

Productivity in the ICT sector in Northern Ireland: A Pilot Study



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1. Introduction

The Department for the Economy (DfE) commissioned Queen's Management School (QMS) to undertake a pilot research project to measure productivity levels in the Northern Ireland Information and Communication Technology (ICT) sector. The aim of the project was to assess the viability of utilising micro-business data to measure and track productivity in priority sectors.

Productivity is identified as a key indicator of a country or region's competitive position and is considered to be the long-run driver of standards of living (Krugman, 1994). The draft Industrial Strategy highlights productivity as an area of concern as levels in Northern Ireland have lagged the UK for a number of decades (DfE, 2017). More recently there have been indications that Northern Ireland's productivity remains lower than that observed pre-recession (PWC, 2017). Previous research (Johnson and Buchanan, 2016) has further shown the Northern Ireland's lagging productivity performance varies significantly by sector, with different underlying contributory factors. Overall however, between 2012 and 2017, while UK turnover increased by 14.5%, purchases by 8.9% and productivity by 30.9%, the comparable figures for NI were 8.4% turnover growth, 12.4% growth in purchases and productivity growth of 17.4% (NISRA, 2019).

As a priority sector for the Department for the Economy, this pilot study seeks to use the Northern Ireland Annual Business Inquiry (ABI) to investigate productivity in the ICT sector, analysing levels by type and size of firm. The aim is to delve beneath the aggregate level to understand the distribution of productivity across the sector and identify whether productivity levels are correlated with other business activities. The research will help to provide a deeper understanding of productivity drivers in this specific sector and identify areas for potential intervention.

2. Data and Methodology

The data used for this study is drawn from the Northern Ireland ABI. This is a survey conducted by the Northern Ireland Statistics and Research Agency (NISRA) that collects both financial and employment information from businesses and other establishments. The survey covers about two thirds of the Northern Ireland economy, including production, construction, distribution and service industries, excluding public sector activity.

The ABI provides a number of high-level indicators of economic activity such as the total value of sales and work completed by businesses; the value of the purchase of goods; materials and services; and total employment costs. Gross Value Added (GVA) which measures the

contribution of each individual business or establishment to the economy is derived from the survey variables.

For the purposes of this study productivity is measured as Approximate GVA per employee. Approximate GVA (aGVA) at Basic prices represents the income generated by businesses, out of which is paid wages and salaries, the cost of capital investment and financial charges before arriving at a figure for profit. It includes taxes on production (e.g. business rates), net of subsidies but excludes subsidies and taxes on products (e.g. VAT and excise duty). This is an output-based measure of aGVA.

The use of aGVA per employee for productivity essentially captures the quantity of goods and services produced per unit of labour input. There are a number of caveats with this approach. On the input side, using a simple measure of labour input, such as the number of employees, fails to take account of the number of hours worked by different employees, or the quality of that labour. Using employee hours worked is a preferable means of capturing labour input but this data is not available within the ABI dataset. Secondly, the use of aGVA per employee represents a partial productivity measure, looking at the efficiency of labour only. Such partial measures do not account for other factors of production, particularly differences in capital intensity amongst firms. Total Factor Productivity (TFP) is a more complete measure of productivity, defined as the ratio of output (or value added) to a weighted sum of the inputs (capital and labour) used in the production process. Given its inclusive nature it overcomes the problem of changing factor intensities in production however it is more difficult to estimate than labour productivity, requiring detailed firm level and price data, the latter of which was not available within the data.

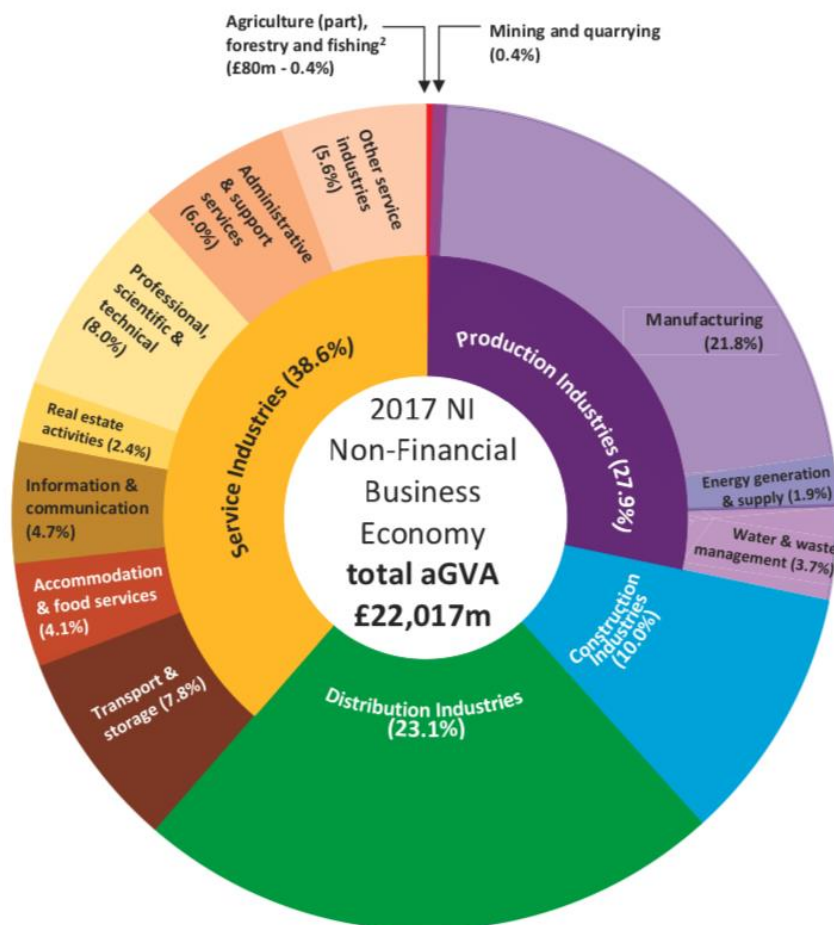
For the purposes of the analysis QMS provided NISRA Economic and Labour Market Statistics branch (ELMS) with the SIC codes representing the ICT sector (see Appendix 1) and the specified variables required for the analysis. The annual datasets drawn from the ABI were provided by NISRA and comprised approximately 400 businesses (reporting units). Weights were provided to gross the data to the sector totals. Once weighted the sector totals comprised between 1,500-1,800 businesses. The annual datasets were anonymised in such a way that they were not able to be linked together longitudinally.

The analysis focuses on two years, 2014 and 2017. Although data was provided from 2011 onwards there was little annual change in the data so 2017 was selected as the latest complete data available; 2014 is used as a comparator year.

3. Characteristics of ICT sector businesses

ICT is a relatively diverse sector comprising a combination of manufacturing, and digital and creative activities. There is no accepted definition of the sector, here we have used the definition as per that of Invest NI, with the addition of the Repair of Computers. In 2017, excluding farming and financial services, aGVA at basic prices in NI was estimated at £22.0 billion. This represented an increase of £258 million (1.2%) from 2016 to 2017. The distribution of aGVA across sectors is represented in Figure 1.

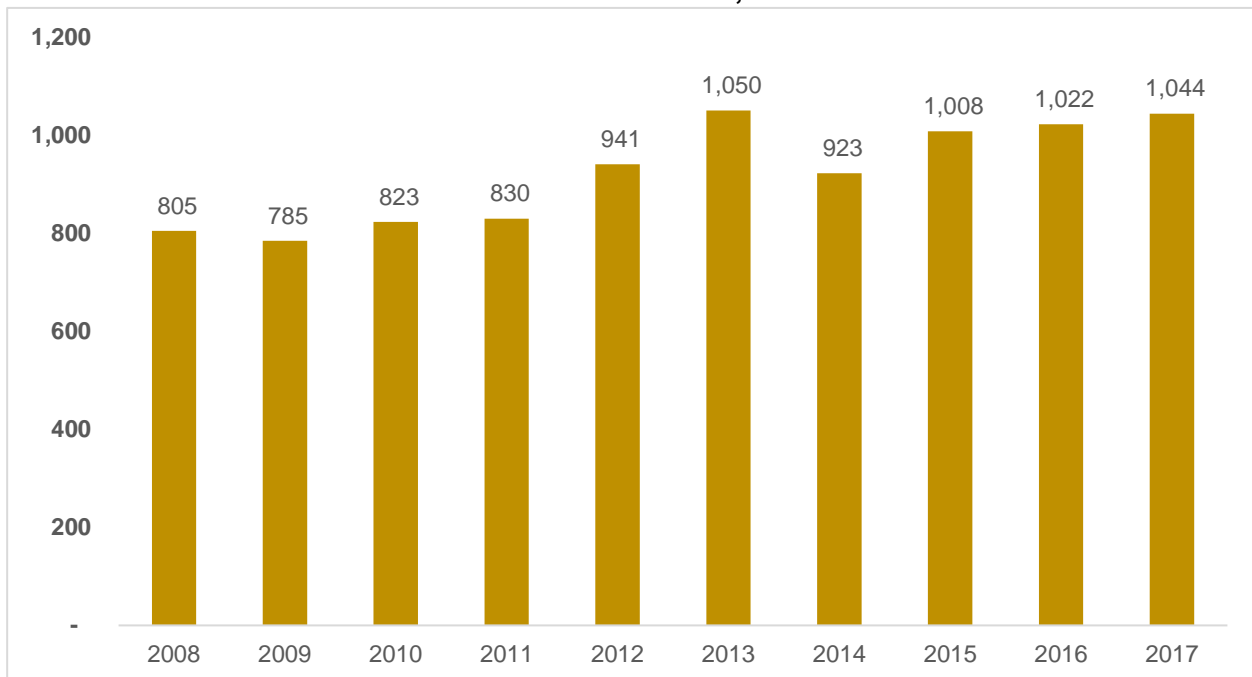
Figure 1: aGVA 2017 by broad industry for NI Non-Finance Business Economy



Source: NISRA (2019) NI Non-Financial Business Economy 2018 Provisional Local Unit Results: https://www.nisra.gov.uk/system/files/statistics/abi-2017-lu-publication-final_1.pdf

ICT accounted for 4.7% of total non-Financial Business Economy aGVA; equivalent to £1,044 million in 2017. As illustrated in Figure 2, aGVA has increased over the past decade with modest growth over the past few years.

Figure 2: Trend in aGVA £m, 2008 to 2017 for Northern Ireland Information and Communication,



Source: [NISRA \(2019\) NI Non-Financial Business Economy 2018 Provisional Local Unit Results](#), source Data.

Table 1 shows the sub-sectoral distribution in terms of share of firms. In Northern Ireland the ICT sector is dominated by Computer Programming, Consultancy and Related Activities which comprises two-thirds of the sector in 2017. The share of firms in this sub-sector has increased by around 8 percentage points since 2014. There has been a 3 percentage point decrease in Programming and Broadcasting Activities. More than one in ten companies within the sector is involved in Motion Picture, Video and TV Production, Sound Recording and Music Publishing Activities.

Table 1: Sectoral Distribution of ICT sector (% of Firms)¹

UK SIC 2007 Division	UK SIC2007 Code	2014	2017
		%	%
Manufacture of Computer, Electronic and Optical Products	26	4.7	3.7
Publishing Activities	58	6.4	5.3
Motion Picture, Video and TV Production, Sound Recording and Music Publishing Activities	59	13.2	14.0
Programming and Broadcasting Activities	60	6.0	2.8
Telecommunications	61	7.7	5.9
Computer Programming, Consultancy and Related Activities	62	58.2	65.7
Information Service Activities	63	2.0	1.2
Repair of Computers and Peripheral Equipment	95	1.9	1.5
Total		100.0	100.0

The main financial indicators for the sector, shown in Table 2, indicate an average productivity level of £42,800 in 2017. The standard deviation for this, and the other financial variables, suggests a relatively wide variation in levels, thus the median values are also provided. The median suggests an average productivity level of £34,300 in 2017, down slightly from 2014. Median employment is 2 in both years, indicating the predominance of micro-firms. Median turnover has increased between 2014-17 from £80,000 to £111,000. The mean values for exports and imports suggest an average export value three times that of imports, however the median values of both are 0. Average capital investment is around £84,000 but again the median is 0.

Table 2: Financial and Employment Statistics of the ICT sector 2014 and 2017

	2014				2017			
	n	mean	median	std dev	n	mean	median	std dev
AGVA (£000s)	1511	795.8	72.5	6391.7	1852	780.0	84.8	6700.9
Productivity AGVA per employee (£000s)	1304	47.3	38.0	150.2	1694	42.8	34.3	96.6
Employment	1511	15.8	2.0	109.2	1852	14.8	2.0	104.1
Turnover (£000s)	1511	1578.4	80.0	12802.2	1852	1462.9	111.0	12369.5
Imports (£000s)	1511	163.5	0.0	2702.2	1852	186.5	0.0	3101.0
Exports (£000s)	1511	680.4	0.0	8673.6	1852	693.8	0.0	9498.8
Capital Investment (£000s)	1511	83.05	0	1102.9	1852	84.54	0.0	1438.7

There were a number of changes between 2014 and 2017 in terms of the business activities of firms in the ICT sector (Table 3). The share of importing firms increased from 20 per cent

¹ See Appendix One for specific SIC codes within each division.

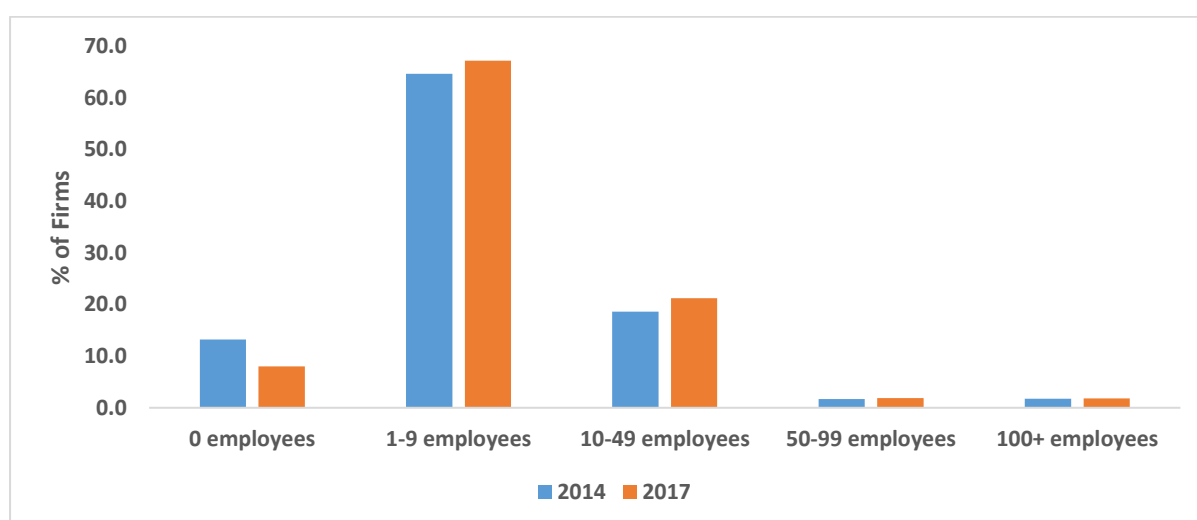
to 28 per cent and the share of exporting firms rose from 35 per cent to 44 per cent. There was a similar increase in the share of firms undertaking R&D which rose from one fifth of firms in 2014 to over one quarter in 2017. Just one third of firms in the sector are under UK ownership² but more than half are family-owned.

Table 3: Business Activity Characteristics of the ICT Sector 2014 and 2017

	2014			2017		
	No	Yes	Total	No	Yes	Total
	%	%	%	%	%	%
Importer	80.5	19.5	100.0	71.9	28.1	100.0
Exporter	65.4	34.6	100.0	56.3	43.7	100.0
Undertake R&D	80.3	19.7	100.0	73.3	26.7	100.0
UK owned	60.8	39.2	100.0	62.7	37.3	100.0
Family business	47.9	52.1	100.0	44.7	55.3	100.0

As suggested in Figure 3 the ICT sector is dominated by micro-firms, those with fewer than 10 employees contributing around two thirds of all firms and leading to a median employment level of 2 employees (compared to the mean of 14.8 employees, 2017: see Table 2) The self-employed, with 0 employees, constitute one tenth. Just 2 per cent of firms in the sector have 100 or more employees. Compared to the Northern Ireland figure for all industries, the ICT sector has a higher share of micro-firms (NI total of 57% in 2017) but around the same share of those with 100 or more employees (NI total of 1% in 2017)³.

Figure 3: Distribution by Firm Employment Size (%) 2014 and 2017

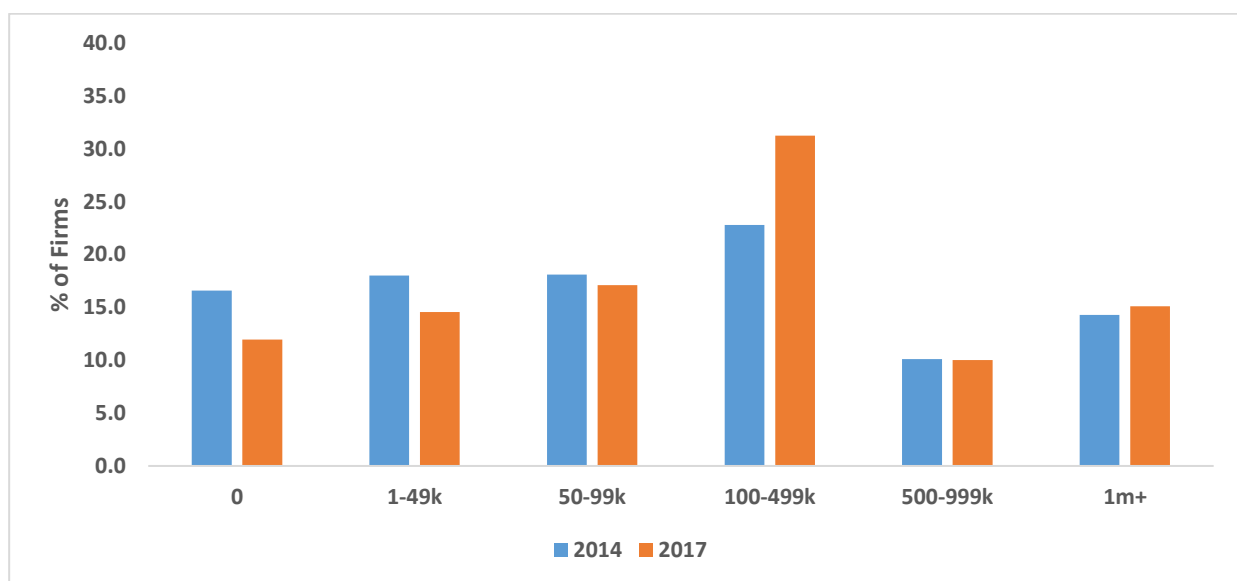


² Note that the ownership data is only available for approximately 400 firms in the sample.

³ Source: [NI IDBR 2017](#)

Despite the predominance of micro-firms in the sector, the distribution of firms by turnover size is more variable (Figure 4). Around one third of firms have a turnover between £100,000 and £499,999 in 2017, an increase from 23 per cent of firms in 2014. A further third have a turnover of between £1 and £99,999. There was no change between 2014 and 2017 in the share of firms with turnover of £500,000 or more while the share recording 0 turnover dropped from 17% to 12% over the period. The distribution is similar to that for the Northern Ireland average for 2017, whereby 37 percent of all firms have a turnover of £100,000-499,999; 27 per cent have a turnover between £0-49,999 and 10 per cent have a turnover of £1m or more⁴.

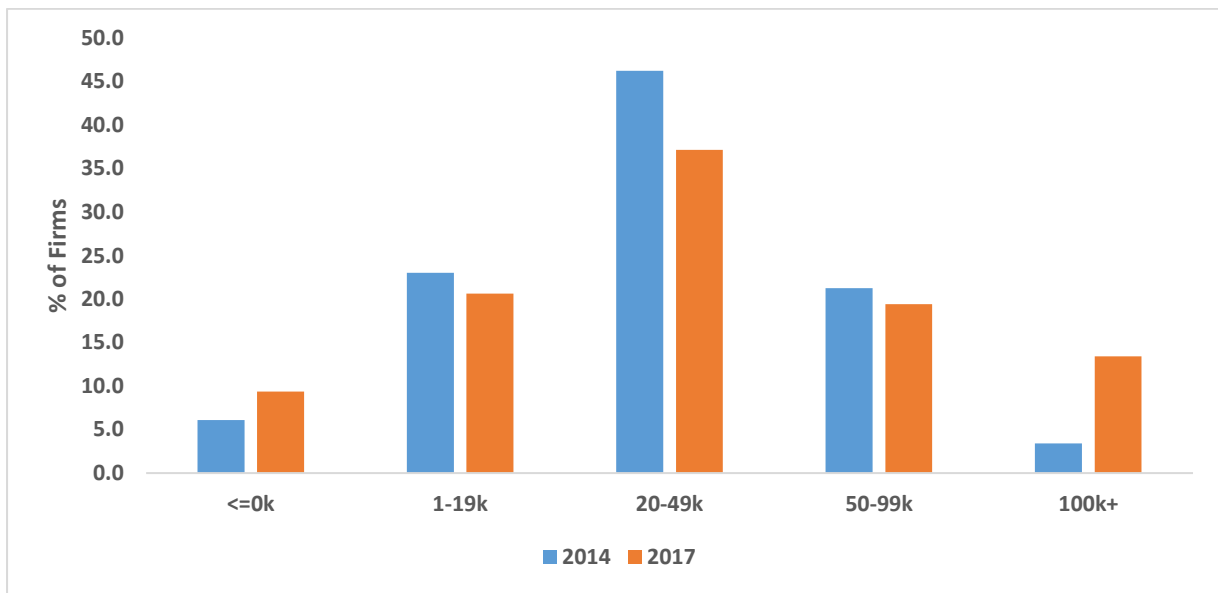
Figure 4: Distribution by Firm Turnover Size (%) 2014 and 2017



The distribution of firms by productivity level is more pronounced (Figure 3) with the highest share, more than one third of firms, having productivity of between £20,000-£49,999. The share in this category has dropped from 46 per cent of firms in 2014; there has been a corresponding increase in the proportion of firms with productivity of £100,000 or more. Given that the previous charts suggested little change between 2014-17 in the share of firms in either the highest employment or turnover sizebands, Figure 5 suggests that the productivity of the largest firms has increased over time.

⁴ Source: [NI IDBR 2017](#)

Figure 5: Distribution by Firm Productivity Level (%) 2014 and 2017

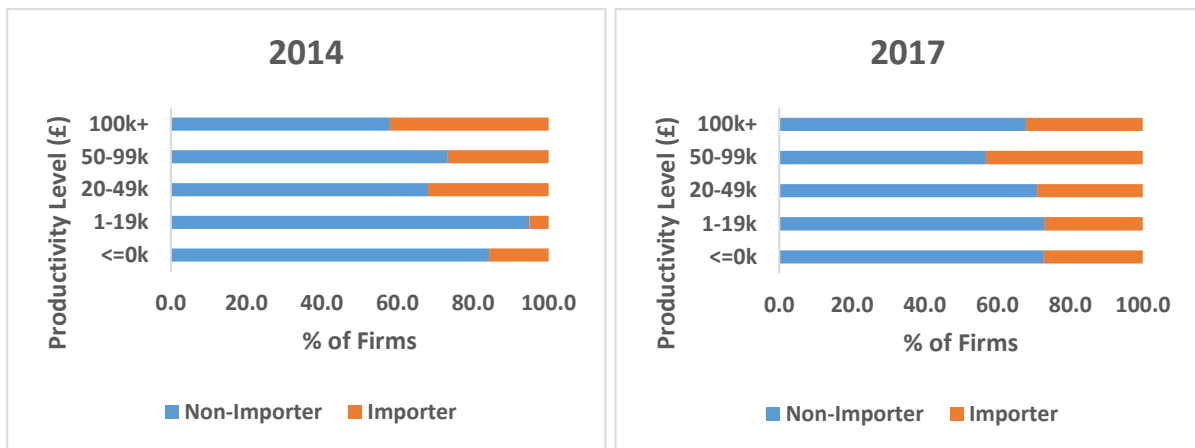


4. Productivity Analysis by Business Activity

Analysing productivity for firms engaged in various business activities can indicate potential correlations. The share of ICT firms by importer status for each productivity size-band is depicted in Figure 6⁵. There is no clear pattern in terms of an association between higher productivity levels and being an importer. However, the Chi-square statistical test shows a significant difference between importers and non-importers. The mean and median productivity values for importers are around 10 percentage points higher than non-importers in 2017, with importers having a mean productivity of £48,800 and a median value of £41,600.

⁵ Note that these figures are based on firms with non-missing data for both importer status and productivity level.

Figure 6: Productivity by Importer Status 2014 and 2017

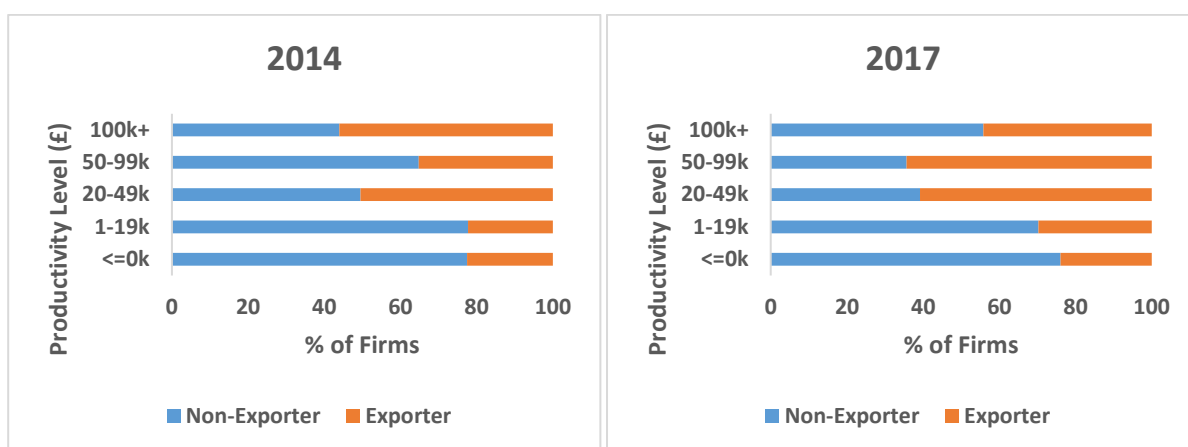


<i>Importer</i>	<i>No</i>	<i>Yes</i>	<i>Importer</i>	<i>No</i>	<i>Yes</i>
<i>Mean productivity (£000s)</i>	41.6	66.6	<i>Mean productivity (£000s)</i>	40.1	48.8
<i>Median productivity (£000s)</i>	33.5	44.1	<i>Median productivity (£000s)</i>	31.8	41.6
<i>Std. dev</i>	134.1	194.5	<i>Std. dev</i>	80.3	125.8
<i>Chi-Sq.</i>	0.00***		<i>Chi-sq.</i>	0.00***	

Assessing the share of ICT firms by exporter status for each productivity size-band (Figure 7⁶) does indicate a higher prevalence for exporting amongst firms with productivity levels of £20,000 or more. In both 2014 and 2017 almost four fifths of firms with productivity of £20,000 or less are non-exporters, this drops to between 40-60 per cent for those with higher productivity. The Chi-square statistical test again shows a significant difference between exporters and non-exporters. The mean productivity of exporters in 2017 is £50,200 compared to £36,100 for non-exporters. The median values also suggest a difference of £11,100 between the two types of firm, with a productivity value of £41,100 for exporters.

⁶ Note that these figures are based on firms with non-missing data for both exporter status and productivity level.

Figure 7: Productivity by Exporter Status 2014 and 2017

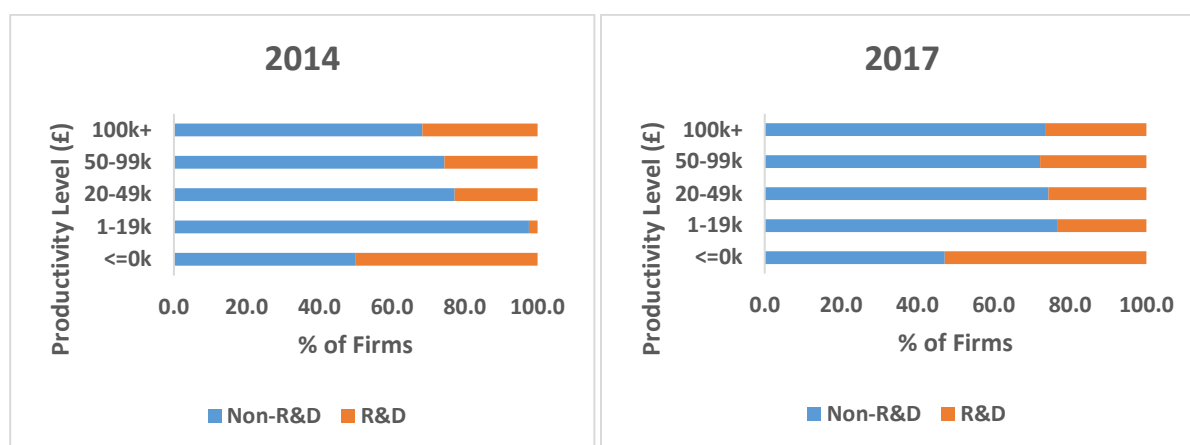


<i>Exporter</i>	<i>No</i>	<i>Yes</i>	<i>Exporter</i>	<i>No</i>	<i>Yes</i>
<i>Mean productivity (£000s)</i>	46.5	48.4	<i>Mean productivity (£000s)</i>	36.1	50.2
<i>Median productivity (£000s)</i>	38.0	43.6	<i>Median productivity (£000s)</i>	30.0	41.1
<i>Std. dev</i>	73.6	106.0	<i>Std. dev</i>	81.0	110.7
<i>Chi-Sq.</i>	0.00***		<i>Chi-sq.</i>	0.00***	

There is little difference in the share of firms engaged in R&D across the differing productivity size-bands, particularly in 2017 (Figure 8⁷). The exception is for firms with productivity levels at £0 or below, half of which are engaged in R&D compared with around one fifth of firms with higher productivity levels. This is the case for both 2014 and 2017 and may be an indication that these firms are in the early-stages of start-up and have yet to generate sufficient turnover to cover their R&D expenditure. In 2014, at £48,400, mean productivity is higher for those not engaged in R&D, the reverse is true in 2017. Both mean and median productivity levels are higher by around £6,000 for those engaged in R&D in 2017.

⁷ Note that these figures are based on firms with non-missing data for both R&D status and productivity level.

Figure 8: Productivity by R&D Status 2014 and 2017

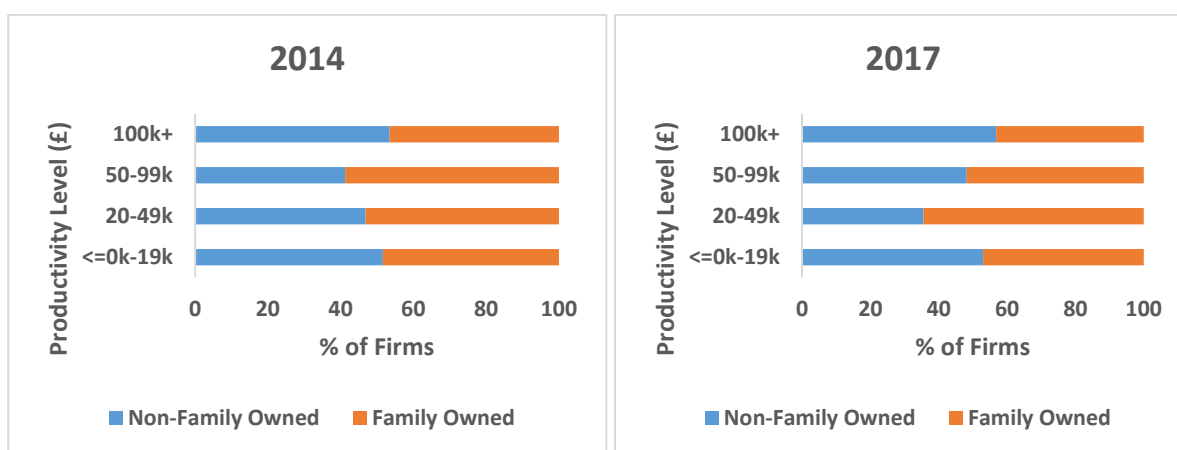


R&D	No	Yes	R&D	No	Yes
<i>Mean productivity (£000s)</i>	48.4	40.7	<i>Mean productivity (£000s)</i>	43.4	48.8
<i>Median productivity (£000s)</i>	38.0	38.2	<i>Median productivity (£000s)</i>	34.3	40.9
<i>Std. dev</i>	174.0	38.6	<i>Std. dev</i>	111.5	65.2
<i>Chi-Sq.</i>	0.00***		<i>Chi-sq.</i>	0.00***	

Between 40-60 per cent of firms in each of the productivity size-bands are family-owned (Figure 9⁸) with no suggestion that family ownership is associated with either particularly high or low productivity levels. The Chi-square statistical test shows a significant difference between the two sets of firms. In 2014 productivity is marginally higher for non-family owned firms; in 2017 mean productivity is higher for family owned firms. In both years non-family owned firms have a much wider variation in productivity levels. The median productivity for family owned firms in 2017 is £33,900 which is £4,000 lower than in 2014; the mean values are relatively unchanged at around £46,000.

⁸ Note that these figures are based on firms with non-missing data for both family ownership status and productivity level.

Figure 9: Productivity by Family Ownership Status 2014 and 2017

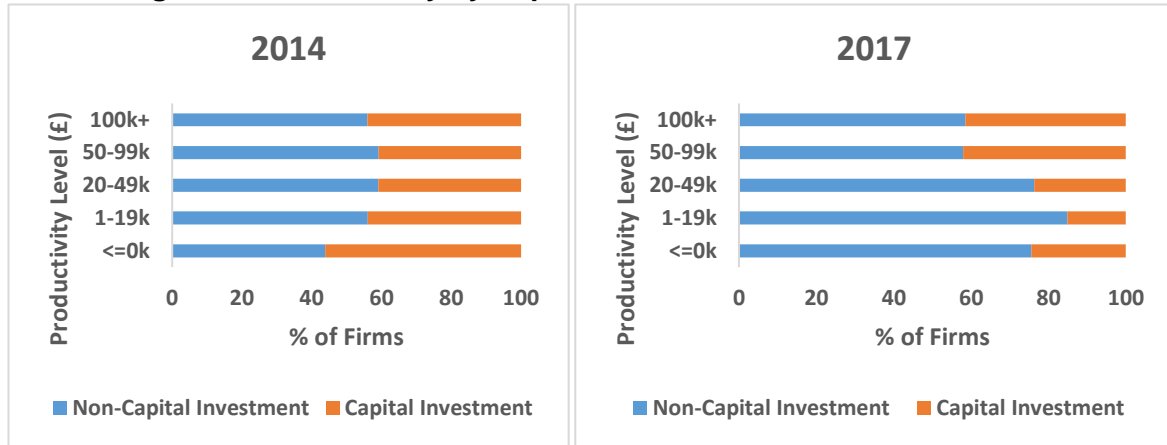


Family Owned	No	Yes	Family Owned	No	Yes
Mean productivity (£000s)	47.3	46.0	Mean productivity (£000s)	41.1	46.4
Median productivity (£000s)	39.6	38.0	Median productivity (£000s)	40.6	33.9
Std. dev	191.8	104.3	Std. dev	140.1	42.9
Chi-Sq.	0.00***		Chi-sq.	0.00***	

The share of firms that undertook capital investment across each of the productivity size-bands differs between 2014 and 2017 (Figure 10⁹). There is a relatively uniform pattern in 2014 with around 40 per cent of those in most productivity sizebands having undertaken capital investment. The Chi-square statistical test shows only a weakly significant difference between the two sets of firms, those investing and not. In 2017 around one quarter, or less, of firms with productivity levels up to £50,000 undertook capital investment compared to 40 per cent of firms with productivity levels above £50,000. In 2017, both the mean and median productivity levels are notably higher for those making capital investments, the mean level £30,000 higher and the median £18,000 higher. The differences for 2017 are statistically significant.

⁹ Note that these figures are based on firms with non-missing data for both capital investment status and productivity level.

Figure 10: Productivity by Capital Investment Status 2014 and 2017



Capital Investment	No	Yes	Capital Investment	No	Yes
<i>Mean productivity (£000s)</i>	49.2	44.4	<i>Mean productivity (£000s)</i>	34.2	65.5
<i>Median productivity (£000s)</i>	39.1	30.7	<i>Median productivity (£000s)</i>	31.8	48.9
<i>Std. dev</i>	129.8	175.6	<i>Std. dev</i>	95.5	96.0
<i>Chi-Sq.</i>	0.09*		<i>Chi-sq.</i>	0.00***	

5. Conclusion

Productivity is an important determinant of long-run growth in an economy, yet to-date little analysis has been undertaken at a micro-level of sectoral productivity levels in Northern Ireland. This analysis has sought to understand productivity across the firm level distribution of the ICT sector, one of the priority sectors for the economy. Analysing productivity at the micro-level can provide further insight, particularly for sub-groups of firms, than the sectoral aggregate allows.

The ICT sector comprises around 2,100 firms in 2017 with firms in Computer Programming, Consultancy and Related Activities accounting for the majority. This represents an increase in the number of firms in this sector, from around 1,700 in 2014. Micro firms (employing between 1 and 9 employees) dominates this sector, accounting for 67.2% of all firms in the sector, an increase from 64.7% in 2014.

Average productivity per employee was £42,800 in 2017 which represents a small decrease from £47,300 in 2014. This is not surprising, given the growth in the number of micro firms in the sector. In addition, alongside new firms in the ICT sector, both turnover and employment have increased. An average decline in productivity may therefore reflect a lagged effect, prior to these changes and investments translating into productivity gains. In total just over one third of firms in the sector have productivity levels of between £20,000-£49,000. The share of firms

with productivity of £100,000 or more has increased from 3 to 13 per cent between 2014 and 2017.

Statistical analysis shows significant differences across productivity sizebands between firms undertaking various business activities. Firms that import or export have higher productivity levels than those not undertaking these activities. A minority of firms undertake R&D yet these firms have higher productivity than non-R&D firms in 2017. Non-family owned firms also tend to have higher productivity levels. Typically, less than 40 per cent of firms make capital investments but these firms have notably higher productivity than their non-investing counterparts. An encouraging finding from the analysis is that the proportion of firms undertaking R&D, importing and exporting have increased over the period. This is likely to contribute to improved productivity performance over the next few years.

In addition to the correlations identified, an interesting future development would focus on the longitudinal aspect, allowing for a causal analysis to further identify whether these business activities are the cause or effect of higher productivity levels.

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Appendix

SIC 2007 codes for the ICT Sector

SIC Code	SIC Sector
26.11	Manufacture of electronic components
26.12	Manufacture of loaded electronic boards
26.2	Manufacture of computers and peripheral equipment
26.3	Manufacture of communication equipment
26.4	Manufacture of consumer electronics
26.51	Manufacture of instruments and appliances for measuring, testing and navigation
26.52	Manufacture of watches and clocks
26.6	Manufacture of irradiation, electromedical and electrotherapeutic equipment
26.7	Manufacture of optical instruments and photographic equipment
26.8	Manufacture of magnetic and optical media
58.11	Book publishing
58.12	Publishing of directories and mailing lists
58.13	Publishing of newspapers
58.14	Publishing of journals and periodicals
58.19	Other publishing activities
58.21	Publishing of computer games
58.29	Other software publishing
59.11	Motion picture, video and television programme production activities
59.12	Motion picture, video and television programme post-production activities
59.13	Motion picture, video and television programme distribution activities
59.14	Motion picture projection activities
59.2	Sound recording and music publishing activities
60.1	Radio broadcasting
60.2	Television programming and broadcasting activities
61.1	Wired telecommunications activities
61.2	Wireless telecommunications activities
61.3	Satellite telecommunications activities
61.9	Other telecommunications activities
62.01	Computer programming activities
62.02	Computer consultancy activities
62.03	Computer facilities management activities
62.09	Other information technology and computer service activities
63.11	Data processing, hosting and related activities
63.12	Web portals
63.91	News agency activities
63.99	Other information service activities n.e.c.
18.20/1	Reproduction of sound recording
18.20/2	Reproduction of video recording
18.20/3	Reproduction of computer media
26.30/1	Manufacture of telegraph and telephone apparatus and equipment
26.30/9	Manufacture of communication equipment (other than telegraph and telephone apparatus and equipment)
26.51/1	Manufacture of electronic instruments & appliances for measuring, testing, & navigation, except industrial process control equipment
26.51/2	Manufacture of electronic industrial process control equipment

SIC Code	SIC Sector
26.51/3	Manufacture of non-electronic instruments & appliances for measuring, testing & navigation, except industrial process control equipment
26.51/4	Manufacture of non-electronic industrial process control equipment
26.70/1	Manufacture of optical precision instruments
26.70/2	Manufacture of photographic and cinematographic equipment
58.14/1	Publishing of learned journals
58.14/2	Publishing of consumer, business and professional journals and periodicals
59.11/1	Motion picture production activities
59.11/2	Video production activities
59.11/3	Television programme production activities
59.13/1	Motion picture distribution activities
59.13/2	Video distribution activities
59.13/3	Television programme distribution activities
62.01/1	Ready-made interactive leisure and entertainment software development
62.01/2	Business and domestic software development
95.110	Repair of computers and peripheral equipment