

Working Paper No. 573

October 2017

Ireland's international trade and transport connections

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Abstract: This paper looks at the transport patterns of Irish international trade. In particular, we examine how trade flows in weight differ from those measured by value and the implications that this has for transport mode and cost. In an environment of uncertainty relating to the impact of Brexit, the much larger share of the UK in total Irish export volumes (tonnages) compared to values signals possible significant impacts on transport and also on costs if increased customs procedures are introduced. We also look at the use of the UK as a land-bridge for Irish trade further afield, finding that a considerable percentage of Irish trade uses this transport option.

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Keywords: Merchandise trade, transport, Brexit.

JEL Classification: F13; F14; F17.

Acknowledgements: This research is part of the joint Economic and Social Research Institute and the Department of Finance/Revenue Commissioners Research Programme on the Macro-Economy and Taxation. We would like to thank the members of the steering committee of the research programme for many helpful comments and Zuzanna Studnicka for assistance on trade scenarios. The views expressed in this paper are those of the authors and they should not be regarded as an official position of the Department of Finance or the Revenue Commissioners.

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1. Introduction

The decision of the UK to leave the European Union is likely to have a significant impact on the economic relationship between the UK and the EU including Ireland, although the magnitude of this effect is quite uncertain and depends on the nature of the future relationship between the UK and Ireland. A number of studies have emerged that are trying to establish how this event would impact on the UK (e.g. Dhingra et al., 2016; or Ebell et al., 2016) and on the EU (e.g. Schoof et al., 2015; Kierzenkowski et al., 2016; or EC, 2016). A key finding from these studies is that Brexit will reduce trade flows between the UK and the EU. Less trade implies that the demand for international transport will also decline. Brexit may also have more direct effects on international transport to and through the UK, through the potential reintroduction of customs controls between the UK and the EU resulting in delays at the border, possible deviation of transport regulation between the UK and the EU and the change of regulation governing transit through the UK to and from Ireland¹.

A number of papers have shown that border controls and customs procedures result in significant costs, which will lead to reduced trade flows. Taylor et al. (2004) estimate that border and related costs between the US and Canada, where a free trade agreement is in place, amount to 2.7 per cent of the value of merchandise trade. The analysis of the effect of different trade clearance regimes across EU Members for imports from non-EU Members, shows that a one percent increase in border delays reduces trade by 0.44% (Bourdet and Persson, 2012). A detailed study of trade compliance costs for meat imports from outside the EU into the UK found that port clearance costs for a 20 foot container containing 13 tonnes of meat range between £382 and £673 (Grainger, 2014).

While all the analysis of trade impacts of Brexit to date has focused on the value of exports, the volume (in terms of tonnage, number of containers or the number and type of transport vehicles), that is key to assessing the impact on the transport sector, as well as the potential implications for customs, has to date not been analysed.

Across all of the UK's trading partners in Europe, the Irish economy appears to be the most at risk of being negatively hit by any increases in trade barriers, due to its higher share of trade going with the UK and the composition of that trade in sectors where higher tariffs tend to apply (Barrett et al., 2015; Lawless and Morgenroth, 2016; Department of Finance, 2016, 2017, Bergin et al., 2017). As the aggregate analysis has consistently found a high level of exposure for agri-food, there have also been pieces more specifically focused on the impact of Brexit on this individual sector, such as Donnellan and Hanrahan (2016) and Matthews (2015). Importantly, Ireland is the only country with a land border with the UK and given that the shortest sea crossings from Ireland are to the UK, the UK is also important for transit traffic to and from Ireland. The potential impact on transit traffic implies that in addition to Ireland other countries will be affected by any change in transit regime.

¹ Transit is a recognised customs procedure for moving Union goods through 3rd countries or non-Union goods from one point of the EU to another, without having to pay customs duty or VAT and without changing the customs status of the goods. Goods currently travel through the UK to/from Ireland under the transit procedure.

Despite declining considerably as a share of Irish merchandise exports in recent decades the UK remains a very large trading partner for Ireland. Under all but the most benign outcomes to the Brexit negotiations, it is likely that some customs procedures will be necessary. The evidence from the international literature shows that this is likely to reduce trade between Ireland and the UK, which will reduce the amount of trade-related transport activity between Ireland and the UK due to increased transaction costs. Given that a significant share of Irish merchandise exports and imports transit through the UK, other Irish trade could potentially also be affected by this.

It is well-known that the UK makes up a large share of Irish trade in terms of value; however, the share of trade volume with the UK is larger again. While the UK accounts for 14 per cent of Irish goods exports in values, it makes up a 55 per cent share of the export weight (based on 2016 trade data). Similarly 25 per cent of the value of Irish imports originates in the UK but this makes up 42 per cent of import volumes. This is consistent with theories of international trade that have always argued that heavier products will be moved shorter distances and that transport costs are a function of the weight (see Pomfret and Sourdin, 2010) and this is reflected in the much larger share of the UK in total Irish export volumes (tonnages) rather in values. Transport decisions and costs depend on many factors but product weight is one crucial determinant with Hummels and Skiba (2004) estimating that a ten per cent increase in product weight relative to its value leads to a four per cent increase in its shipping cost.

This paper analyses the transport patterns of Irish international trade, focusing particularly on the share of the UK in overall trade volumes (and how these patterns differ from values), the importance of unit weight and product bulkiness and how the UK's exit from the EU might impact on these transport patterns. We also look at the role of the UK as a "land-bridge" route for transport of Irish exports and imports with other markets.

Section 2 profiles the overall composition of Irish trade with the UK and the rest of the world (RoW), comparing volume and value distributions. One of our first findings of interest relates to the much greater share of Irish trade volumes accounted for by the UK compared to trade values. On the export side, this is driven largely by the much higher share of low-weight but high-value pharmaceuticals being sold outside the UK market. On the import side there is less of a gap due to the importance of the UK as a source of mineral products, which tend to be heavier relative to their value than other sectors.

We then look in Section 3 at the transport modes for Irish international trade, presenting numbers on port and road freight in particular. The UK has been the main partner for traffic to and from Irish ports for many years. A higher volume of cargo arrives into the Irish ports than is shipped out, showing again how volume movements can differ from the value pattern of a large Irish goods trade surplus. Road freight via Northern Ireland is the other main transport method for Irish imports and exports to reach their destination with air freight accounting for only a very small proportion of total international freight movements. Section 4 goes more deeply into how product weight and bulk

affect transport patterns at the goods level. Different densities (weight to volume) mean that the same weight of different products can require very different amounts of space in the containers or vessels in which they are to be moved. We apply information on stowage factors of different products and examine their impact on transport modes.

Section 5 looks at the possible impact of Brexit on the transport patterns described in the previous sections, using scenarios based on the application of the EU's WTO tariff schedule and combining the tariffs with a non-tariff barriers estimate based on World Bank research (Kee, Nicita and Olarreaga, 2009). These scenarios are related to the value estimations on total EU-UK trade by Lawless and Morgenroth (2016) and on North-South trade within Ireland by InterTradeIreland (2017). The large variation in weight per unit of value and stowage factors across the various product lines would suggest that the volume impact of these scenarios could be very different from the value estimates. However, we find that the overall impacts on trade volumes are actually very much in line with those found for trade values. The main transport mode affected is the use of refrigerated transport (primarily used by the food sector) with a significant fall also affecting live animal transport. Other types of transport, more associated with manufactured products, show reductions of 2 to 3 per cent.

The use of the UK land-bridge as a route for Irish international trade with markets beyond the UK has been raised as a potential concern in terms of future transport costs if any delays or disruption to this route emerges (even temporarily) in the immediate aftermath of Brexit. Section 6 therefore compares the trade and transport data available to get an estimate of how significant this route is. The land-bridge estimates suggest a very considerable proportion of Irish exports to the rest of the world as measured by weight uses this route (around 53 per cent) while its use as an import route is lower in terms of its share of total imports (11 per cent) although the actual level in tonnes is similar for both directions of trade. Finally, Section 7 concludes.

2. Composition of Irish-UK trade

Transport decisions and costs depend on many factors, but the composition of trade and differences in weight and size of products across sectors are amongst the main determinants of how and how far any product is traded. It is therefore useful to look at how Ireland's trade with the UK is distributed across sectors, both in terms of value and volumes, and to what extent Irish-UK trade differs from that between Ireland and the rest of the world. All of the calculations presented are aggregates from product level data from the Irish Central Statistics Office (CSO) and from the United Nations ComTrade database and relate to values of 2016 trade flows in thousands of euros and in metric tonnes (thousands of kilograms).² The CSO data contains additional detail including a disaggregation of the UK trade flows into Northern Ireland and Great Britain. For the initial description of trade structure, we look at the UK numbers but this disaggregation will be used later when looking at transport patterns.

² Some trade is reported in alternative units (pieces, litres etc) but these are converted to kg equivalents for comparison purposes.

Table 1 shows the sectoral structure of Irish exports and Table 2 does the same for imports. A number of interesting differences in patterns emerge in comparing the distributions of values and physical weights of goods exported, which are likely to have important implications for transport patterns. The pharmaceutical sector accounts for over one-third of the value of Irish exports outside of the UK and a significant, although considerably lower, share of the value of exports to the UK (11 per cent). These are largely products with a very high value relative to their weight as can be seen from the extremely low shares of trade volume as measured in tonnage that they account for.

The UK is a major export destination for Irish food products with the first eight sectors listed in Table 1 (from live animals to food residues) combining to account for 37 per cent of exports to the UK, whereas the same sectors make up 8.4 per cent of exports to the rest of the world. The meat and fish industry then makes up the largest component of this. These patterns fit with the higher reliance of more traditional Irish-owned firms on the UK as an export destination (Lawless, Siedschlag and Studnicka, 2017).

For imports the most obvious difference in the patterns when looked at by weight rather than by value is the minerals sector (which includes petrol and other oil products). Along with the high share of minerals in imports from the UK, the other main difference between Irish imports from the UK relative to the rest of the world is the greater reliance on the UK as a source of processed food and conversely the much higher contribution of transport equipment to imports from the rest of the world.

Table 1: Sectoral Structure of Irish Exports

	Share UK values	Share of RoW values	Share of UK volumes	Share of RoW volumes
Live animals	2.6%	0.1%	0.7%	0.2%
Meat and fish	10.0%	2.5%	3.7%	8.8%
Dairy	5.7%	1.3%	3.6%	5.0%
Products of animal origin	1.7%	0.1%	2.1%	1.3%
Products of milling industry	5.5%	0.4%	3.9%	2.2%
Sweets, nuts, flour	7.3%	2.7%	4.6%	6.0%
Beverages	2.4%	1.2%	5.6%	3.6%
Residues of food and tobacco	1.8%	0.1%	4.7%	1.4%
Minerals	12.7%	29.8%	45.3%	51.7%
Pharmaceutical products	11.2%	35.9%	0.4%	2.2%
Non-organic chemicals	2.8%	4.0%	0.9%	2.6%
Plastic and rubber	4.3%	1.1%	2.1%	2.1%
Leather	0.5%	0.2%	0.2%	0.8%
Wood and paper	4.0%	0.4%	13.1%	7.0%
Textiles	0.5%	0.2%	0.4%	0.9%
Carpets, footwear, umbrellas	1.4%	0.3%	0.2%	0.2%
Cement, glass, ceramics	2.0%	0.2%	6.4%	0.5%
Machinery	15.0%	12.6%	1.1%	2.9%
Transport equipment	6.4%	6.6%	0.5%	0.4%
Other	2.3%	0.3%	0.6%	0.3%
Total	100.0%	100.0%	100.0%	100.0%

Table 2: Sectoral Structure of Irish Imports

	Share UK values	Share of RoW values	Share of UK volumes	Share of RoW volumes
Live animals	1.6%	0.2%	0.0%	0.0%
Meat and fish	2.7%	0.8%	0.7%	0.7%
Dairy	3.0%	0.5%	4.4%	0.5%
Products of animal origin	1.9%	1.9%	2.6%	7.1%
Products of milling industry	3.0%	1.3%	2.6%	2.6%
Sweets, nuts, flour	9.6%	2.1%	4.6%	3.0%
Beverages	2.2%	1.1%	3.6%	1.9%
Residues of food and tobacco	2.0%	1.2%	3.2%	10.3%
Minerals	24.3%	14.0%	64.8%	60.3%
Pharmaceutical products	3.4%	9.6%	0.2%	0.1%
Non-organic chemicals	1.8%	1.5%	1.0%	0.5%
Plastic and rubber	5.9%	3.8%	2.5%	2.9%
Leather	0.4%	0.3%	0.0%	0.1%
Wood and paper	5.7%	1.8%	5.1%	3.6%
Textiles	0.3%	0.2%	0.1%	0.1%
Carpets, footwear, umbrellas	5.1%	3.8%	0.4%	0.6%
Cement, glass, ceramics	1.8%	1.3%	1.7%	1.5%
Machinery	16.1%	22.2%	1.1%	1.8%
Transport equipment	5.6%	30.8%	0.7%	1.7%
Other	3.6%	1.7%	0.5%	0.7%
Total	100.0%	100.0%	100.0%	100.0%

Table 3 compares the unit values (i.e. value trade in €'000s divided by metric tonnes) across sectors and how they compare between trade flows with the UK and the rest of the world. The high share of the pharmaceutical sector in total Irish exports (and most particularly in exports outside the UK) results in considerably higher unit values for Irish exports than for imports. The greater share of pharmaceuticals also largely accounts for the higher unit values of Irish world exports relative to Irish exports to the UK. In terms of imports, there is a slightly higher unit value for imports from the rest of the world relative to imports from the UK but the ratio is considerably less than that of exports. This indicates that Irish exports to the UK are heavier than worldwide exports and changes in transport costs would therefore be expected to have a greater importance for UK trade than for

overall trade.³ The difference in unit values for live animals between the imports from outside the UK and the other trade directions is due to the imports from the rest of the world having a higher share of premium breeding stock (it should be noted that this is also a much smaller flow in absolute terms).

This is further emphasised if we calculate the share of the UK in total Irish export volumes rather than values – the UK accounts for 14 per cent of Irish goods exports in values but due to the trade composition, it makes up a 55 per cent share of the export weight. On the import side, a gap is also present but it is not so large with the UK accounting for 25 per cent of import values and a corresponding 42 per cent of volumes.

Table 3: Average Unit Values (value/weight) by Sector and Trade Direction

	UK Exports	RoW Exports	UK Imports	RoW Imports
Live animals	5.4	5.4	57.8	74.8
Meat and fish	3.8	2.9	3.6	2.8
Dairy	2.3	2.7	0.7	2.4
Products of animal origin	1.2	0.5	0.7	0.6
Products of milling industry	2.0	1.8	1.1	1.1
Sweets, nuts, flour	2.3	4.6	2.0	1.6
Beverages	0.6	3.5	0.6	1.3
Residues of food and tobacco	0.6	0.9	0.6	0.3
Minerals	0.4	5.9	0.4	0.5
Pharmaceutical products	40.1	167.8	14.5	163.0
Non-organic chemicals	4.2	15.5	1.7	6.2
Plastic and rubber	3.0	5.2	2.2	3.0
Leather	2.9	2.3	12.9	11.5
Wood and paper	0.4	0.5	1.1	1.2
Textiles	1.8	2.0	4.2	4.7
Carpets, footwear, umbrellas	7.9	15.3	12.5	13.2
Cement, glass, ceramic	0.5	5.1	1.0	2.0
Machinery	19.9	43.9	13.4	28.1
Transport equipment	19.5	157.0	8.1	41.4
Other	5.8	11.3	6.3	5.8
All Trade	1.4	10.2	0.9	2.3

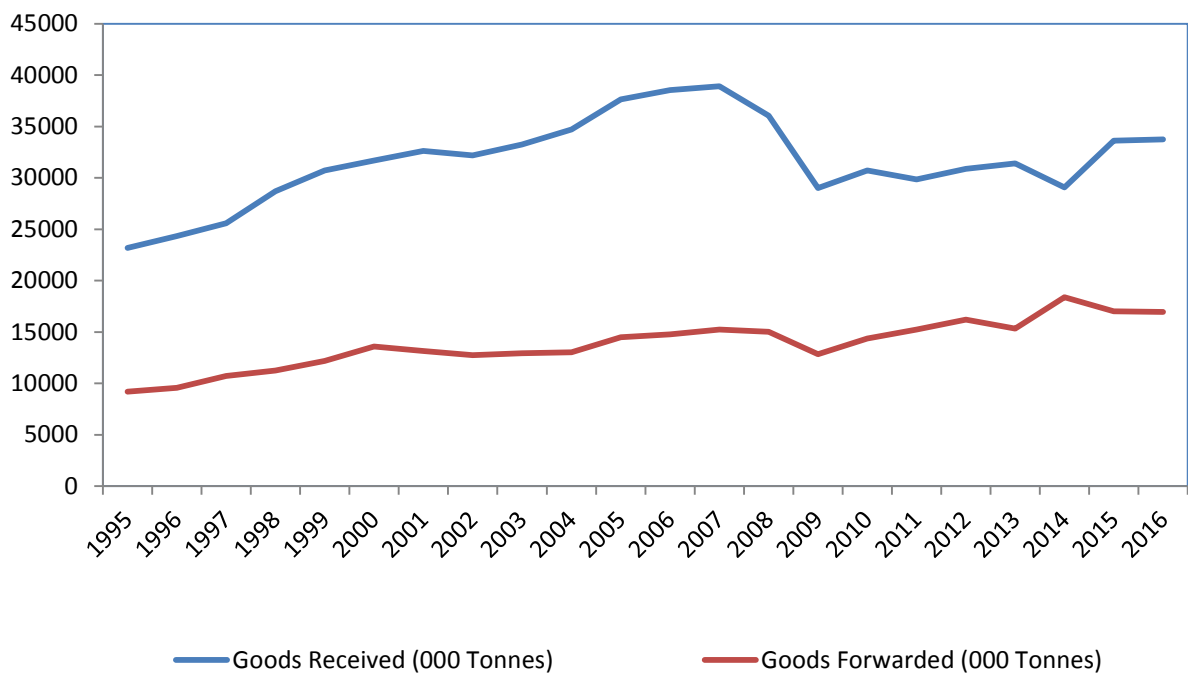
³ Unit values are sometimes used as an indicator of quality when comparing within narrow product categories. This would not be an accurate interpretation of the calculation here as the average is being taken across a wide variety of products and the measure should therefore only be taken as an indicator of bulkiness.

3. Transport data

This section looks at the main statistics on Irish freight transport, describing the information available on port, road and air transport, using information from the CSO for port and air freight and combining CSO road freight data with information on cross-border crossings of haulage vehicles provided by Transport Infrastructure Ireland.

Figure 1 plots the evolution of cargo into and out of Irish ports over the past twenty years. In 2016 a total of 51 million tonnes of cargo was handled by the ports, approximately 34 million of which was goods received and 17 million tonnes were forwarded. The port figures show a steady increase in the quantity of goods received from 1996 up until 2007, at which point the quantity of cargo handled falls fairly sharply back to the levels of the late 1990s. There is a subsequent slight recovery over the following five years followed by a stronger pickup in 2015 and 2016, broadly in line with the patterns of growth in the overall economy although slightly more muted. The quantity of goods forwarded through the ports is around half of the amounts received, a gap that widened during the peak years of the economic boom before returning to previous relative levels. The increase over time in goods forwarded is very moderate and there is little evidence of an impact of the boom or the recession. The ratio of inward to outward trade flowing through the ports contrasts with the overall pattern of a large Irish goods trade surplus. The large role played by the high-value but low weight pharmaceutical sector is the most likely factor behind the very different patterns of volume growth compared to merchandise trade in value terms. The Irish economy is also increasingly focused on services trade.

Figure 1: Tonnage of Goods Handled at Irish Ports



Although cargo from Irish ports is bound for many destinations, the UK makes up a major share of traffic and this has remained reasonably stable over time. The UK has been the destination for between forty and forty-five per cent of goods forwarded from Irish ports, with a sharp uptick to over half of all outward traffic in 2015 and 2016. The UK's share of inward traffic is slightly lower but at approximately one-third of goods received remains extremely significant. The stability of the overall traffic levels in Figure 1 and of the share travelling to and from the UK is striking given the volatility of many other economic series over this period of time.

Figure 2: UK Share of Irish Port Traffic, 1995-2016

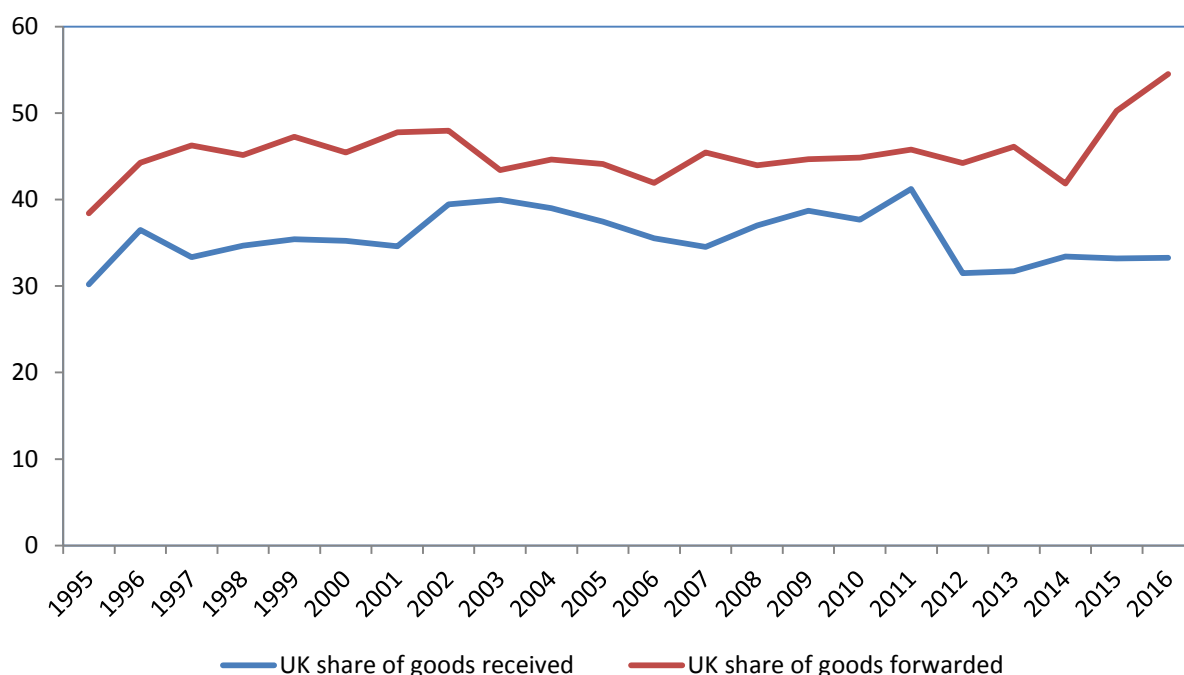


Table 4 gives some additional detail on the geographic breakdown of goods going through the Irish ports for 2016 (as a share of total foreign trade tonnage).

Table 4: Share of International Trade Handled at Irish Ports by Region, 2016

	Goods Received (%)	Goods Forwarded (%)
UK	34.0	57.8
Other EU	32.1	38.1
Other Europe	11.1	2.1
Other Ports	22.8	2.0

As noted above, the UK is the main destination for goods forwarded at close to 55 per cent and makes up one-third of goods received. The other ports of the European Union make up the bulk of

the remainder of goods forwarded but goods arrive from a broader spread of countries, with over twenty per cent originated from outside of Europe and eleven per cent coming from non-EU ports within Europe.

Along with port traffic, road freight via Northern Ireland is the main transport method for Irish goods imports and exports to reach their destination. The data available on this comes from records of border crossings on major roads by goods vehicles collected by Transport Infrastructure Ireland (TII) together with information on vehicle types and tonnage carried for all road freight collected by the CSO. Border crossings (in both directions) are divided into three different vehicle types for goods delivery – light goods vehicles, which make up the majority of crossings but would carry the smallest loads per vehicle, then rigid and articulated heavy goods vehicles (HGV). The group of articulated HGVs account for over 1.4 million border crossings in 2016.

Table 5: Border Crossings by Goods Vehicles

Light goods vehicle	2,605,896
Rigid heavy goods vehicle	660,187
Articulated HGV	1,418,314

Source: Transport Infrastructure Ireland, 2016

To apply these traffic counts to a volume of trade flows, we need information on the average tonnage per vehicle for different types of freight, which is available from the CSO Road Freight Transport Survey, which gives details about international transport. Table 6 below shows the tonnage, vehicle kilometres, number of journeys (own calculations) and average distance by vehicle type for international transport. The data for tonnage and vehicle kilometres is from the CSO and the number of journeys and average distance is calculated using these along with an assumption that average tonnage carried per vehicle is 3.5 tonnes for the smallest category, 40 tonnes for the largest category and the mid-point of the other categories i.e. 7.5 tonnes for vehicles between 5 and 10 tonnes capacity⁴. This shows that the bulk of international transport is carried out with larger vehicles. Those with a capacity over 25 tonnes account for over 90% of tonnage and tonne kilometres and over 80% of journeys. Using these numbers one can calculate the average load per vehicle/journey to be 30.77 tonnes.

⁴ It is thus assumed that not all vehicles are always fully laden.

Table 6: International Road Freight by Vehicle Type

Vehicle Capacity	Tonnes Carried (1000)		Tonne Kilometres (Million)		Journeys		Average Distance
Up to 5,000 kgs	19	0%	3	0%	5,429	2%	158
5,001 - 10,000 kgs	36	1%	6	0%	4,800	2%	167
10,001 - 15,000 kgs	82	1%	19	1%	6,560	3%	232
15,001 - 20,000 kgs	221	3%	51	2%	12,629	6%	231
20,001 - 25,000 kgs	236	3%	130	6%	10,489	5%	551
25,001 - 35,000 kgs	3169	46%	932	44%	105,633	47%	294
Over 35,000 kgs	3106	45%	996	47%	77,650	35%	321
Total	6867	100%	2137	100%	223,189	100%	311

Source: CSO Road Freight Statistics. Note: The number of journeys is calculated by dividing the tonnage carried by the mid-point of the vehicle capacity. For the smallest vehicles the average tonnage carried is assumed to be 3.5 tonnes and for the vehicles in excess of 35 tonnes it is assumed that the tonnage carried is 40 tonnes. The maximum permissible tonnage in Ireland for conventional transport is 46 tonnes.

Manufacturers' specifications suggest that refrigerated articulated trucks have a capacity of 20 tonnes and we assume that both specialised and bulk transport has an average load of 35 tonnes. The average load can then be calculated to be 32 tonnes but this will depend also on the space required (bulkiness or stowage factor) of the goods being transported, which will be discussed further in the next section.

The final mode for goods to enter and exit the Irish market is to be transported by air but, as Table 7 shows, this remains very much a minority option with a total of 76 thousand tonnes imported and 70 thousand tonnes of freight exported in 2016. Placing this in context, the Irish sea ports handled over 50 million tonnes in the same year. A caveat should however be made as we have already noted the important share of high-value, low weight pharmaceuticals in Irish exports so it is reasonably likely that if this sector disproportionately uses air transport that the share of trade value accounted for by air freight could be well in excess of its share of quantities. The information is not currently available however on the composition of the products using the different types of transport modes to establish how sensitive this assumption is. In terms of the geographic breakdown, we see that the UK accounts for more than one-quarter of imports by air and slightly less for exports. Although this makes it the single largest destination, it is less dominant than was the case for port traffic (and of course all international trade by road is with the UK, although we will discuss in a later section how much of this might be transiting the UK for other markets). The EU also accounts for a smaller share of air transport than it does for sea freight, with the USA becoming a large partner for goods imported and exported by air.

Table 7: Air Freight by Direction and Country (2016)

	000 Tonnes	Percent
<i>Imports</i>		
UK	20.4	27%
EU26	18.9	25%
USA	13.7	18%
RoW	23.6	31%
Total	76.6	100%
<i>Exports</i>		
UK	17.0	24%
EU26	13.1	19%
USA	18.5	26%
RoW	21.6	31%
Total	70.2	100%
<i>Source: CSO, 2016</i>		

4. Transport patterns of Irish trade

In order to examine the transport patterns of trade, we first divide the detailed product list coming from the trade data into the main types of transport that different products might use. There is a degree of subjectivity to this for some products but for most the broad division into unitised, bulk, refrigerated or special categories is clear from the type of good being transported. Table 8 shows how the products are allocated across the transport modes, based on the number of products in each transport mode. Unitised refers to products that are or could be transported in conventional trucks or containers and these make up the vast majority of goods to be transported. Bulk are dry bulk products that are likely to be transported in open or in specialised blower trucks, but are likely to be transported internationally by dry bulk carrier ships. Examples of bulk are coal, animal fodder or wood pellets.

Refrigerated products are perishable products that require some degree of climate control and around eight per cent of products fall into this category. Special products are those that might not easily fit onto standard trucks or into containers either because of their size shape or weight. Examples of Special products are cars, aircraft, and construction cranes. In total, around five per cent of individual product lines fall into this non-standard group. Live animals are also treated as a separate category. Although they account for a small share of product lines (one per cent), it is important to consider them separately in terms of transport implications as very particular standards and requirements must be met in this case.

Table 8: Products by Main Transport Mode

	No. of Product Lines	Share of Total
Unitised (Conventional Truck or Container)	3425	78%
Bulk	367	8%
Refrigerated Truck or Trailer	349	8%
Special	230	5%
Live Animals	22	1%
Total	4393	100%

While the weight of a product is a key determinant of costs of transportation, different densities or volumes mean that the same weight of different products can require very different amounts of space in the containers or vessels in which they are to be moved. Although of considerable importance to the freight industry, there is little evidence that the bulkiness or “stowage factor” of products or other elements of special handling that might affect their transportability have been taken into account in models of trade, generally being subsumed into a fixed effect for the sector due to the constant nature over time. In considering how a change in trade relationships might affect transport patterns however the different space requirements of products could lead to quite different outcomes in terms of changes in number of trips if trade falls in one specific sector more than others. The Transport Information System of the German Insurance Association (see below) gives a specific definition of the concept as used in calculating efficient shipping requirements of cargos:

The stowage factor of a cargo is the ratio of weight to stowage space required under normal conditions. It indicates how many cubic meters one metric ton of a particular type of cargo occupies in a hold... These values include unavoidable stowage loss, i.e. the unavoidable gaps between parts of the cargo and the space requirements for specific stowage measures and for stowing. The stowage factor of a cargo may vary, since it depends on the packaging and the nature of the cargo.⁵

Thus, for example, a heavy product such as steel rods might have a stowage factor of 0.5 as it will reach the weight limit on a transport vehicle well before filling the available volume. On the other hand, light products such as clothing will fill the volume of a container without reaching the weight limit. To transport an equivalent tonnage of clothes as of steel therefore requires several times more container loads to be transported.

⁵ http://www.tis-gdv.de/tis_e/misc/staumass.htm

The information on stowage factors for the different products comes from two sources – most come from the Cargo Handbook website⁶, which is a database containing information on marine transportation of a wide variety of cargoes compiled by BMT Surveys (a private marine surveying company). Information on approximately 800 product lines and their transport requirements is available from this source, including the stowage factor in most instances and additional information on special requirements such as temperature controls and if the product is listed as being dangerous under the International Maritime Dangerous Goods Code (IMDG). This is supplemented by similar information from the Transport Information System (TIS) of German marine insurers.⁷ Where data is not available for specific products, the information is extrapolated from the most similar products type (generally within the same four or five digit sub-sector).

The live animal transport load sizes come from guidelines provided on *Livestock Transport* by QMS, a public body for the meat sector in Scotland. These are guidelines as actual load sizes depend on a wide range of factors including the animal size, distance to be transported, veterinary requirements and additional space provision in hot weather amongst other considerations. In addition, pure-bred breeding horses are assumed to be transported individually. Other horses, asses and buffalo are assumed to be transported at the same quantity per load as large cattle. The trade category of other live bovine animals is assumed to relate to calves and the average load of heavy calves is applied. The upper load size for sheep and lambs is applied to lambs. The transport load for live poultry was provided as a guideline from the haulage industry.

Figures 3 and 4 show how Irish exports and imports respectively are distributed across these different stowage factor or density measures for trade with Northern Ireland, Great Britain and the rest of the world. As might be expected from the universal finding across empirical trade research that distance is an important factor in transport costs, we find that the share of exports and imports with low stowage factors (i.e. particularly heavy products) going to and coming from Northern Ireland is considerably higher than the share of these products to the rest of Britain and is lowest for rest of the world trade. Expressing this in terms of value however shows a more even spread across the different groupings of stowage factors, reflecting the earlier pattern of sectors with high unit values having a further geographic spread.

⁶ www.cargohandbook.com

⁷ http://www.tis-gdv.de/tis_e/ware/inhalt.htm

Figure 3: Share of exports by stowage factor

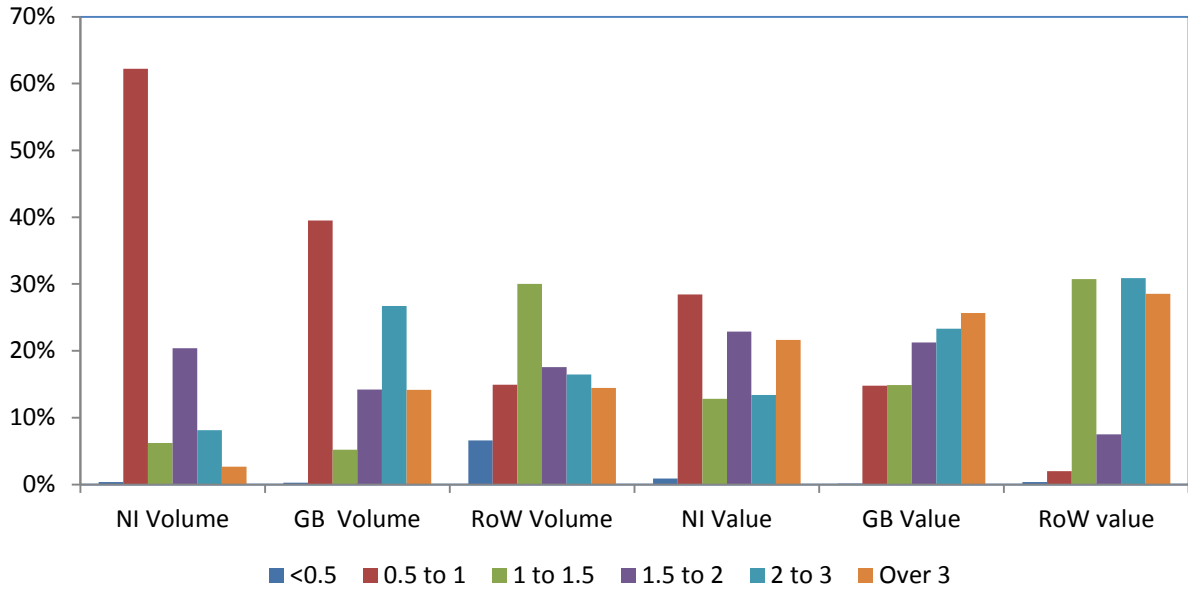
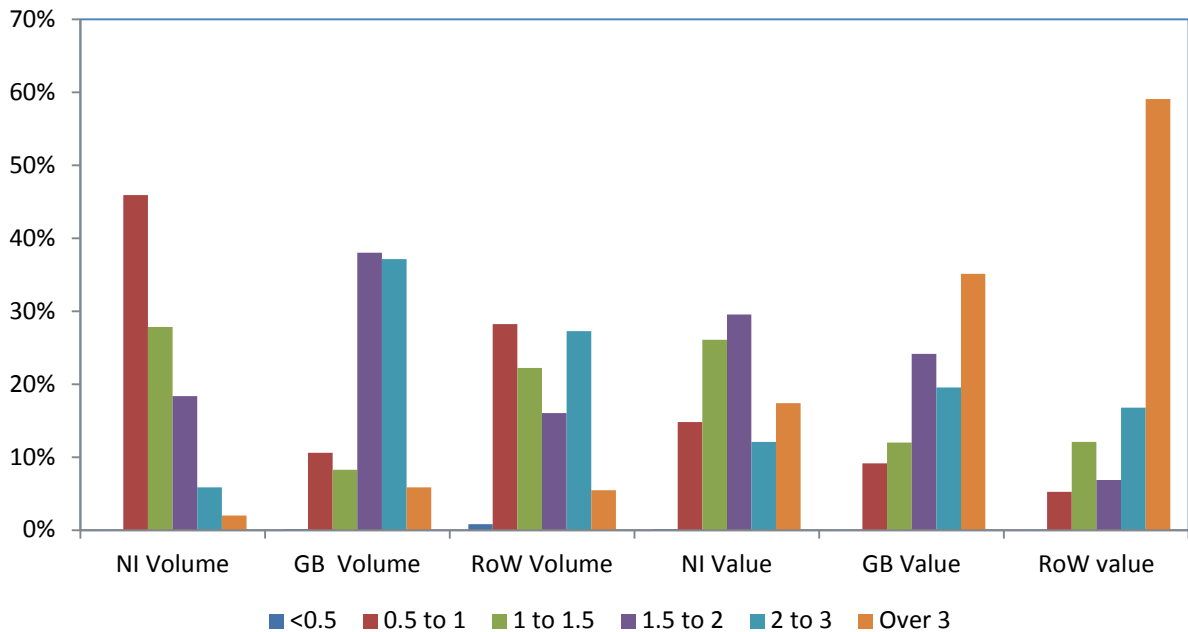


Figure 4 : Share of imports by stowage factor



Comparing the patterns of trade volumes across transport types in Table 9, we see a somewhat different picture from when we look at the allocation of products across the same typology in Table 8, reflecting how the distribution of stowage factors and shares of trade translate into transport mode decisions. The share of unitised transport is much lower, apart from its share of UK imports, but it is still the single largest category for exports to both the UK and rest of the world. Bulk transport (commonly associated with heavier products as noted above) accounts for a much greater share of both exports and imports when trade is described in terms of physical quantities. The share

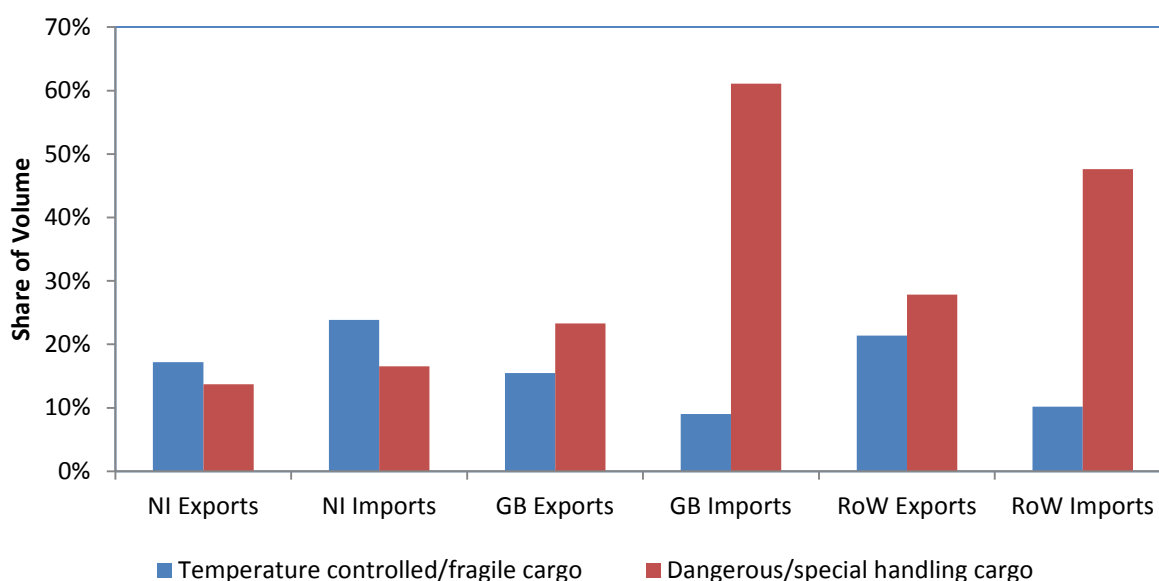
of refrigerated transport is also greater, particularly for exports, driven largely by the significant share of the chilled or frozen meat and fish sectors in outward trade.

Table 9: Share of trade volumes by transport type

	UK Exports	UK Imports	RoW Exports	RoW Imports
Unitised	41%	78%	46%	27%
Bulk	40%	13%	30%	61%
Refrigerated	11%	7%	18%	7%
Special	2%	2%	4%	5%
Live Animals	6%	1%	2%	0%
Total	100%	100%	100%	100%

A final consideration for differing transport costs across products is the extent to which products may need special handling. Figure 5 shows the shares of export volumes from temperature-controlled or fragile cargo (including live animals) and cargos that are listed as dangerous under the International Maritime Dangerous Goods Code (IMDG). The IMDG code specifies cargo that may be dangerous under nine headings - 1) Explosives; 2) Gases; 3) Flammable liquids; 4) Flammable solids; 5) Oxidising substances; 6) Toxic substances; 7) Radioactive substances; 8) Corrosives and 9) Other dangerous substances. Here imports are shown to have a considerable volume of cargo categorised as dangerous, largely coming from the reliance of the Irish market on imported fuel oils.

Figure 5: Temperature controlled and dangerous cargo



5. Potential impact of Brexit on transport modes

This section models how significant changes in trading relationships in the light of Brexit could affect transport flows between Ireland and the UK. The analysis applies a WTO tariff scenario combined with a hypothetical tariff equivalent of non-tariff barriers based on international research carried out by Kee, Nicita and Olarreaga (2009) for the World Bank (similar to Lawless and Morgenroth, 2016 and InterTradeIreland, 2017). The considerable heterogeneity in the transport requirements of different products and the much greater volume share in the totals of Irish-UK trade relative to their value shares, the changes in numbers of cargo loads could potentially be considerably different than the previously modelled changes in trade values would suggest.

The tariff schedule registered by the EU at the WTO for third countries can be regarded as the fall-back arrangement in the absence of a trade or transitional deal when the UK leaves the EU. It gives the highest possible level of tariffs that could be imposed on Irish-UK trade and includes a number of further assumptions to translate these into trade and transport effects, most importantly that the full amount of any tariff related price increase is passed on in full to consumers and that the demand response to individual products price increases is the same for all products within a specific sector. We also for the purposes of presenting the transport scenarios assume that the same level of tariffs and non-tariff barriers apply in both directions, so that the UK adopts the WTO fall-back schedule. This is somewhat less likely than it being used by the EU. Alternative potential outcomes such as an UK exit from the Customs Union and unilateral reduction of tariffs to all trading partners would require considerable speculation as to what the replacement levels of tariffs would look like and the changes in competitive environment based on a world-wide consideration of substitutability for Irish products currently selling into the UK.

As noted in the previous work in this area, there is considerable variation in the levels of tariffs applied across specific product lines under the fall-back scenario of applying the WTO-registered tariff schedule. Across the 5,000 individual products that are listed with the WTO, some sectors would encounter no tariff or tariffs only slightly above zero – these sectors include many products classed as paper products, pharmaceuticals, iron and steel. Food and textiles sectors on the other hand could potentially face rates many times higher, with rates of over 80 per cent on some meat products. The sectors with the highest tariffs all fall within the broader headings of food, clothes and tobacco products.

The WTO registered schedule gives a fairly clear fall-back position on tariffs but what could happen in terms of changes in other rules of trade is considerably more difficult to quantify. The term “non-tariff barriers” (NTB) is an extremely broad one that effectively covers any and all policies that restrict international trade flows apart from direct tariffs. These can be very significant with Kee, Nicita and Olarreaga (2009) finding an average *ad-valorem* equivalent of all non-tariff barriers of 12 per cent using worldwide data on international trade flows at a product level. NTBs can include quantity limits (quotas) and a wide variety of technical requirements such as licensing, labelling, standards and rules designed to protect health and food safety. They also cover requirements on customs inspections and documentation and measures to restrict competition from imports to

protect domestic firms. These non-tariff barriers, whether rule-based or arising from time taken for documentation to be filed and checked, are likely to move to the forefront of understanding how trade and transport with the UK will operate post-Brexit.

The data we use as a basis for the scenario including NTBs comes from detailed work by Kee, Nicita and Olarreaga (2009) undertaken for the World Bank. They combine data collected by the United Nations on more than 30 different types of NTBs (the TRAINS database – Trade Analysis Information System) supplemented by additional information from the WTO’s trade policy reviews and the EU Standard’s Database.⁸ As with tariffs, non-tariff barriers are not equally allocated across all trade and the tariff equivalent for the products where non-tariff barriers apply can be many times the average effect. In fact, we find that for over half of the products where non-tariff barriers are in effect, the *ad valorem* equivalent of the non-tariff barrier is higher than the tariff.

Given that the UK and other members of the EU currently apply the same standards in terms of product quality and that Kee, Nicita and Olarreaga (2009) find that richer countries tend to impose lower barriers on trade and drawing on the work estimating the effect of Brexit on the UK economy by Dhringa et al (2016) our scenarios assume that the non-tariff barriers that would be faced would be one-quarter of those estimated by Kee et al. (2009).

As in Lawless and Morgenroth (2016) and InterTradeIreland (2017), we make the assumption that the full tariff amount would be passed through into the price. We use the lower estimates of sector level elasticities from Imbs and Mejean (2016) to calculate the impact of tariffs and NTBs on trade volumes. It should again be emphasised that these are not forecasts as the outcomes on trade will depend to a great extent on the detail of a final trade agreement. They are however indicative of where the current trade and transport structure would be most affected in this “no deal” Brexit scenario.

Table 10 gives the results of the two scenarios (the imposition of WTO tariffs in the top panel and both tariffs and non-tariff barriers in the second panel). Looking at the distribution across transport modes shows how the main impact comes through the effect on refrigerated transport with a significant fall also affecting live animal transport. Other types of transport, more associated with manufactured products, are relatively unaffected with very moderate falls of 2 to 3 per cent in unitised and bulk cargos across all trade flows. The table also highlights that non-tariff barriers can add a sizeable amount to the trade impacts but these again are focused on the products with the same transport implications (refrigerated and live animals) as the tariff effects alone. The stand-alone effect of non-tariff barriers is the difference between the two scenarios as no additional interaction is assumed.

⁸ UNCTAD describe the variety of non-tariff measures used here http://unctad.org/en/PublicationsLibrary/ditctab20122_en.pdf

Table 10: Potential reductions in trade volumes by mode

	Exports NI	Imports NI	Exports GB	Imports GB
<i>WTO tariffs scenario</i>				
Unitised	3%	5%	2%	2%
Bulk	3%	2%	0%	6%
Refrigerated	50%	35%	32%	14%
Special	1%	3%	2%	4%
Live Animals	14%	10%	9%	4%
Total	9%	12%	5%	3%
<i>WTO tariffs + NTB scenario</i>				
Unitised	6%	10%	4%	4%
Bulk	5%	5%	1%	11%
Refrigerated	64%	59%	48%	27%
Special	2%	3%	2%	4%
Live Animals	20%	14%	16%	9%
Total	12%	20%	8%	5%

Looking at the results from a sectoral perspective in Table 11, the fall in refrigerated transport is clearly linked to the large falls in the meat, fish and dairy trades, which show trade volume decreases of large magnitudes. Other food products follow in terms of decreases in trade volumes while more manufactured product sectors are relatively minimally affected. The minerals sector (including petrol) which we noted earlier was particularly important in terms of the differences in looking at sector value shares and sector volume shares is not affected at all in these scenarios which largely explains why the distribution of effects on volumes is in line with the previous work on export values. The imposition of any barrier on that sector in particular would have had the potential to result in greater divergence between the measures.

Table 11: Sectoral distribution of trade volume reductions by scenario

	<i>WTO tariffs scenario</i>				<i>WTO tariffs + NTB scenario</i>			
	Exports NI	Imports NI	Exports GB	Imports GB	Exports NI	Imports NI	Exports GB	Imports GB
Live animals	14%	10%	9%	4%	20%	14%	16%	9%
Meat and fish	68%	12%	38%	16%	76%	20%	53%	26%
Dairy	42%	40%	29%	18%	66%	66%	49%	38%
Vegetable products	16%	6%	8%	18%	24%	17%	15%	27%
Flours, oils, fats	21%	17%	9%	18%	35%	31%	21%	31%
Other foodstuffs	8%	7%	9%	16%	21%	18%	22%	32%
Beverages	1%	0%	3%	4%	5%	7%	8%	10%
Food & tobacco residues	4%	5%	4%	3%	10%	11%	11%	9%
Mineral products	0%	0%	0%	0%	0%	0%	0%	0%
Chemicals & pharmaceuticals	2%	2%	1%	2%	3%	2%	1%	2%
Other organic chemicals	0%	3%	1%	2%	1%	3%	2%	2%
Other chemicals	3%	2%	3%	12%	4%	3%	3%	14%
Plastic and rubber	2%	2%	2%	2%	2%	3%	2%	2%
Leather and furs	0%	2%	0%	3%	0%	2%	0%	3%
Wood and wood products	0%	0%	1%	0%	0%	0%	1%	0%
Textiles	3%	3%	3%	3%	16%	9%	13%	15%
Carpets, footwear etc.	7%	10%	7%	9%	18%	18%	17%	16%
Stone, glass	0%	1%	1%	2%	0%	1%	1%	2%
Metals	0%	0%	0%	1%	1%	1%	1%	1%
Machinery, electrical	1%	1%	1%	1%	1%	1%	1%	1%
Transport equipment	3%	4%	2%	4%	3%	4%	3%	5%
Miscellaneous	1%	1%	1%	1%	1%	2%	1%	1%

6. UK Land-bridge

A significant concern for Irish trade in the event of potential disruptions in the aftermath of Brexit is how transport to and from Ireland of non-UK exports and imports might be affected because of the use of the UK as a land-bridge for Irish trade connecting to the rest of Europe and beyond.

While transit transport of Union Goods, that is goods that are consigned in one EU member state and that are destined to another EU member state (Union Transit)⁹, through EU Member States such as the UK is currently not subject to significant administrative controls¹⁰, post-Brexit transport of

⁹ There currently exist some specific requirements for transit through a number of territories such as the Channel Islands, the Canary Islands, French Overseas Departments, San Marino and Andorra.

¹⁰ For Union Transit the current requirement is that a Transit Declaration needs to be lodged, goods need to be accompanied by Transit Accompanying Document (TAD), and a guarantee for any taxes, duties or other charges due in the destination country.

goods through the UK may be subject to some new requirements in terms of documenting that the goods are not entering the UK market and therefore are not subject to tariffs or other customs procedures. For example transit through the UK of Irish imports or exports from other EU Member states, might have to comply with the TIR Convention, which governs international transportation by road. This requires that the goods need to be accompanied by harmonised customs document called a TIR Carnet, which has to be purchased. Goods need to be transported in a sealed container, and any tariffs or taxes due must be covered by an internationally valid guarantee. The cost of such a carnet in the UK is currently between US\$65 and US\$102 depending on the number of countries that need to be crossed. The manner by which the containers are to be sealed is set out in the TIR convention and might require some modification to vehicles which comes at a cost.

International trade statistics are based on accurately capturing the origin and final destination of products but information on how products travel and what other countries they pass through on route is rarely captured. Estimating how important the UK land-bridge route is to Irish trade is therefore an important first step to assessing the impact of any potential change in the use of this as a way of delivering goods.

To do this, we take data on the volumes of exports leaving the island of Ireland and adjust them to take account of trade between Ireland and Northern Ireland and the share of Northern Irish trade being handled by its ports. Table 12 shows the tonnage of freight going from Irish ports and airports to the UK (taken from the CSO as above). For freight transferring through Northern Ireland, Warrenpoint Harbour Authority (2016) report that approximately 40 per cent of inward and outward freight handled by that port originates or is destined for the Republic of Ireland, while for Belfast, which is further from the border between Ireland and Northern Ireland the reported percentage is 20%¹¹, which we also assume for Larne. Weighting these by harbour size yields an average percentage of 22.6%, which we attribute to the total freight handled taken from the data published by NISRA (2016). However, some of this freight will be passing through the Northern Irish ports for final sale in Great Britain rather than transiting for further destinations. No Northern Ireland air freight is included in the calculations as the direction and destination information was not available – however, as the total freight handled was approximately 30 thousand tonnes for all airports (Department of Infrastructure, 2016) the impact on the land-bridge estimate should be negligible.

The next step is to compare the total freight leaving for Britain via the Irish and Northern Irish ports and Irish airports with the quantity of trade with Britain as the final destination. All trade with Northern Ireland is assumed to be by road with only the amount passing on to the ports to be of relevance in the land-bridge calculations. The total of almost 15 million tonnes of freight arriving in Ireland from Great Britain and over 11.5 million tonnes departing are considerably higher than can be accounted for by exports demonstrating the significance of the land-bridge route for Irish trade to other countries.

¹¹ <https://www.belfast-harbour.co.uk/news/belfast-harbour-posts-positive-trade-figures-37/>

The resulting land-bridge volumes are presented as a percentage of total Irish trade with the rest of the world (i.e. excluding the UK). We do not express the result as a percentage of European trade as the UK land-bridge may well be connecting trade with countries beyond Europe, in particular via major ports such as Rotterdam. The land-bridge estimates are considerably higher as a share of the total for Irish exports than they are for imports. Additional information on the structure of trade would be needed to establish why the effect differs in each direction.

Table 12: Estimation of Land-bridge Share of Trade

	Arriving in Ireland from GB (000s tonnes)	Departing Ireland for GB (000s tonnes)
Rol Ports	11,228	9,247
Air	20	17
NI Ports (22.6% Rol share)	3,526	2,192
Total transported (GB)	14,774	11,456
GB-Irish trade	12,269	7,203
Land-bridge = Amount transported via UK less GB trade		
Volume	2,505	4,253
Share of RoW	11%	53%

An alternative method is to estimate the road freight volumes crossing the border rather than the percentage of Irish trade using Northern Irish ports. Calculations on this basis involve making a number of assumptions on the direction of travel and load sizes (both in terms of product bulk and whether the containers operate at full capacity on most journeys). As stronger assumptions would be required for this alternative approach, the estimates based on port data provide our preferred estimates.

7. Conclusions

This paper profiles the main transport modes of Irish trade, contrasting the value and volume distributions across sectors. In light of the potential trade policy changes that may emerge following Brexit, the patterns of trade and transport with the UK are a particular focus, as is gauging the importance of the UK land-bridge for trade with other markets.

Although the share of Irish merchandise trade with the UK has fallen in relative terms, the UK still makes up a large share of Irish trade in terms of value. We highlight that the share of trade accounted for by the UK is substantially larger if measured in volume terms, which is of potentially greater significance when considering how trade patterns affect transport costs and decisions on

transport modes. In relation to this point, differences across products in unit weights and bulk can also affect transport – for example lighter products will fill a standard shipping container’s available volume without reaching the weight limit so more container loads will be needed to ship the same tonnage of a light product compared to a heavy or dense one. This is an aspect of international trade patterns that has attracted very little attention in economic analysis outside of work narrowly focused on the efficiency of the shipping industry.

Relating these transport estimates to potential increases in tariffs and non-tariff barriers in the absence of a free trade agreement between the UK and EU, we find that the overall reductions in trade volumes – ranging from 3 to 20 per cent depending on scenario and trade direction – are broadly similar to those previously estimated for trade values. This was not necessarily a finding to expect given the large variation in unit weights and stowage factors across the various product lines. The result is mainly driven by the impact of tariffs and other barriers on the food sector and hence on the use of refrigerated transport with a significant fall also affecting live animal transport. Other types of transport (unitised containers and bulk shipping) which are more associated with manufactured products, show much more modest reductions of 2 to 3 per cent.

We also look at estimates of how widely used the UK land-bridge is as a route for Irish international trade with the rest of the world markets. This involves combining a number of different sources of trade and transport data, along with some assumptions on average load sizes. The results suggest that a very considerable proportion of Irish exports to the rest of the world uses this route. The importance in terms of value shares may however be much lower if higher unit value products that are less sensitive to shipping cost are more likely to be transported directly but this cannot be empirically validated with the data available. A further issue to consider in relation to the land-bridge is that our calculations relate to the current pattern of trade and there is the potential that the transport route could become more significant from a volume perspective in the circumstances where Ireland may seek to diversify markets post Brexit.

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