

Productivity and Business Dynamism Across Regions

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ABBREVIATIONS

CSO	Central Statistics Office
ESRI	Economic and Social Research Institute
EU	European Union
FDI	Foreign direct investment
GVA	Gross Value Added
NISRA	Northern Ireland Statistics and Research Agency
NUTS	Nomenclature of territorial units for statistics
ONS	Office of National Statistics
SME	Small and Medium Enterprise

EXECUTIVE SUMMARY

This report examines some of the potential drivers of variation in productivity across regions in Northern Ireland and Ireland at the most granular level at which data is available.

At an aggregate level, there is a difference in productivity (gross value added per person employed) of close to 25 per cent between Ireland and Northern Ireland.

At a regional level, there is considerably greater variance in levels of productivity across regions in Ireland whereas productivity is reasonably consistent across the regions within Northern Ireland.

We examine the extent to which a range of factors contribute to regional productivity: education, infrastructure, sector and size distribution of activity, FDI presence and firm entry rates.

The report uses the most detailed geographic level of data available but this limits the number of inputs that can be considered. A range of potentially important drivers of productivity, such as spending on innovation activity, clustering, managerial capacity and detailed sectoral specialisation cannot be incorporated but this should not be taken to suggest that they do not play an important role.

Comparing predictions from the model to actual regional productivity shows a close relationship for most regions in Northern Ireland but leaves more performance unexplained in several Irish regions, with Dublin productivity levels in particular being higher than the model inputs can account for.

Educational attainment is an important factor behind cross-regional productivity differentials. In a scenario experiment where educational attainment of all regions is set equal to the level of the highest performing region, productivity increases of up to 20 per cent are simulated across regions in Northern Ireland. The effects of the education scenario are also substantial for the Border and Midlands regions in Ireland.

Productivity is found to be positively linked to road network infrastructure, higher shares of services, more medium and large firms, and greater FDI presence. A scenario of FDI increases across regions also had strong simulated effects on productivity, again particularly across regions in Northern Ireland and in the Border region where the initial levels are generally lower.

Broadband infrastructure has a strong positive direct effect. However, as broadband coverage increases, the productivity return coming from each further addition to the infrastructure coverage begins to decline.

Firm entry is positively correlated with overall regional productivity although the effect of a simulation increasing entry rates across regions predicted a relatively

modest productivity improvement.

SECTION 1: INTRODUCTION

There is considerable variation in productivity between Northern Ireland and Ireland, between sub-regions in both and between firms (particularly by nationality of ownership in Ireland). While productivity can be affected by a very wide range of factors, five broad categories of drivers of productivity growth can be summarised as coming from skills, innovation, entrepreneurship, investment and competition. This report examines productivity variation and some of its drivers at a detailed regional level across Northern Ireland and Ireland.

There are a small number of existing research papers that compare economic performance either between Ireland and Northern Ireland or between Northern Ireland and other large regions in the UK. However, these studies almost all use data on Northern Ireland as a single region and with Ireland divided into at most two or three broad regions. A key contribution of this report is to examine productivity patterns and links with other factors at a much more granular regional level. Data is compiled on as many regional indicators as possible using the eight NUTS3 regions of Ireland and the eleven local districts in Northern Ireland. For the econometric modelling of the determinants of productivity levels, we further use data from across NUTS3 regions of Great Britain to provide greater robustness for the statistical estimations.

The report investigates how a range of factors at the regional level relate to productivity. These include indicators of human capital skills (education level) and investment in physical infrastructure (roads and broadband). We also examine how differences in productivity may be related to the broad sectoral structure of the region, the firm size distribution and the presence of multinational activity. In addition, we look at the importance of entrepreneurship, proxied by the rate of new business start-up.

The inclusion of business dynamism as a potential factor in understanding regional productivity is motivated by recent evidence from a number of countries that shows firm entry and exit contributes significantly to regional productivity outcomes. This is in turn linked to an increased focus on the importance of firm entry with the OECD (2017) raising concerns that there has been a significant decline in business dynamism in developed economies in recent years, particularly in terms of the share of start-up firms, and this may be affecting overall productivity growth.

The aim of the report is to highlight where differences in productivity outcomes

across regions may be due to differences in economic structures and that may point towards opportunities for policy interventions. To examine which of the factors have the most substantial potential given the different current levels of productivity across regions, the statistical estimation of effects is supplemented by several scenario experiments. In these, we create counterfactual scenarios where all regions have the same level of an input variable (education, FDI or firm start-up) and calculate how much this would affect the regional productivity levels relative to the baseline estimations.

The structure of the report is as follows: section 2 discusses the existing literature on regional productivity, focusing on those dealing with either Ireland or Northern Ireland and also discussing the role of business dynamism at a regional level. Section 3 presents the data on regional differentials in productivity and some of the key factors that may drive these differentials. Section 4 presents the main results of the statistical estimation and the outcomes of the scenario analysis. Section 5 then concludes.

SECTION 2: EXISTING RESEARCH

2.1 COMPARISONS OF IRELAND AND NORTHERN IRELAND

There are a number of papers that compare economic performance either between Ireland and Northern Ireland or between Northern Ireland and other large regions in the UK. The level of regional granularity in these studies are typically at the NUTS-2 level which treats all of Northern Ireland as one region and divides Ireland into initially two regions and, since 2016, into three regions.¹

In some of the most recent work on comparing the two jurisdictions, McGuinness and Bergin (2019) provided a comparison of Northern Ireland, the UK and Ireland at this broad regional level (NUTS2 regions) focusing on the extent to which economic convergence could be found over time. They documented growth from 2000 to 2014, showing low economic growth in Northern Ireland and evidence of a growing gap compared to richer UK regions. Compared to Irish regions, the Northern Irish income per capita was around 50 per cent lower than Ireland's Southern and Eastern region but slightly higher than Border, Midland and West, indicating the level of regional variation within Ireland even at the broad NUTS-2 level. In terms of the drivers of this divergence of performance of the Northern Irish economy, the weakness of the Northern Irish education system was highlighted as a likely factor behind low productivity especially its low share of graduates. Lower inward investment flows were also pointed to as being a potentially major driver of regional difference. Similar conclusions were reached by FitzGerald and Morgenroth (2020) that a lack of investment in both human and physical capital have held back the performance of the Northern Irish economy relative to other regions of the UK.

Mac Flynn (2016) also compared productivity in Northern Ireland to other regions in the UK, going into more detail in relation to sectoral differences. He found that the gap in productivity could not be explained purely by different industrial structure but that a productivity gap could also be found to exist within sectors. While manufacturing performed well in relative terms, services sectors were found to be notably less productive than in other regions of the UK. In addition, the productivity gap was especially large in the agricultural sector which plays a larger role in Northern Ireland than in many other UK regions.

¹ The two region NUTS-2 split was into a Southern and Eastern region and the Border, Midlands and West region. This was reclassified from 2016 into three groups – Northern and Western, Eastern and Midland, and Southern.

Goldrick-Kelly and Mac Flynn (2018) emphasise the productivity gap within Ireland between foreign-owned and domestic firms is important to consider when comparing Ireland to Northern Ireland. While they found that Northern Ireland underperforms both the foreign-owned and the domestic sectors of the Irish economy, this distinction has a considerable impact on the size of the effect. Two policy implications are drawn by the authors from the investigation of this analysis. The first is that attracting FDI would help the Northern Irish economy considerably. The second is that FDI performance has compensated for areas where the Irish economy has not performed so strongly. They suggest “Building capacity within domestic industries should be examined on an all-island basis and all domestic firms on the island... should be assisted to benefit from FDI wherever it occurs”.

In relation to evidence of a more integrated all-island economy, Teague (2016) provides an overview of the evolution of the Northern Irish economy with a focus on changes after the Good Friday Agreement. The weaknesses identified are a dependence on public sector spending, with the private sector engaging in low value-added activity in the non-tradeable sector. He finds that evidence of moves to greater integration of an all-island economy are limited.

In the context of an all-island economy, InterTradelreland (2015) suggests that the development of clusters or sectoral ecosystems could bring broader benefits if pursued on a joint basis. Benefits of sectoral clusters are evident internationally in terms of information and knowledge flow, network building, and gains from both cooperation and competition. Focusing these clusters on firms with export potential would also bring further benefits with InterTradelreland (2018) showing that exporting firms on both sides of the border have consistently higher productivity, turnover and employment than non-exporters. Firms in Ireland tend to be more export-orientated than firms in Northern Ireland, another potential factor in driving the overall productivity gap between the two.

2.2 ROLE OF BUSINESS DYNAMISM

One factor that has been increasingly identified as a potential driver of productivity across regions but that has not been examined in an Irish context is the role of entrepreneurship or business dynamism. Looking across regions in the UK, Iparraguirre D’Elia (2007) identifies five broad drivers of labour productivity, which are classified as Investment, Skills, Innovation, Entrepreneurship, and Competition. While the first four should all unambiguously positively impact on labour productivity, he notes that the direction of a competition effect is less clear with too little competition not incentivising innovation or investment but a risk that too

much competition makes it difficult for firms to become established.

The importance of firm entry and exit has recently been emphasised by the OECD (2017), who have raised concerns that slowing rates of business dynamism across developed countries may be a factor in reduced productivity growth in the longer run. Linking entry to employment growth at an aggregate level, Lawless (2014) found that younger firms play a disproportionate role in job creation and are more dynamic than older firms. Firm size is not an important factor in job creation when firm age is controlled for.

Linking firm formation with regional developments, research from Portugal (Baptista and Torres Preto, 2011), Belgium (Bosma, Stam and Schutjens, 2011) and the Netherlands (Dejardin, 2011) all suggest positive links between start-up rates and regional performance, with performance measured either as employment growth or productivity developments. In the Portuguese study, the key finding was that knowledge-based start-ups bring the greatest benefits, and these are further enhanced if the start-up is in an already more agglomerated region. A breakdown by sector in the work on both Belgian and Dutch regions found that entry impacts productivity growth in services but did not find similar evidence for manufacturing.

Other work on regional employment and firm entry found that the effect is mainly concentrated in regions with already high productivity levels and the effects are very persistent over time (Fritsch and Mueller, 2008). The strength of the relations can also be non-linear with other features of the region such as population density, share of medium skilled workers, innovation (measured by numbers of R&D workers) and the share of small businesses in total employment have a role to play (Fritsch and Schroeter, 2011). The presence of multinationals has been found to have a positive effect on productivity, particularly when they are in sectors that are more intensive in R&D and intangible assets (Bournakis, Papanastassiou and Pitelis, 2019).

SECTION 3: COMPARING REGIONAL PRODUCTIVITY

3.1 DATA SOURCES

The primary focus of this report is on differentials in productivity across regions on the island of Ireland and the extent to which these can be correlated with observable characteristics. In order to strengthen the statistical identification of relationships between productivity and regional characteristics, however, we draw on a wider dataset of regions that includes all of the UK. We use the most granular level of regional unit for which a reasonably wide variety of characteristics is available, resulting in a considerably greater level of fine geographic identification than used in the majority of previous studies described in section 2. The geographic unit for data from Great Britain is at the NUTS3 level, which constitutes 133 areas within England, 21 in Scotland and 12 in Wales. For Ireland, we also use data at the NUTS3 level and there are eight of these regions. The regional breakdown in Northern Ireland is available at a slightly finer geographic degree with data available for the eleven local government districts. The areas in Ireland and Northern Ireland are listed in Table 1.

TABLE 1: REGIONS IN IRELAND AND NORTHERN IRELAND

Ireland	Northern Ireland
Border	Antrim and Newtownabbey
Dublin	Ards and North Down
Mid-East	Armagh City, Banbridge and Craigavon
Mid-West	Belfast
Midland	Causeway Coast and Glens
South-East	Derry City and Strabane
South-West	Fermanagh and Omagh
West	Lisburn and Castlereagh
	Mid Ulster
	Mid and East Antrim
	Newry, Mourne and Down

The majority of the data at the regional level is available for the period 2014 to 2018, primarily drawn from the Central Statistics Office (CSO) for Ireland and the Office of National Statistics (ONS) for the UK with additional data for Northern Ireland coming from the Northern Ireland Statistics and Research Agency (NISRA). Where necessary some supplementary data has been used from other sources as referenced in each figure.

Drilling down to a fine geographic level comes with certain trade-offs. A number of factors that one would like to include in an analysis of productivity differentials – such as spending on research and development or innovation activity – are not available at levels lower than country. Other potential drivers of productivity gaps across countries such as measures of managerial capacity are also absent from the official statistics drawn on here (McKinsey, 2009). Confidentiality constraints on data from small countries also limit the subgroups that can be looked at within regions in terms of sectoral breakdown or firm types although we use as much as is available on these characteristics across regions. These data limitations are important however in contextualising the findings of the report as the exclusion of many factors is due purely to their absence in regional data sources rather than an indicator of their potential significance.

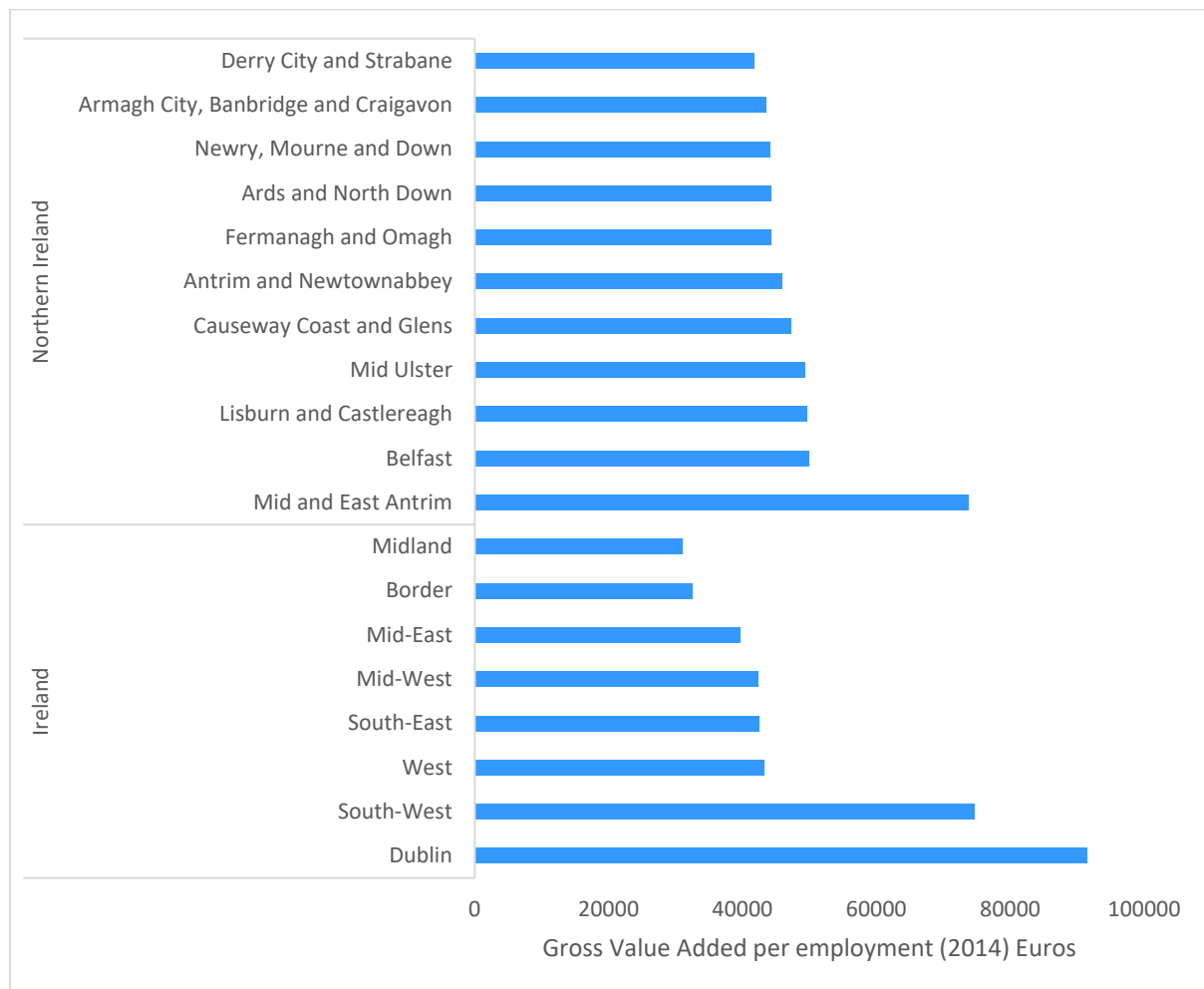
3.2 GROSS VALUE ADDED ACROSS REGIONS

We define productivity, our main variable of interest, as gross value added (GVA) divided by employment for each region. For comparability, GVA levels must be converted into the same currency. This does bring in some potential measurement error given that price levels may vary across the regions which cannot be entirely captured by using the average exchange rate. While this suggests a degree of caution should be used on the precise levels, the main focus throughout the report will be on variation across regions and correlations with other factors generally measured as shares of activity which should be less sensitive to this issue. Figure 1 compares the regions across Northern Ireland and Ireland for 2014 where the widest range of data is available.² Ignoring differences in region size for a moment, the simple averages are broadly similar with productivity across regions in Northern Ireland being €48,500 and €49,700 in Ireland. However, the higher productivity regions in Ireland have much greater employment and hence weight in generating aggregate productivity so the overall gap between the two jurisdictions is much more significant than this implies. The average GVA per person employed in Ireland was slightly over €60,000 compared to €48,600 in Northern Ireland, a productivity gap of close to 25 per cent.

Perhaps the most striking aspect of Figure 1 is the much greater variance in regional productivity in Ireland compared to Northern Ireland. With the exception of the higher performance in the Mid and East Antrim region, the other ten districts in Northern Ireland are quite closely bunched in terms of productivity performance. The spread in Ireland, on the other hand is quite considerable, with productivity levels in Dublin almost three times those in the Border or Midlands regions and the South-West region also reporting productivity levels of more than double most of the other regions.

² Data for the South-West is redacted in later years of CSO regional data.

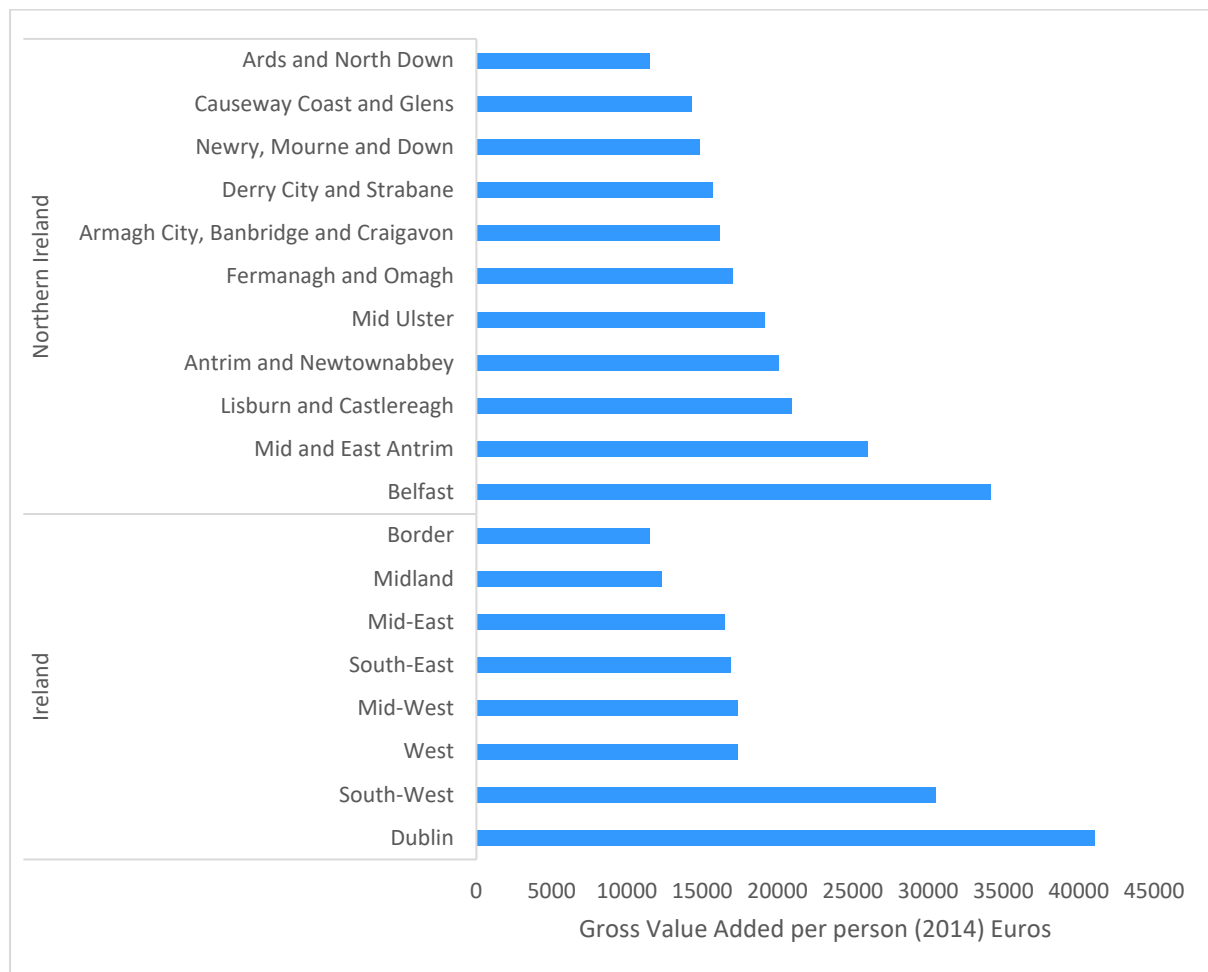
FIGURE 1: GROSS VALUE ADDED PER EMPLOYMENT BY REGION IN NORTHERN IRELAND AND IRELAND



Source: Author calculations from ONS and CSO data

Figure 2 presents a similar figure but uses GVA per person rather than per person employed to adjust for employment intensity across the regions. This gives broadly the same picture in terms of dispersion for Ireland (with the levels being lower as the value added is spread over a larger number). For Northern Ireland, however, the picture across regions is now rather more dispersed suggesting that regional differentials in employment participation are important in overall regional differences whilst GVA per person employed is at broadly similar levels. Using this metric, we note a greater dominance of the two capitals in terms of economic activity with GVA per person substantially higher in Belfast and Dublin than in the other regions. Proximity to these hubs also appears to be a potential factor in the spread of productivity across regions although data at an even more granular level would be needed to distinguish between the role of proximity to the capital and that of other regional cities.

FIGURE 2: GROSS VALUE ADDED PER PERSON BY REGION IN IRELAND AND NORTHERN IRELAND

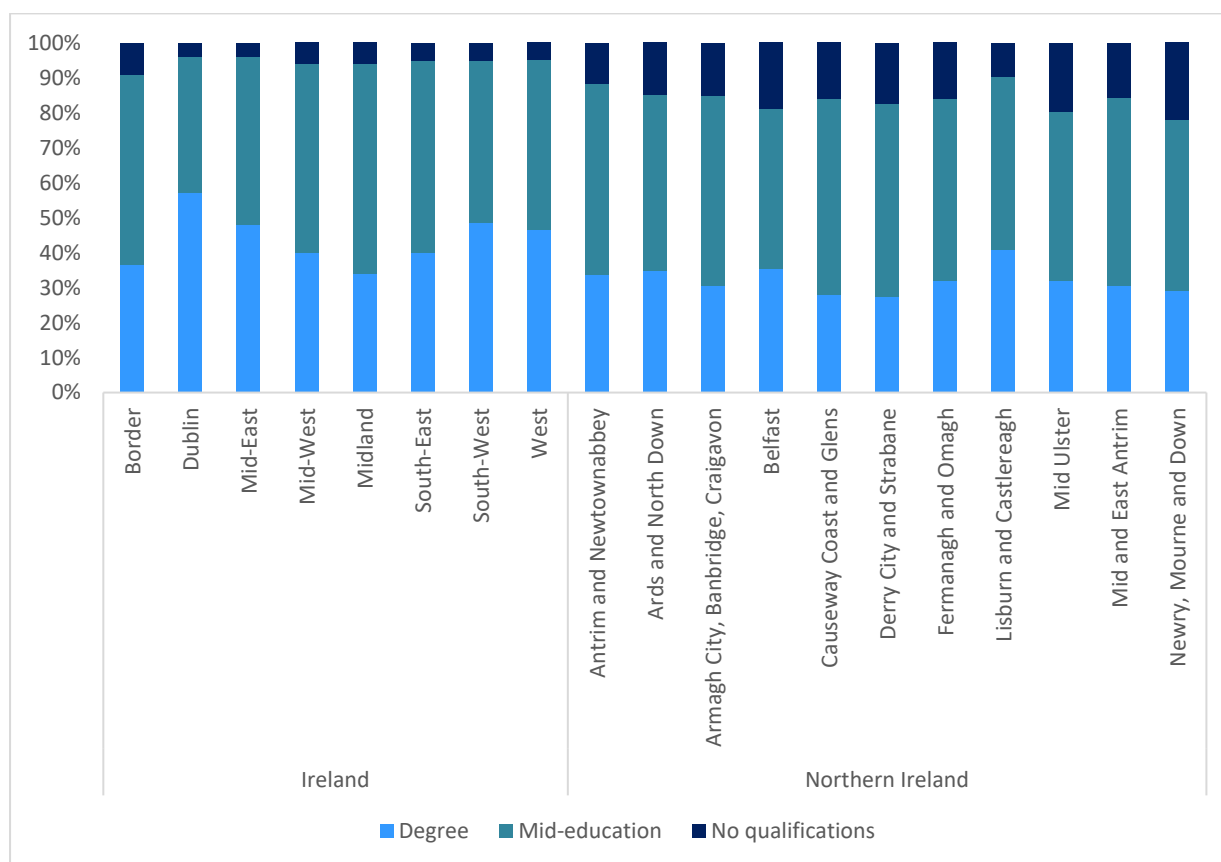


Source: Author calculations from ONS and CSO data

3.3 HUMAN CAPITAL AND INFRASTRUCTURE

Differences in overall educational attainment were highlighted by FitzGerald and Morgenroth (2020) as a central element in comparing the performance of the economies in Northern Ireland and Ireland over time. This subsection compares educational outcomes across each of the regions. In Figure 3, educational attainment of the working age population is divided into three broad categories – those with a third level degree or equivalent, those with a mid-level education (less than degree but having at least completed second-level schooling) and those with no qualifications.

FIGURE 3: EDUCATIONAL ATTAINMENT BY REGION



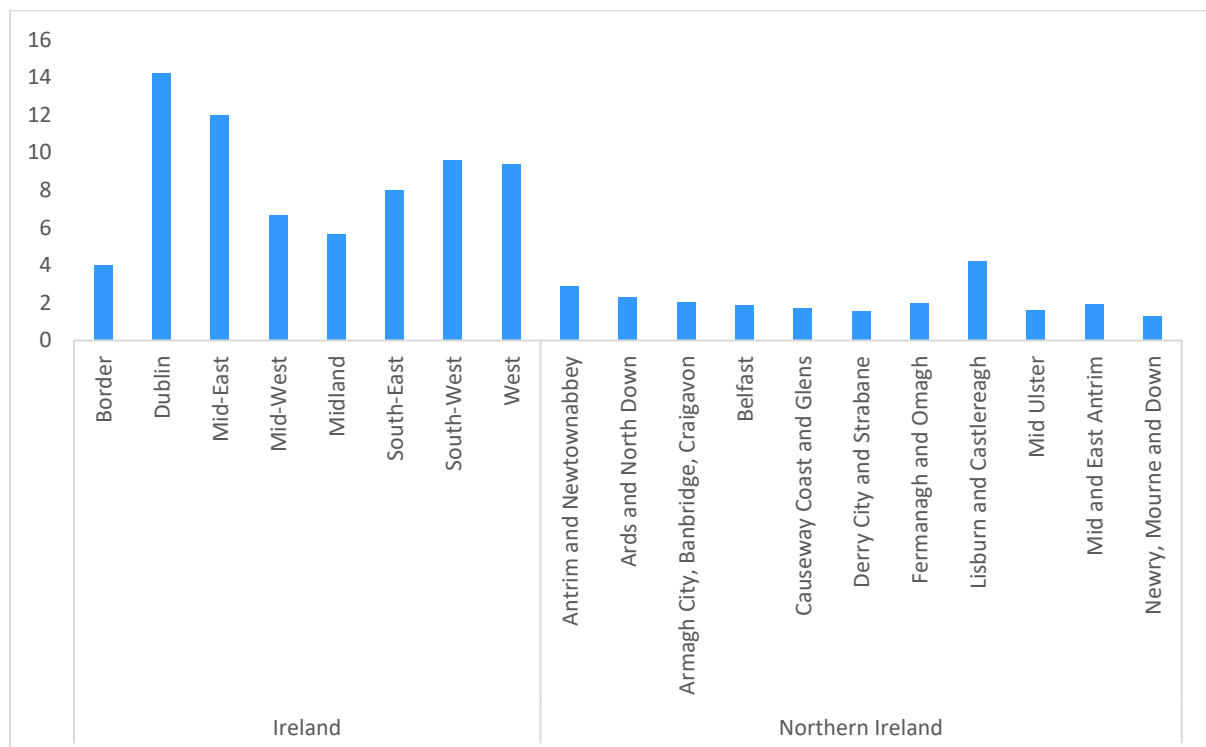
Source: Author calculations from NISRA and CSO data (2017)

Within Ireland, we find that third-level degree attainment varies from 57 per cent of the working-age population in Dublin to 34 per cent in the Midlands. The share of adults with no qualifications is between 4 and 5 per cent in almost every region, apart from a slightly higher incidence of 9 per cent in the Border region. The share of the working age population with no qualifications is substantially higher across all regions in Northern Ireland compared to Ireland with the lowest incidence (10 per cent in Lisburn and Castlereagh) being higher than that of the Border region in Ireland. In other Northern Irish regions, the share of adult population with no qualifications is mainly in the region of 15 to 19 per cent, topping 22 per cent in the Newry, Mourne and Down region. The share of adults with a third level degree ranges from 27 per cent in Derry City and Strabane and also Causeway Coast and Glens to a high of just over 40 per cent in Lisburn and Castlereagh.

Figure 4 expresses the differences across regions rather more starkly by comparing the ratio of those with degrees to those without qualification. In Dublin, there are fourteen times more people with degrees than with no qualifications. Across regions in Ireland, we find a considerably higher share – 6 to 8 times as many – of

adults with degrees relative to those with no qualifications. Only in the Border region is this ratio somewhat smaller, but still considerable: a ratio of four times as many adults with degrees as with no qualifications. In contrast, in Northern Ireland a ratio of four is at the upper end of internal regional educational differentials. Across almost all of the other Northern Irish districts, we find that there are in the region of twice as many people with degrees than there are without any qualifications. When interpreting these patterns, two aspects of the data should be borne in mind. The first is that education levels within a region may be subject to reverse causation – in other words, those with higher education levels may be attracted to move to a particular region with higher productivity and better job opportunities as well as education contributing to the productivity level. Secondly, the education measure is based on the residence rather than the workplace of the population so the link between education and production may be weakened by commuting between regions. As the definition of the regions are smaller geographic units in Northern Ireland than in Ireland reflecting the availability of data, this might have a larger impact on our ability to correlate education with productivity in Northern Ireland.

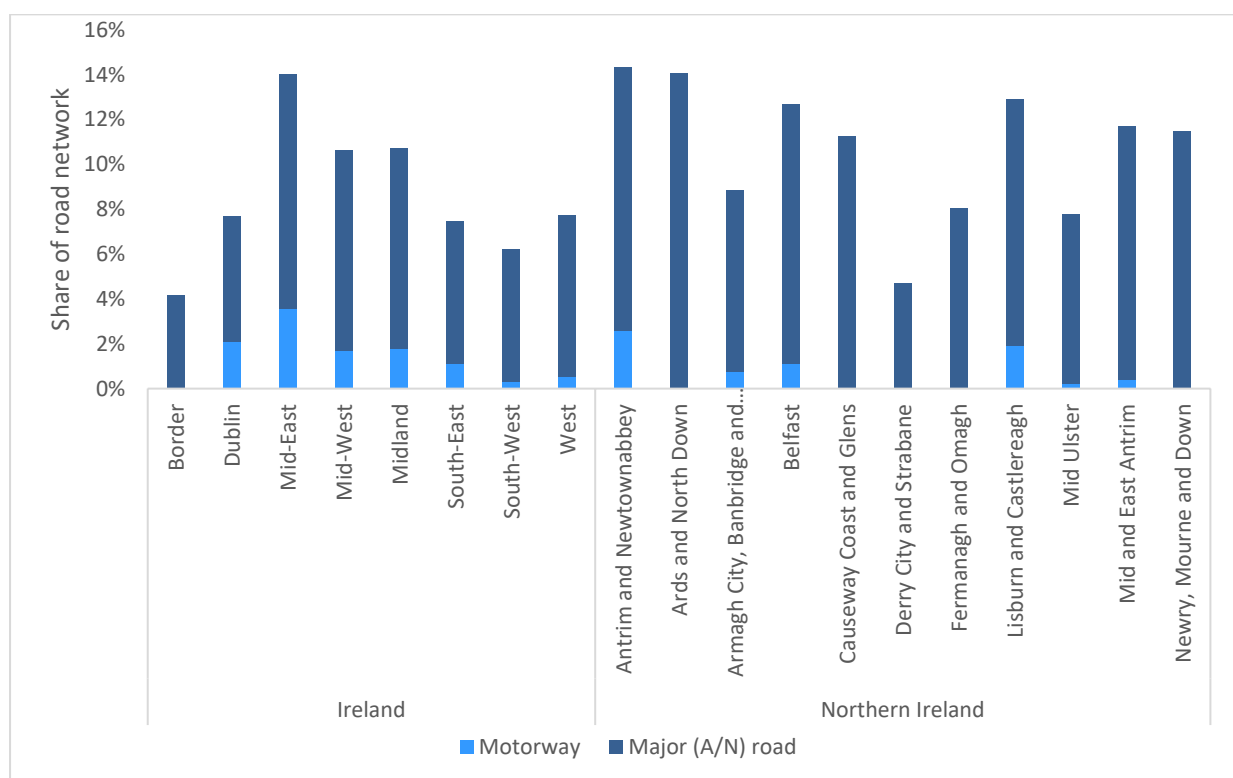
FIGURE 4: RATIO OF WORKING AGE POPULATION WITH DEGREE TO NO QUALIFICATIONS



Source: Author calculations from NISRA and CSO data (2017)

Following on from human capital endowments, Figures 5 and 6 examine differences across regions in physical capital infrastructure. Figure 5 compares indicators of the quality of the road network, showing the share of motorways or major roads (A-roads in Northern Ireland and N-roads in Ireland) in the total road network in each region. The motorway network is a small share of the overall network in most regions with 4 per cent of roads in the Mid-East of Ireland being the densest network followed by 3 per cent in Antrim and Newtownabbey. In most regions, between 1 and 2 per cent of all roads are motorway standards. A number of regions have no motorways – the Border region in Ireland and several regions in Northern Ireland. The major road network is more extensive in Northern Ireland however with most regions having more than 10 per cent of the road network classified as major roads whereas this is the case for only the Mid-East. The Border region in Ireland and Derry City and Strabane have the lowest incidence of major road infrastructure in each country along with no motorways. Once again, the differing sizes of the regions in Northern Ireland compared to Northern Ireland should be borne in mind when drawing conclusions from these measures.

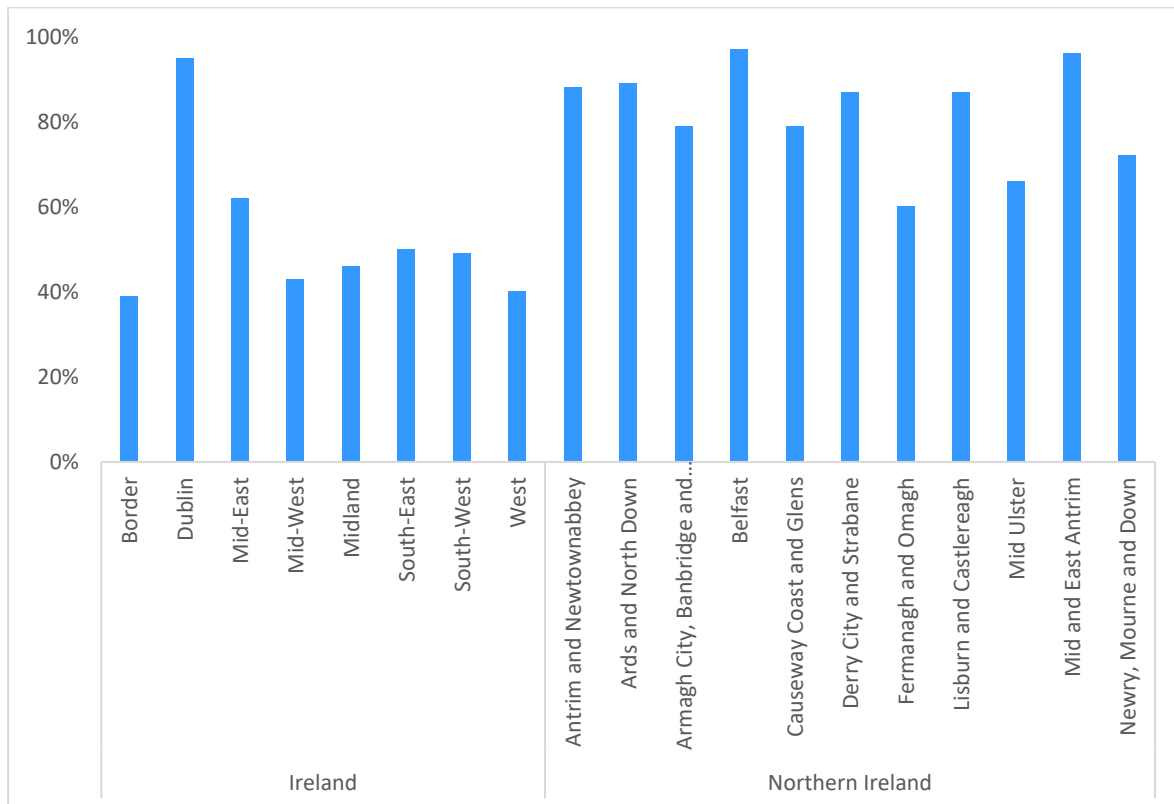
FIGURE 5: PHYSICAL INFRASTRUCTURE (MOTORWAYS & A/N-ROADS) DENSITY



Source: Author calculations from NISRA and CSO data

The second major indicator of infrastructure supporting productivity used is the share of firms with access to high-speed broadband networks.³ Figure 6 shows that there is considerable variation in the extent of broadband access across regions in Ireland, ranging from 95 per cent of firms in Dublin to approximately 40 per cent in the West and Border regions. This relates to the most recent available data which is for 2017 with a National Broadband Plan in progress to increase these rates. The general level of access to high-speed broadband is higher in most regions in Northern Ireland with less variation across them although some areas such as Fermanagh and Omagh and Mid-Ulster have notably lower levels of broadband infrastructure than other regions. Funding has been allocated under Project Stratum to roll out high speed broadband to the remaining businesses in Northern Ireland that cannot currently access it.⁴

FIGURE 6: BROADBAND INFRASTRUCTURE (SHARE OF FIRMS WITH HIGH-SPEED ACCESS)



Source: Author calculations from ONS for NI and external calculations using DCCAE and National Broadband Plan for Ireland

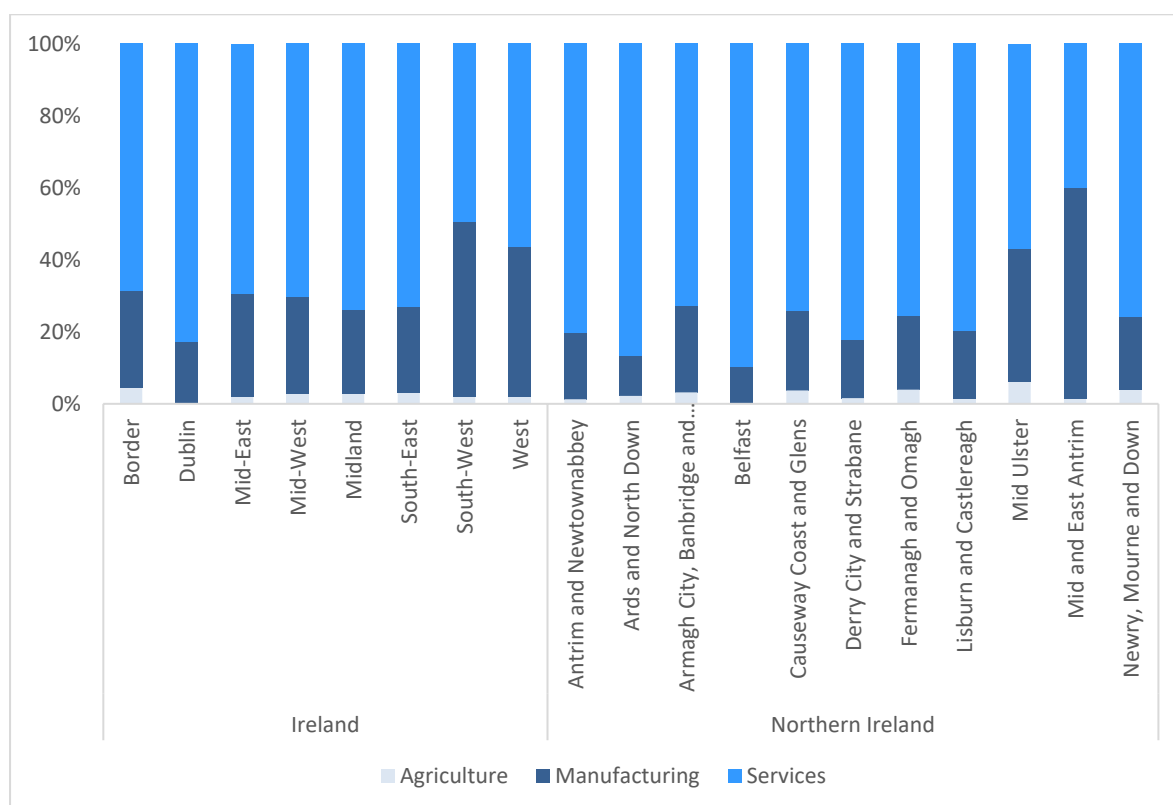
³ Note that this access definition means that high-speed broadband is available in the areas the firms are located not a measure of connections at the firm-level.

⁴ <https://www.economy-ni.gov.uk/topics/telecoms/project-stratum>

3.4 SECTORAL STRUCTURE, OWNERSHIP AND FIRM SIZE DISTRIBUTION

While the direction of influence of broad sectoral structure on productivity may vary depending on the more granular composition of the sectors, data constraints restrict us to looking at a sectoral structure at a high level. Figure 7 shows the overall contribution to GVA across sectors by agriculture, manufacturing and services. Agriculture is a relatively modest share of total GVA across all regions, averaging 2 to 3 per cent in most. The highest contributions of agriculture to GVA are in the Border region (4 per cent of the region’s GVA), Mid-Ulster (6 per cent), Fermanagh and Omagh and Newry, Mourne and Down (both 4 per cent). The services sector makes up the largest share of total GVA in most regions, particularly in Dublin and Belfast. Only in the South-West of Ireland and the Mid and East Antrim region of Northern Ireland does manufacturing generate more than half of GVA.

FIGURE 7: BROAD SECTORAL SHARES OF GROSS VALUE ADDED BY REGION

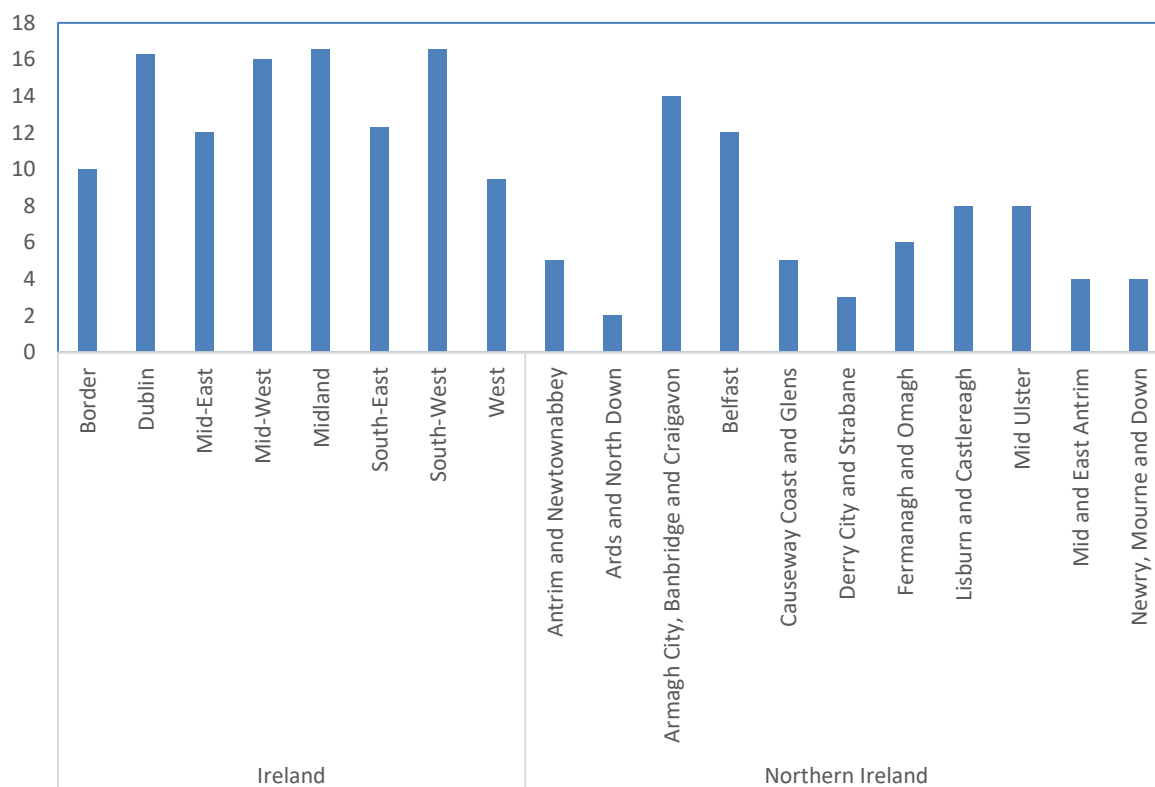


Source: Author calculations from NISRA and CSO data

A distinguishing feature of the Irish economy is the extent of foreign direct investment. Figure 8 shows the prevalence of this in terms of employment shares across regions using survey data from the Department of Business, Enterprise and Innovation to allocate total FDI employment across regions (as the CSO does not publish this data on a regional basis). This shows a very substantial share of FDI

across regions in Ireland, averaging 14 per cent of total employment. This is in contrast to Northern Ireland where the presence of FDI is much lower across most regions with the exception of Armagh City, Banbridge and Craigavon.

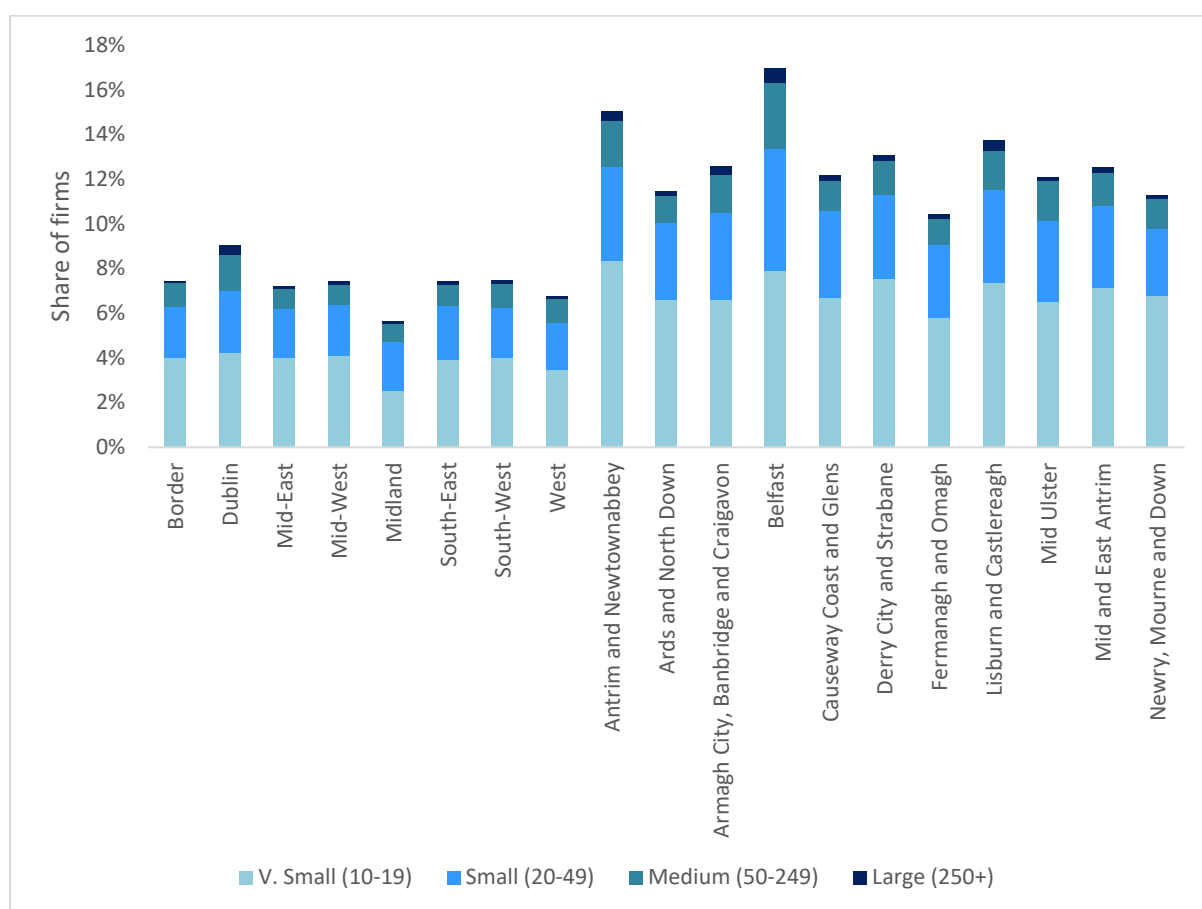
FIGURE 8: FOREIGN-OWNED FIRMS (EMPLOYMENT BASED) SHARE



Source: Author calculations from ONS, CSO and DBEI data

The size distribution of firms across regions is shown in Figure 9 (expressed as a share of firm numbers). The majority of firms in all regions are micro firms (those with fewer than ten employees) which make up between 80 and 90 per cent of firms in most cases (closer to the former in Northern Ireland and the latter in Ireland). These are excluded from the figure to make the scale across other firm types more readable. Very small firms (ten to nineteen employees) make up the next largest segment of the firm size distribution while large firms (250 or more employees) make up less than half of one per cent of firm numbers.

FIGURE 9: SIZE DISTRIBUTION OF FIRMS



Note: Micro firms (<10 employments) excluded for scale.

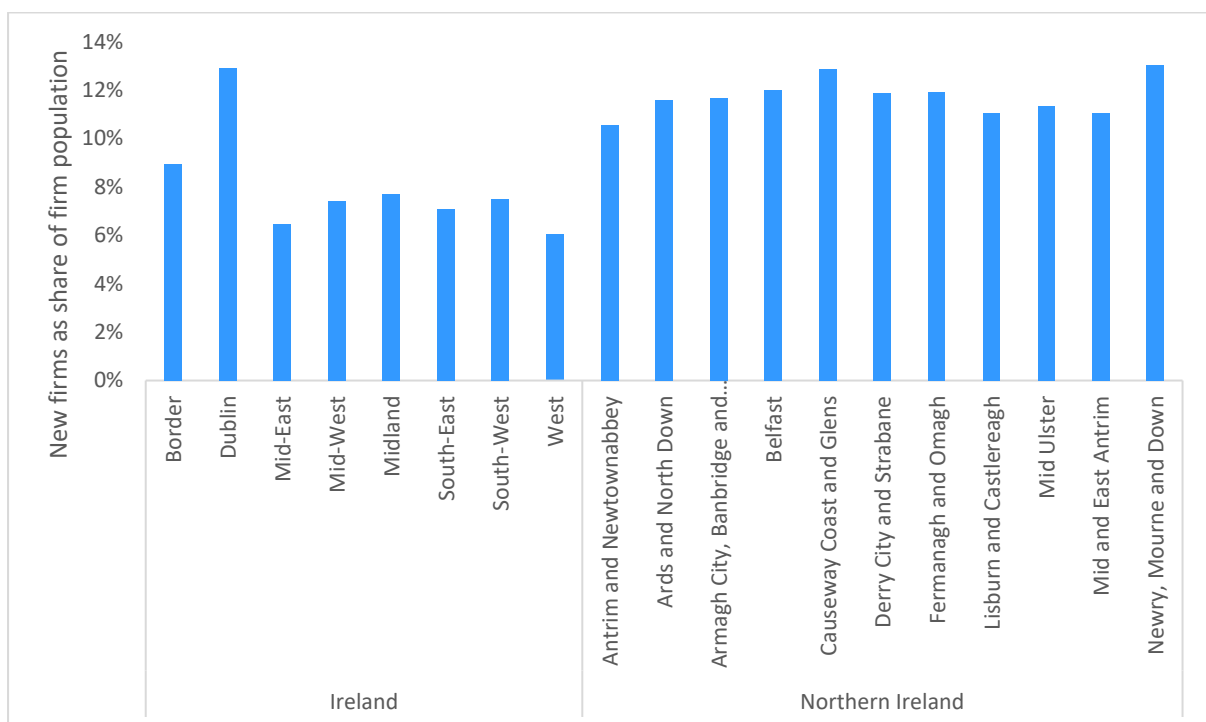
Source: Author calculations from NISRA and CSO data (2017).

3.5 FIRM DYNAMISM

Along with economic structure and human and physical capital inputs, one element motivating this report is the extent to which entrepreneurship and new firm formation may be a driver of cross-regional productivity differentials. The establishment and growth of new businesses are key ingredients for economic growth and job creation with Lawless (2014) showing that young firms are disproportionate creators of new jobs. Encouraging and supporting a continuing flow of new enterprise start-ups is a critical element of maintaining and growing this sector and, from a policy perspective, it is important to recognise that the appropriate strategies may be quite different for the establishment and first employment stages of a firm’s development relative to those suitable for more established firms.

The inclusion of this firm dynamism factor as a potential driver of regional productivity comes against the background of a broad international trend whereby the share of start-ups had been steadily decreasing (Criscuolo, Gal and Menon, 2014). Figure 10 shows newly established firms as a share of the total firm population across each region. Firm entry is consistently higher in Northern Ireland than in Ireland, averaging 11 to 12 per cent each year. Only in Dublin is the entry rate in Ireland at this level with most regions showing entry of between 7 and 8 per cent of the firm stock each year.

FIGURE 10: ENTRY RATE OF NEW FIRMS



Source: Author calculations from NISRA, CSO and Companies Registration Office data

This section has provided descriptive background on a number of factors that evidence from the existing literature suggests may be behind differentials in regional productivity. It has focused on how each of these factors varies across regions in Ireland and Northern Ireland. In the next section, we examine more rigorously the extent to which these factors can indeed be linked to productivity performance at the regional level, adding additional data from regions across the UK to provide more depth into our estimations of the strength of each relationship.

SECTION 4: DRIVERS OF REGIONAL PRODUCTIVITY DIFFERENTIALS

4.1 CORRELATIONS

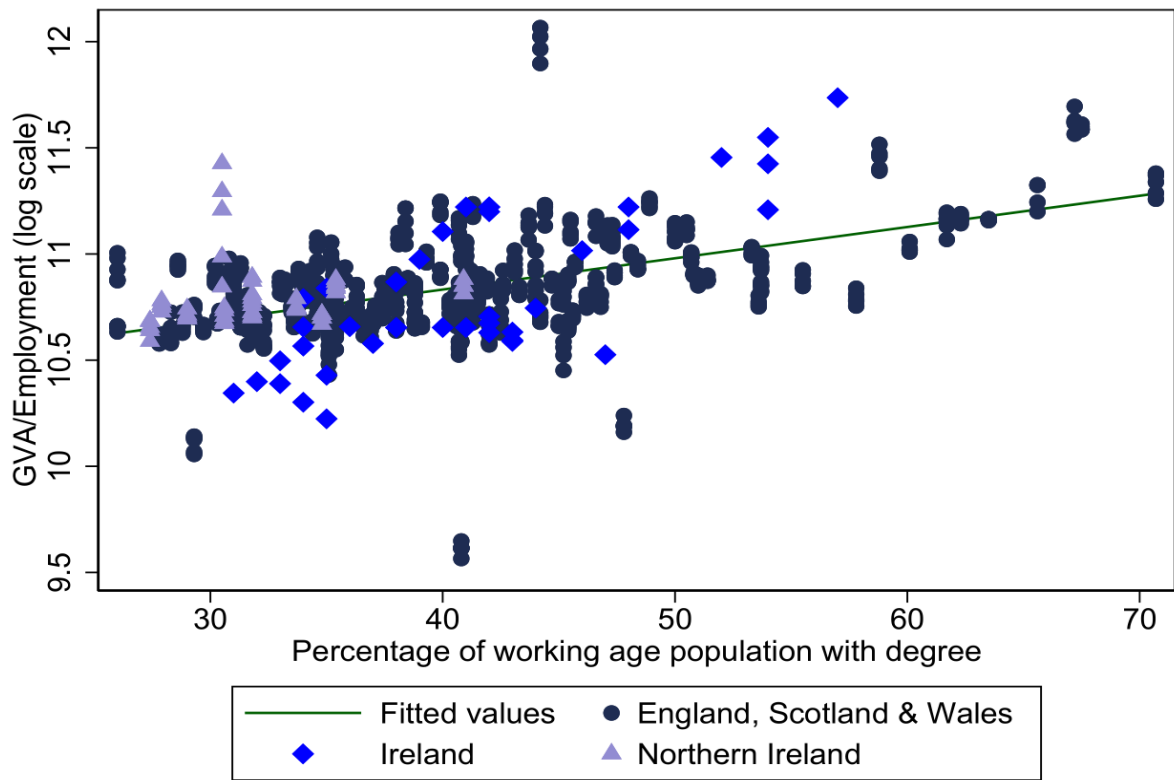
Before modelling the relationships between the full set of variables and regional productivity, this section examines some of the bilateral correlations to illustrate the general pattern across regions. Each of the following figures (Figures 11 to 16) graphs a potential driver of productivity with the output variable of GVA per person employed (using a log scale to adjust for outlier regions). As the number of regions across the island of Ireland is rather small for reliable statistical estimation of this type of relationship, the sample of regions is expanded to include NUTS-3 regions from across England, Scotland and Wales.

Beginning with educational attainment, Figure 11 presents a scatter plot of the share of working age population against regional activity. As a broad indicator of human capital, the expectation would be that this plays a positive role in productivity generation and we do indeed find evidence of a positive connection between the two.

Figure 12 shows the relationship between road infrastructure and regional productivity (once again, not controlling for any other factors). The relationship with motorway infrastructure on the left panel shows no particular link to productivity outcomes. The right-hand panel shows major roads and productivity have a potentially positive link but one that is weaker than that observed for education. Figure 13 shows a similar link between broadband and productivity as observed for major roads, with a slight upwards trend but also considerable variation around it.

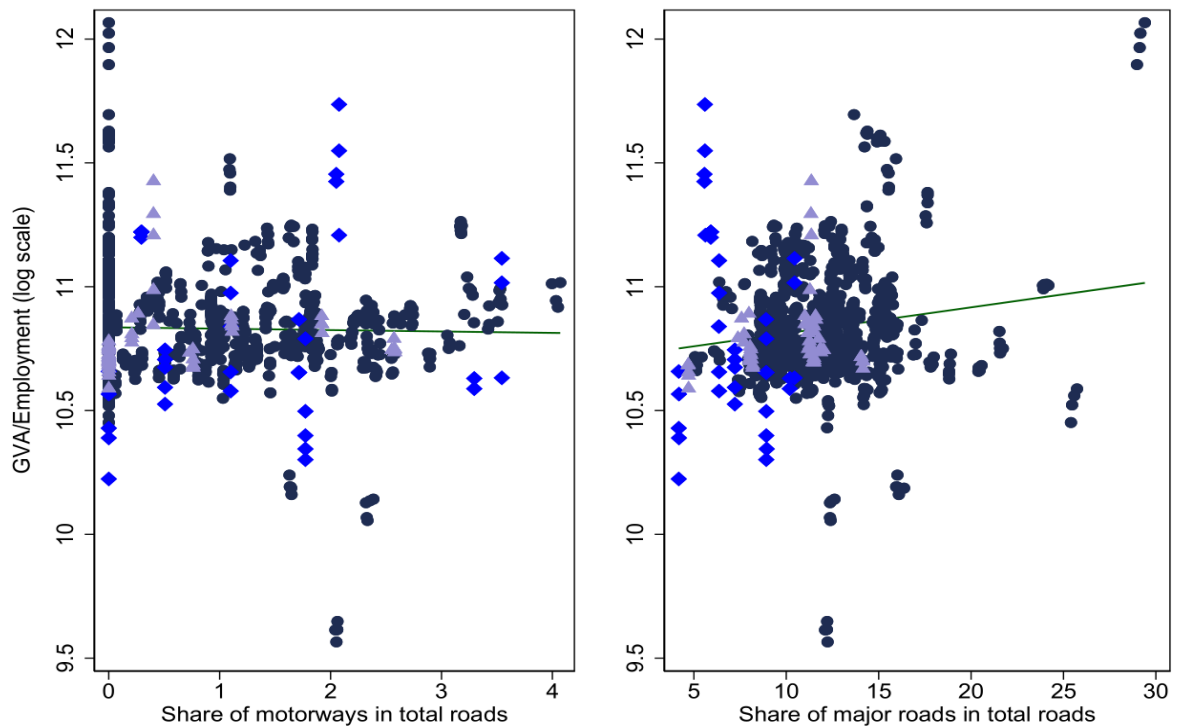
Sectoral structure (Figure 14) indicates that a greater share of services is associated with greater productivity with the opposite holding for regions with higher shares of manufacturing. Due to data constraints, only these very broad sectoral categories were available and it is important to note that, within both manufacturing and services, there is likely to be considerable productivity dispersion across individual activities. The share of FDI in employment across regions shows a relatively clear positive slope linking increased FDI with higher regional productivity performance as shown in Figure 15. The final relationship plotted is between regional productivity and firm entry rates which also shows a positive correlation.

FIGURE 11: CORRELATION BETWEEN GVA PER EMPLOYMENT AND DEGREE ATTAINMENT



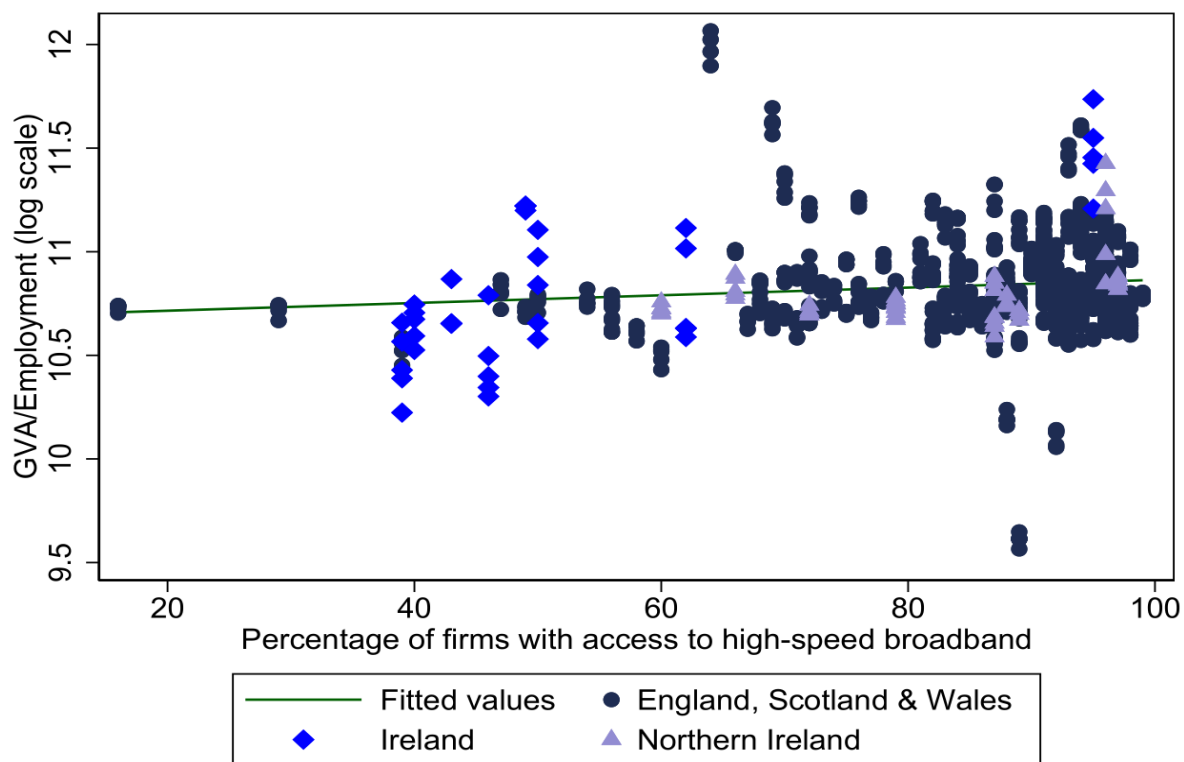
Source: Author calculations from ONS, NISRA and CSO data

FIGURE 12: CORRELATION BETWEEN GVA PER EMPLOYMENT AND ROAD INFRASTRUCTURE



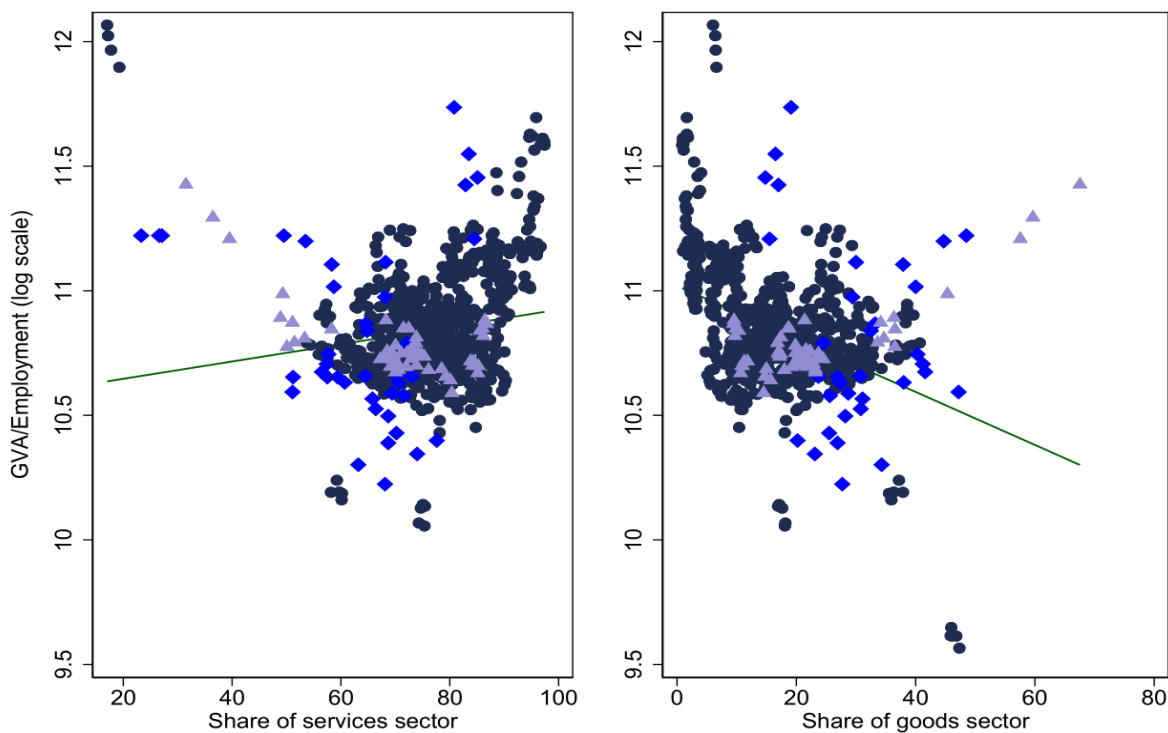
Source: Author calculations from ONS, NISRA and CSO data

FIGURE 13: CORRELATION BETWEEN GVA PER EMPLOYMENT AND BROADBAND ACCESS



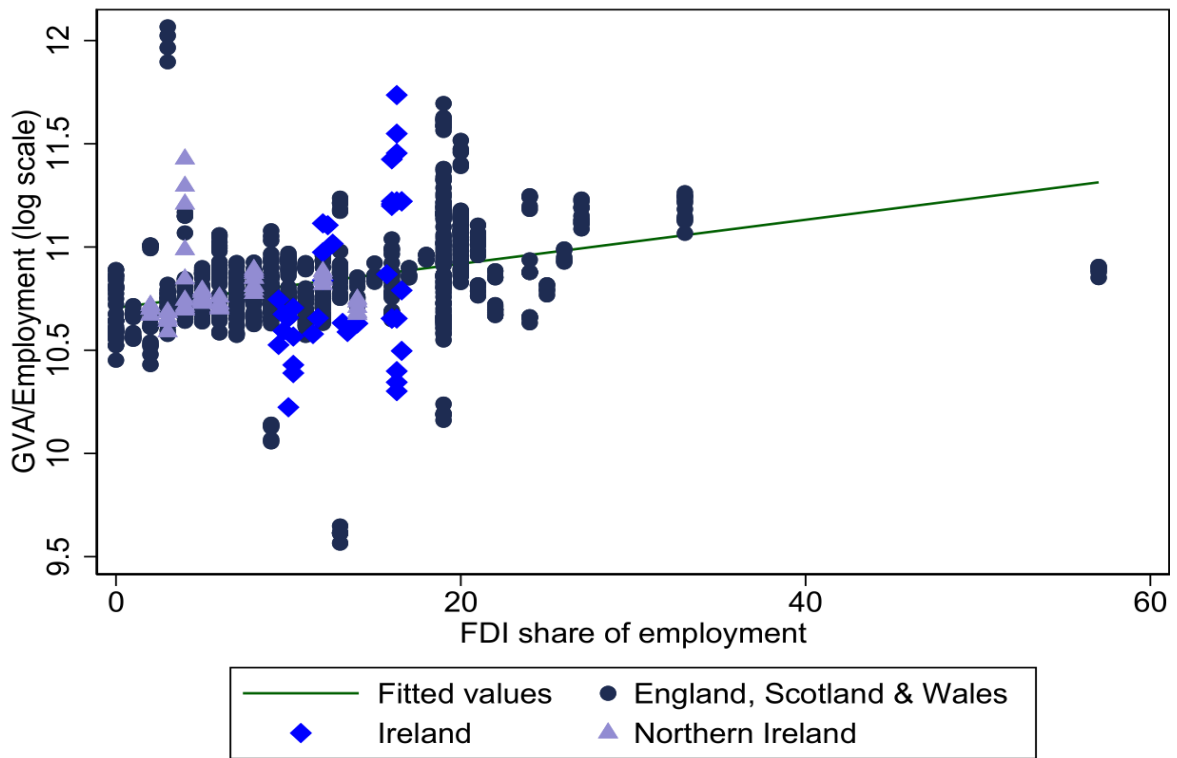
Source: Author calculations from ONS, NISRA and DCCAE data

FIGURE 14: CORRELATION BETWEEN GVA PER EMPLOYMENT AND BROAD SECTORAL SHARES



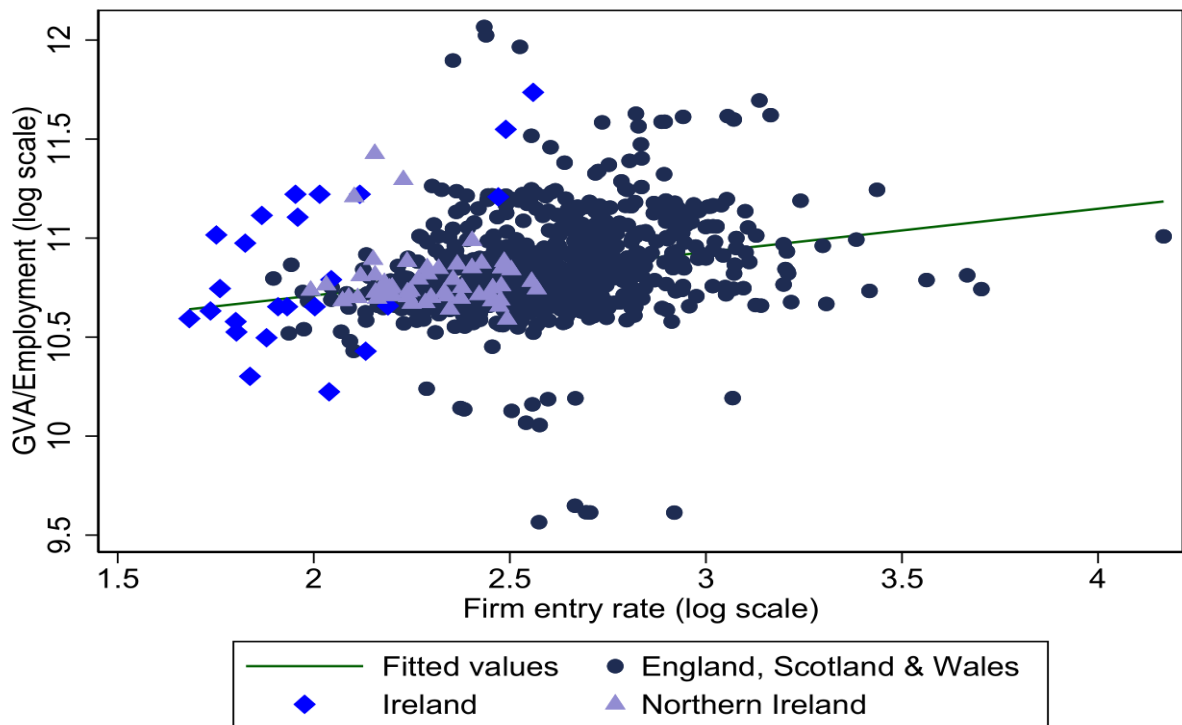
Source: Author calculations from ONS, NISRA and CSO data

FIGURE 15: CORRELATION BETWEEN GVA PER EMPLOYMENT AND FDI SHARE



Source: Author calculations from ONS, NISRA and DBEI data

FIGURE 16: CORRELATION BETWEEN GVA PER EMPLOYMENT AND ENTRY RATE OF NEW FIRMS



Source: Author calculations from ONS, NISRA, CSO and CRO data

TABLE 2: SUMMARY OF CORRELATIONS BETWEEN GVA/EMPLOYMENT AND REGIONAL CHARACTERISTICS

Broadband	0.1145*
FDI	0.3414*
Entry rate	0.2253*
V small firm share	0.0669
Small firm share	0.0406
Medium share	0.1305*
Large share	0.2009*
% degree	0.5191*
% mid-education	-0.4975*
Major roads	0.1417*
Agriculture share	-0.2721*
Manufacturing share	-0.3594*

*Pairwise correlations across all regions, * indicates significance at 1% level*

Table 2 summarises the slopes of the factors graphed in this sector, showing the strength of their individual relationships with GVA per person employed. The table also includes the correlations of the firm size structure (which is not graphed due to the number of categories). These show that the share of medium and large firms in a region are positively related to productivity. Table 2 also shows most of the relationships we looked at in this section are statistically different from zero when looked at in isolation. The next subsection incorporates all of the factors into an econometric framework to investigate if these relationships continue to hold when all of the factors are examined simultaneously.

4.2 ECONOMETRIC ESTIMATIONS

Our key variable of interest in this report is regional productivity, measured as gross value added per person employed in each region. Our econometric specification examines the relationship this has with all of the potential explanatory factors described earlier and controlling for changes over time by including year effects. The regressions are estimated using ordinary least squares (OLS) so most of the coefficients on continuous variables can be interpreted as elasticities. It should be emphasised that the results are evidence of correlation between the variables in question but that the time span of data is not long enough for causation to be established. This is particularly the case in relationships where causation might run in either direction: with education level for example, high productivity regions might attract migration of workers with higher levels of education as well as education contributing to the higher productivity level. A further caveat is that the regions are treated as independent units whereas there could be spillover effects, especially coming from commuting patterns, between regions.

The results are presented in Table 3. The first important point to make is in terms of the overall performance of the model. The share of variation across regions in productivity performance accounted for by the model is represented by the R-squared statistic. The data available on explanatory factors are found to explain 41 per cent of the differences across regions in productivity performance. The link between the model's estimated productivity and the level observed in the actual data is shown in Figure 17. While this is a considerable share of variation being explained by a relatively small number of factors, it clearly leaves much unexplained.

TABLE 3: ESTIMATED DETERMINANTS OF REGIONAL PRODUCTIVITY ACROSS IRELAND, NORTHERN IRELAND, ENGLAND, SCOTLAND AND WALES

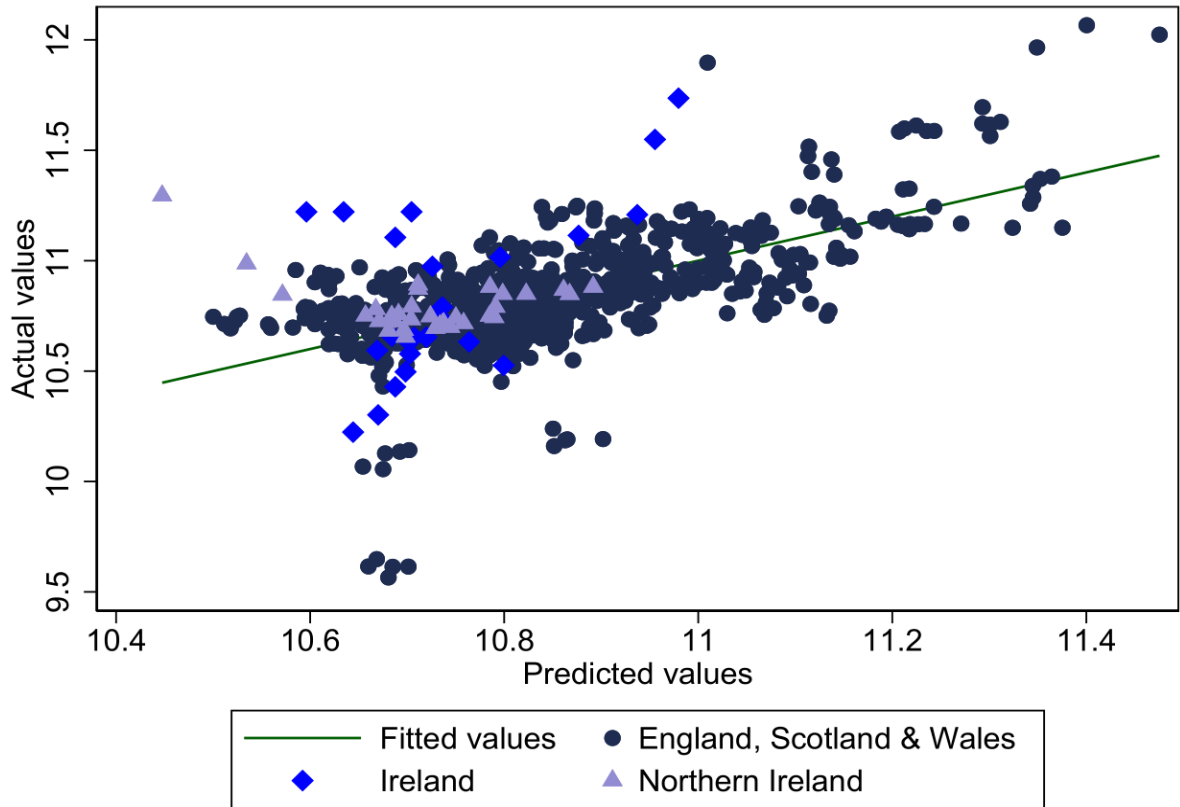
	Effect on GVA/employment	Significance
Degree	0.74	1%
Mid-education	-0.29	N.S.
Major roads	0.37	10%
Broadband	0.82	1%
Broadband squared	-0.70	1%
Agriculture share	-1.73	1%
Manufacturing share	-0.50	1%
FDI employment share	0.71	1%
Firm entry	0.31	10%
Very small firm share	1.35	N.S.
Small firm share	-2.84	N.S.
Medium firm share	10.83	1%
Large firm share	-24.31	1%
	Observations 865	
	R-squared 0.41	

Note: N.S. indicates that the result is not statistically significant.

Figure 18 shows how well the model performs in predicting the regional productivity of each of the regions in Ireland and Northern Ireland. This shows a close relationship between the estimated and actual values for most regions in Northern Ireland but significant gaps in explaining the performance of several Irish regions. Actual productivity in Dublin, in particular, being considerably higher than the model inputs can explain pointing to some important, possibly unmeasurable, factors being omitted. It also shows some regions, such as the West and Mid-West, performing better than would be anticipated from observation of the underlying factors we include in this framework. One element that may drive the better performance of some regions is greater specialisation in particularly high-productivity activities (such as pharmaceuticals or medical devices) which the

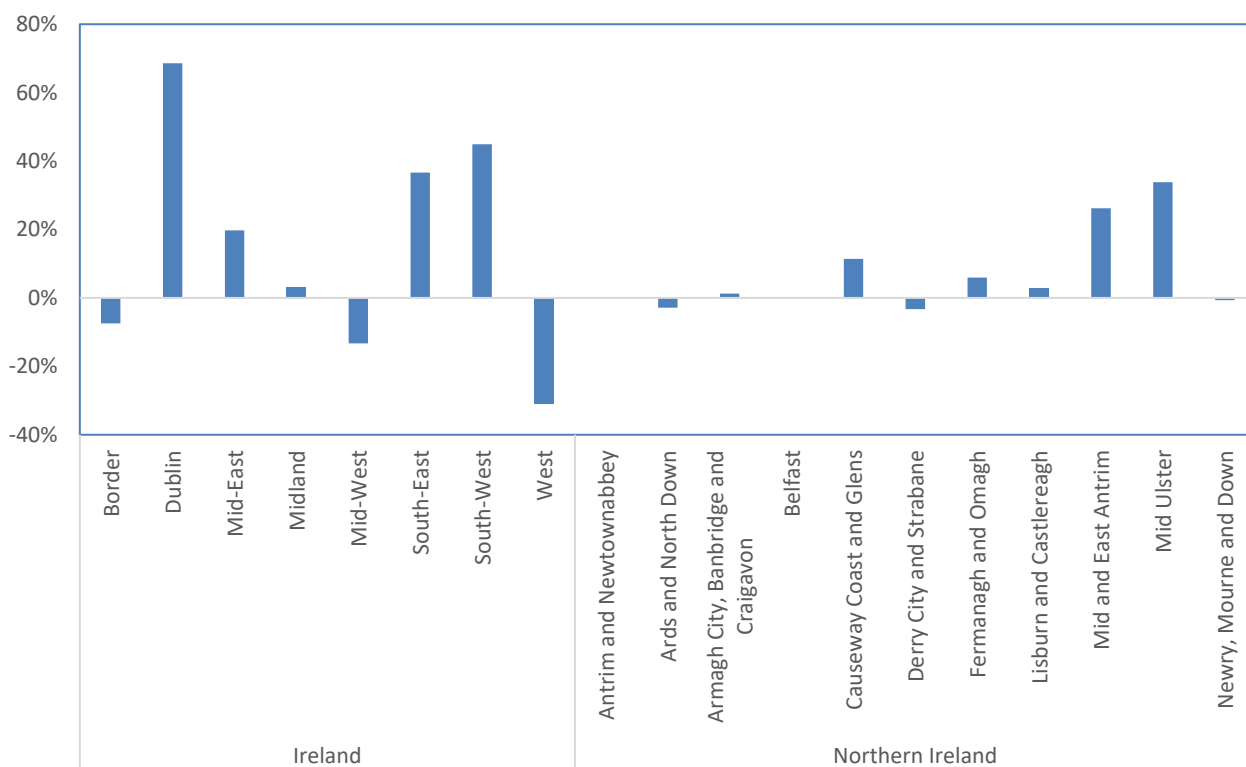
average relationship between manufacturing share and regional performance is not capturing.

FIGURE 17: CORRELATION BETWEEN GVA PER EMPLOYMENT VALUES AND MODEL PREDICTIONS



Source: Author calculations using data and estimations as above.

FIGURE 18: DIFFERENCE BETWEEN ACTUAL PRODUCTIVITY AND MODEL PREDICTION



Source: Author calculations using data and estimations as above.

The results in Table 3 validate the expectation that educational attainment is an important factor behind cross-regional productivity differentials. This shows a strong statistically significant link with a 1 percentage point increase in the share of population with a third-level degree contributing 0.74 per cent to regional productivity. The education effect is concentrated in third-level attainment with completion of secondary level schooling displaying no statistically significant difference in terms of its effect on productivity relative to no qualifications.

The road network infrastructure has a positive, albeit significant only at the 10 per cent level, effect on productivity. Alternative specifications found no impact from motorways over that of national routes/A-roads. The effect of broadband infrastructure was found to be non-linear with a positive direct effect but the strength of the effect declines as broadband infrastructure becomes more prevalent – in other words, there is considerable benefit to increasing broadband access in regions with low starting levels but the returns to increasing access at higher levels become progressively smaller. This may underestimate the effect somewhat as broadband infrastructure may also be a factor influencing other variables that impact positively on regional productivity such as the extent of FDI and the size of the services sector. Previous research linking broadband

infrastructure to firm start-up rates found that the effect of broadband depended to some extent on the presence of other factors such as levels of human capital (McCoy, Lyons, Morgenroth, Palcic and Allen, 2018)

As indicated by the raw correlations, productivity is higher in regions with a larger share of GVA generated by the services sector (the reference category against which the agriculture share and the manufacturing share in the table are compared to). A high agricultural share of GVA has a particularly large negative association with overall regional productivity. The presence of FDI similarly has a large and statistically significant effect on regional productivity. The comparison of the model predictions and actual GVA per person employed shown in Figure 18 suggests that this effect may be understated given the sizeable unexplained gap in Dublin and the two Southern regions of Ireland. This is possibly due to the use of employment share to measure the presence of FDI which may be understating the contribution of FDI to gross value added. This would be consistent with CSO figures on the contribution of FDI-dominated sectors contributing close to 40 per cent to aggregate gross value added when FDI companies account for approximately 14 per cent of total employment.⁵

The firm entry rate is statistically significant (although at the marginal 10 per cent level) with an effect size of 0.31. This indicates that a 1 percentage point increase in the entry rate is associated with a regional productivity performance increase of 0.31 per cent. One limitation of the data is that the entry rate is available only on an overall basis and a deeper investigation into entry by different types of firms would be likely to provide a more nuanced result that would be informative for policy.

Finally, on firm size, there is little evidence of productivity differentials coming from higher shares of small or very small sized firms (compared to the reference group of micro firms). A greater share of medium firms (employing 50 to 249) has a considerable positive effect on regional productivity. There are then declining returns to scale apparent with more very large firms (over 250 employees) actually having a negative relationship with overall GVA per person employed. This differs from the positive basic correlation between the share of larger firms and

⁵ Note that the two numbers are not strictly comparable as the FDI GVA contribution is based on foreign-dominated sectors (<https://www.cso.ie/en/releasesandpublications/er/gvafm/grossvalueaddedforforeign-ownedmultinationalenterprisesandothersectorsannualresultsfor2018/>) whereas the employment contribution is generated from firm-level data (<https://www.cso.ie/en/releasesandpublications/ep/p-fdi/foreigndirectinvestmentinireland2017/ae/>). Regional detail is not available so this point cannot be investigated further in this context.

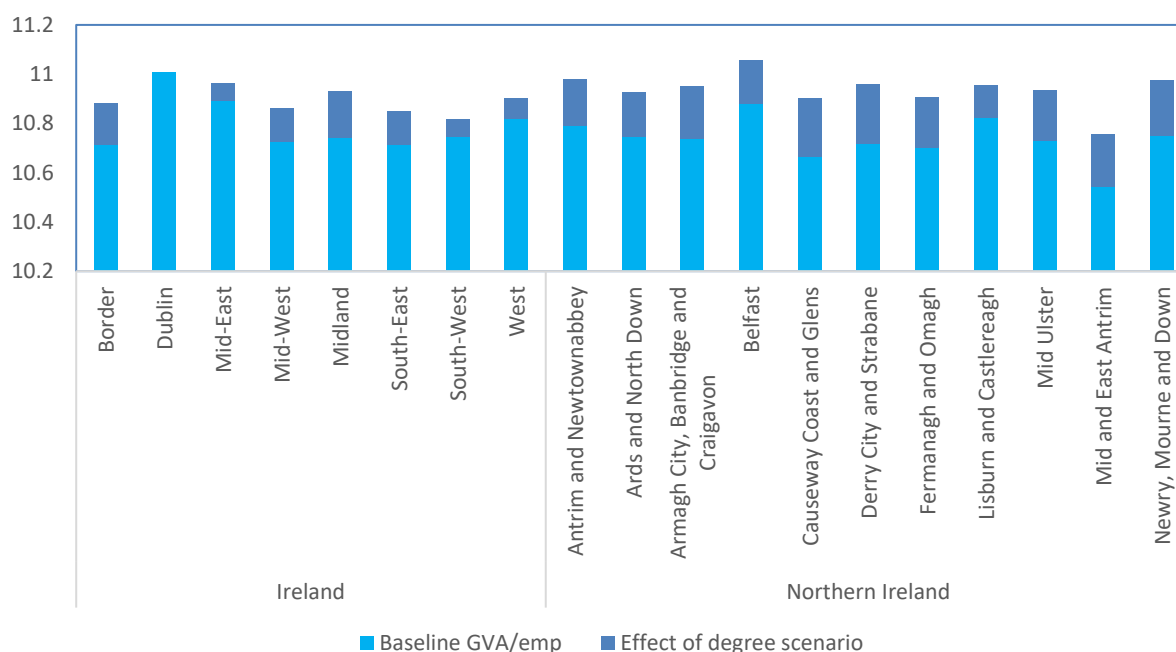
productivity shown in Table 2. This suggests that the positive correlation has been mainly picked up by other factors (including the share of FDI and human capital factors) and the size structure does not add further to productivity once these are controlled for.

4.3 SCENARIOS OF ALTERNATIVE INTERVENTION EFFECTS

To give a clearer picture of the size of the effects estimated above, this section provides some hypothetical scenarios where inputs are adjusted across all regions for some of the key explanatory variables and the magnitude of the effects compared across regions. The approach is to take three of the key factors – education, FDI presence and firm entry rate – and assume that all regions have the same level of that factor as the highest value of all regions on the island. This shift in regional values up to the level of the highest region are then inputted into the fitted model estimated above and regional GVA per person employed recalculated. Each of the graphs for the scenarios below then show the baseline estimated productivity level and the change coming from the scenario.

The first scenario is to increase the educational attainment of all regions to the highest observed across the island (57 per cent in Dublin). The Dublin-level education percentage is then inserted into the estimation equation for regional productivity, holding all other factors constant. Figure 19 shows the impact such a change in education inputs would have on productivity outcomes across all regions. Dublin is unchanged as its value is used as the benchmark. The effects for Northern Ireland are quite substantial, averaging a 20 per cent increase in productivity outcomes. This reflects the relatively low starting point in terms of degree-level qualifications in most Northern Irish regions as described earlier and highlighted in other work such as FitzGerald and Morgenroth (2020). The impacts on regions in Ireland is relatively lower as the change being applied is smaller. Substantial effects are found for the Border and Midlands regions, however, similar to those in Northern Ireland.

FIGURE 19: EFFECT ON REGIONAL PRODUCTIVITY OF INCREASING EDUCATIONAL ATTAINMENT



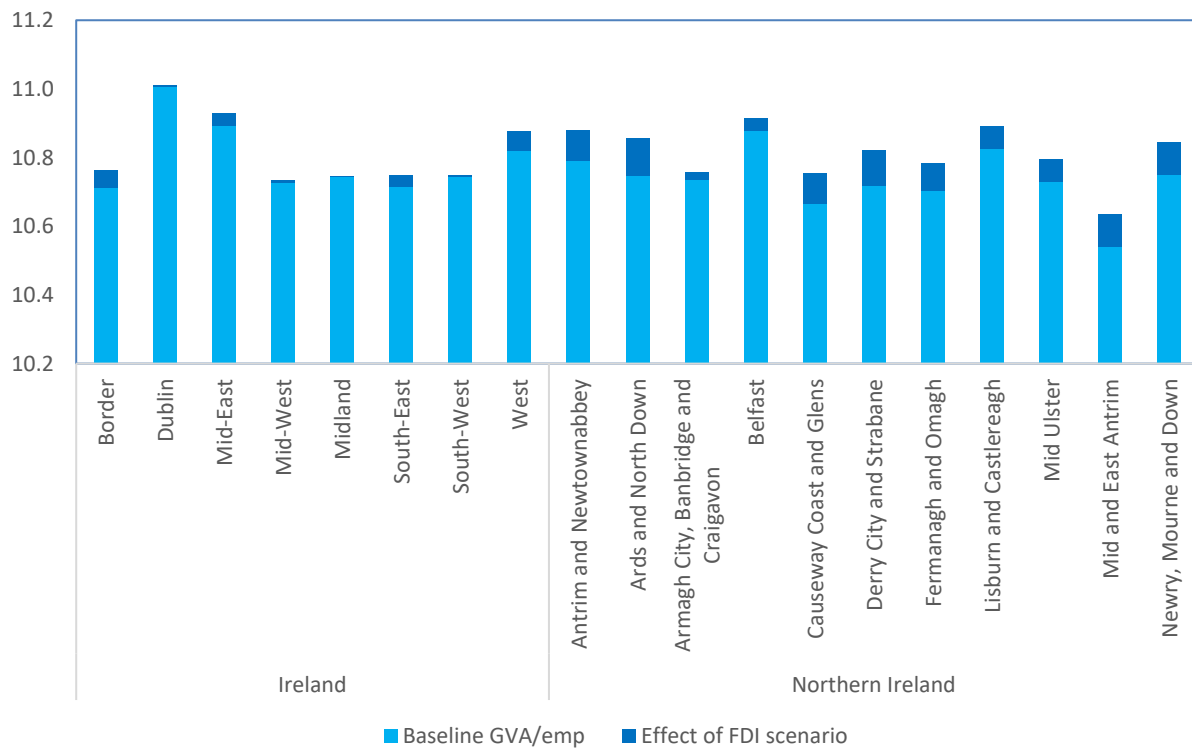
Note: The baseline GVA used in the scenario is that predicted by the regression model.

The second scenario is to increase the FDI presence in all regions to the highest estimated across the island (17 per cent in Midlands and South West).⁶ As the Irish rates of FDI presence are already relatively substantial, the impact of this increase is large only in the Border and West regions. Figure 20 shows that for these two regions a shift to the highest region’s FDI intensity equivalent could increase productivity performance by approximately 5 per cent. For Northern Ireland regions, the impact is more substantial – between 7 and 10 per cent.

The final scenario is to increase the entry rate in all regions to the highest estimated across the island (13 per cent in Newry, Mourne and Down). Figure 21 shows that despite the statistically significant effect of entry rates in the regression model, this scenario increases productivity across regions but by a relatively modest amount compared to the other two scenarios. This largely reflects the small degree of variation in entry rates across regions. The effect of this narrow existing range is that the change being applied to bring all regions up to the rate of the highest entry rate sector is a smaller change to underlying inputs than were the case for the other two scenarios where there was much greater variation in the base levels.

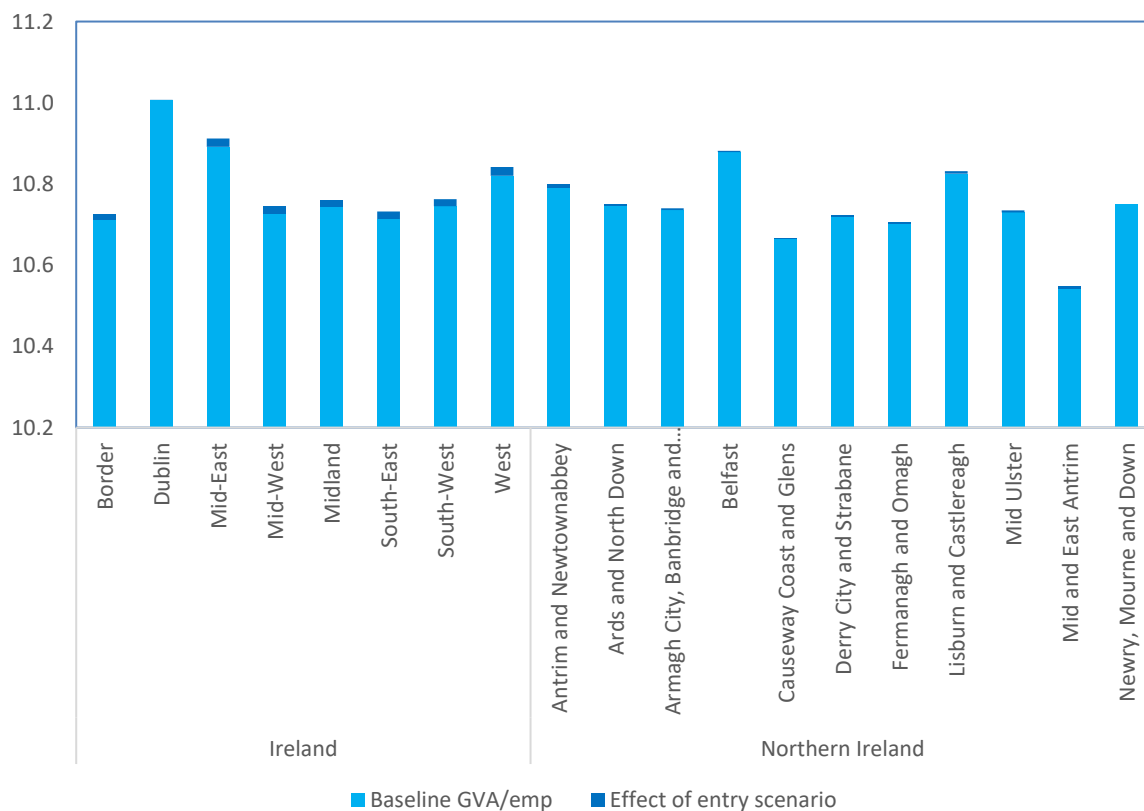
⁶ As a caveat, recall that the employment share may not be entirely reflective of the value-added share.

FIGURE 20: EFFECT ON REGIONAL PRODUCTIVITY OF INCREASING FDI PRESENCE



Note: The baseline GVA used in the scenario is that predicted by the regression model.

FIGURE 21: EFFECT ON REGIONAL PRODUCTIVITY OF INCREASING FIRM ENTRY RATE



Note: The baseline GVA used in the scenario is that predicted by the regression model.

SECTION 5: CONCLUSIONS

This report examines some of the potential drivers of variation in productivity between sub-regions in both Northern Ireland and Ireland, using additional data from the rest of the UK in the econometric analysis to help identify relationships as accurately as possible. The patterns and statistics presented in this report are intended to provide a better understanding of regional productivity across the island of Ireland at the most granular level available.

The existing literature suggests that key drivers of regional productivity differentials come from differences in skills, innovation, entrepreneurship, investment and competition. Not all of these factors have readily available data at the regional level so this report uses the best measured proxies for skills (education level) and investment in physical infrastructure (roads and broadband) as well as controlling for a range of sectoral characteristics, firm size distribution and the presence of multinational activity. In relation to the importance of entrepreneurship, this report uses the rate of new business start-up to examine if business dynamism can be a potential factor in the performance of regional productivity.

As noted in the report, the level of regional granularity used is much more detailed than in previous work which has generally compared Ireland and Northern Ireland at an aggregate level or compared Northern Ireland to other large UK regions. However, the detailed geographic level comes with some trade-offs as variables such as spending on research and development or innovation activity are only available at country level. Other factors are not measured at a comparable level even at country level, such as the potential role played by managerial capacity or risk attitudes and the limitations as to what can be included in a statistical analysis need to be borne in mind when interpreting the results.

We define productivity as gross value added (GVA) divided by employment for each region. At an aggregate level, the average GVA per person employed in Ireland was slightly over €60,000 compared to €48,600 in Northern Ireland in 2014, a productivity gap of close to 25 per cent. At a regional level, we find notably greater variance in regional productivity in Ireland compared to Northern Ireland. The share of variation in productivity performance across regions accounted for by the econometric model estimated in this report is approximately 41 per cent of the total variation. Comparing predictions from the model to actual regional productivity shows a close relationship for most regions in Northern Ireland. However, it leaves much more unexplained in terms of explaining the performance of several Irish regions, with Dublin productivity levels in particular being higher than the model inputs can account for.

Educational attainment is found to be an important factor behind cross-regional productivity differentials. To examine the returns to increasing educational attainment across regions, we use the model to simulate some hypothetical scenarios. The first of these is to increase the educational attainment of all regions to the level of the highest performing region. The effects of this scenario for Northern Ireland are quite substantial, averaging a 20 per cent increase in productivity outcomes. In Ireland, large effects are found for the Border and Midlands regions, with smaller effects in other regions due to their already higher educational attainment levels. This provides further evidence that a gap in educational attainment plays a key role in explaining the relative underperformance of the Northern Irish economy as already noted in recent work by FitzGerald and Morgenroth (2020) and McGuinness and Bergin (2019).

The road network infrastructure was found to have a positive effect on productivity but little additional benefit came from motorways over that of national routes/A-roads. Broadband infrastructure has a strong positive direct effect but the strength of the effect begins to decline as coverage increases. Overall productivity is higher in regions with a larger share of services compared to agriculture or manufacturing.

As expected, the presence of FDI has a large and statistically significant effect on regional productivity. The second hypothetical scenario investigated is an increase in the FDI presence in all regions to the highest estimated across the island. As the Irish rates of FDI presence are already relatively substantial, the impact of this increase is modest for most regions. A substantial increase in productivity level from a higher FDI presence is however simulated in the Border and West regions. The impact is more substantial for Northern Ireland regions, suggesting a considerable return from policies to attract greater FDI investment across these regions. This scenario approach holds constant all other factors and it is important to bear in mind that there may be overlaps between the factors and hence synergies in the policy interventions. In this example, the link between FDI presence and educational attainment is one of particular relevance. Siedschlag and Koecklin (2019) found that education is a key attractor of FDI and estimated that a 1 per cent increase in the share of employees with tertiary education would increase Northern Ireland's attractiveness as a location for FDI projects by 0.31 per cent.

The firm entry rate is found to be statistically significantly (albeit rather weakly) with overall regional productivity. In a final scenario where the entry rate was increased across all regions, relatively modest productivity improvements were estimated, particularly when compared to the other two scenarios. This mainly reflects the smaller degree of variation in entry rates across regions.

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