# Firm growth and regional factors: evidence from Ireland


## Abstract

Heterogeneity in the performance of firms is well acknowledged in the firm growth literature. Although several studies have linked firm growth heterogeneity to variations in firm characteristics and resources embedded within firms, as well as fluctuations in the business cycle, the role of regional characteristics in explaining these observed differences is yet to be fully explored. This paper explores the role of regional factors measured in terms of market conditions, innovation conditions and human capital embedded in those regions. It contributes to existing knowledge by employing a large scale firm-level panel dataset, the Census of Industrial Production (CIP), which is merged with data on region-specific characteristics. This allows for an analysis of the impact of regional-characteristics on a balanced panel of 1,492 firms over the time period 2008-2012. Quantile regression is used as this allows for the investigation of the entire firm growth distribution. Using this methodology it is possible to identify whether the observed impact of regional factors on firm growth varies along the growth rate distribution. The results show that firm growth is systematically shaped by the firm's location. Specifically, workforce quality, innovation conditions, industry specialisation and market conditions were identified as the key region-specific characteristics that drive the firm growth process. Further evidence is provided that the impact of location on firm growth varies along the conditional growth distribution, with the effect being more pronounced for local units at the lower parts of the growth distribution.



Keywords: firm performance; firm growth; firm location; manufacturing; quantile regression.

JEL Classifications: C21, L25, L60, R32.

## 1 Introduction

Heterogeneity in the performance of firms even within narrowly defined industries (Bartelsman and Doms, 2000) is well acknowledged in the firm growth literature. This has given rise to a large volume of empirical studies investigating the sources of divergence in firm growth. Although several studies (see Coad, 2009; Peric and Vitezic, 2016) have linked firm growth heterogeneity to variations in firm characteristics and resources embedded within firms, as well as fluctuations in the business cycle, the role of regional characteristics in explaining these observed differences is yet to be fully explored (Bogas and Barbosa, 2015).

In analysing firm growth, the business environment, defined in terms of geographical location, matters. The firm's location decision has the potential to foster firm growth since it determines access to markets, labour, as well as specialised knowledge and inputs (Barbosa and Eiriz, 2011). Hence, firms located in certain regions may perform better than others due to some advantage (such as availability of skilled labour, large market, low-cost inputs and high average income) inherent in the location. A study of the interaction between regional characteristics and firm growth is, therefore, necessary to address the following questions: to what extent is there a regional dimension to firm growth? and to what extent is firm heterogeneity explained by region-specific factors? Nevertheless, the role of regional characteristics in explaining the observed variations in firm growth has received scant attention in the firm growth literature till date.

This paper extends and contributes to the firm growth literature in the following ways. First, it considers spatial patterns of firm growth across Irish regions. This allows us to determine whether patterns of firm growth are related to region-specific effects. Second, this study provides empirical evidence on how regional characteristics influence firm growth. This offers insights on why and which regional factors are important in explaining firm growth heterogeneity. Third, it investigates the regional determinants of employment growth using the quantile regression method to analyse an unbalanced panel of manufacturing firms from the Irish Census of Industrial Production over the period 2008-2012. More specifically, the paper explores the role of regional factors measured in terms of market conditions, innovation conditions and human capital embedded in those regions. The use of quantile regression technique, which allows the investigation of the entire firm growth distribution and its dependence on regional determinants, provides knowledge on whether the observed impact of regional factors on firm growth varies along the growth rate distribution.

Ireland provides an interesting context for the analysis of the effect of region-specific factors on firm growth. The remarkable economic growth experienced in Ireland during the 1990s resulted in widening disparities at the regional level (Garnier, 2003). Significant differences in terms of population, employment growth and infrastructure existed between the Eastern core of the country (including Dublin, the capital city) and the Western and North-Western periphery. The classification of the country into two Nomenclature of Territorial Units for Statistics (NUTS2) regions: Southern and Eastern (SE) and Border, Midlands and Western (BMW), and the disaggregation into NUTS3 regions (consisting of eight regions) further widened these differences, with the SE region being relatively more prosperous than the BMW region (Drudy and Collins, 2011). The unsustainable credit-led domestic demand-driven growth experienced in the Irish economy post-2000 gave way to a recession from 2008 onwards (Honohan, 2009). This recent economic downturn has contributed to widening the gap between Irish regions (O'Hara, 2013). Within the regional/ local economy, the impact of a recession is more pronounced in the labour market, as local employers may respond to the resultant contraction in output demand through worker lay-offs and redundancies (Fingleton et al, 2012). Job creation is, therefore, important in engendering economic recovery in poorly performing regions, and in narrowing the gap between the highest and lowest performing regions. This research defines firm growth in terms of employment growth, providing an understanding of how regional factors may drive employment growth during an economic downturn.

Although there is a wide variation in key regional indicators such as unemployment and average income in Ireland, Morgenroth (2007) notes that the extent to which regional disparities are observed is greatly dependent on the selected variables. The gap between the regions with the highest and lowest unemployment rates increased from 3.6 per cent in 2008 to 7.7 per cent in 2012 (CSO 2014a). On the other hand, examination of data on total per capita income in the same period (2008-2012) indicates a convergence across regions with the difference between incomes in the highest and lowest income regions decreasing from 8,043 euro in 2008 to 7,622 euro in 2011(CSO 2014b).

However, this gap begins to widen again from 2012. There is also a divergence in terms of output across regions, with only the Dublin and South-West regions having Gross Value Added (GVA) per capita above the national average between 2008 and 2012 (CSO 2014c). O'Hara (2013) attributes the regional differences and widening disparities in Ireland to the spatial concentration of economic activity in the Dublin and South-West regions. Together, both regions accounted for 52 per cent of industrial GVA and 67 per cent of output generated in the modern sector[1] in 2010. Additionally, 64 per cent of high tech manufacturing jobs were located in the Dublin, South West and Mid-East regions in 2012 (O'Hara, 2013). The observed disparity in economic performance, particularly between the Dublin and South-West regions, and all other regions justify a focus on the regional dimension of firm growth in Ireland.

The growing concern with regional disparities in Ireland is reflected in various government policies implemented till date. These include the National Development Plan (2002-2006), the National Spatial Strategy (2002-2020) aimed at directing investments to the less prosperous regions so as to promote more balanced regional development (White, 2004), and of recent, the Action Plans for Jobs implemented both at the national and regional levels to sustain firm growth and increase economic activity and employment in Irish regions, as well as the National Planning Framework (Ireland 2040 Plan) currently under development. Following on from the above discussion, a study of the determinants of firm growth in Ireland, which takes account of the regional context, provides evidence on how and which regional factors help drive job creation so as to reduce these disparities.

The rest of the paper is structured as follows. Section 2 provides the theoretical background. The data and method employed is described in Section 3. Section 4 presents a discussion of the empirical findings. Section 5 concludes.

## 2 Theoretical Framework

In line with other firm growth studies, the starting point of the analysis in this paper is Gibrat's *Law of Proportionate Effect (*LPE), which states that the growth rate of a firm is independent of its initial size. That is, every firm has an equal opportunity to grow irrespective of their initial size (Gibrat, 1931; Fotopoulous and Giotopoulos, 2010). Thus, firm growth is a random process. The validity of Gibrat's Law (GL) was confirmed in earlier studies (Hart and Prais, 1956, Simon and Bonini, 1958 for UK manufacturing firms) and rejected in more recent studies. Results from some studies favour the growth of large firms (e.g. Singh and Whittington, 1975 for UK manufacturing and service firms; Bentzen et al, 2012 for 2,500 Danish firms). The more recent compelling evidence on GL, however, presents a negative relationship between firm size and growth. This finding, which suggests that small firms grow faster than their larger firm counterparts, has been confirmed across different time periods for many industries, in different country contexts (see Sutton, 1997; Coad, 2009). The seemingly inconclusive evidence on the validity of GL suggests the need to examine other drivers of firm growth such as the firm's internal characteristics and the business environment within which it operates.

Heterogeneity in firm growth has been frequently linked to internal and external factors such as firm size and age, innovation and training activities, and the macroeconomic environment in previous empirical studies (Mazzucato and Parris, 2015; Ipinnaiye et al, 2016). However, location factors such as access to markets, specialised skills and knowledge, infrastructure and labour markets are also critical to success in the firm. Distance from markets may result in higher costs due to, for example, transportation costs, while proximity to research institutes or universities may bring about knowledge spillovers from joint collaboration, which may lead to higher innovative activity or provide firms with access to high skilled workers. Additionally, location in urban centres may promote firm growth due to urbanisation externalities, whereas small firms may have reduced growth opportunities due to higher rents and wages inherent in such areas (Otto and Fornahl, 2009). Thus, regional variations may pose as a potential source of growth disparities in firms. Geographical location is, therefore, another important factor to consider in the firm growth process. Nevertheless, there is still a distinct dearth of research on the effect of geographical location on firm growth. Additionally, the wide dispersion of firm growth rates across firms has been largely overlooked by previous studies (Goedhuys and Sleuwaegen, 2010).

[1] The modern sector includes the following industrial sectors: Chemicals and pharmaceuticals, Computer, electronic, optical and electrical equipment, Reproduction of recorded media and Medical and dental instruments and supplies (CSO, 2014d).

A number of international studies such as Audretsch and Dohse (2007), Barbosa and Eiriz (2011) have considered the effect of geographic location in their firm growth analyses in German technology-based firms and Portuguese manufacturing firms respectively. However, the use of the quantile regression method, which provides a more accurate picture of the dependence between firm growth and regional characteristics, differentiates the current study from the aforementioned studies. Although Reichstein et al (2010) include a regional specialisation growth index to control for the effect of local regional dynamics in their quantile regression estimation of firm growth in Danish firms, the effect of other region-specific factors such as workforce quality and innovation conditions, which can potentially influence firm performance, are not considered in their study. Within the Irish context, studies such as Gleeson et al (2006) and Morgenroth (2008) have examined the effect of spatial specialisation on manufacturing activity within Irish regions over the periods 1985 -2002 and 1972 - 2003 respectively. Analyses in the abovementioned studies are, however, mainly descriptive with the use of indices and correlations. The current research aims to address the gap in the firm growth literature by employing quantile regression methodology to analyse the regional drivers of firm growth during a period of economic crisis in Ireland. This provides insights on the regional factors that influence the dispersion of firm growth rates in manufacturing firms.

### *2.1 Regional Determinants of Firm Growth*

The new economic geography literature, pioneered by Paul Krugman (for example, see Krugman, 1991) highlights the significance of agglomeration economies (i.e. positive externalities) in driving the spatial concentration of economic activity, and consequently economic growth. According to Audretsch and Dohse (2007), the geographical location effect may be related to knowledge externalities and agglomeration economies – that is, benefits external to the firm, but internal to the spatial area within which the firm operates. Thus, the firm's location decision, which can potentially shape its consequent growth, is influenced by perceived agglomeration economies embedded in the location. Firm growth differences may be driven by regional variations in the endowment of resources such as technology, access to raw materials and human capital[2]. Accordingly, divergence in firm performance across regions may stem from two contrasting forces. Agglomeration forces such as scale economies, transportation costs, demand linkages and a large pool of skilled labour may lead to geographical concentration of economic activities - reinforcing disparities between regions (Faggio et al, 2016). On the other hand, dispersion forces such as high rental and wage costs, as well as local competition may disperse economic activity, further widening the gap between regions and between firms located within them.

Based on the theoretical literature and data availability, the region-specific determinants of employment growth considered in this analysis are industry diversity/specialisation, workforce quality and innovation conditions, population density and average income.

#### 2.1.1 Industry diversity/specialisation

Based on the theory of Marshallian externalities, agglomeration effects result from labour market pooling, knowledge spillovers and sharing of inputs within the region (Faggio et al, 2016). Consequently, industry specialisation may promote firm growth. In contrast, the presence of Jacobs' externalities in a region imply that firms benefit more from industry diversity which incentivises firms to develop new ideas - industrial diversity may, thus, promote firm growth. In addition to the positive externalities previously mentioned, there are also negative externalities in concentrated regions which may lower firm growth. These include externalities due to local competition for resources (e.g. human capital, financial support and market demand), as well as technological lock-ins which hinder the rate of generating radical innovation, and subsequently firm growth (Otto and Fornahl, 2009; van Oort and Stam, 2009). Following Barbosa and Eiriz (2011), two measures of industry specialisation are included to capture the effect of geographic concentration of economic activity on firm growth. First, specialisation is investigated using the *Herfindahl-Hirschman index* (HHI). Sectoral HHI is defined as

[2] Barney (1991) identifies three categories of firm resources: physical capital resources including technology, firm plant and equipment, its geographic location and access to raw materials; human capital resources including training, experience and insight of individual managers and workers in the firm; organisational capital resources which include formal reporting structure, informal relations among groups within a firm and between a firm and those in its environment.

the ratio between the regional employment share for the industry and total employment in the region (Gleeson et al, 2006). The higher the value of the index, the greater is the degree of concentration of employment within an industry sector in the region. The second measure of specialisation employed is the *Location Quotient*, which assesses the intensity of agglomeration economies within the region. The interpretation of this variable is similar to the HHI and has been suggested as a better measure of industry specialisation due to excluding internal economies and capturing Marshallian economies only (Barbosa and Eiriz, 2011).[3] Based on the above, it is assumed:

H1: Growth is likely to be higher among firms located in regions with a high degree of industry specialisation.

### 2.1.2 Workforce quality

Human capital is a driver of overall economic growth, while it represents a vital asset and source of competitive advantage at the firm-level (Penrose, 1959; del Valle and Castillo, 2009). As previously indicated, spatial concentration of firms within the same industry promotes knowledge spillover between firms, which stimulates innovation and economic growth. However, the extent to which a firm is able to appropriate these spillovers is largely determined by the human capital embedded in the firm. Higher educational qualifications enable workers to create knowledge and be better positioned to utilise knowledge spillovers from other firms. Therefore, firms located in regions with higher endowments of human capital have access to better knowledge resources, and thus perform better relative to competitors in less endowed regions (Audretsch and Dohse, 2007). To test workforce quality, two variables are employed: *College Education*, the proportion of working age population with third-level college degree in the region, and *Workforce Qualifications*, the proportion of working age population with an educational qualification.[4] The latter assesses the effect of regional skill diversity, while the former captures the impact of a regional concentration of skills on firm growth. Due to a lack of regional data on the educational qualifications of employees, workforce quality variables are measured in relation to the working age population - the latter provides an indication of the number of potential workers in the economy. Following on from this it is assumed:

H2: Growth is likely to be higher among firms located in regions with high endowments of human capital.

### 2.1.3 Innovation conditions

Previous studies have shown that innovation is important for firm growth. Firm-level investments in new technology and/or processes confer competitive advantage on firms particularly in highly competitive industries (Cleff et al, 2005; Barbosa et al, 2013). Firms may, however, benefit not only from individual investments in innovative activities, but also from externalities accruing from the R&D investments of other firms in the region. To assess the region's potential to create knowledge, generate innovation and consequently, foster firm growth two variables, *R&D Intensity and PhD researchers* are included*.* These capture the effects of the region's share of R&D expenditure and PhD qualified researchers on employment growth respectively. An alternate measure *Research workers,* which assesses the effect of a regional concentration of researchers on firm growth is also considered. It is expected that regional innovation conditions will have a positive effect on firm growth.[5] Hence, it is assumed:

H3: Growth is likely to be higher among firms located in regions characterised by high levels of innovative activity.

### 2.1.4 Population density

In addition to agglomeration economies, another factor considered by firms in the location decision is factor costs (.e.g. land, labour and capital). Thus, *Population Density* is included in the analysis as an

[3] For a detailed discussion on the merits of the location quotient as a measure of industry specialisation, the interested reader should refer to Figueiredo et al (2009).
[4] Qualified employees are defined, according to the CSO 2006 census data, as employees who have technical/vocational, non-degree, primary degree, professional qualification (degree status at least), post-graduate certificate or diploma, post-graduate degree (Masters) and PhD qualifications or who have completed primary and secondary school education.
[5] All innovation variables are available only at the NUTS2 regional level.

approximate proxy for industrial land costs. Guimarães et al (2000) argue that the above variable should reflect land costs due to competition between residential and industrial land use. Moreover, firms located in densely populated areas may experience lower growth due to higher costs (e.g. rent, taxes and wages) inherent in such areas (Otto and Fornahl, 2009). Alternatively, population density may also be an indication of urbanisation economies. Firms located in areas with high population density may benefit from access to a wider range of resources such as capital, labour, infrastructure and services (Guimarães et al, 2000 and Otto and Fornahl, 2009). Thus, such firms may enjoy higher growth relative to firms in sparsely populated areas. Thus, it is assumed:

H4: Growth is likely to be higher among firms located in sparsely populated regions.

#### 2.1.5 Average income

To capture the effect of potential regional market demand, the variable, *Average income,* defined as log total income per capita is included. Per capita income is frequently used as an indicator of the overall standard of living in an economy. Thus, high per capita incomes suggest higher standards of living, which could translate into a higher demand for goods and services in the economy. It is expected that firms located in regions with higher average incomes should have higher employment growth. Therefore, it is assumed:

H5: Growth is likely to be higher among firms located in regions characterised by high average incomes.

#### 2.1.6 Urbanisation economies

As previously highlighted, there is a spatial concentration of economic activity in the Dublin and South-West regions in Ireland. Due to uncertainty associated with new investments, firms are often attracted to highly urbanised locations to minimise risk (Guimarães et al, 2000). Consequently, two dummy variables, *Dublin* and *South-West* are included in the growth analysis to account for unobserved urbanisation economies that may be embedded in the Dublin and South-West regions. It is assumed:

H6: Growth is likely to be higher among firms located in the Dublin and South-West region respectively.

## 3 Data and Methodology

This section details the firm growth model, along with the dataset and variables employed in this analysis.

### *3.1 Model Specification*

To investigate the region-specific drivers of firm growth, the following model is estimated:

$$\Delta \ln(S)_i = \beta_0 + \beta_1 \ln(S)_{i,t-1} + \beta_2 \ln(S_{i,t-1})^2 + \beta_3 X_{i,t} + \varepsilon_{i,t}$$

where $\Delta \ln(S)_i$ is employment growth of firm *i* at time *t*, $\ln(S)_{i,t-1}$ is log of firm size in the previous period and $X_{i,t}$ is a vector of explanatory variables consisting of region-specific variables.

As previously discussed, the link between region-specific characteristics and firm growth is driven by agglomeration economies resulting from the availability of specialised skills and knowledge spillovers in the location. Nonetheless, the firm's ability to benefit from these spillovers is also largely dependent on its absorptive capacity, which itself may be moderated by firm-specific characteristics such as size. Due to their size and having higher absorptive capacity, large firms may derive more advantages from the geographic concentration of industry relative to smaller firms (Barrios et al, 2006). On the other hand, local competition for resources resulting from industry localisation may be more pronounced in small firms than in larger firms, as the former is commonly prone to financial constraints (Lai et al, 2016). Hence, the effect of location on firm growth may vary along the

conditional distribution of firm growth rates. Consequently, a quantile regression approach is adopted in this study to investigate the relationship between firm growth and its regional drivers. In contrast to the average effect observed with the ordinary least squares (OLS) approach, quantile regression provides information on possible differences in the effects of region-specific factors at various points of the distribution of firm growth rates (Reichstein et al, 2010). By employing the quantile regression method, which provides a more comprehensive picture of the firm growth process, and the OLS estimation, which focuses on the mean growth rate, it is possible to answer the following question: do region-specific factors influence firm growth differently for slow growing or fast growing firms than for average growth firms?

### *3.2 Data*

This study employs data from the Census of Industrial Production (CIP) obtained from the Irish Central Statistics Office (CSO). The CIP is an annual census of all manufacturing firms in Ireland with three or more persons engaged. It consists of two surveys, the Census of Industrial Production and the Census of Local Units (CLU). [6] Given that the central focus of this research is to investigate the impact of region-specific characteristics on firm growth, analysis is based on data from the CLU. The CLU dataset provides some distinctive features. First, it provides complete coverage of all manufacturing local units including small local units (< 50 employees), more specifically micro-sized local units, with fewer than ten employees. The latter represent 57 per cent of all enterprises in the CIP (CSO, 2014e), and 83 per cent of all active manufacturing firms in Ireland in 2012.[7] Second, it provides information on local units operated by the same enterprise across several locations, thus offering a more accurate representation of enterprise activity at the regional level. Third, the dataset is maintained with unique firm identifiers that allow firms/ local units to be tracked across years. The availability of multiple observations on each firm/local unit across years mean variations in firm size from the initial size at the beginning of the period can be observed. This allows the tracking of firm growth across the regions.

Within the larger dataset, focus is on 6,913 manufacturing local units in NACE sectors 10-33 over the period 2008 -2012. After data cleaning - which included dropping local units with less than two years of observations, local units with non-consecutive observations, local units with missing employment data which could not be imputed and local units with zero employees – there is an unbalanced panel of 4,582 local units. There are 1,492 local units observed in 2008, while in 2012, this number increased to 3,266. The geographical unit of analysis employed in this study is the NUTS3 statistical regions consisting of 8 regions (Border, Dublin, Mid-East, Midland, Mid-West, South-East, South-West and West), which allows the study of the interactions between region-specific determinants and firm growth at a more disaggregated level of analysis than the NUTS2 statistical regions.

### *3.3 Summary Statistics*

Table 1, which presents the number of local units, number of employees and employment growth rates, reveals considerable differences across the eight regions in 2008. The Dublin and South-West regions had the highest concentration of local units, together accounting for about 35 per cent of the total number of units in the sample in 2008. Plant size also varies across regions - local units in the Mid-West region have an average size of 110 employees, double the average size of 55 employees found for local units in the Border region. In terms of employment growth, the South-West experienced the highest mean growth rate, followed by the Border and South-East regions, the Mid-West and Dublin showed the lowest average growth rates.

6 The CSO (2014e: p3) defines an enterprise as "…the smallest combination of legal units that is an organisational unit producing goods or services …", and a local unit as "… an enterprise or part thereof (e.g. a workshop, factory, warehouse, office, mine or depot) situated in a geographically identified place".

7 The latter figure is based on the author's calculations using Business Demography data from the CSO database direct.

**Table 1.** Number of local units, employees and employment growth by region, 2008

| | Number of local units | Number of employees | Employment growth[a] |
|---|---|---|---|
| **Border** | 209 | 55.8 | 45.3 |
| **Dublin** | 304 | 62.7 | 36.4 |
| **Mid-East** | 157 | 86.4 | 41.9 |
| **Midland** | 106 | 61.0 | 38.7 |
| **Mid-West** | 134 | 110.9 | 32.2 |
| **South-East** | 213 | 74 | 44.5 |
| **South-West** | 218 | 84.6 | 46.3 |
| **West** | 151 | 92.6 | 43.8 |
| **Total** | 1492 | 76.3 | 41.4 |

Source: Author's calculations from CIP dataset, 2008-2012

[a] Employment growth from 2008- 2009 expressed in percentages.

Based on the European Commission (2003) definitions, local units are classified as micro-sized (<10 employees), small (10-49 employees), medium-sized (50-249 employees) and large (250 employees). Table 2, which provides a regional breakdown of the sample by size class, reveals a skewed size distribution, with many more micro-sized and small units than medium-sized and large units. The largest concentration of small and medium-sized local units (i.e. with 249 or less persons employed) is in the Dublin region (21 per cent), while 19 per cent of the total number of large units in the sample is located in the South-West region.

**Table 2.** Regional distribution of local units by size class, 2008

| | Micro (<10 employees) | Small (10-49 employees) | Medium (50-249 employees) | Large (>250 employees) |
|---|---|---|---|---|
| **Border** | 74 | 72 | 53 | 10 |
| **Dublin** | 98 | 124 | 69 | 13 |
| **Mid-East** | 53 | 57 | 36 | 11 |
| **Midland** | 35 | 40 | 26 | 5 |
| **Mid-West** | 37 | 44 | 35 | 18 |
| **South-East** | 82 | 71 | 45 | 15 |
| **South-West** | 79 | 65 | 55 | 19 |
| **West** | 59 | 50 | 31 | 11 |
| **Total** | 517 | 523 | 350 | 102 |

Source: Author's calculations from CIP dataset, 2008-2012

The means and standard deviations of the variables to be analysed along with the variable definitions and data source are outlined in Table 3. In estimating the growth equation, all variables, with the exception of the dummy variables, were expressed in natural logs. Overall, the variables show significant variability, which suggests that employment growth and region-specific characteristics vary considerably across the regions.

**Table 3.** Description of variables, data source, means and standard deviations

| Variable | Definition | Data Source[a] | Mean | Standard Deviation |
|---|---|---|---|---|
| Employment growth | Logarithm difference of employment in consecutive years | Census of local units, 2008-2012 | 0.039 | 0.403 |
| Log employment$_{t-1}$ | Logarithm of employment in previous period | Census of local units, 2008-2012 | 2.811 | 1.350 |
| Industry | 2-digit Nace Rev. 2 classification (10-33) | Census of local units, 2008-2012 | | |
| Dublin | 1 if firm is located in the Dublin region; 0 = otherwise | Census of local units, 2008-2012 | 0.201 | 0.401 |
| South-West | 1 if firm is located in the South-West region, 0 = otherwise | Census of local units, 2008-2012 | 0.149 | 0.356 |
| Location quotient | Ratio of firms' share in industry and region (number of firms in an industry and region divided by the total number of firms in industry) to employment share in region (employment in region divided by total employment); year: 2008-2012 | Census of local units, 2008-2012 | 0.586 | 0.473 |
| Herfindahl-Hirschman index | Sum of squares of regional employment share for the industry and total employment in the region; 2008-2012 | Census of local units, 2008-2012 | 21.376 | 24.676 |
| R&D intensity | Ratio of R&D expenditure at the region to industrial output in the region; 2006 | Business Expenditure on R&D region, 2009, Innovation in Irish Enterprises | | |
| PhD researchers | Ratio of PhD qualified researchers in region to total working age population in region; 2006 | Business Expenditure on R&D by region, 2009, Innovation in Irish Enterprises | 0.002 | 0.001 |
| Research workers | Ratio of researchers in region to total working age population in region | | | |
| College education | Ratio of working age population in region with third level degree to total working age population in region | Census of Population, 2006 | 0.149 | 0.036 |
| Workforce qualifications | Ratio of working age population in region with qualifications to total working age population in region | Census of Population, 2006 | | |
| Average income | Log of total per capita income | County incomes and regional accounts, 2008, National Accounts | 10.229 | 0.098 |
| Population density | Log of persons per sq. km | Census of population, 2006 | 4.556 | 1.381 |

Source: Author's calculations from CIP dataset, 2008-2012
Note: [a]With the exception of microdata from the census of local units, all data are collected from the CSO Statbank.

## 4 Discussion of Results

Table 4 presents the results from the estimation of the impact of location on firm growth. OLS estimates are detailed in column 1, whilst columns 2 to 5 present quantile regression estimates for the 10th, 25th, 75th and 90th quantiles respectively. Overall, the OLS and quantile regression results support most of the hypotheses stated in section 2, thus confirming the importance of regional factors for firm growth. Additionally, the signs on the OLS and quantile estimates are identical. Therefore, discussion is based on the quantile regression results. All region-specific variables, except *location quotient* are statistically significant in explaining firm growth. The magnitude of the location effect also varies greatly along the growth rate distribution, with the effect being more pronounced at the lower ends of the firm growth distribution. Specifically, consistent with the literature (e.g. Mazzucato and Parris, 2015), the coefficient for initial firm size is negative and increases steadily as we move from the lower to upper quantiles along the conditional growth distribution. This implies that smaller firms grow faster and this size effect is stronger for fast growing firms. Thus, Gibrat's Law is not valid in the sample when location factors are considered. Similarly, Lotti et al (2003) in their study of Italian manufacturing firms find that small firms show higher growth rates relative to their larger firm counterparts, and this finding is consistent across the 10th, 25th, 50th, 75th and 90th quantiles. Additionally, the negative size-growth effect is non-linear as indicated by the positive statistically significant coefficient on the squared size term.

**Table 4.** Regression estimates of the impact of region-specific characteristics on firm growth

| | *Employment growth* | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| | OLS | q10 | q25 | q75 | q90 |
| Log employment$_{t-1}$ | -0.476*** | -0.100*** | -0.072*** | -0.534*** | -0.853*** |
| | (0.019) | (0.016) | (0.006) | (0.022) | (0.030) |
| (Log employment$_{t-1}$)$^2$ | 0.059*** | 0.014*** | 0.009*** | 0.069*** | 0.109*** |
| | (0.003) | (0.002) | (0.001) | (0.003) | (0.005) |
| Dublin | 0.550*** | 0.600*** | 0.261*** | 0.145* | 0.155 |
| | (0.133) | (0.232) | (0.068) | (0.081) | (0.196) |
| Southwest | 0.157*** | 0.156*** | 0.093*** | 0.052*** | 0.030 |
| | (0.024) | (0.048) | (0.015) | (0.014) | (0.034) |
| Location Quotient | 0.003 | 0.007 | 0.003 | -0.002 | -0.001 |
| | (0.003) | (0.006) | (0.002) | (0.002) | (0.004) |
| Herfindahl Index | 0.352*** | 0.340*** | 0.184*** | 0.125*** | 0.128*** |
| | (0.028) | (0.057) | (0.021) | (0.020) | (0.039) |
| R&D intensity | 6.373*** | 6.341*** | 3.541*** | 2.305*** | 1.987*** |
| | (0.531) | (1.069) | (0.407) | (0.372) | (0.731) |
| College education | -0.590*** | -0.447** | -0.262*** | -0.203*** | -0.302** |
| | (0.110) | (0.194) | (0.063) | (0.063) | (0.154) |
| PhD researchers | 0.757*** | 0.785*** | 0.431*** | 0.264*** | 0.208** |
| | (0.065) | (0.131) | (0.050) | (0.045) | (0.088) |
| Average income | 4.229*** | 3.787*** | 2.084*** | 1.568*** | 1.641** |
| | (0.505) | (0.943) | (0.317) | (0.325) | (0.733) |
| Population density | -0.278*** | -0.276*** | -0.125*** | -0.090*** | -0.104 |
| | (0.051) | (0.088) | (0.027) | (0.032) | (0.077) |
| Constant | -11.304*** | -7.360 | -3.865* | -3.832 | -5.647 |
| | (4.072) | (7.033) | (2.073) | (2.347) | (5.829) |
| Observations | 10,630 | 10,630 | 10,630 | 10,630 | 10,630 |
| $R^2$/Pseudo-$R^2$ | 0.261 | 0.045 | 0.033 | 0.109 | 0.331 |
| F-test | 30.96(0.000) | | | | |
| Breusch-Pagan test | 4764 | | | | |

*** Significant at 1%, ** significant at 5%, * significant at 10%.
Note: Values in parentheses are cluster robust standard errors for OLS estimates, and standard errors bootstrapped with 200 replications for the quantile estimates. All estimates include industry dummies.

Industry specialisation has a positive and statistically significant effect on employment growth for firms at all points of the growth distribution. That is, the greater the degree of concentration of firms in an industry in a region, the higher is the growth of firms. This is similar to findings by Otto and Fornahl

(2009) for German firms. The positive concentration effect is larger for firms at the lower end of the distribution, suggesting that slowly growing firms derive more benefits from agglomeration economies arising from regional industry specialisation. In contrast, no statistically significant effect is found for location quotient (alternate measure of industry specialisation) across all quantiles.

In relation to workforce quality, contrary to expectations, the negative coefficient on the *College education* variable implies that the higher the concentration of highly educated workers (college degree level) in a region, the lower the growth of firms in that region. This is similar to findings by Barbosa and Eiriz (2011) for Portuguese manufacturing firms. The effect is highest for local units at the lower ($10^{th}$ quantile) and upper ($90^{th}$ quantile) tails of the distribution. Thus, employment growth in slowly growing and fast growing firms is more sensitive to a high regional share of college educated workers. Workers with high levels of education often command a wage premium, with resultant cost implications for firms. Thus, firms may employ fewer workers because of higher costs associated with employing college-educated workers. Due to being highly correlated with the *college education variable*, the *workforce qualification* variable was entered separately into the growth equation. Interestingly, a positive effect which also varies along the growth distribution was found. [8] This implies that firms benefit from being located in regions with a diversity of workforce qualifications. Again, the effect of workforce qualifications was stronger for slowly growing units, followed by fast growing local units. Taken together, the above findings suggest that firms derive greater benefit from a regional diversity of workforce qualifications (skills) than from a regional specialisation of skills.

As expected, the coefficients on both measures of innovation conditions (i.e. regional R&D intensity and regional share of PhD researchers) were positive and decreasing, moving from the lower to the upper quantiles along the growth distribution. Thus, slowly growing units located in regions with high amounts of R&D spending and a large proportion of researchers in the workforce show higher growth rates relative to fast growing units. A different measure of innovation (the regional share of researchers in the workforce) entered alternatively into the growth equation was also found to have a positive effect on employment growth.[9] Similar to the results found with the regional share of PhD workers variable, the positive innovation effect was higher for slowly growing units.

Location in a region with high average incomes has a positive effect on employment growth as evidenced by the positive and statistically significant coefficient on *Average Income*. This suggests that the higher potential market demand implied by high average incomes in such locations encourage firms to employ more workers. The returns to employment growth from locating in regions with high average incomes is, however, higher for slowly growing units.

In line with *a priori* expectations, the coefficient of *population density* is negative, similar to findings for other studies such as Otto and Fornahl (2009). Consequently, employment growth is lower for firms located in densely populated regions. This suggests that the *population density* indicator reflects high costs which may constrain firms to employ fewer workers. A statistically significant effect is, however, not found for firms in the $90^{th}$ quantile - thus employment growth in fast growing firms is not sensitive to the higher costs implied by locating in densely populated regions.

Location in the Dublin and South–West regions, as expected, fosters employment growth. The coefficients of both dummy variables are positive and statistically significant. This suggests that local units located in the Dublin and South-west regions perform better than local units in other regions in Ireland - evidence that unobserved urbanisation economies may be at play here. The presence of well-developed infrastructure, professional services and existing firms in similar industries make these regions attractive locations for firms. Indeed, a number of multinationals such as Apple, Yahoo and Pfizer have located their European headquarters in these regions. The South-West region serves as a hub for technology, life sciences and business services operations, while the Dublin region is also host to clusters of firms in the technology and financial services industries (IDA Ireland, 2016).

The robustness of the above findings is assessed as follows: First, analysis is restricted to a sample of small and medium-sized local units. Second, the analysis is repeated across sub-samples

[8] Results from this estimation are available on request from the author.

[9] Results from this estimation are available on request from the author.

of local units classified by technology intensity (i.e. high-tech *versus* low-tech).[10] Estimation results for the small and medium-sized local units are presented in Table 5. Similar to the previous findings, the limiting effect of firm size on employment growth is larger for units at the upper parts of the growth distribution. Notably, fast growing local units at the 75th and 90th quantiles are not sensitive to location in Dublin, while location in the South-West regions has no significant effect on employment growth for firms in the 90th quantile only. In contrast to the previous result observed for the overall sample *Location Quotient* which has no effect on employment growth of the average firm, based on the OLS results, has a weak positive effect on local units in the lower tail of the growth distribution only (10th quantile), suggesting that slowly growing firms benefit from both external and internal economies derived from industry specialisation. The negative effect of locating in regions that are densely populated with a high degree of skills specialisation is absent for fast growing units in the 90th quantile of the distribution. The growth-enhancing effect of location in regions with high average income is also missing for units in the 90th quantile. Following on from the above, the effects of regional factors are weaker for fast growing firms when firm size is taken into account.

**Table 5.** Regression estimates of the impact of region-specific characteristics on firm growth in SMEs

| | *Employment growth* | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| | OLS | q10 | q25 | q75 | q90 |
| Log employment$_{t-1}$ | -0.628*** | -0.175*** | -0.116*** | -0.645*** | -1.015*** |
| | (0.022) | (0.024) | (0.009) | (0.020) | (0.027) |
| (Log employment$_{t-1}$)$^2$ | 0.090*** | 0.027*** | 0.017*** | 0.092*** | 0.143*** |
| | (0.004) | (0.004) | (0.001) | (0.003) | (0.004) |
| Dublin | 0.529*** | 0.726*** | 0.249*** | 0.104 | -0.021 |
| | (0.136) | (0.260) | (0.088) | (0.080) | (0.171) |
| Southwest | 0.146*** | 0.171*** | 0.089*** | 0.048*** | -0.001 |
| | (0.025) | (0.047) | (0.018) | (0.015) | (0.032) |
| Location Quotient | 0.003 | 0.011* | 0.003 | -0.001 | -0.003 |
| | (0.003) | (0.006) | (0.002) | (0.002) | (0.004) |
| Herfindahl Index | 0.329*** | 0.342*** | 0.180*** | 0.126*** | 0.126*** |
| | (0.029) | (0.054) | (0.021) | (0.020) | (0.038) |
| R&D intensity | 5.944*** | 6.495*** | 3.477*** | 2.235*** | 2.053*** |
| | (0.548) | (1.046) | (0.410) | (0.384) | (0.790) |
| College education | -0.541*** | -0.518*** | -0.225*** | -0.188*** | -0.098 |
| | (0.113) | (0.199) | (0.076) | (0.065) | (0.156) |
| PhD researcher | 0.709*** | 0.798*** | 0.424*** | 0.257*** | 0.232** |
| | (0.067) | (0.128) | (0.050) | (0.047) | (0.097) |
| Average income | 3.978*** | 4.208*** | 2.006*** | 1.471*** | 0.952 |
| | (0.521) | (0.950) | (0.379) | (0.313) | (0.668) |
| Population density | -0.267*** | -0.320*** | -0.123*** | -0.078** | -0.032 |
| | (0.052) | (0.095) | (0.035) | (0.031) | (0.066) |
| Constant | -10.625** | -10.822 | -3.272 | -3.101 | 2.094 |
| | (4.164) | (6.805) | (2.653) | (2.448) | (5.584) |
| Observations | 10,165 | 10,165 | 10,165 | 10,165 | 10,165 |
| $R^2$/Pseudo $R^2$ | 0.300 | 0.040 | 0.027 | 0.037 | 0.180 |
| F-test | 36.51(0.000) | | | | |
| Breusch-Pagan test | 4188 | | | | |

*** Significant at 1%, ** significant at 5%, * significant at 10%.

Note: Values in parentheses are cluster robust standard errors for OLS estimates, and standard errors bootstrapped with 200 replications for the quantile estimates. All estimates include industry dummies.

Tables 6 and 7 present the results for high-tech and low-tech local units respectively. Overall, the effect of location on firm growth is more important for low-tech units than it is for high-tech units in the sample. In particular, the dampening effect of firm size on growth is absent for slowly growing high-

[10] High-tech local units are defined using the Eurostat (2016) definition based on NACE Rev. 2 2-digit codes, as local units in the following sectors: chemicals and chemical products (20), pharmaceutical products and pharmaceutical preparations (21), computer, electronic and optical products (26), electrical equipment; machinery and equipment n.e.c.; motor vehicles, trailers and semi-trailers; other transport equipment (27-30).

tech units at the 10th quantile. In terms of industrial specialisation, a weak positive *Location Quotient* effect is found only at the 10th quantile, while a positive effect is found for the *Herfindahl Index* measure only at the 25th quantile in high-tech local units. With regards to low-tech units, the results are largely comparable with those found for the overall sample. However, similar to the findings for high-tech units, the negative effect of location in a region with a high share of college-educated workers and a high population density is not found for units at the 90th quantile. Additionally, fast-growing units at the 90th quantile are not responsive to location in the Dublin and the South-West regions respectively. In summary, the location effect becomes less important for fast growing local units (90th quantile) when technology intensity and firm size are taken into account, whereas the impact of regional factors is more pronounced for low-tech units relative to high-tech local units.

**Table 6.** Regression estimates of the impact of region-specific characteristics on firm growth in high-tech local units

| | *Employment growth* | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| | OLS | q10 | q25 | q75 | q90 |
| Log employment$_{t-1}$ | -0.375*** | -0.040 | -0.038*** | -0.288*** | -0.673*** |
| | (0.041) | (0.038) | (0.009) | (0.055) | (0.062) |
| (Log employment$_{t-1}$)$^2$ | 0.042*** | 0.004 | 0.004*** | 0.031*** | 0.074*** |
| | (0.005) | (0.004) | (0.001) | (0.006) | (0.009) |
| Dublin | 0.205 | 0.171 | 0.058 | -0.247 | 0.336 |
| | (0.283) | (0.461) | (0.116) | (0.237) | (0.452) |
| Southwest | 0.062 | -0.104 | -0.006 | -0.008 | 0.054 |
| | (0.051) | (0.098) | (0.041) | (0.042) | (0.090) |
| Location Quotient | 0.008 | 0.020* | 0.004 | 0.002 | 0.003 |
| | (0.007) | (0.011) | (0.004) | (0.006) | (0.012) |
| Herfindahl Index | 0.188*** | 0.058 | 0.063** | -0.017 | 0.017 |
| | (0.057) | (0.103) | (0.027) | (0.040) | (0.073) |
| R&D intensity | 3.424*** | -0.093 | 1.037 | -0.080 | -0.131 |
| | (1.094) | (1.961) | (0.673) | (0.749) | (1.485) |
| College education | -0.116 | 0.212 | 0.063 | 0.149 | -0.264 |
| | (0.213) | (0.399) | (0.118) | (0.142) | (0.336) |
| PhD researchers | 0.393*** | -0.029 | 0.127 | -0.026 | -0.050 |
| | (0.132) | (0.236) | (0.081) | (0.092) | (0.179) |
| Average income | 1.841* | 0.260 | 0.348 | -0.781 | 0.479 |
| | (1.028) | (1.899) | (0.472) | (0.681) | (1.483) |
| Population density | -0.135 | -0.148 | -0.044 | 0.096 | -0.120 |
| | (0.111) | (0.179) | (0.040) | (0.084) | (0.167) |
| Constant | -1.117 | -2.383 | 1.860 | 8.132 | -4.224 |
| | (8.011) | (14.188) | (3.202) | (5.396) | (12.008) |
| Observations | 2,052 | 2,052 | 2,052 | 2,052 | 2,052 |
| $R^2$/Pseudo $R^2$ | 0.204 | 0.026 | 0.019 | 0.087 | 0.266 |
| F-test | 8.354(0.000) | | | | |
| Breusch-Pagan test | 1275 | | | | |

*** Significant at 1%, ** significant at 5%, * significant at 10%.

Note: Values in parentheses are cluster robust standard errors for OLS estimates, and standard errors bootstrapped with 200 replications for the quantile estimates. All estimates include industry dummies.

**Table 7.** Regression estimates of the impact of region-specific characteristics on firm growth in low-tech local units

| | *Employment growth* | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| | OLS | q10 | q25 | q75 | q90 |
| Log employment$_{t-1}$ | -0.516*** | -0.129*** | -0.087*** | -0.590*** | -0.942*** |
| | (0.023) | (0.020) | (0.007) | (0.014) | (0.031) |
| (Log employment$_{t-1}$)$^2$ | 0.067*** | 0.018*** | 0.011*** | 0.080*** | 0.127*** |
| | (0.004) | (0.002) | (0.001) | (0.002) | (0.005) |
| Dublin | 0.616*** | 0.822*** | 0.336*** | 0.233*** | 0.171 |
| | (0.150) | (0.312) | (0.081) | (0.080) | (0.199) |
| Southwest | 0.179*** | 0.234*** | 0.130*** | 0.074*** | 0.035 |
| | (0.028) | (0.060) | (0.018) | (0.017) | (0.037) |
| Location Quotient | 0.002 | 0.005 | 0.001 | -0.001 | -0.001 |
| | (0.003) | (0.006) | (0.002) | (0.002) | (0.004) |
| Herfindahl Index | 0.382*** | 0.407*** | 0.225*** | 0.165*** | 0.162*** |
| | (0.032) | (0.063) | (0.026) | (0.022) | (0.049) |
| R&D intensity | 6.871*** | 7.940*** | 4.337*** | 2.987*** | 2.742*** |
| | (0.605) | (1.202) | (0.486) | (0.422) | (0.906) |
| College education | -0.704*** | -0.637*** | -0.375*** | -0.320*** | -0.288 |
| | (0.127) | (0.235) | (0.076) | (0.075) | (0.176) |
| PhD researchers | 0.817*** | 0.984*** | 0.527*** | 0.345*** | 0.308*** |
| | (0.074) | (0.146) | (0.060) | (0.051) | (0.108) |
| Average income | 4.749*** | 4.832*** | 2.745*** | 2.195*** | 1.799** |
| | (0.579) | (1.127) | (0.378) | (0.384) | (0.857) |
| Population density | -0.307*** | -0.344*** | -0.160*** | -0.132*** | -0.104 |
| | (0.058) | (0.113) | (0.032) | (0.034) | (0.079) |
| Constant | -14.270*** | -10.223 | -6.804*** | -6.922** | -3.413 |
| | (4.746) | (7.938) | (2.461) | (2.731) | (6.326) |
| Observations | 8,578 | 8,578 | 8,578 | 8,578 | 8,578 |
| $R^2$/Pseudo $R^2$ | 0.278 | 0.017 | 0.014 | 0.017 | 0.133 |
| F-test | 34.84(0.000) | | | | |
| Breusch-Pagan test | 3585 | | | | |

*** Significant at 1%, ** significant at 5%, * significant at 10%.

Note: Values in parentheses are cluster robust standard errors for OLS estimates, and standard errors bootstrapped with 200 replications for the quantile estimates. All estimates include industry dummies.

## 5 Conclusion

This paper analyses the regional determinants of employment growth in manufacturing local units in Ireland over the period 2008-2012. This study contributes to the firm growth literature (from theoretical and policy perspectives) by providing empirical evidence on the regional drivers of firm growth during an economic downturn. The use of the quantile regression approach in this analysis, which allows an investigation of the relationship between region-specific characteristics and employment growth at different points of the conditional growth distribution, provides a more accurate representation of the effect of location on firm growth. This analysis leads to three broad conclusions. First, results show that firm growth is systematically shaped by the firm's location decision. Specifically, workforce quality, innovation conditions, industry specialisation and market conditions were identified as the key region-specific characteristics that drive the firm growth process. This finding remained robust even when firm size and technology intensity are taken into consideration. Second, significant variations in the effect of location on firm growth were found between local units with low and high growth rates. That is, the impact of location on firm growth varies along the conditional growth distribution, with the effect being more pronounced for local units at the lower parts of the growth distribution. The implication of this result is that the location decision is more important for slowly growing local units than it is for fast growing units. Third, when technology intensity is taken into account, region-specific characteristics matter more for local units in low-tech industries. Hence, firm growth in high-tech local units is less sensitive to the firm's location choices.

The results of this study, which highlight the importance of the location decision in engendering firm growth, suggest that firms should give careful consideration to their location choice as this can potentially determine their future growth path. From a policy perspective, the findings imply that firm growth varies between regions, driven by certain characteristics inherent in the regions. Thus, firm growth heterogeneity may create regional disparities in income, unemployment and other socio-economic conditions. These results highlight the potential role of policy to foster innovative activity, skill/knowledge diversity, and industrial clustering at the regional level. Policies such as these which help to promote job creation, will serve to break up regional disparities across regions. Moreover, results also support policy initiatives which encourage firms to locate outside the Dublin and South-West regions (particularly outside Dublin and Cork areas) as firms benefit from unobserved urbanisation economies embedded in the regions. The finding that slowly growing local units, as well as local units in low-tech industries are more sensitive to the firm's location choice provides support for the design of more targeted regional policy to promote growth in low-growth and low-tech firms.

Although situated within an Irish context, this analysis of the regional determinants of firm growth is a valuable contribution to an important topic that is worthy of further exploration in other country contexts. The study is, however, not without limitations which provide clear avenues for future research. One such limitation is the non-availability of data disaggregated at the NUTS3 level for some variables (e.g. innovation variables). Availability of such data enables the investigation of the role of regional factors in driving the firm growth process to be undertaken at a more disaggregated regional level of analysis. Additionally, the absence of data on entrepreneurial activity at the regional level precludes a study of how firm growth may be influenced by regional entrepreneurial capabilities. A future line of research worth exploring would be to extend the study to cover a period of economic recovery. This allows an analysis of how the regional drivers of firm growth may vary with changes in the business cycle. By providing empirical evidence on how region-specific characteristics influence firm growth, and how this relationship may matter more or less for firms at different points of the conditional growth distribution, this study contributes to the scant literature on the role of regional characteristics in explaining firm growth heterogeneity.

**References**


Audretsch, D. B. and D. Dohse (2007) Location: A neglected determinant of firm growth, *Review of World Economics*, 143(1), 79-107.

Barbosa, N., A. P. Faria and V. Eiriz (2014) Industry- and firm-specific factors of innovation novelty, *Industrial and Corporate Change*, 23(3), 865-902.

Barbosa, N., and V. Eiriz (2011) Regional variation of firm size and growth: The Portuguese case, *Growth and Change*, 42(2), 125-158.

Barney, J. B. (1991) Firm resources and sustained competitive advantage, *Journal of Management*, 17(1), 99-121.

Barrios, S., L. Bertinelli and E. Strobl (2006) Geographic concentration and establishment scale: An extension using panel data, *Journal of Regional Science,* 46(4), 733-746.

Bartelsman, E. J. and M. Doms (2000) Understanding productivity: Lessons from longitudinal microdata, *Journal of Economic Literature*, 38(3), 569-594.

Bentzen, J., E.S. Madsen and V. Smith (2012) Do firms' growth rates depend on firm size? *Small Business Economics*, 39(4), 937-947.

Bojas, P. and N. Barbosa (2015) High-growth firms: What is the impact of region-specifoc characteristics? in Rui Baptista, João Leitão (eds.) *Entrepreneurship, Human Capital, and Regional Development*: Labor Networks, 295-308, Switzerland: Springer.

Cleff, C., G. Licht, A. Spielkamp and W. Urban (2005) Innovation and competitiveness, *ZEW Economic Studies***,** 32, 103-155.

Coad A. (2009) *The growth of firms: A survey of theories and empirical evidence*, Cheltenham: Edward Elgar.

CSO (2014a) ILO Unemployment Rate (15 - 74 years) by NUTS 3 Regions and Quarter, *Quarterly national Household survey main results*, CSO Statbank, www.cso.ie , (accessed 13 July 2016).

CSO (2014b) Estimates of Household Income by County and Region, Year and Statistic, *County Incomes and regional accounts*, CSO Statbank, www.cso.ie , (accessed 13 July 2016).

CSO (2014c) Gross Value Added (GVA) by Region, Year and Statistic, County Incomes and regional accounts, CSO Statbank, www.cso.ie , (accessed 13 July 2016).

CSO (2014d) *Background notes,* http://www.cso.ie/en/surveysandmethodology/industry/monthlyproductioninquiry/backgroundnotes/ , (accessed 13 July 2016).
CSO (2014e) *Standard Report on Methods and Quality on Census of Industrial Production*, http://www.cso.ie/en/media/csoie/surveysandmethodologies/surveys/industry/documents/pdfdocs/StdRptCIP2012.pdf, (accessed 13 July 2016).
Drudy, P.J. and M.L. Collins (2011) Ireland: From boom to austerity, *Cambridge Journal of Regions, Economy and Society,* 4(3), 339-354.
del Valle, I. D. and M.A.S. Castillo (2009) Human capital and sustainable competitive advantage: An analysis of the relationship between training and performance, *International Entrepreneurship and Management Journal*, 5(2), 139-163.
European Commission (2003) SME definition user guide and model declaration, Enterprise and Industry Publications, http://ec.europa.eu/enterprise/policies/sme/files/sme_definition/sme_user_guide_en.pdf, (accessed 28 January 2016).
Faggio, G., O. Silva and W.C. Strange (2016) Heterogenous agglomeration, *Review of Economics and Statistics*, doi: 10.1162/REST_a_00604.
Figueiredo, O., P. Guimarães and D. Woodward (2009) Localisation economies and establishment size: was Marshall right after all?, *Journal of Economic Geography*, 9(6), 853-868.
Fingleton, B., H. Garretsen and R. Martin (2012) Recessionary shocks and regional employment: Evidence in the resilience of UK regions, *Journal of Regional Science,* 52(1), 109-133.
Fotopoulos G. and L.Giotopoulos (2010) Gibrat's Law and persistence of growth in Greek manufacturing, *Small Business Economics*, 35(2), 191-202.
Garnier, C. (2003) Conclusion of the conference, in Funck, B. and L. Pizzati (eds.), *European integration, regional policy and growth*, 249-254, Washington: World Bank.
Gleeson, AM., Ruane, F., and J. Sutherland (2006) Public policy, sectoral specialisation and spatial concentration: Irish Manufacturing 1985-2002, *Journal of the Statistical and Social Inquiry Society of Ireland*, 35, 110-150.
Goedhuys, M., and Sleuwaegen, L. (2010). High-growth entrepreneurial firms in Africa: a quantile regression approach, *Small Business Economics*, 34(1), 31-51.
Guimarães, P., O. Figueiredo, and D. Woodward (2000) Agglomeration and the location of foreign direct investment in Portugal, *Journal of Urban Economics*, 47(1): 115-135.
Hart, P. E. and S.J. Prais (1956) The analysis of business concentration: A statistical approach, *Journal of the Royal Statistical Society*, Series A (General), 119, 150-191.
Honohan, P. (2009) What went wrong in Ireland?, Prepared for the World Bank, May 2009, Trinity College Dublin, http://www.tcd.ie/Economics/staff/phonohan/What%20went%20wrong.pdf, (accessed 5 May 2017).
IDA Ireland (2016) *Business in Ireland,* http://www.idaireland.com/business-in-ireland/locations/?type=locations, (accessed 5 May 2017).
Krugman, P. (1991) Increasing returns and economic geography, *Journal of Political Economy*, 99(3), 483–499.
Lai, Y.G., G. Saridakis, R. Blackburn and S. Johnstone (2016) Are the HR responses of small firms different from large firms in times of recession? *Journal of Business Venturing,* 31(1), 113-131.
Lotti, F., E. Santarelli and M. Vivarelli (2003), Does Gibrat's law hold among young, small firms? *Journal of Evolutionary Economics*, 13(3), 213–235.
Mazzucato, M., & Parris, S. (2015) High-growth firms in changing competitive environments: The US pharmaceutical industry (1963 to 2002), *Small Business Economics,* 44(1), 145-170.
Morgenroth, E. (2008) Exploring the Economic Geography of Ireland, *Journal of the Statistical and Social Inquiry Society of Ireland*, 38, 42-73,
Morgenroth, E. (2007) Trends in the regional economic activity of Ireland: The role of productivity, in C. Aylward and R. O'Toole (eds.), *Perspectives on Irish Productivity: A Selection of Essays by Irish and International Economists*, 66-83, Dublin: Forfás.
O'Hara, P. (2013) What future for the regions, in B. Reynolds and S. Healy (eds.), *A future worth living for: Sustainable foundations and frameworks,* 147-172, Dublin: Social Justice Ireland.
Otto, A. and D. Fornahl (2009) Long-term growth determinants of young businesses in Germany: The effects of regional concentration and specialisation, *Romanian Journal of Regional Science*, 3(1), 1-35.

Penrose, E. (1959) *The theory of the growth of the firm,* New York: John Wiley.
Peric, M., and V. Vitezic (2016) Impact of global economic crisis on firm growth, *Small Business Economics*, 46(1), 1-12.
Reichstein, T., M. S. Dahl, B. Ebersberger and M. B. Jensen (2010) The devil dwells in the tails, *Journal of Evolutionary Economics*, 20(2), 219-231.
Simon, H. A. and C. P. Bonini (1958) The size distribution of business firms, *American Economic Review*, 48(4), 607-617.
Singh, A. and G. Whittington (1975) The size and growth of firms, *Review of Economic Studies,* 42(1), 15-26.
Sutton, J. (1997) Gibrat's legacy, *Journal of Economic Literature*, 35(1), 40-59.
van Oort, F.G. and E. Stam (2009) Agglomeration economies and firm growth: Testing for spatial externalities in the Dutch ICT industry, in C, Karlsson, B. Johansson and R.R. Stough (eds.), *Innovation, Agglomeration and Regional Competition*, 346-374, Cheltenham: Edward Elgar.
White, M.C. (2004) Inward investment, firm embeddedness and place: An assessment of Ireland's multinational software sector, *European Urban and Regional Studies,* 11(3), 243-269.