ECONOMIC STATISTICS CENTRE OF EXCELLENCE

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A Data Map of Existing UK Data Sources Related to Regional Trade

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Abstract

Considering the political importance of devolution, and emerging economic issues in UK's trade policy arising from Brexit, there's a pressing demand for data which can help understand internal trade flows within the UK. This paper is the first in a series which seeks to understand and evaluate the feasibility of producing robust interregional trade flows statistics for the UK.

The paper offers a description of common approaches to estimating interregional trade, and the data requirements needed to implement them. Since the project, as a whole, is primarily focused on the feasibility of non-survey approaches, the paper describes the process of "regionalizing" national tables to produce regional tables using non-survey methods.

It is argued that the best starting point for an interregional trade matrix for the UK is one which encompasses the four home nations; Wales, Scotland, Northern Ireland and England. This is due to the fact that the Office for National Statistics, HMRC and devolved administrations already produce a considerable volume of data that can be used directly in the estimation of interregional trade flows. The general methods do however; offer a principle for further disaggregation of England in future.

This paper offers a description of current data in the UK relevant to the production of interregional trade estimates. This includes a short review of current data produced by HMRC, the ONS, the Northern Irish and Scottish administrations. This is followed by a brief description of new data sources which could be used for the implementation of popular approaches to estimating interregional trade. It is shown that freight data is the most promising data source for goods but that there are gaps in data sources suitable for estimating the interregional trade flows in services.

Key words: regional trade, UK, regional economic statistics

JEL classification: R12, F15, E01

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Executive Summary

Considering the political importance of devolution, and emerging economic issues in UK's trade policy arising from Brexit, there's a pressing demand for data which can help understand internal trade flows within the UK. This paper is the first in a series which seeks to understand and evaluate the feasibility of producing robust interregional trade flows statistics for the UK.

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This paper offers a description of current data in the UK relevant to the production of interregional trade estimates. This includes a short review of current data produced by HMRC, the ONS, the Northern Irish and Scottish administrations. This is followed by a brief description of new data sources which could be used for the implementation of popular approaches to estimating interregional trade. It is shown that freight data is the most promising data source for goods but that there are gaps in data sources suitable for estimating the interregional trade flows in services.

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1. Introduction

1.1 Interregional trade estimation

The onset of devolution in the UK has resulted in demand for more regionalised statistics to help inform policy making and to improve accountability. Various new publications, offering regional breakdowns, have become available[2].

This is particularly true for devolved regions, with both the Northern Ireland Executive and the Scottish Government now offering a set of economic regional accounts as part of their core statistical outputs. This includes not just estimates of regional GVA, but estimates of both imports and exports and single region Supply Use Tables (SUTs).

However, there remain important gaps and overall UK regional data is not as comprehensive as they perhaps could be. Indeed, improving regional economic indicators was a key recommendation of the Bean Review[3].

A gap identified by many users of regional economic statistics in the UK is the lack of regular measures of interregional trade flows. This is particularly relevant considering the extensive interdependencies that exist between the UK regions.

It is important from a policy perspective. For example, to fully understand the economic success of policies such as "the Northern Powerhouse" we need much better information on inter-regional supply chains. Similarly, understanding the implications of the major new fiscal powers of the Scottish Parliament and the Welsh Assembly, and how different tax policies within the UK may spill-over between regions, is now of vital importance.

That being said, interregional trade estimation is one of the most difficult aspects of a regional system of accounts to estimate. No official estimates of interregional trade currently exist except of Northern Irish/Scottish trade with the rest of the UK (RUK). The aim of this project is to attempt to fill this gap by undertaking a study of how such estimates could be produced. This is the first output of that project.

The document maps existing datasets related to regional trade, outlines the methodologies that could be used to provide interregional trade estimates and identifies the data requirements – including the data sources.

[2] See for example, www.gov.scot/Topics/Statistics/Browse/Economy, www.nisra.gov.uk, www.ons.gov.uk/economy/regionalaccounts and https://statswales.gov.wales/Catalogue/Business-Economy-and-Labour-Market/Economic-Indices.

[3] www.gov.uk/government/publications/independent-review-of-uk-economic-statistics-final-report

1.2 Outline of the document

The purpose of this document is to outline what datasets are currently available in the UK in terms of trade flow estimates for UK regions (and crucially the origin and destination of interregional trade).

In Section 2, we provide an overview of the existing methodological approaches that we believe can be used to obtain regular annual estimates of interregional trade in the UK.

In Section 3 we describe available data related to regional trade that can be used as a starting point for this project.

In Section 4, we offer a description of some key data that might be used to develop interregional trade statistics.

The paper concludes with some discussion of the next steps to be taken in the subsequent stages of the project.

2. Methodology

The aim of this project is to create interregional trade matrix by product for four UK devolved regions. Table 1 presents a stylised version of regional trade matrix with only 2 regions. In this section we discuss possible methodological approaches to producing such matrix.

Table 1: A stylised regional trade matrix

		Importing region….		
		Region 1	Region 2	Region N
Exporting region…	Region 1	$r_{1,1}$	$r_{1,2}$	$r_{1,N}$
	Region 2	$r_{2,1}$	$r_{2,2}$	$r_{2,N}$
	Region N	$r_{N,1}$	$r_{N,2}$	$r_{N,N}$

Source: *Fraser of Allander*

The most obvious method to estimating interregional trade is to conduct a survey of major companies across the UK and to ask them how and what they sell to different parts of the country. Whilst technically straightforward, such an approach has several weaknesses.

Firstly, it would be resource intensive and, even then, could miss out a lot of key information (particularly if firms do not know which part of the country their goods or services are being sold to).

Secondly, it is likely that the data collected in a new bespoke survey would not be immediately consistent with the existing suite of economic data and regional accounts, which would create problems for producers

and consumers of these data. It is likely to take some time for a new survey to be fully integrated within an existing framework of national accounts.

Methodologically, it is logical to begin by estimating regional production and consumption[4]. This has a few important advantages when coming to estimate interregional trade.

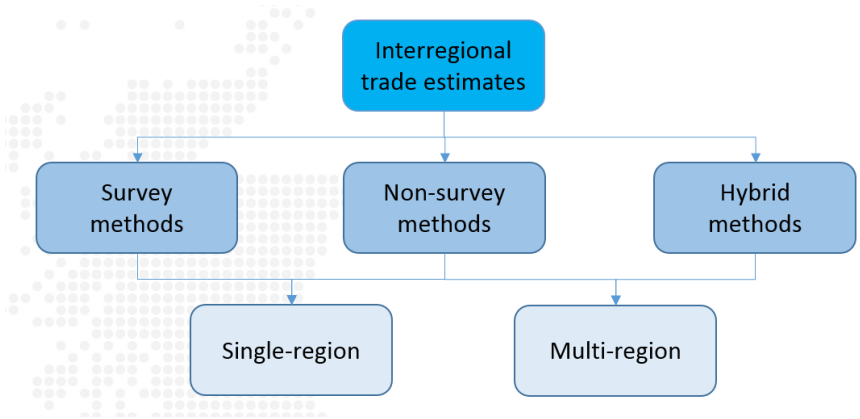
First, it allows for more methods, such as commodity balancing (i.e., the remaining balance of regional production and regional consumption after considering international imports and exports), to be used to estimate interregional trade flows by sector. Second, regional production and consumption statistics can be used to validate import and export statistics.

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

We discuss three key methods to producing estimates of interregional trade – as outlined in Figure 1. 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 of course possible to make an estimate for a single-region. These, in principle, can be less concerned with consistency, particularly between regions. There might, however, still be some value in estimating in greater detail regional trade flows within a specific part of the UK given the policy importance attached to a specific area.

Figure 1: Systems of estimating interregional trade estimates



Source: *Fraser of Allander*

[4] We use the term "consumption" to refer to all categories of demand.

2.1 Survey and non-survey methods

Survey methods and *non-survey methods* are two broad terms used when discussing the estimation of interregional trade flows.

Survey methods, as the name suggests, relies on a survey, or series of surveys, to estimate the various parameters and values directly. As highlighted above, such surveys could, in principle, encompass the volume and origins and destinations of interregional trade flows, without any other regional data being required.

As we discuss in Appendix, the Commodity Flow Survey (CFS) in the US, provides the best example of interregional trade estimates from a survey. Even here however, it is supplemented through additional surveys and estimation to produce a comprehensive picture of interregional trade.

The Northern Ireland Statistics and Research Agency (NISRA) has accumulated a large enough database on regional imports and exports, discussed in section 3, through the Northern Ireland Annual Business Inquiry (NIABI) so that its set of interregional trade estimates is close to a survey method.

Survey simply asks companies to declare how many goods and services are imported and exported (and their value) during the given period.

An alternative approach is to use non-survey methods. They rely on mathematical and statistical methods which seek to estimate interregional trade flows indirectly, usually from national accounts and other information.

Non-survey methods will, generally, use regional data to infer regional-trade flows from a set of national accounts. Various techniques to do this have been developed over decades and so a plethora of different approaches are now available.

Generally, these methods produce regional estimates by apportioning supply and demand from the national accounts (Supply and Use (SUTs) or Input-Output (IOTs) tables) to regions using data that are available at a regional level, and making broad assumptions about regional technology[5] based on the extent of specialisation (e.g., Thissen *et al*, 2013)[6]. Interregional trade is then apportioned between different regions based upon some form of allocation method.

In the simplest case, it is assumed that each region has the same production profile as the national economy only scaled by the relative sizes of each sector within each region. Additionally, it is assumed that there is no cross-hauling of goods and services, and so interregional trade flows simply account for the goods and services which are surplus to regional consumption/production.

[5] In this context, technology refers to the different percentages and ratios of inputs required to produce one unit of output in a given sector of the economy.

[6] This type of methodology was used by the Greater London Authority (GLA) Economics, to estimate international services exports from London prior to the publication of these statistics by the Office of National Statistics (ONS) (Keijonen, 2015).

Of course, such unrealistic assumptions can be relaxed with more advanced methods – e.g. encompassing heterogeneous technology assumptions and making assumptions to capture cross-hauling – but the underlying principle is the same. The key point is that, in a pure non-survey method, no parameters or values are directly estimated at a regional level through a survey, but instead everything is derived from key national data.

These methods tend to be used primarily by research institutions, and are useful in cases where data are not available but developing a set of regional tables is needed for system-wide analyses (Szabo, 2015). They can also be quite useful if the sole aim of the work is to get an approximate picture of long-term structural flows with the focus being upon the domestic and international consumption and production patterns within a region. These methods, though, likely lack a suitable level of precision for a regular annual or quarterly assessment of interregional trade flows themselves.

In summary, survey methods are generally considered more accurate but resource intensive. Concerns can still exist over accuracy, particularly if the firms responding to the survey do not know where the end destination of their product is.

Non-survey methods are significantly less resource intensive but necessarily build more statistical uncertainty into the estimation process.

A hybrid approach is therefore much more likely to be beneficial.

2.2 Hybrid methods

An alternative approach to choosing between survey or non-survey methods is to adopt a mixture of both. These so-called *hybrid methods* are arguably the most popular ways to estimate regional tables for the purposes of official statistics, and interregional trade.

In this case, the approach is two-fold. Firstly, a set of regional tables (either SUTs and IOTs) is estimated. Secondly, and concurrently, interregional trade flows are estimated using whatever information is available to apportion such flows. Some of this could come from surveys – e.g. asking companies where they are exporting to – or other data sources – e.g. sales information between firms in one region and consumers in another.

This mixed approach is ubiquitous in economic statistics. For example, the Statistics Canada's approach to estimating interregional trade (see Appendix) is comparatively very well developed, and elements of interregional trade are estimated directly from surveys; but this is not universal across all sectors, and so non-survey methods are used to infer interregional trade flow where there are no survey data.

Indeed, most comprehensive regional accounts will likely have to take the form of a hybrid approach, where certain sectors of the economy, or other components such as interregional trade, cannot be adequately – or cost effectively – estimated through a survey.

In our view, this is likely to be especially true for interregional trade estimates, since interregional importing and exporting are one of the most difficult statistics in regional accounts to observe.

Approaches used by other statistical bodies and organisations are outlined in the Appendix.

2.3 Our Approach

We have reviewed the full range of methods that could be adopted and discussed the various options with a group of key stakeholders at an event in October 2017 at the Fraser of Allander Institute – see Box 1.

Following this event, we resolved to adhere to the following three core principles for this project:

i. Consistency with National Accounts;

ii. Using available official statistics as much as possible;

iii. Consistency between regions.

Our approach belongs to the category of hybrid methods, i.e. we will use surveys where possible and complement them with other data and apportioning methods where there are gaps.

Figure 1: A stylised multi-regional Supply-Use Table

		Region A		Region B		Final Demand				Total
						Domestic uses	Exports			
		Products	Industries	Products	Industries		Region A	Region B	Rest of World	
Region A	Products		Intermediate demand			Consumption and GFCF		Interregional exports	International exports	Total use
	Industries	Output								Total output
Region B	Products				Intermediate demand	Consumption and GFCF	Interregional exports		International exports	Total use
	Industries			Output						Total output
Value Added			Regional GVA		Regional GVA					
Imports	Region A			Interregional Imports						
	Region B	Interregional Imports								
	Rest of World	International imports		International imports						
Total		Total supply	Total output	Total supply	Total output					

Source: *Fraser of Allander*

Figure 1 presents a simple diagram of a multi-regional SUT in which there are only two regions, and the incorporation of interregional trade into a consistent system of regional accounts.

As highlighted above, the hybrid methodology relies upon concurrently estimating both a set of regional economic accounts and finding some method to measure (or allocate) interregional trade flows. We discuss the first element of this in the next sub-section and then the estimation of origin and destination flows.

Box 1: Stakeholder Workshop – Fraser of Allander Institute, 13 October 2017

As part of a key deliverable of this project, the Fraser of Allander Institute hosted a workshop to discuss the proposed approach and developments so far.

Key stakeholders from the ONS, Scottish Government, Welsh Government and the Northern Irish Social Research Agency met at the Fraser of Allander Institute to discuss official statistics that may be useful in the production of interregional trade estimates for the United Kingdom.

The first part of the workshop discussed recent developments in improving trade statistics across the UK, both at a national and regional level. The workshop heard about developments and activities taking place in Wales, Northern Ireland, Scotland and the UK (via ONS).

The second part focussed on the work being undertaken to develop interregional trade estimates as part of the ESCoE project.

Researchers from the Fraser of Allander Institute provided a summary of the methods adopted in other countries and the benefits and challenges with different approaches.

The emerging outline of a methodological framework was presented and discussed. It was agreed that the broad approach was appropriate and the consistency with National Accounts principles was welcomed. It was also recommended that the best approach was to focus on the four nations of the UK as a starting point for the project's results.

Everyone in attendance agreed that the challenges to obtaining robust interregional trade statistics were significant. But that developing a methodology and utilising what data was available currently was an important first step, and would shed much needed light on what improvements would be needed over time.

2.4 Regional economic accounts estimation

At the outset, it is necessary to produce supply and use estimates for every region – a set of economic accounts for each region showing what is produced and consumed domestically; and what is traded outside the region.

These can be obtained either through the development of specific regional survey estimates or through the regionalisation of national IOTs (e.g., Szabo, 2015) or SUTs (e.g., Tobben, 2014).

In the UK, we are fortunate to have a mixture of region-specific estimates and estimates derived from the regionalisation of national tables.

Taking the four nations of the UK as a starting point –

- Both Scotland and Northern Ireland produce regular regional accounts containing some local estimates of technology (i.e., the input structure of production). This means that technology is not merely 'assumed' but observed for these regions of the UK for a number of sectors.
- The last IO tables for Wales were produced by the Welsh Economic Research Unit for 2007. Whilst dated, results from this study could be refreshed and used as a benchmark for further regionalisation attempts.
- Finally, no single-region SUT (or IO) has been produced for England. It could, in theory, be generated as a 'residual' region once regionalised tables are created for the devolved nations and then subtracted from the UK SUT (or IO).

As a starting point, it seems logical to proceed with pulling together regional economic accounts that embody the estimates that currently already exist for devolved regions (and thereby use available official statistics where possible) to derive a consistent set of regional accounts constrained to the national tables. Of course, in time and perhaps as more be-spoke regional tables are estimated, these could be updated and replaced once the methodology and modelling framework have been developed.

A new ESCoE project aims to produce a set of regional IO tables and to integrate them into the global IO table in order to estimate the extent to which regions in the UK are integrated into the world economy. We will collaborate with the team to exploit available synergies.

2.5 Origin and Destination Estimation

The development of a multi-region interregional trade matrix is the most difficult part of any complete multi-regional table.

While data are generally available to provide reasonable estimates of production and consumption at a regional level, little data are generally available to provide information of where goods and services may go to or come from. This is especially true in cases when a very large number of geographies may wish to be estimated.

Businesses themselves do not often know where products are ultimately sold within a country. And this is also true for trade within a firm – for example, where a company's service wing provides support for manufacturing activity in another location in the UK.

There are three broad groups of models that can be used to derive multi-regional trade flows, each having vastly different data requirements ranging from virtually no data to drawing upon extensive origin-destination data.

- *Location Quotients*

  Location Quotients, in their simplest form, will simply apportion interregional trade based on surpluses and deficits in production and consumption based on regional specialisation with no concept of distance included.

  These can sometimes be used as some initial estimates in a much more comprehensive estimation strategy. For example, Tobben (2015) determined the origins of imports based on the market-shares of the other region's exports and purchasing coefficients, as an initial estimate before updating them with the use of freight data.

  These methods tend to ignore concepts of distance and natural boundaries which may cause friction in trade flows, but – in turn – are theoretically simple and can be applied with virtually no data.

- *Gravity Models*

  Gravity models are much more widely used since these models add an additional layer of sophistication to simple location quotients by considering distance and other factors which may cause friction.

  These methodologies can sometimes rely on difficult to observe sensitivity parameters. Such methods are popular since the data requirements are not arduous and the results tend to offer a good approximation of true trade flows. Szabo (2015) defines such a model as

$$z_i^{rs} = \frac{(x_i^r)^{c_i^r}(x_i^s)^{b_i^s}}{(d^{rs})^{e_i}}$$

  Where z_i^{rs} is the magnitude of interregional trade from region *r* to region *s* by product*, x* is the regional output*, d* is the distance between the two regions, and *b, c,* and *e* are all sensitivity parameters, with *e* as a distance sensitivity parameter.

- *Use of data to infer origin and destination*

  The third approach is to use available origin-destination data to estimate potential trade flows. These methodologies are becoming increasingly popular, with the use of – for example – freight flow data to infer the value of interregional trade flows.

  Tobben (2015) uses an entropy maximising approach, where the initial estimate is generated from location quotients.

  The fundamental principle of this entropy maximisation approach is to estimate an Origin-Destination matrix that is consistent with a maximum number of all possible 'micro-states'

(essentially, various permutations of possible freight flow estimates between regions that are consistent with the observed data).

Thissen et al (2013) used freight data to derive a probabilities matrix for interregional trade from each origin to each destination, the total volume of interregional trade was derived from the regionalisation of national SUTs. The methodology makes a distinction between direct trade (i.e., trade which moves directly from its origin to destination) and indirect trade (i.e., trade which may move through transhipment locations). These are estimated separately to arrive at estimates of both interregional imports and exports.

The estimated probability of direct trade from region *i* to region *k,* $P^0_{i,k}$ with $T_{i,k}$ being the amount of goods transported.

$$P^0_{i,k} = \frac{T_{i,k}}{\sum_i T_{i,k}}$$

The fraction of goods transported directly between two regions, λ, can be observed or assumed, and is then used to estimate total trade.

The probability of indirect trade is also estimated, in case with a single transport hub *j*.

$$P^1_{i,k} = \sum_j P^0_{i,j}\, P^0_{j,k,k\neq i}$$

Thissen et al (2013) allow for the incorporation of more than one transport hub, and estimated both origin and destination separately, and using an objective function to reconcile the two estimates.

3. UK Data Sources Related to Regional Trade

In this section we map out the data that currently exist – or could be used – to help obtain an estimate of interregional trade in the UK. The overall framework and data sources that could be used to produce a multi-regional SUT are shown in Table 2.

Both Northern Ireland and Scotland use hybrid approaches in constructing their regional accounts. The data sources they use are very similar. Both devolved nations rely heavily on the Annual Business Survey/Inquiry, but also use UK tables and constrain some variables (e.g. value added) to ONS regional estimates (regional GVA). They also use sector-specific surveys where appropriate, primarily in agriculture but also in some services and transport.

Table 2: Data map for a UK interregional Supply and Use Table

		England		Scotland		Wales		Northern ireland		Final Demand						Total
											Exports					
		Products	Industries	Products	Industries	Products	Industries	Products	Industries	Domestic Uses	England	Scotland	Wales	Northern Ireland	Rest of World	
England	Products		None							None		None	None	None	HMRC (RTS); ONS (ITIS)	Total use
	Industries	None														Total output
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 (rUK)		EES (rUK)	EES (rUK)	EES; HMRC (RTS); ONS (ITIS)	Total use
	Industries			Primarily ABS, UK Tables (Also public-sector financial accounts, ASHE and some sector-specific surveys)												Total output
Wales	Products						Last known 2007 (WERU)			Last known 2007 (WERU)	Last known circa 2007 (WERU) (rUK)	Last known circa 2007 (WERU) (rUK)		Last known circa 2007 (WERU) (rUK)	HMRC (RTS); ONS (ITIS)	Total use
	Industries					Last known 2007 (WERU)										Total output
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 (rUK)	BESES (rUK)	BESES (rUK)		BESES; HMRC (RTS); ONS (ITIS)	Total use
	Industries							ABI, ONS Regional Accounts, UK Supply Table, HMT OSCAR database								Total output
Value Added			ONS Regional Accounts		ONS Regional Accounts		ONS Regional Accounts		ONS Regional Accounts							
Imports	England			Commodity Balancing (rUK)		Last known circa 2007 (WERU) (rUK)		Balancing, NISRA Broad Economy Sales & Imports Stats (rUK)								
	Scotland	None				Last known circa 2007 (WERU) (rUK)		Balancing, NISRA Broad Economy Sales & Import Stats (rUK)								
	Wales	None		Commodity Balancing (rUK)				Balancing, NISRA Broad Economy Sales & Import Stats (rUK)								
	Northern Ireland	None		Commodity Balancing (rUK)		Last known 2007 (WERU) (rUK)										
	Rest of World	HMRC (RTS); ONS (ITIS)		Pre-balance estimates from RTS, IPS, and Tourist Survey; HMRC (RTS); ONS (ITIS)		HMRC (RTS); ONS (ITIS)		CSO Trade Stats, Balancing, NISRA Broad Economy Sales & Import Stats; HMRC (RTS); ONS (ITIS)								
Total		Total Supply	Total Output	Total Supply	Total Output	Total Supply	Total Output	Total Supply	Total Output							

data available

some data available

no data available

Where methodologies deviate is in the estimation of trade, and particularly interregional trade (both Scotland and Northern Ireland estimate trade with RUK). Both methodologies are discussed in more detail in sections 3.2 and 3.3.

While Wales does not currently produce its own single-region SUTs, many economic variables that are used in the generation of Scottish and Northern Irish SUTs will likely also be available to those wishing to generate Welsh SUTs.

Before discussing interregional trade, we turn first to regional estimates of international trade by region. Such estimates provide an important first step in estimating interregional trade. The next subsection focuses on the international regional imports and exports, and how these are currently estimated in the United Kingdom.

The following sub-sections look at the methods used at a regional level, including the surveys undertaken by the Northern Irish and Scottish Governments.

3.1 UK estimates of international trade by regions

There are two primary sources of international regional trade estimates; the HMRC's Regional Trade Statistics (RTS) and the ONS experimental estimates of the value of international service exports for the UK regions. We discuss them in turn.

HMRC's Regional Trade Statistics

The HMRC's RTS estimates include all merchandise trade (i.e., goods but not most services), and is a regional breakdown of its Overseas Trade Statistics (OTS). A comprehensive list of imports and exports that the UK has used, in some form or other, for centuries.

It excludes intangibles and some services such as banking and tourism. The OTS is a dataset covering the whole of the UK at a partner country and product level.

The OTS uses the Combined Nomenclature (CN) classification, and is used not only for statistical purposes but also for tariff purposes. Each item in the OTS is identified through an eight-digit commodity code. In RTS these are aggregated to two-digit SITC Divisions.

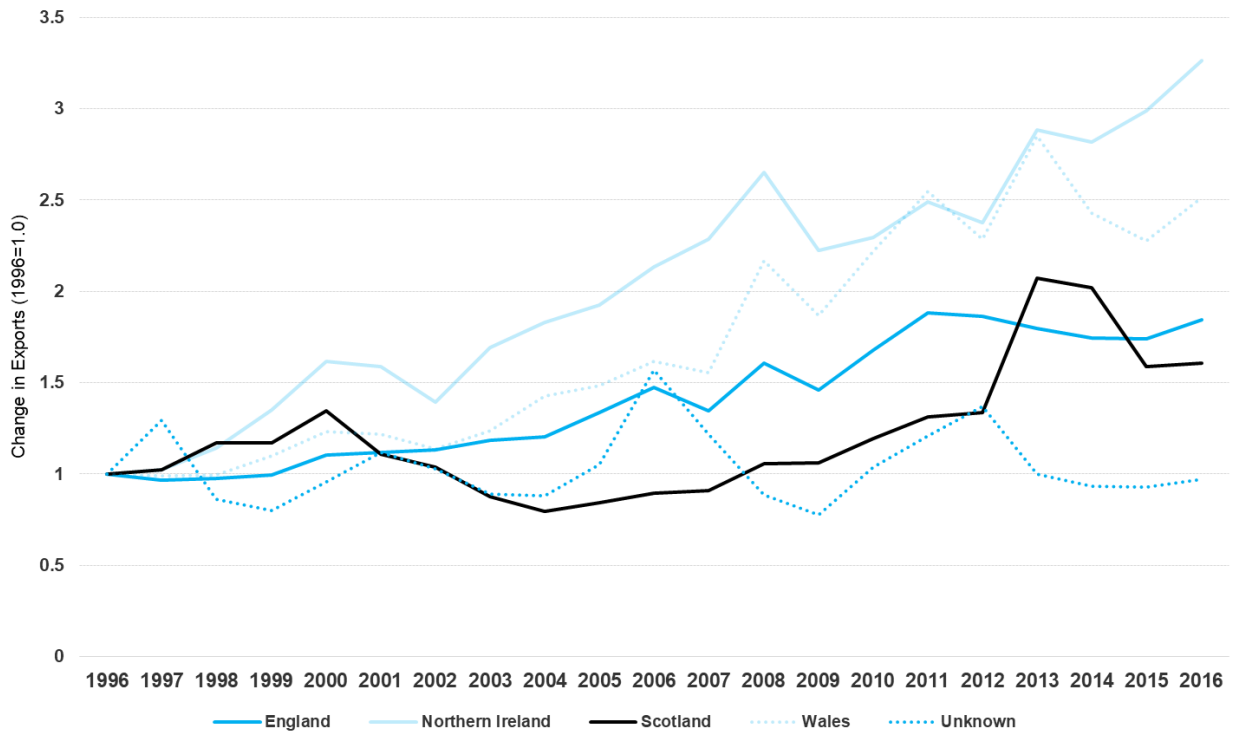
In compiling the RTS, the OTS is first merged with the Inter-Departmental Business Register (IDBR) based on VAT registrations. For companies which only have one branch the whole trade is allocated to the region where the company is registered for VAT. For companies with sites in different regions, the trade is allocated to a region based on the proportion of its employees employed in that region. This is consistent with the approach that assumes that all parts of an organisation contribute to exporting (rather than one based on head offices) or production centres.

Where a business is not matched with the IDBR, its head office postcode is obtained from the HMRC Departmental Trader Register (DTR) and matched with ONS postcode data in the National Statistics Postcode Lookup File. For businesses that are matched this way all trade is allocated to the region where the Head Office is registered.

Under this methodology, not all trade can be assigned to a UK region. This is referred to as 'Unallocated Trade'. This is split into 'Unallocated – Known' and 'Unallocated – Unknown'. The former is where trade details are known but it is not appropriate to allocate to a region (e.g. trade within the Channel Islands, trade by the UK Government, or trade by overseas companies who have a VAT presence in the UK). The latter includes invalid data, private individuals and low value trade. In 2017 Q1, roughly 8% of all overseas trade was unallocated, and roughly 2.4% was "unknown".

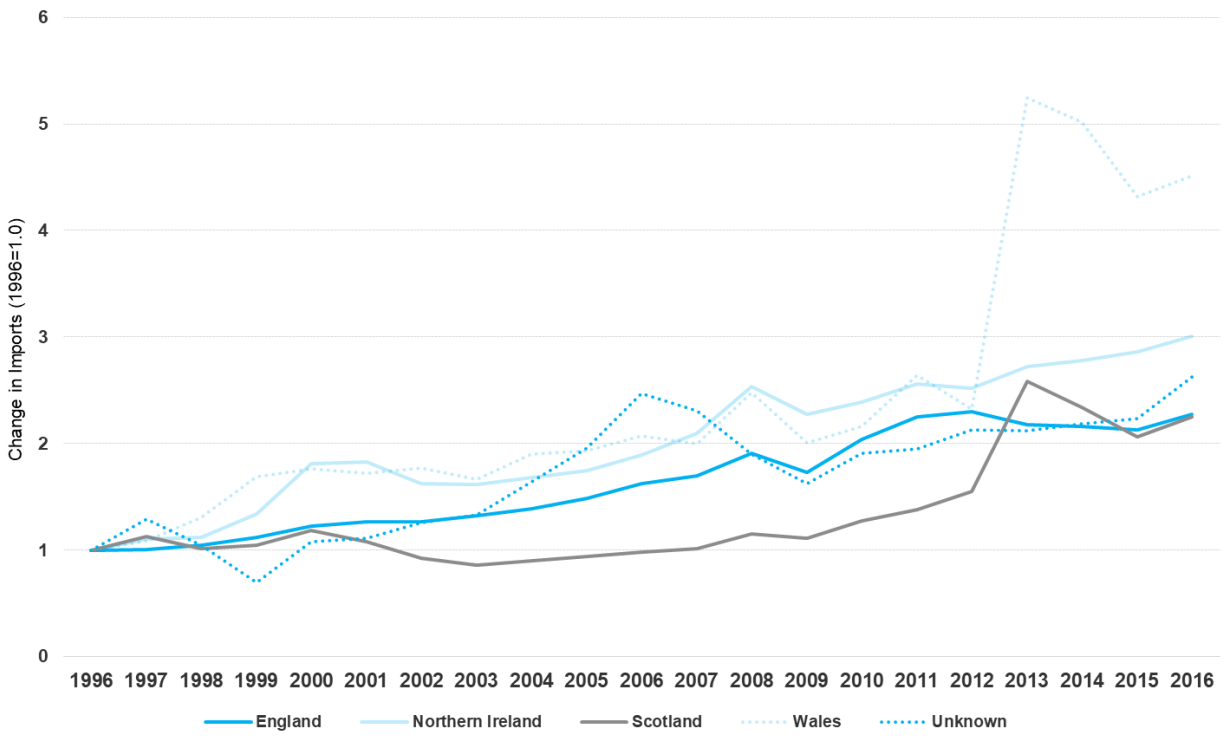
Figures 3 and 4 show the time series of regional international imports and exports. A significant revision took place in 2013. This is highlighted in Figure 4 where Welsh imports appear to have increased five-fold since the start of the RTS series.

Figure 3: Regional Trade Statistics estimates for international exports the four home nations, 1996-2016



Source: *HMRC RTS*

Figure 4: Regional Trade Statistics estimates for international imports for the four home nations, 1996-2016



Source: *HMRC*

This is likely due to a change in legislation on 1st May 2016 which affected the way goods are declared to Customs and the statistics are now produced on a "special trade basis", where goods are only recorded as an import once they are removed from customs warehouses and enter free circulation.

Due to a revision and changes in methodology, time series analysis incorporating stretching across 2013 (the date the revision was made) must be undertaken with caution.

ONS experimental estimates of regional service exports

ONS has recently produced experimental estimates of regional service exports (ONS, 2016). With services comprising most of economic output in the UK, this aims to respond to the demand for data on the exports of services distribution across the UK and by destination market.

The methodology essentially distributes the UK's national of international trade in services based upon the International Trade in Services (ITIS) survey to the UK regions. This survey collects the value of transactions by country of origin and destination from a sample of approximately 14,500 UK businesses each year.

Responses to the survey are used to calculate annual ITIS estimates of total UK trade in services. The data is classified by Standard Industrial Classification 2007 (SIC) four-digit code.

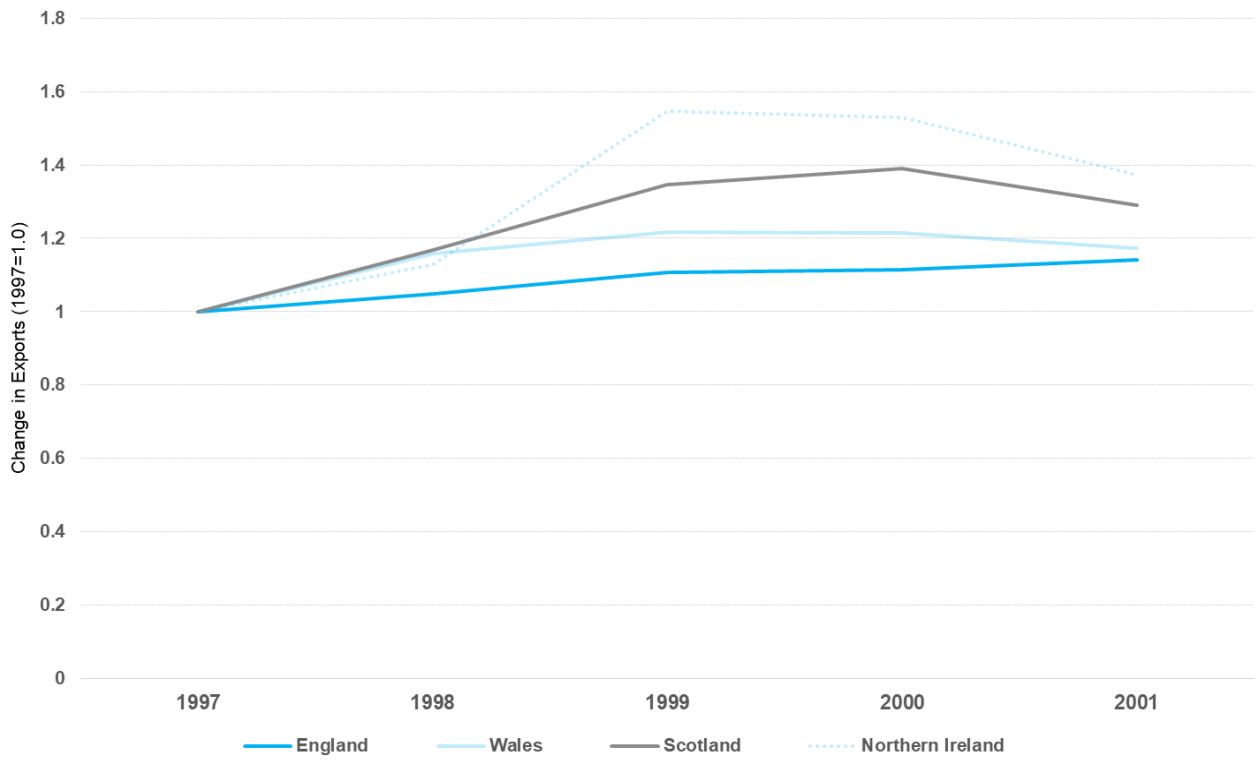
As with the HMRC approach for goods, the microdata contained within ITIS is then merged with the IDBR. Exports from each business are allocated based upon the company's regional employment distribution.

For some sectors alternative surveys are used for allocation: travel (International Passenger Survey (IPS)), transport services (Business Register and Employment Survey (BRES)/Annual Business Inquiry (ABI) for Northern Ireland), financial services (indicators of economic activity from the Bank of England and the IDBR), and pension & insurance services (BRES).

The resulting estimates are disaggregated into 13 sectors based on "functional categories".

Figure 5 shows the time series of regional international services exports by region.

Figure 5: ONS experimental estimates of international services exports for the four home nations, 2011-2016



Source: *ONS*

3.2 Scottish Government's trade flow estimates for Scotland

Scottish Exports

Alongside these UK-wide estimates, some parts of the UK also produce their own international and interregional trade statistics.

There are two sources of export data in Scotland.

- Export Statistics Scotland (ESS) and
- Index of Manufacturing Exports (IME).

The IME estimates the real-terms growth of export sales in the manufacturing industries using a Scottish extract of data on international sales collected by the ONS as part of their Monthly Business Survey (MBS).

The IME has been around for some time and is now incorporated into the Scottish quarterly bulletin on national accounts and primarily used to allow for a timely indication of quarterly changes in manufactured export demand.

The ESS uses the Global Connections Survey (GCS) to estimate the cash value of exports originating in Scotland. The Scottish Government views the GCS as the best source of information on exports from Scotland. It was introduced in 2002 and collects data annually.

The GCS is a voluntary survey and response rates have been noted to be disappointing (around 29% in the last round in 2015).

The GCS also attempts to capture trade flows to/from RUK. As an experiment, in the 2017 survey the Scottish Government has asked a question about where in the UK any inter-UK trade is going (split by England, Wales and Northern Ireland).

The GCS's sample of businesses is derived from the IDBR on the basis of area, size, industry, and export status.

The survey results are grossed up – using procedures consistent with the make-up of the IDBR – to ensure a robust reflection of the population of businesses in Scotland.

Since there are large variations in response rates at high levels of disaggregation by SIC and strata, the SG has an algorithm which iteratively collapses strata to ensure estimates have a minimum number of responses before statistical estimates are produced. The (employment) size strata is collapsed iteratively for each six digit industrial classification.

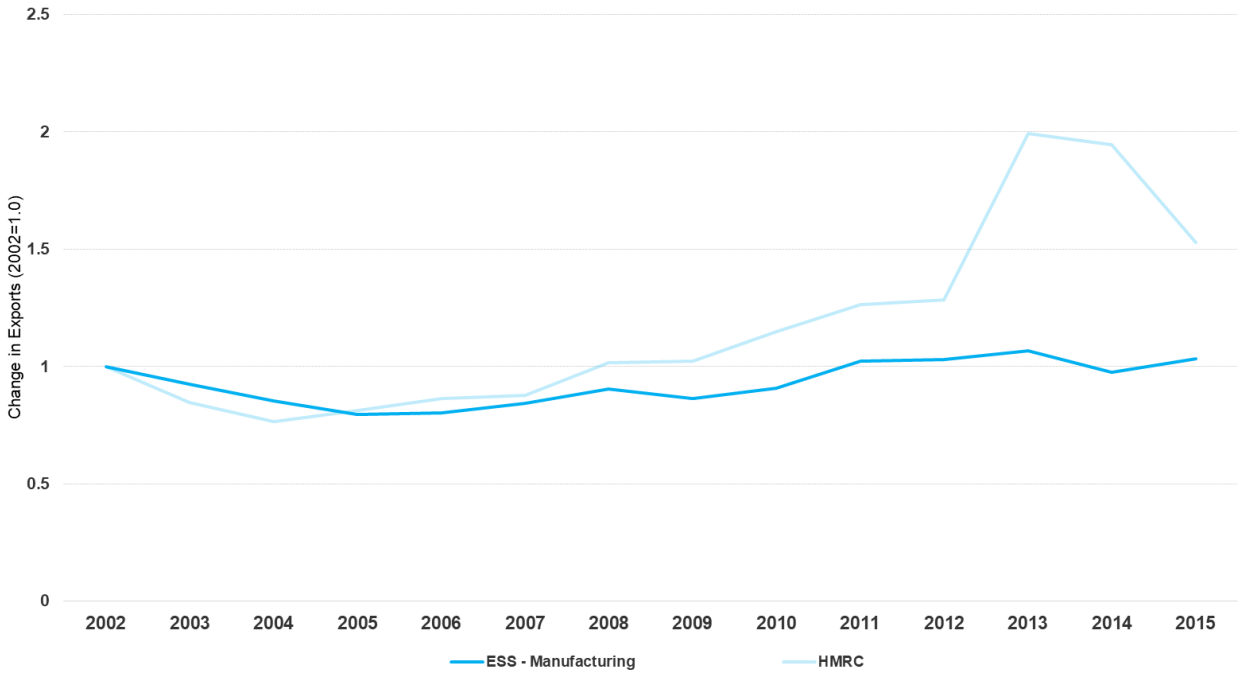
Ten companies are considered sufficient to estimate a multiplier (the ratio of exports to turnover). This multiplier is then applied to each company within their (collapsed) stratum.

Responses to the GCS are supplemented with information from other UK surveys supplied by the Office for National Statistics (ONS).

Estimates for some service sector international exports from the UK surveys take a share of UK international exports using Scottish employment, unless additional information is available to adjust for Scottish activity.

Figure 6 shows Scottish international exports estimates by the Scottish Government and HMRC. Since the HMRC only provides estimates of merchandise trade, ESS estimates of manufacturing exports are used as a comparison. The HMRC figures, show slightly different trends than the ESS.

Figure 6: A comparison between Scottish manufacturing international exports from the ESS and HMRC international export estimates, 2002-2015



Source: *ESS and HMRC RTS*

Even before accounting for the methodological change in 2016, that affects the series from 2013, the trends have diverged since 2008. This is likely due, in part to HMRC, attributing offshore crude oil exports based on rigs location, whereas the ESS does not.

The GCS feeds into the Scottish IO system.

Within the Scottish IO system, GCS export estimates are apportioned to exports on product Input-Output Classification (IOC) (the EES use SIC) using the Scottish SUTs at basic prices.

To differentiate between services and goods, adjustments are made to allow for the margin costs of that product to be recorded under the distribution product (such as the costs incurred by a retailer for selling a

good), and the product value (such as the costs incurred to a producer to make the good) to be assigned to the IOC of that product.

Scottish Imports

The Scottish Government does not estimate imports directly. The value of imports is calculated by using a balancing procedure, whereby total imports are inferred from the aggregate levels of Scottish production and consumption. This means that the Scottish Government depends upon a close to full set of regional accounts to produce estimates of imports. This, in turn, makes it especially difficult to estimate interregional imports. Imports from the RUK are considered to be of a "poor quality" by the Scottish Government, and caution is advised in their use.

Data from the RTS, IPS, and the Great Britain Tourist Survey allow for "pre-balance" estimates, for the Rest of the World imports. RUK imports are then estimated based on the proportion of RUK imports in total supply in the previous year, and are distributed by product based on GCS results and the UK import structure in the UK SUTs.

Note on extra-regio

Extra-regio refers to output that cannot be assigned to a region, and includes output associated with offshore oil production. Historically, ONS regional accounts do not assign extra-regio activities to any single region.

Since Scottish national accounts tend to heavily rely on the ONS regional accounts framework, oil & gas extraction activity is excluded from the Scottish IO tables, and only mainland activities "incidental to extraction" are included. The Scottish Government does publish national accounts including oil & gas.

The Scottish Government is working on a project to develop a greater coverage of offshore and onshore trade flows between onshore and offshore Scotland. This will be presented as an offshore satellite account alongside the Quarterly National Accounts for Scotland publication in February 2018.

3.3 Northern Ireland Statistics and Research Agency (NISRA) trade flow estimates for Northern Ireland

Historically, Northern Ireland has had a number of surveys that measure exports, but no single published source which provides the comprehensive statistical picture on exports for the whole economy.

There are several data sources offering estimates of different facets of Northern Ireland's export performance: HMRC Regional Trade Statistics (RTS); the annual NISRA Manufacturing Sales and Exports Survey (MSES); the Exporting NI Services Survey (ENIS) (Buchanan, 2015).

More recently, NISRA has started producing "experimental" series, Broad Economy Sales and Exports Statistics (BESES). The purpose of this publication is to provide a unified picture of Northern Ireland's trade

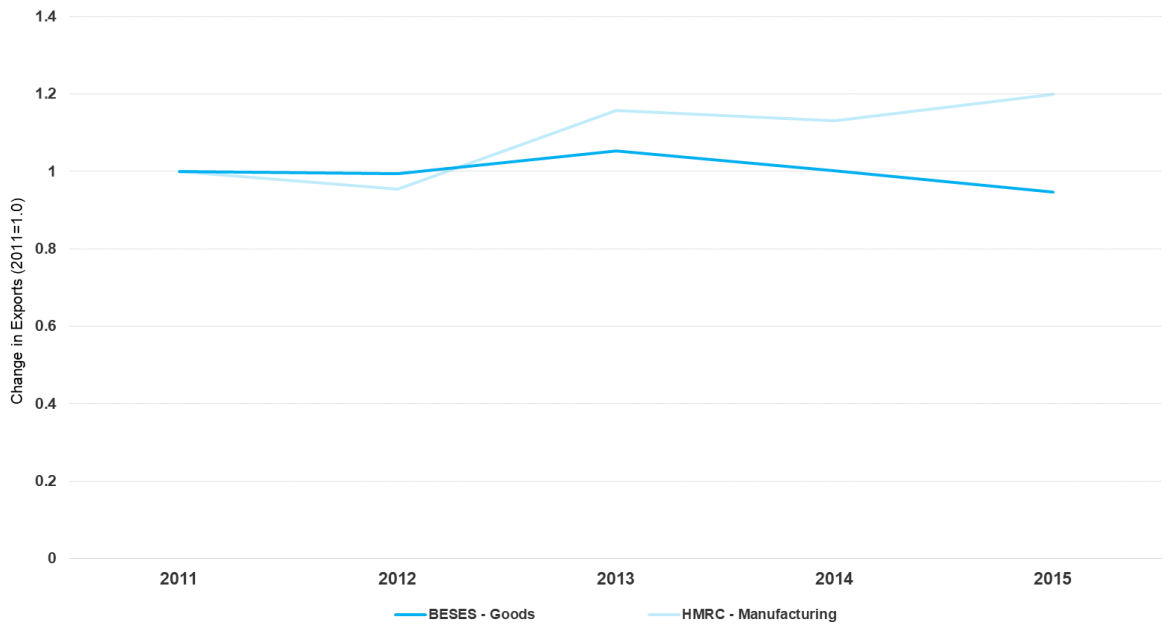
with the outside world. Trade estimates (import and export) are disaggregated by SIC derived directly from the Northern Ireland Annual Business Inquiry (NIABI). The survey covers all large businesses (50+ employees and manufacturing businesses with 5+ employees), and a sample of smaller businesses. This covers around 20% of all businesses each year.

The nature of the NISRA's survey has meant that Northern Ireland now has a large database that links companies' exports, imports and external sales to Great Britain. Both HMRC RTS and BESES data are used to derive import and export figures by sector, and significant reconciliation work is conducted periodically to identify gaps and issues in the data. The primary concern for NISRA statisticians currently is discrepancies between these two data sources arising from differences in ROW trade.

Furthermore, ROW imports to Northern Ireland can rely on both HMRC and BESES totals to derive import totals by industrial sector. For RUK imports, NISRA will only use 'commodity balancing' as a last resort for RUK imports, which are less certain since only BESES captures a survey estimate of total interregional imports to Northern Ireland.

Figure 7 compares BESES and RTS data, in this case the trends are different, with HMRC suggesting a large increase since 2011, and BESES showing very little change. The change in HMRC methodology may have had an impact on these results.

Figure 7: A comparison between Northern Irish goods international exports from BESES and HMRC international export estimates, 2011-2015



Source: *BESES and HMRC RTS*

Work is currently being undertaken by NISRA to identify the key differences between HMRC and BESES estimates.

3.4 Welsh Economic Research Unit's (WERU) Input-Output Tables for Wales

The latest example of Welsh international and interregional trade estimate we found in a 2007 Welsh IOT produced by the WERU in 2010 (Jones *et al* 2010).

The overarching methodological framework was one of apportionment from a UK national IO framework, "often based upon the different industry/employment specialisation of the region compared to the national average" (*ibid,* p. 7).

International exports were derived from RTS for manufacturing goods. Both international services exports and interregional (with RUK) exports were estimated through questions in WERU's own survey data.

The interregional and international imports were estimated as balancing items only once a Combined Use table was constructed. The trade balance would also have been inferred from final demand estimates.

The WERU team produced import propensities for each sector in the economy, which were largely based on existing data sources but complimented to a limited degree by surveys. This determined how much of final demand for each product is serviced by Welsh produced goods and services for each type of demand in a standard IO system.

4. Data sources for origin-destination statistics

Section 3 established the current data that can be used to partially complete the multi-regional SUT shown in Table 2. This section gives examples of data required to determine the origin and destination of goods and services within the UK. This is just the beginning of the exploration of the new data sources which will be continued in the second deliverable for this project.

Table 3 shows that the methodology currently differentiates between two sectors; goods and services. It is assumed that most goods can be approximated using freight data, while services must be approximated with business-class travel statistics.

As a result, the section is primarily focused on freight statistics, which is likely the best available official statistic that could be used to estimate the origin and destination of goods within the UK. The section finishes with discussion of availability of data that would likely be necessary to estimate the origin and destination of services within the United Kingdom.

Table 3: Data requirements for estimating destination and origin of interregional trade flows

Sector	Possible Sources	Source	Section
Goods	Road Freight	Continuing Survey of Good Transport (DfT)	4.1
	Rail Freight	Office of Road and Rail data collections	
	Shipping Freight	DfT data collections	
	Air Freight	CAA surveys and data collections	
Services	Business-class travel (air)	CAA surveys and data collections	4.2
	Business-class travel (rail)	ORR data surveys and data collections	
	Financial transaction data	ONS data campus	4.3
	Other sources	Various (discussion)	

Source: *Fraser of Allander*

4.1 Origin and destination for trade in goods

In section 2.5, it was discussed that freight statistics are often used to infer the origin-destination of trade flows. In practice, freight flows are only used to estimate the flow of goods. This is because services trade consists mainly of intangibles which are not physically moved.

Continuing Survey of Road Goods Transport (CSRGT)

According to the Department for Transport, road (HGV) freight accounted for nearly all goods lifted within Great Britain in 2015 (circa 90%), and accounted for around three-quarters (76%) of goods moved[7].

The main source of road freight data in the UK comes from the Continuing Survey of Road Goods Transport (CSRGT), administered as two separate surveys for Great Britain and Northern Ireland.

The CSRGT is a survey sampled from DVLA-registered Heavy Goods Vehicles (HGVs); stratified by region and vehicle type and weight. It excludes information on Light Goods Vehicles, the activity of GB-registered HGVs operating outside of Great Britain and foreign-registered HGVs.

The full sample size (for returned survey forms containing trip information) for the last year (2016) was roughly 8,500.

The CSRGT provides a considerable amount of information concerning commodities being transported by road, along with information on the origins and destinations of these commodities.

[7] Goods lifted measure the weight of freight goods carried, measured in tonnes. Goods moved measure the weight of goods carried, multiplied by the distance hauled, measured in tonne kilometres.

The current annual survey is not believed to give a sufficient sample size for a complete suite of inter-regional freight flows to be publicly available. Table 3 shows publicly available data for 2015. Not all information is readily available, but the underlying data can provide a better picture.

Table 4: Estimates of interregional road freight in the United Kingdom, 2015

Million tonne kilometres

	Destination			
Origin	**England**	**Wales**	**Scotland**	**Northern Ireland**
England	135,448	3,917	6,425	
Wales	4,150	3,478		
Scotland	4,950		11,239	
Northern Ireland				200

Estimates not recorded or unavailable due to sample size

Source: *Continuing Survey of Road Goods Transport (Great Britain)*

Further inspection of this dataset will be required to examine the unpublished interregional data. In developing an initial approach, one option could include comparing the statistics that are unpublished with any outputs that the Scottish Government may obtain as part of their experiment with the Global Connections Survey to estimate Scottish exports to other parts of the UK. Another could be to use pooled samples over a few years to obtain some estimates for any gaps that remain.

While it is likely that considerably more volumes of indirect trade may go undetected at long distances, it is also likely that, in the case of Northern Ireland, there are significant modal differences (e.g., Northern Ireland has quite different multi-modal freight links with other parts of the UK).

Rail Freight statistics

The Office of Road and Rail collects data on rail freight. For freight moved, data are available from Network Rail. 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%.

These companies do not have consistent commodity groups in the data that are supplied. At the current time therefore, freight lifted cannot be provided at the same level of disaggregation as freight moved. An exercise would therefore be required to align them.

The Office of Road and Rail statistics on UK-wide freight flow are published according to the following major commodity groups – Coal, Metals, Construction, Oil and Petroleum, International, Domestic Intermodal and Other. Other includes domestic automotive, domestic waste, enterprise, general

merchandise, mail and premium logistics, royal mail, and bio mass. These statistics are published on a quarterly basis.

The annual official statistics publication currently do not offer a comprehensive origin and destination of freight by commodity types. Further breakdowns are possible but are commercially sensitive and so not included in statistical releases.

We will investigate the possibility of using these data to allocate the interregional trade in goods within the UK.

Shipping Freight Statistics

Published maritime statistics are largely based on returns from ports that allow for estimates of both inward and outward shipping freight by main port. The data concerns freight handled at UK ports, by weight and number of units loaded and unloaded. The data are complemented by a survey of inland waterways to produce figures of total waterborne freight in the United Kingdom. The maritime statistics are also complemented by ship arrival data provided by Lloyd's Marine Intelligence Unit.

Shipping information between the four nations of the UK, provides overall tonnage moving between ports. Since these data are estimated by main port, issues around re-export 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).

Northern Ireland has considerable volumes of HGVs, which is to be expected since there is no road link.

Air Freight

The Civil Aviation Authority (CAA) collects statistics from all UK airlines, and produces monthly aggregate information. The CAA publishes high-level aggregate information about the activities of UK airlines, and reports the information in monthly bulletins. This includes information on total cargo lifted by airline on domestic and international services, respectively.

A great deal of other information may be contained within the Airline database, but is considered too sensitive for publication.

European Transport Policy Information System (ETIS)

ETIS-PLUS is a European Transport Policy Information System that combines data across Europe, offering origin-destination data for freight flows between regions (as low as NUTS 3). The ETIS-PLUS database forms the core of the various European transport models.

The database contains a series of freight matrices for each mode of transport. For Road Freight, estimates of interregional road freight by commodity was estimated using international road freight statistics, road freight between country pairs, and total road freight per region. ETIS-PLUS also obtained a partial NUTS3-NUTS3 road freight matrix from Eurostat. The construction of the rail freight Origin-Destination matrix was "as reliable as possible given the limited – and sometimes problematic – data availability".

ETIS-PLUS obtained rail freight information from the Department for Transport in 2010. The database, therefore, contains the estimates of UK interregional rail freight based on NUTS 1-NUTS 1 rail freight information, which was not further disaggregated by commodity.

Estimating interregional maritime freight was relatively simple since most EU countries contained port-to-port information. This information simply meant that commodity distributions had to be estimated on mode of appearance (e.g., containers, dry bulk, liquid bulk) and trade data.

Air Freight was also estimated. This process involved building up an air cargo network and 'enriching air links and air nodes' with measured cargo volumes from world trade statistics. These, in turn, were used as the basis of updating previous estimates.

We will investigate the possibility of using this database to estimate interregional trade flows.

4.2 Origin and destination for trade in services

Estimating the origin and destination of services is much more difficult. Many services are intangible, meaning they are not physically moved. Furthermore, many services can be difficult to define appropriately.

Business-class travel

One option used by others (e.g. Thissen *et al*, 2013) to infer the origin-destination of interregional services trade is business travel. The idea is that companies' representatives are traveling to the regions where their clients are located.

Departing Passenger Survey

Surveys have been undertaken since the late 1960s to obtain information on departing passengers. This is the responsibility of the Civil Aviation Authority (CAA).

The surveys collect various determinants of passenger air travel, and includes some origin-destination statistics.

The surveys initially operated in cycles until demand for more regular data has resulted in continuous surveys in 1996 at Gatwick, Heathrow, and Manchester airports. In 2001 Luton and Stansted were added to the continuous survey, in 2010 Birmingham and East Midlands were added, and in 2012 London City airport was added. Other airports are also surveyed, but much less regularly. Overall, around 200,000 passengers are interviewed per annum.

The CAA offers bespoke subsets of these data, which are available for purchase.

Business-class Ticketing (Rail)

Steer Davies Gleave is an international consultancy, which currently produce an origin-destination matrix using the Model of Inter-Regional Activity (MOIRA). This is the train service model of business-class passenger volumes based on the Latest Earnings Network Nationally Over Night (LENNON) ticketing and revenue database (Steer Davies Gleave, 2013).

Upon privatisation of the train operators, responsibility for passenger demand forecasting passed to the Passenger Demand Forecasting Council (PDFC). The PDFC restricts access to only those that contribute to the development of their forecasting models, which includes MOIRA and its results (Worsely, 2012).

MOIRA acts to link passengers travelling between origins and destinations identified through LENNON to timetable data, including data on train capacities. The database is largely used to project and forecast passenger demand.

Steer Davies Gleave's Origin-Destination Matrix (ODM) uses the demand matrix from MOIRA with many adjustments and overlays. These adjustments include processes such as allocating demand across London terminals and accounting for 'unknown destinations'.

4.3 Other Origin-Destination Statistics

There are limitations in using business-class ticketing to estimate interregional services trade. While these data do offer an indication on the movement of individuals, there is no guarantee that they accurately reflect the origin and destination of sales, particularly across several uniquely different sectors.

It should also be remembered that certain services sectors might be easier to estimate than others. For example, Statistics Canada use cable subscriptions for estimating interprovincial trade of telecommunications. But they also accept there are some sectors which are too difficult to estimate through a survey, and use non-survey, apportioning methodologies to assign interprovincial Financial Services trade.

We will investigate various alternatives to the use of business travel data to estimate the origin and destination of services trade flows.

One possible alternative which could be used for both trade in goods and services is financial transactions data from one or more major payment technology providers and/or banks.

ONS via Data Campus have begun exploring the potential of using this type of data for the purposes of improving ONS outputs. However, at this stage the timeline of acquiring these data and what information it will contain is still unclear. We will continue our dialog with the Data Campus to explore the possibility of using these data when/if it becomes available.

5. Data Gaps and Discussion

This paper has discussed the methodologies allowing to estimate the interregional trade and availability of the required data in the UK.

International experience (see Appendix) suggests there are different options to produce more detailed information on regional economic interactions. These range from an 'Australian model' of assisting a large academic consortium which can produce regionalised accounts that may not qualify for UKSA certification. Less regular surveys undertaken every few years, modelled on the Finnish case or the American case, could also be used to estimate key interregional trade parameters that could allow others to take forward more comprehensive estimation procedures. The 'Canadian model' of fully integrating regional dimensions into the existing surveys would allow for rigorous estimates of internal trade patterns across the UK but that would be expensive.

We suggest that any approach to interregional trade should begin with the devolved nations of the United Kingdom. This is primarily due to the investment that has been committed to the production of regional economic statistics by the Scottish Government, Northern Ireland Executive, and the Welsh Government.

Any methodology should ensure consistency with national accounts, consistency between regions, and use official statistics where possible. To produce meaningful interregional trade estimates from existing data, there are three key issues that must be resolved.

- ***Regionalisation of UK SUTs or IOs***: If deriving an English table as a residual from the regionalisation of devolved nations from national tables is straightforward, the main data gap in the data infrastructure is an up-to-date single-region SUT (or IO) for Wales. The primary solution to filling this gap will be to update the last known SUT (or IO) for Wales, which is 2007. Otherwise, a more conventional non-survey method of regionalisation would have to be adopted.
- ***Freight-flow statistics in the United Kingdom***: The primary data collected by the Department of Transport is promising as a starting point for allocation of the interregional trade in goods within the UK. We will explore this option during the second stage of the project.

- ***Estimating flow of services through a proxy***: While some data on business travel for rail exists, it is likely that the information required for domestic flights has significant disclosure issues. We will pursue this line of enquiry and will also evaluate other data sources, such as financial transactions data from banks.

There are many data sources that are currently available to complete such a task. In the case of both regional production and consumption, both Scotland and Northern Ireland call on existing surveys to produce regional accounts. In the case of Wales, it is likely similar sources could be called upon.

In terms of international trade, both Scotland and Northern Ireland conduct their own surveys to estimate interregional trade estimates. The key difference between the two nations is that Northern Ireland estimates imports directly, while Scotland relies on commodity balancing to infer import totals for the rest of the UK.

HMRC also offer a source of international trade figures, but care must be taken when using these data since there are several significant revisions to the methodology that have made comparison over time problematic.

ONS experimental figures on international services exports by regions are not official statistics, but is likely a key source of data for Wales, and other regions of the United Kingdom, if further regionalisation of England was desirable.

Both Scotland and Northern Ireland estimate interregional trade through their respective surveys. There are, however, alternatives to using a survey to estimate interregional trade for any given region that is unable to commit to a full survey.

In terms of estimating the origin and destination of interregional imports and interregional exports, we have suggested it might be possible to provide non-survey estimates of origins and destinations given appropriate data. While freight seems a logical choice for estimating trade in goods, for estimating the flows of services there is no immediately apparent, universal data source that can satisfy the complex nature of services importing and exporting.

Appendix. International Practice

The methodologies discussed in section 2 have been applied across the world. Since non-survey methods can have relatively small requirements, it is unsurprising that these methods have been applied on more widespread basis than survey methods.

The data-light approaches tend to be unappealing to statistical authorities since it would be much more difficult to justify an official statistics designation.

Most official statistics, therefore, rely upon using surveys to generate estimates of interregional trade.

However, in some cases official statistics organisations may work with data users to produce the means to create regionalised accounts that may not be sufficient to warrant official statistics designation.

Canada

Statistics Canada provides complete sets of official regional accounts. This is a good example of a comprehensive hybrid approach. See Généreux P.A. & Langen B. (2002) for a complete overview of the methodology.

Interprovincial trade flows underwent a significant development in 1997. Now interprovincial trade is estimated using a "blended approach of, on one hand, survey/administrative data providing essential information on provincial 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 provincial supply (mainly production) and demand statistics" (i.e., a regional IO framework) (ibid, p. 6).

Most sectors are covered by some form of destination-origin question in a survey (e.g., interprovincial movements of agricultural products are derived from surveys Agricultural Services of Canada or from administrative records), but certain service sectors, notably Financial Services, are not covered by surveys, and these sectors will rely on non-survey methods.

Finland

Statistics Finland estimated interregional trade flows as part of two ad-hoc projects in 1996 and 2002 in the process of producing interregional IOTs.

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 Finish regions.

Statistics Finland followed these ad-hoc projects with the application of non-survey methods (both gravity models and a freight-flow). The results were used to evaluate the effectiveness of non-survey methods in estimating interregional trade in Finland.

Louhela (2006) concluded that the freight flow model "worked" for goods, but no attempt was made to capture services. There were, however, problems in the estimation of trade between small, distant regions.

United States

The US Census Bureau (2016) together with the Bureau of Transport Statistics provides an example of a relatively pure survey method to provide some estimates of interstate trade flows.

Albeit limited in scope, the Commodity Flow Survey (CFS) is conducted every five years and tries to provide a comprehensive assessment of interstate trade flows. The CFS is a survey of interstate trade flows of mining, manufacturing, wholesale, and selected retail and services trade industries.

The survey only offers partial coverage and is, therefore, currently performing a fundamental role in internal trade analysis, offering a more complete state level accounts, and also a basis for others who may wish to estimate a complete set of regional accounts (Southworth, 2005).

In order to produce a full set of interregional trade statistics, encompassing all industries, a much more comprehensive strategy is required, which draws on other data sources at a state and national-level. For example, Caron et al (2014) construct a multi-regional input-output table and use the CFS to infer interstate trade flows.

Australia

The Australian Bureau of Statistics (ABS) does not produce interregional IO tables itself, because they would rely on many assumption, which is inconsistent with the principles of national statistics. Instead the ABS works closely with universities to allow them to produce multi-regional IO tables, by providing the necessary underlying data.

The ABS instead worked with a large consortium of Australian universities to create the Industrial Ecology Virtual Lab (IELab) (Lenzen et al, 2017).

Researchers working on the IELab argue that the choice of regionalisation should be informed by the delineation of data structures within the system, and so the platform allows users to choose their own regionalisation strategies, and offers the choice of ten different non-survey methods that can be used in the formulation of an interregional trade matrix.

The IELab, essentially walks the users through the process of creation of full multi-regional IO matrices at levels of geographic disaggregation. The ABS provide a large amount of data underlying the system, which is then used within IELab and forms the basis of subsequent regionalisation.

Examples of unofficial estimates of interregional trade

Producers of official statistics, have a number of options when developing tools for analysis at a subnational level.

In the case of Canada, considerable amount of effort has been used to develop comprehensive interprovincial trade flow estimates within a suite of regional economic accounts. The USA and Australia, in comparison, offer the tools for others to create more comprehensive measures of international trade than their respective statistical agencies provide.

In the case of the USA, some interstate estimates are generated through a survey, and the ABS simply works closely with the academic sectors to allow the creation of customisable regionalised tables.

Finland, in comparison, conducted an ad-hoc project to estimate a full suite of interregional trade data, conducting a large one-off survey.

There are, however, a plethora of regionalisation exercises that take place outside of national statistical agencies (e.g., Haddad and Hewings (1998), Tobben (2015)). However, two large-scale projects stand out.

Detailed Regional Economic Accounting Model (DREAM)

Gibson *et al* (2005), much like the academic team in Australia, produced software which allows for the automation of the broad methodological steps outlined in the methodology section. The DREAM software has existed for some time, and is constantly adjusted based on consultation with producers of official statistics.

DREAM largely produces tables for use within local economic impact studies that take place in the United Kingdom. This software relies upon gravity models to allocate the origin and destination for exports and imports, as well as deriving full multiregional SUTs as far down as NUTS4 regions using location quotient modelling.

European Union

Thissen et al (2013) outlines a complete non-survey approach in the generation of a multi-regional interregional trade matrix for European Union NUTS2 regions, using a methodology very similar to the one described in section 2.

Using multiple national-level tables, a regionalisation strategy was followed using location quotients and assumptions around cross-hauling to derive estimates of regional production and consumption.

Freight flow data produced by European Transport policy Information System (ETIS) (discussed in section 4) was used to estimate the origins and destinations of trade flows, in the methodology described in section 2.

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