Determinants of Intra-Firm Trade: Evidence from a Small Open European Economy[1]

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Abstract

In recent years there has been a surge of intra-firm trade following on from the increase in foreign direct investments and the emergence of global value chains. While there is a well established theoretical literature on intra-firm trade and more broadly on the organisation of international production networks, existing empirical evidence based on firm-level data is still limited. This paper analyses highly detailed firm-level data on exports and imports by product and country of destination/origin available for Ireland over the period 1994-2015. It provides three empirical contributions to the literature on global sourcing. First, the analysis identifies patterns and trends of intra-firm exports and imports. Second, it uncovers the importance of the extensive and intensive margins of intra-firm trade. Third, this study identifies firm, product, industry and country characteristics that explain the engagement of firms in intra-firm trade and the intensity of intra-firm trade.

Key Words:	Intra-firm trade; extensive and intensive trade margins; international sourcing.
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1   Introduction

One of the features of international trade in recent years has been a surge of intra-firm trade following on from the increase in foreign direct investments and the emergence of global value chains. Intra-firm trade is related to the organisation and the activities of multinational firms and consists of trade in goods and services between parent companies and their affiliates or among foreign affiliates (i.e. trade within the same enterprise group).

While there is a well established theoretical literature on intra-firm trade and more broadly on the organisation of international production networks (Helpman 2006; Lanz and Miroudot 2011; Bernard et al. 2012; Yeaple 2013; Antràs and Yeaple 2014), existing empirical evidence based on firm-level data is still limited and to it relates mainly to large economies such as the US, France, Spain (Bernard et al. 2010; Corcos et al. 2013; Defever and Toubal 2007; Kohler and Smolka 2011).

This paper analyses highly detailed firm-level data on exports and imports by product and country of destination/origin available for Ireland over the period 1994-2015. The research is structured around three main questions. First, the analysis identifies patterns and trends of intra-firm exports and imports. Second, it uncovers the importance of the extensive and intensive margins of intra-firm trade. Third, the study identifies firm, industry and country characteristics that explain the engagement of firms in intra-firm trade and the intensity of intra-firm trade.

Ireland is one of the most globalised economies[2] in the world with a high share of multinational enterprises in its economic activity. The results of the *International Sourcing Survey* conducted in 2012 in Ireland found that the majority of firms which engaged in international sourcing over the period 2009-2011 were foreign affiliates of multinational firms. Furthermore, the survey highlighted that 78% of firms engaged in international sourcing sourced business functions within their enterprise group. Over 54% of firms engaged in international sourcing sourced at least one business function to the UK and 50% sourced at least one business function to one of the other EU-15 countries. Other popular destinations for international sourcing were the EU-12, India, the United States and Canada. Given the extensive engagement of its firms in international sourcing, Ireland is a relevant case for the purpose of this analysis.

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[2] The 2017 KOF Globalisation Index, measuring economic, social and political globalisation, ranks Ireland second among 207 countries. With respect to the economic dimension of globalisation, Ireland ranks second after Singapore. The rankings are based on data for 2014 available from:
http://globalization.kof.ethz.ch/media/filer_public/2017/04/19/rankings_2017.pdf

Against this background this paper provides novel empirical evidence on the extent and determinants of intra-firm trade in a small open economy, Ireland. Using highly disaggregated trade data by product and country of origin/destination over the period 1994-2015, the analysis makes three empirical contributions to the literature on global sourcing. Firstly, it uncovers patterns and trends of intra-firm exports and imports of manufactured goods. Secondly, it identifies the importance of the extensive and intensive margins of intra-firm exports and imports. Thirdly, it identifies firm, product, industry and country characteristics that explain firms' engagement in and the intensity of intra-firm trade.

The key findings indicate that Ireland's intra-firm trade is sizeable, accounting for one third of total exports and a quarter of total imports. Over the analysed period, the scale of the intra-firm exports increased while it declined for intra-firm imports. The empirical analysis also finds that during the financial crisis, intra-firm exports were resilient while intra-firm imports decline sharply. The variation of intra-firm trade across firms is explained to a large extent by the intensive margin (the average intra-trade per product per firm), while the extensive margin (the number of products traded intra-firm) plays a less important role. The empirical results indicate that firms engaged in intra-firm trade are larger and they are more likely to trade with the US and other larger economies. Further, in line with international evidence, intra-firm trade is more likely with countries having strong contract enforcement laws and higher R&D intensity. In terms of product characteristics, intra-firm exports are more likely with intermediate goods and more intensive in capital goods. In contrast, intra-firm imports are less likely in capital goods and more intensive in both intermediate and capital goods.

The remainder of this paper is structured as follows. Section 2 discusses the theoretical and empirical framework for this analysis. Section 3 describes the data and reports the descriptive analysis of patterns of intra-firm exports and imports. Section 4 discusses empirical results from an econometric analysis of determinants of the extensive and intensive margins of intra-firm exports and imports. Key findings are summarised in Section 5.

2   Theoretical and Empirical Background

Intra-firm trade, or vertical integration of multinational activity, was theoretically formalised by Antràs (2003), Antràs and Helpman (2004) and Grossman and Helpman (2002; 2005). These models highlight the role of contracting and its associated costs in the decisions of multinational firms to source inputs in-house or at arm's length and their choice of locations for activities at home and abroad. These models are novel in that they focus on traded intermediated goods and the cost of writing contracts for specialised inputs.

Grossman and Helpman (2002) examined a firm's choice between outsourcing and intra-firm vertical integration. In determining their organisational mode, firms, which are assumed to be equally productive, are faced with the trade-off between the costs of running a large and less specialised organisation versus the search and monitoring costs of an input supplier. The authors show that outsourcing is likely to be more prevalent in some industries than in others. Outsourcing is more likely to be viable in large firms and in large economies. Further, in competitive markets, outsourcing requires a high per unit cost advantage for specialised input producers relative to integrated firms, while in markets with less competition, outsourcing depends on the comparison of the fixed costs between specialised producers and integrated firms.

Antràs (2003) demonstrated formally that incomplete contracts help to explain why some firms source input abroad via FDI (intra-firm trade) while others source them via outsourcing (arm's length trade). Combined with productivity differences across firms within industries, this approach predicts the relative prevalence of alternative forms of the international organisation of production as a function of sectoral characteristics and differences in features of the trading partners.

Antràs and Helpman (2004) theoretically formalised the decision of firms to engage in international markets either through foreign outsourcing or foreign direct investment (FDI). Their model predicts that in a vertically integrated industry, the most productive firms will source their intermediates from affiliates while less productive firms will outsource them from arm's length suppliers.

Nunn and Trefler (2013) constructed measures of industry characteristics from disaggregated US import data and found that an industry's skill, capital and R&D intensity predicted intra-firm trade shares as expected. Furthermore, they showed that the type of capital intensity matters: industries whose capital is not firm-specific do not have high levels of intra-industry trade.

Further, industry R&D and capital intensity explain the share of international trade conducted within multinationals better than outsourcing (Bernard, Jensen, Redding and Schott, 2012).

Helpman (2006) reviewed the theoretical and empirical literature on trade, FDI and organisation choices of firms. He highlighted that productivity differences are linked to different production and distribution choices of the organisation. In this context, trade and FDI patterns are jointly determined with organisational structures such as sourcing and integration strategies. The theoretical models in international trade and investment focus on an individual firm's choices of engagement in activities across national borders linked to firm and industry characteristics and the returns from foreign trade and investment. Organisational choices, such as sourcing and integration strategies, are important in this context (Spencer, 2005).

Stylised facts on the importance of intra-firm trade across countries

Empirical analysis of intra-firm trade highlighted the importance of product and country characteristics to explain the engagement of firms in intra-firm trade and its scale (see, for example, Yeaple, 2006; Defever and Toubal, 2007; Corcos et al., 2013; Nunn and Trefler, 2008; Bernard et al., 2009; Bernard et al., 2010; Lanz and Miroudot, 2011; Bernard et al., 2012).

Intra-firm trade accounts for a large share of world trade and has increased over time. Based on trade statistics, in 2009, Bernard et al. (2009) found that the US' intra-firm trade accounted for 46% of imports and 30% of exports. Further evidence on the extent of intra-firm trade from nine OECD countries based on AMNE statistics (Lanz and Miroudot, 2011) indicated that intra-firm trade accounted for about half of foreign affiliates' exports.

The size of intra-firm trade varies greatly across countries and industries. Evidence on intra-firm trade in the US provided by Bernard et al. (2010) indicated that while 46% of US imports are intra-firm, 74% of US imports from Japan were intra-firm. In contrast, only 2% of US imports from Bangladesh were intra-firm. With respect to intra-firm trade by industry, the same study found that the extent of intra-firm trade ranged from 70% of US imports of cars, medical equipment and instruments to only 2% of US imports of rubber and plastics, and footwear.

Further research for the US trade, reported by Bernard et al. (2009), found that the intensive margin was relatively more important for intra-firm trade than for arm's length trade.

Existing evidence discussed by Lanz and Miroudot (2011) indicated that intra-firm trade is also sizeable in services and has increased over time, in particular in services supporting the activities of multinational enterprises (MNEs).

Intra-firm trade is important within global value chains (it connects different production stages) as well as for trade in final goods. Evidence for the US reported by Lanz and Miroudot (2011) indicated that intra-firm transactions accounted for 46% of imports of intermediate goods and 27% of exports of intermediate goods. Furthermore, trade between related parties accounted for a significant share of trade in consumption and capital goods. This result suggests that multinationals play an important role in distribution networks, and not only in production networks. Further evidence on the importance of wholesale trade in the US intra-firm trade was provided by Zeile (2003).

Intra-firm trade appears to have been more resilient to macroeconomic shocks compared to arm's length trade. Bernard et al. (2009) showed that during the Asian crisis in 1997, the intra-firm trade in the US was more resilient than arm's length trade. This message is consistent with further evidence for the US with respect to the recent crisis over 2008-2009 reported by Lanz and Miroudot (2011). However, the more disaggregated analysis indicated heterogeneity at the country, industry and product levels.

Further evidence provided by Altomonte and Ottaviano (2009) found that the greater resilience of intra-firm trade to macroeconomic shocks is related to the less important inventory effects within vertically integrated global value chains. This result is linked to a reduction of uncertainty of demand in vertically integrated firms that leads to more similarity in the size of orders and inventories along the supply chain. Additional evidence for the US reported by Lanz and Miroudot (2011) indicated that the trade decline was less severe for intermediate inputs traded between related parties.

Empirical international evidence on determinants of intra-firm trade

Given the limited available data, there are only a few studies which analysed determinants of intra-firm trade. Bernard et al. (2012) reviewed recent available evidence for the US, France and Spain. The key findings are discussed below.

Nunn and Trefler (2008) found that the intensity of intra-firm trade in the US is positively linked to the importance of parent companies' investments (proxied by interactions between capital and skill intensity) and the quality of property rights in the foreign affiliates' host countries (proxied with a measure of rule of law). Additional evidence from the US was provided by Yeaple (2006). This evidence indicated that the share of intra-firm trade in US imports is positively associated with industry capital intensity and R&D intensity, and the dispersion of productivity across firms within industries.

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Bernard et al. (2010) analysed the extent and the intensity of intra-firm trade in the US as outcomes of interactions of product and country characteristics. The results indicated that factors associated with the engagement of firms in intra-firm trade are different from those associated with the intensity of intra-firm trade. At the extensive margin, a higher probability of intra-firm trade is associated with a higher quality of governance at the country level. At the intensive margin, intra-firm trade shares are high for capital-intensive products imported from capital-abundant countries while improvements in governance are associated with the largest reductions in intra-firm trade in low-contractibility products. Firms in industries with higher skill intensity are more likely to engage in intra-firm trade and they have higher shares of intra-firm trade, particularly in more skills-scarce countries. Greater county-level skill abundance is linked to a lower intensity of intra-firm trade and larger reductions in skill-intensive products.

Following on from Bernard et al. (2010), Corcos et al. (2013) provided evidence on the extensive and intensive margins of intra-firm trade in France. Their results indicated that intra-firm imports are more prevalent in more productive firms, in firms with higher capital and skills intensities, and from countries with better quality judicial institutions. In addition, they find that complex goods and inputs are more likely to be produced intra-firm.

Defever and Toubal (2007) analysed the implications of fixed costs for firms' choices between intra-firm trade (vertical integration) and outsourcing (arm's length trade) for French firms. They found that under high fixed costs of outsourcing, more productive multinationals are more likely to outsource their inputs while those less productive are more likely to engage in intra-firm trade.

Kohler and Smolka (2011) provided evidence on intra-firm trade in Spain. They found that more productive firms are more likely to engage in intra-firm trade than outsourcing. Further evidence on sourcing choices indicates that more productive firms are more likely to source inputs from foreign, rather than domestic, suppliers.

In summary, while recent theoretical models help to explain the decision of multinationals to source inputs within the boundaries of the firm or at the arm's length, empirical evidence based on firm-level data is still very scarce and it comes mainly from large economies. This paper contributes novel empirical evidence on the extent and determinants of intra-firm trade in a small open economy, Ireland with a large multinational sector.

3   Data and Descriptive Analysis

The analysis is based on two linked data sets combining trade statistics by product and country of origin/destination (Intra-Stat, Extra-Stat), and firm-level accounting variables from the Census of Industrial Production. The data set covers merchandise trade over the period 1994-2015.[3]

Trade statistics: Intra-Stat and Extra-Stat

These data sets include trade statistics (exports and imports) of intra-EU and extra-EU merchandise trade collected monthly from all VAT registered traders (Intra-Stat) and from administrative data of Revenue Commissioners (Extra-Stat). The following data are collected: Company VAT number; Commodity code (CN); Transaction type (import, export); Invoice value; Net mass and/or supplementary units; Country of destination for exports; Country of origin for imports; Delivery terms; Statistical value; Nature of transaction.

Census of industrial production

This data set consists of structural information on accounting variables at firm-level including: ownership, the location and nationality of the parent company, turnover, exports, imports, sales of capital assets, employment and earnings. The survey includes all enterprises with three or more persons engaged in industrial production. Value added in industry accounted for 25.6% of Ireland's GDP over 2011-2015, down from 28.3% over 1996-2000.[4]

Measures of intra-firm trade

Following international evidence (Bernard et al. 2010; Kohler and Smolka 2011; Corcos et al. 2013), intra-firm trade is identified as all trade between foreign affiliates in Ireland and the country where the headquarters of the parent company is located.

Other data

Additional country-level data from international sources are used in the econometric analysis. These include: GDP at constant prices, R&D intensity, capital intensity, an index for the rule of law, corporate tax rates, distance between Ireland and its trading partners and cultural and geographical proximity. Detailed definitions and data sources are given in Table A1 in the Appendix.

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[3] Statistics for trade in services are not available at the detail level required to identify intra-firm trade. Trade with goods accounted for 41% of Ireland's total trade in 2014.

[4] Data available from the World Bank, http://data.worldbank.org.

Patterns and trends in intra-firm trade between Ireland and other EU and non-EU countries

The scale of intra-firm trade

Figure 1 shows the importance of Ireland's intra-firm trade over the period 1994-2014. The scale of intra-firm imports was larger than the scale of intra-firm exports until 2007. It is worth noticing that during the financial crisis the share of intra-firm imports and the corresponding share on intra-firm exports had opposite trends. The share of intra-firm imports in total imports declined from 30.7% in 1994 to 16.4% in 2008 and increased in the aftermath of the financial crisis, reaching 25.7% in 2015. The share of intra-firm exports in total exports was much lower at the beginning of the analysed period at 7.6% and it increased over time reaching 30.4% in 2013. In 2015 the share of intra-firm exports in total exports was 29.4%.

Considering intra-firm trade by country of destination and origin, Tables 1 and 2 indicate that – in line with international evidence – the importance of intra-firm trade varies greatly by country of export destination and import origin. The US dominates Ireland's intra-firm trade, accounting for 69.6% of the total number of intra-firm export flows and 71.9% of the total number of intra-firm import flows over the analysed period.[5] This dominance is explained by the presence of the US multinationals in Ireland. Germany and the United Kingdom are the next most important intra-firm trade partners, followed by Japan, France, Switzerland and the Netherlands. Germany accounts for 8.8% of the total number of intra-firm export flows and 7.5% of the total number of intra-firm import flows. The corresponding shares for the United Kingdom are 8.3% and 9.5%.

Figure 1: Share of Ireland's intra-firm trade in total trade, 1994-2014

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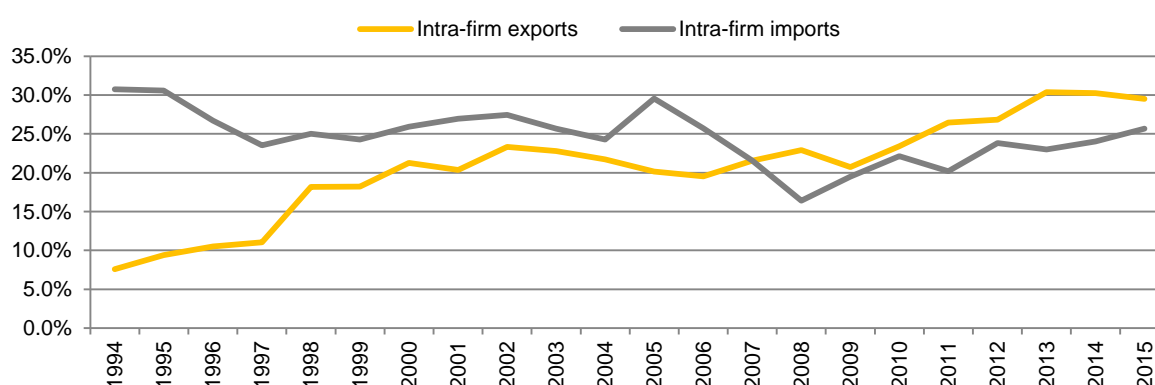
[5] The number of intra-firm trade flows is identified by counting the trade transactions between foreign affiliates and the country where the headquarters of the parent company is located.

Intra-firm trade by country

Table 1: Count of intra-firm export flows, 1994-2015

Destination country	Number of flows	Share (%)
USA	46655	69.60
Germany	5889	8.79
United Kingdom	5558	8.29
France	1966	2.93
Japan	1612	2.40
Netherlands	1372	2.05
Switzerland	1149	1.71
Canada	552	0.82
Denmark	494	0.74
Italy	432	0.64
Sweden	271	0.40
Belgium	243	0.36
Spain	194	0.29
Finland	123	0.18
Korea	96	0.14
Norway	83	0.12
Singapore	61	0.09
Turkey	51	0.08
Australia	43	0.06
Austria	34	0.05
India	35	0.05
Malta	36	0.05
Israel	26	0.04
Greece	16	0.02
Luxembourg	12	0.02
Russia	9	0.01
Saudi Arabia	5	0.01
Thailand	7	0.01
Bermuda	1	0.00
Iceland	3	0.00
Lichtenstein	1	0.00
Total	**67029**	**100.00**

Table 2: Count of intra-firm import flows, 1994-2015

Country of origin	Number of flows	Share (%)
USA	205883	71.92
United Kingdom	27307	9.54
Germany	21396	7.47
Japan	8937	3.12
France	6245	2.18
Netherlands	3518	1.23
Switzerland	3302	1.15
Canada	1577	0.55
Belgium	1486	0.52

Italy		1361	0.48
Denmark		1039	0.36
Sweden		996	0.35
Finland		618	0.22
Turkey		630	0.22
South Korea		497	0.17
Spain		352	0.12
Singapore		301	0.11
Norway		252	0.09
Austria		205	0.07
Australia		74	0.03
India		77	0.03
Luxembourg		76	0.03
Greece		48	0.02
Iceland		44	0.02
Russia		21	0.01
Israel		3	0.00
Malta		8	0.00
Panama		1	0.00
Saudi Arabia		1	0.00
Thailand		12	0.00
Total		**286267**	**100.00**

Source: Own calculations based on transaction-level trade data provided by the Central Statistics Office of Ireland.

Tables 3 and 4 show the extent of Ireland's intra-firm trade with its main trade partners in 2015. The figures highlight again the sizeable intra-firm trade between Ireland and the US. It appears that 82.5% of Ireland's exports to the US were intra-firm while 74% of Ireland's imports from the US were intra-firm. Other countries with sizeable intra-firm trade were Switzerland (77.3% of total exports; 50.9% of total imports), France (62.8% of total imports; 14.2% of total exports), Denmark (31% of total exports; 43.3% of total imports), Germany (21.5% of total imports; 10.1% of total exports) and Luxembourg (37.5% of total imports).

Table 3: The value of intra-firm exports by country, 2015

	Intra-firm exports (EUR)	Total exports (EUR)	Share intra-firm
EU countries			
Austria	604,871	153,491,111	0.39%
Belgium	51,100,984	12,416,203,030	0.41%
Germany	294,740,491	2,906,816,453	10.14%
Denmark	96,736,775	312,155,647	30.99%
Spain	2,780,598	986,980,691	0.28%
Finland	8,683,637	183,275,195	4.74%
France	275,840,619	1,936,497,749	14.24%
United Kingdom	592,527,697	6,729,495,199	8.80%
Italy	61,979,926	788,092,022	7.86%
Netherlands	7,761,844	1,911,945,796	0.41%
Sweden	2,003,042	433,867,737	0.46%
non-EU countries			
Canada	1,626,666	528,803,644	0.31%
Switzerland	4,093,031,197	5,297,083,552	77.27%

Japan	46,267,430	1,065,289,377	4.34%
Korea	142,543	274,157,535	0.05%
Saudi Arabia	73,823	168,911,055	0.04%
USA	10,929,651,083	13,242,476,372	82.53%

Source: Own calculations based on transaction-level trade data provided by the Central Statistics Office of Ireland.

Table 4: Value of intra-firm imports by country, 2015

	Intra-firm imports (EUR)	Total imports (EUR)	Share intra-firm
	EU countries		
Austria	8,260	118,765,776	0.01%
Belgium	10,434,747	386,093,487	2.70%
Germany	273,209,528	1,271,821,579	21.48%
Denmark	56,155,819	129,663,184	43.31%
Spain	923,601	162,068,037	0.57%
France	513,621,184	818,534,946	62.75%
United Kingdom	259,088,087	3,116,177,752	8.31%
Italy	43,863,408	287,567,536	15.25%
Luxembourg	6,045,034	16,141,570	37.45%
Netherlands	25,408,026	1,120,166,365	2.27%
Switzerland	5,749,386	158,334,924	3.63%
	non-EU countries		
Canada	3,666,582	75,134,397	4.88%
Switzerland	283,997,828	557,864,308	50.91%
India	1,842,083	164,610,625	1.12%
Japan	83,467,988	975,187,147	8.56%
Norway	3,336,911	184,210,032	1.81%
Singapore	48,019	230,300,259	0.02%
Thailand	6,379,719	148,091,336	4.31%
USA	2,590,090,651	3,501,038,206	73.98%

Source: Own calculations based on transaction-level trade data provided by the Central Statistics Office of Ireland.

Intra-firm trade by major industry categories

Table 5 shows the share of intra-firm trade by major industry groups[6] over the analysed period. It appears that intra-firm trade is particularly important in industries producing intermediate goods, capital goods as well as consumer non-durable goods. In 2015, intra-firm trade in intermediate goods accounted for 41.5% of total exports and 30.25 of total imports while intra-firm trade in capital goods represented 20.8% of total exports and 21.7% of total imports.

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[6] This classification is based on the Eurostat NACE Rev. 2 industry classification and concordance tables with the UN product categories by end-use (BEC codes).

Table 5: The extent of Ireland's intra-firm trade by major industry group, 1995-2015

Major industry group category	1995	2000	2005	2010	2015
Intra-firm exports					
Other goods	3.50%	7.80%	6.40%	11.80%	19.90%
Capital goods	14.60%	17.80%	13.30%	27.30%	20.80%
Consumer durables	0.00%	0.00%	0.00%	10.00%	4.40%
Consumer non-durables	4.90%	15.40%	10.10%	23.60%	29.60%
Intermediate goods	4.20%	41.60%	48.40%	14.60%	41.50%
Energy	0.10%	0.30%	0.00%	0.00%	0.00%
Intra-firm imports					
Other goods	7.50%	12.60%	2.50%	5.00%	3.70%
Capital goods	37.10%	26.60%	34.90%	32.50%	21.70%
Consumer durables	0.00%	0.00%	0.00%	18.20%	7.90%
Consumer non-durables	22.40%	23.90%	25.80%	25.50%	27.20%
Intermediate goods	19.00%	32.40%	27.80%	14.10%	30.20%
Energy	0.00%	0.00%	0.00%	0.00%	0.20%

Source: Own calculations based on transaction-level trade data provided by the Central Statistics Office of Ireland.

Over the time period, the share of intra-firm exports of capital goods increased while the share of intra-firm imports of capital goods declined. The share of intra-firm trade with intermediates goods increased over time, with a sharp dip in 2010 which might be related to the financial crisis. These opposite developments for intra-firm exports and imports are consistent with the trends shown in Figure 1.

Intra-firm trade by product

Table 6 shows the top 10 products traded intra-firm. These are predominately chemicals, medical devices and pharmaceuticals, as well as electronics reflecting the specialisation of multinational firms located in Ireland. The figures shown indicate intra-firm exports are highly concentrated: the top 10 products exported intra-firm account for 66.9% of the intra-firm export sales. Intra-firm imports are less concentrated with the top 10 products imported intra-firm representing 39.3% of the intra-firm import value.

Table 6: Top 10 products traded intra-firm

Intra-firm exports

HS6 Code	Trade share	Product
293490	0.175	Other heterocyclic compounds
300490	0.089	Other medicaments put up in packing for retail sale
293359	0.084	Other nitrogen compounds containing a pyrimidine ring or piperazine ring system
293390	0.069	Other heterocyclic compounds with nitrogen hetero-atom only
847330	0.043	Parts and accessories of the automatic data processing machines
901839	0.035	Medical, surgical, dental or vet inst, parts (other)
854213	0.024	Electronic integrated circuits & micro-assembled, parts (other)
300220	0.023	Vaccines for human medicine

		Pacemakers for stimulating heart muscles, excluding parts and accessories
902150	0.023	thereof
293799	0.022	Other hormones and their derivatives, other steroids used primarily as
293339	0.021	Other nitrogen compounds containing unfused pyridine ring system
292219	0.017	Other amino-alcohols, their ethers, esters, salts thereof
294190	0.016	Other antibiotics
293100	0.015	Other organic-inorganic compounds
854214	0.013	Electronic integrated circuits & micro-assembled, parts (other)

Intra-firm imports

HS6 Code	Trade share	Product
847330	0.084	Parts and accessories of the automatic data processing machines
300490	0.051	Other medicaments put up in packing for retail sale
293390	0.045	Other heterocyclic compounds with nitrogen hetero-atom only
854213	0.036	Electronic integrated circuits & micro-assembled, parts (other)
902190	0.031	Other appliances which are worn in the body, to compensate for a defect
847170	0.022	Automatic data process machines, computer hardware (other)
300390	0.022	Other medicaments
841112	0.017	Turbo-jets of a thrust exceeding 25kn
851790	0.015	Parts of Electrical Apparatus for Line Telephony or Line Telegraphy
841989	0.013	Other apparatus for treatment of materials by temperature
853400	0.012	Printed circuits
880240	0.012	Airplanes and other aircraft, of an unladen weight exceeding 15,000 kg
292429	0.012	Other cyclic amides and their derivatives, salts thereof
901839	0.011	Medical, surgical, dental or vet inst, no elec, parts (other)
291817	0.010	Phenyl glycolic acid (mandelic acid), its salts and esters

Source: Own calculations based on transaction-level trade data provided by the Central Statistics Office of Ireland.

Intra-firm traders: Summary statistics

Tables 7 and 8 present summary statistics for intra-firm traders. Table 7 shows that average intra-firm exports sales per firm[7] increased over the period with the exceptions of declines in 2001, 2003, 2005 and 2009. Looking at the intensive margin, average intra-firm export sales per product increased, reaching a peak in 2008 and then declining until 2013. The figures for 2014 and 2015 indicate increases of intra-firm exports at the intensive margin. At the extensive margin, the average number of products exported intra-firm ranges between 4.4 and 8.4. These developments over time may be indicative of quality upgrading of products exported intra-firm and/or transfer pricing within the boundaries of multinational firms. These hypotheses could be examined in a further analysis.

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[7] Export sales are in nominal euros.

Table 7: Summary statistics for intra-firm exporters, 1994-2015

Year	Average intra-firm exports (EUR)	Average intra-firm exports per product (EUR)	Average number of intra-firm products	Average number of export destinations
1994	3,826,931	869,757	4.4	8.0
1995	6,338,943	1,267,789	5.0	9.0
1996	7,084,444	1,336,688	5.3	9.2
1997	7,948,835	1,472,006	5.4	9.5
1998	16,775,443	2,943,060	5.7	9.6
1999	23,351,234	3,958,853	5.9	9.9
2000	33,864,412	5,462,002	6.2	9.9
2001	33,490,966	5,581,828	6.0	9.8
2002	39,810,264	6,220.354	6.4	10.0
2003	37,209,420	6,644,539	5.6	10.2
2004	38,201,116	5,968,924	6.4	10.1
2005	36,771,816	5,329,249	6.9	10.2
2006	38,811,844	5,466,457	7.1	9.7
2007	46,975,044	7,576,620	6.2	9.9
2008	52,244,176	8,868,635	5.9	9.5
2009	46,977,604	7,962,306	5.9	9.9
2010	52,324,944	7,809693	6.7	10.4
2011	60,067,616	7,800,989	7.7	10.4
2012	60,400,020	7,190,479	8.4	10.6
2013	61,420,452	7,059,822	8.7	10.4
2014	60,366,944	7,186,541	8.4	10.5
2015	62,606,680	7,924,896	7.9	10.4

Source: Own calculations based on transaction-level trade data provided by the Central Statistics Office of Ireland.

Table 8 shows summary statistics for intra-firm importers. Average intra-firm imports per firm[8] increased over the period with the exceptions of declines in 1996, 2001-2004, 2006-2009. At the extensive margin, the average number of products imported intra-firm is higher than the case of products exported intra-firm ranging between 25.9 and 35.3. At the intensive margin, in comparison to intra-firm exports, intra-firm imports appear much lower in value and more volatile, with more frequent declines of the average value of intra-firm imports per product. The developments over time discussed above are consistent with the scale and trends in Ireland's intra-firm trade shown in Figure 1.

Table 8: Summary statistics for intra-firm importers, 1994-2015

Year	Average intra-firm imports (EUR)	Average intra-firm imports per product (EUR)	Average number of products imported intra-firm	Average number of origin countries
1994	6,394,032	244,982	26.1	5.0
1995	7,985,388	308,316	25.9	5.0
1996	6,804,965	243,906	27.9	5.2

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[8] In nominal euros.

1997	7,038,659	242,712	29.0	5.3
1998	9,111,639	299,725	30.4	5.6
1999	9,104,210	257,910	35.3	6.1
2000	12,800,000	367,816	34.8	6.1
2001	11,400,000	372,549	30.6	6.1
2002	10,500,000	350,000	30.0	6.0
2003	9,856,730	329,233	28.5	6.2
2004	9,383,140	331,560	28.3	6.2
2005	12,500,000	423,729	29.5	6.2
2006	11,800,000	409,722	28.8	6.0
2007	11,200,000	395,760	28.3	5.6
2008	8,635,692	314,025	27.5	5.8
2009	7,774,739	302,519	25.7	5.9
2010	9,098,249	326,102	27.9	6.1
2011	9,361,486	334,339	28.0	6.2
2012	10,700,000	360,269	29.7	6.6
2013	11,000,000	364,238	30.2	6.7
2014	13,300,000	449,324	29.6	6.8
2015	14,000,000	501,792	27.9	6.8

Source: Own calculations based on transaction-level trade data provided by the Central Statistics Office of Ireland.

4   Determinants of intra-firm trade: econometric analysis

This section examines determinants of the engagement of firms in intra-firm trade and the intensity of intra-firm trade.

Intra-firm trade: extensive and intensive margins

We begin by looking at the decomposition of intra-firm trade by the extensive and intensive margins. As discussed above, intra-firm trade can be broken down by the number of products exported (extensive margin) and the average export sales per product (intensive margin).

The regression decomposition of intra-firm trade by product margins is based on the following model specification:[9]

$$\ln x_{it} = \ln p_{it} + \ln \overline{x_{it}} + \varepsilon_{it} \tag{1}$$

where x_{it} denotes the total intra-firm trade of firm i in year t, p_{it} is the number of products traded intra-firm by firm i in year t, $\overline{x_{it}}$ indicates the average intra-firm sales per firm-product in year t and ε_{it} is the error term.

The results reported in Table 9 are obtained by regressing each trade margin ($\ln p_{it}$, $\ln \overline{x_{it}}$) on total intra-firm trade ($\ln x_{it}$). These regression decompositions allow the quantification of the

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[9]   This decomposition has been used in previous analyses of the extensive and intensive margins of trade at transaction level. Recent evidence is reviewed by Bernard et al. (2012).

proportional contributions of the extensive and intensive margins to the variation of intra-firm trade across firms over the analysed period.

Table 9: Regression decomposition of trade into extensive and intensive margins

	Share	Std. error.	Obs.	R-sq.	Share	Std. error.	Obs.	R-sq.
					All firms			
		Exports				**Imports**		
Product count by firm	0.197***	0.0023	27,288	0.4377	0.312***	0.0021	40,524	0.5898
Average exports by product by firm	0.803***	0.0023	27,288	0.8945	0.688***	0.0021	405,24	0.7939
					Intra-firm trade			
		Exports				**Imports**		
Product count by firm	0.133***	0.005	6,049	0.227	0.287***	0.0052	7,798	0.4214
Average exports by product by firm	0.867***	0.005	6,049	0.887	0.713***	0.0052	7,798	0.7167

Notes: All regressions include firm and year fixed effects. *** Indicates statistical significance at the 1% level.

The estimates shown in Table 9 indicate that the intensive margin, the average intra-trade per product per firm, explains most of the intra-firm variation across firms while the extensive margin, the number of products traded intra-firm, plays a less important role. In the case of intra-firm exports, the intensive margin accounts for 86.7% of the variation of intra-firm exports while the extensive margin accounts for much less at 13.3%. In the case of intra-firm imports, the contribution of the intensive margin also dominates although to a lesser extent at 71.3% while the contribution of the extensive margin is 28.7%. These results are consistent with the descriptive analysis of intra-firm trade discussed above showing more pronounced changes in the intra-firm trade values per product in comparison with changes in the number of products traded intra-firm.

Firm, industry and country determinants of intra-firm trade

This section examines determinants of Ireland's intra-firm trade over 2009-2014. This analysis draws on the stylised facts and the international evidence discussed in Section 1.

The econometric analysis is based on a two-step Heckman selection model as follows:

Selection equation

$$\Pr(D_{ikjt} = 1 \,|\, observables) = \phi(\sum_{i} \alpha_i F_{ikjt} + \sum_{k} \beta_k I_{ikjt} + \sum_{j} \delta_j C_{ikjt}) \qquad (2)$$

The selection equation models the propensity of firms to engage in intra-firm trade. The dependent variable is a binary variable, D = 1 if trading firm i in industry k, trading with country j, is engaged in year t in intra-firm trade; 0 otherwise.

F is a vector of *firm characteristics:* productivity, size (proxied by employment) and location (region); and I is a vector of *industry characteristics*: technology intensity (high-tech industries; medium tech-industries; low-tech industries), primary product group (capital goods; consumer durables; consumer non-durables; intermediate goods; energy; other goods). C is a vector of *country characteristics*: market size (GDP), contract enforcement (rule of law index), R&D intensity, capital-intensity, bilateral distance, common language, common border. Given the dominance of the intra-firm trade a dummy variable equal to 1 for intra-trade firm with the US is included. All regressions include year-specific effects.

Intensity equation

$$\ln X_{ikjt} = \alpha + \beta_i F_{ikjt} + \delta_k I_{ijkt} + \gamma_j C_{ijkt} + \varepsilon_{ijkt} \tag{3}$$

The dependent variable in the intensity equation is the share of intra-trade firm at firm i, industry k traded with country j at time t. The explanatory variables in the intensity equation are the same as in the selection equation with the exception of the following variables which are excluded for identification purposes: firm size, market size, common language and common border. The regression analysis is carried out separately for intra-firm exports and intra-firm imports. Explanatory variables are lagged by one year with respect to the dependent variables to alleviate potential endogeneity related to possible reverse causality. Standard errors are clustered at firm-level to account for the fact that firm unobserved characteristics may be correlated across firms within industries and countries.

Table 10 shows the estimates for intra-firm exports obtained with a two-step Heckman model. A number of consistent messages emerge from the regressions shown in the table.

Relative to other exporters, intra-firm exporters are larger, are more likely to export intermediate goods, and are more likely to export to the US. Over and above these firm characteristics, characteristics of export market destinations are also conditions for the engagement of firms in intra-firm trade. Intra-firm exports are more likely with larger countries, geographically closer to Ireland, however not sharing borders with Ireland. These results are consistent with the descriptive statistics discussed in the previous section.

Other determinants are statistically significant in some but not in all models. For example, we find that intra-firm exports are more likely with English-speaking countries, in countries with strong contract enforcement (proxied by the rule of law index), with higher R&D intensity and with lower capital intensity. Taxation does not appear to play a role in the propensity of firms to engage in intra-firm exports. At the intensive margin, the share of intra-firm exports in total exports is higher in less productive exporters and exporters of capital goods and in medium tech-industries. Intra-firm export intensity is higher with the US and with other countries with higher corporate tax rates. Trade costs (proxied by distance to destination markets) reduce the intensity of intra-firm exports. The test for selection bias is statistically significant which indicates that the Heckman selection model is appropriate.

Table 11 shows the estimates for intra-firm imports. In contrast with intra-firm exports, and in line with international evidence, intra-firm importers are more likely to be more productive than other importers. The estimates also indicate that, similarly to intra-firm exporters, intra-firm importers are larger and they are more likely to import from the US and from larger countries. Other evidence, although not statistically significant in all model specifications, indicates that intra-firm imports are more likely from countries with strong contract enforcement and higher R&D intensity. At the intensive margin, the share of intra-firm imports in total imports are higher in less productive importers, in the case of imports with intermediate and capital goods. The intensity of intra-firm imports is higher from the US and from countries with higher corporate tax rates. The test statistics indicate that the Heckman selection model is appropriate in all regression models.

These results are broadly in line with existing evidence from other advanced economies discussed in Section 1 (Bernard et al., 2010 – for the US; Defever and Toubal, 2010, and Corcos et al., 2013 for France; Kohler and Smolka, 2011 for Spain). In contrast to existing evidence, in the case of Ireland the engagement in intra-firm exports is linked to less capital-abundant countries while at the intensive margin, capital abundance in the destination countries does not matter. However, similarly to the US, the shares of intra-firm imports are higher in the case of imports from capital-abundant countries.

Two findings at the intensive margin of Ireland's intra-firm trade stand out: the intensity of intra-trade firm is negatively linked to firm productivity and positively linked to trading partners with higher corporate tax rates. Both findings might reflect the use of transfer pricing by multinationals operating globally as a business strategy to boost profits.

The negative relationship between the share of intra-firm trade in total trade and firm productivity indicate a low productivity cut off level for firms' engagement in intra-firm trade as opposed to arms' length trade. This result may be linked to the sizeable transfer pricing by multinationals in Ireland.

The high intensity of Ireland's intra-firm trade with countries with higher corporate tax rates is consistent with evidence for the US provided by Egger and Seidel (2013) showing that corporate tax rate differentials boost intra-firm trade due to transfer pricing.[10] A competitive tax rate has been part of Ireland's strategy to attract foreign direct investment over the past five decades. Multinational firms make a sizeable positive contribution to Ireland's competitiveness.[11] Currently at 12.5% Ireland's corporate tax rate is one of the lowest among EU countries. This competitive corporate tax rate combined with a skilled English-speaking labour force has boosted Ireland's attractiveness as a location for multinational firms, particularly from the US, the UK and other large advanced economies which tend to have higher corporate tax rates.

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[10] Davies et al. (2015) provide evidence using data from France on the sensitivity of intra-firm prices to corporate tax rates mainly driven by exports to tax havens.

[11] Siedschlag and Zhang (2015) provide evidence on the contribution of multinational firms to Ireland's innovation and productivity performance.

Table 10: Determinants of intra-firm exports, 2009-2014

Variables	Intensity	Selection	Intensity	Selection	Intensity	Selection	Intensity	Selection	Intensity	Selection	Intensity	Selection
Productivity	-0.896***	0.003	-0.874***	0.003	-0.932***	0.003	-0.915***	0.002	-0.886***	0.002	-0.868***	0.002*
	(0.159)	(0.003)	(0.147)	(0.002)	(0.143)	(0.002)	(0.142)	(0.001)	(0.144)	(0.001)	(0.144)	(0.001)
Size		0.017***		0.012***		0.001***		0.008***		0.008***		0.007***
		(0.003)		(0.002)		(0.002)		(0.002)		(0.001)		(0.001)
Hi-tech industry	-1.067	0.001	-1.063	0.003	-0.056	0.005	-0.081	0.004	0.071	0.004	0.171	0.003
	(0.679)	(0.008)	(0.651)	(0.006)	(0.634)	(0.005)	(0.627)	(0.005)	(0.631)	(0.004)	(0.643)	(0.004)
Medium-tech industry	3.102***	0.018	2.833**	0.013	3.617***	0.010	3.683***	0.009	4.015***	0.009	4.095***	0.008
	(1.186)	(0.012)	(1.233)	(0.009)	(1.251)	(0.007)	(1.228)	(0.006)	(1.150)	(0.006)	(1.169)	(0.005)
Intermediate goods	0.321	0.009**	0.207	0.006*	0.489**	0.007***	0.471**	0.006***	0.516**	0.005***	0.545**	0.005***
	(0.253)	(0.004)	(0.237)	(0.003)	(0.237)	(0.002)	(0.235)	(0.002)	(0.242)	(0.002)	(0.243)	(0.002)
Capital goods	0.855***	0.001	0.820***	0.002	1.102***	0.004	1.075***	0.003	1.115***	0.003	1.151***	0.002
	(0.269)	(0.005)	(0.249)	(0.003)	(0.245)	(0.003)	(0.243)	(0.002)	(0.249)	(0.002)	(0.250)	(0.002)
US	3.795***	0.402***	1.928***	0.086***	4.197***	0.072*	3.470***	0.047	2.861***	0.044	2.680***	0.025
	(0.549)	(0.033)	(0.606)	(0.029)	(0.864)	(0.041)	(0.921)	(0.030)	(0.883)	(0.028)	(0.811)	(0.021)
GDP				0.024***		0.021***		0.018***		0.017***		0.013***
				(0.003)		(0.003)		(0.003)		(0.003)		(0.003)
Distance					-1.580***	-0.019***	-1.297***	-0.009**	-1.728***	-0.009**	-1.676***	-0.009***
					(0.295)	(0.004)	(0.328)	(0.004)	(0.295)	(0.004)	(0.351)	(0.003)
Common language						0.016		0.002		0.002		0.009
						(0.011)		(0.009)		(0.009)		(0.009)
Common border						-0.021***		-0.014**		-0.013**		-0.014***
						(0.004)		(0.006)		(0.005)		(0.004)
Rule of law							0.352	0.018***	0.880	0.018***	-0.475	0.004
							(0.482)	(0.004)	(0.621)	(0.004)	(0.972)	(0.004)
Corporate tax rate									5.053***	0.007	3.715**	0.001
									(1.482)	(0.013)	(1.659)	(0.012)
R&D intensity											2.223*	0.018***
											(1.264)	(0.005)
Capital intensity											-5.480***	-0.037***

											(1.708)	(0.011)
rho		1.164***		0.910***		0.955***		0.930***		1.028***		1.084***
		(0.091)		(0.097)		(0.092)		(0.101)		(0.089)		(0.084)
Ln sigma		1.610***		1.504***		1.511***		1.500***		1.537***		1.556***
		(0.053)		(0.045)		(0.045)		(0.046)		(0.046)		(0.046)
Observations	179,394	179,394	179,394	179,394	179,394	179,394	179,394	179,394	179,394	179,394	179,394	179,394

Notes: Marginal effects obtained with a Heckman two step estimator. The explanatory variables are lagged by one year with respect to the dependent variables. The following variables are in logarithms: productivity, size, GDP, distance, rule of law, corporate tax rate, R&D intensity, capital intensity. The rest of the variables are dummy variables. All intensity regressions include year-specific, industry-specific and region-specific effects. Standard errors are clustered at firm level. ***, **, * denote statistical significance at 1 per cent, 5 per cent and 10 per cent, respectively.

Table 11: Determinants of intra-firm imports, 2009-2014

Variables	Intensity	Selection	Intensity	Selection	Intensity	Selection	Intensity	Selection	Intensity	Selection	Intensity	Selection
Productivity	-0.403***	0.017**	-0.423***	0.017**	-0.456***	0.017**	-0.452***	0.017**	-0.432***	0.016**	-0.409***	0.016**
	(0.121)	(0.007)	(0.117)	(0.007)	(0.113)	(0.007)	(0.113)	(0.007)	(0.116)	(0.006)	(0.116)	(0.006)
Size		0.034***		0.034***		0.033***		0.033***		0.032***		0.031***
		(0.007)		(0.007)		(0.007)		(0.007)		(0.007)		(0.006)
Hi-tech industry	-1.614***	0.004	-1.586***	0.008	-1.372***	0.009	-1.401***	0.008	-1.355***	0.008	-1.401***	0.007
	(0.449)	(0.021)	(0.434)	(0.021)	(0.438)	(0.021)	(0.437)	(0.021)	(0.440)	(0.020)	(0.438)	(0.020)
Medium-tech industry	-0.273	0.023	-0.345	0.023	-0.184	0.017	-0.163	0.016	-0.183	0.016	-0.240	0.014
	(0.654)	(0.022)	(0.640)	(0.022)	(0.651)	(0.019)	(0.653)	(0.019)	(0.659)	(0.019)	(0.643)	(0.018)
Intermediate goods	0.518***	-0.003	0.487***	-0.005	0.489***	-0.005	0.478***	-0.006	0.472***	-0.006	0.457***	-0.007
	(0.161)	(0.007)	(0.156)	(0.007)	(0.154)	(0.007)	(0.154)	(0.007)	(0.158)	(0.007)	(0.161)	(0.007)
Capital goods	0.509***	-0.015**	0.511***	-0.015**	0.516***	-0.012*	0.506***	-0.013*	0.515***	-0.013*	0.500***	-0.013**
	(0.178)	(0.007)	(0.172)	(0.007)	(0.173)	(0.007)	(0.173)	(0.007)	(0.176)	(0.007)	(0.180)	(0.006)
US	2.831***	0.447***	2.396***	0.269***	3.033***	0.328***	2.845***	0.330***	1.869***	0.283***	2.122***	0.268***
	(0.280)	(0.034)	(0.313)	(0.049)	(0.696)	(0.104)	(0.675)	(0.104)	(0.676)	(0.101)	(0.579)	(0.102)
GDP				0.043***		0.046***		0.046***		0.040***		0.032***
				(0.011)		(0.011)		(0.011)		(0.012)		(0.011)
Distance					-0.447*	-0.046**	-0.361	-0.021	-0.541**	-0.021	-0.744**	-0.034
					(0.263)	(0.018)	(0.266)	(0.021)	(0.232)	(0.019)	(0.290)	(0.021)
Common language						0.005		-0.045		-0.044		-0.006
						(0.048)		(0.056)		(0.053)		(0.046)
Common border						-0.081		-0.030		-0.021		-0.020
						(0.053)		(0.062)		(0.057)		(0.054)
Rule of law							-0.026	0.048*	0.519	0.055**	-0.860	-0.016
							(0.630)	(0.026)	(0.747)	(0.025)	(0.821)	(0.033)
Corporate tax rate									4.155***	0.101*	2.970***	0.064
									(0.884)	(0.060)	(0.798)	(0.055)
R&D intensity											2.317***	0.110***
											(0.877)	(0.038)
Capital intensity											-2.300*	0.007

	(1)	(2)	(3)	(4)	(5)	(6)
					(1.397)	(0.066)
Rho	1.373***	1.268***	1.245***	1.242***	1.308***	1.366***
	(0.063)	(0.057)	(0.071)	(0.070)	(0.063)	(0.060)
Ln sigma	1.399***	1.357***	1.347***	1.345***	1.368***	1.388***

Notes: Marginal effects obtained with a Heckman two step estimator. The explanatory variables are lagged by one year with respect to the dependent variables. The following variables are in logarithms: productivity, size, GDP, distance, rule of law, corporate tax rate, R&D intensity, capital intensity. The rest of the variables are dummy variables. All intensity regressions include year-specific, industry-specific and region-specific effects. Standard errors are clustered at firm level. ***, **, * denote statistical significance at 1 per cent, 5 per cent and 10 per cent, respectively.

5   Conclusions

This paper analyses highly disaggregated trade data from Ireland by product and country of destination/origin over the period 1994-2015 to address three questions. First, the analysis identifies patterns and trends of intra-firm exports and imports of manufactured goods. Second, it uncovers the importance of the extensive and intensive margins of intra-firm trade. Third, firm, product, industry and country characteristics that explain the engagement of firms in intra-firm trade and the intensity of intra-firm trade are identified. The key findings are summarised below.

The scale of intra-firm trade in Ireland is consistent with evidence from other developed economies discussed in Section 2. Intra-firm trade in Ireland accounts for 30% of exports and 25% of imports. Over the period, the scale of intra-firm exports increased while it declined for intra-firm imports. During the financial crisis, intra-firm exports were resilient, while intra-firm imports declined sharply and then rebounded in 2009.

The US dominates Ireland's intra-firm trade, accounting for 70% of the total number of intra-firm flows and 72% of the total number of intra-firm import flows. This dominance is explained by the large number of US multinationals located in Ireland. Germany and the United Kingdom are the next most important trading partners, followed by Japan, France, Switzerland and the Netherlands.

Ireland's intra-firm trade is important, and in particular, in industries producing intermediate goods, capital goods, as well as consumer non-durable goods. Over the period, the share of intra-firm exports of capital goods increased while the share of intra-firm imports of capital goods declined. The scale of intra-firm trade with intermediate goods increased over the period with the exception of a sharp decline in 2010. The top 10 products traded intra-firm are predominantly chemicals and pharmaceuticals, medical devices and electronics, reflecting the specialisation of multinational enterprises located in Ireland.

On average, intra-firm traders are larger than foreign-owned traders. However, on average, foreign-owned traders are slightly more productive than intra-firm traders. The average intra-firm exports per firm increased over the period with the exceptions of declines in 2001, 2003, 2005, and 2009. The average share of intra-firm exports per firm ranges from 35% to 39%. The average intra-firm imports per firm increased over the period with the exceptions of declines in 1996, 2001-2004, and 2006-2009. The average share of intra-firm imports per firm over the analysed period ranges between 41% and 56%.

The variation of intra-firm trade across firms is explained, to a large extent, by the intensive margin (the average intra-trade per product per firm), while the extensive margin (the number of products traded intra-firm) plays a less important role. In the case of intra-firm exports, the intensive margin accounts for 87% of the variation of intra-firm exports while the extensive margin accounts for 13%. In the case of intra-firm imports, the intensive margin also dominates, although to a lesser extent at 71%, while the extensive margin accounts for 29% of the variation of intra-firm imports across firms.

Firms engaged in intra-firm trade are likely to be larger and more likely to trade with the US and with other larger economies. Trade costs reduce the propensity of firms to engage in intra-firm trade. Intra-firm exports are more likely for exports of intermediate goods. The empirical results also suggest, in line with international evidence, that intra-firm trade is more likely with countries having strong contract enforcement laws and higher R&D intensity.

The intensity of intra-firm exports is negatively linked to firm productivity and positively linked to exports of capital goods. Trade costs reduce the intensity of intra-firm trade. The intensity of intra-firm trade is higher in less productive firms. Over and above other factors affecting intra-firm trade, the intensity of intra-firm trade is higher with countries with higher corporate tax rates. These latter two results might be linked to the use of transfer pricing by multinationals operating globally as a business strategy to boost profits.

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Appendix

Table A1   Definitions of Variables and Data Sources

Variable	Definition	Data source
Intra-firm export flow	Firm-product level export flow between foreign affiliate and the country where the headquarter is located	Central Statistics of Ireland, transaction level trade statistics
Intra-firm import flow	Firm-product level import flow between foreign affiliate and the country where the headquarter is located	Central Statistics of Ireland, transaction level trade statistics
Intra-firm trader	Firm with intra-firm trade	Central Statistics of Ireland, transaction level trade statistics
Firm productivity	Total turnover per person employed	Central Statistics of Ireland, Census of Industrial Production
Firm size	Total persons employed	Central Statistics of Ireland, Census of Industrial Production
High-tech industry	Binary variable equal to 1 for high-tech industries	Eurostat
Capital goods	Binary variable which is equal to 1 for trade with capital goods; 0 otherwise	UN Trade Statistics
Corporate policy tax rate	Statutory corporate tax rate	KPMG
Real GDP	GDP in 2005 prices	The World Bank, Economy & Growth Indicators
Distance	Distance in km between Dublin and capital cities of countries of destination/origin	CEPII
Common language	Binary variable equal to 1 if home and host countries have a common official primary language, 0 otherwise	CEPII
Common border	Binary variable equal to 1 if home and host countries share a border, 0 otherwise	CEPII
Rule of law	Index that reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	The Worldwide governance indicators, 2015 update www.govindicators.org
R&D expenditure intensity	Public and private R&D expenditure as per cent of GDP	The World Bank, Science & Technology Indicators
Capital intensity	Gross fixed capital formation as per cent of GDP	The World Bank, Economy & Growth Indicators