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Department of Finance

Trade costs and Irish goods exports

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Executive Summary

This paper re-examines the key drivers of Irish goods exports and the mechanisms through which firms adjust. This work is motivated by the need to further develop our understanding of the potential trade implications of the UK's forthcoming exit from the EU. It is also relevant in the context of a rising trend in trade protectionism driven by non-tariff barriers (Zhaohui et al. 2018, Kinzius et al. 2019).

Working within a gravity model framework, we examine the extent to which Irish exporting activity is affected by trade costs including tariff and non-tariff barriers (which is proxied by using border waiting times associated with customs and documentary compliance). We use a recent firm product level trade data set compiled by the CSO (based on customs data, 2013-2015) to undertake the analysis. In the paper, to understand how firms adjust to various trade costs we decompose total goods exports in a sector into the relative contributions from the number of exporting firms and the range of products exported (i.e. extensive margins), and the value of exports per product per firm (i.e. intensive margin).

Results with respect to the standard gravity model variables are consistent with findings in the literature. In the context of Brexit, the significant impact of costs associated with distance on the exporting decisions highlight the challenge of finding alternative destination markets to the UK for firms. However, efforts to address and lower other trade costs through for instance communication and infrastructure investment could help support further trade integration with our European trade partners.

Focusing on non-tariff measures, our results suggest that border waiting times are negatively associated with exporting activity; a 10 per cent increase in waiting times at customs for goods reduces the total value of trade by just over 1 per cent. This manifests itself primarily through both a significant decline in the number of exporters (0.3%) and the number of products exported (0.4%).

We find that results differ across sectors, with sectors such as *Pharmaceuticals and Chemicals* and *Food and Beverages* that contain time-sensitive goods experiencing a greater negative impact from waiting times. Looking at differences by firm size, SMEs are particularly sensitive to waiting times and likely to reduce total exports by exiting the export market and reducing the range of exported products.

Such findings are important in the context of Brexit and the negotiation of the future trade relationship between the UK and the EU. This research is relevant for informing policy seeking to assist firms and sectors which are sustainable over the longer term but potentially vulnerable to sudden shifts in trade policy.

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Section 1: Introduction and background¹

As a small open economy, the extent to which firms engage internationally and trade matters for the performance of the Irish economy. The success of Irish firms in trading with other countries reflects in many respects their capacity to overcome trade costs. These costs come in various forms including, for instance, transport costs, legal and regulatory compliance, communication costs, tariffs and other non-tariff measures. While overcoming such costs is an enduring challenge, ongoing international trade tensions and the UKs pending exit from the European Union have particularly, brought the potential costs of tariff and non-tariff measures into sharp focus for many, including firms and policy makers.

This has motivated new research on the determinants of Irish exporting activity. Much is understood in terms of the aggregate impacts of rising trade costs (e.g. Bergin et al. (2019)), while in terms of sector level analysis, Byrne and Rice (2018) show for instance, that longer border waiting times are associated with significantly lower exports of Irish goods. However, there are many ways in which exporters can adjust to trade costs that have not been fully investigated. Potential adjustments to firm exporting strategies include for example, changes to the number of markets supplied, the range of products sold and the volumes supplied. Furthermore, variation in exporter responses to trade costs changes is likely to exist across and within sectors.

That said, the micro level picture of the firm exporting behaviour that underlies adjustments to national trade aggregates continues to develop with the greater availability of firm and product level datasets. Recently, Lawless et al (2019) analyse the aforementioned firm level trade adjustments in relation to the border effects, focusing in particular on Ireland's South North exporting activity.. Their analysis uses a binary variable to capture the border effect. However, from a policy perspective it is useful to explore and quantify what aspects of the border effect (e.g. border waiting times, administrative costs, type of import controls etc) firms are most sensitive to, and potentially most damaging to trade. Research of this nature is especially relevant as non-tariff measures are becoming increasingly prominent within the set of modern trade policy instruments, Kinzius et al. (2019).

This paper contributes to the literature by making use of a product-level trade dataset compiled by the CSO based on customs data to explore the relationship between the exporting activity of Irish firms and destination country trade costs. Particular attention is given to the role of tariff and non-tariff barriers and we examine how the estimated relationships differ across sectors, by firm size and firm ownership nationality.

In the context of seeking to mitigate the adverse effects of Brexit, this analysis is useful from a policy perspective in identifying the relative importance of various trade costs and understanding how the means of adjustment to such costs vary by sector and firm type. By way of example, the appropriate

¹ This paper was produced by Gavin Murphy and Luke Rehill, economists in the Department of Finance and members of the Irish Government Economic and Evaluation Service ("IGEES"). Unless explicitly referenced by Government decision, any proposal contained in this document does not represent Government policy and should not be represented as such. The analysis and views set out in this paper do not necessarily reflect the views of the Minister for Finance. The authors would like to thank Brendan O'Connor and Martina Lawless for helpful comments, as well as Ciarán Coughlan for the provision of data.

policy response to a significant drop in the value of exports due to a rising trade cost may be quite different if the decline was driven primarily by a large exit in the number of firms exporting rather than a consolidation in exported products. This research is relevant for informing policy seeking to assist firms and sectors which are considered to be viable over the longer term but potentially vulnerable to sudden shifts in trade policy.

The analysis in this paper is undertaken through the application of a gravity model. Gravity models have been the standard for modelling international trade, being first used in the 1960s by Tinbergen (1962) and Linnemann (1966). The basic gravity model links exports with the size of the economies (capturing supply and demand) and the distance between them (as a broad proxy for transport costs). In addition to these primary elements, the literature on gravity models has identified a large number of factors as being particularly important including for example, geography, infrastructure, institutional factors and free trade agreement (FTA) memberships. It is within this framework that we measure how non-tariff barriers, proxied by delays at the border, relate to exporting activity.

More generally, there has been an increasing interest among policymakers in addressing barriers to trade other than tariffs, known as non-tariff barriers (Cernat and Madsden, 2011; Baldwin and Evenett 2009). This has in part been the result of tariffs declining steadily since the 1940s, while government interventions have increasingly moved to non-tariff forms to restrict imports.² Indeed, the Trade Analysis and Information System (TRAINS) database reported that about 2,852 product lines were subject to a type of non-tariff barrier in 2015, compared to nearly half that (1,456) product lines in 1997.

These non-tariff barriers are defined as any measure, other than ordinary customs tariffs, that acts as a barrier to international trade. They can take the form of quotas which limit the amount of a certain product that can be sold in a market, licences or standards to ensure a certain level of health, safety or environmental quality. While they are less visible and thus harder to measure than tariff barriers, they are no less important. In fact, with the exception of a few sensitive products where tariffs remain high, it is non-tariff barriers that pose a real impediment to international trade today, with a study of the trade policies of 91 countries finding that non-tariff barriers were equivalent to a 12% tariff barrier across the sample, (WTO, 2012). In addition to this, a report by UNCTAD (2012) found non-tariff barriers to contribute more than twice as much as tariffs to overall market access trade restrictiveness. In the context of Brexit, the House of Commons Exiting the European Committee's Whitehall briefing (2018) acknowledged non-tariff barriers as the most important driver of potential trade impacts, producing tariff equivalents of these that were as high as 20 per cent in the retail and wholesale trade sector.

While this research is important, it provides limited insight on the channels through which aggregate exports are affected (i.e. export decisions taken by firms on whether to export and how much to export). How tariff and non-tariff barriers impact on these different channels depends on how they relate to the fixed and variable costs that a firm faces when exporting. In terms of the firm and product extensive margins (the number of exporting firms/number of products exported, respectively), an increase in either the fixed or variable costs will lower the number of firms who participate in the

² Bown, C.P. and Irwin, D.A., 2016. The GATT's starting point: tariff levels circa 1947. The World Bank.

export market as profits for firms at the margin will become negative (Lawless, 2008), while it will also lead to a reduction in the number of goods exported.

For the intensive margin (average value per product per firm), the potential effect of the country level variables that proxy for trade costs depends on whether they reflect fixed or variable costs, as the relationship between variable trade costs and aggregate sales is ambiguous. A rise in variable trade costs will result in a profit maximising firm reducing the quantity it sells which in turn could lower total revenue. On the other hand, greater variable costs force some firms from the export market, and as these firms are likely to be those with smaller export sales this results in an ambiguous overall effect on average exports sales (per product per firm) to a country. In that context, it is left to the empirical research to quantify the effect.

Lawless (2010) was among the first to use firm-level data, which allowed for the investigation of factors on both the number of firms exporting to each market and the average exports per firm. The paper showed, using US data, that in line with the Melitz (2003) predictions, the extensive margin is negatively affected by both fixed and variable trade costs, but that there is no such clear prediction for the intensive margin.

For gravity research focusing on Ireland, Lawless (2010) provides a good account of the literature, starting with Fitzpatrick (1984), who in addition to the economic size and distance of trading partners, used dummy variables for geographical regions to show the strong positive effect EEC membership had on Irish exports and imports. Using firm-level export data, Lawless (2010) showed firm exporting decisions to be consistent with the theory of trade costs, with language, internal geography, and import cost barriers having a significant impact on the firm extensive margin, but not the intensive one. More recently, Byrne and Rice (2018) employ a form of a gravity model to analyse the impact of the UK's exit from the European Union on Irish goods, finding that it could lead to a 9.6% decline in Irish-UK trade.

The aforementioned paper also highlighted that the impact of non-tariff measures will differ by good type, with beverages, fresh foods and raw materials the most exposed. This is unsurprising given how certain goods may be more exposed to longer delays at the border if they are perishable or time-sensitive, raising the cost of such waiting times. Heterogeneity in the impact of non-tariff barriers by firm size has also been found, with Fontagné et al. (2015) showing that product standards have the largest negative impact on small firms, as larger firms find it easier to absorb the time cost.

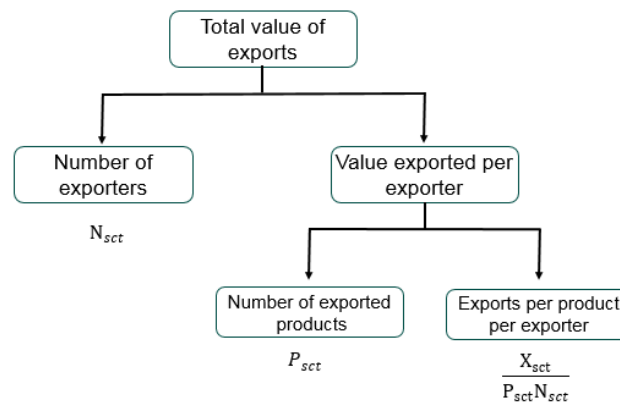
Recently, Lawless et al (2019) find a significant border effect for total trade at firm and product level using Irish product level customs data. Firms adjust to Ireland's border mainly through the intensive margin, both in terms of average exports per firm and average exports per product within firms.

The rest of the paper is organised as follows: section 2 will describe the gravity model framework used in the paper. Section 3 provides a description of the variables used and their sources, as well as providing some summary statistics of the trade data by region. Section 4 contains the gravity model results for total exports, as well as decomposing this by the extensive and intensive margins. Section 5 carries out the analysis for different firm types. Section 6 contains sector results focusing specifically on border waiting time impacts while section 7 concludes the paper.

Section 2: Methodology

We use an augmented gravity model to examine the determinants of Irish good exports at NACE 2 digit sector level. We explore the key drivers that affect total exports³ and the channels through which the relationships are strongest, i.e. through the extensive margins (i.e. number of exporters and products) and the product intensive margin (i.e. average product exports per exporter).

Figure 1: Sector export margins



For each exporting firm in sector s , total exports are separated into their extensive and intensive margins as follows:

$$X_{sct} = N_{sct} * P_{sct} * \frac{X_{sct}}{N_{sct}P_{sct}} \quad (1)$$

where X_{sct} denotes total value of goods exported by firms in sector s to country c in period t . N_{sct} is the number of exporters (firm extensive margin), P_{sct} is the number of products exported (product extensive margin) and $\frac{X_{sct}}{P_{sct}N_{sct}}$ is the value of exports per product per exporter in sector s (product intensive margin). Taking logs gives the expression in Equation (2),

$$\ln X_{sct} = \ln N_{sct} + \ln P_{sct} + \ln \frac{X_{sct}}{P_{sct}N_{sct}} \quad (2)$$

We incorporate these components into our gravity model which takes the following form:

$$Y_{sct} = \alpha_0 + \alpha_i Z_c + \delta_s + \gamma_t + \varepsilon_{sct} \quad (3)$$

The dependent variable (expressed in logs) denotes either the total value of goods exported, or one of its components the number of exporters, products, or exports per firm per product in 2-digit sector s , which export to country c in period t . Z denotes the vector of key trade determinants. It is useful to note that estimates of explanatory variables expressed in logs can be interpreted as elasticities. A number of the index variables are expressed in levels in the model and the estimated coefficients

³ Data is classified using NACE Rev 2 nomenclature. Analysis is conducted at the 2 digit level of aggregation.

represent semi-log elasticities. The 2-digit sector dummies δ_s control for sector differences. Time specific effects are controlled for using year dummies, γ_t .

The model specifications are estimated with ordinary least squares. An advantage of this estimation approach is that the sum of the point estimates on the extensive and intensive trade margins equals the point estimate for total exports. It is, therefore, possible to identify what is the most important trade margin through which the trade variables affect total exports.

In terms of the country explanatory variables, GDP in the destination market is included to capture the size of the market and is expected to lower exporting costs. The second key gravity model variable, distance, is measured as the distance between Ireland and the destination country. This variable proxies for transportation costs and the greater the geographic distance between two countries the larger are the expected transportation costs.

GDP per capita is included in the model to proxy for the destination country's level of development. Countries with higher GDP per capita tend to trade more and to have better transportation infrastructure. This would suggest that GDP per capita is negatively correlated with trade costs. On the other hand, a positive correlation may be present if for example, advertising and distribution operating costs are more expensive in more developed countries.

As is often the norm in gravity trade models, a binary variable that indicates whether the export destination market shares a common language with the home country is included. It is expected that this variable has a positive effect on export participation, as it should make it easier for firms to communicate with buyers in export markets and well as reduce the need to repackage goods for example.

To control for the communication infrastructure, two variables are included: log of the number of mobile cellular subscriptions per 100 inhabitants in the destination country, and the log of secure internet servers per 1 million inhabitants in the destination country. It is expected that better communication infrastructure reflected in higher values of the two variables should make it easier to connect with and gather information on buyers in the destination markets resulting in lowering search costs associated with exporting.

To account for the effects of internal geography of the destination market, population density of the country is included. It is expected that the costs of exporting should be lower for countries with a higher population density as, other things equal, it should be less costly to access a larger proportion of the population.

Exporting carries an element of risk in terms of product delivery and payment; it follows that the strength of the legal institutions and property rights matter for firm exporting decisions. We include an index variable, ranging from 1 to 10 database to account for how well a country's property rights are defined and protected. The higher the index value the stronger the country's property protection rights are considered to be. An indicator variable is also included to account for the cost of legal enforcement

of contracts based on the time and monetary cost required to collect a debt. Both indices are reordered with higher values indicating that a country has stricter tariff or regulatory barriers.

Tariff and non-tariff barriers are also predicted to affect the cost of exporting. For tariffs, a composite index accounts for the stringency of tariffs in a destination country. The index takes into account the country's relative performance in relation to revenue from trade taxes (% of trade sector), mean tariff rate and standard deviation of tariff rates. For the non-tariff barriers, a measure of the waiting times associated with exporting a product into a destination country is used as a proxy of the level of regulatory requirements. This is taken from the World Bank Doing Business survey and is based on the time cost of procedures required to import a full 20-foot container of dry goods that contains no hazardous or military items. Other measures are also collected including administrative costs associated with customs clearance. We did consider this additional measure in our analysis (see Appendix B) however its impact tended to be quite limited and on this basis we focus our attention on the role of border waiting times.

Finally, an EU dummy is included for the 28 countries in the European Union. This dummy captures the impact of all other factors attributed to a common market which may impact on trade not accounting for in our model specification. These could include for example, trade impacts emanating from the enforcement of strict laws on anti-competitive practices, and the free movement of labour which in turn enhances firms' capacity to network and enter new markets as well as source inputs.

Section 3: Data

Irish customs data is collected through two systems: Extrastat collects extra European trade, while Intrastat gathers data for intra-European trade. The threshold for reporting of exports differs between the two systems, above €635,000 per annum for intra-European exports and €254 per transaction for extra European exports.⁴ Customs data is collected on a monthly basis, but was aggregated to annual amounts by the Central Statistics Office before being made available. Customs data is available for the period 2013-2016, covering 168 destination countries.

The country level data variables are obtained from a number of sources to 2015. GDP, GDP per capita, population density and the communication infrastructure variables were taken from the World Bank's World Development Indicators dataset. The distance measure and common language indicator were obtained from CEPII. The property rights index, contract enforcement costs index are taken from the Polity IV data, while, the tariff index is taken from the Frasier Institute's Economic Freedom of the World database.⁵

The primary variable of interest in this study is waiting times at the border to import a good, taken from the World Bank Doing Business Survey. This is in the form of total hours taken to ensure documentary and border compliance when importing a good. According to the World Bank,

⁴ More information on the survey thresholds can be found here:

<https://www.cso.ie/en/media/csoie/methods/externaltrade/explanatorynotes2015.pdf>

⁵ Detailed descriptions of how the indices are constructed are available at: <http://www.freetheworld.com/>

documentary compliance captures the time taken for “compliance with the documentary requirements of all Government agencies of the origin economy, the destination economy and any transit economies”. Customs inspections captures the time taken for “compliance with the economy’s customs regulations and with other inspections that are mandatory in order for the shipment to cross the country’s border, as well as the time for handling that takes place at its port or border”.

Section 4: Aggregate results

The results of the gravity model specifications are presented in Table 1. For each explanatory variable we discuss the estimated effect on total exports and the three export margins.

GDP

The size of the destination country is positively related to total exports for Irish firms. For example, the GDP coefficient of 0.876 implies that if say country A is 10 percent larger than country B then firms will export 8.8 percent more to country A than to country B on average. Looking at the margins through which the GDP effect manifests itself in Table 1, the extensive margins are the main drivers explaining about 80 percent of the total effect.

Distance

Distance to the destination market has a significant and negative impact on total exports, highlighting the importance of transport costs to firms. The distance estimate of -0.426 implies that if country A is 10 percent further away than country B to Ireland, firms will on average export 4.3 per cent less to country A than to country B. Decomposing the distance effect in Table 1, the negative impact on total exports is driven by reduced exporter participation and lower product variety.

GDP per capita

The level of development of the destination country is negatively related to total exports. This effect largely emanates through the two extensive margins, with the intensive margin turning out slightly negative and insignificant. These results are not unexpected, if one assumes that more developed countries have higher fixed entry costs due to, for example, higher costs of establishing a distribution network or higher advertising costs.

Population density

Trading costs related to the internal geography of the destination country show a positive relationship with total exports of Irish firms. Decomposing this effect reveals some evidence that more densely populated countries attract a larger number of exporters and products, with the average product per firm an insignificant component.

Common Language

A shared first language between trading partners is an important factor affecting total exports of Irish firms. The estimates indicate that a common language is positively linked with the number of exporters and number of products exported, consistent with the theory that it is easier for exporters to advertise and package their goods in fellow English speaking countries. There is however a negative, albeit insignificant, effect of a common language on firms' average exports per product. This suggests that a shared language enables less productive firms to export.

Communication Infrastructure

The phone network measure is positively associated with the total exports for Ireland to each destination, with this coming through a significant positive impact on the number of exporters and both product margins. A more developed internet network in the destination market also has a positive impact on total trade via the two extensive margins.

Property right protection and legal contract enforcement costs

Property rights protection in the destination market is positively related to total goods exports and is particularly important in supporting the number of exporting firms and products exported. In terms of the legal contract enforcement costs, the estimates indicate that for countries where costs are high, participation of Irish exporters and the range of products exported are lower. Interestingly, those firms which do participate in these markets tend to export a larger average firm product volume offsetting the extensive margin impacts. Interestingly, this results in an insignificant relationship between legal costs and total trade to destination markets.

Non-tariff barriers

An increase in the waiting times for exporting products due to stricter regulatory compliance in a destination country is associated with a reduction in the value of export traded. The elasticity of -0.103 indicates that a 10% increase in the waiting time at the border will reduce total trade by just over 1%. Each of the three margins contributes roughly the same proportion to this overall impact, however only the coefficients on the extensive margins appear statistically significant. Therefore the negative relationship between waiting times and total trade is due to the fall in the number of exports to a destination country and the number of products they export, but not in the average value of exports per product per firm. The insignificant effect is consistent with a higher proportion of less productive firms exiting the export market.

Tariffs

A higher tariff burden is associated with lower total exports, which is expected given that they impose a direct cost on firms' exports.⁶ Further, the decomposition of the effect shows that it appears to be significantly associated with only a smaller range of products exported. The tariff index does not appear to raise variable costs sufficiently to force Irish exporters out of the market. A useful avenue for further research would be to investigate the trade impacts using more detailed tariff schedules combined with firm product level export data.

EU

As expected, we observe a positive association between EU membership and total exports. Interestingly, the EU coefficient is negative for the product extensive margin while the intensive margin is positive. This adjustment suggests that firms tend to prioritise and more intensively export their 'core competency' products to EU markets.

⁶ As we measure tariffs using indices which rank a country for their tariff stringency, we cannot model the impact of specific changes in tariff rates on Irish exporting activity.

Table 1. Gravity Model Estimations for Irish Exports

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.876*** [18.41]	0.301*** [13.81]	0.413*** [18.80]	0.162*** [4.80]
Distance	-0.426*** [-3.74]	-0.089*** [-3.93]	-0.222*** [-5.91]	-0.116 [-1.49]
GDP per capita	-0.292*** [-3.32]	-0.121*** [-5.97]	-0.186*** [-6.43]	0.016 [0.20]
Common language	0.687*** [4.58]	0.231*** [7.72]	0.389*** [8.13]	0.067 [0.57]
Population Density	0.057* [1.96]	0.034*** [4.63]	0.028*** [2.84]	-0.005 [-0.23]
Phone network	0.705*** [4.87]	0.165*** [3.07]	0.214*** [3.17]	0.326*** [3.06]
Internet network	0.184*** [3.09]	0.104*** [6.68]	0.129*** [6.37]	-0.048 [-0.88]
Waiting times	-0.103*** [-2.78]	-0.032*** [-2.84]	-0.036** [-2.43]	-0.034 [-1.04]
Tariff	-0.084** [-2.04]	0.007 [0.73]	-0.029** [-2.13]	-0.062 [-1.62]
Property Rights	0.114*** [3.15]	0.049*** [6.13]	0.065*** [5.18]	0.000 [0.01]
Legal costs	0.043 [1.49]	-0.021*** [-2.65]	-0.024** [-2.42]	0.088*** [3.88]
EU	0.730*** [3.69]	-0.016 [-0.20]	-0.200** [-2.08]	0.946*** [5.54]
R²	0.386	0.539	0.505	0.071
Observations	10,423	10,423	10,423	10,423

Note: Sector fixed effects and Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Section 5: Results by firm type

Given the potential for significant differential effects of trade policy based on the size of the firm (e.g. Fontagné et al, 2015), we re-estimate our gravity model for separate firm size samples. We measure firm size as the number of employees, as contained in the CSO customs data. Small firms are defined as those with 0-49 employees, medium-sized firms as those between 50 and 249 employees, and large firms as those with 250 or more employees.

Table 2. Gravity model estimations for Irish exports – Small firms

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.777*** [16.98]	0.259*** [10.37]	0.362*** [16.21]	0.156*** [5.36]
Distance	-0.646*** [-6.11]	-0.110*** [-4.69]	-0.210*** [-6.22]	-0.326*** [-4.42]
GDP per capita	-0.520*** [-5.83]	-0.121*** [-4.86]	-0.155*** [-5.65]	-0.244*** [-3.51]
Common language	0.709*** [5.04]	0.238*** [9.82]	0.374*** [8.94]	0.097 [0.90]
Population Density	0.047 [1.60]	0.021** [2.43]	0.022** [2.13]	0.004 [0.18]
Phone network	0.678*** [3.01]	0.109 [1.51]	0.249*** [3.73]	0.320* [1.97]
Internet network	0.203*** [4.08]	0.100*** [5.77]	0.115*** [5.56]	-0.012 [-0.29]
Waiting times	-0.058* [-1.74]	-0.024** [-2.27]	-0.014 [-1.16]	-0.020 [-0.59]
Tariff	-0.176*** [-3.70]	-0.020 [-1.40]	-0.029* [-1.97]	-0.127*** [-3.45]
Property Rights	0.177*** [4.83]	0.049*** [5.88]	0.063*** [5.75]	0.066** [2.02]
Legal costs	0.032 [0.96]	-0.014* [-1.90]	-0.015 [-1.63]	0.061** [2.24]
EU	0.513*** [2.80]	-0.068 [-0.84]	-0.136* [-1.71]	0.717*** [4.70]
R²	0.337	0.478	0.504	0.079
Observations	8,051	8,051	8,051	8,051

Note: Sector fixed effects. Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table 3. Gravity model estimations for Irish exports – Medium sized firms

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.820*** [16.93]	0.224*** [9.85]	0.369*** [18.82]	0.227*** [5.00]
Distance	-0.387*** [-3.13]	-0.097*** [-4.25]	-0.182*** [-5.60]	-0.108 [-1.27]
GDP per capita	-0.187 [-1.62]	-0.102*** [-4.08]	-0.176*** [-5.16]	0.091 [0.91]
Common language	0.599*** [4.13]	0.152*** [4.58]	0.309*** [6.13]	0.138 [1.04]
Population Density	0.045 [1.19]	0.035*** [4.21]	0.033*** [3.55]	-0.023 [-0.80]
Phone network	0.626*** [2.81]	0.151*** [3.71]	0.234*** [2.82]	0.241 [1.41]
Internet network	0.132 [1.62]	0.058*** [3.11]	0.112*** [4.82]	-0.039 [-0.51]
Waiting times	-0.160** [-2.48]	-0.044*** [-2.91]	-0.033* [-1.93]	-0.083 [-1.52]
Tariff	-0.112** [-2.00]	-0.003 [-0.38]	-0.023* [-1.76]	-0.085* [-1.72]
Property Rights	0.130** [2.48]	0.049*** [5.15]	0.070*** [5.56]	0.011 [0.29]
Legal costs	0.063 [1.57]	-0.013 [-1.43]	-0.019 [-1.59]	0.095*** [2.77]
EU	0.314 [1.04]	-0.011 [-0.17]	-0.132 [-1.58]	0.457** [2.18]
R²	0.340	0.462	0.559	0.074
Observations	5,894	5,894	5,894	5,894

Note: Sector fixed effects. Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table 4. Gravity model estimations for Irish exports – Large firms

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.931*** [11.41]	0.188*** [7.18]	0.359*** [18.52]	0.383*** [6.29]
Distance	-0.625*** [-3.30]	-0.079*** [-3.14]	-0.183*** [-3.75]	-0.364** [-2.65]
GDP per capita	-0.070 [-0.67]	-0.053* [-1.90]	-0.154*** [-5.00]	0.138 [1.38]
Common language	0.483* [1.72]	0.132*** [3.00]	0.287*** [4.79]	0.064 [0.27]
Population Density	0.081 [1.18]	0.030*** [2.77]	0.025 [1.63]	0.026 [0.53]
Phone network	0.865*** [4.07]	0.132** [2.59]	0.156** [2.14]	0.577*** [3.60]
Internet network	0.160* [1.69]	0.058*** [2.84]	0.132*** [5.37]	-0.030 [-0.40]
Waiting times	-0.048 [-0.69]	-0.018* [-1.89]	-0.016 [-1.02]	-0.014 [-0.24]
Tariff	-0.048 [-0.72]	0.023** [2.51]	-0.009 [-0.54]	-0.062 [-1.11]
Property Rights	0.015 [0.27]	0.020* [1.83]	0.035* [1.96]	-0.040 [-0.89]
Legal costs	0.019 [0.34]	-0.004 [-0.35]	-0.009 [-0.56]	0.032 [0.64]
EU	0.485 [1.61]	-0.051 [-1.11]	-0.140* [-1.80]	0.676** [2.38]
R²	0.374	0.387	0.523	0.159
Observations	4,026	4,026	4,026	4,026

Note: Sector fixed effects. Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Results for small firms, medium-sized firms and large firms are shown below in Tables 2, 3 and 4, respectively. The coefficients for the traditional gravity model variables, GDP and distance, all remain the positive and significant across margins as in the baseline model results in Table 1. However it is interesting to note that the contribution to the total coefficient on GDP from the product intensive margin increases with firm size, supporting the theory that larger firms are able to avail of economies of scale when exporting to larger countries, resulting in higher average firm exports per product in a sector.

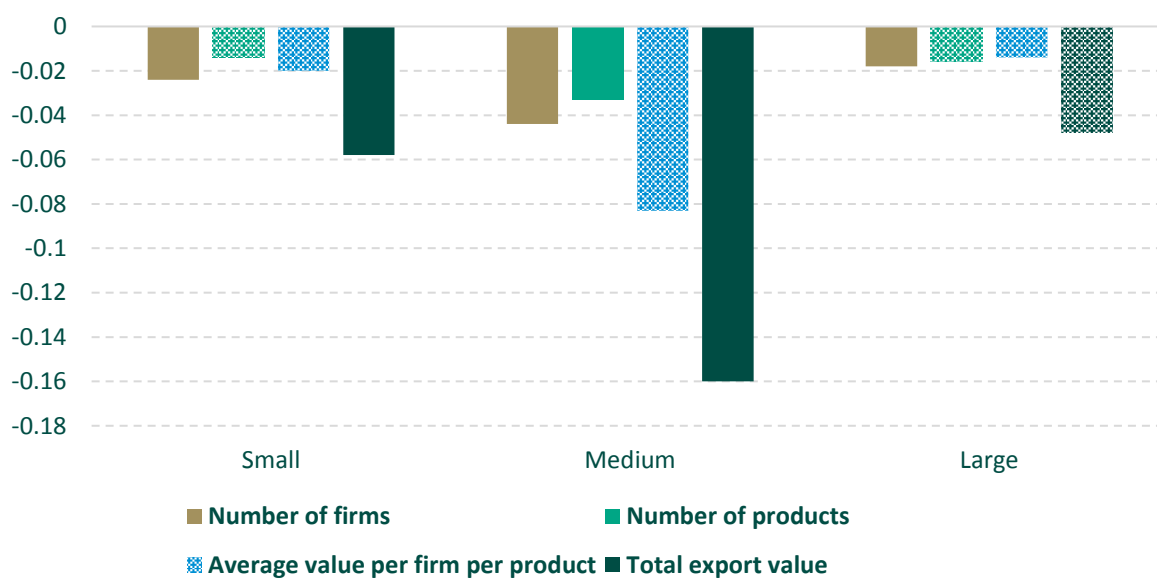
When investigating for different firm sizes the total trade impact of exporting to more developed country on trade, proxied by GDP per capita, or to a destination that is also English-speaking, it mainly emanates through the extensive margins, as in the full sample. Interestingly, the coefficient on the common language dummy is of a higher magnitude and more statistically significant for SMEs. This suggests that larger firms (many of which are foreign owned) are better positioned to cover the costs of trading in more than one language.

As in the aggregate results, higher tariffs do not appear to negatively affect the firm extensive margin, suggesting that even for small firms, tariffs do not raise variable costs sufficiently to force Irish firms to leave the export market. However, the results suggest they significantly reduce the total value of goods exported for SMEs, with this emanating through both the number of products exported and the intensive margin.

The impact of waiting times across the different margins within the sub-samples is illustrated in Figure 2. All coefficients show a negative impact, although the only margin this is significant for across all three firm sizes is the firm extensive margin, in line with Lawless (2010). However, the total impact is only statistically significant for SMEs, while suggesting that larger firms find it easier to overcome and absorb these related trading costs. This is consistent with findings in the international literature on trade impacts of non-tariff barriers, Fontagné et al. (2015).

Interestingly, the border waiting time coefficient is larger for medium-sized firms than small firms. One possible explanation is that the mid-sized firms are more likely to export high-value goods that are sensitive to higher waiting times, and to overcome the associated higher trading costs in those markets they may adjust the composition of their exports away from these types of goods. This would also explain the negative result for the number of products in this group. It is also worth noting that due to the minimum export value thresholds applied when collecting the data, many micro and small firms are not captured in the data, some of whom might be particularly vulnerable to higher time costs.

Figure 2: Gravity model estimates for border waiting times by firm size



Source: Department of Finance analysis using CSO customs data

Note: dashed bars indicate statistical insignificance.

Firm ownership

To the extent that Ireland is considered an export platform for foreign owned firms into the EU for example, it is worth investigating how firm exporting decisions in response to trade costs differ by firm nationality. Moreover, foreign-owned exporters tend to be more globally connected and therefore potentially more capable of mitigating various trade costs. We re-estimate our gravity model separating the sample into two groups based on whether firms are Irish- or foreign-owned. The results are presented in Tables 5 and 6.

Focusing on a number of specific trade cost estimates, we see a much larger coefficient on the *Common language* dummy for Irish-owned firms. This is expected given that these firms are likely to be less globalised and therefore will find it easier to adapt products to fellow English-speaking countries.

In terms of border waiting times, both groups are equally sensitive in terms of how the total value of goods exported adjusts. Interestingly, for Irish-owned firms the effect comes through the extensive margins, while for foreign-owned firms it is a combination of the firm-extensive and product intensive margins.

The tariff index is negatively associated with total exports through the product intensive margin for Irish-owned firms only.

Table 5. Gravity model estimations for Irish exports – Irish exporters

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.766*** [17.15]	0.258*** [10.48]	0.385*** [19.46]	0.123*** [2.71]
Distance	-0.523*** [-4.54]	-0.086*** [-3.19]	-0.167*** [-4.89]	-0.271*** [-3.21]
GDP per capita	-0.384*** [-3.55]	-0.126*** [-4.60]	-0.185*** [-5.39]	-0.073 [-0.71]
Common language	0.847*** [6.02]	0.206*** [7.29]	0.343*** [8.21]	0.297** [2.64]
Population Density	-0.041 [-1.17]	0.023** [2.44]	0.015 [1.52]	-0.079** [-2.59]
Phone network	0.695*** [3.33]	0.078 [1.25]	0.222*** [2.92]	0.395** [2.65]
Internet network	0.174** [2.32]	0.089*** [5.06]	0.129*** [6.09]	-0.044 [-0.59]
Waiting times	-0.135*** [-2.82]	-0.042*** [-3.51]	-0.034* [-2.00]	-0.058 [-1.64]
Tariff	-0.158*** [-3.86]	-0.010 [-0.70]	-0.026 [-1.54]	-0.121*** [-3.61]
Property Rights	0.209*** [4.36]	0.070*** [6.55]	0.077*** [7.06]	0.062 [1.49]
Legal costs	0.043 [1.60]	-0.007 [-0.67]	-0.009 [-0.79]	0.059* [1.92]
EU	0.306 [1.33]	-0.054 [-0.65]	-0.139 [-1.30]	0.499** [2.47]
R²	0.411	0.502	0.511	0.127
Observations	5,755	5,755	5,755	5,755

Note: Sector fixed effects. Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table 6. Gravity model estimations for Irish exports – Foreign exporters

	Total export value	Number of exporters	Number of products	Average value per product per exporter
GDP	0.946*** [14.84]	0.242*** [9.28]	0.401*** [17.83]	0.304*** [8.59]
Distance	-0.378*** [-2.75]	-0.084*** [-4.13]	-0.186*** [-4.90]	-0.108 [-1.07]
GDP per capita	-0.219** [-2.02]	-0.080*** [-3.26]	-0.187*** [-7.54]	0.048 [0.51]
Common language	0.338** [2.51]	0.122*** [4.37]	0.296*** [5.38]	-0.080 [-0.71]
Population Density	0.137*** [3.20]	0.038*** [4.41]	0.043*** [4.14]	0.056* [1.78]
Phone network	0.649*** [3.67]	0.162*** [3.89]	0.190** [2.43]	0.297** [2.53]
Internet network	0.216*** [3.24]	0.077*** [4.93]	0.146*** [8.90]	-0.007 [-0.11]
Waiting times	-0.135** [-2.55]	-0.028** [-2.36]	-0.023 [-1.34]	-0.084** [-2.21]
Tariff	-0.069 [-1.14]	0.012* [1.94]	-0.005 [-0.38]	-0.075 [-1.36]
Property Rights	0.101*** [2.73]	0.023*** [3.21]	0.049*** [3.38]	0.029 [0.96]
Legal costs	0.019 [0.47]	-0.009 [-1.03]	-0.016 [-1.64]	0.044 [1.35]
EU	0.383 [1.47]	-0.003 [-0.06]	-0.114* [-1.72]	0.500** [2.38]
R²	0.366	0.506	0.564	0.066
Observations	5,910	5,910	5,910	5,910

Note: Sector fixed effects. Year dummies included. Robust standard errors in parentheses.

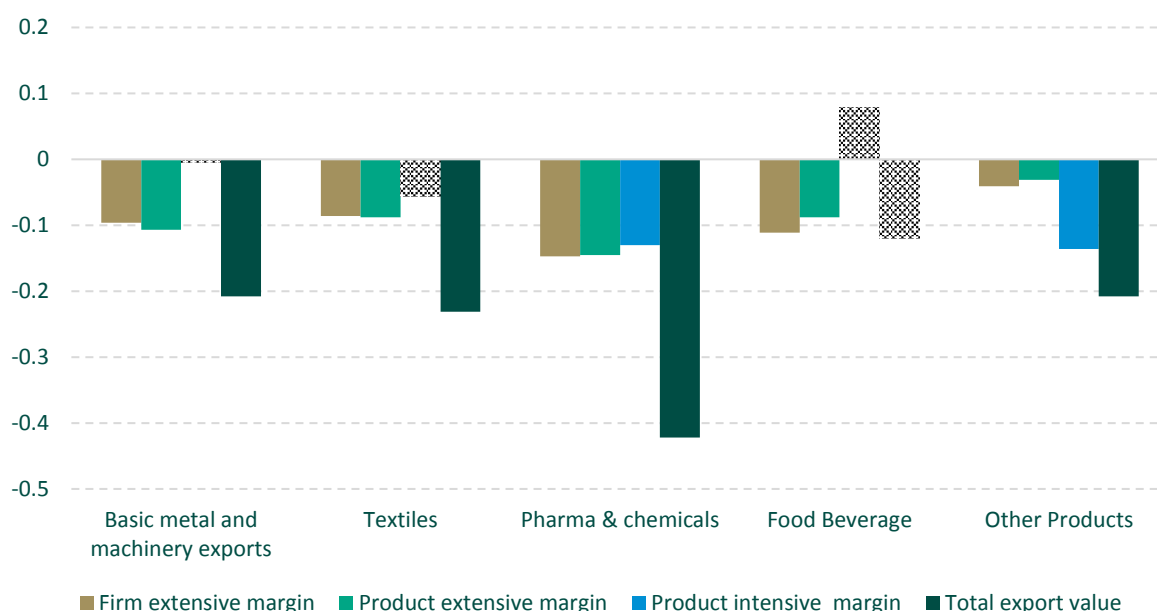
*** indicates significance at 1% level, ** at 5% and * at 10%.

Section 6: Results by sector

In this section, we narrow our focus and explore the sector variation in the relationship between our non-tariff measure (i.e. border waiting times) and exporting activity. We re-estimate our gravity model for 8 sector samples and present the waiting time estimates graphically below for the 5 sectors in which estimates are significant.⁷

In summary, each of the 5 sectors (i.e. *Basic Metals and Machinery, Textiles, Pharmaceutical and Chemical, Food and Beverage and Other Products*) are found to adjust to higher waiting times through the two extensive margins firms tend to exit the market and the number of exported products is reduced. The *Pharmaceutical and Chemical* sector is relatively more responsive in this regard. In addition, longer border waiting times are associated with a significant reduction in the intensity with which products in the sector are exported.

Figure 3: Gravity model estimates for border waiting time by sector



Source: Department of Finance analysis using CSO customs data

Note: dashed bars indicate statistical insignificance.

Looking at the results in more detail, in the *Basic metals and Machinery* sector, total exports to a trading partner country tend to be lower where border waiting times are higher. The adjustment tends to take place through a reduction in firms who decide to export, and in the number of products exported. Bulky goods such as machinery, which are likely to be prevalent in this sector, have been identified in previous literature as being more sensitive to delays (Byrne & Rice, 2018). Similarly, increases in the waiting times for exporting products in the *Textiles* sector are associated with a fall in the number of exporters and exported products.

⁷ The full set of regression results for each of 8 sectors are contained in Appendix D.

The *Pharmaceutical and Chemical* sector exhibits a particularly strong negative relationship between border waiting times and total exports. The channels through which this emanates all show approximately the same level of magnitude. This is likely to reflect the fact that pharmaceutical and chemical goods are both time sensitive and temperature sensitive, increasing the cost of delays due to non-tariff barriers (House of Commons, 2018), while the significant impact on the intensive margin suggests it is the high-value pharmaceutical goods that are affected.

In the *Food and Beverage* sector, longer waiting times are linked to a fall in the number of exporters and products. Although the product intensity adjustment is positive, it is insignificant. This contributes to an insignificant impact of the waiting time on the total value of exports. This negative extensive margin impacts are understandable given the time-sensitive nature of many of the goods, especially within the food sector.

Section 7: Conclusion

This paper re-examines the relative importance of key drivers of Irish goods exports and the mechanisms through which firms adjust. Results with respect to the standard gravity model variables are in line with findings in the literature. The significant impact of costs associated with distance on the exporting decisions highlight the challenge of finding alternative destination markets to the UK for firms in light of Brexit. However, from a European trade integration perspective, efforts to address and lower other trade costs through for instance communication and infrastructure investment could be beneficial.

Border waiting times matter significantly for total exports and firm export participation. A 10 per cent increase in waiting times at customs for goods reduces the total value of trade by just over 1 per cent on average. This is primarily driven by a significant decline in the number of exporting firms, while the number of products exported declines also.

Our results indicate that total exports in five out of the eight sectors are significantly affected by border waiting times. Firm export adjustments primarily work through the two extensive margins with the magnitude of the response varying across the sectors. Exporters in the pharmaceutical sector are particularly responsive across each of the three exports margins. This perhaps reflects that most goods in this sector are time and temperature sensitive.

We also find evidence for the potential differential effect of changes in trade policy across firms. Our results indicate that small and medium sized enterprises are particularly sensitive to border waiting times, with reductions in total exports determined by reduced firm export participation and a decline in the number of products exported. In the context of Brexit the papers findings point towards the importance of ensuring that SMEs are as well prepared as possible for significant adverse shifts in trade policy. This is especially relevant given their importance to the economy in terms of output and employment, and the large number of these enterprises who export to the UK.

While outside the scope of this paper, any significant reduction in the number of firms participating in exporting over an extended period is likely to have important knock on implications for productivity growth. Reduced exporting activity is likely to curtail the innovative capabilities of Irish firms. Examining the linkages between shifts in trade policy and developments in Irish firm productivity would be an important avenue for future work.

Section 8: References

Bergin, A., Garcia-Rodriguez, A., McInenrey, N., Morgenroth, E., and D. Smith. 2017. "Modelling the Medium to Long Term Potential Economic Impact of Brexit on Ireland", *Economic and Social Review*, Vol. 48(3), pp.305-316

Bernard, A., Bradford, J., Redding, S. and Schott P. 2007 Firms in international trade. *The Journal of Economic Perspectives* Vol. 21, No. 3, pp. 105-130

Bown, C.P. and Irwin, D.A., 2016. *The GATT's starting point: tariff levels circa 1947*. The World Bank.

Byrne, S. and Rice, J. 2018. "Non-Tariff Barriers and Goods Trade: a Brexit Impact Analysis", Central Bank Research Technical Paper.

Damijan, J, Mirza, D and Murphy, G. 2014. "Market Destination Characteristics and Firm Export Performance by Destination". Background Study for the European Competitiveness Report 2014.

Department of Finance. 2016. UK EU Exit – An Exposure Analysis of Sectors of the Irish Economy.

Department of Finance. 2018 Brexit: Analysis of Import Exposures in an EU Context.

EU Exit Analysis Cross Whitehall Briefing, 2018. House of Commons Exiting the European Union Committee.

Fitzpatrick, J., 1984. The Geographical Pattern of Irish Foreign Trade: Test of a Gravity Model. *Economic and Social Review*, 16(1), pp.19-30.

Fontagné, L., Orefice, G., Piermartini, R. and Rocha, N., 2015. Product standards and margins of trade: Firm-level evidence. *Journal of international economics*, 97(1), pp.29-44.

Hummels, David L., 2007. "Transportation Costs and International Trade in the Second Era of Globalization", *Journal of Economic Perspectives*, vol. 21, pp. 131-154

Keogh, G., 2018. A Gravity Model Analysis of Irish Merchandise Goods Exports under Brexit. *arXiv preprint arXiv:1812.08591*.

Kinzius, L., Sandkamp, A. and Yalcin, E., 2019. Trade protection and the role of non-tariff barriers. *Review of World Economics*, 155(4), pp.603-643.

Lawless, Martina and Morgenroth, Edgar, 2016. "The Product and Sector Level Impact of a Hard Brexit across the EU", ESRI Working Paper, Working Paper No. 550.

Lawless, Martina. 2009 'Destinations of Irish Exports: A Gravity Model Approach'. - Dublin: *Journal of the Statistical and Social Inquiry Society of Ireland*, Vol.XXXIX, pp1-22.

Lawless, M., 2010. Deconstructing gravity: trade costs and extensive and intensive margins. *Canadian Journal of Economics/Revue canadienne d'économique*, 43(4), pp.1149-1172.

Linnemann, H. (1966) *An Econometric Study of International Trade Flows*. Holland Publishing, Amsterdam.

Mayer, T. and Ottaviano, G.I., 2008. The happy few: The internationalisation of european firms. *Intereconomics*, 43(3), pp.135-148.

Melitz, M. J., 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, Vol. 71, No. 6, pp. 1695-1725

Murphy, G. and Siedschlag, I., 2011. "Has the Euro Boosted Intra-Euro Area Exports? Evidence from Industry Data", *Review of Economics and Institutions*, vol. 2-3, Article 4.

OECD, 2018. *The Potential Macroeconomic and sectoral consequences of Brexit on Ireland*, OECD Publishing, Paris.

Tinbergen, J., 1962. *Shaping the World Economy: Suggestions for an International Economic Policy*. The Twentieth Century Fund, New York.

Zhaohui, N., Chang, L., Saileshsingh G., and Chris Milner, 2018. "Non-tariff and overall protection: evidence across countries and over time," *Review of World Economics*, vol. 154(4).

Appendix A - Descriptive statistics

Table A1 - average share of exports by geographical region (%)

Africa	3.9
Asia	15
Caribbean	0.17
Central America	1.7
Europe ⁸	25
Middle East	3.8
North America	48
Oceania	1.8
South America	1.1

Table A2 - average share of exporters that export to each geographical region

Africa	29
Asia	49
Caribbean	3.4
Central America	8.1
Europe ⁷	40
Middle East	27
North America	58
Oceania	21
South America	10

Table A3 - ratio of average exports per firm to a region relative to average exports per firm to Europe (ex EU-28).

Africa	0.22
Asia	0.54
Caribbean	0.078
Central America	0.44
Europe ⁷	1.00
Middle East	0.26
North America	1.56
Oceania	0.16
South America	0.19

Table A4 - ratio of average exports per firm to a region relative to average exports per firm to Europe (ex EU-28).

Africa	0.34
Asia	0.43
Caribbean	0.78
Central America	1.82
Europe ⁷	1.00
Middle East	0.34
North America	1.04
Oceania	1.98
South America	0.55

⁸ Note: Europe excludes EU-28 countries due to difference in Intrastat EU-28 data collection criteria.

Table A5 – description of variables

Variable	Measure	Source
GDP	Natural logarithm of GDP (USD constant) in destination country	World Bank's World Development Indicators
Distance	Natural logarithm of distance between Ireland and export destination country.	CEPII
GDP per capita	Natural logarithm of GDP (USD constant) in destination country	World Bank's World Development Indicators
Common language	Dummy variable equal to 1 if destination country speaks English	CEPII
Population density	Natural logarithm of population per km squared	World Bank's World Development Indicators
Phone network	Natural logarithm of mobile telephone subscriptions per 100 inhabitants in a country	World Bank's World Development Indicators
Internet network	Natural logarithm of secure internet servers per 1 million inhabitants in a country	World Bank's World Development Indicators
Tariff	A composite index which accounts for the stringency of tariffs in a country is included. The index takes into account the country's relative performance in relation to revenue from trade taxes, mean tariff rate and standard deviation of tariff rates.	Frasier Institute's Economic Freedom of the World
Waiting times	Delays (in hours) due to documentary compliance and customs inspections when importing through borders	World Bank Doing Business Survey
Property rights	A constructed index which ranks how well defined and protected property rights.	Frasier Institute's Economic Freedom of the World
Legal costs	An index that ranks the country's cost of legal enforcement of contracts based on the time and expenses required to collect a clear-cut debt.	Frasier Institute's Economic Freedom of the World
EU	A dummy that is equal to 1 if the country is a member of the European Union, 0 if not.	n/a

Table A6. Gravity Model of Total Irish exports

	Total export value	Total export value	Total export value	Total export value	Total export value	Total export value	Total export value
GDP	0.917*** [17.90]	0.820*** [17.48]	0.819*** [17.52]	0.877*** [17.48]	0.868*** [18.38]	0.886*** [18.53]	0.876*** [18.41]
Distance	-0.844*** [-12.23]	-0.812*** [-9.51]	-0.793*** [-9.18]	-0.718*** [-7.84]	-0.595*** [-5.87]	-0.559*** [-5.42]	-0.426*** [-3.74]
GDP per capita		0.327*** [4.75]	0.327*** [4.73]	-0.406*** [-5.55]	-0.262*** [-3.20]	-0.311*** [-3.48]	-0.292*** [-3.32]
Common language		0.856*** [7.32]	0.799*** [6.50]	0.602*** [4.32]	0.753*** [5.18]	0.687*** [4.53]	0.687*** [4.58]
Population Density			0.112*** [4.08]	0.078*** [3.03]	0.070** [2.46]	0.066** [2.26]	0.057* [1.96]
Phone network				0.438*** [2.90]	0.602*** [4.13]	0.723*** [5.07]	0.705*** [4.87]
Internet network				0.371*** [7.73]	0.192*** [3.23]	0.177*** [2.95]	0.184*** [3.09]
Waiting times					-0.176*** [-4.57]	-0.204*** [-5.16]	-0.103*** [-2.78]
Tariff					-0.136*** [-3.55]	-0.136*** [-3.44]	-0.084** [-2.04]
Property Rights						0.098*** [2.78]	0.114*** [3.15]
Legal costs						0.068** [2.29]	0.043 [1.49]
EU							0.730*** [3.69]
R²	0.335	0.358	0.361	0.374	0.378	0.383	0.386
Observations	11,102	11,102	11,102	11,091	10,533	10,423	10,423

Note: Sector fixed effects. Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Appendix B – Robustness checks

Restricting sample to 2013/2014:

From 2015 onwards, CSO microdata does not contain observations on companies what are known as its Large Case Units (LCUs), who are approximately the largest 50 companies in Ireland. Given that a number of these firms are also likely to be large exporters, the fact they are omitted in 2015 could potentially affect the estimation results. Table B2 therefore carries out the analysis on the years 2013 and 2014 (i.e. years where LCU firms are present in the data). Table B3 contains results on the model beings estimated on a cross-section. Tables B3 and B4 below show that the both the significance, direction and magnitude of the coefficients are unaffected by restricting to years where LCU firms are included, or if it is just ran as a cross-section.

Table B1. Decomposition of Gravity Model of Total Irish Exports - 2013/14

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.888*** [17.12]	0.302*** [13.76]	0.419*** [19.24]	0.166*** [4.61]
Distance	-0.403*** [-3.28]	-0.079*** [-3.37]	-0.209*** [-5.13]	-0.114 [-1.37]
GDP per capita	-0.252** [-2.49]	-0.128*** [-5.50]	-0.207*** [-7.00]	0.083 [0.94]
Common language	0.693*** [4.35]	0.222*** [6.91]	0.380*** [7.33]	0.092 [0.72]
Population Density	0.058* [1.76]	0.035*** [4.55]	0.026** [2.61]	-0.004 [-0.15]
Phone network	0.656*** [4.30]	0.165*** [3.10]	0.213*** [3.02]	0.278** [2.27]
Internet network	0.167** [2.49]	0.104*** [6.28]	0.128*** [6.26]	-0.064 [-1.10]
Waiting times	-0.101** [-2.57]	-0.029** [-2.54]	-0.041*** [-2.74]	-0.030 [-0.85]
Tariff	-0.074* [-1.69]	0.009 [0.87]	-0.030* [-1.93]	-0.053 [-1.25]
Property Rights	0.100** [2.45]	0.050*** [5.81]	0.068*** [5.19]	-0.018 [-0.55]
Legal costs	0.009 [0.31]	-0.027*** [-3.32]	-0.033*** [-2.89]	0.069*** [2.99]
EU	0.753*** [3.32]	-0.015 [-0.19]	-0.232** [-2.39]	1.000*** [4.96]
R²	0.387	0.541	0.506	0.084
Observations	7,100	7,100	7,100	7,100

Note: Sector fixed effects. Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Running model on a cross section:

Table B2. Decomposition of Gravity Model of Total Irish Exports - 2014

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.891*** [29.46]	0.306*** [39.18]	0.420*** [36.89]	0.165*** [6.69]
Distance	-0.474*** [-4.26]	-0.082*** [-3.19]	-0.231*** [-6.27]	-0.161** [-2.04]
GDP per capita	-0.190 [-1.62]	-0.143*** [-5.03]	-0.218*** [-5.61]	0.171* [1.74]
Common language	0.838*** [6.15]	0.250*** [7.28]	0.444*** [9.10]	0.144 [1.28]
Population Density	0.035 [1.10]	0.028*** [3.71]	0.023** [2.14]	-0.016 [-0.63]
Phone network	0.667*** [3.07]	0.188*** [3.59]	0.231*** [3.32]	0.247 [1.36]
Internet network	0.114* [1.68]	0.106*** [6.58]	0.124*** [5.47]	-0.116** [-2.07]
Waiting times	-0.152*** [-2.59]	-0.036** [-2.51]	-0.041** [-2.06]	-0.076* [-1.73]
Tariff	-0.084 [-1.50]	0.009 [0.67]	-0.032* [-1.76]	-0.061 [-1.29]
Property Rights	0.130*** [2.96]	0.056*** [5.19]	0.081*** [5.35]	-0.007 [-0.19]
Legal costs	0.042 [1.04]	-0.024*** [-2.58]	-0.030** [-2.26]	0.095*** [2.86]
EU	0.507** [2.51]	-0.017 [-0.35]	-0.250*** [-3.75]	0.774*** [4.49]
R²	0.543	0.696	0.645	0.307
Observations	3,534	3,534	3,534	3,534

Note: Sector fixed effects. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Testing other non-tariff barriers:

While the time cost component of non-tariff barriers is the main focus of this paper, we also consider separately the impact of the administrative costs of compliance checks and documentation, using the same source (World Bank Doing Business Survey). Table B4 below shows that these have an insignificant impact on the total value of trade.

Table B3. Decomposition of Gravity Model of Total Irish Exports

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.710*** [13.35]	0.283*** [12.60]	0.368*** [15.66]	0.059* [1.77]
Distance	-0.182 [-1.57]	-0.099*** [-4.05]	-0.166*** [-4.32]	0.083 [0.99]
GDP per capita	-0.142 [-1.35]	-0.122*** [-5.07]	-0.154*** [-5.02]	0.134 [1.31]
Common language	0.563*** [3.73]	0.194*** [6.98]	0.309*** [7.25]	0.060 [0.47]
Population Density	0.036 [1.27]	0.033*** [4.21]	0.024** [2.30]	-0.020 [-0.88]
Phone network	0.643*** [3.87]	0.143** [2.52]	0.164** [2.28]	0.336*** [2.71]
Internet network	0.238*** [3.91]	0.109*** [7.42]	0.133*** [6.71]	-0.004 [-0.07]
Administrative costs	0.140 [1.35]	0.060** [2.23]	0.057 [1.53]	0.022 [0.26]
Tariff	0.004 [0.10]	0.012 [1.39]	-0.013 [-1.07]	0.006 [0.15]
Property Rights	0.112** [2.37]	0.082*** [6.84]	0.089*** [5.91]	-0.059 [-1.59]
Legal costs	0.001 [0.04]	-0.032*** [-3.71]	-0.040*** [-3.51]	0.073*** [2.90]
EU	-0.917*** [-3.11]	-0.169* [-1.96]	-0.501*** [-4.64]	-0.247 [-0.97]
R²	0.289	0.531	0.480	0.012
Observations	7,280	7,280	7,280	7,280

Note: Sector fixed effects. Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Appendix D – sector results

The regression results for each sectoral sub-sample is included in Tables D1-D8 below, where we followed the same sectoral breakdown as that of Keogh (2018) for Ireland.

Table C1. Basic metal and machinery exports

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.895*** [17.94]	0.384*** [21.80]	0.512*** [23.70]	-0.001 [-0.04]
Distance	-0.285 [-1.44]	-0.067 [-1.08]	-0.023 [-0.29]	-0.195* [-1.72]
Common language	0.647*** [2.83]	0.311*** [3.79]	0.358*** [3.40]	-0.022 [-0.16]
Population Density	-0.126* [-1.79]	0.004 [0.14]	0.000 [0.01]	-0.130*** [-2.74]
Waiting times	-0.208*** [-2.80]	-0.096*** [-3.90]	-0.107*** [-3.40]	-0.005 [-0.12]
Tariff	-0.226** [-2.11]	-0.111*** [-3.11]	-0.152*** [-3.44]	0.038 [0.51]
R²	0.370	0.453	0.464	0.026
Observations	775	775	775	775

Note: Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table C2. Wood and paper products

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.671*** [11.18]	0.227*** [19.26]	0.310*** [18.03]	0.135** [2.43]
Distance	-1.338*** [-5.15]	-0.324*** [-5.77]	-0.320*** [-4.11]	-0.694*** [-3.71]
Common language	0.688** [2.24]	0.463*** [7.72]	0.489*** [5.62]	-0.264 [-1.00]
Population Density	-0.049 [-0.57]	0.029* [1.71]	-0.003 [-0.12]	-0.075 [-0.97]
Waiting times	0.053 [0.54]	-0.027 [-1.39]	0.035 [1.24]	0.045 [0.57]
Tariff	-0.389*** [-2.85]	-0.006 [-0.25]	-0.062* [-1.76]	-0.321*** [-2.59]
R²	0.311	0.504	0.404	0.098
Observations	584	584	584	584

Note: Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table C3. Textiles

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.870*** [10.26]	0.278*** [14.16]	0.516*** [19.31]	0.076 [1.13]
Distance	-0.936*** [-3.87]	0.029 [0.50]	-0.218*** [-2.70]	-0.747*** [-4.17]
Common language	0.711** [2.03]	0.309*** [3.67]	0.458*** [4.27]	-0.056 [-0.20]
Population Density	-0.256*** [-2.91]	-0.003 [-0.14]	0.008 [0.26]	-0.261*** [-3.92]
Waiting times	-0.232** [-3.26]	-0.086*** [-1.87]	-0.088*** [-3.78]	-0.057 [-2.15]
Tariff	-0.530** [-2.12]	-0.063* [-3.83]	-0.179*** [-2.76]	-0.288** [-0.66]
R²	0.384	0.391	0.511	0.174
Observations	397	397	397	397

Note: Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table C4. Pharma & chemicals

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	1.031*** [16.02]	0.345*** [23.93]	0.442*** [24.05]	0.244*** [4.92]
Distance	-0.081 [-0.33]	0.002 [0.03]	-0.004 [-0.05]	-0.078 [-0.56]
Common language	0.247 [0.88]	0.160** [2.22]	0.302*** [3.47]	-0.215 [-1.09]
Population Density	0.059 [0.71]	0.028 [1.30]	0.012 [0.46]	0.019 [0.35]
Waiting times	-0.422*** [-4.55]	-0.147*** [-6.01]	-0.145*** [-4.96]	-0.130** [-2.23]
Tariff	-0.089 [-0.71]	-0.039 [-1.26]	-0.048 [-1.27]	-0.002 [-0.02]
R²	0.368	0.483	0.480	0.080
Observations	766	766	766	766

Note: Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table C5. Mining & Quarrying

	Total export value	Number of firms	Number of products	Average value per product per firm	Total export value
GDP	0.584** [2.47]	0.082*** [2.94]	0.180*** [4.12]	0.322 [1.45]	
Distance	-1.839*** [-5.47]	-0.170** [-2.50]	-0.256*** [-2.74]	-1.414*** [-4.26]	
Common language	-1.836** [-2.51]	0.051 [0.53]	0.374** [2.59]	-2.261*** [-3.24]	
Population Density	0.012 [0.06]	-0.009 [-0.64]	-0.031 [-1.16]	0.052 [0.30]	
Waiting times	-0.265 [-1.12]	0.012 [0.47]	0.038 [0.86]	-0.316 [-1.36]	
Tariff	-0.234 [-0.77]	-0.028 [-1.13]	-0.004 [-0.08]	-0.202 [-0.69]	
R²	0.443	0.178	0.211	0.432	
Observations	124	124	124	124	

Note: Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table C6. Agriculture, forestry and fishing

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.244 [1.48]	0.118*** [5.02]	0.169*** [5.07]	-0.043 [-0.29]
Distance	-1.617*** [-3.75]	-0.303*** [-4.00]	-0.322*** [-3.88]	-0.991*** [-2.90]
Common language	0.826 [1.18]	0.332*** [3.30]	0.567*** [4.13]	-0.073 [-0.11]
Population Density	0.167 [0.93]	0.056** [2.09]	0.063* [1.75]	0.049 [0.31]
Waiting times	0.383 [1.64]	0.044 [1.51]	0.046 [1.12]	0.293 [1.48]
Tariff	-0.503 [-1.62]	-0.098*** [-2.79]	-0.069 [-1.54]	-0.336 [-1.15]
R²	0.178	0.315	0.295	0.085
Observations	199	199	199	199

Note: Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table C7. Food and beverages

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.812*** [16.55]	0.336*** [20.70]	0.398*** [20.17]	0.078** [1.98]
Distance	-0.666** [-2.47]	-0.259*** [-3.40]	-0.266*** [-2.80]	-0.142 [-0.98]
Common language	1.351*** [6.24]	0.400*** [5.55]	0.500*** [5.73]	0.451** [2.56]
Population Density	0.032 [0.45]	0.046* [1.93]	0.004 [0.15]	-0.018 [-0.33]
Waiting times	-0.120 [-1.37]	-0.111*** [-4.29]	-0.088*** [-2.68]	0.079 [1.55]
Tariff	-0.097 [-1.12]	-0.048* [-1.71]	-0.077** [-2.02]	0.028 [0.48]
R²	0.362	0.542	0.469	0.027
Observations	672	672	672	672

Note: Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

Table C8. Other products

	Total export value	Number of firms	Number of products	Average value per product per firm
GDP	0.530*** [24.27]	0.164*** [25.05]	0.242*** [28.13]	0.124*** [7.62]
Distance	-0.399*** [-5.46]	-0.022 [-1.07]	-0.147*** [-5.07]	-0.230*** [-4.47]
Common language	0.477*** [4.80]	0.159*** [5.14]	0.350*** [8.63]	-0.031 [-0.43]
Population Density	0.072** [2.51]	0.010 [1.06]	0.006 [0.51]	0.056*** [2.78]
Waiting times	-0.207*** [-6.79]	-0.041*** [-4.69]	-0.031*** [-2.69]	-0.136*** [-6.12]
Tariff	-0.202*** [-4.71]	-0.030*** [-2.58]	-0.056*** [-3.70]	-0.115*** [-3.61]
R²	0.158	0.109	0.146	0.062
Observations	6,976	6,976	6,976	6,976

Note: Year dummies included. Robust standard errors in parentheses.

*** indicates significance at 1% level, ** at 5% and * at 10%.

