

# **UK Interregional Trade Estimation: Estimates of trade between Northern Ireland, Scotland, Wales and England**

Alastair Greig, Mairi Spowage and Graeme Roy

**ESCoE Discussion Paper 2020-09**

June 2020

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## **Abstract**

In the UK, there is major economic change such as Brexit on the horizon. The impact of such change is likely to vary across UK regions. There is also a growing demand for improved regional economic analysis to help inform devolution and City Deal-type policymaking. Despite these concerns, there are no comprehensive national statistics on interregional trade in the UK. This paper fills this gap, proposing a framework for estimating interregional trade between the devolved nations of the UK: England, Scotland, Wales, and Northern Ireland. We explain where gaps exist in the current UK data landscape and suggests various ways in which these could be addressed. We then apply our framework using currently available data, presenting initial results for trade between the 4 nations of the UK in 2015. Recommendations for future work are also presented, including the need to evaluate current methods for collecting trade information within the UK.

*Keywords:* Interregional Trade Flows, Regional Supply Use Tables, Trade Surveys, Origin Destination Data

*JEL classification:* F15, F17, R12

Mairi Spowage, Fraser of Allander Institute, University of Strathclyde, [mairi.spowage@strath.ac.uk](mailto:mairi.spowage@strath.ac.uk) and Graeme Roy, Fraser of Allander Institute, University of Strathclyde, [graeme.roy@strath.ac.uk](mailto:graeme.roy@strath.ac.uk).

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**Alastair Greig\*, Mairi Spowage\*, Graeme Roy\***

**\* ESCoE, Fraser of Allander Institute, University of Strathclyde**

**June 2020**

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A workshop was held in January 2019 to discuss a set of indicative results for trade between Scotland and Northern Ireland, with ONS, the Welsh Government, the Scottish Government and NISRA. The continued advice, engagement and discussion throughout has shaped this work and been of great benefit to its quality and relevance.

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## Executive Summary

*In many respects, the UK lags behind other countries in terms of understanding how and why goods and services are moved internally. There has never been comprehensive national statistics on interregional trade and, in the past, interregional trade could have been considered a peripheral issue, or something that “would be nice to have”.*

*However, with major economic changes such as Brexit on the horizon and the growing demand for improved regional economic analysis to help inform devolution and City Deal-type policymaking, this is a key gap to fill.*

*In other respects, the UK might be considered a leader in regional economic data. The Scottish Government and Northern Ireland Statistics & Research Agency have produced trade figures with the rest of the UK for a number of years. In both cases, these products can be considered high profile, and part of comprehensive regional accounts, which help inform economic policy in those countries.*

*Neither the Scottish nor Northern Ireland data, however, sets out the nature of interregional trade in great detail. There are headline figures, by category, of external sales to the rest of the UK, but with little detail of the destination of Scottish or Northern Ireland goods or services within the UK.*

*This report proposes a framework for estimating the origin and destination of interregional trade between the devolved nations of the UK: England, Scotland, Wales, and Northern Ireland. It explains where gaps exist in the current UK data landscape, and suggests various ways in which this could be addressed.*

*The final part of the report applies that framework with current data availability, and presents initial results for trade between the 4 nations of the UK. The sensitivity of the results to different assumptions is also presented to highlight the methods.*

*Recommendations for building on the work on this paper are presented, including the need to evaluate the current methods of the collection of trade information within the UK. The conceptual and practical challenges are such that the development of a framework for the consistent collection and definition of regional trade are proposed, which would fill data gaps and increase consistency.*

*Ultimately, this could lay the framework for the estimation of Supply and Use Tables for different parts of the UK, building upon the work already done in Scotland and Northern Ireland. This is the key method through which estimates of trade which are consistent with regional consumption and production could be generated.*

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## 1. Introduction

Interregional exporting and importing are integral to any comprehensive system of regional accounts. Therefore these have significant analytical and policy interest from users around the UK. There has, however, traditionally been only limited information on interregional trade in the UK. The current data landscape reflects the asymmetric nature of UK political devolution where interregional trade statistics are only produced by the devolved governments in Scotland and Northern Ireland. In both cases, these statistics are high-profile publications and are often at the centre of much economic debate in those countries. These statistics form a key part of the economic policy making toolkit available at the regional level.

Other component parts of the UK do not currently produce estimates of interregional trade. The Welsh Government, for example, do not produce interregional trade statistics and [HMRC Regional Trade Statistics](#) (i.e. international goods exports) are used to infer the [export performance of the Welsh economy](#). This is true for all regions of England, although the Greater London Authority (GLA) has produced experimental international export figures in the past (Keijonen, 2015).

Therefore, the UK system of estimating interregional trade can be considered a patchwork. While this is partly due to devolution, the nature of regional accounting can also be seen as a contributing factor. Producing regional accounts in the UK is generally done as a regionalisation of national (UK) accounts, with the case of Northern Ireland being slightly different for historical reasons. This uses the best proxy information available in line with regional accounting manuals (e.g., Eurostat, 2013a), such as employment and other survey data. As such, any estimate at a country or regional level is generally less accurate than the equivalent UK-wide figure. This can limit the utility and reliability of data that can be extracted and reported on at a regional level.

This document discusses the feasibility of producing interregional trade estimates for the nations of the UK: Scotland, England, Wales and Northern Ireland. Existing practice is presented, alongside a summary of the current data landscape. This leads into our suggested methodology for deriving origin-destination estimates, which is applied on a sector-by-sector approach. Results are presented at a sector level for trade between the 4 nations. Where we discuss the countries of the UK, we are referring

to the four nations: Scotland, England, Northern Ireland and Wales. We also refer to regional analysis, interregional trade or regions when discussing more generic concepts of regional accounting.

In section 2, we set out the background to this work, including the research included in previously submitted ESCoE papers. This includes an assessment of the various UK and international approaches to estimating interregional trade, including data sources available.

In section 3, the methodological approach is described in detail, including the approaches taken for different sectors. In section 4, we set out the results, with the sensitivity of the results to assumptions about the presence of transport hubs being tested.

Finally, in Section 5, we discuss our findings, and provide recommendations for further work.

## 2. Background

### 2.1 Introduction

The most immediately obvious method to estimating interregional trade within the UK would be to conduct a survey of major companies across the UK and to ask what they sell to different parts of the country. While this is the methodology used in the context of international trade, the method does have several practical issues in the context of interregional trade.

Such practice, were it to be produced, would be resource intensive and would add a significant burden to business. Depending on the granularity of both geography and economic sectors, any survey would likely have to miss out on a lot of key information (particularly if firms do not know which part of the country their goods or services are being sold to).

There are also important conceptual issues with the collection of such information. While, in general a company is aware whether they are selling goods from one country to another in the case of international exports (although even this can be challenging, in the case of international service trade asymmetries (Chesson, 2018)), in the case of sales within the UK, the concept of trade is much less clear. If a company has a manufacturing arm in one nation in the UK, but a sales division in another, where is the origin of the good? Even more tricky, if electricity is generated in one nation, but it is owned and sold by a firm based in another, where is the origin? Trickier still are service sales. For a pan UK insurance company selling to customers all over the UK, the concept of interregional trade becomes very difficult to define.

At the same time, the data collected in any bespoke survey may not be immediately consistent with the existing suite of economic data and regional accounts, and the concepts that are in line with international accounting manuals. Clearly, for producers of official statistics, it is important to develop measures of interregional trade in a manner that is consistent (and flows from) a system of national and regional accounts. One of the main issues here is the concept of change of economic ownership, rather than the flow of physical goods, which was introduced with the implementation of ESA 2010 (Eurostat, 2013b).

Methodologically, we believe that it is important to integrate interregional estimates with regional production and consumption statistics. This allows for more methods, such as commodity balancing,

to be used to estimate trade flows by sector. Furthermore, regional production and consumption can be used to validate import and export statistics.

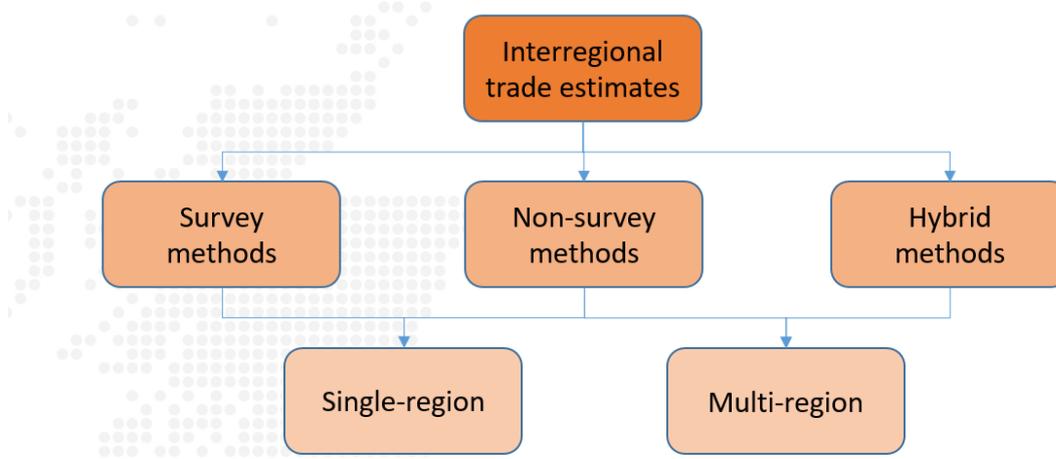
In short, estimates of regional import and export statistics from a survey may contain biases, which can be highlighted only once regional production and consumption is estimated. Overestimation of exports might be discovered by, for example, the number of exports exceeding domestic production for a given sector.

There are three key methods to producing estimates of interregional trade – as outlined in Figure 1. Hybrid methods tend to estimate a regional trade matrix through a combination of dedicated surveys and non-survey methodologies. Non-survey methods might make use of administrative data, or – more usually - using a wide array of regionalisation methods (see Szabo (2015) for an overview).

Each method can be applied on a multi-region or a single-region basis. Multi-regional estimates seek to estimate interregional trade flows between all regions in the country and ensure that each interregional table is consistent with one another (and the National Accounts as a whole).

It is possible to make single-region estimates. These, in principle, can be less concerned with consistency, particularly for external regions. There is, however, still some value in estimating UK regional trade flows in greater detail within specific parts of the UK given the policy importance attached to interregional trade flows in specific areas, and also the quality of existing data that can be used to help with the estimation process.

**Figure 1: Summary of Methodological Approaches**



## 2.2 Current International Practice

Producers of official statistics, have two main options in catering for user demand for interregional trade estimates. Two broad approaches can be seen to interregional trade estimation by national producers;

- Estimating a full set of interregional trade estimates in accordance to a standard expected from official statistics, or
- Providing the tools required so others can produce unofficial estimates.

### *Examples of official estimates of interregional trade*

The [Finnish experience](#) is interesting in-so-far as it not only produced interregional trade estimates through a comprehensive survey, but also tested the accuracy of non-survey methods. Statistics Finland estimated interregional trade flows as part of two ad-hoc projects in 1996 and 2002 in the process of producing interregional Input-Output Tables (IOTs). This was a comprehensive survey approach, and two large surveys were applied as ad-hoc projects. The first of which had a sample size of roughly 10,000. These resulted in a complete interregional trade matrix for Finnish regions.

Statistics Finland have followed their two large surveys with projects examining the application of non-survey methods (both gravity models and freight-flow). The results were used to evaluate the effectiveness of non-survey methods in estimating interregional trade in Finland. Louhela (2006)

concluded that a freight flow model “worked” for goods, but no attempt was made to capture services. The main issue this study found with using freight data to estimate goods is that it tended to overestimate trade links between neighbours. Thissen et al (2013) outlines a similar approach which accounts for this issue by using an adjustment parameter to reflect that only a fraction of goods are transported directly to their final destination without using a transport hub. This study also departs from traditional gravity model approaches which assume the data has a geographical structure.

The US Census Bureau (2016) together with the Bureau of Transport Statistics provides an example of a relatively pure survey method to estimate of interstate trade flows. The survey only offers partial coverage but still performs a fundamental role in internal trade analysis. The US Census Bureau conducts this survey every five years. Both the Finnish and American comprehensive survey approaches can be seen to develop key interregional trade parameters every few years (or on an ad-hoc basis) as a way to limit the costs and burden of such a large survey.

Statistics Canada provides complete sets of official regional accounts. This is a good example of a comprehensive hybrid approach. See Génereux P.A. & Langen B. (2002) for an overview of the methodology. Interregional trade is estimated using a “blended approach of, on one hand, survey/administrative data providing essential information on regional trade patterns and on the other hand, an economic structural accounting framework in which the trade patterns are transformed into trade flow measures consistent with regional supply (mainly production) and demand statistics” (i.e., a regional input-output (I-O) framework) (ibid, p. 6). Overall, the Canadian methodology can be seen to mitigate the cost by offering surveys for key sectors only, while relying on non-survey methods to fill in the gaps.

### *Examples of unofficial estimates of interregional trade*

There is a plethora of regionalisation exercises that take place outside of national statistical agencies (e.g., Haddad and Hewings (1998), Tobben (2015), Boero et al. (2017)). These can use varying amounts of data and can even be built entirely from consumption and production data with little or no information on relative linkages between regions. In nearly all cases, estimates on interregional trade rely almost wholly on national statistics.

The Australian Bureau of Statistics (ABS) does not produce interregional IOTs itself. The ABS instead works with a large consortium of Australian universities to create the Industrial Ecology Virtual Lab (IELab) (Lenzen et al, 2017). The IELab, essentially walks the users through the process of the building of full multi-regional IOTs at various levels of geographic disaggregation. In the UK, Gibson *et al* (2005) produced software which allows for similar automation of non-survey methods. The DREAM software has existed for some time, and is constantly adjusted based on consultation with producers of official statistics.

The USA's Commodity Flow Survey (CFS) performs a similar perfunctory role and, while offering only partial coverage, also forms a basis for others who may wish to estimate a complete set of regional accounts (Southworth, 2005). This is usually completed on an ad-hoc basis by users of the CFS. For example, Carron et al (2014) constructed a multi-regional IOT and other users utilise the CFS in interstate trade flow modelling.

### 2.3 UK Data Mapping

The UK has a considerable amount of official statistics that could be used to produce regional Supply Use Tables (SUTs) (Greig et al, 2018), shown in Table 2.

Both Northern Ireland (Buchanan, 2015) and Scotland (Scottish Government (2017)) use hybrid approaches in constructing their regional accounts, which includes SUTs, and Input-Output (I-O) analytical tables and multipliers. The data sources used are similar. Both rely on the Annual Business Survey/Inquiry, but also use UK tables and constrain some variables (e.g. value added) to ONS regional accounts estimates (such as regional GVA and income components). They also use sector and region-specific surveys where appropriate, primarily in agriculture but also in some services and transport activities. Currently, Scotland and Northern Ireland are the only parts of the UK that produce regular estimates of trade with the rest of the UK, or "RUK" as we will refer to it in the rest of this document.

An area where methodologies deviate is in the estimation of trade, and particularly interregional trade. Both Scotland and Northern Ireland conduct their own surveys to estimate international and interregional trade estimates. But there are three key differences.

Firstly, the Northern Ireland Executive can draw upon a separate Business Register for businesses in Northern Ireland, which means they know that all of the businesses they are approaching are either wholly NI based businesses, or distinct parts of wider UK businesses. For GB, the reporting units can be GB wide.

Secondly, NI collect this information as part of their statutory ABI, and therefore the response rate and quality of the information is high. The Scottish survey, the “Global Connections Survey”, has a response rate of around 25%.

Thirdly, Northern Ireland estimates imports directly, while Scotland relies on commodity balancing to infer import totals for the rest of the UK.

While Wales does not currently produce its own SUTs, many economic variables that are used in the generation of Scottish and Northern Ireland SUTs are also be available to those wishing to generate Welsh SUT. There is, however, a lack of any interregional exporting and importing data for Wales, which would have to be addressed. This is also true for most English regions of comparable size to Scotland, Wales and Northern Ireland.

Table 1 shows the current situation concerning data required for interregional trade in the UK. In most cases, however, there is room for improvement, especially in those sectors where significant manual balancing takes place (i.e., imputing data or data adjustments that are required to ensure supply-use consistency). Likewise, a great deal of sectors rely more on UK national accounts and not local estimates.

Table 1: Full data map of all data sources in a hypothetical interregional SUT for the UK

		England		Scotland		Wales		Northern Ireland		Final Demand	Exports					Total
		Products	Industries	Products	Industries	Products	Industries	Products	Industries		England	Scotland	Wales	Northern Ireland	Rest of World	
England	Products		Demand (UK Table)							Final aggregate consumption	N/A	None	None	None	HMRC / ITIS (UK estimates)	Row Total
	Industries	Supply (UK Table)														
Scotland	Products				Primarily ABS, ABS Purchaser's Inquiry, and UK Tables (Also public-sector financial accounts, ASHE and some sector-specific surveys)					HHFCe, University Accounts, Scottish Government and Public Sector Accounts, (Import Export data sources)	EES (classified as rUK)	N/A	EES (classified as rUK)	EES (classified as rUK)	EES (classified as rUK)	Row Total
	Industries			Primarily ABS, UK Tables (Also public-sector financial accounts, ASHE and some sector-specific surveys)												Row Total
Wales	Products						No official tables published			No official tables published	Last known circa 2007 (WERU)	Last known circa 2007 (WERU)	N/A	Last known circa 2007 (WERU)	HMRC / ONS	Row Total
	Industries					No official tables published										Row Total
Northern Ireland	Products								ABI, ONS Regional Accounts, UK Use Tables, HMT OSCAR Database	Living Cost & Food Survey, HHFCe, Universities Financial Statements, HMT OSCAR database, DOE Final Outturn data (Import Export data sources)	BESES (classified as rUK)	BESES (classified as rUK)	BESES (classified as rUK)	N/A	BESES (classified as rUK)	Row Total
	Industries							ABI, ONS Regional Accounts, UK Supply Table, HMT OSCAR database								Row Total
Value Added			UK Estimates		ONS Regional Accounts		Not estimated in Supply Use format		ONS Regional Accounts							
Imports	England	None		Commodity Balancing (classified as rUK)		Last known circa 2007 (WERU)		Balancing, NISRA Broad Economy Sales & Exports Stats (as rUK)		Same data sources as products						
	Scotland	None		N/A		Last known circa 2007 (WERU)		Balancing, NISRA Broad Economy Sales & Exports Stats (as rUK)		Same data sources as products						
	Wales	None		Commodity Balancing (classified as rUK)		N/A		Balancing, NISRA Broad Economy Sales & Exports Stats (as rUK)		Same data sources as products						
	Northern Ireland	None		Commodity Balancing (classified as rUK)		Last known circa 2007 (WERU)		Balancing, NISRA Broad Economy Sales & Exports Stats (as rUK)		Same data sources as products						
	Rest of World	HMRC (Goods) / ITIS (as UK)		Pre-balance estimates from RTS, IPS, and Tourist Survey		HMRC / ONS		CSO Trade Stats, HMT Regional Trade Stats, Balancing, NISRA Broad Economy Sales & Exports Stats		Same data sources as products						
Total		Column Total		Column Total		Column Total		Column Total		Column Total						

## 2.4 *Note on Welsh and English data*

Of the nations of the UK, Wales and England have the largest data gaps. Table 1, shows that no official estimates of interregional Wales-RUK or England-RUK data exists.

The Welsh Economic Research Unit (WERU) produced Input-Output tables for 2007 (Jones et al, 2010), including intermediate tables. This can be used to infer some information on the nature of Welsh-RUK trade.

Around three quarters of Welsh exports (75%) were reported to be RUK exports in 2007 using the WERU methodology, higher than the (62%) of Scottish exports for 2007. And higher than the GB share of external Northern Ireland sales (55%) in 2015<sup>1</sup>.

When it comes to interregional trade, the same issues that apply to Wales also apply to English regions. As a general rule, any English region wishing to develop official statistics probably would require a survey of interregional imports and exports, similar to the respective surveys in Scotland and Northern Ireland. Administrative data could potentially offer an alternative, but viable sources (e.g. credit card or banking data) have yet to be identified and accessed for such purposes.

Non-survey estimates of import and export origins and destinations require data that set out the origin and destinations of goods, such as freight data described below. In this regard, Wales (and English regions) have very similar data to Scotland and Northern Ireland.

## 2.5 *Origin and Destination data in the UK*

Almost any administrative UK-wide origin-destination data could be used instead of a survey to estimate the origin-destination of goods and services, provided they can offer complete coverage of the UK for a given sector. The most obvious are various forms of freight data for goods.

Despite this there are clear limitations currently in the quantity and quality of origin-destination data, particularly in terms of their ability to infer robust interregional trade statistics.

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<sup>1</sup> Note the Scottish figure did not change significantly between 2007 and 2015.

In addition, there are the issues of the compatibility of physical movements of goods with the concepts in national accounting of changes in economic ownership. It may be that further research could consider adjustments that could be made to estimates in order to make them more compatible with these concepts.

### *The Continuing Survey of Road Goods Transport (CSRGT)*

According to the Office of the Rail and Road, road (HGV) freight accounts for nearly all of freight lifted in the Great Britain (circa 90%), and accounts for three-quarters of freight moved. The CSRGT-GB has suitable (UK-wide) coverage of most goods being moved around the UK. The CSRGT-GB is a survey sampled from DVLA-registered Heavy Goods Vehicles (HGVs) operators, and stratified by vehicle size. It excludes information on Light Goods Vehicles, on HGVs registered in Northern Ireland, and the activity of HGVs operating outside of Great Britain. The full sample size for any given year is roughly 7,500 vehicles. Northern Ireland has its own survey which samples Northern-Ireland registered HGVs, in its CSRGT-NI, which is similar in scope to the CSRGT-GB.

The CSRGT, however, does not cover the full journey of goods, likewise it does not currently value the goods being moved. While HMRC lookups do exist, and are used in this paper, there are clear issues with using price multipliers to infer broad commodity classifications, and is unlikely to be representative of the true value of goods being transported on specific roads.

In order to identify any linkages between Scotland and Wales, a pooled sample, over ten years, was used. Even the ten-year pooled sample showed very little freight movement between Scotland and Wales directly.

The issue raised by Louhela where the use of freight data can lead to an overestimation of trade between neighbours is apparent in this dataset. Freight tends to move over short distances in the CSRGT, generally within regions or between contiguous ones. This is because goods may first arrive at a transport hub before being transported to their final destination. The ONS also suggests that the patterns in the data reflect a combination of long distance journeys to local distribution centres followed by short journeys to the goods' final destination. Table 2 shows that, even using a pooled sample, Scottish metal ore lifted are only detectable going as far south as Yorkshire and Humber using official CSRGT statistics. Likewise, no outbound or inbound Northern Ireland freight is detectable. The

vast majority of road freight are very short within region journeys, all of the goods lifted from Northern Ireland would appear to have an origin and destination in Northern Ireland, while the equivalent figure for Scotland is 98%. The West Midlands has the largest number of journeys outside the region. ‘Only’ 56% of goods lifted in West Midlands have a destination in the West Midlands, yet it would appear no metal ores are moved from there to the London, North East, Scotland, or Northern Ireland (four of the six regions not contiguous to the West Midlands).

**Table 2: Metal ore and quarrying: Goods lifted by origin and destination, 2007-2016: Extract from the CSRGT pooled sample, million tonnes**

Origin	Destination												United Kingdom
	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East	London	South East	South West	Scotland	Wales	Northern Ireland	
North East	93	1	8	1	:	:	:	:	:	1	:	:	105
North West	4	203	10	6	9	3	:	2	1	4	5	:	248
Yorkshire and The Humber	14	15	199	18	2	1	:	1	:	:	:	:	252
East Midlands	1	32	30	175	34	21	2	9	1	:	1	:	308
West Midlands	:	7	3	15	174	2	:	2	5	:	6	:	216
East	:	:	3	12	2	189	18	9	1	:	:	:	237
London	:	:	:	:	:	21	101	28	:	:	:	:	151
South East	:	1	1	3	2	7	21	205	6	:	:	:	248
South West	:	:	:	:	5	1	1	17	230	:	4	:	259
Scotland	:	2	1	:	:	:	:	:	:	267	:	:	271
Wales	:	21	:	1	8	:	:	1	3	:	146	:	181
Northern Ireland	:	:	:	:	:	:	:	:	:	:	:	2	2
<b>United Kingdom</b>	113	284	257	231	238	247	145	275	248	274	163	2	2,477

‘:’ = none recorded in the sample or not available due to small sample size, or the total amount of goods lifted is less than half a million tonnes.

### Rail Freight

The Office of Road and Rail collects data on rail freight. For freight lifted, information comes from four major companies – DB Cargo UK, Freightliner Ltd., Direct Rail Services, and GB Railfreight. The four freight companies have a combined market share of 99%. The annual official statistics publication currently does not offer a comprehensive origin and destination of freight by commodity types. Likewise, each company have different reporting standards. Further breakdowns are possible but are commercially sensitive and so not included in statistical releases.

### Port-to-Port Marine Freight

Published maritime statistics are largely based on returns from ports that allow for estimates of both inward and outward shipping freight by port. Since these data are estimated by main port, issues around transport hubs are likely to affect trade in Southern Scotland and Wales for ports close to the internal borders. Some commodities can be directly estimated. But the contents of road freight passing through the ports cannot be easily identified (i.e., there are figures for the overall flow of HGVs on domestic shipping, but not of the contents of the HGVs).

These statistics are generally of a good quality and have excellent coverage. However, current reporting standards mean it is difficult to determine which goods are being lifted in various forms of HGV, trailers and roll-on/roll-off freight. Like road freight, the value of goods in containers are not given, and so lookups are used to determine this.

### *Air Freight*

The Civil Aviation Authority (CAA) collects statistics from all UK airlines, and produces monthly aggregate information. Scottish-Welsh-Northern Ireland-English passenger numbers, and freight flow figures are possible, but require intermittent surveys of airports that take place at different years. It would be possible to combine surveys over a ten-year period to ensure suitable coverage of airports, but it was considered too inaccurate to be useful in this report.

### *Other origin-destination statistics*

Other forms of origin-destination data, particularly for services, may exist with excellent, up-to-date information. Satellite subscription companies and the BBC, utilities providers, banks, and large construction firms could hold information that could provide robust interregional trade figures in their own right. These data, however, are nearly all commercially sensitive.

There are some data sources, such as on construction, which are used to some extent in the production of official and national statistics already which should be investigated in further research. Whilst this data has limitations, it is likely to give an insight into construction trade.

### 3. Methodological Approach

Due to the differences in devolution settlements and the range of statistics available across the UK, there are different data requirements for each region of the UK. Due to these different requirements, the range of economic statistics that have been developed in each constituent part of the UK are distinct from each other.

Current data availability for Scotland and Northern Ireland makes estimating trade between these parts of the UK perhaps the most straightforward. Both Scotland and Northern Ireland have exporting surveys, despite the differences in these surveys discussed above, and the designation of origin-destination of those exports is – in theory – a relatively simple matter.

However, in some cases, sample sizes can make it challenging to estimate full sector breakdowns (by industrial or product classifications). This is particularly relevant to Scotland, where Northern Ireland population comprises just over 3% of Scotland's RUK population. With a survey size of 6,000 businesses, there will be difficulty in obtaining enough responses of Northern Ireland exporters to provide an industrial breakdown of Scottish exports to such a small part of the UK.

It is true that the sum of all interregional exports must equal the sum of all interregional imports. In the case of three regions (Scotland, Northern Ireland and RUK), the overall interregional trade balance between RUK and Scotland and Northern Ireland inclusively can be determined as a residual of the Northern Ireland and Scottish trade balances.

This means that an export (import) -orientated methodology only needs to estimate the proportion of Northern Ireland exports (imports) to (from) Scotland, and Scottish exports (imports) to (from) Northern Ireland to complete a Scotland, Northern Ireland and England and Wales trade matrix.

It is also possible to estimate all interregional trade flows between Scotland, Northern Ireland and RUK using data for one country only, if, for example, better data becomes available. It is entirely feasible for Scotland and/or Northern Ireland to derive their own estimates of the origin (of imports) and destination (of exports) of their goods and services, and doing so would also generate a three region trade matrix.

### 3.1 Welsh and English interregional trade estimation

In chapter 2, it was explained that there are current gaps in the current Welsh and English interregional trade data. In order to complete the deliverables required for this project, a transparent approach in the estimation of Welsh trade with the rest of the UK was adopted. Therefore, this project rebased the 2007 Welsh Economic Research Unit (WERU) Combined Use Table to derive estimates of interregional exports. These figures in themselves should therefore be viewed with caution, and *should not* be described as an updated set of statistics on trade between Wales and the rest of the UK: rather that they have been produced for completeness to illustrate this methodological approach.

Welsh international goods export figures are based on HMRC's Regional Trade Statistics. These could, in theory, be combined with ONS experimental regional services exports estimates to derive a complete picture of Welsh international exports for 2015, which could then have acted as an alternative rebasing methodology than that ultimately used.

However, there are a few issues with this that make it more difficult than it would first appear. Firstly, there is the translation of the HMRC categories into sensible categories for the SUT, particularly given the historic nature of the last set of SUTs for Wales. Secondly, the categories currently published in the experimental services data also make combination with RTS data and SUT categories tricky, without access to the microdata. Thirdly, the time series of the services estimates does not extend back to 2007.

Other data could be considered in producing more realistic Welsh estimates in the future, including a more detailed examination of using the data described above. For example, the techniques and data used in the new [experimental regional expenditure estimates](#). This should be included in any future research. These should all be considered in any update to the Welsh Supply and Use Tables, which was beyond the scope this project.

In order to ensure the methodology was both simple and transparent, therefore, changes in total UK international exports were used as multipliers for the Welsh interregional trade estimates. The SIC2003 codes were mapped to 2007 codes using highly aggregated sectors (see appendix for details). The baseline methodology assumes:

- the proportion of international UK exports that are Welsh has remained the same since 2007; and
- the proportion of total Welsh exports that are interregional exports has remained the same since 2007.

Data for Welsh imports is also derived, following a similar methodology. WERU data shows a very slight trade surplus for Wales with RUK in 2007, this is exaggerated through rebasing, and the Welsh RUK trade surplus is significantly higher rebasing to 2015.

England is treated as a residual and its import and export totals are not directly estimated. This is under the assumption that the interregional trade it has with Scotland, Wales and Northern Ireland is so large in comparison with the other regions, that most of the RUK totals can be attributed to it for exports for each of the devolved regions.

### 3.2 “Whole of Scotland” interregional exports

Experimental offshore satellite accounts have been produced by the Scottish Government. These have been used to adjust the Scottish import and export totals, to adjust “onshore” Scottish trade figures into figures for the whole of Scotland, i.e. Scotland including the Scottish part of the UK Continental Shelf.

These accounts are still at an experimental stage, and can show certain sectors importing (exporting) more from (to) Scotland than Scotland had been reported to export (import) to the whole of RUK. The inclusion of the experimental data is an attempt to properly account for the role offshore extraction activity may have in UK supply chains, and to ensure Scottish trade figures are not skewed by the inclusion of trade with the Scottish part of the UKCS.

These statistics will be updated again later in 2019, and our understanding is that these will be developed further to ensure more consistency with the established onshore Supply and Use Tables. Therefore these improved estimates can be used in the future to provide a more complete picture of Whole of Scotland Trade.

### 3.3 Estimating the origin and destination of interregional trade flows

An important feature of current Scottish and Northern Ireland data is that exports to RUK are generally more robust than import data from RUK. In Scotland’s case, for the most part, imports are not estimated directly, and are a residual left over from manual balancing at a product and sector level once exports have been estimated.

Therefore, it is likely that *export-orientated* methodologies are generally more suited to the current data collections in Scotland and Northern Ireland. This is where origin-destination statistics are derived by allocating interregional exports to their likely destinations. This can be contrasted to *import-orientated* methodologies where origin-destination statistics are derived by allocating imports to origins.

Both import and export methodologies can be considered analogues, with only the direction of trade changed. For export-orientated methodologies, estimated probability of direct trade exported from region  $i$  to region  $k$ ,  $P_{i,k}$  with  $T_{i,k}$  being the amount of goods or services transported in a given data source (e.g., freight transport).

$$P_{i,k} = \frac{T_{i,k}}{\sum_i T_{i,k}}$$

It is then straightforward to estimate the exports,  $X$ , from region  $i$  to  $k$  with an optional adjustment parameter  $\lambda$  capturing the fraction of goods which are transported directly to their final destination.

$$X_{i,k} = (\lambda)P_{i,k}X_i$$

In situations where interregional import data are, at least, as robust as interregional export data, using *import-orientated* methods would be more suited. This is the general framework Thissen et al. (2013) proposed, where freight data was used to estimate the origin-destination of goods and flight information for the origin-destination of services.

For some sectors both import and export statistics may equally plausible. In such cases, Thissen et al proposed a reconciliation which minimises the sum of errors between both *export-orientated* and *import-orientated* estimates.

In cases where there are fewer imports ( $I_k$ ) than exports, Thissen introduced the  $Z_k$  parameter and associated adjustment to the second equation above.

$$Z_k = \max\left(-I_k + (\lambda) \sum_i P_{i,k} X_i, 0\right)$$

$$X_{i,k} = (\lambda) P_{i,k} X_i - \frac{Z_k}{(\lambda) \sum_i P_{i,k} X_i} (\lambda) \sum_i P_{i,k} X_i$$

This adjustment, however, becomes much less important in scenarios with a small number of regions. This can be solved by hand and can be shown to reduce to a simple “all or nothing” adjustment in many such cases. With relatively smaller numbers of regions, and of highly heterogeneous sizes (like devolved nations in the UK), it may be more appropriate to apply those results (either *import-orientated* or *export-orientated* methodology) which satisfy the condition  $X_k = X_k - \sum_i I_{k,i}$ . This will, in effect, constrain the appropriate estimates.

This general framework can be applied to any origin-destination data.

### 3.4 Application by Sector

Each sector has distinct methodologies, shown in table 3. The mapping of sectors to the Welsh Economic Research Unit (WERU), Northern Ireland and Scottish tables is shown in Annex A. Each sector can be seen to be either estimated through an import or export methodology (or both).

**Table 3: Sector-by-Sector description of methodological approach of each sector**

Sector	Primary Data Sources	Import/Export Orientated
Agriculture	CSRGT-GB, CSRGT-NI, Port-to-Port Maritime Statistics, Transport Scotland	Import-orientated
Other Primary	CSRGT-GB, CSRGT-NI, Port-to-Port Maritime Statistics, Transport Scotland	Import-orientated
Manufactured Goods	CSRGT-GB, CSRGT-NI, Port-to-Port Maritime Statistics, Transport Scotland	Export-orientated (Import-orientated for Northern Ireland exports)
Utilities	Interconnector Data	Import-orientated and Export-orientated
Construction	UK, Northern Ireland, Scotland Use Tables, Re-based WERU Use Table	Export-orientated
Retail	Margins estimated on imports calculated from Supply Tables	Import-orientated
Transport & Communications	CSRGT-GB, CSRGT-NI, Port-to-Port Maritime Statistics	Export-orientated
Business & Computing	UK, Northern Ireland, Scotland Use Tables, Re-based WERU Use Table	Export-orientated
Financial	UK, Northern Ireland, Scotland Use Tables, Re-based WERU Use Table	Export-orientated
Public	UK, Northern Ireland, Scotland Use Tables, Re-based WERU Use Table	Export-orientated
Recreational	Northern Ireland Tourism Surveys, GB Tourism Survey, Transition tables from Scottish Government/NISRA	Export-orientated

Table 3 shows that freight data is used to estimate the origin and destination of *Agriculture*, *Other Primary Goods*, *Manufacturing*, and *Transport & Communications*. Other services are broadly based on consumption shares, with *Recreational* and tourism spend calculated through the GB Tourist Survey, and relies strongly on Northern Ireland tourism data which has a breakdown of Northern Ireland tourist

exports by Scotland, Wales and England. *Retail* is estimated separately based on the distribution of margins across sectors.

The following sections explain the methodology for each sector.

### 3.5 Estimation of Goods (*Agriculture, Other Primary, Manufacturing*)

The origin and destination of goods are estimated using freight data. Even using a ten-year pooled sample of the CSRGT, it was found that there was insufficient information to provide robust origin-destination information for Northern Ireland road freight, and also commodities moving between Scotland and Wales. Ultimately, port-to-port statistics compliment the CSRGT, but are not viable as a replacement for it. This means that any approach using Northern Ireland data would rely only on a single data source, Northern Ireland port-to-port maritime data. Air freight may ameliorate the situation to an extent, but the port-to-port statistics to and from Northern Ireland are currently inappropriate to use without further information of the contents of on-board HGVs.

Since the commodity breakdown, and scale, of RUK-Scottish freight and Welsh-RUK trade can be estimated using the CSRGT, both port-to-port maritime statistics and the CSRGT can be combined to estimate inward and outward Scottish and Welsh freight to Northern Ireland. This data, then, forms the basis of estimation. This means that the Northern Ireland interregional trade is estimated via import-orientated methodologies.

For primary goods (for both *Agricultural* and *Other Primary*), whole of Scotland accounts results in very large exports of crude oil to RUK, import-orientated methods are used to constrain Scottish exports to Welsh and Northern Ireland import totals.

#### *Combining freight volumes*

A ten-year pooled CSRGT sample is used to provide the breakdown of commodities moving around Great Britain, while the maritime port-to-port statistics are also used. Since most freight crossing the Irish Sea from the UK is unspecified freight of some description, the CSRGT breakdowns (CSRG-T-NI) are scaled and applied to maritime port-to-port statistics (e.g., if there were one million tonnes of roll-on roll-off freight moving to Northern Ireland from Scotland, it is assumed these have the same product

structure as goods moving within Northern Ireland by HGV). All goods volumes were converted to values using Regional Trade Statistics (RTS) data for Scotland, Ireland and England, where appropriate.

The vast majority of Scottish interregional imports of other primary goods (94%) are accounted for by offshore activities. This is likely, in part, due to the inconsistency between Scottish offshore satellite accounts and the Scottish national accounts.

### *Valuing freight volumes*

Weightings are applied to the origin country's price per tonnage. These are applied to both the CSRGT and adjusted maritime freight flows to derive a total value of commodity flows between England, Scotland, Wales, and Northern Ireland.

*Adjusting for the presence of transport hubs* The total value of freight moving between Scotland and Northern Ireland, based solely on maritime port-to-port statistics is large, around 15% of all outbound freight moves to Northern Ireland from Scotland. Data from the Scottish Government suggests that the Republic of Ireland is not a significant importer of Scottish goods (the 15th largest goods export market for Scotland, behind Sweden and Singapore), which would suggest that Northern Ireland does not act as a transport hub for a significant quantity of Scottish commodities that originate in Scotland.

Port-to-port maritime data, in terms of raw counts, currently suggests several billion pounds' worth of goods cross the Irish Sea from Scotland to Northern Ireland and vice-versa. Scotland is likely to act as transshipment hub for England. In other words, a large amount of reported freight moving between Northern Ireland and Scotland could consist of goods with no ultimate origin and destination in Scotland or Northern Ireland.

Likewise, the CSRGT and maritime port statistics suggest that Wales exports very little directly to Northern Ireland or Scotland. It is, therefore, likely that England acts as a transshipment hub for both incoming and outgoing Welsh trade.

There are no estimates of indirect trade flows through transport hubs for either of these logistical paths (Northern Ireland-Scotland-England, or Wales-England-Northern Ireland/Scotland). A major issue with estimating adjustment parameters for the UK is the asymmetrical size of each region.

England comprises nearly 90% of the total economic activity in the UK, but at the same time acts as a transshipment location for Scotland, Wales, and Northern Ireland when trading with each other.

Scottish Transport Statistics publish estimates of freight entering and leaving Scotland using ad-hoc information prepared by the Department for Transport on road freight using information from the CSRG, CSRG-NI, and international hauliers for road freight. While maritime port-to-port statistics suggest over two and a half million tonnes of freight move from Scotland to Northern Ireland by road vehicle, the figures produced by Transport Scotland suggest only half a million tonnes of road freight travel between Scotland and Northern Ireland. There are many reasons for this discrepancy, but if we are to assume that data held by the Scottish Government is a more accurate reflection of Scottish-Northern Ireland direct freight links, our adjustment parameter would be around 80% for Scotland<sup>2</sup>.

Scottish Transport Statistics estimates that (in 2010) slightly more Welsh-Scottish direct freight than the freight data would imply. Using these figures would suggest around 4% of Scottish-English freight is actually bound for Wales, while around 1% of Welsh-English freight is actually bound for Scotland.

Table 4 describes the adjustment parameters used. With the absence of data on direct Northern Ireland-Wales freight links, we assume England has an adjustment parameter of just under 3% (the average of the Scottish-English-Welsh logistic path).

**Table 4: Adjustment parameters assumed, 2015**

Sector	Transshipment Hub	Adjustment Parameter
England-Northern Ireland	Scotland	79.65%
Northern Ireland-England	Scotland	78.19%
Northern Ireland-Wales	England	2.78%
Scotland-Wales	England	4.31%
Wales-Northern Ireland	England	2.78%
Wales-Scotland	England	1.25%

<sup>2</sup> This might be considered more akin to an overcount/undercount adjustment to the freight data

### 3.6 Utilities

Utilities comprises both electricity, water transmission, and related services. For Scotland, the vast majority of interregional activity in these sectors is the trading of both electricity and gas. For Northern Ireland, it reports a larger quantity of water services being exported, while all its imports are either electricity or gas.

Interconnector data are used in this case. We assume there can be electricity transfers between grids (Scotland, England and Wales, and Northern Ireland), where the Welsh share of production and consumption in the England and Wales grid determines its share of imports and exports to Scotland. Conversely, we assume it is not physically possible to transfer electricity between the “Northern Ireland grid” and the England and Wales grid.

While the data is useful, it is not clear whether this reflects the true nature of interregional trade in Utilities in the UK. It may be that the physical flows of electricity between countries is not a good guide for national accounting definitions of exports and imports. This is because –

- the economic ownership of the electricity may not be in the country of generation; or
- the same KWh of electricity can be sold and resold, and hedging behaviour of energy firms means that the value generated may have no relationship with the location or magnitude of generation.

Some of these issues are also of concern for other physical movement of goods, but they are particularly an issue for this sector. However, the coverage of this data means it is a useful source as a proxy for trade in this context.

### 3.7 Construction

Consumption is used to allocate the relative trade volumes from the SUTs, where Northern Ireland reports no importing of Construction activity.

As touched upon in section 2 above, there are data on construction new orders, which are used to some extent in the production of official and national statistics already. These data should be investigated in further research. Whilst this data has limitations, it is likely to give an insight into construction trade.

### 3.8 *Transport & Communications*

Communications is inferred directly from the volumes of freight flows. Northern Ireland report a large trading surplus in the sector, and very little imports of transportation services.

The origin and destination of Welsh and Scotland exports is split between its component sectors, but Northern Ireland do not publish statistics below an overall figure. For Northern Ireland, raw port-to-port maritime statistics are used to estimate their origin-destination of services and this is combined (in sheer volume terms) with road freight to generate similar figures for Scotland.

Following the methodology laid out in section 2, an export orientated approach is used, where reconciliation occurs if the results need to be constrained by the relevant import and export totals. On a pairwise basis this can be done by hand. Despite using freight data, it is assumed that Transport & Communications do not need to be adjusted for transport hubs.

### 3.9 *Retail*

From a national accounts perspective, retail is a special case in terms of all other sectors since margins are composite goods, being exported and imported entirely via the trade of other goods and services. Retail margins are therefore determined by the level of interregional imports through an import-orientated methodology. The margins are assumed to have a similar profile as for all domestic goods supplied. The supply table, therefore, determines which products carry a margin.

Both Northern Ireland and Scottish SUTs identify the products on which margins are being generated. The origin and destination of exports and imports of margins should be generated last, as a weighted sum of the export and import of those goods on which margins are generated. For Wales, margins

are available from the intermediate analytical tables but do not conform to the same methodology as Scottish or Northern Ireland statistics due to their historic nature.

### *3.10 Financial Services and Business & Computing Services*

For Financial Services, both NISRA and the Scottish Government report difficulties in estimating the import and export of Financial Services (not just within the UK but also internationally). This is due to a number of factors including: the conceptual difficulty of defining these types of service exports within the UK, limited data on origin-destinations of services; and, in many cases, data confidentiality issues. In light of no other information at this stage, consumption shares are used to allocate the destination of interregional trade flows through an export-orientated approach.

Conceptually, this might not be a poor approximation of exports and imports particularly as the sector tends not to have boundaries and most products are sold on a pan-UK basis.

For Business & Computing Services, a sector encompassing a large number of heterogeneous service activities, it is theoretically possible to provide breakdowns to yield relatively bespoke estimates (particularly for telecommunications). In lieu of such information at the current time, consumption shares have also been used.

### *3.11 Public Services*

Very little interregional trade is reported for public services in most national accounts for Scotland and Northern Ireland. It may be possible for government agencies to establish more accurate estimates of imports and exports but, from our discussions to date, this remains uncertain. Overall, it is not something that we believe will have a material impact on the results given the small scale in terms of estimation. Just over half the component of Northern Ireland exports in 'Public Services' is from non-resident expenditure. This is the basis for allocating Public Service exports.

### 3.12 *Recreational Services*

For Recreational Services, the primary data sources used is the last available UK Tourist Survey, which provides shares of origin-destination tourist expenditure for England, Scotland, Wales, and Northern Ireland. The Northern Ireland tourist data also provides a full breakdown of the ‘destination’ of Northern Ireland tourist exports, and so was also used where possible.

For Scottish, English and Welsh residents, their expenditure in Northern Ireland is published regularly, is consistent with Northern Ireland national accounts, and so it is a straightforward matter to allocate Northern Ireland exports to both Scotland and RUK. Specifically, it is export-orientated, with the destination of Northern Ireland exports being directly observed from their surveys.

Estimates for Recreational Services can be considered in terms of allocating non-resident household expenditure. This can be seen in most raw, published SUTs with further breakdowns possible from data providers. Exports from certain sectors are almost entirely composed of non-resident expenditure (particularly ‘Accommodation and Food & Drink’ services). Data obtained from both Scotland, WERU and NISRA give a breakdown of non-resident expenditure across all sectors. In all cases, nearly all of exports are identified as non-resident household expenditure in Recreational Services.

## 4. UK interregional trade results

This section shows the results of the methodology explained in chapter 3.

### 4.1 Welsh interregional export estimation

Table 5 shows the current rebased estimates for Wales in 2015. They have been derived from a domestic Use table for Wales as described in Section 3 above. As we discussed previously, they have been derived to demonstrate the methodological approach discussed in this paper and should be viewed as such, rather than specific Wales-RUK trade estimates.

The results show Wales is assumed to have a large trading surplus in Manufactured Goods. The results can largely be seen to reflect large increases in the international export of transport machinery and computer and electronic equipment between 2007 and 2015, key interregional exporting sectors for Wales in 2007.

**Table 5: Hypothetical Welsh interregional trading position, 2015, £ million**

Sector	Exports	Imports	Trade Balance
Agriculture	1119	666	453
Other Primary	123	376	-253
Manufactured Goods	25731	17256	8474
Utilities	1389	1093	296
Construction	1628	1925	-297
Retail	3107	1581	1526
Communications	2159	2929	-770
Business & Computing	2490	6249	-3758
Financial	4962	4087	875
Public	1829	3065	-1236
Recreational	1080	1062	18

#### 4.2 Baseline results – no indirect trade flows using transport hubs

Table 6 presents the results of the methodology outlined in chapter 3. The freight data implies very little Scottish-Welsh trade, and comparatively large trade between Scotland and Northern Ireland.

Scottish-Northern Ireland trade is largely driven by *Manufactured Goods* and, to a lesser extent, *Transport & Communications*. This is largely driven by the presence of large amounts of freight that crosses the Irish Sea between Scotland and Northern Ireland.

Direct Scottish-Welsh freight links are undetectable through the CSRGT, even using a ten year pooled sample. Only crude oil, wood products (from Scotland to Wales), and food commodities (from Wales to Scotland) show significant movement between Wales and Scotland through the CSRGT. This is reflected in the figures, and most other trade is inferred through the relative size of the Welsh economy (e.g., *Business & Computing* and *Financial Services*). Crude oil exports from Scotland are a lot higher if estimated through export-orientated methodologies, and the results here had to be constrained to Welsh import totals.

**Table 6: Export estimates from primary methodology – no indirect trade flows using transport hubs, £ million**

Sector	Scotland			Northern Ireland			Wales			England		
	N.I.	WAL	ENG	SCO	WAL	ENG	SCO	N.I.	ENG	SCO	N.I.	WAL
Agriculture	27	-	1,322	38	-	20	1	1	1,118	980	72	666
Other Primary	21	159	12,217	62	0	32	0	3	120	360	496	217
Manufactured Goods	1,148	54	11,740	972	17	5,609	123	1,629	23,980	22,287	9,431	17,186
Utilities	387	216	3,366	78	-	-	297	-	1,389	1,302	-	877
Construction	-	20	909	126	37	1,596	118	-	1,510	6,675	-	1,868
Retail	6	31	396	80	3	162	10	7	3,089	1,865	43	1,547
Transport & Communications	57	128	2,088	399	9	730	5	34	2,119	3,922	1	2,792
Business & Computing	168	233	10,649	70	21	911	173	38	2,279	17,619	2,814	5,994
Financial	117	222	6,608	6	3	74	374	83	4,504	5,695	776	3,863
Public	-	11	593	11	1	33	42	-	1,787	445	-	3,052
Recreational	83	33	1,780	39	5	121	25	11	1,014	2,803	113	1,024

Northern Ireland-Welsh freight similarly implies relatively weak trade links. Almost the only good being recorded by both marine and road freight surveys moving between Wales and Northern Ireland is substantial quantities of refined petroleum, resulting in a large Welsh trading surplus, and a very large amount of manufactured goods exports from Wales to Northern Ireland. The scale of this estimate is likely, at least in part, a result of the 2007 Welsh tables that have been used, explained above. Transport hubs may be an issue here as well, where Northern Ireland might behave as a transit hub for the rest of Ireland, and distribute significant volumes of refined petroleum throughout Ireland.

#### *4.3 Accounting for indirect trade flows using transport hubs*

The results in table 7 shows the Welsh interregional trade figures are highly susceptible to assumptions about transport hubs, and that if the adjustment parameters used in table 5 are a more accurate reflection of reality would mean Scottish-Welsh trade is greater than Scottish-Northern Ireland trade.

There is an assumed significant exporting of Northern Ireland freight via Scotland (80%) to England. Welsh-Scottish trade is largely a result of the assumed value of key Welsh exports, and, in part, the assumption the refined petroleum is exported via England to Scotland (which accounts for 27% of total Welsh Manufactured Goods exports to Scotland in table 7). If Wales exporting refined petroleum to Scotland is unrealistic, it would suggest the need for sector specific adjustment parameters, which are not available.

The issue of exporting between Wales and Northern Ireland is less affected by transport hubs, largely due to the value of goods being assumed on Northern Ireland maritime freight.

**Table 7: Export estimates with adjustment parameters, £ million**

Sector	Scotland			Northern Ireland			Wales			England		
	N.I.	WAL	ENG	SCO	WAL	ENG	SCO	N.I.	ENG	SCO	N.I.	WAL
Agriculture	27	2	1,320	38	4	16	11	11	1,097	970	62	659
Other Primary	21	175	12,201	62	4	29	8	3	112	352	495	197
Manufactured Goods	250	506	12,186	216	57	6,324	417	1,713	23,601	22,748	10,245	16,694
Utilities	387	216	3,366	78	-	-	297	-	1,389	1,302	-	877
Construction	-	20	909	126	37	1,596	118	-	1,510	6,675	-	1,868
Retail	2	60	371	20	6	219	34	8	3,065	1,901	47	1,514
Transport & Communications	57	128	2,088	399	9	730	5	34	2,119	3,922	1	2,792
Business & Computing	168	233	10,649	70	21	911	173	38	2,279	17,619	2,814	5,994
Financial	117	222	6,608	6	3	74	374	83	4,504	5,695	776	3,863
Public	-	11	593	11	1	33	42	-	1,787	445	-	3,052
Recreational	83	33	1,780	39	5	121	25	11	1,014	2,803	113	1,024

#### 4.4 *Headline results vs comparator data*

In terms of how our results relate to the existing literature, like Louhela, who use freight flows to estimate interregional trade in Finland, we find that freight flows appear to overestimate trade to nations nearby and underestimate trade between nations further apart. This highlights the importance of the adjustment parameter used in analysis. Interestingly, in our case, adjustment does not necessarily increase the level of trade between nations which do not share a border.

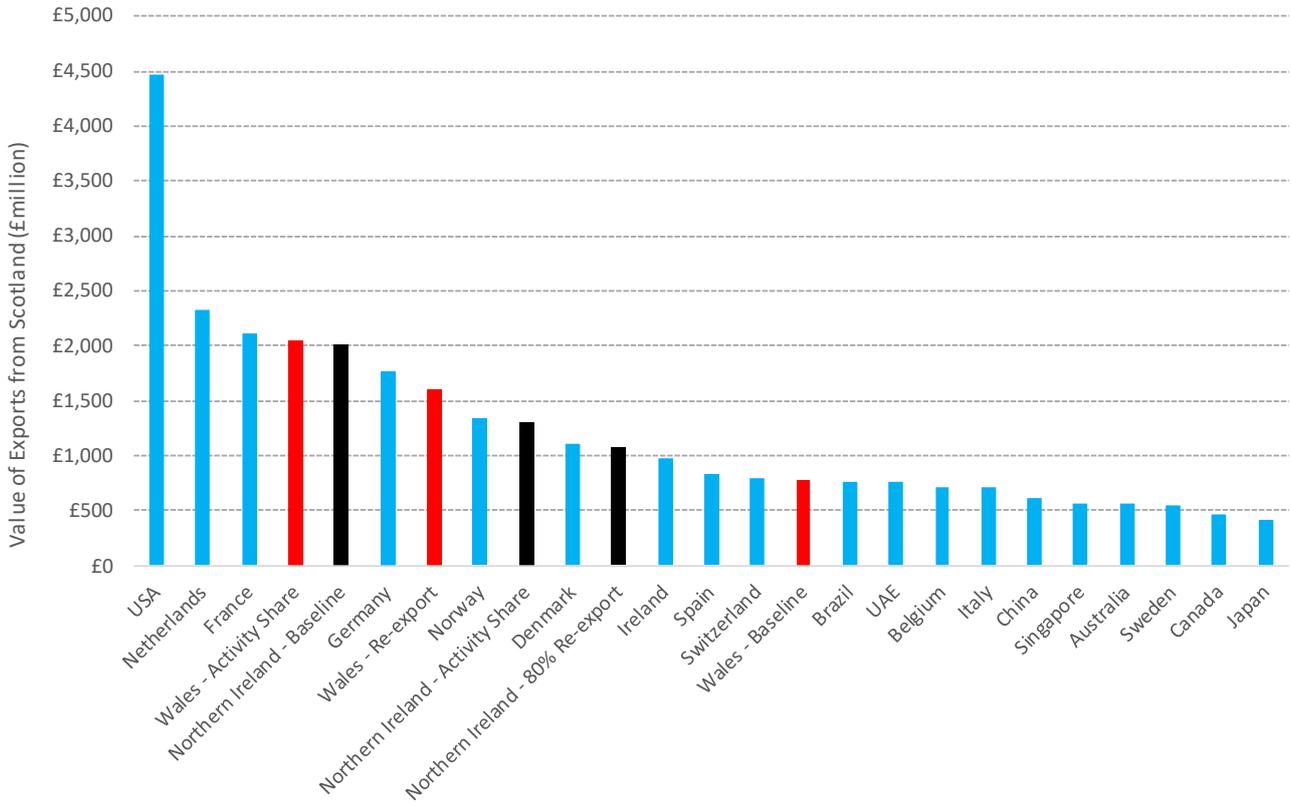
While Thissen et al produce interregional trade flows for the UK in the context of estimating interregional trade flows for Europe, there are a number of key differences from our study which invalidates any meaningful comparison. First, the most recent year for which Thissen et al produce estimates is 2013. More importantly, they use national SUTs available from Eurostat then regionalise them to NUTS2 level using regional data on production and consumption. While we deploy aspects of his methodology, moving away from gravity model approaches which assume the data has a geographical structure, our approach is tailored to UK data availability. Thus we begin our analysis with regional SUTs adjusted to account for off-shore Scotland, proceed using region-specific adjustment parameters and, already facing significant challenges at the nation level, do not attempt to examine trade flows at NUTS2 level.

In this section, however, we develop an alternative means to examine whether our results are as expected. For Scotland (Figure 2) and Northern Ireland (Figure 3) we present trade with the other nations (excluding England) according to our baseline estimate with adjustment and our estimate adjusted for transport hubs. We also present what level of trade we would expect if RUK trade flows were split into three, depending on each nation's share of overall UK activity (GVA). We also show how trade with the other nations compares to that with international trading partners.

Figure 2 shows that Northern Ireland, without adjustment parameters, is one of Scotland's largest export destinations, much higher than its share of GVA ("activity share") of Scotland's RUK. This suggests that, if there is no exporting via transport hubs, Northern Ireland imports a lot more from Scotland than might be expected given its relative size in the UK. With the adjustment, Northern Ireland imports less than its activity share would imply.

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#### **Figure 2: Scotland's exports estimates with international comparators, 2015**



The impact of transport hubs most starkly effects results for Wales. Wales – for example – becomes a major export destination with the adjustment parameter of the scale proposed in chapter 3. Without assuming transport hubs, Wales imports around third of its “activity share” of Scottish exports.

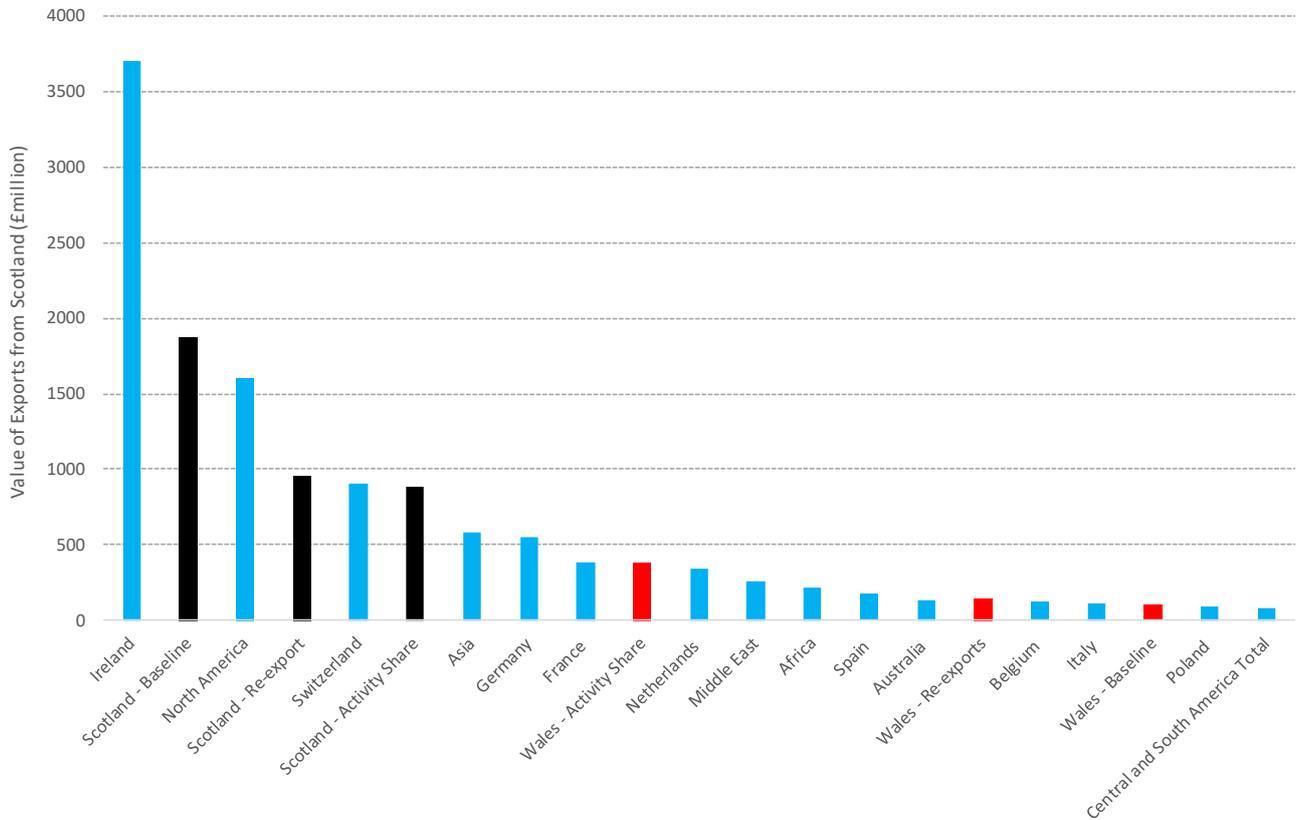
Figure 3 presents a similar story for Northern Ireland, without adjustment parameters, Scotland is the largest destination of Northern Ireland sales behind the Republic of Ireland (and England, also excluded). Once transport hubs are accounted for, Scotland becomes Northern Ireland’s fourth biggest destination for external sales, and is an export destination which is close to the relative size of Scotland’s economy in Great Britain.

Northern Ireland external sales to Wales, however, are less sensitive to assumptions about transport hubs. Even with exporting via England, Wales does not constitute a significant export destination for Northern Ireland. This is largely due to the lack of a road link between the UK and Northern Ireland, and only a proportion of the maritime freight leaving and entering Northern Ireland is assumed to

consist of Welsh goods, this constrains the physical volume of goods that can be exported via England.

If the Welsh figure should be closer to its activity share, it would suggest there are other transit paths not covered by the data used here. An up-to-date Welsh SUT would not change these inferences, and improved data on Northern Ireland-Welsh connectivity would be required to examine these issues further.

**Figure 3: Northern Ireland’s external sales estimates with international comparators, 2015**



## 5. Discussion , Conclusions & Recommendations

In this section, we discuss the results we have produced, data issues for particular sectors, and recommendations for the next stage of this work.

### 5.1 Discussion of overall results

The results overall suggest a high degree of linkage between the countries of the UK on trade, significant in the context of international export partners.

The results here are an initial estimate of interregional trade in the UK, with the conclusion above resulting from the current estimates of trade between constituent countries and the rest of the UK. If Scotland, Wales and Northern Ireland are all estimated to import and export significant volumes of goods and services with the rest of the UK, they will very likely import and export significant volumes with each other, when compared to all other export destinations. This is due to the fact that even a small proportion of goods would translate into large trade volumes with each other. For Scottish-Northern Ireland trade, even assuming a high presence of transport hubs does not change this significantly (and would still make the whole of Ireland one of Scotland's largest export destinations). Likewise, a relatively modest adjustment parameter of around 4% would suggest a large volume of trade between Scotland and Wales. The volume of trade between Northern Ireland and Wales needs more investigation, given the relative lack of freight flows between the two countries.

Overall, we find that many of our results align with what we would expect. Specifically, in Wales, Northern Ireland and Scotland we find that the majority of exports go to England. We also find that Northern Ireland and Scotland have large trade deficits with England reflecting the corresponding SUTs which show large trade deficits with RUK. However, assumptions surrounding adjustment parameters and the multipliers used to rebase of Welsh data require further consideration. While there is significant Scottish-Northern Ireland trade and sectoral results show promise (e.g. flows in utilities from Northern Ireland to Scotland), the destination mix of Northern Irish exports is most sensitive to the use of an adjustment parameter to account for transshipment hubs. Use of an adjustment parameter, also results in Wales receiving more exports from Scotland than Northern Ireland which we think requires further scrutiny. The Welsh data gaps also pose a challenge with the Welsh trade surplus with England

in 2007 being exaggerated when rebasing the data to 2015. We also find evidence of issues with Welsh data at a sectoral level (e.g. flows in manufactured goods from Wales to Northern Ireland).

## 5.2 Sector-by-sector data issues

Overall recommendations for further work are discussed in section 5.3. In this section, we discuss some of the specific data issues, and potential areas for further investigation and research.

### All goods

All goods estimated via freight data have a number of issues associated with them. Maritime data is very useful, but for a full suite of UK interregional trade, estimates of multimodal freight links (e.g., HGV->boat->HGV) would need to be taken into account. Since Northern Ireland can be seen to trade extensively with Britain, Northern Ireland freight could interfere with interregional estimates for Great Britain, through key transshipment locations.

A number of results in chapter 4 for Northern Ireland and Scotland will be in part derived from assuming the goods profile of the containers on Northern Ireland-GB ships. The commodity profile of the maritime data to and from Northern Ireland is assumed to be the same as internal road freight of departure port's country (i.e., it is assumed Northern Ireland bound Scottish freight has a similar profile to Scottish-English freight). This results in a large volume of Food & Drink commodities being estimated to cross the Irish Sea via Scotland.

The origin and destination of Welsh exports and imports can be seen to be highly sensitive to adjustment for transport hubs. This is to be expected from using freight data, which is known to overestimate trade to regions nearby and underestimate trade between regions further apart. A more up-to-date Welsh RUK export figure from a single-region SUT would not alleviate these issues.

For English regions, this issue could be more pronounced, particularly in southern English regions, where there may exist important sectors in the regional economy that have distribution across the UK

but are moved to a transshipment location elsewhere in the country. It is also likely that England has several transshipment points that may vary by sector. In other words, an interregional SUT would need to address the lack of empirically derived adjustment parameters, perhaps for regions or sectors, and also work on the identification of transshipment locations. In our report, Scotland can be considered the only possible transshipment hub in relation to Northern Ireland trade to Britain, and otherwise England acts as a transshipment hub.

The main issue for Northern Ireland estimation is the relative importance of the Northern Ireland-Scotland trade link to the Northern Ireland economy. In this study, it is assumed that the Northern Ireland freight data is too unreliable to derive estimates since it relies solely on the port-to-port maritime statistics. Using Northern Ireland data, would imply Scottish-Northern Ireland trade of a magnitude larger than reported here, even after accounting for transport hubs, since around a third (by tonnage) of all outgoing and incoming Northern Ireland freight to Britain would appear to go through Scotland. Whether commodities transit through Ireland, and how significant that might be (to a region like Wales), would need to be investigated. This project found only a limited amount of information is available, however.

### *Oil extraction and oil refining*

The most important UK commodity in *Other Primary* is crude oil, this (alongside refined petroleum products) can be seen to dominate maritime freight movements between Scotland, Wales, Northern Ireland and England. The value of crude interregional exports from Scottish waters was so large, the estimates had to be constrained to Welsh and Northern Ireland import totals.

Removing oil extraction from the estimates is possible, but special care would have to be taken in doing so, since a substantial proportion of interregional freight in the UK is derived from this sector, especially when combined with petroleum refining to develop an understanding of the UK oil & gas supply chain.

### *Utilities*

Interconnector data was used, a point of note is that it is assumed there are three distinct “grids”; England and Wales, Scotland and Northern Ireland. This creates an issue when attempting to use interconnector information at an English regional level.

Likewise, an assumption that only Scotland can export electricity to Northern Ireland and vice-versa seems contentious and a similar methodology which considers the UK as a single grid for all forms of utilities where it can (production and consumption shares) might be a more suitable estimation methodology.

### *Transport & Communications*

Transport & Communications, right now, is driven by the raw freight data used in the goods component. The number of trips between regions by HGVs, rail, and air should be sufficient. The availability of reliable interregional air transport data is perhaps the biggest data gap, while there is a great deal of restrictions on rail data, which might also be used to infer communications trade across regions.

### *Other Services*

In general, it is clear that in some cases expensive data collection may not be very useful for certain types of services. From both the Scottish and Northern Ireland experience of these sectors, it is not clear that surveys always provide accurate estimates.

If Wales and English regions are required to provide estimates of interregional trade, non-survey approaches might be more optimal. We discuss this further in the next section.

### 5.3 Further work & research

The production of these estimates has raised a number of issues about the collection of trade data as it currently exists in the UK, and how that data is then used in the production of regional Supply and Use Tables. There are differences in terms of approaches taken, consistency, and different data that is used.

As we outlined in the introduction, there is growing policy interest in understanding the different linkages between parts of the economy within the UK, both in terms of linkages between industry, but also links between regions. Devolution of new powers, and of course Brexit, have heightened the policy requirement for data such as this.

Therefore we would recommend that a strategic approach to the collection of trade information and estimation of trade within the UK is developed, with different approaches for goods and services. Specifically, we would like to set out the best approach for each sector, whether that is through survey collection, gravity based estimation, or the use of other proxies.

This project considered, and estimated, interregional trade flows between Scotland, Wales, Northern Ireland, and Scotland, using the best data that was valuable. The next steps of research could:

- Support & facilitate discussions between ONS, HMRC and the devolved administrations on trade collections in goods, developing a strategic approach to these surveys across the UK;
- Carry out a qualitative review of service sector companies; and
- Carry out a quantitative appraisal of methods used for estimating inter-regional service trade, testing the sensitivity of current approaches and providing recommendations.

The current project found that some type of survey information is required to track goods movement throughout the UK. Surveys are currently undertaken by NISRA (for trade (or “external sales” as it is labelled) between NI and GB) and by the Scottish Government (for trade between Scotland and RUK).

These surveys are carried out in different ways, with very different response rates and questions, as we discussed in Section 2. With the Welsh Government considering such a survey, it is important to review the approach to this and consider whether there would be benefits in a consistent approach.

For services, however, this project concluded that a survey may not be the best approach to estimating interregional trade. Therefore, further research could build on this work by investigating more fully the nature of that assumption.

Focusing on business services and financial services, further work could provide an overview of the spatial structure of financial and business services, and capital movement interregionally within the UK, in order to feed into any future work which seeks to estimate interregional services trade.

Further research could involve a survey, generating both qualitative and quantitative information, of key service providers operating across devolved borders. In short, this could test assumptions around different sectors and company types, to test the feasibility of gathering inter-regional trade information and test the quality of information currently collected.

Overall, this could lead to a set of recommendations about a framework for collection and estimation of trade within the UK, which could be consistent and agreed across organisations.

Ultimately, this could lead to a framework for the consistent production of Supply and Use Tables for Scotland, England, Northern Ireland & Wales. Ultimately, these tables are the methods through which these trade estimates are reconciled with more established figures for regional production and consumption.

The SUTs for Northern Ireland and Scotland have been a key source of information for this project on inter-regional trade. More widely than that, they give these devolved administrations an insight into the linkages between different parts of the domestic economy, and allows the estimation of impact assessments and the construction of models of the economy.

As touched on above, the project has highlighted some questions about the approaches taken by the different bodies in constructing SUTs; for the purposes of this project we focussed on those which may affect trade. So, different decisions about how to approach the manual balance of an industry may affect the level of output of an industry and therefore the associated trade.

Therefore the development, as discussed above, of a framework for estimation of regional trade, could sit within a wider framework of the approach to regional SUTs: this is the most robust and consistent way to approach trade estimation.



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## Data Sources

### Department for Energy and Climate Change

[Interconnector Data \(readings from National Energy Grid on the volume of energy imported and exported\)](#)

### Department for Transport

[Freight transport by road: Goods lifted within Northern Ireland by goods vehicles over 3.5 tonnes: 2012-2016](#)

[Table RFS0138 pooled: Goods lifted by region and country of origin and destination: 2007-2016](#)

[UK coastwise freight, country to country by cargo category, 2015](#)

### HMRC

[Regional Trade Statistics \(Price per tonne\)](#)

### Office of National Statistics

[Demand for products in 2015: The 'Combined Use' matrix](#)

Supply of products in 2015

### Northern Ireland Statistics and Research Agency

[Non-resident expenditure in Northern Ireland, 2015](#)

[Northern Ireland Supply Use Table Multipliers 2014 and 2015](#)

[Number of External Overnight Trips to Northern Ireland by Place of Origin, 2011-2017](#)

### Scottish Government

[Combined Use Table 1998-2015](#)

[Goods lifted or moved by UK HGVs, entering or leaving Scotland, to or from rest of UK, by origins and destinations of journeys, 2015](#)

Non-resident expenditure in Scotland, 2015

[Scottish Exports by Sector and Destination, 2013 & 2015](#)

[Supply and Demand for products 1998-2014: Scottish adjacent waters satellite account: intermediate use and trade](#)

Supply Table 1998-2015

[Visit Britain](#)

[The GB Tourist: Statistics 2015](#)

[The UK Tourist 2010](#)

[Visit Scotland](#)

[The key facts on tourism in 2016](#)

**Annex A: Mapping of UK, Welsh classifications, Northern Ireland Sections and Scottish I-O categories to our sectors**

Sector	Name	Codes	Code Names	WERU classifications
A	Agriculture and Forestry	1	Agriculture	Agric & Fish Forestry
A		02.1, 02.4	Forestry planting	
A		02.2-3	Forestry harvesting	
A		3.1	Fishing	
A		3.2	Aquaculture	
B	Other Primary	5	Coal & lignite	Coal & other primary extraction
B		06-08	Oil & gas extraction, metal ores & other	Other mining & quarrying
B		9	Mining Support	
CA	Manufactured Goods	10.1	Meat processing	Meat
CA		10.2-3	Fish & fruit processing	Dairy
CA		10.4-5	Dairy products, oils & fats processing	Fish products, vegetables, grain mill products
CA		10.6	Grain milling & starch	Bread & biscuits
CA		10.7	Bakery & farinaceous	Misc Foods
CA		10.8	Other food	Confectionery
CA		10.9	Animal feeds	Drinks and Tobacco
CA		11.01-04	Spirits & wines	
CA		11.05-06	Beer & malt	
CA		11.07	Soft Drinks	
CA		12	Tobacco	
CB		13	Textiles	Textiles
CB		14	Wearing apparel	Clothing
CB		15	Leather goods	
CC		16	Wood and wood products	Wood Products
CC		17	Paper & paper products	Paper and Pulps

UK Interregional Trade Estimation – estimates of trade between Northern Ireland, Scotland, Wales, and England

CC		18	Printing and recording	Publishing
CC/CE		19, 20B	Coke, petroleum & petrochemicals	Oil Processing
CE		20.3	Paints, varnishes and inks etc.	Chemicals
CE		20.4	Cleaning & toilet preparations	Soaps
CE		20.5	Other chemicals	
CE		20AC	Inorganic chemicals, dyestuffs & agrochemicals	
CF		21	Pharmaceuticals	Pharmaceutical
CG		22	Rubber & Plastic	Rubber products
CG		23.5-6	Cement lime & plaster	Plastics
CG		23OTHER	Glass, clay & stone etc.	Glass and Ceramics Cement/plaster
CH		24.1-3	Iron & Steel	Iron and Steel
CH		24.4-5	Other metals & casting	Aluminium & non-ferrous metals
CH		25	Fabricated metal	Forging/pressing Structural metals
CI		26	Computers, electronics & opticals	Machinery, Domestic appliances, Office machinery, Electrical motors and transformers, Wires and Cables, Industrial electrical equipment, Electronic Components, TVs, Control equipment
CJ		27	Electrical equipment	
CK		28	Machinery & equipment	
CL		29	Motor Vehicles	Motor Vehicles
CL		30	Other transport equipment	Other Vehicles
CM		31	Furniture	Furniture
CM		32	Other manufacturing	Other manufacturing
CM		33	Repair & maintenance	
D	Utilities	35.1	Electricity	Electricity – Coal, Electricity – Gas, Electricity – Nuclear, Electricity – Hydro, Electricity - Other Renewables, Electricity - Transmission, Distribution & Supply, Gas
D		35.2-3	Gas etc.	

UK Interregional Trade Estimation – estimates of trade between Northern Ireland, Scotland, Wales, and England

E		36, 37	Water and sewerage	Water
E		38, 39	Waste, remediation & management	Sanitary Services
F	Construction	41-43	Construction	Construction
G	Wholesale, Retail & Margins	45	Wholesale & Retail - vehicles	Distribution and Repairs
G		46	Wholesale – excl. vehicles	Wholesale
G		47	Retail - excl vehicles	Retail
H	Transport & Communications	49.1-2	Rail transport	Railways
H		49.3-5	Other land transport	Road transport
H		50	Water transport	Sea and Air transport
H		51	Air transport	Transport services
H		52	Support services for transport	Postal services
H		53	Post & courier	
I	Recreational Services	55	Accommodation	Large Hotels, Small Hotels, B&B and Guest House, Self Catering, Other Accom, Restaurants etc
I		56	Food & beverage services	
J	Business & Computer Services	58	Publishing services	Telecomms
J		59, 60	Film video & TV etc.; broadcasting	Other Recreation, media & film
J		61	Telecommunications	
J		62	Computer services	
J		63	Information services	
K	Financial Services	64	Financial services	Banking and Finance
K		65	Insurance & pensions	Insurance
K		66	Auxiliary financial services	Other Financial services
L		68.1-2	Real estate - own	Real estate
L		68.2IMP	Imputed rent	Ownership & Rental of Dwellings
L		68.3	Real estate - fee or contract	Renting of moveables
M		69.1	Legal activities	Legal services

UK Interregional Trade Estimation – estimates of trade between Northern Ireland, Scotland, Wales, and England

M		69.2	Accounting & tax services	Accountancy services	
M		70	Head office & consulting services	Computer and related activities	
M		71	Architectural services etc.	R&D	
M	Business & Computer Services	72	Research & development	Market research, advertising	
M		73	Advertising & market research	Other business services	
M		74	Other professional services	Other professional Services	
M		75	Veterinary services		
M		77	Rental and leasing services		
N		Business & Computer Services	78	Employment services	Travel Agents
N			79	Travel & related services	
N	80		Security & investigation		
N	81		Building & landscape services		
N	82		Business support services		
O	Public Services	84	Public administration & defence	Public Admin	
P		85	Education	Education	
Q		86	Health	Health and social work	
Q		87, 88	Residential care and social work		
R	Recreational Services	90	Creative services	Museums & Galleries	
R		91	Cultural services	Attractions, Gardens & other entertainment nec.	
R		92	Gambling	Theme parks and stadia	
R		93	Sports & recreation		
S	Recreational Services	94	Membership organisations		
S		95	Repairs - personal and household		
S		96	Other personal services		
T	Other	97	Households as employers	Other Services	