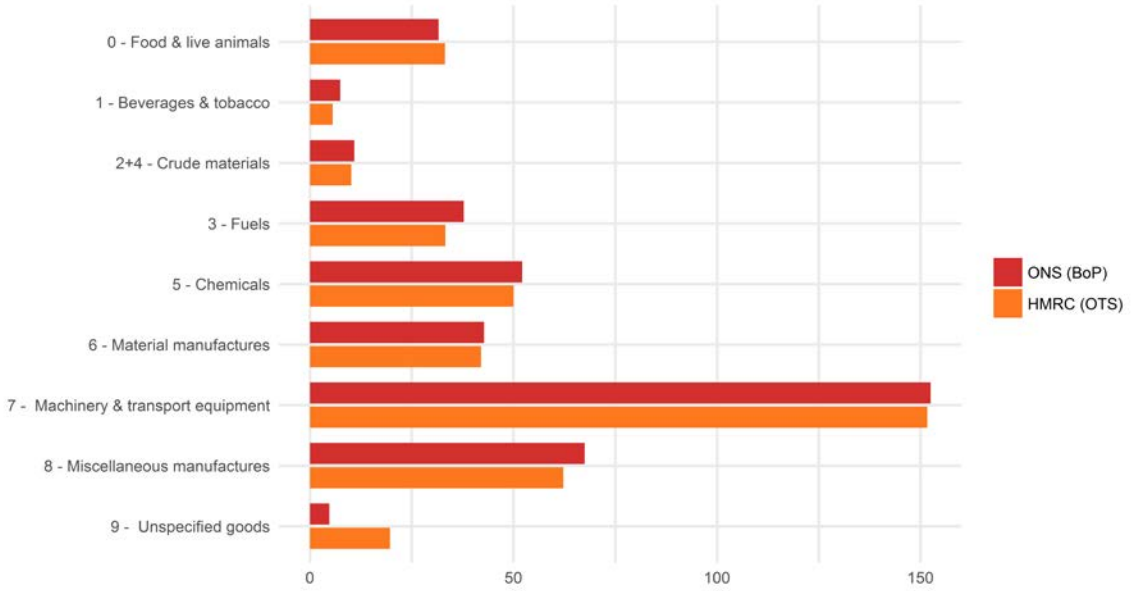
The HMRC and ONS data are also very similar in their composition (Figures 5 and 6). Both UK exports and imports are dominated by machinery and transport equipment, followed by chemicals and miscellaneous manufactures, but in each product category the ONS BOP data closely resembles the HMRC transactions total. The largest divergence between HMRC and ONS is in unspecified goods: this is due to non-monetary gold, where ONS uses data from the Bank of England instead of HMRC data, and which makes up most of unspecified goods.

Figure 5: UK exports by commodity, HMRC OTS and ONS BOP, special trade, £bn 2015



Source(s): ONS, HMRC, authors calculations

Figure 6: UK imports by commodity, HMRC OTS and ONS BOP, special trade, £bn 2015



Source(s): ONS, HMRC, authors calculations

4 Methods

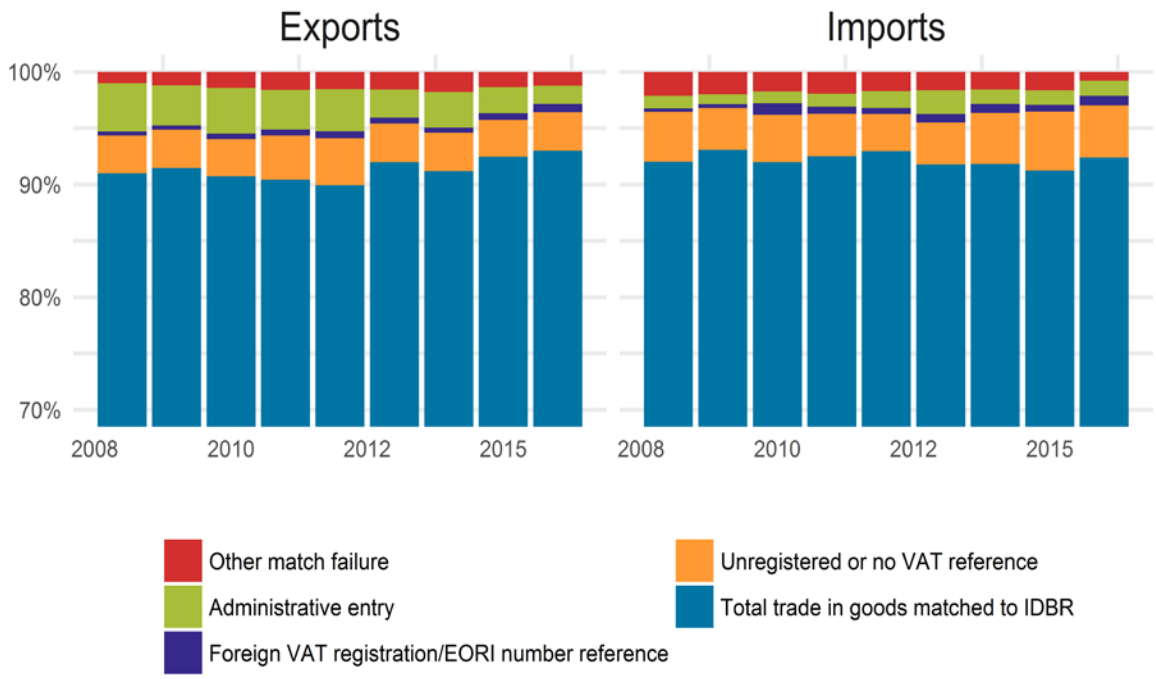
The key methods used in this paper relate to the difficulty of linking data on trade in goods – provided on a VAT unit basis – to information on productivity – at the reporting unit level. This work is carried out in two steps: firstly, records from HMRC's trade in goods declarations were linked to snapshots of the Inter-Departmental Business Register (IDBR) and aggregated to the enterprise or enterprise group level[11]. Secondly, an apportionment mechanism is used to divide total trade in goods across the reporting units which are linked to the enterprise. A detailed exposition of these methods – and our robustness and triangulation work – are provided in the appendix. This section provides a high-level summary[12].

The first stage in our approach links the VAT unit information on trade in goods to the IDBR, which provides a directory of the other identifiers which are linked to the business (enterprise group, enterprise, reporting units – see section 3 for a discussion). The match rates at this stage in the process are good: around 91.3% of the value of exports and around 92.2% of the imports recorded in the trade in goods transactions can be matched to specific businesses through the IDBR on average between 2008 and 2016 (Figure 7). Of the remaining trade which cannot be matched to businesses, the majority is undertaken by traders which are not registered for VAT purposes and consequently do not have a VAT number which can be linked. Some trade is also declared by businesses using Economic Operator Registration and Identification (EORI) numbers, rather than VAT numbers. Some additional trade is recorded administratively by HMRC – such as imports and exports of gas and electricity – and is not linked to a specific business. Excluding trade in goods declarations which do not include a VAT number, the match process successfully links around 98.5% of exports and 98.2% of imports to specific businesses on average over the 2008 to 2016 period.

[11] Strictly, we aggregate to the highest level of the corporate hierarchy which applies. In the majority of cases, this is the enterprise. However, for complex enterprises which form part of a larger enterprise group, we aggregate to this higher structure.

[12] Natural alternatives to our approach would be to conduct the analysis at the Enterprise/Enterprise Group or VAT unit levels. Either of these approaches would negate the need to aggregate and then apportion our trade in goods data. However, four considerations pushed us to use the reporting unit level. Firstly, while the trade data could be aggregated to the Enterprise/Enterprise Group level, in some instances the variables required for the productivity calculation could not be – in particular, where not all of the reporting units attached to an Enterprise were sampled by the ABS. Secondly, the underlying motivation for the reporting unit structure is to collect data for distinct types of economic activity, which would be lost in aggregation. Thirdly, many other ONS surveys are targeted at the Reporting Unit level, and consequently our new dataset can be matched with these. Fourthly, the data we use to triangulate our results is available at the reporting unit level. Finally, we choose not to conduct the analysis at the VAT unit level for two reasons. Firstly, we do not have access to both turnover and purchases data by VAT units prior to 2011. Secondly and more substantively, the measure of purchases recorded in the VAT data comprises both intermediate consumption and capital spending. This precludes the estimation of approximate value added for productivity purposes from the VAT returns.

Figure 7: Proportion of trade by value which can be mapped to at least one IDBR unit

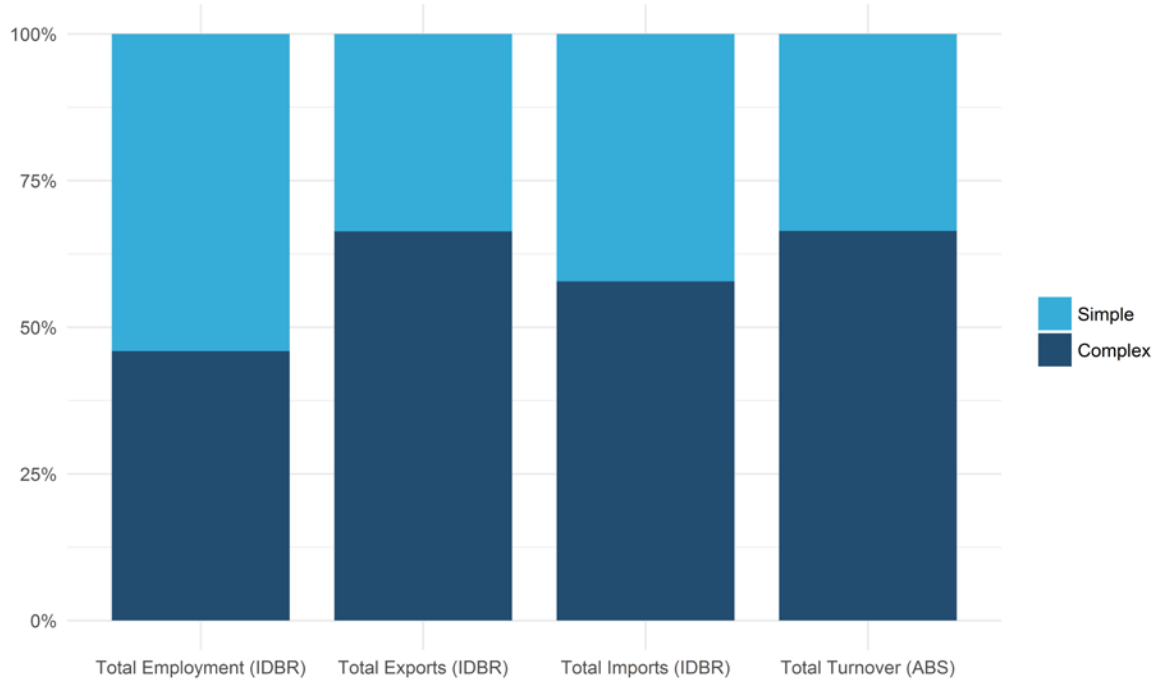


Source(s): HMRC, ONS, authors calculations

The second stage of the matching process involves apportioning these high-level estimates of trade in goods to the business' reporting units. As the majority of businesses have a single reporting unit, this is a trivial aggregation process in most cases. For these businesses, trade in goods declarations made by one or more VAT units link directly to a single reporting unit. However, while these 'simple' businesses account for most businesses by count, they account for a much smaller fraction of employment, turnover and trade (Figure 8). To ensure that our descriptive statistics on trading behaviour and our productivity analysis captures complex firms, we adopt an approach which allows us to divide the trade in goods of complex businesses among the multiple reporting units which pertain to that unit.

To achieve this, we devise three strategies to apportion trade within multi-reporting unit businesses. The first uses the employment shares of the reporting units within a business to divide total trade. This approach is simple and transparent, but also has some undesirable properties. In particular, it takes no account of the differing industries of the reporting units which comprise an enterprise, and ignores available information on the product which is being traded.

Figure 8: Shares of employment, turnover and trade accounted for single- and multi-reporting unit businesses, Q4 2016 (IDBR), 2016 (ABS)



Source(s): ONS, HMRC
Notes: ABS proportions calculated using sample selection and grossing weights.

To mitigate these issues, we develop two alternative approaches which involve weighting the employment of reporting units using product-industry correspondence matrices. These matrices contain data on the intensity with which 'simple' businesses in an industry trade specific products – highlighting for instance that businesses in one industry are more likely to trade a given product than those in another industry. Weighting employment within the different reporting units of businesses by these matrices pushes trade flows towards reporting units which are more likely to have been involved in the trade, and is therefore likely to improve the quality our productivity analysis.

To ensure the robustness of our results, we adopt two sets of product-industry correspondence matrices. The first uses mean exports or imports per head of single-reporting unit businesses, smoothed over a two-year window to deliver correspondence tables which give a sense of how the product intensity of an industry has varied through time. As means can be susceptible to outlier bias, we also experiment with using the median value of exports or imports per head among single-reporting unit businesses. We subject these different approaches to a set of robustness checks by comparing the trader status of businesses in our resulting datasets with their self-reported trader status, and compare our estimates of the levels of trade in goods with related – if imperfect – equivalents

from survey sources. These robustness checks suggest that survey sources and our estimated trade data are a reasonable fit and therefore a good basis for productivity analysis, although as would be expected, the degree of correspondence is weaker for complex than for simple businesses.

Finally, as all three apportionment mechanisms produce similar results – both for our descriptive statistics and our productivity analysis – we focus on those produced using our preferred mechanism: those using mean exports or imports per head assumptions. More details, including the precise form of our weights, are included in the appendix.

5 Results

The results of this analysis are set out in two parts. The first part provides descriptive statistics using our new, linked, firm-level dataset, including information on the prevalence of different forms of trading relationships, the resulting industry level estimates of trade in goods, and the average number of destinations and products traded. Unless otherwise specified, these data are provided at the reporting unit level, and take their characteristics from the Inter-Departmental Business Register (IDBR).

The second part of the results section provides information on the analysis that we have conducted using the Annual Business Survey (ABS) and HMRC's Trade in Goods data. Although the ABS contains detailed information on the activities of businesses, it is a sample of the population. The results in this section are consequently weighted to reflect the composition of businesses in the UK economy. As before, this section uses reporting unit level data.

As set out in the data and limitations sections, the form of these data imposes some limitations on our analysis. In particular, these data pertain to direct trade in goods alone: we do not observe domestic purchases of imported goods, nor goods sold domestically for subsequent export – only the records from trade carried out directly by the reporting company. Secondly, the results should be read with the changes to the Intrastat threshold in mind: many of the changes in observed trade with the EU, especially for imports, may be due to the different reporting thresholds in different years, not changes in underlying economic conditions. Finally, the use of the ABS weights adds further limits to our work (see limitations section).

5.1 Descriptive statistics

5.1.1 The prevalence of trading businesses

Only a small proportion of businesses are traders, but these businesses account for a large proportion of total employment (Table 3). The first panel in Table 3 shows the proportion of the business population from whom we have identified trade in goods declarations for different kinds of trade. The second panel shows equivalent metrics for the population of businesses with at least 10 workers, while the third panel shows the proportion of employment accounted for by trader status. Note that there is some evidence here that the changes in the thresholds for inclusion in HMRC's Intrastat survey (see Table 1) have had some impact on the reported prevalence of importing. In particular, the increase of the thresholds for EU imports in 2010, 2014 and 2015 are all associated with slight

reductions in the prevalence of trading behaviour. These results should consequently be handled carefully.

Table 3: Shares of firms by trade in goods based trader status: 2008 to 2016, IDBR basis

	All Businesses, %								
	2008	2009	2010*	2011	2012	2013	2014*	2015*	2016
No trade in goods declarations	94.7	94.9	94.9	95.1	95.1	95.2	95.3	95.4	95.4
Traders	5.3	5.1	5.1	4.9	4.9	4.8	4.7	4.6	4.6
of which									
Exporters only	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9
Importers only	2.2	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.8
Exporters & Importers	2.1	2.1	2.2	2.1	2.0	2.0	2.0	1.9	1.8
	Businesses with greater than 9 employment, %								
	2008	2009	2010*	2011	2012	2013	2014*	2015*	2016
No trade in goods declarations	77.9	79.0	79.5	79.5	79.6	80.3	80.7	81.2	81.1
Traders	22.1	21.0	20.5	20.5	20.4	19.7	19.3	18.8	18.9
of which									
Exporters only	3.2	3.1	3.1	3.1	3.2	3.1	3.1	3.1	3.0
Importers only	6.3	5.8	5.3	5.1	5.2	5.0	4.9	4.9	5.0
Exporters & Importers	12.6	12.1	12.1	12.2	12.0	11.6	11.3	10.8	10.8
	Employment share by trade in goods declaration status, %								
	2008	2009	2010*	2011	2012	2013	2014*	2015*	2016
No trade in goods declarations	53.9	53.7	54.9	57.0	57.4	57.6	58.9	59.9	59.7
Traders	46.1	46.3	45.1	43.0	42.6	42.4	41.1	40.1	40.3
of which									
Exporters only	2.0	2.0	2.2	2.4	2.2	2.4	2.9	2.7	2.3
Importers only	10.1	10.8	11.2	8.3	8.7	8.8	8.1	8.0	8.2
Exporters & Importers	34.0	33.5	31.8	32.3	31.8	31.2	30.1	29.5	29.7

Source(s): HMRC, authors calculations

Note(s): (1) Counts here are based on the reporting unit classifications of businesses. (2) Employment and firm size are both based on information from the IDBR. (3) Years are starred when there is a significant increase in the Intrastat threshold on EU imports and a reduction in the number of firms in the Intrastat survey, which likely explains the falls in the number of importers and employment at importers around these years. (4) Figures may not sum owing to rounding.

These results suggest that around 5% of UK businesses were active goods importers or exporters according to trade declarations over the 2008 to 2016 period, or between 22% and 19% of businesses employing at least ten workers over the same period. The most common form of trading behaviour was as both an exporter and an importer, although the gap is narrower for businesses in the population than for those with at least ten workers. Among this latter group, around 11% of businesses were both

importers and exporters in 2016, in addition to around 5% who only imported, and around 3% who were exporters[13].

While traders are a minority of businesses, they are the largest employers. The results in the third panel suggest that, in 2016, businesses with trade declarations accounted for around 40% of all employment. Businesses reporting both exports and imports accounted for around 30% of employment, while businesses with only exports declarations and only imports declarations accounted for 2.3% and 8.2% of total employment respectively.

The prevalence of UK businesses' trading links to the EU and the non-EU is more difficult to judge because of differences in the reporting thresholds for trade to these markets. Among businesses with trade declarations, only 0.6% reported two-way trade – both importing and exporting – with the EU alone in 2016; around 6.1% declared export and imports with both the EU and non-EU, while around 22% of traders declared two-way trade with the non-EU alone. This seems likely to reflect the higher reporting threshold for EU trade than non-EU trade. It is clear, however, that many of the largest traders have some of the most complex trading links: the 6% of businesses which reported two-way trade with the EU and non-EU accounted for around 38% of trader employment in 2016.

Table 4: Proportion of businesses and employment by type of trade in goods declarations, businesses declaring trade in goods, IDBR basis, 2016

		Exports			
Businesses		None	EU	Non-EU	Both
Imports	None		1.5%	17.5%	1.7%
	EU	1.7%	0.6%	0.3%	0.4%
	Non-EU	36.4%	1.0%	22.0%	7.7%
	Both	1.2%	0.5%	1.4%	6.1%

		Exports			
Employment		None	EU	Non-EU	Both
Imports	None		0.4%	4.7%	0.7%
	EU	1.2%	0.5%	0.4%	0.4%
	Non-EU	17.1%	0.4%	19.8%	6.2%
	Both	2.1%	1.3%	7.1%	37.8%

Source(s): HMRC, ONS, authors calculations

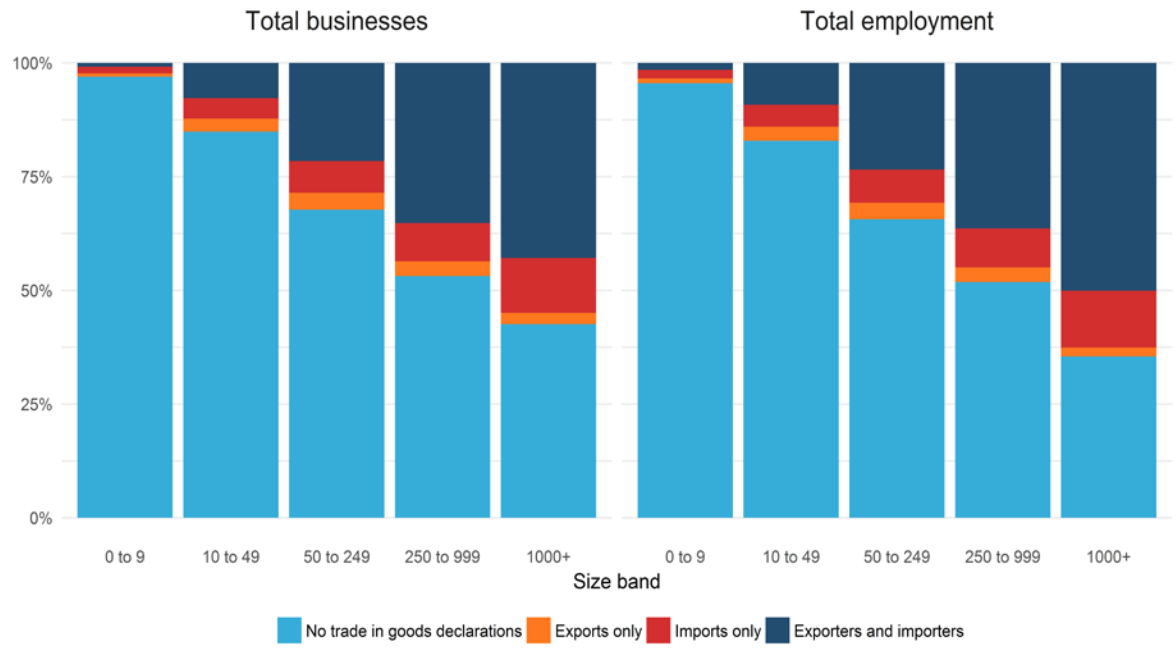
[13] These figures are notably lower than those published as part of ONS' 'Annual Business Survey importers and exporters' release, which estimates that around 4.6% and 6.5% of businesses were exporters and importers respectively in 2016. The reasons for this difference are varied and examined at length in the appendix, and include (a) the capture of below threshold trade on the ABS, which is excluded from our analysis by the nature of the data and (b) the weighting used to aggregate ABS to the business population, which can only partly take account of trader status. However, there are other discrepancies between the HMRC trade in goods declarations and the ABS reported trader status, as well as potential issues introduced by our apportionment methodology which will also have a bearing on these results. The trends shown in the 'importers and exporters' release – particularly around trader status and employment, and foreign ownership, are largely consistent with our results.

5.1.2 **Characteristics of firms that trade**

Larger businesses are more likely to engage in trade above reporting thresholds than smaller businesses. Panel A of Figure 9 shows the proportion of businesses in each of five size-classes by their trade in goods declarations status. On this basis, very few of the smallest businesses engaged in trade: fewer than 4% made a submission to HMRC in 2016 to report trade in excess of the reporting thresholds. Moving up the business size distribution, the prevalence of trade increases markedly. Around one in six businesses with between 10 and 49 workers reported trade to HMRC, while approximately half of businesses employing between 250 and 999 workers reported trade over the same period. Among the largest businesses – defined as those with more than 1,000 workers – almost 60% reported some measure of exports or imports over this period. Overall, around one in five businesses with ten or more workers declared some trade in 2016.

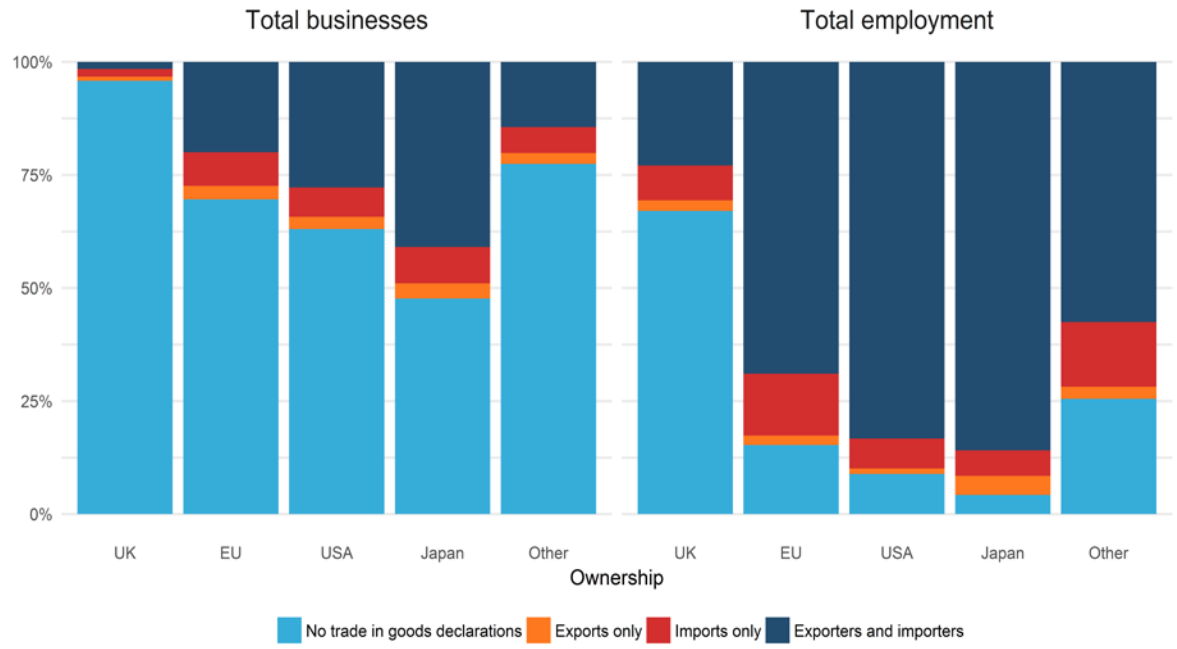
In common with the international literature on trade in goods, our analysis suggests that foreign owned businesses are more likely to be active traders than domestically held businesses (Figure 10). Among the British-owned business population, fewer than 5% of businesses declared trade in goods in 2016. By contrast, around 30% of UK businesses owned by companies in the EU reported some trade to HMRC over the same period, as well as 37% of UK businesses owned in the US. Businesses with Japanese owners are the most likely to trade, and the 48% of non-trading Japanese-owned businesses only account for 4% of total employment in Japanese-owned businesses.

Figure 9: Trade in goods reporters by firm size, 2016, IDBR basis



Source(s): HMRC, ONS, authors calculations

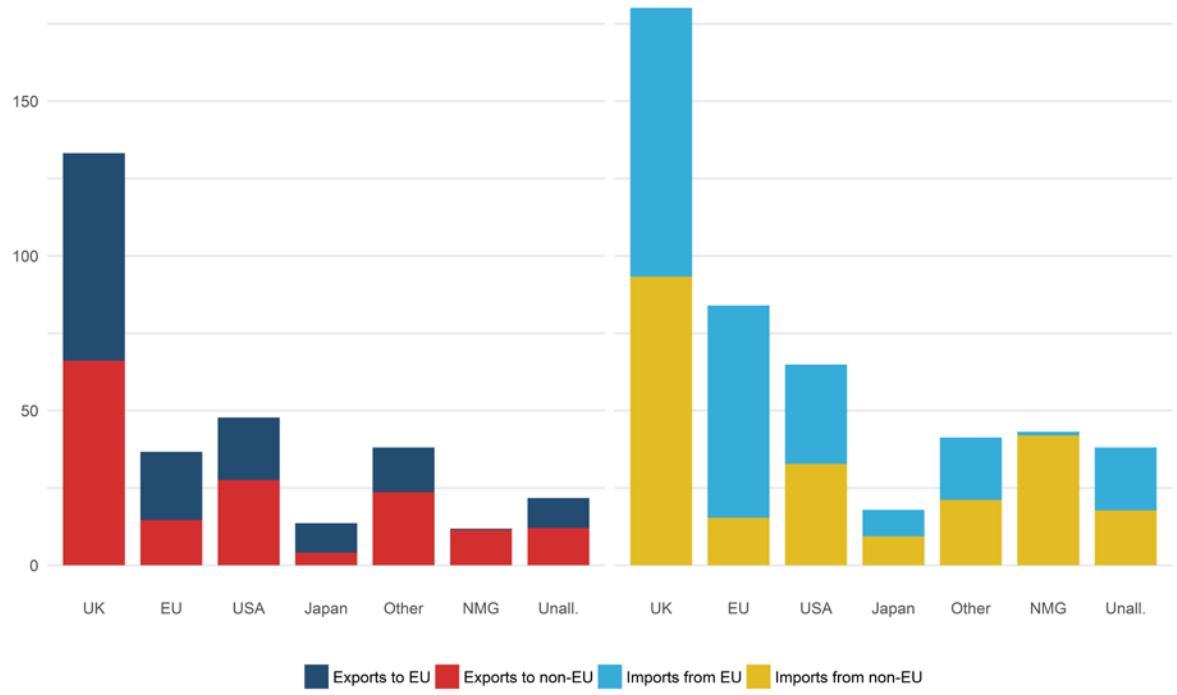
Figure 10: Trade in goods reporters by country of ultimate ownership, 2016, IDBR basis



Source(s): HMRC, ONS, authors calculations

EU and US owned businesses in the UK also appear to have strong connections to their 'home' markets relative to domestically owned traders (Figure 11). In 2016, the goods trade of UK businesses divided fairly evenly between the EU and non-EU countries: around 50.4% of their export declarations and 48.2% of their import declarations by value were accounted for by the EU. However, businesses where the ultimate foreign owner is based in another EU country have trade that is more oriented towards the EU, with 60.1% of their reported exports went to the EU and 81.7% of their reported imports came from the EU in 2016. Similarly, US owned firms are slightly more orientated towards the non-EU. The imports of US owned businesses came roughly equally from the EU and non-EU (50.5% and 49.5%), but 57.6% of their reported exports were shipped outside the EU. These results suggest some degree of 'home market' bias in the behaviour of these EU and US businesses. By contrast, Japanese-owned businesses were the opposite, reporting a similar value of imports from EU and non-EU countries (47.8% and 52.2%), but sending 70% of reported exports to the EU in 2016.

Figure 11: Total trade by country of ultimate ownership, 2016, £bn, IDBR basis

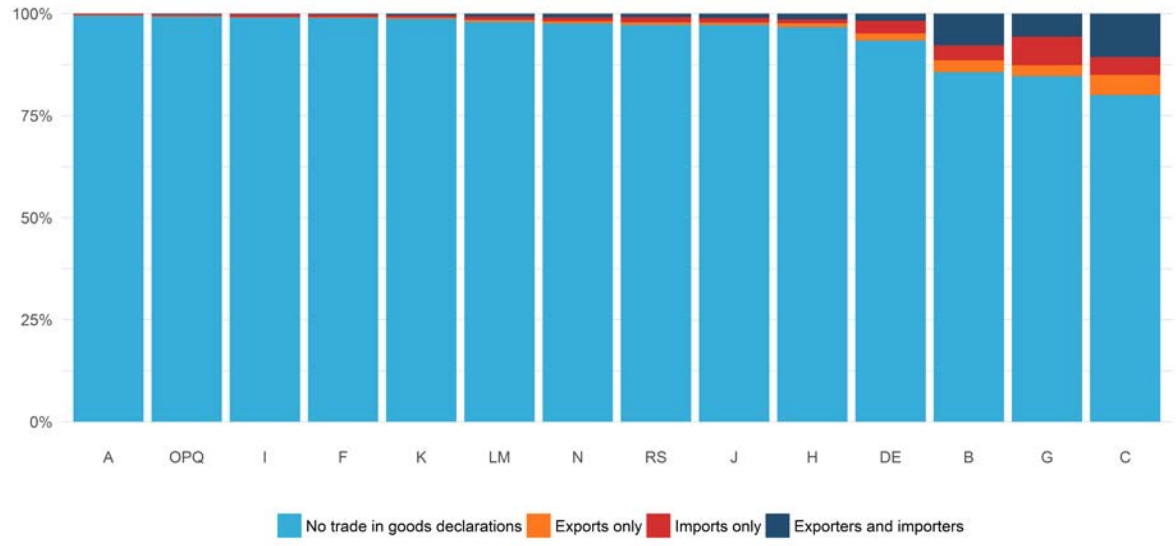


Source(s): HMRC, ONS, authors calculations
Note(s): A proportion of trade cannot be allocated to IDBR businesses, marked as unallocated. Trade in non-monetary gold (NMG) is also excluded.

Trading propensity also varies significantly by industry (Figure 12)[14]. Businesses in the Manufacturing (C), Wholesale & Retail (G), Mining & Quarrying (B, including oil extraction) and Electricity, Gas, Water Supply, Sewerage & Waste Collection (D and E) industries are most likely to be traders[15]. However, even among the most active trading industries, traders account for less than one-quarter of businesses. The smallest fractions of businesses which trade in goods according to trade declarations are in the Agricultural (A), Accommodation & Food Services (I) and Construction (F) industries.

[14] Note that businesses may trade goods, even if they are classified in the services industries. Note also that these results are based on trade in goods alone, and do not take services trade into account.
[15] Trade in goods data for D is most likely to be an underestimate of physical trade – data on trade in electricity, oil and gas through the continental connectors is collected directly and not from businesses.

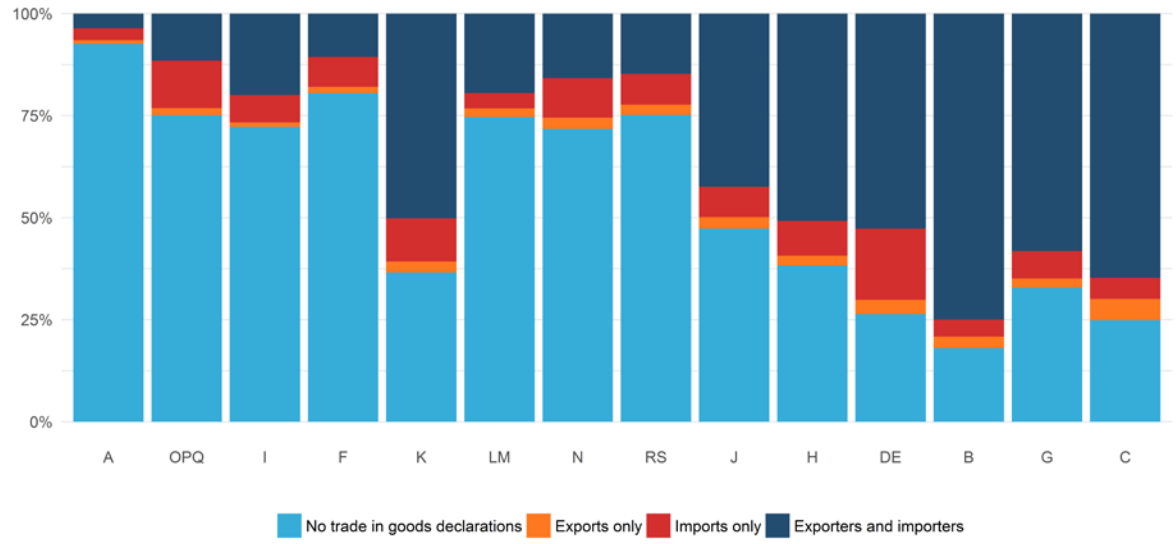
Figure 12: Trade in goods reporters by industry, percentage of total number of businesses, 2016, IDBR basis



Source(s): HMRC, ONS, authors calculations
Note(s): Industrial classification: A, Agriculture, Forestry & Fishing; B, Mining & Quarrying, i.e. oil extraction; C, Manufacturing; D, Electricity, Gas & Steam; E, Water Supply, Sewerage & Waste Management; F, Construction; G, Wholesale & Retail; H, Transport & Storage; I, Accommodation & Food Service; J, Information & Communication; K, Finance & Insurance; L, Real Estate; M, Professional, Scientific & Technical; N, Administrative & Support Services; O, Public Administration, Defence & Compulsory Social Security; P, Education; Q, Human Health and Social Work; R, Arts, Entertainment & Recreation; S, Other Services.

While these results suggest that a minority of businesses in each high-level industry declared trade in goods in 2016, differences in the prevalence of large businesses across industries mean that the proportions of employment accounted for by traders across industries are markedly different (Figure 13). The presence of large, trading businesses in Manufacturing (C), Mining & Quarrying (B), and Wholesale & Retail (G) in particular means that the proportions of employment accounted for by traders is considerably higher in these industries than their share of all businesses. In Manufacturing – where 20% of businesses reported either exports or imports during 2016 – the share of employment accounted for by businesses with trade in goods declarations was 75%. In Mining & Quarrying, which in the UK is mostly oil and gas extraction, the employment share accounted for by traders is around 82%, while in Wholesale & Retail (G), the 15% of businesses declaring trade in goods accounted for about two thirds of employment in that industry in 2016.

Figure 13: Trade in goods reporters by industry, percentage of total employment, 2016, IDBR basis



Source(s): HMRC, ONS, authors calculations.
Note(s): Industrial classification: A, Agriculture, Forestry & Fishing; B, Mining & Quarrying, i.e. oil extraction; C, Manufacturing; D, Electricity, Gas & Steam; E, Water Supply, Sewerage & Waste Management; F, Construction; G, Wholesale & Retail; H, Transport & Storage; I, Accommodation & Food Service; J, Information & Communication; K, Finance & Insurance; L, Real Estate; M, Professional, Scientific & Technical; N, Administrative & Support Services; O, Public Administration, Defence & Compulsory Social Security; P, Education; Q, Human Health and Social Work; R, Arts, Entertainment & Recreation; S, Other Services.

5.1.3 Trade balance by industry

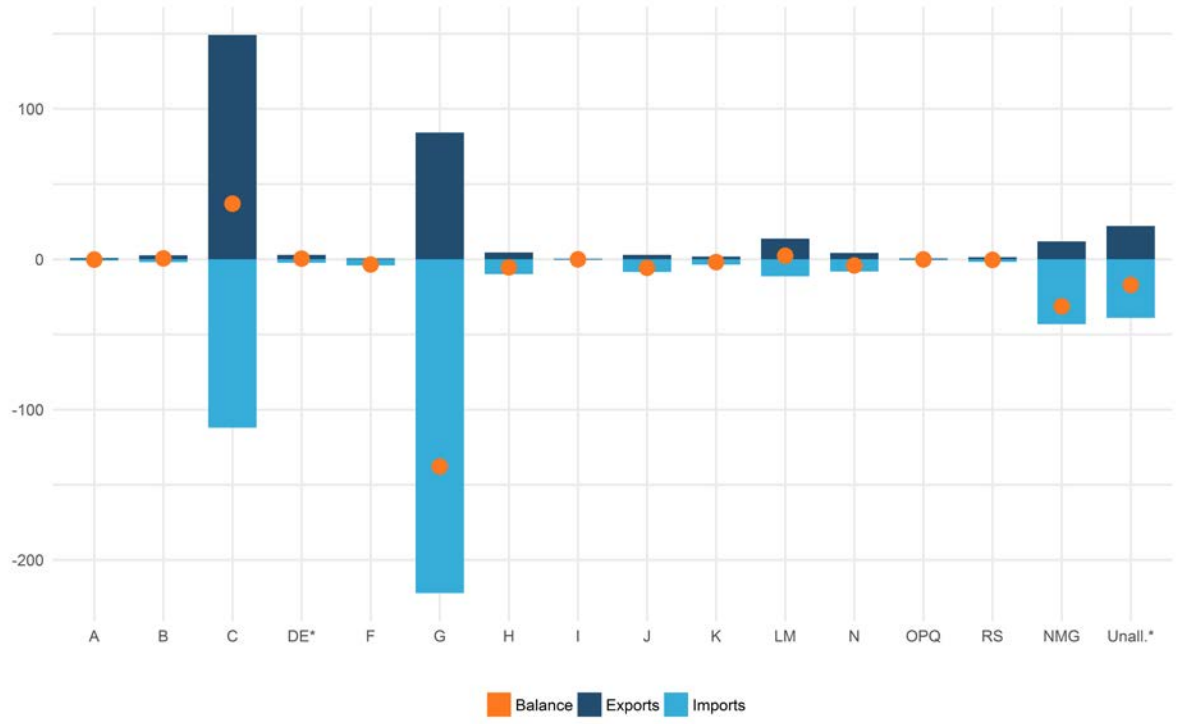
The results of our linking methodology can also be used to produce industry level estimates of exports, imports and trade in goods balance. These results are similar to data published by HMRC on a different basis[16], and capture only direct trade flows: they do not capture intermediation of traded content through supply chains.

This work suggests that direct trade in goods is dominated by the Manufacturing and Wholesale & Retail industries (Figure 14[17]). On this basis, UK manufacturing industries are estimated to have run a substantial trade surplus in 2016: exporting almost £150bn and importing £112bn over this period. By contrast, the Wholesale & Retail industry ran a trade in goods deficit, importing £222bn while exporting £84bn of goods in 2016.

[16] Specifically, HMRC's Trade by Business Characteristics statistics present information on trade in goods by industry and size, based on the markers attached to the enterprise, rather than the reporting unit.
[17] Figure 14 also shows exports, imports and trade balance for (a) the trade of non-monetary gold and (b) unallocated trade. The former category we exclude from our analysis on the basis that these transactions likely have little bearing on the productivity of businesses; the latter cannot be linked to individual businesses, and so in common with HMRC, we include an 'unallocated' group.

Among the remaining industries – whose direct trade in goods values are an order of magnitude smaller than Manufacturing and Wholesale & Retail, the Real Estate Activities and Professional, Scientific & Technical services (LM) and Mining & Quarrying (B) industries were the only other industries to run trade in goods surpluses of more than £400m over this period. Based on the allocated proportion of trade, a small goods surplus was also run by the utilities industries (Electricity, Gas, Water Supply, Sewerage and Waste Collection, D and E).

Figure 14: Trade in goods by industry, 2016, £bn, IDBR basis

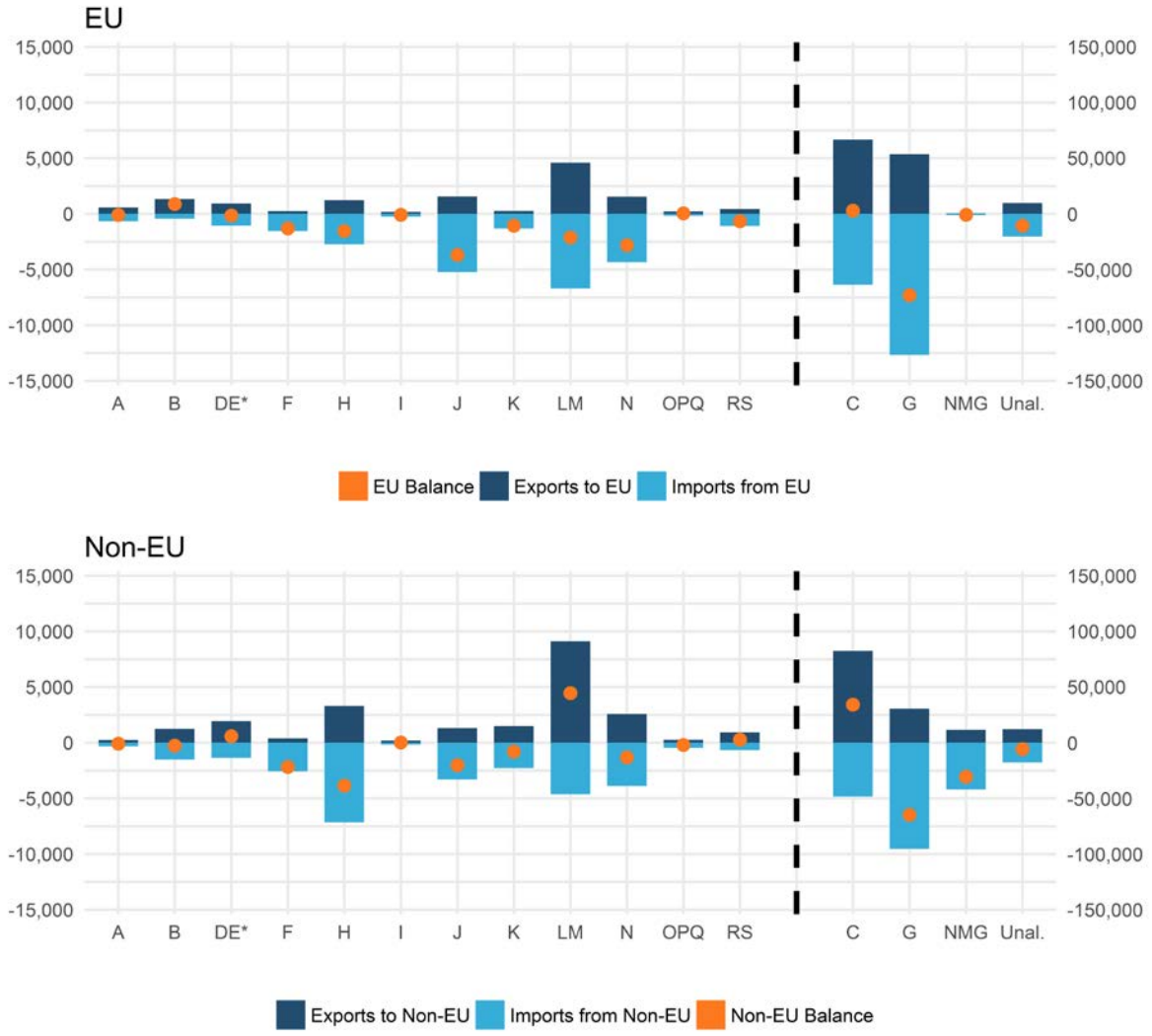


Source(s): HMRC, ONS, authors calculations
Note(s): (1) Industrial classification: A, Agriculture, Forestry & Fishing; B, Mining & Quarrying, i.e. oil extraction; C, Manufacturing; D, Electricity, Gas & Steam; E, Water Supply, Sewerage & Waste Management; F, Construction; G, Wholesale & Retail; H, Transport & Storage; I, Accommodation & Food Service; J, Information & Communication; K, Finance & Insurance; L, Real Estate; M, Professional, Scientific & Technical; N, Administrative & Support Services; O, Public Administration, Defence & Compulsory Social Security; P, Education; Q, Human Health and Social Work; R, Arts, Entertainment & Recreation; S, Other Services; NMG = Non-monetary gold; Unall. = Total unallocated trade to industries, some portion of which is likely due to DE.

These results are largely reflected in the division of exports, imports and trade balance between the EU and the non-EU. Figure 15 shows equivalent data for the UK's trade with the EU and outside the EU. As before, the Manufacturing and Wholesale & Retail industries account for the largest proportion of UK trade in goods (right-hand axis). On this basis, the manufacturing industries ran a small trade surplus of £3bn with the EU in 2016, as a consequence of £67bn of exports, and £64bn of imports. Mining & Quarrying (B) also ran a surplus with the EU over this period. By contrast, the Wholesale & Retail industry (G) ran a significant trade in goods deficit (£73bn) with the EU in 2016,

as a consequence of exports worth £54bn being offset by imports worth £127bn over the same period. This likely reflects the important intermediation role of this industry.

Figure 15: EU and Non-EU trade in goods, by industry, 2016, £bn, IDBR basis



Source(s): HMRC, ONS, authors calculations

Note(s): (1) Industrial classification: A, Agriculture, Forestry & Fishing; B, Mining & Quarrying, i.e. oil extraction; C, Manufacturing; D, Electricity, Gas & Steam; E, Water Supply, Sewerage & Waste Management; F, Construction; G, Wholesale & Retail; H, Transport & Storage; I, Accommodation & Food Service; J, Information & Communication; K, Finance & Insurance; L, Real Estate; M, Professional, Scientific & Technical; N, Administrative & Support Services; O, Public Administration, Defence & Compulsory Social Security; P, Education; Q, Human Health and Social Work; R, Arts, Entertainment & Recreation; S, Other Services; NMG = Non-monetary gold; Unall. = Total unallocated trade to industries, some portion of which is likely due to DE.

(2) Industries C and G, as well as non-monetary gold and unallocated trade is shown on the right-hand axis, while all other industries are shown on the left-hand axis for ease of exposition.

(3) Note that data on trade in natural gas and oil through pipelines is collected directly and not from businesses; as these items are likely to relate to industry D in particular, it is possible that estimates of exports and imports for these industries are understated.

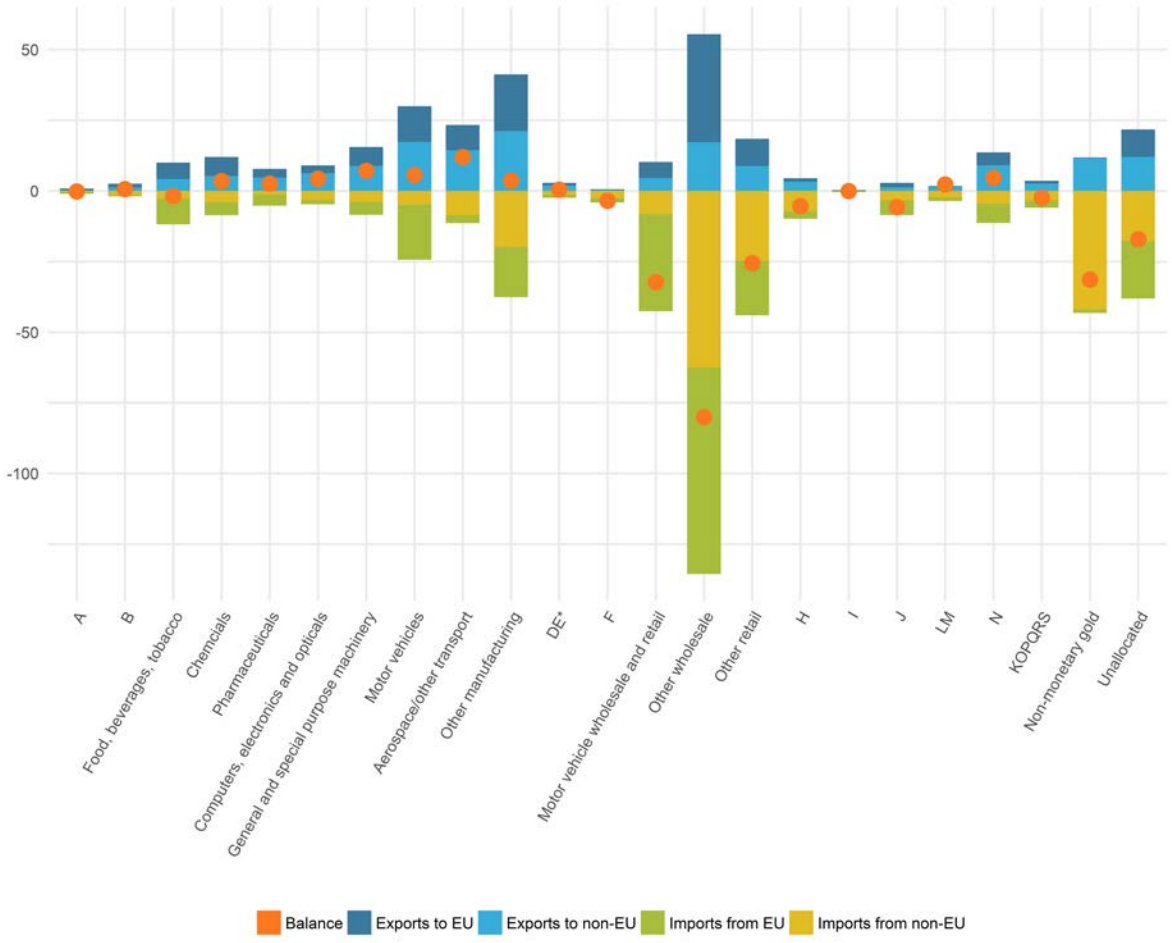
Equivalent data for non-EU trade largely repeats these patterns, although there are some notable differences. As before, the Manufacturing (C) runs a surplus and the Wholesale & Retail industries (G) run a trade in goods deficit, and together these industries account for the majority of UK trade. However, Manufacturing runs a larger surplus outside the EU, with £82bn of exports and £48bn of imports. The utilities industries (D and E) also ran trade surpluses outside the EU[18]. Several other service industries also run very small goods surpluses.

To examine this in more detail, Figure 16 breaks down trade in goods within subdivisions of these industries – increasing the granularity of the Manufacturing and Wholesale & Retail industries in particular. Non-motor vehicle wholesalers are the largest traders, and of the manufacturing sub-industries, aerospace/other transport equipment ran the largest goods surplus (£12bn), and the largest goods surplus with the EU (£6bn) in 2016. The motor industry ran a goods deficit with the EU of £7bn, but a surplus with non-EU countries of £12bn.

While these data permit new analysis of the direct trading behaviour of businesses in different industries, the importance of Wholesale & Retail trade to the UK's trade in goods records highlights the need for further work to understand supply chains better. It would be helpful to be able to observe which industries make use of intermediate goods imported by wholesalers, and to identify which industries supplied the goods which this industry subsequently exported. While these estimates are a step forward, they are clearly not a final statement of the dependence of different industries on traded content.

[18]For waste services, this is largely due to exports of scrap metal.

Figure 16: EU and Non-EU trade in goods, by detailed industry, 2016, £bn, IDBR basis



Source(s): HMRC, ONS, authors calculations

Note(s): (1) Industrial classification: A, Agriculture, Forestry & Fishing; B, Mining & Quarrying, i.e. oil extraction; C, Manufacturing; D, Electricity, Gas & Steam; E, Water Supply, Sewerage & Waste Management; F, Construction; G, Wholesale & Retail; H, Transport & Storage; I, Accommodation & Food Service; J, Information & Communication; K, Finance & Insurance; L, Real Estate; M, Professional, Scientific & Technical; N, Administrative & Support Services; O, Public Administration, Defence & Compulsory Social Security; P, Education; Q, Human Health and Social Work; R, Arts, Entertainment & Recreation; S, Other Services; NMG = Non-monetary gold; Unallocated = Total unallocated trade to industries

(2) Note that data on trade in natural gas and oil through pipelines is collected directly and not from businesses; as these items are likely to relate to industry D in particular, it is possible that estimates of exports and imports for these industries are understated.

5.1.4 **Concentration of trade in goods**

Our estimates suggest that direct trading behaviour is very unequally distributed, with the largest traders responsible for the bulk of trade. Table 5[19] presents some simple statistics on the degree of concentration of trade: of total UK exports, 35-40% are reported by the 50 largest exporting enterprise groups; of total UK imports, 30-35% are reported by the 50 largest importing enterprise groups. These

[19] Note that this table is provided for Enterprise Groups, and not reporting units, so as to show the proportion of independent businesses which account for different portions of UK trade as recorded in trade in goods transactions.

results also suggest that trade in goods is more concentrated for exports than for imports. The top 50 and top 100 enterprise groups for exports make up a higher share of total UK exports than do the top 50 and top 100 importing enterprise groups.

Table 5: Enterprise Group level total trade as proportion of UK total, by size of enterprise group trade, 2008 to 2016, %

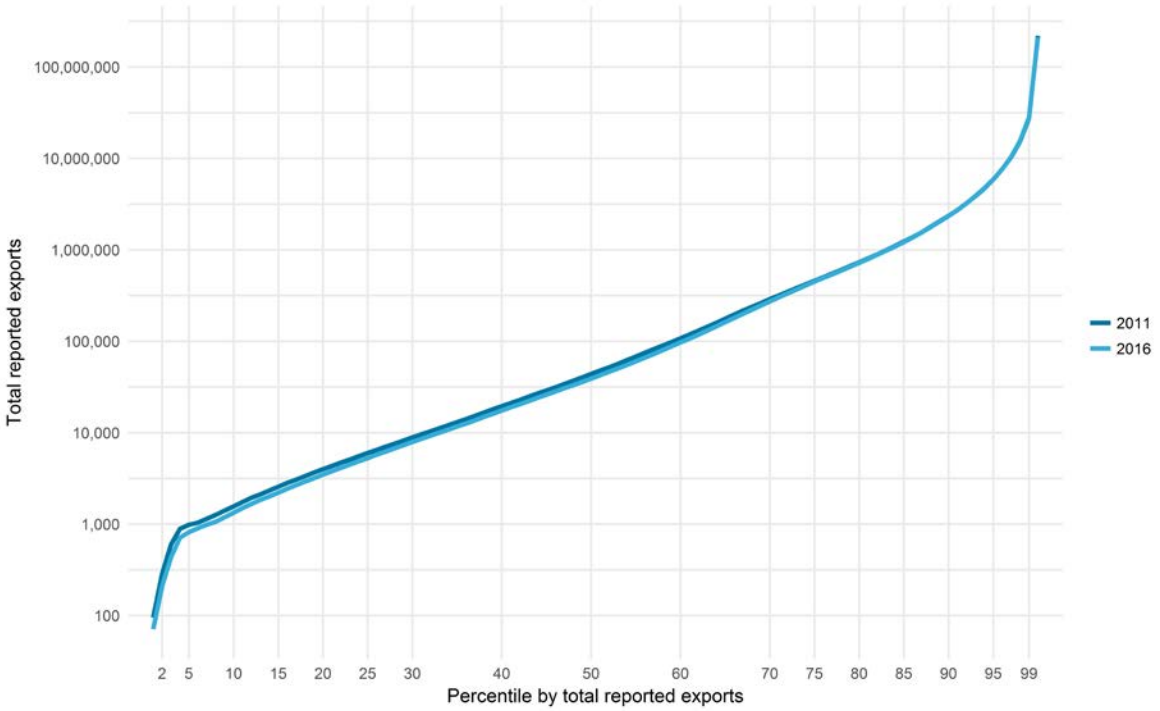
	Percentage of total UK exports due to enterprise groups that are in the top:				Percentage of total UK imports due to enterprise groups that are in the top:			
	50 exporters	100 exporters	500 exporters	2,000 exporters	50 importers	100 importers	500 importers	2,000 importers
2008	36%	44%	62%	77%	30%	37%	57%	72%
2009	35%	43%	62%	77%	31%	39%	58%	74%
2010	37%	45%	63%	77%	32%	40%	59%	74%
2011	39%	47%	64%	77%	35%	42%	60%	75%
2012	37%	45%	62%	76%	37%	44%	61%	76%
2013	44%	51%	67%	78%	33%	40%	59%	74%
2014	39%	46%	63%	76%	32%	39%	58%	73%
2015	40%	47%	64%	78%	30%	39%	57%	73%
2016	38%	45%	63%	78%	34%	42%	60%	74%

Source(s): HMRC, ONS, authors calculations

This concentration of trade in goods is evident in the distributions of export and import values across trading businesses. Figure 17 shows the distribution of export values for all exporters with trade in goods declarations, presenting percentile points in the distribution export values on a logarithmic scale. For about 5% of businesses with goods exports declarations, the exports were worth less than £1,000, while around 30% of businesses shipped goods to a value of £10,000 abroad over the same period. Around 40% of UK exporters shipped more than £100,000 abroad in 2016, while around 17% shipped more than £1m.

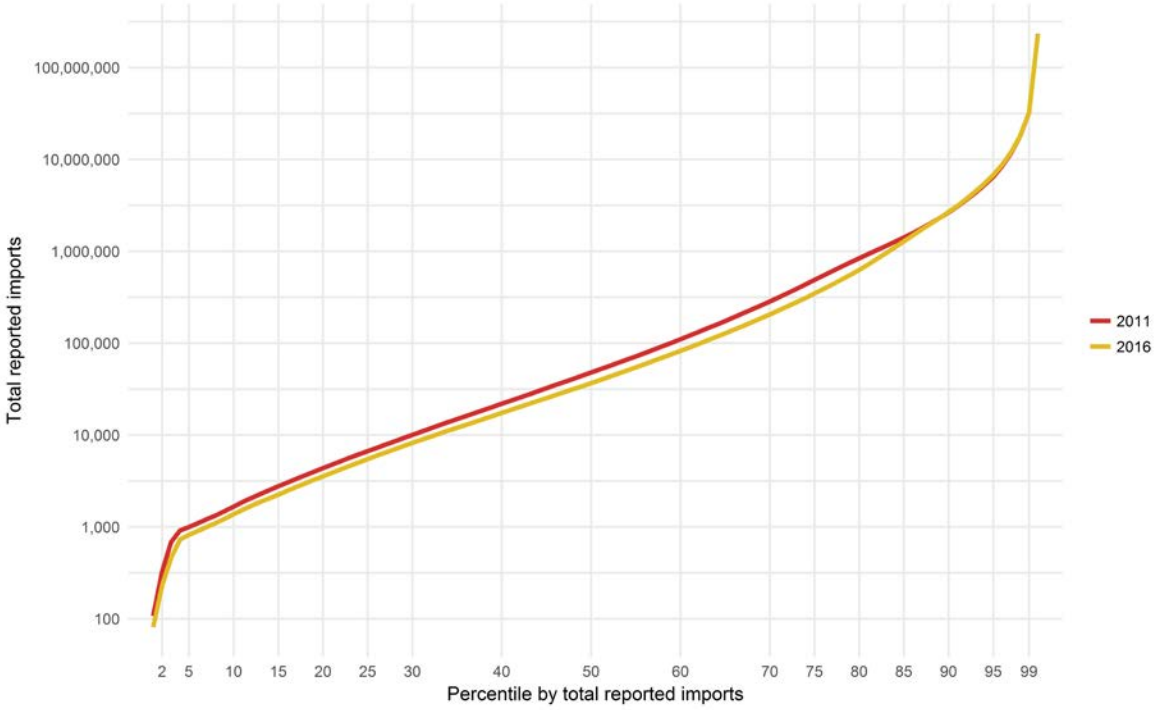
The distribution of imports across importing businesses is less concentrated, with more relatively smaller importers than smaller exporters (Figure 18). 5% of businesses with goods imports declarations import less than £1,000 in 2016; around 40% of businesses with goods imports declarations received more than £100,000 in imports; and about 15% of importing businesses received more than £1m. As a result, the median value of imports among importers in 2016 was £28,000, while the equivalent for businesses reporting goods exports in 2016 was a median value of £39,000.

Figure 17: Distribution of firm-level exports, businesses with goods export declarations, current prices, 2011 and 2016, IDBR basis



Source(s): HMRC, ONS, authors calculations
Note(s): Excludes the top and bottom 1% by value in each period.

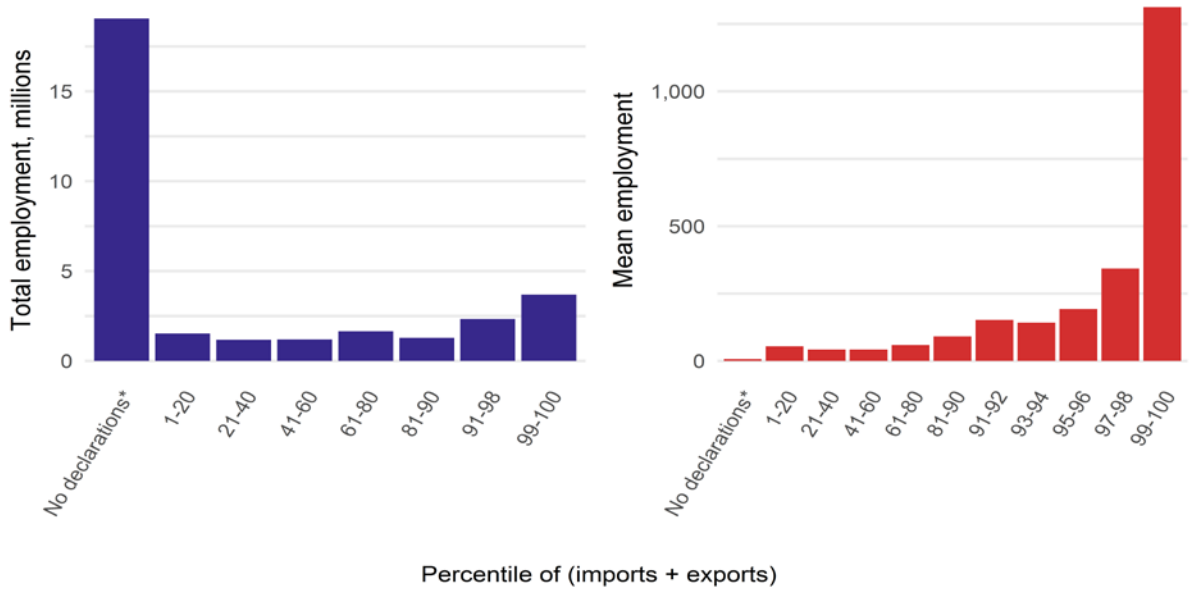
Figure 18: Distribution of firm-level imports, businesses with goods imports declarations, current prices, 2011 and 2016, IDBR basis



Source(s): HMRC, ONS, authors calculations
Note(s): Excludes the top and bottom 1% by value in each period.

The UK's most internationally orientated firms – the businesses with the largest total trade in goods exposure – are also some of the largest. Figure 19 shows the characteristics of businesses by size of total trade. Businesses are ranked by the total value of imports and exports declarations combined, and grouped into bins: those with the least (greatest) trade exposure are on the left (right). Most employment is in businesses which do not have any trade in goods declarations. However, average employment in these businesses was around six in 2016, compared to average employment of 54 among the businesses in the bottom 20% of the trade exposure distribution. By contrast, average employment among businesses in the top 2% of this distribution was around 1300 over the same period.

Figure 19: Total employment and mean employment, businesses by percentile of (imports + exports), and no trade in goods data, 2016

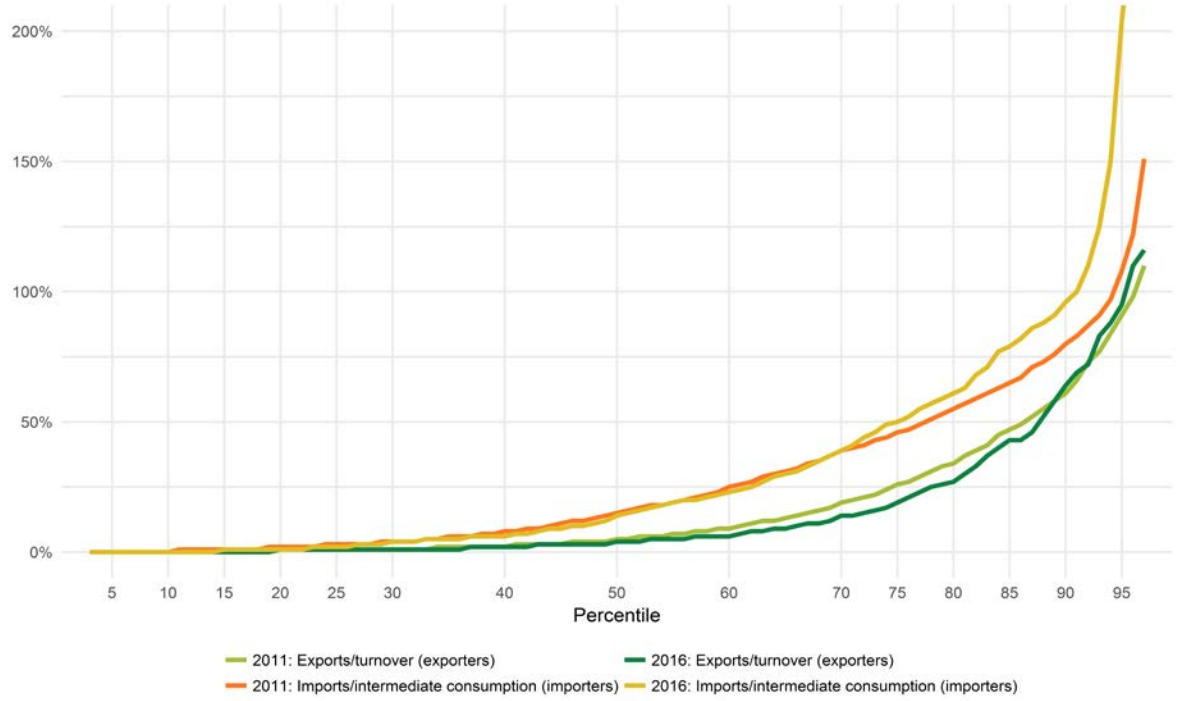


Source(s): HMRC, ONS, authors calculations
Note(s): No declarations = business does not report EU trade on Intrastat or make customs declarations for Non-EU trade

The concentration of trade flows to and from a relatively small number of quite large businesses reflects distributions of trade intensity. Figure 20 presents two relatively crude measures of trade intensity: using information from these trade in goods data and the Annual Business Survey (ABS), it calculates the ratio of import values to intermediate consumption and export values to total turnover, and shows the distribution of these ratios across businesses in 2011 and 2016. It indicates that in 2016, for about one in five workers at businesses with goods exports declarations, the exported goods were worth more than 25% of the turnover of the business. For about 40% of workers at businesses with goods imports declarations, the imported goods were worth more than 25% of intermediate consumption of the business.

Figure 20 also indicates that business-level import intensity is greater on average than export intensity, and that import intensity shifted upwards among some traders between 2011 and 2016. While these data raise several questions about the consistency of administrative trade in goods declarations and the ABS[20] – explored in more detailed in the appendix – they provide a more fine-grained analysis of the direct trading behaviours of businesses in the UK.

Figure 20: Distribution of trader intensity, businesses reporting exports, businesses reporting imports, 2011 and 2016, ABS basis



Source(s): HMRC, ONS, authors calculations,
Note(s): (1) Excludes top and bottom 2% of each distribution and covers firms included in the Annual Business Survey. (2) Strictly, this measure of export intensity should be bounded at one: where all turnover is accounted for by export turnover. There are several possible reasons for the observation of some values above one, including error induced by our methods and issues to do with the timing and reporting of data to ABS and HMRC. These are examined further in the Appendix. (3) Weighted by employment and sample selection and grossing weights

5.1.5 **Composition of trade - products**

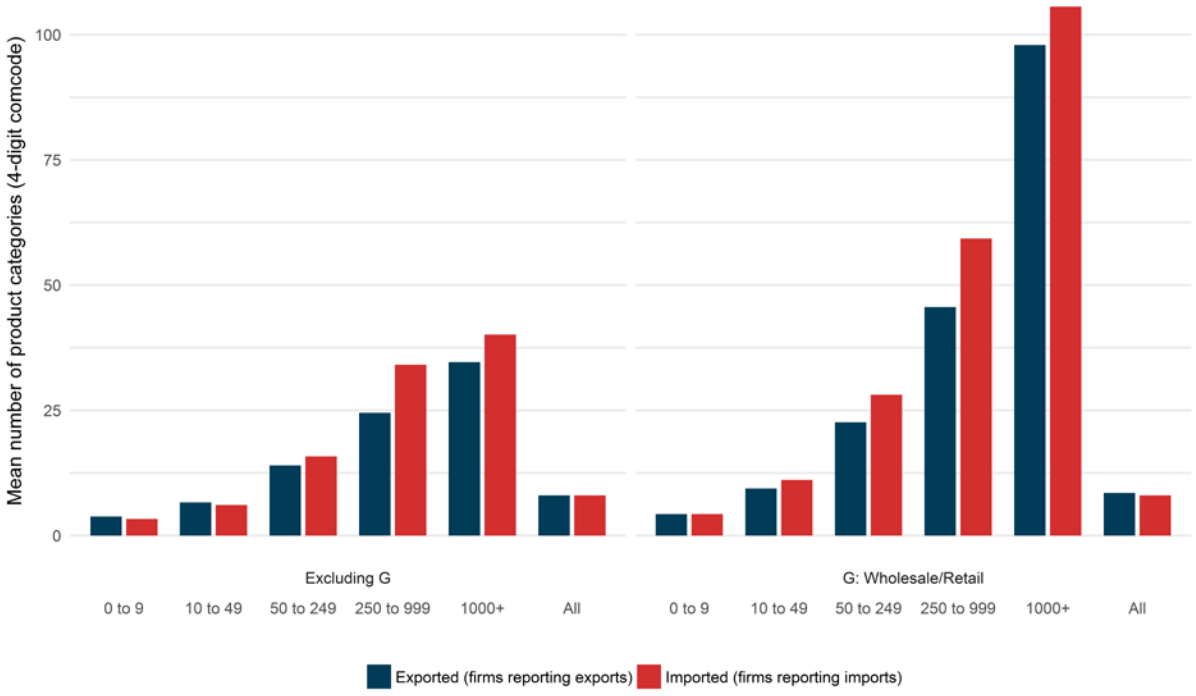
As the size of businesses and business-level trade increases, so does its complexity. Larger traders import more types of products from more markets and export more types of products to more

[20] If the ABS and the trade in goods declarations were perfectly consistent, then no business could report an exports-to-turnover ratio of more than one. Export to turnover ratios higher than unity may indicate some issues of timing regarding the reports of trading behaviour to HMRC or on the reporting of turnover on the ABS. These issues are explored at length in the appendix. Note that a ratio of import values to intermediate consumption greater than one is possible, as imports may include capital items.

destinations. This section quantifies the extent of this relationship for UK firms, using four-digit commodity codes[21] recorded in HMRC's trade in goods data to identify different types of product.

These data suggest that the mean number of products traded tends to rise with the size of the business. Figure 21 shows the mean number of products imported or exported by firm size, dividing reporting units with trade in goods data into those in the Wholesale & Retail industry (second panel) and those in all other industries (first panel). This figure shows that the relationship between size and products traded is particularly striking in the wholesale industry – in which the largest businesses export and import about 100 unique product categories on average. It also shows that the mean number of product categories exported tends to be higher than the mean number of products imported for a given size-band.

Figure 21: Average number of product categories traded, by firm size, businesses reporting goods exports, businesses reporting goods imports, 2016, IDBR basis

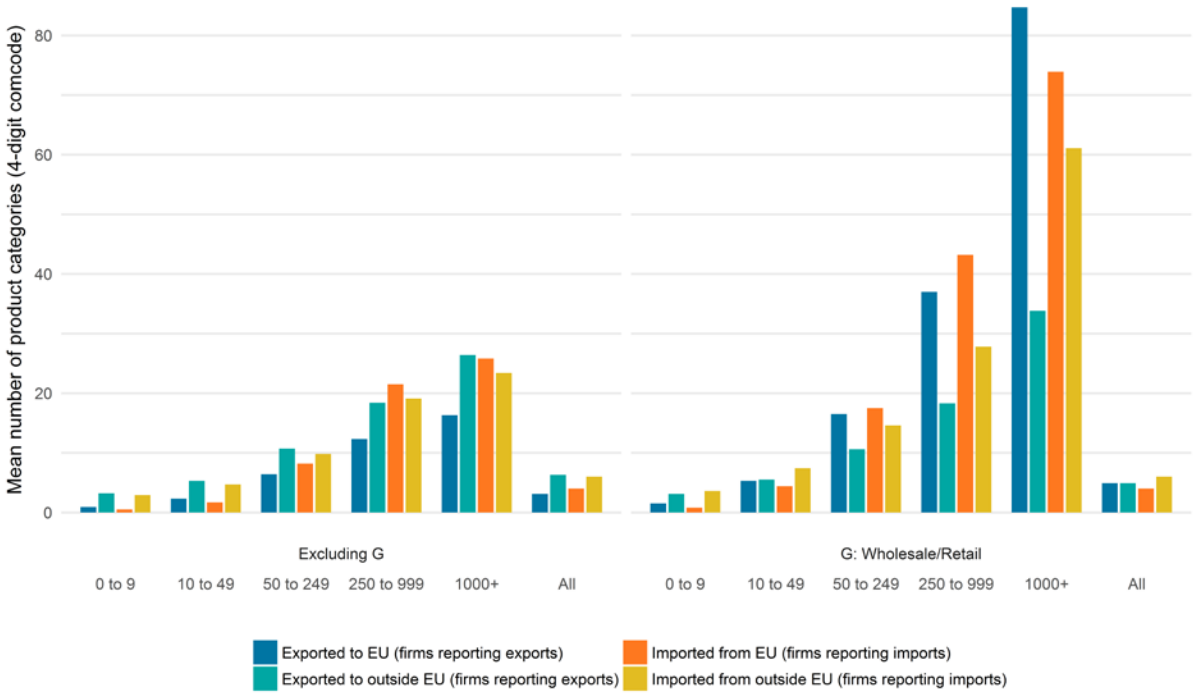


Source(s): HMRC, ONS, authors calculations
Note(s): (1) The data to which we have access is mostly at the transaction level. However, for low-value non-EU trade, some aggregation takes place. Differences in the reporting thresholds for imports and exports – particularly for EU trade – may also play a role. These estimates are consequently a lower bound – as these aggregates may mask some product variation. Future, more detailed data deliveries from HMRC may permit a revision to account for these low-value trades. See data section for more details

[21] These are highly detailed breakdowns – for instance 8508, 'vacuum cleaners', or 2002, 'tomatoes prepared or preserved otherwise than by vinegar or acetic acid'. The full range of product categories is available at https://www.trade-tariff.service.gov.uk/trade-tariff/sections. Product classifications are relatively slow to update, potentially causing bias – newer products, such as electronics, are covered in relatively less granularity.

The mean number of product categories traded also varies by geographical market. Figure 22 extends this analysis by showing the mean number of products exported to or imported from EU and non-EU nations by size-band. Some care is needed here – as Intrastat reporting arrangements for EU trade will not capture many smaller traders relative to the customs arrangements for non-EU trade. However, these data suggest that the association between the mean number of products traded and business size holds for both EU and non-EU trade. It also suggests that businesses trading with non-EU nations tend to trade more product categories on average than equivalently sized businesses focussed on the EU market – although this pattern is reversed for wholesalers and retailers, who trade a similar or wider variety of products with the EU than with the non-EU in most size classes. This suggests that the largest and most diversified firms in the Wholesale & Retail sector have substantially more complex trade with the EU than with countries outside the EU.

Figure 22: Average number of product categories traded by firm size, businesses reporting goods exports, businesses reporting goods imports, 2016, IDBR basis



Source(s): HMRC, ONS, authors calculations

Note(s): (1) The data to which we have access is mostly at the transaction level. However, for low-value non-EU trade, some aggregation takes place. Differences in the reporting thresholds for imports and exports – particularly for EU trade – may also play a role. These estimates are consequently a lower bound – as these aggregates may mask some product variation. Future, more detailed data deliveries from HMRC may permit a revision to account for these low-value trades. See data section for more details

These results also hold for a more detailed breakdown of industries, reported in Figure 23 (excluding businesses with fewer than 10 workers). This shows that businesses in the Mining & Quarrying (B), Manufacturing (C) and Wholesale & Retail (G) industries tend to trade a larger number of product categories than businesses in other industries – largely reflecting the focus of these data on trade in goods, not services. Some manufacturing industries trade more products with the EU than countries outside the EU – for instance, the chemicals and pharmaceuticals industries. However, for most industries it is the inverse. Figure 23 also demonstrates that it is only for the largest firms within Wholesale & Retail that EU trade is more vastly more complex.

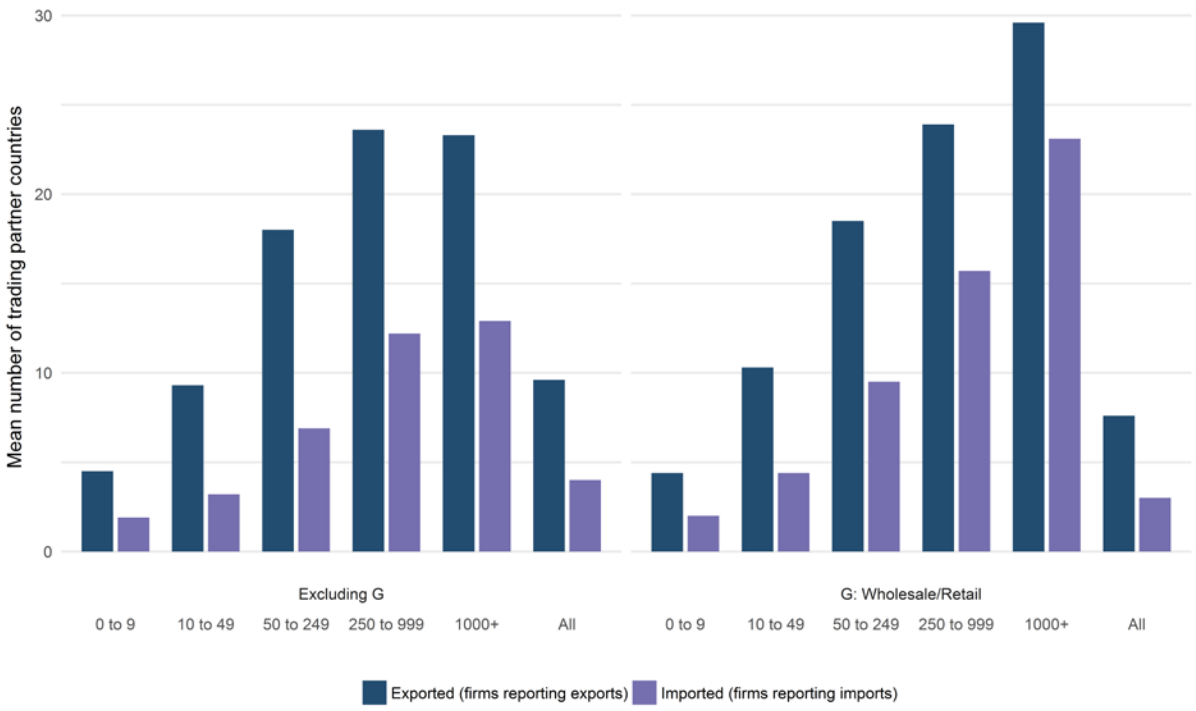
Figure 23: Average number of product categories traded by industry, businesses reporting goods exports, businesses reporting goods imports, businesses with 10+ workers, 2016, IDBR basis

Source(s): HMRC, ONS, authors calculations
Note(s): (1) Industry classification: 10-12, Food products, beverages and tobacco; 20, Chemicals; 21: Pharmaceuticals; 26: Computer, electronic and optical products; 28: General and special purpose machinery; 29: Motor vehicles 30: Other transport equipment, i.e. aerospace, trains; 45, Motor vehicle wholesale & retail; 46, Other wholesale; 47, Other retail.
(2) The data to which we have access is mostly at the transaction level. However, for low-value non-EU trade, some aggregation takes place. Differences in the reporting thresholds for imports and exports – particularly for EU trade – may also play a role. These estimates are consequently a lower bound – as these aggregates may mask some product variation. Future, more detailed data deliveries from HMRC may permit a revision to account for these low-value trades. See data section for more details

5.1.6 **Number of trading partners**

As the size of business and the value of business-level trade increases, so too does the number of trading partners. Figure 24 shows the mean number of export destinations for exporters and the mean number of import origin countries for importers by size-band. The first panel shows that the mean number of countries exported to (imported from) rises from fewer than 5 (2) for the smallest businesses to around 24 (12) for businesses of between 250 and 999 workers outside Wholesale & Retail. In contrast to the results for the number of products, the complexity of trade levels off above this point, with no substantial change between the 250 to 999 worker businesses and the largest businesses. Among Wholesale & Retail businesses, average complexity increases monotonically with size.

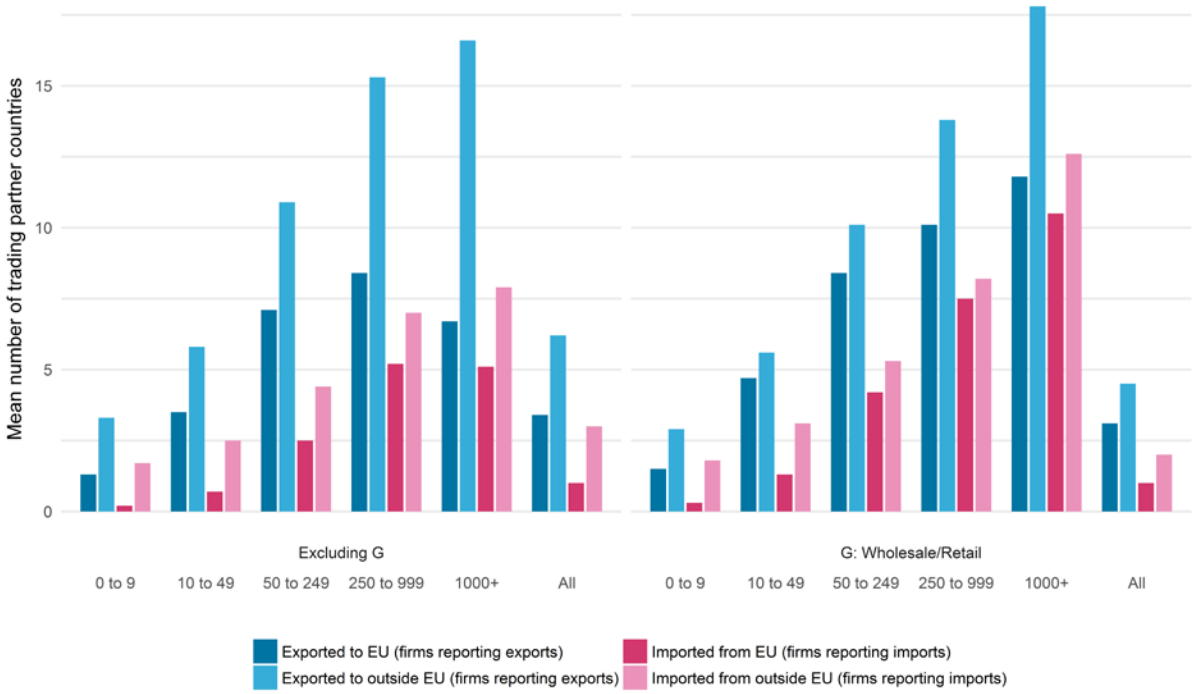
Figure 24: Average number of destinations exported to and imported from by firm size, businesses reporting goods exports and businesses reporting goods imports respectively, IDBR basis, 2016



Source(s): HMRC, ONS, authors calculations
Note(s): (1) The data to which we have access is mostly at the transaction level. However, for low-value non-EU trade, some aggregation takes place. Differences in the reporting thresholds for imports and exports – particularly for EU trade – may also play a role. These estimates are consequently a lower bound – as these aggregates may mask some product variation. Future, more detailed data deliveries from HMRC may permit a revision to account for these low-value trades. See data section for more details

These trends are largely replicated when comparing EU and non-EU trade: as business size increases, so too does the mean number of EU and non-EU trading partners (Figure 25). As previously, this trend is clearer for Wholesale & Retail businesses than for businesses in other industries – for whom the number of EU and non-EU trading partners rises monotonically with business size. The mean number of EU trading partners tends to be smaller than the mean number of non-EU trading partners – likely reflecting the larger number of countries outside than inside the EU.

Figure 25: Average number of destinations exported to and imported from by firm size, businesses reporting exports, businesses reporting imports, IDBR basis, 2016



Source(s): HMRC, ONS, authors calculations
Note(s): (1) The data to which we have access is mostly at the transaction level. However, for low-value non-EU trade, some aggregation takes place. Differences in the reporting thresholds for imports and exports – particularly for EU trade – may also play a role. These estimates are consequently a lower bound – as these aggregates may mask some product variation. Future, more detailed data deliveries from HMRC may permit a revision to account for these low-value trades. See data section for more details

To complete the analysis of the mean number of trading partners, Figure 26 shows the equivalent measures for different industries, excluding businesses with fewer than 10 workers. The picture presented here is highly varied, but suggests that some of the trade surplus generated by Manufacturing businesses (Figure 14) may be a consequence of greater than average geographical reach in non-EU markets.

Figure 26: Average number of destinations exported to and imported from by industry, businesses reporting goods exports, businesses reporting goods imports, businesses with 10+ workers, IDBR basis, 2016

Source(s): HMRC, ONS, authors calculations
Note(s): (1) Industrial classification: 10-12, Food products, beverages and tobacco; 20, Chemicals; 21: Pharmaceuticals; 26: Computer, electronic and optical products; 28: General and special purpose machinery; 29: Motor vehicles 30: Other transport equipment, i.e. aerospace, trains; 45, Motor vehicle wholesale & retail; 46, Other wholesale; 47, Other retail.
(2) The data to which we have access is mostly at the transaction level. However, for low-value non-EU trade, some aggregation takes place. Differences in the reporting thresholds for imports and exports – particularly for EU trade – may also play a role. These estimates are consequently a lower bound – as these aggregates may mask some product variation. Future, more detailed data deliveries from HMRC may permit a revision to account for these low-value trades. See data section for more details

5.1.7 **The correspondence of measures of trade**

To complete our set of descriptive statistics, we examine the correlations between various measures of trade intensity at the business level. Table 6 shows the correlation coefficients between:

- The total value of trade in goods declarations (exports plus imports), logged
- Export value, logged
- Import value, logged

- Number of products exported and imported, logged
- Number of trading partners for exports and imports, logged

All of these correlations are positive, indicating that as business trade grows in value it also tends to grow in its geographical reach and product detail. Small value traders consequently tend to serve fewer markets and buy from fewer markets than larger value traders, and are likely to trade fewer products with these markets.

Table 6: Correlation of log values, businesses with import and export trade in goods data, 2016, IDBR basis

	Total trade	Exports	Imports	Exp. Dest.	Imp. Orig.	Products exp.	Products imp.
Total trade	1						
Exports	0.83	1					
Imports	0.88	0.57	1				
Exp. Dest.	0.57	0.72	0.38	1			
Imp. Orig.	0.63	0.51	0.66	0.60	1		
Products exp.	0.55	0.66	0.40	0.75	0.59	1	
Products imp.	0.62	0.44	0.69	0.49	0.78	0.62	1

Source(s): HMRC, ONS, authors calculations

A more detailed breakdown of this correlation matrix – which includes EU and non-EU divisions of exports, imports and products traded – is shown in Table 7[22]. This highlights one further finding. While declared exports and imports are well correlated (see Table 6), business-level trade is more closely correlated within markets than between markets. For instance, EU exports and imports have a correlation of 0.5, and non-EU exports and imports have a correlation of 0.37. By contrast, EU exports and non-EU exports are more weakly correlated (0.18), while non-EU imports and EU imports are even more weakly correlated (0.09). This appears to indicate that business-level trade flows tend to be relatively geographically specialised: something that will be the subject of future research.

[22] Using an inverse hyperbolic sine (IHS) transform, almost exactly a log transform, to account for the zero values when businesses have zero trade in any direction.

Table 7: Correlation of Inverse hyperbolic sine values, businesses with trade in goods declarations, 2016, IDBR basis

		Total Trade	Exports		Imports		Countries		Products exported		Products imported	
			EU	Non-EU	EU	Non-EU	Ex	Im	EU	Non-EU	EU	Non-EU
	Total trade	1										
	EU	0.68	1									
Exports	Non-EU	0.41	0.18	1								
	EU	0.61	0.50	0.11	1							
Imports	Non-EU	0.53	0.27	0.37	0.09	1						
	Export	0.57	0.70	0.56	0.35	0.32	1					
Countries	Import	0.63	0.53	0.33	0.67	0.46	0.60	1				
	EU	0.60	0.83	0.20	0.51	0.29	0.66	0.59	1			
Products exported	Non-EU	0.39	0.31	0.72	0.21	0.32	0.71	0.50	0.42	1		
	EU	0.56	0.48	0.15	0.91	0.15	0.39	0.69	0.59	0.30	1	
Products imported	Non-EU	0.46	0.33	0.36	0.22	0.68	0.48	0.66	0.46	0.56	0.33	1

Source(s): HMRC, ONS, authors calculations

Note(s): The Inverse hyperbolic sine transformation almost exactly approximates log transformations, but takes zeros.

5.2 **Productivity analysis**

The final part of this results section presents analysis of the association between estimates of trade in goods and labour productivity. These results draw on both the estimates of trade which are described in the previous section, and on estimates of labour productivity at the business level, which we take from the Annual Business Survey (ABS).

Several data constraints are worth noting. Firstly, as the ABS data is a sample of the business population focussed on the private non-financial business economy, the results here necessarily have a more limited industrial breakdown than those in preceding sections. Secondly, as comparable, historical ABS data were not available for Northern Ireland at the time of writing, this section is focussed on businesses in Great Britain alone. Thirdly, the use of the ABS weights – which are designed to make the results representative of the business population – impose some further limitations which are explored below. As firm-level estimates of capital inputs and prices are not presently available, we focus on measures of nominal labour productivity. We consequently limit our analysis to comparisons of the levels of labour productivity between businesses with different forms of trading behaviour, and leave discussion of relative rates of labour productivity growth for future work.

5.2.1 **Distribution of output per worker by trade in goods declarations**

Levels of labour productivity are considerably higher for businesses which declare trade than for businesses which do not. Table 8 shows the median (first panel) and mean (second panel) levels of output per worker at businesses which have different trader statuses in the HMRC trade in goods data, excluding the very largest traders[23]. Median labour productivity among businesses which both export and import was around £40,000 per worker per year in 2016, compared with around £22,000 per worker per year at businesses which have no trade declarations. Businesses which only report exports or imports – which are an unusual group of businesses – had output per worker of £45,000 and £33,000 per worker per year in the same period. On a mean basis – which is considerably affected by a few very high-productivity businesses – the gap is similarly stark: businesses with both export and import trade in goods declarations had labour productivity almost 70% higher than that of businesses without trade declarations in 2016.

[23] We exclude the largest 2% of exporters and the largest 2% of importers.

Table 8: Labour productivity, ABS basis, employment weighted, £ thousands per worker per year, 2008 to 2016

	Employment weighted				
Median	No trade in goods declarations	Exports only	Imports only	Both	*All businesses*
2008	19.7	33.7	25.5	32.4	*23.0*
2009	18.6	35.5	23.6	31.7	*22.2*
2010	20.2	38.0	23.3	33.4	*24.0*
2011	20.5	39.5	26.8	35.3	*24.3*
2012	20.3	39.5	27.0	37.6	*24.5*
2013	20.6	34.5	29.7	38.1	*25.2*
2014	21.1	37.2	31.2	37.8	*26.3*
2015	22.2	40.4	33.2	40.3	*27.5*
2016	22.0	44.6	32.8	40.2	*26.6*
Mean					
2008	30.6	45.6	39.9	48.7	*36.3*
2009	28.5	45.5	38.4	45.3	*34.0*
2010	31.8	49.4	39.5	49.7	*37.4*
2011	32.6	53.5	44.5	51.3	*38.6*
2012	32.7	57.9	45.8	51.7	*38.9*
2013	34.2	57.6	48.5	57.1	*41.2*
2014	36.4	55.3	54.8	60.1	*43.8*
2015	37.7	54.8	54.3	62.4	*45.0*
2016	37.2	64.9	55.3	62.9	*44.3*

Source(s): HMRC, ONS, authors calculations

Note(s): Excludes the top 2% of exporters and the top 2% of importers

Categorical markers for the trader status of different businesses may hide more nuanced differences between businesses which trade to differing extents. Table 9 uses measures of trade in goods dependence to identify 'intensive' traders – defined as businesses which export more than 10% of the value of their turnover, import more than 10% of the value of their intermediate consumption, or both[24]. On this basis, median labour productivity for businesses which are both intensive goods importers and intensive goods exporters was around £50,000 per worker per year in 2016, compared with £22,000 per worker per year for businesses with no trade in goods declarations, and around £37,000 per worker per year for non-intensive trading businesses. Reflecting the impact of a number of very high productivity businesses in all these groups, the differences in mean labour productivity

[24] Businesses with goods exports declarations worth more than 110% of total turnover were excluded as the IDBR-linked data was unlikely to be comparable to the ABS data for the business. Similarly, businesses were excluded if goods imports were worth more than 200% of total intermediate consumption. (See appendix for further discussion on comparability.)

are smaller, but the most intensive traders retain a considerable productivity advantage over businesses with no trade in goods declarations.

Table 9: Labour productivity, by intensity, ABS basis, employment weighted, £ thousands per worker per year, 2008 to 2016

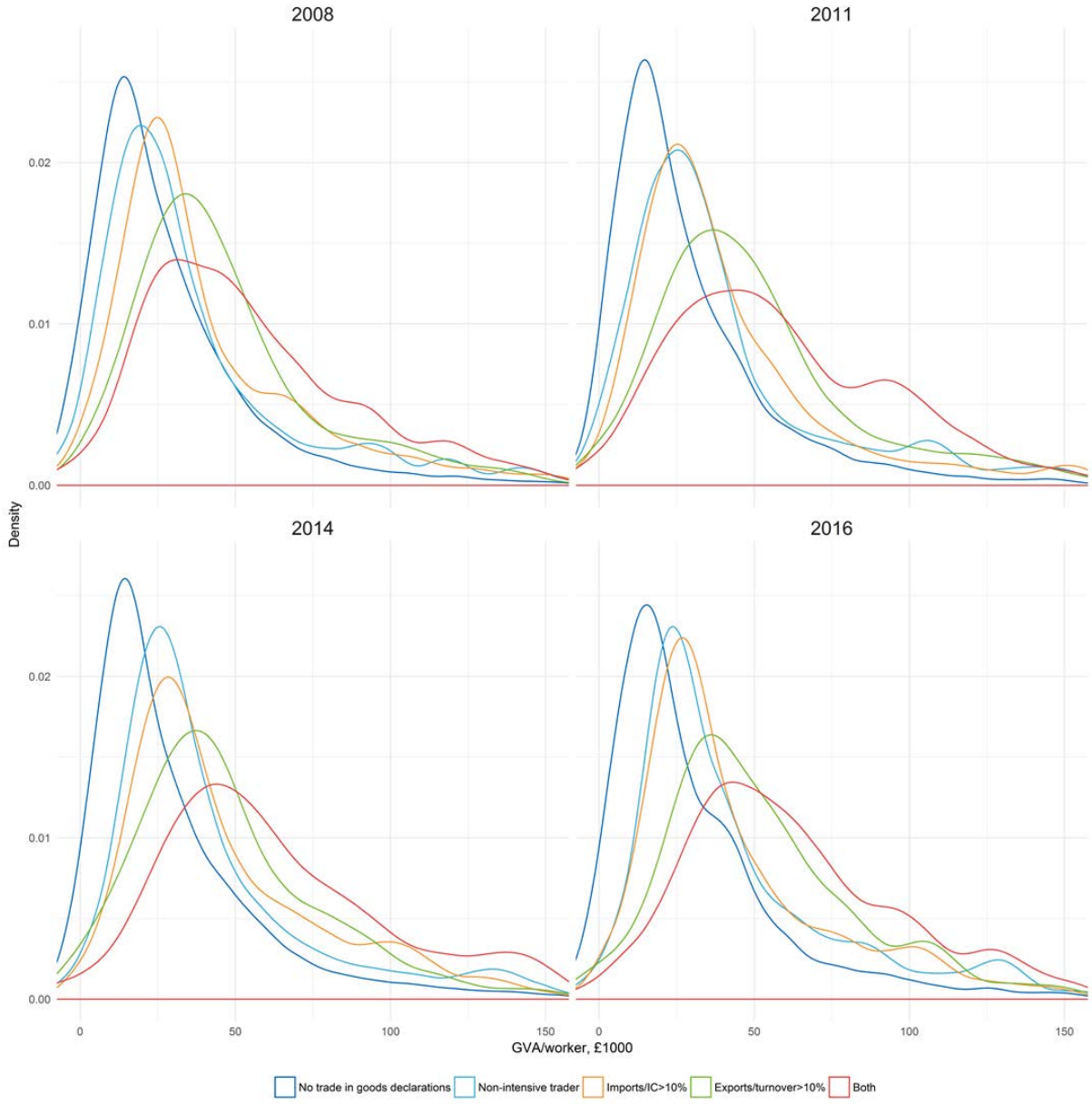
	Employment weighted					
Median	No trade in goods data	Non-int. trade in goods	Export intensive	Import intensive	Export & import intensive	*All*
2008	19.7	28.8	35.3	34.7	37.5	*23.0*
2009	18.6	28.9	32.6	32.5	37.6	*22.2*
2010	20.2	29.8	34.7	35.0	43.3	*24.0*
2011	20.5	31.5	40.9	37.3	44.0	*24.3*
2012	20.3	31.9	38.8	40.1	43.1	*24.5*
2013	20.6	33.7	39.8	39.2	45.2	*25.2*
2014	21.1	35.0	37.2	43.4	47.7	*26.3*
2015	22.2	38.1	38.1	42.6	47.3	*27.5*
2016	22.0	36.7	39.2	42.2	49.8	*26.6*
Mean						
2008	30.6	47.6	38.7	48.4	45.2	*36.3*
2009	28.5	43.7	39.9	48.9	44.8	*34.0*
2010	31.8	46.4	42.4	52.0	52.3	*37.4*
2011	32.6	50.3	48.1	50.3	52.5	*38.6*
2012	32.7	50.4	43.8	55.5	52.9	*38.9*
2013	34.2	55.2	45.3	59.4	54.4	*41.2*
2014	36.4	59.4	40.1	59.4	57.6	*43.8*
2015	37.7	61.7	40.4	57.9	57.1	*45.0*
2016	37.2	62.7	40.8	58.3	59.9	*44.3*

Source(s): HMRC, ONS, authors calculations

Note(s): (1) Excludes the top 2% of exporters and the top 2% of importers. (2) 'Intensive' exporters are those businesses which have an export to turnover ratio of more than 10%. 'Intensive' importers are those businesses which have import values larger than 10% of their intermediate consumption. Businesses with export intensity greater than 110% or import intensity greater than 200% are excluded

The higher level of productivity among trading businesses is evident in the distribution of output per worker among these businesses, shown in Figure 27. In these figures, the rightwards shift of the labour productivity distribution for intensive traders is particularly apparent. The distributions of labour productivity for intensive exporters and importers are also shifted rightwards, while in each year the distribution of output per worker for non-traders is furthest to the left. Although these distributions are overlapping – indicating that there are high-productivity non-trading businesses – there is a fairly clear association between trader status and productivity in these data.

Figure 27: Distribution of labour productivity by trader status, employment weighted, 2008 to 2016, ABS basis



Source(s): HMRC, ONS, authors calculations
Note(s): (1) Excludes the top 2% of exporters and the top 2% of importers by value. (2) 'Intensive' exporters are those businesses which have an export to turnover ratio of more than 10%. 'Intensive' importers are those businesses which have import values larger than 10% of their intermediate consumption. Businesses with export intensity greater than 110% or import intensity greater than 200% are excluded on comparability grounds.

5.2.2 Export and import premia: the extensive margin

To provide further weight to these descriptive statistics, this section reports the results of conditional analysis designed to examine the link between labour productivity and trade declarations status after controlling for other characteristics of the business. Table 10 presents the results of a regression of

logged firm-level labour productivity on trade in goods declarations-based trader status (specification 1), and sequentially adds business-level characteristics including controls for location of the ultimate foreign owner of the business, year and two-digit industry fixed effects. Consistent with practice in the literature, we exclude the top 2% of importers and exporters from this analysis. These outlying cases are unusual, large traders and would otherwise likely bias our results.

Table 10: Labour productivity and trade in goods declaration status, ABS basis, 2008 to 2016

	(1) ln(prod)	(2) ln(prod)	(3) ln(prod)	(4) ln(prod)	(5) ln(prod)	(6) ln(prod)
i.Exp.	0.35***	0.35***	0.24***	0.21***	0.21***	
	(56.1)	(56.4)	(41.8)	(35.9)	(34.6)	
i.Imp.	0.25***	0.26***	0.27***	0.22***	0.20***	
	(43.2)	(44.5)	(49.5)	(37.2)	(33.8)	
ln(employment)				0.021***	0.017***	0.019***
				(24.8)	(20.3)	(22.2)
i.Ownership: EU					0.14***	0.15***
					(16.6)	(17.4)
i.Ownership: USA					0.18***	0.19***
					(18.2)	(19.0)
i.Ownership: Japan					0.35***	0.35***
					(9.85)	(9.89)
i.Other foreign own					0.15***	0.15***
					(16.4)	(16.5)
i.Exp.-EU						0.043***
						(5.85)
i.Exp-Non-EU						0.19***
						(30.2)
i.Imp-EU						0.017**
						(2.62)
i.Imp-Non-EU						0.18***
						(30.7)
Year F.E.	No	Yes	Yes	Yes	Yes	Yes
Industry F.E.	No	No	Yes	Yes	Yes	Yes
Adjusted R2	0.049	0.054	0.202	0.203	0.205	0.204
N	369,807	369,807	369,041	369,041	369,041	369,041

Note(s): (1) Excludes the top 2% of exporters and the top 2% of importers. (2) Results are weighted by employment and sample selection and grossing weights. (3) Ownership refers to country of ultimate foreign ownership – UK-owned is the baseline. (4) Variables prefixed with i are binary indicator variables, or interactions thereof. (5) t statistics in parentheses, * p < 0.05, ** p < 0.01, *** p < 0.001

The results of these regressions suggest a strong, consistent, positive link between labour productivity and trade in goods-based trader status. While both coefficients attenuate somewhat with the inclusion of other characteristics, both are positive and significant in each specification. According to specification (5), businesses which export are around 21% more productive than businesses which do not, while businesses which import are around 20% more productive, after controlling for an array of their characteristics.

The market with which a business trades also appears to be important. Specification (6) unpacks these extensive margin effects by estimating productivity premia by geographical market. These results suggest that businesses which export to (import from) the EU are around 4.3% (1.7%) more productive than otherwise equivalent non-traders. However, these effects are much smaller than the estimates for non-EU trade: businesses which export to (import from) non-EU nations are around 19% (18%) more productive than equivalent non-traders. This result could reflect reporting threshold effects, but is consistent with the theory that increased barriers to trade are only surmounted by more productive firms: producing for the domestic market is 'easiest', trading within the EU presents some barriers, but remains 'easier' than trading with the non-EU[25]. We plan to investigate this finding – including whether reporting thresholds play a role in this result – in future work.

These results are also consistent with our earlier findings (ONS 2017f) that businesses with an immediate foreign owner are more productive than domestic businesses. While the effects estimated here are somewhat smaller than in our earlier work, they suggest that businesses owned in the EU and the US are around 15% and 19% more productive than British owned businesses. British firms which are ultimately owned in Japan are around 35% more productive than their domestically held equivalents.

To assess the robustness of these estimated export and import premia, Table 11 provides two further analyses of the productivity premium associated with the extensive margin. Specification (1) uses our linked dataset, comprising trade in goods declarations and data from the ABS, while specification (2) uses data on trade in goods status reported to the ABS. In both cases, the productivity premiums associated with trading are positive and significant, although for exports the coefficient is considerably smaller using self-reported trader status than using our linked data. While the discrepancy in these two effects is rooted in differences in trader status from the two sources (see appendix) the smaller magnitude of the ABS-based effect is consistent with low-trade value, low-productivity traders returning a positive trader status on the ABS, but failing to cross the required Intrastat reporting threshold to appear in our linked dataset.

[25] One discussion in the literature is whether this result should hold: while the barriers to trade among EU countries are lower, another theory is that it may be more 'difficult' to export to richer markets with more sophisticated and productive incumbents, such as the EU or the USA.

Table 11: Labour productivity and trade in goods declaration status, ABS basis, 2016

	(1) ln(prod)	(2) ln(prod)
i.Exp.	0.26***	
	(13.9)	
i.Imp.	0.21***	
	(11.58)	
i.ABS exporter		0.09***
		(5.01)
i.ABS importer		0.19***
		(11.41)
ln(employment)	0.027***	0.052***
	(11.6)	(26.6)
Ownership F.E.	Yes	Yes
Industry F.E.	Yes	Yes
Adjusted R2	0.256	0.255
N	41,478	38,146

Note(s): (1) Excludes the top 2% of exporters and the top 2% of importers. (2) Results are weighted by employment and sample selection and grossing weights. (3) Variables prefixed with i are binary indicator variables, or interactions thereof. (4) t statistics in parentheses, * p < 0.05, ** p < 0.01, *** p < 0.001

5.2.3 **Productivity and alternative measures of trade: the intensive margin**

Alongside these significant extensive margin effects, our analysis suggests that productivity is related to several aspects of the intensive margins of trade – how much trade is undertaken, how many products are traded and with how many markets. However, these effects are considerably more complex in their functional form and appear to vary across markets.

Table 12 reports the results of regressions which build on earlier specifications by adding measures of the export intensity (the ratio of exports to turnover) and import intensity (the ratio of imports to intermediate consumption). As before, the coefficients on the binary trader status variables are significant and positive, and are either of broadly the same or slightly larger magnitude. These effects are largely dominant: in these specifications, most traders are more productive than non-traders. Import intensity is also found to increase with productivity: a 10-percentage point increase in the ratio of imports to intermediate consumption is associated with a 2.1% increase in labour productivity (specification 4). However, export intensity is found to have the opposite effect: a 10-percentage point increase in the exports to turnover ratio is associated with 2.1% lower productivity[26].

[26] Results reported in the appendix suggest that these effects vary by industry (see table A1). For the Manufacturing industries, the coefficient on the binary exporting variable is slightly smaller - around 17% (compared with 21% for the Wholesale & Retail industries and 21% across the other industries) – and the coefficient on the binary importing term is also slightly smaller – around 14% (compared with 0.16 for Wholesale & Retail and 20% for other industries). The intensive margin terms in specification (4) for the manufacturing industry are also slightly smaller, but retain their sign, rough magnitude and significance.

Table 12: Labour productivity and trade intensity, ABS basis, 2008-2016

	(1) ln(prod)	(2) ln(prod)	(3) ln(prod)	(4) ln(prod)	(5) ln(prod)	(6) ln(prod)
i.Exp.	0.33***	0.24***	0.21***	0.20***	0.21***	
Exp./turn.	0.029	-0.24***	-0.20***	-0.21***	-0.50***	
Exp./turn. ^2					0.44***	
i.Imp	0.23***	0.25***	0.20***	0.18***	0.19***	
Imp./int.con.	0.27***	0.20***	0.24***	0.21***	0.17***	
Imp./int.con. ^2					0.049	
i.Exp-EU						0.065***
EU-exp./turn.						-0.30**
EU-exp./turn. ^2						0.080
i.Exp-Non-EU						0.19***
Non-EU-exp./turn.						-0.73***
Non-EU-exp./turn. ^2						0.94***
i.Imp-EU						-0.022**
EU-imp./int.con.						0.43***
EU-imp./int.con. ^2						-0.090
i.Imp-Non-EU						0.18***
Non-EU-imp./int.con.						0.029
Non-EU-imp./int.con. ^2						0.16***
ln(employment.)			0.017***	0.013***	0.012***	0.014***
Year F.E.	No	Yes	Yes	Yes	Yes	Yes
Industry F.E.	No	Yes	Yes	Yes	Yes	Yes
Ownership F.E.	No	No	No	Yes	Yes	Yes
Adjusted R2	0.06	0.24	0.24	0.24	0.24	0.24
N	340,859	340,235	340,235	340,235	340,235	340,235

Note(s): (1) Excludes firms with outlier ratios, top 2% of importers and top 2% of exporters. Businesses with export intensity greater than 110% or import intensity greater than 200% are excluded on comparability grounds (2) Results are weighted by employment and sample weights. (3) Variables prefixed with i are binary indicator variables, or interactions thereof. (4) t statistics omitted, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To explain these effects, specifications (5) and (6) provide some initial evidence on whether these measures of trade intensity are non-linear in their impact on productivity (specification 5) or vary by geography (specification 6). Specification (5) provides some evidence that the link between productivity and export intensity is non-linear: These coefficients suggest that exporters are more productive than non-exporters, and that the total exporter premium is largest at the extreme ends of the export intensity distribution. No conclusive evidence of a non-linear trend in import intensity is presented in specification (5).

There is also some evidence that the link between productivity and trade intensity varies by geographical market (specification 6). This analysis presents the coefficients on the extensive and intensive margins for EU and non-EU trade respectively. As before, the linear effect of export intensity is negative – now for both EU and non-EU export intensity – and as in specification (5), the linear effects of import intensity are positive – although evidence of this is stronger for the EU than the non-EU. The nonlinearity in export intensity identified in specification (5) is also traced to non-EU trade. Combined, these coefficients suggest that labour productivity is increasing in import intensity in both markets and falls with export intensity, although the form and size of these effects suggests that the link between this intensive margin and productivity is not straightforward.

The second intensive margin that we examine is the number of products traded. We find a positive association between the total number of products exported to global markets and labour productivity, but we find the converse for import varieties: larger numbers of products imported is negatively associated with labour productivity (Table 13). These effects are attenuated by the inclusion of year, industry and ownership fixed effects, but remain significant in specification (4), in which each additional exported product category is associated with a 0.1% increase in labour productivity. Each additional product category imported is associated with a 0.15% fall in labour productivity in the same specification.

These effects also appear to vary across markets. The number of product categories traded is further split into their EU and non-EU equivalents in specification (5). These results suggest that the exports intensive margin is strongest for non-EU exports: each additional product category traded with non-EU nations is associated with a 0.17% increase in labour productivity, while there is no significant relationship between the number of products exported to the EU and labour productivity. For imports, there is little difference between the effects from number of product categories imported between the EU and non-EU. As before, these effects are joined by a large, positive and significant coefficient on the extensive margin terms. These effects need further research, but may indicate that quite different product types are being traded with these markets, which affect labour productivity to different extents.

Table 13: Labour productivity and the number of products traded, ABS basis

	(1) ln(prod)	(2) ln(prod)	(3) ln(prod)	(4) ln(prod)	(5) ln(prod)
i.Exp	0.36***	0.24***	0.22***	0.21***	
	(56.8)	(40.7)	(35.3)	(34.2)	
Ex com. groups	0.0012***	0.00095***	0.0010***	0.0011***	
	(8.43)	(6.99)	(7.48)	(7.77)	
i.Imp	0.28***	0.28***	0.23***	0.21***	
	(46.7)	(50.0)	(38.4)	(35.2)	
Im com. groups	-0.0026***	-0.0011***	-0.0014***	-0.0015***	
	(-20.4)	(-8.97)	(-11.4)	(-12.4)	
i.Exp-EU					0.037***
					(4.76)
Ex com. EU					0.0002
					(1.07)
i.Exp-non-EU					0.19***
					(29.8)
Ex com. non-EU					0.0017***
					(8.14)
i.Imp-EU					0.062***
					(8.23)
Im com. EU					-0.0016***
					(-9.88)
i.Imp-Non-EU					0.19***
					(31.1)
Im com. non-EU					-0.0017***
					(-6.90)
ln(Emp)			0.022***	0.018***	0.019***
			(25.7)	(21.2)	(22.5)
Year F.E.	No	Yes	Yes	Yes	Yes
Industry F.E.	No	Yes	Yes	Yes	Yes
Ownership F.E.	No	No	No	Yes	Yes
Adjusted R2	0.049	0.202	0.203	0.205	0.205
N	369,807	369,041	369,041	369,041	369,041

Note(s): (1) Excludes the top 2% of exporters and the top 2% of importers. (2) Results are weighted by employment and sample selection and grossing weights (3) Ownership fixed effects are for five categories of country of ultimate ownership, see table 10. (4) Variables prefixed with i are binary indicator variables, or interactions thereof. (5) t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Analysis of the third intensive margin we investigate – the number of trading partners – tends to confirm this conclusion. Table 14 shows the results of regressions of labour productivity on both trader status as well as the number of nations exported to and imported from. These results suggest businesses which export to more countries have higher productivity, even after controlling for their trader status (specification 4). Each additional export destination is associated with a 0.2% increase in labour productivity, although no significant impact of the number of source nations is detected in this analysis. Specification 5 – which disaggregates by EU and non-EU trading partners – suggests that much of the power of the exporting effect comes from EU trade. Each additional EU export

destination is associated with a 0.4% increase in labour productivity, where no significant effect can be detected for non-EU nations. Additional import partners in the EU (non-EU) are associated with marginally lower (higher) productivity. These intensive margin effects – particularly for EU exports – attenuate the extensive margin more than the other intensive margins.

Table 14: Labour productivity and number of partner countries, ABS basis

	(1) ln(prod)	(2) ln(prod)	(3) ln(prod)	(4) ln(prod)	(5) ln(prod)
i.Exp	0.32***	0.22***	0.19***	0.19***	
	(49.1)	(36.2)	(31.2)	(30.2)	
Ex countries	0.0026***	0.0017***	0.0019***	0.0019***	
	(10.9)	(7.47)	(8.61)	(8.68)	
i.Imp	0.25***	0.26***	0.21***	0.19***	
	(41.1)	(46.2)	(35.7)	(32.6)	
Im countries	-0.0005	0.0018***	0.0006	0.0003	
	(-1.17)	(4.36)	(1.45)	(0.82)	
i.Exp-EU					-0.0082
					(-0.88)
Ex countries EU					0.0037***
					(5.23)
i.Exp-non-EU					0.18***
					(28.9)
Ex countries non-EU					0.0002
					(0.47)
i.Imp-EU					0.046***
					(5.28)
Im countries EU					-0.0069***
					(-6.76)
i.Imp-non-EU					0.17***
					(28.1)
Im countries non-EU					0.0060***
					(7.50)
ln(Emp)			0.020***	0.017***	0.018***
			(23.8)	(19.4)	(21.8)
Year F.E.	No	Yes	Yes	Yes	Yes
Industry F.E.	No	Yes	Yes	Yes	Yes
Ownership F.E.	No	No	No	Yes	Yes
Adjusted R2	0.049	0.202	0.203	0.205	0.205
N	369,807	369,041	369,041	369,041	369,041

Note(s): (1) Excludes the top 2% of exporters and the top 2% of importers. (2) Results are weighted by employment and sample selection and grossing weights (3) Ownership fixed effects are for five categories of country of ultimate ownership, see table 10. (4) Variables prefixed with i are binary indicator variables, or interactions thereof. (5) t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Finally, to examine the relative importance of the extensive and intensive margins, we regress labour productivity on binary indicators of export status, as well as the variables which capture trade dependence, the number of products traded and the number of markets served, as well as our array of

other business characteristics (Table 15). These results show consistency across specifications – apart from the effect of the number of source countries – in terms of both their size and their sign. The number of different country-product combinations for both exports and imports are also found to be significant, although of an order of magnitude smaller in size. These results suggest that the extensive margins – whether a business is an importer or an exporter – have the largest quantitative association with labour productivity. However, there are variations in the productivity of trading businesses which also appear to be related to measures of trade dependence, geographical reach and the range of products traded.

Table 15: Combinations, ABS basis

	(1) ln(prod)	(2) ln(prod)	(3) ln(prod)	(4) ln(prod)	(5) ln(prod)
iExp	0.20***	0.21***	0.19***	0.20***	0.20***
	(36.6)	(37.0)	(33.3)	(35.0)	(34.1)
Exp./turn.	-0.21***	-0.50***	-0.79***	-0.79***	-0.79***
	(-8.62)	(-7.99)	(-12.0)	(-12.0)	(-12.0)
Exp./turn. ^2		0.44***	0.70***	0.69***	0.69***
		(5.21)	(8.10)	(8.05)	(8.07)
iImp	0.18***	0.19***	0.19***	0.19***	0.19***
	(32.7)	(32.5)	(32.1)	(33.3)	(32.8)
Imp./int.con.	0.21***	0.17***	0.16***	0.20***	0.20***
	(13.8)	(5.20)	(4.68)	(5.91)	(6.00)
Imp./int.con ^2		0.049	0.062*	0.041	0.040
		(1.69)	(2.14)	(1.42)	(1.37)
Ex countries			0.0030***	0.0023***	0.0026***
			(13.6)	(9.61)	(10.4)
Im countries			-0.0009*	0.0038***	0.0036***
			(-2.34)	(8.43)	(6.51)
Ex com. groups				0.0004**	0.0009***
				(3.27)	(5.04)
Im com. groups				-0.0026***	-0.0028***
				(-19.7)	(-17.4)
Ex country X com.					-0.0001***
					(-4.06)
Im country X com.					0.0001
					(1.95)
ln(Emp.)	0.013***	0.012***	0.011***	0.012***	0.012***
	(15.4)	(14.8)	(13.0)	(14.0)	(14.0)
Year F.E.	Yes	Yes	Yes	Yes	Yes
Industry F.E.	Yes	Yes	Yes	Yes	Yes
Ownership F.E.	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.24	0.24	0.25	0.25	0.25
N	340,235	340,235	340,235	340,235	340,235

Note(s): (1) Excludes firms with outlier ratios, top 2% of importers and top 2% of exporters. Businesses with export intensity greater than 110% or import intensity greater than 200% are excluded on comparability grounds (2) Results are weighted by

employment and sample weights. (3) Variables prefixed with i are binary indicator variables, or interactions thereof. (4) t statistics omitted, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6 Limitations

The results presented in this paper depend on several new data sources and methods, which impose some limitations on our analysis. This section presents the most significant of these, grouped under three headings: data, methods and analysis.

6.1 Data

Firstly, the data used in this paper impose some constraints and limitations on our work. Some of these constraints are familiar from earlier ONS work on productivity (ONS 2016, 2017a, 2017b, 2017c, 2017d, 2018) and include the timeliness and relevance of the firm-level employment estimates for micro-data analysis as well as the industrial and geographical coverage of our ABS data. Sample size restrictions also prevent analysis by very detailed industries, which in principle the HMRC trade in goods data can support. To alleviate these issues and to provide more detailed analysis, ONS intends to make use of data collected for VAT purposes alongside these trade in goods declarations in future work.

The use of trade in goods transactions data from HMRC also imposes some limitations on our work, the impact of which is difficult to quantify. While this dataset offers a very detailed picture of trade in goods, changes in the Intrastat survey eligibility threshold – in particular for imports – complicate analysis of changes in trading behaviour through time. As set out above, it is difficult to establish the extent to which changes in prevalence of trading behaviours reflect changes in economic conditions or changes in these thresholds. The lack of a comprehensive picture of below threshold trade with the EU in particular also imposes some challenges for our work – missing out transactions of a select group of businesses. Future, more comprehensive deliveries of data from HMRC's VAT system may enable the impact changes in the Intrastat thresholds to be quantified, however, at present it is difficult to say how much of an impact this has on the results of our analysis.

Thirdly, using combinations of administrative and survey data inevitably highlights inconsistencies which must be handled with care. As set out in the Appendix, we have sought to triangulate our estimates of trade against estimates drawn from the few survey sources which collect data on trade in goods. These suggest a reasonable degree of alignment between sources, but also highlight some inconsistencies. ONS continues to work to understand these differences. Here, we have sought to modify our approach to ensure they do not bias our results, and have taken steps to remove the largest inconsistencies from our analysis.

6.2 **Methods**

The main contribution of this paper is an experimental set of trade in goods data at the reporting unit level, combining information from HMRC and the Inter-Departmental Business Register (IDBR). This rests on several detailed assumptions which are set out in the appendix. Among these, the use of trade intensity data from simple businesses on an industry-by-product basis to divide trade among the reporting units of complex businesses is an important innovation. The extent to which this assumption holds is difficult to establish – although it appears a conceptually better method than simply using employment shares. However, if simple businesses in a given industry use traded products with different intensities to equivalent units within large complex businesses, then the basis for our apportionment may be inaccurate. Quantifying this effect is not possible at present.

Secondly, the ABS data on which our productivity analysis depends is collected in a survey which is stratified to deliver estimates by industry, size and region which reflect the UK's business population. The weights consequently do not take trader status into account. As a result, the prevalence of different forms of trading behaviour are likely to differ across our business-register based estimates and those implied by our analysis of ABS. Future work may consider producing an adjusted set of weights for the ABS which account for trader status, which would eliminate some of these effects.

6.3 **Analysis**

The analysis presented here is limited by the nature of the data collected. Perhaps the key limitation on our analysis is in the direct nature of the trade in goods transactions which are collected by HMRC. These data capture, for example, the import of an intermediate good by one company, but do not capture the onwards purchases of the good to UK households or businesses. This is most obvious in the data for the Wholesale & Retail industry, which appears to act as gateway industry for goods coming into and leaving the UK. As a consequence, the data presented here do not capture the 'final' dependence of particular industries on trade: instead, they capture the extent of direct trading of businesses in different industries. Capturing these secondary flows at the business level is a considerable challenge, and beyond our capability at present.

The absence of business-level prices also prevents analysis of how the productivity of trading and non-trading businesses has changed over time. Examination of real productivity growth requires price indices which can deflate industry level output. These are typically constructed using domestic and export prices for the products produced by an industry: weighting these together to deliver an average industry-level deflator. As businesses vary in their export intensity, an ideal firm-level deflator would

vary across businesses with the share of domestic and export sales. This is an area for future work: in this paper we limit ourselves to cross-sectional analysis of the levels of productivity at trading and non-trading businesses, rather than changes through time.

Finally, the results presented here are silent on the matter of causation. Specifically, it cannot be established from these results whether businesses which trade are more productive because they trade, or whether more productive business are more likely to trade. In the literature on this matter, there is considerably more evidence that more productive businesses choose to enter international markets. Evidence of the 'learning through trade' channel – which posits that businesses become more productive as a consequence of exposure to international markets – is scarcer. Establishing the relative importance of these different effects we leave to future work.

7 Conclusions and discussion

Despite a large international literature on the relationship between firm-level trading behaviour and business performance (see Wagner 2007, 2012 for surveys), evidence on this link for the UK has been hampered by long-standing data issues. This paper addresses this data gap: developing a dataset which combines information from the ONS' Annual Business Survey (ABS), the Inter-Departmental Business Register (IDBR) and HMRC's trade in goods trade in goods declarations.

As set out above, the linking of these datasets is not straightforward, hampered by differences in the units for which data are collected by statistical surveys and for administrative purposes. Building on ONS' recent efforts to improve trade in goods statistics and drawing on methods used by ONS to incorporate VAT data in the UK's National Accounts, we devise and implement a strategy which apportions the trade reported by a business' VAT units to its reporting unit structure. For a majority of businesses, this is a simple aggregation exercise. For more complex businesses – responsible for a large proportion of UK business turnover, employment and trade – this involves more difficult apportionment work between their VAT entities and their reporting unit structures.

While the resulting datasets have their limitations, to our knowledge this is the first time that data on financial performance and transaction level trade in goods data have been combined in a large sample capable of delivering representative analysis for the UK economy. At the aggregate level, the trends evidenced in these data closely match those published by ONS on a Balance of Payments basis, both in total and in their composition. At the business level, the data show a reasonable correspondence with the few other sources of data which are available on trade in goods. In particular, the process matches a large fraction of trade to businesses which report being traders in the ABS. The levels of estimated trade also match fairly closely on average with estimates of trade provided as part of the Monthly Business Survey.

We apply this dataset to two contemporary policy debates. Firstly, in view of the UK's decision to leave the European Union and wider debates regarding trade policy, we document the prevalence of different forms of trading behaviour for different types of businesses. We examine the value of trade in goods for different industries, the average number of products traded and the geographical reach of UK trade in goods, as well as the degree of concentration of trade in goods flows among businesses.

The results of this analysis show that large businesses and those which are foreign-owned are most likely to trade goods directly. Among businesses with more than 10 employees, only around one-in-five firms report trade in goods to HMRC, but trading businesses accounted for around 40% of all employment in 2016. Most trade in goods is undertaken by the Manufacturing industry – which

exported (imported) goods worth almost £150bn (£112bn) in 2016 – and the Wholesale & Retail industry – which exported (imported) goods worth £84bn (£222bn) over the same period. Large businesses in the Wholesale & Retail industry also appear to have some of the most complex trading arrangements with the EU. Our analysis also suggests that trade in goods is strikingly concentrated: 38% of the value of UK goods exports was accounted for by the top 50 exporters in 2016, while the top 50 importers accounted for 34% of the value of imports over the same period.

Secondly, we examine the link between business-level productivity and trade in goods behaviour. We draw on recent ONS analysis to examine the drivers of productivity at the micro-level (ONS 2016, 2017a, 2017b, 2017c, 2017d, 2018) – seeking to explain differences in labour productivity across businesses in relation to their trade in goods behaviour. We examine the link between productivity and trade at the extensive margin – whether a business trades or not – and the intensive margin – how much a business trades – using data for a large sample of business' in the non-financial business economy in Great Britain.

Our analysis suggests that the productivity of UK businesses which declare international trade in goods was around 70% higher on average than for businesses which did not in 2016. After controlling for their size, industry and foreign ownership status, businesses which declare goods exports and imports have labour productivity premia relative to non-traders of around 21% and 20% respectively. These extensive margin effects also appear to vary by geography: the labour productivity premia associated with EU trade (4.3% and 1.7% for EU exports and imports respectively) are notably smaller than those associated with non-EU trade (19% and 18% for exports and imports respectively). These results may reflect differences in reporting thresholds, but are consistent with lower barriers to EU goods trade enabling relatively less productive businesses to access these markets, while only a considerable productivity advantage enables access to wider markets with varying goods trade regulations.

Our analysis of the link between labour productivity and the intensive margin – how much a business trades, how many products, and with how many markets – suggests a highly varied picture. Businesses which source a large proportion of their inputs abroad, which export more products (particularly to non-EU nations), or which export to more countries (particularly within the EU) tend to be more productive than traders which have less internationalised supply chains, which export fewer products and which have a more limited geographical reach within the EU. However, these initial findings suggest that how much a business trades can have quite a complicated relationship with their productivity, and will be subject of future work.

The characteristics of these data and the nature of this analysis places some limits on our work. In particular, our results are not causal: they cannot say whether these businesses are more productive because they trade or whether they trade because they are more productive. Secondly, they cannot take account of indirect traded content – where a wholesaler acts as an intermediary, exporting or importing content purchased in other industries. As a result, it is difficult to say exactly how 'dependent' any specific industry is on traded goods, as the role of wholesalers is considerable. Thirdly, we cannot say anything meaningful about dynamic effects using these results: in particular, we avoid estimating rates of productivity growth for non-traders and traders, as this requires firm-level pricing information which is not yet available. Finally, the relative reporting thresholds for Intrastat and non-EU trade should be carefully considered. Despite these limitations, the results provide a detailed picture of the types of businesses which engage directly in trade, they highlight the important role of intermediation, and they give a sense of which businesses are most likely to be affected by future changes in the UK's trading relationships.

The development of these data creates the potential for a wide range of analytical applications. ONS is actively pursuing several themes using these data. In particular, we are developing a production system that will support regular updates on detailed statistics on trade in goods by industry, product and destination. We are also exploring the product dimension of these data – examining the extent to which different industries depend on different products for their export turnover – and combining this information with the data supplied by businesses on their VAT forms, so as to produce a more holistic range of information on trade intensity by industry. A natural extension of this work is to include information on trade in services in our analysis, to identify the association between productivity and trade as a whole. We are also interested in the striking differences in productivity associated with trading in different markets, and we plan to further examine the role of the reporting thresholds in determining this result. Finally, we are also interested in the dynamic effects of trade, and better understanding how aggregate productivity growth has evolved for non-traders and traders respectively over the past decade. For this, a set of firm-level deflators which reflects the varying trade intensity of each business is required, which will need more work. These areas will be the subject of further analysis and research.

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Appendix

A1 Methods

This appendix provides a detailed exposition of the methods we use to link data on trade in goods – which is provided for VAT units – to data on productivity – which ONS holds for reporting units.

A1.1 Background

As set out in Section 3, information on UK businesses is collected using a range of reference numbers or identifiers. For instance, when a business registers with HMRC for VAT purposes, it is issued with a unique VAT number. Similarly, businesses that run a Pay As You Earn (PAYE) payroll tax scheme are issued with a PAYE registration number. These administrative identifiers determine whether a business appears on the UK's business register: the Inter-Departmental Business Register (IDBR). Specifically, any business with either a VAT or PAYE registration number will appear on the IDBR: other businesses – typically smaller businesses – do not appear.

Once on the IDBR, ONS carries out several processes. Firstly, a matching procedure is applied to link together identifiers for the same business. VAT and PAYE reference numbers – as well as Companies House identifiers – are linked together around a core 'Enterprise' – defined as a unit which enjoys a high degree of autonomy. Secondly, a new Enterprise goes through a 'proving' process and is surveyed about its structure. At this stage, several additional units are created to enable information to be collected about the business: ONS creates a set of 'Local units' for each business – which map the geographical locations of the business' premises – and one or more 'Reporting Units' – which are constructs designed to gather information at the lowest level of granularity for which the company can provide consistent information.

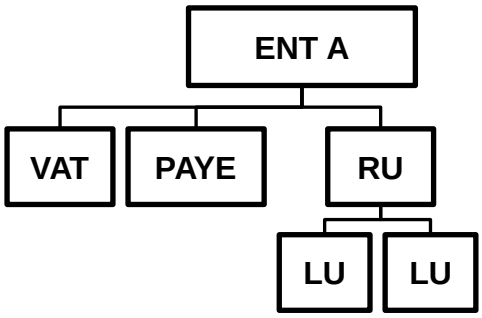
Most UK businesses are straightforward. They have a single set of administrative markers – a single VAT number, a single PAYE scheme number and a single Companies House number – and the units that ONS creates for these businesses are similarly simple. Most companies have a single reporting unit covering all their activities, although they may have one or more site. However, while these simple businesses account for practically all enterprises numerically, they account for a considerably smaller proportion of activity. The largest businesses are complex. Businesses with more than one reporting unit accounted for around 46% of IDBR employment in 2016, for instance.

A1.2 **The challenge**

The key challenge in this work is linking data on trade in goods – which is supplied on a VAT unit level – with information on productivity – which is collected on a reporting unit basis. For simple businesses – such as those in the panel A of Figure A1 – this is trivial: as this enterprise has only one VAT unit and one reporting unit, all the trade reported by the VAT unit must accrue to the reporting unit[27]. However, in a business like that in panel B – where a single VAT unit corresponds to more than one reporting unit – it is unclear which of these reporting units has been involved in the trade. Equivalently, in Panel C, it is unclear which of the three reporting units is involved in the trades reported by the two VAT units within this Enterprise Group. In these cases, we use an apportionment methodology to estimate the value of trade undertaken by each reporting unit, for analysis with productivity[28].

Figure A1: Relational information on the IDBR

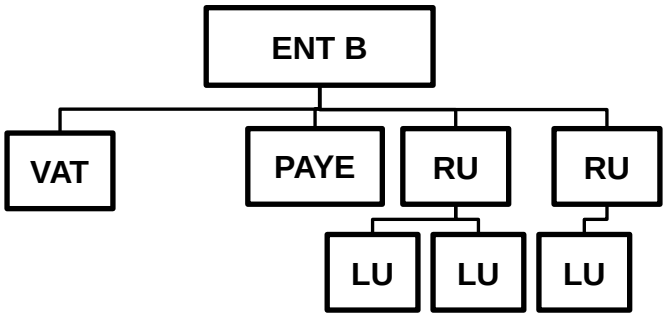
Panel A: 'Simple' businesses



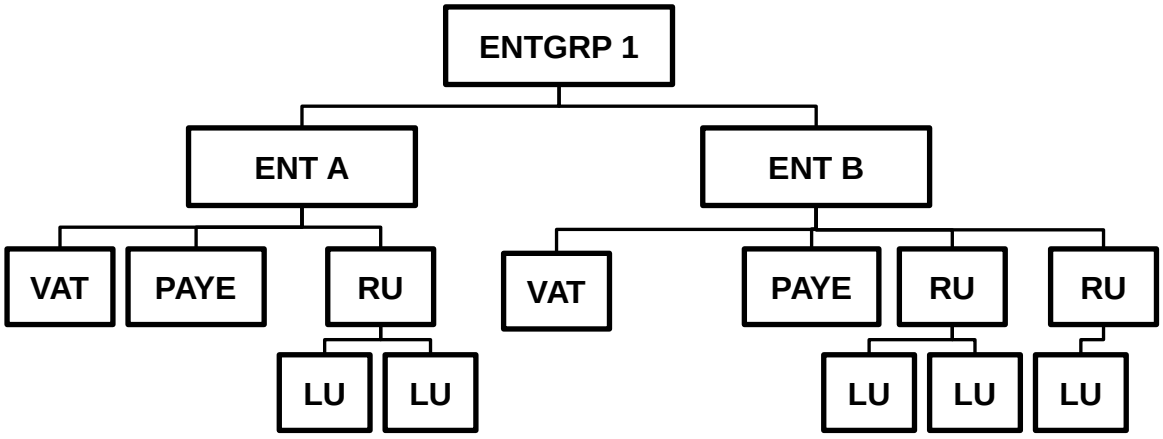
[27] The key feature here is that the Enterprise has a single reporting unit. If an Enterprise has several VAT numbers, but only a single reporting unit, we can assert that the trades carried out by any of the VAT units accrue to the single reporting unit.

[28] A natural alternative to our approach is to aggregate the data to the Enterprise- or Enterprise-Group level and conduct the analysis at this level of the corporate hierarchy instead. Arguably, this would reduce the measurement error induced through the apportionment mechanisms we adopt. However, four considerations encouraged us to adopt the apportionment approach. Firstly, while trade data might safely be aggregated to the Enterprise level, the variables required for productivity could not be so easily aggregated – in particular where not all the reporting units of an Enterprise were sampled by the ABS. Secondly, the underlying motivation for the reporting unit structure is to collect data for distinct types of economic activity, which would be lost in aggregation. Thirdly, many other ONS surveys are targeted at the Reporting Unit level, and consequently our new dataset can be matched with these quite simply. Fourthly, the data we use to triangulate our results is available at the reporting unit level. We choose to aggregate to the Enterprise Group level before apportioning to reporting units as inspection of the data suggested that some complex businesses may report all their trade through a single VAT unit – regardless of whether the trade originates from a reporting unit in one Enterprise or another. Sensitivity checks on both these issues – apportionment to reporting units and from enterprise groups – suggests this makes little overall difference to our results. Finally, we choose not to conduct the analysis at the VAT unit level for two reasons. Firstly, we do not have access to both turnover and purchases data by VAT units prior to 2011. Secondly and more substantively, the measure of purchases recorded in the VAT data comprises both intermediate consumption and capital spending. This means that estimates of value added from VAT returns are depressed, and that labour productivity estimates, in turn, would be depressed as well.

Panel B: 'Complex' businesses



Panel C: 'Highly Complex' businesses



Source(s): ONS

A1.3 **Linkage**

To produce estimates of trade in goods at the reporting unit level, we first link the trade in goods transactions data to the Inter-Departmental Business Register (IDBR) using the VAT number recorded in these data. This links the trade in goods records with the other reference numbers that identify a business (see Figure A1). The match rates between these datasets are good, indicating that we can link around 91.3% of the value of goods exports and 92.2% of goods imports to specific companies on the IDBR on average over the period (Figure A2)[29].

[29] A similarly high match rate is achieved on an observation basis – indicating that we can match a high proportion of the transactions data by count and by value.

Figure A2: Proportion of trade by value which can be mapped to at least one IDBR unit

Source(s): HMRC, ONS, authors calculations
Note(s): These match rates are close to those achieved by HMRC in the matching work that supports their Trade by Business characteristics release.

There are several reasons why a proportion of trade in goods cannot be mapped directly to an enterprise on the IDBR. Firstly, data on trade in commodities such as gas and electricity are gathered from administrative sources rather than trade in goods declarations and are not linked to specific businesses. Secondly, some trade is undertaken by businesses which are not registered for VAT purposes. This group accounts for the largest non-matched proportion of trade in recent years[30]. Thirdly, some trades are reported by foreign companies registered for VAT in another EU country, using an Economic Operator Registration and Identification (EORI) number, rather than a VAT number. These we label as foreign VATREFs. In all these cases, the absence of a standard VAT number means there is no way of linking these observations to the IDBR. The remaining unmatched trade is largely accounted for by trade in goods declarations which contain unusual VAT reference numbers – often shorter than the standard length – which also cannot be matched. Excluding trade undertaken by VAT unregistered and foreign businesses, and excluding administratively entered records, this process succeeds in linking 98.5% of exports and 98.2% of imports by value.

[30] We assume that these are the trades of small businesses. We make no attempt here to impute the value of these trades to small businesses: while it is possible that these businesses feature on the IDBR, they are unlikely to account for a large proportion of UK trade. We leave this for future work – which, with greater access to the VAT returns of UK businesses, will be able to be more precise regarding the trading patterns of very small businesses

A1.4 **Apportionment**

Having linked the trade in goods transactions of VAT units to the IDBR, our next steps are to aggregate trade to the enterprise or enterprise group level, and then to apportion the value of those trades across their constituent reporting units. In most cases, this is a simple aggregation exercise. Where a business has a single reporting unit, the trade of their VAT unit(s) is combined and attributed to their reporting unit. Precisely, the exports (E) and imports (I) of a VAT unit (V) are equal to the exports and imports of the reporting unit (R) – where i, p and t index industries, products and time respectively, and where v and r index the VAT and reporting units within an Enterprise.

Table A1: Simple firm apportionment:

$$\sum_{v} E^{V}_{p,t} = \sum_{r} E^{R}_{i,p,t} \equiv E^{R}_{i,p,t}$$

$$\sum_{v} I^{V}_{p,t} = \sum_{r} I^{R}_{i,p,t} \equiv I^{R}_{i,p,t}$$

The apportionment process is more complicated where a VAT unit is linked to an enterprise which has more than one reporting unit. In these cases, we draw on information about the reporting units linked to an enterprise (including their industry and employment) and information about the product being traded to design three alternative approaches to the apportionment of a trade flow within a business[31]. These are summarised in Table A2 below. As these mechanisms are equivalent for imports, we record only the export approaches.

Our first apportionment mechanism divides the total value of trade undertaken by the VAT units of an Enterprise group among its constituent reporting units in proportion to their employment (W). Reporting units which account for a larger share of Enterprise Group employment consequently account for a larger proportion of their trade[32].

[31] In this work, we draw on existing rules established in ONS' recent work on incorporating VAT into the National Accounts.

[32] This approach is consistent with the current set of rules for dividing out turnover recorded by HMRC's VAT system among constituent reporting units for the purposes of National Accounts.

Table A2: Export apportionment mechanisms for complex businesses

Employment	$E^R_{i,p,t} = \sum_v E^V_{p,t} \cdot \frac{W^R_{i,t}}{\sum_r W^R_{i,t}}$	Exports allocated across an Enterprise Group's RUs in proportion to employment in those RUs
Mean Exports per head by product and industry:	$E^R_{i,p,t} = \sum_v E^V_{p,t} \cdot \frac{\hat{e}_{i,p,t} . W^R_{i,p,t}}{\sum_r \hat{e}_{i,p,t} . W^R_{i,p,t}}$ $\hat{e}_{i,p,t} = \frac{\sum_{R,s} E^R_{i,p,t}}{\sum_{R,s} W^R_{i,t}}$	Exports are allocated across RUREFs based on (a) employment in each RUREF, weighted by (b) the mean exports per head in simple firms by RUREF industry.
Median Exports per head by industry	$E^R_{i,p,t} = \sum_v E^V_{p,t} \cdot \frac{\tilde{e}_{i,p,t} . W^R_{i,p,t}}{\sum_r \tilde{e}_{i,p,t} . W^R_{i,p,t}}$ $\tilde{e}_{i,p,t} = median \left[\frac{E^{R,s}_{i,p,t}}{W^{R,s}_{i,t}} \right]$	Exports are allocated across RUREFs based on (a) employment in each RUREF, weighted by (b) the median exports per head among simple firms by RUREF industry.

While the simplicity of this approach is appealing, it has several unattractive properties. In particular, this approach implicitly assumes that exports and imports per head are constant within the complex business. This seems unlikely – particularly where an Enterprise Group comprises several different reporting units, with different industrial activity markers. The approach also makes no reference to the product being traded, ignoring a key feature of the transaction level trade data. Combined, these properties mean that high-employment reporting units absorb a large proportion of a company's trade, irrespective of whether the traded product is a close fit for the industrial activity of the reporting unit.

The second and third apportionment mechanisms attempt to address these shortcomings by constructing weights for reporting unit employment which give a sense of the intensity with which different industries trade different products. In the second apportionment mechanism, we use the subset of single ('simple') reporting units[33] to calculate mean exports and imports per head of employment[34] on an industry by product basis[35]. As mean exports and imports per head on an industry by product basis can be affected by outliers, the third apportionment mechanism uses the same data for simple businesses to calculate median exports and imports per head. Both series are smoothed using a two-year moving average, which serves to eliminate both the seasonality which is evident in

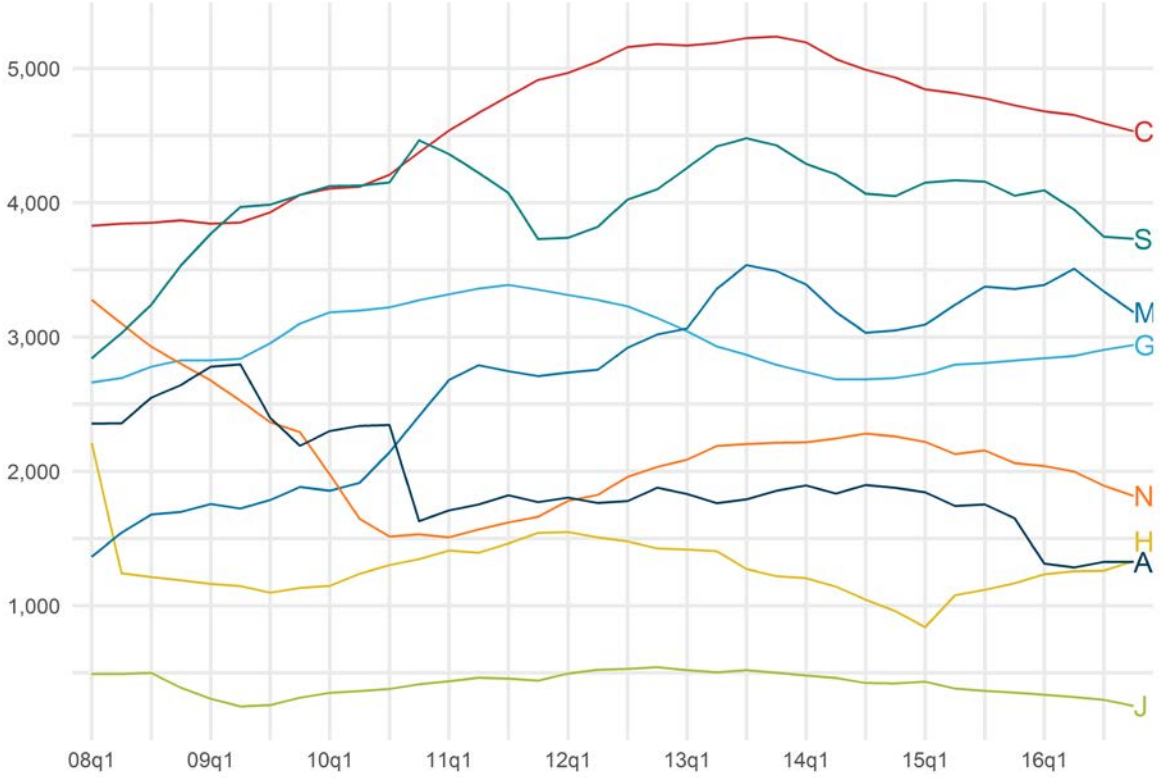
[33] In these cases, there is no ambiguity over the industry marker at the reporting unit level. These are denoted by the superscript R,s.

[34] We exclude reporting units which account for more than 5% of total trade in the product, and do not estimate for industry-product combinations where the reporting units of simple businesses account for fewer than 500 employees.

[35] We experimented with doing this at different levels of industrial and product granularity. The results of our triangulation work suggested that relatively high levels of aggregation (20 industries, 10 product categories) offered the best match with other data available.

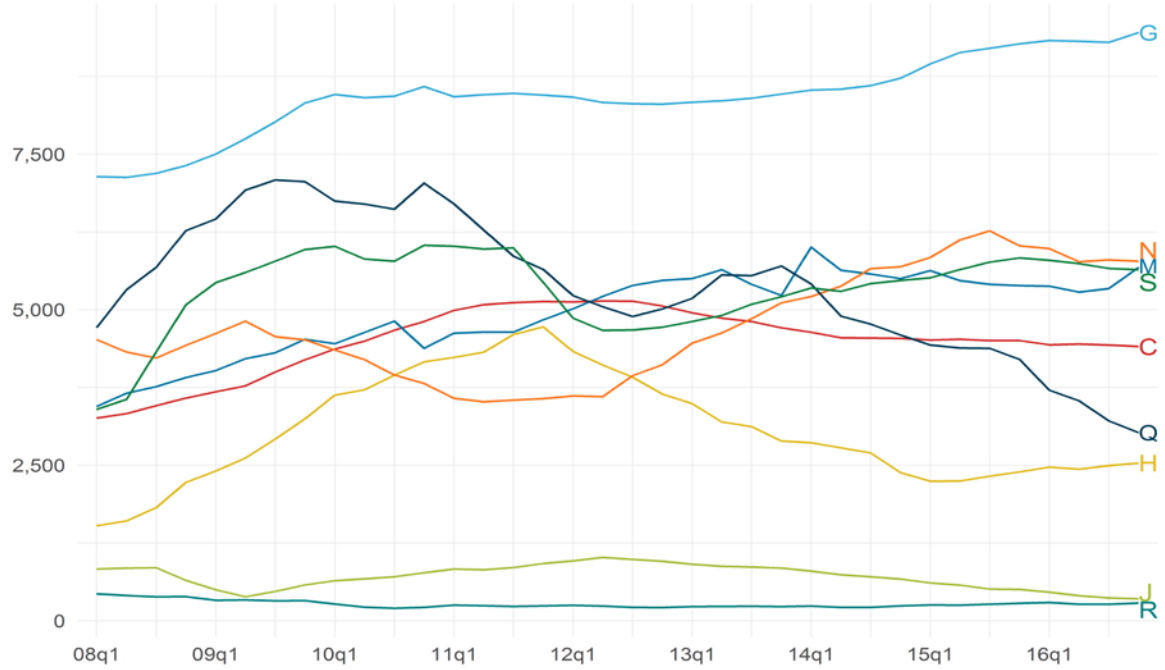
some of these series, and to reduce noise from – in some cases – relatively small sample sizes. A selection of the resulting weights are shown below. Figure A3 shows mean exports per head of material goods (including leather, glass, rubber, fabric and metal products) for single-reporting unit businesses in different industries, while Figure A4 shows the equivalent imports per head values for chemicals and related products. While it is evident from these charts that at this level of aggregation, a given product may be traded by simple firms in many industries, it is also evident that certain industries trade some products much more intensively than others (Figure A5).

Figure A3: Exports per head assumptions: SITC 6 (goods classified chiefly by materials), selected industries, 2008 to 2016



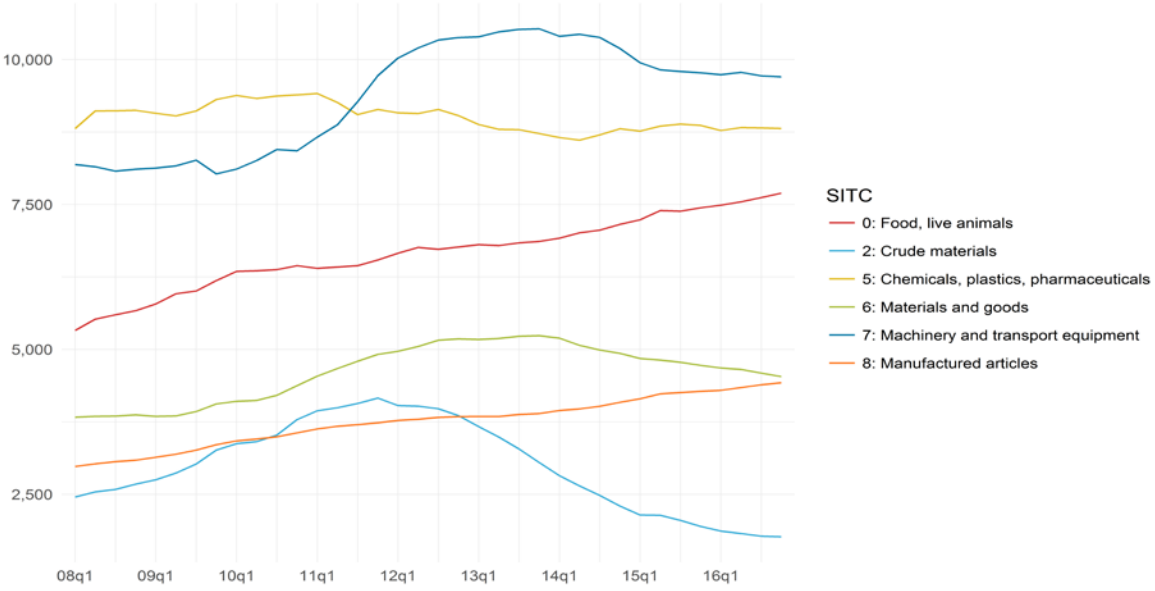
Source(s): HMRC, ONS, authors calculations

Figure A4: Imports per head assumptions: SITC 5 (chemicals and related products), selected industries, 2008 to 2016



Source(s): HMRC, ONS, authors calculations

Figure A5: Exports per head assumptions, C (manufacturing), selected products, 2008-2016



Source(s): HMRC, ONS, authors calculations

Once constructed, these exports and imports per head assumptions are used to weight employment, and in turn to calculate the share of trade accounted for by each reporting unit. This final stage is

completed in two steps: first, we eliminate any reporting units which account for less than 3% of weighted employment. Second, we recalculate the share of weighted employment in each reporting unit and allocate the value of trade accordingly.

The effect of this process is to concentrate the attribution of trade within a business to reporting units whose industry classification is more closely related to the product involved. It does not eliminate some erroneous matches, and it depends on the assumption that the exports and imports per head of simple businesses are reflective of the behaviour of complex business, but it does help to move trade towards the reporting units which are more likely to have been involved. To ensure the robustness of our results, we re-run the productivity analysis presented using all three measures and find that none of the main messages are affected.

A1.5 **Triangulation**

To assess the strength of our methods, we compared our reporting unit estimates of trade in goods with other, limited sources of information on firm-level trade. This section records the results of this triangulation work, which suggest that – at least on average – the modelling work we have undertaken provides a sensible starting point for analysis of trade and productivity.

We focus on two comparison datasets: the Annual Business Survey (ABS) and the Monthly Business Survey (MBS). While the ABS does not collect information on the value of trade in goods undertaken by businesses, it does collect binary information on whether a reporting unit is an exporter or an importer of goods. This enables us to compare our modelled trade in goods results with self-reported trader status. As the ABS has a large sample size and a wide industrial coverage, this provides a sense-check of our apportionment work, albeit using a binary marker for trade in goods. The MBS, by contrast, collects data on export turnover from businesses in the production industries. This is a stiffer test for our modelling work, as we can compare levels of apportioned trade reported to MBS with our results. However, this source has a narrower industry base and the MBS question asks for all export turnover – including both goods and services. Consequently, neither comparison is perfect, but together they provide a sense of the performance of our modelling work.

A1.5.1 **Triangulation with ABS**

Table A3 summarises the triangulation between ABS and our trade in goods declarations records for 2016. The rows of this table record whether a given reporting unit self-reports as an exporter (first panel) or an importer (second panel) in the ABS, and whether they are a single- or multiple-reporting unit business. The columns record the number of reporting units in each of these groups which have

trade in goods declarations and those which do not. If there was perfect agreement between these sources, all the weight would lie in cells which 'agree'.

Examining the single-reporting unit businesses, Table A3 suggests a fairly good correspondence between the ABS return and the trade in goods data. For the majority of businesses which report either exporting or importing in a period there are declarations in the HMRC data which confirm this status. Among simple businesses, there are also some businesses which report being traders but for whom we can identify no trade in goods declarations (possibly indicating low-value trade with the EU, which meant they were not sufficiently large to be included in the Intrastat survey). However, there are also some businesses which report not being traders, for whom there are trade in goods declarations. The reason for this discrepancy is not clear, but may be related to confusion over the target of the ABS survey or the timing of the survey and the trading behaviour. Among complex businesses – where some apportionment has taken place – we also find reasonable agreement between the ABS returns and the trade in goods declarations. However, the level of disagreement is higher here – particularly for imports – than for simple businesses. This likely reflects the imprecision of the modelling process, but suggests that the mechanism works reasonably well on average.

Table A3: Reporting unit trading status: ABS and HMRC

			Administrative data	
			No declarations	Trader
ABS response	Unique VAT reference RU link	Non-exporter	30,020	920
		Exporter	1,330	2,730
	VAT reference links to multiple RU	Non-exporter	4,390	1,940
		Exporter	270	2,630
	Unique VAT reference RU link	Non-importer	28,640	900
		Importer	2,130	3,240
	VAT reference links to multiple RU	Non-importer	3,840	1,720
		Importer	450	3,200

Source(s): HMRC, ONS, authors calculations

Information on the value of trade apportioned to each of these groups also tends to support the finding that the modelling process works reasonably well, albeit better for exports than imports. Table A4 shows the value of trade in the trade in goods declarations which are attributed to each category of reporting unit from the ABS. Among simple businesses, around 92% of total exports and around 94% of total imports are allocated to reporting units which declare they are traders on the ABS. This suggests – particularly on the exporting side – that some of the misreported non-trader status arises from businesses which do trade relatively low values. Among complex businesses, the level of success is slightly lower: around 21% of the value of exports and around 22% of the value of imports

are attributed to reporting units which report they are non-traders on the ABS. However, this suggests that in most cases and for a large majority of the value of trade, the modelling work and the ABS reach agreement.

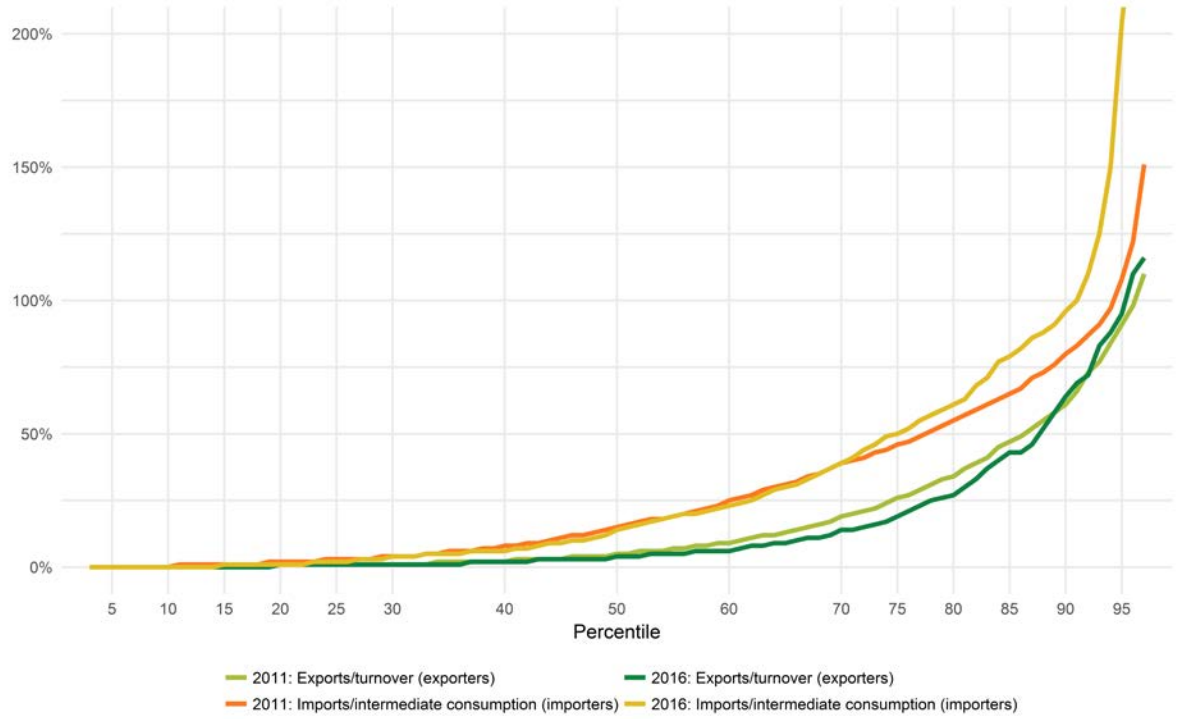
Table A4: Reporting unit trading values: ABS and HMRC

			Total value of trade (Admin)	
			£m	% of group
ABS response	Unique VAT reference RU link	Non-exporter	1,590	8%
		Exporter	17,720	92%
	VAT reference links to multiple RU	Non-exporter	25,710	21%
		Exporter	98,850	79%
	Unique VAT reference RU link	Non-importer	2,680	6%
		Importer	39,110	94%
	VAT reference links to multiple RU	Non-importer	34,750	22%
		Importer	124,200	78%

Source(s): HMRC, ONS, authors calculations

Finally, while the ABS does not contain any information on the value of trade in goods, it is possible to compare the value of trade with other information provided by businesses. Figure A6 presents the distribution of employment by two basic measures of trade intensity in 2011 and 2016: the ratio of declared exports to business-reported turnover from the ABS and the ratio of declared imports to intermediate consumption from the ABS. If the two sources were perfectly consistent, the former measure would have an upper limit of one, as no business should report more export value than turnover. For most traders, their exports to turnover ratio is well below this threshold. However, around 7% of traders report an export intensity of greater than 1 in both 2011 and 2016, indicating some apparent inconsistency between these sources. These may arise for a range of statistical reasons – such as the timing of the reporting of trade to HMRC or of turnover to ONS, because of currency conversion discrepancies, because the apportionment methods we have used are imperfect, or simply because of error on the survey returns. The ratio of imports to intermediates shows similar behaviour, although as this measure is not upwardly bounded by one – owing to the import of capital items as well as intermediates – it is more difficult to interpret these results. Two future workstreams will continue to explore these apparent inconsistencies: firstly, ONS will examine the ratio of imports to all business-level purchases (intermediates and capital items) reported on the ABS, and secondly, we will explore using the turnover data supplied to HMRC for VAT purposes to see whether this improves the consistency of the results.

Figure A6: Distribution of trader intensity, businesses reporting goods exports, businesses reporting goods imports, 2011 and 2016, ABS basis



Source(s): HMRC, ONS, authors calculations,
Note(s): (1) Excludes top and bottom 2% of these distributions. (2) Weighted by employment and sample selection and grossing weights.

A1.5.1 **Triangulation with MBS**

The second comparison source that we use to test our results is the Monthly Business Survey, which collects information on the value of exports undertaken by businesses in the production industries. No information is collected on imports, and as export turnover here comprises both goods and services, the MBS estimates offer only a partial test of our methods.

Table A5 repeats the previous analysis for the reporting units which featured in each month of the MBS in Q4 2016. As before, a majority of the reporting units fall in cells which 'agree'. Table A5 also suggests that the value of apparently mis-recorded trade in goods is relatively low: among the complex businesses, around £1.7bn of export declarations are attributed to apparent non-traders from the MBS, compared with £29bn to firms which do trade: a mis-attribution rate of 5.6%. This is higher than the same error rate among simple businesses, which is around 1.7% over the same period, but the weight of trade in goods otherwise lies in cells which agree.

Table A5: Share of businesses by trading status, MBS and HMRC, 2016 Q4

Frequency, MBS response for any month in quarter

			Administrative data	
			Non-exporter	Exporter
MBS	Unique VAT reference RU link	Non-exporter	1,246	74
		Exporter	506	1,123
	VAT reference links to multiple RU	Non-exporter	362	327
		Exporter	172	2,061

Total value according to administrative data, £m

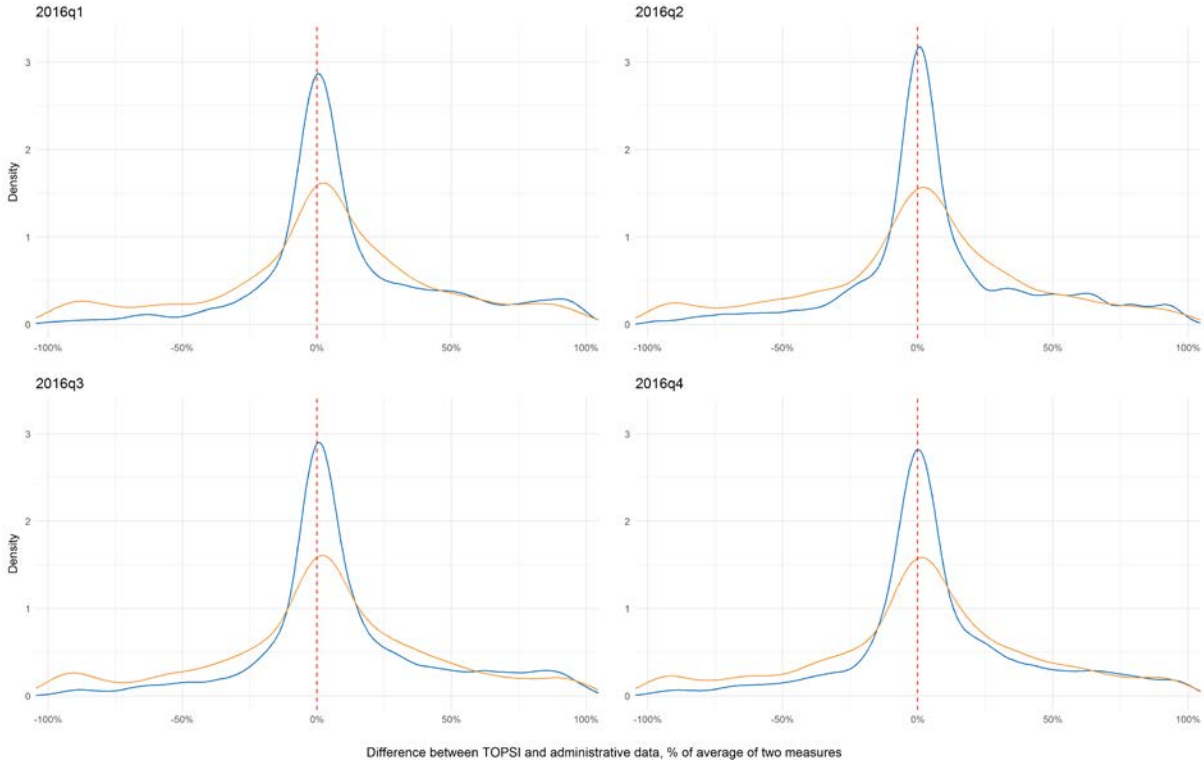
			Administrative data	
			Non-exporter	Exporter
MBS	Unique VAT reference RU link	Non-exporter	0	70
		Exporter	0	4,170
	VAT reference links to multiple RU	Non-exporter	0	1,742
		Exporter	0	29,022

Source(s): HMRC, ONS, authors calculations

Finally, to examine the levels of trade reported in the MBS with the levels reported in trade in goods declarations, we calculate the percentage difference between these quantities at the reporting unit level. The distributions of these differences in each quarter of 2016 are shown in Figure A7: if there was perfect agreement between these sources, all the observations would lie at zero; if the value of trade in goods declarations related to the business is typically higher (lower) than the value of trade reported on the MBS, then the weight will lie to the left (right) of zero.

Figure A7 – which shows the distribution of differences separately for single-reporting unit and multi-reporting unit businesses separately – indicates that the mass in both distributions is at zero, although there is some disagreement in the levels, as shown by the weight in the tails of the distribution. This agreement is stronger among single-reporting units, indicating a closer match in the levels of trade where no modelling work has been required. However, even among these businesses, there is some weight in the tails – particularly in the right-hand tail: indicating that trade reported to the MBS is typically higher than the trade in goods declarations. Among multi-reporting unit businesses, the mass of the distribution is less concentrated, but remains centred around zero. How much of the difference between these measures – particularly in the right-hand tail – is driven by the turnover of exported services being included in the MBS total is difficult to assess.

Figure A7: Exports: HMRC and MBS



Source(s): HMRC, ONS, authors calculations

A1.6 **Sensitivity analysis**

Some additional regression specifications are presented in Table A1, which provide some sensitivity analysis of our results. In particular, we assess whether our headline results are influenced by our weighting approach (specifications (1) and (2)), to the separate treatment of the Manufacturing and Wholesale & Retail industries (specifications (3) and (4)), and for potential measurement error in our estimates of trade (specifications (5) and (6)).

The analysis section presented results weighted by employment, so that the results were more representative of the economy as a whole. This is also the appropriate weighting for analysis of the impact of trade on labour productivity. However, to satisfy ourselves that this approach does not bias the results towards a positive result, specifications (1) and (2) in Table A6 remove the employment weighting, and are consequently weighted to the business population. Putting less weight on larger firms changes the relationship between trade and productivity – the binary marker has a larger effect, and the effect from the intensive margin of trade is smaller. However, the sign and significance of these effects is unchanged from our main analysis.

Specifications (3) and (4) in Table A6 show the results for different groups of industries: specifically, allowing the extensive and intensive margins to vary for the Manufacturing, Wholesale & Retail and

all other industries. The premium is lower for Manufacturing, for both imports and exports. Terms of export and import intensity are also given, to show that the shape of the intensive margins varies by industry. These additional non-linearities will be the subject of future research.

Models (5) and (6) are robustness checks on the apportionment procedure. (5) repeats the specification in (1), excluding observations for businesses with a complex IDBR structure. These are different types of businesses – large and diversified businesses are much more likely to have a complex structure – which will account for part of the differences in the parameters. Nonetheless, the direction and magnitudes of the coefficients are consistent. Model (6) checks measurement error using an instrumental variables approach. Specifically, we model reporting unit level exports and imports in a first stage using employment weighted trade apportionment as an exclusion restriction. There is little difference in any of the parameters, although the employment parameter is attenuated.

Table A6: Additional regressions, ABS 2008-2016

	(1) ln(prod)	(2) ln(prod)	(3) ln(prod)	(4) ln(prod)	(5) ln(prod)	(6) ln(prod)
	OLS	OLS	OLS	OLS	OLS	IV
i.Exp	0.20***	0.41***			0.26***	0.22***
	(36.6)	(29.4)			(31.0)	(39.0)
i.Imp	0.18***	0.33***			0.23***	0.21***
	(32.7)	(24.7)			(29.0)	(36.3)
Exp./turn.	-0.21***	-0.17***			-0.15***	-0.21***
	(-8.62)	(-3.73)			(-5.26)	(-8.75)
Imp./int.con.	0.21***	0.11***			0.25***	0.20***
	(13.8)	(4.19)			(12.7)	(12.7)
Other: i.Exp			0.21***	0.45***		
			(30.9)	(19.0)		
C: i.Exp			0.17***	0.33***		
			(11.6)	(11.4)		
G: i.Exp			0.21***	0.44***		
			(16.8)	(20.0)		
Other: i.Imp			0.20***	0.36***		
			(29.5)	(16.5)		
C: i.Imp			0.14***	0.29***		
			(9.00)	(9.61)		
G: i.Imp			0.16***	0.33***		
			(13.1)	(16.1)		
Other: exp./turn.			-0.59***	-0.47***		
			(-9.80)	(-4.83)		
C: exp./turn.			-0.11***	-0.045		
			(-3.39)	(-0.58)		
G: exp./turn.			0.012	-0.052		
			(0.22)	(-0.70)		
Other: imp./int.con.			0.16***	-0.011		
			(5.43)	(-0.20)		
C: imp./int.con.			0.19***	0.18**		
			(6.72)	(2.76)		
G: imp./int.con.			0.32***	0.14***		
			(12.7)	(3.75)		
ln(Emp.)	0.013***	-0.038***	0.012***	-0.038***	0.0027*	0.0085***
	(15.4)	(-18.7)	(14.4)	(-18.6)	(2.50)	(10.3)
Sample selection and grossing weights	Yes	Yes	Yes	Yes	Yes	Yes
Employment weights	Yes	No	Yes	No	Yes	Yes
Year, Industry, Ownership F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.24	0.09	0.24	0.09	0.20	0.24
N	340,235	340,174	340,235	340,174	268,985	339,850

Note(s): (1) Excludes firms with outlier ratios, top 2% of importers and top 2% of exporters. (2) C: Manufacturing; G: Wholesale & Retail; Other = anything else. (3) Specification 5 excludes observations where trade data is apportioned from enterprise group level; only uses observations with direct matches in administrative data. (4) Ownership fixed effects are for five categories of country of ultimate ownership, see Table 10. (5) t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A1.7 **Discussion**

The absence of a collection of trade in goods data at the reporting unit level has been a significant hindrance to comparisons of the characteristics and performance of businesses which trade and those which do not. Linking data on trade in goods – which is collected at the VAT unit level by HMRC – with data on productivity – which is only available at the reporting unit level – is the key empirical challenge of this work, and offers an analytical route around this data-gap.

In the linking and apportionment work that is carried out here, we have sought to combine the best of the survey data with the strength of the administrative data: using these sources in combination to produce defensible measures of reporting unit trade. While this modelling work will always be subject to error, and there is always room for improvement in methods, the robustness checks and triangulation reported here suggest that the estimates developed offer a sensible starting point for analysis of the link between productivity and trade in goods. Comparing our results to the ABS and MBS respectively, our process links trade in goods declarations to a large proportion of businesses who report that they are traders, and the value of trade allocated to those businesses who report not being traders is relatively low. Examining estimated levels of trade – which is difficult because of the lack of an 'ideal' comparison dataset – suggests a reasonable degree of correspondence between our modelled estimates and the reported levels of trade in the MBS.

This correspondence notwithstanding, ONS intends to continue to develop estimates of trade in goods at the reporting unit level, improving our existing methods of matching, linking and apportionment as more data becomes available. Specifically, ONS hopes to make use of information recorded on businesses VAT returns on the total value of trade in goods with the EU in the future. This information – which enables HMRC to set the reporting thresholds for the Intrastat survey – offers the chance to calculate a more precise estimate of the total value of trade in goods by smaller traders in particular. Secondly, we plan to make use of additional information about the turnover of reporting units in our future apportionment work.