Economic perspectives

The growth dynamics of technology-based firms in Scotland

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1. Introduction

In recent years high growth firms (HGFs) undertaking rapid, transformative growth, have been identified as important contributors to economic growth (Acs et al, 2008; Anyadike-Danes et al, 2009; OECD, 2010). For a wide variety of reasons, notably their contribution to employment growth, high export intensity, strong contribution to productivity growth and innovation, HGFs have been hailed as vital drivers of economic competitiveness (Henrekson and Johansson, 2010). As a consequence, these firms (often referred to as 'gazelles'), have been accorded a central role in many economic development strategies at both national and regional levels, especially during a time of economic austerity where employment growth has been an overriding policy goal for many governments (BERR, 2008; NESTA, 2011; OECD, 2010; Scottish Enterprise, 2011). Yet despite the strong policy focus on the promotion of HGFs in recent times, much remains unknown about these organisations and how best to support them (Henrekson and Johansson, 2010; Anyadike-Danes et al, 2012; Mason and Brown, forthcoming).

Scottish Enterprise recently commissioned research on Scotland's population of HGFs (Mason and Brown, 2010). This was the first comprehensive analysis of these firms ever conducted in Scotland and some of the findings were published in this journal (Brown and Mason, 2010). One of the most significant conclusions from this study was that they are extremely heterogeneous in terms of their age, size, ownership and industry sector. Few fit the stereotypical 'gazelle' definition which refers to young high growth firms that are less than five years old. The vast majority are over 10 years old, with some significantly older (Mason and Brown, 2010). Furthermore, only a relatively small proportion of these firms are in high-tech areas of the economy. According to some scholars, there is 'no

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evidence that Gazelles are overrepresented in high-technology industries' (Henrekson and Johansson, 2010, p.240). Despite their strong prioritisation by policy makers, the reality is that the representation of technology based firms (TBFs) in the population of HGFs is roughly on a par with their proportion in the economy (Mason and Brown, forthcoming).

In view of these twin priorities of promoting high growth in general and high tech firms in particular, Scottish Enterprise commissioned further research to explore HGFs, especially in high tech areas of the economy. The objectives of this paper are twofold: to provide an update on the level of HGFs in Scotland and to assess the population of TBFs in Scotland. The paper proceeds as follows. First, the terms high growth and technology-based enterprises are defined. Second, the methodology is outlined. Third, the aggregate evidence on the levels of HGFs in Scotland is presented. Fourth, the population of TBFs in Scotland, including analysis of high growth TBFs is profiled. Fifth, some of the key characteristics of high growth TBFs in Scotland are examined. Sixth, some of features of these firms which were captured during the qualitative part of this research process are summarised. The paper finishes with some brief conclusions and issues for further research.

2. Defining high growth and high tech

Firm growth is generally an uneven, discontinuous process with high growth representing a transitory phase in a firm's lifespan (Garnsey et al, 2006). Quite often a period of high growth is interspersed with a period of moderate or low growth (or sometimes even contraction). High growth is therefore typically a temporary phase and does not designate a particular cohort of firms. The OECD (2008) defines HGFs as: 'enterprises with average annualised growth in employees or turnover greater than 20% per annum, over a three year period, and with more than 10 employees in the beginning of the observation period'. Unless otherwise stated, the analysis in this paper uses growth in turnover as the main criterion for measuring high growth.

Although HGFs are very important generators of employment within economies, they constitute a very small proportion of the overall business population in Scotland. The OECD definition of three consecutive years of growth of 20% or above (for firms with 10+ employees) is a very exacting growth threshold. It is important to stress that the analysis in this paper refers only to enterprises with 10+ employees, which account for 5% of all private sector enterprises in Scotland (including self employed enterprises) and 69% of private sector employment (equivalent figures for the UK are 5% and 75% respectively).

During this research we specifically examined high tech firms (so-called TBFs)[1]. It is important at the outset to define what is meant by high technology and how 'high tech' firms can be identified. A pioneering approach in the UK was undertaken by Butchart (1987) which identified specific four digit categories in the 1980 Standard Industrial Classification (SIC) as being high technology. These firms had higher than average expenditures on R&D as a proportion of sales or employed proportionately more `qualified scientists and engineers' than other sectors. This definition is now somewhat outdated. This study therefore adopts the definition used by Glasson et al (2006) in their study of high tech industry in Oxfordshire which was based on an updated and extended Butchart definition. The definition, which is based on the 2003 SIC, includes both high-tech manufacturing and high-tech services and also allows for the definition to be modified to take account of local/regional circumstances such as the oil and gas industry in Scotland (see Mason and Brown, forthcoming). This combination of rigour, derived by using measurable criteria, plus an element of subjectivity to take account of local circumstances, has considerable appeal.

3. Methodology

The analysis reported in this paper is based on an extensive, multi-method programme of research on high growth TBFs within Scotland conducted between January 2011 to January 2012 (Mason and Brown, 2012). Recent assessments of mixed methods studies have found them be a useful methodology for undertaking business-related, entrepreneurship research (Molina-Azorin, et al, forthcoming). Funded by the regional development agency, Scottish Enterprise, the main focus of the work was to provide an up-to-date analysis of the nature of HGFs in Scotland, including a specific focus of the growth of TBFs. The work involved a team of researchers from Aston University, Scottish Enterprise and Strathclyde University.

The programme of research is based on three main sources of information. First, quantitative analysis was undertaken on the aggregate nature of HGFs in Scotland. This aggregate analysis utilised the Inter Departmental Business Register (IDBR)-based Business Demography dataset held by the Office for National Statistics (ONS)[2]. The main benefit of using this dataset is the ability to compare Scotland with other parts of the UK. This data source has been used by other organisations such as Nesta to examine HGFs in the UK (Anyadike-Danes et al 2009; Nesta, 2011). This quantitative analysis also included examination of the size of the population of TBFs in Scotland, including analysis of high growth TBFs. Second, in-depth interviews were conducted with a sample of high growth TBFs in Scotland. Finally, the work has involved close consultation with account managers from Scottish Enterprise who work intensively with some of the companies interviewed as part of this study.

4. High growth firms in Scotland: aggregate volume and characteristics

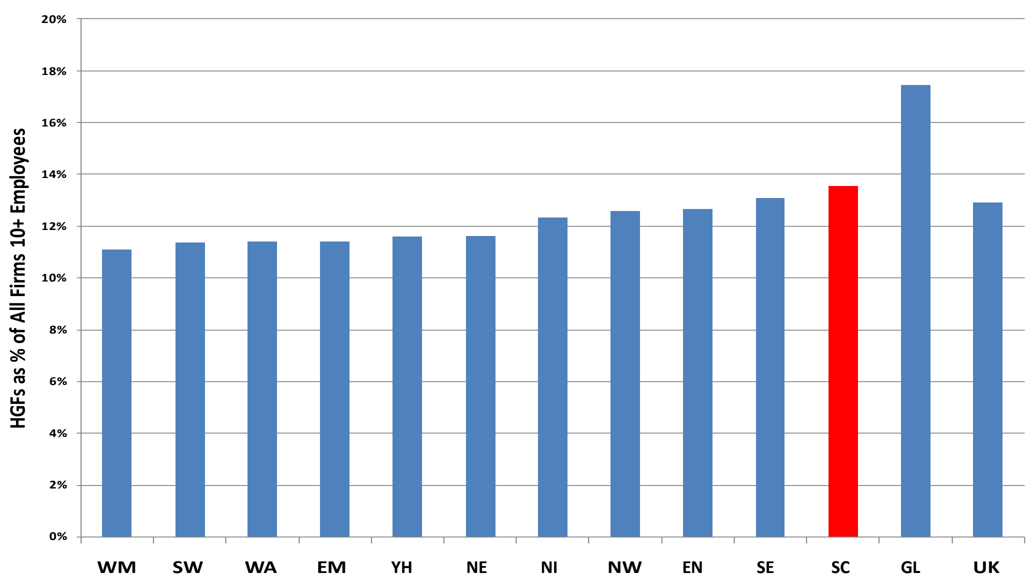
The latest ONS data shows that between 2007-2010, Scotland had 1,544 HGFs (13.5% all firms with 10 +

employees) – a rate above the UK average (12.9%). Because of the different data sources in this study this figure is significantly higher than in the previous work on Scottish HGFs (see Brown and Mason, 2010)[3]. Using an employment definition (to be consistent with the previous NESTA work), between 2007 and 2010, 7% of Scotland's businesses with 10+ employees were HGFs, which again is just slightly above the UK average (6.9%) (Nesta, 2011)

In recent years Scotland has outperformed much of the UK in terms of the percentage of businesses that are HGFs. In fact, data from the most recent time period available, 2007-2010, reveals that compared to all UK regions Scotland had the second highest proportion of businesses (behind Greater London) that were high growth (see Figure 1 below).

The 1,544 Scottish HGFs employed 285,146 people in Scotland in 2010 – an increase of 23% over the three years (+54,190 jobs). The equivalent percentage increase for the UK was 39.5% over the same time period. This suggests that Scottish HGFs are not as prodigious employment generators, in terms of domestically located employment, as UK HGFs. The precise reasons for this are unclear, but may partly be attributable to the small nature of the domestic market in Scotland coupled with the highly internationalised operations of many Scottish HGFs. During the previous high growth research for Scottish Enterprise, it was noted that Scottish HGFs often have significant overseas operations, hence a substantial amount of the employment that they generate is located outwith Scotland (Mason and Brown, 2010).

Figure 1: High-Growth Firms in the UK Regions 2007-10 (as a proportion of all firms with 10+ Employees)



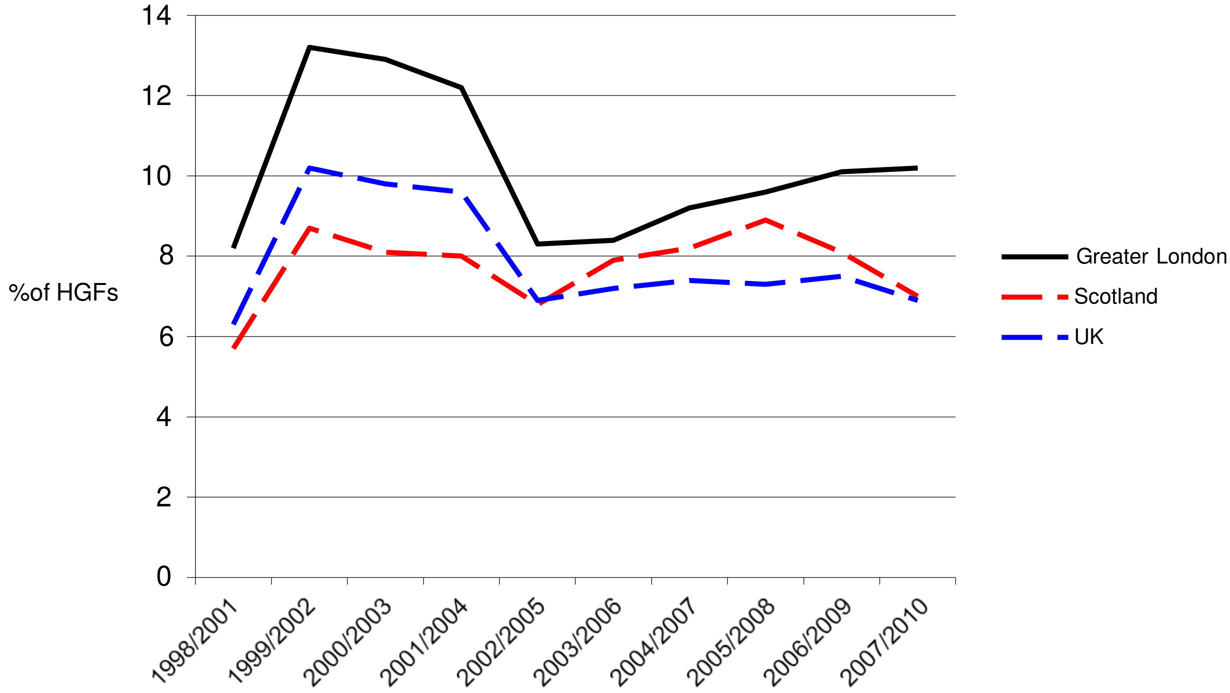
Source: ONS Business Structure Database

Key characteristics of the 1,544 HGFs in Scotland are as follows:

- they employed 285,146 people in the three year time period between 2010;
- they are relatively small – 45% have 10 to 19 employees and almost 80% employ 10 to 49 people;
- they are well established - just over half (53%) have been established for 10 years or more.

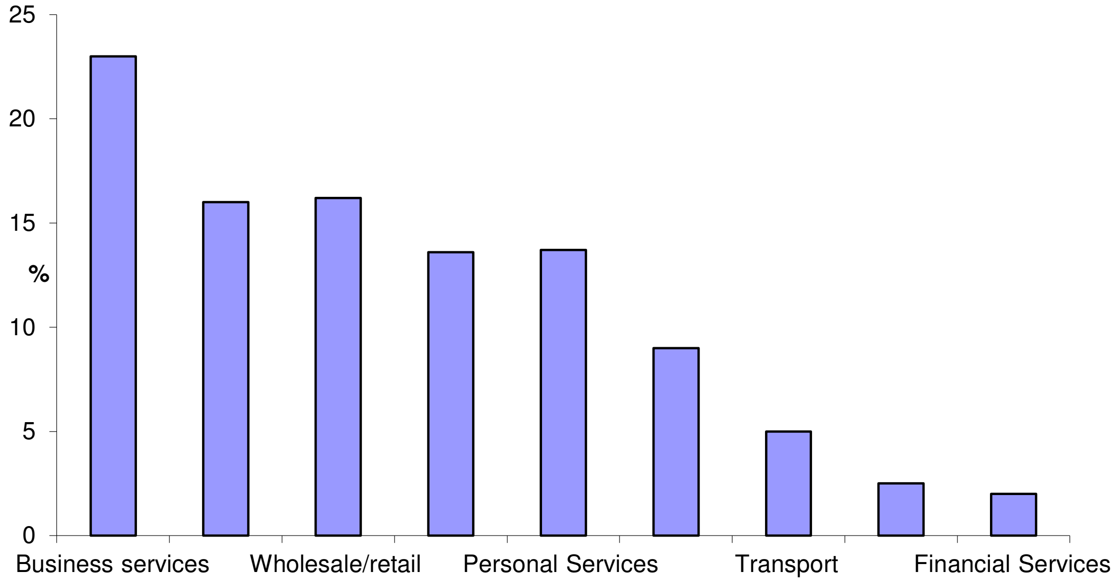
Figure 2 shows time series data on the incidence of HGFs in Scotland during the last decade and how this compares to the UK average. Throughout this period, the top performing UK region was Greater London. During the first half of the decade the performance of Scotland's HGFs was around the UK average, but since the mid 2000s it has been slightly

Figure 2: High Growth Firms in Scotland and London compared to the UK average



Source: ONS Business Structure Database

Figure 3: High Growth Firms in Scotland by broad sector, 2007-10 (%)



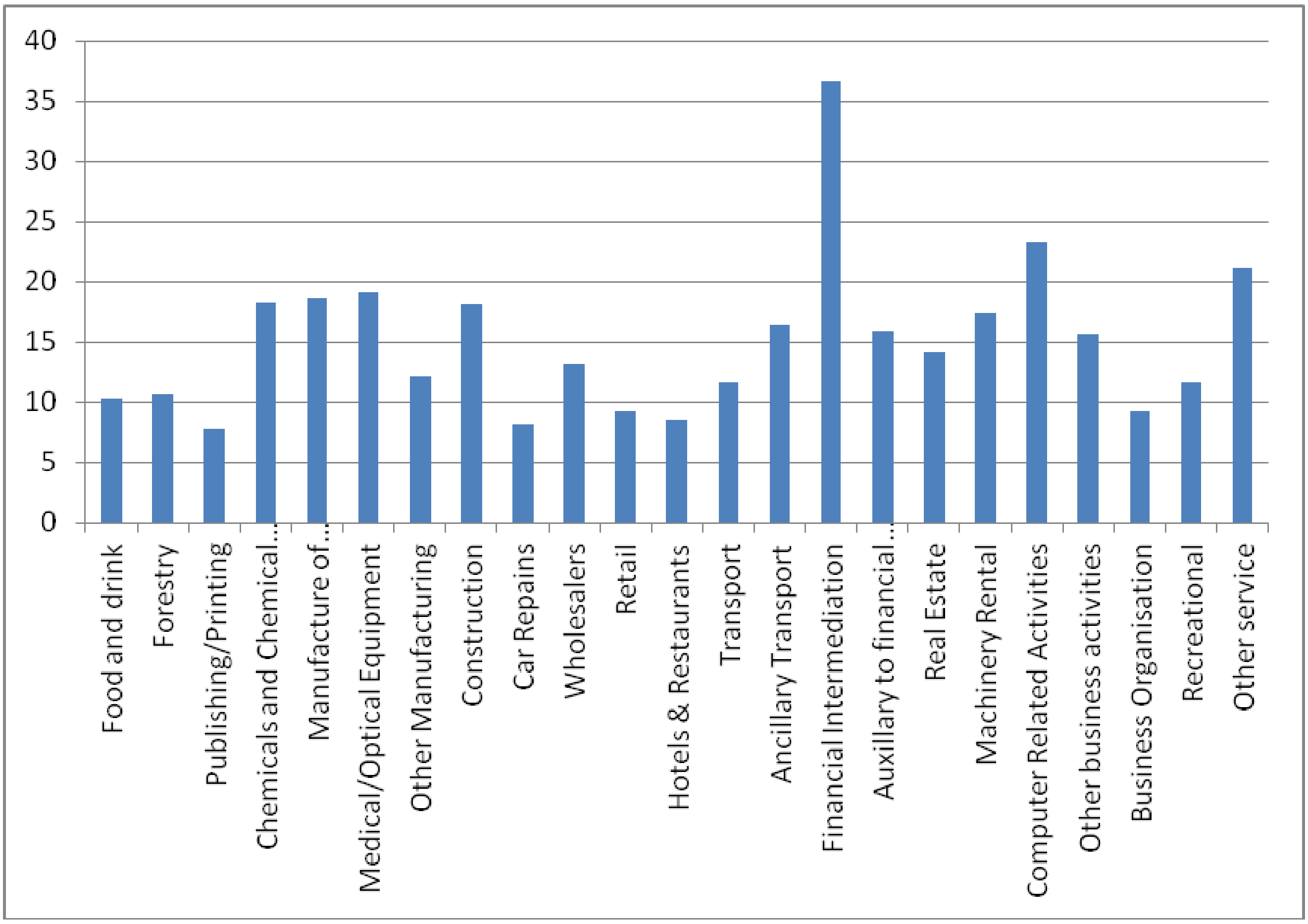
Source: ONS Business Structure Database above the UK average. The decline in the proportion of HGFs in both Scotland and the UK as a whole between 2007-2010 suggests that the recent economic downturn and recession has had a negative effect on the ability of companies to achieve high growth.

One of the most important features of HGFs firms is their extremely diverse sectoral composition (Figure 3). The largest single contributor of HGFs is the business service sector. Other sectors with high proportions of HGFs include construction, wholesale/retail, manufacturing and personal services. In common with other studies, there is not a particularly strong representation of technology-based firms among HGFs (Henrekson and Johansson, 2010).

Closer inspection of the data reveals that some discrete sectors are more likely to produce HGFs. Analysis of their sectoral composition using two-digit SIC codes highlights that HGFs are more common within high-tech areas like financial intermediation, computer-related activities, 'other' services, chemicals, electrical equipment, medical and optical equipment (Figure 4). The single strongest performer is financial intermediation with nearly 40% of firms in this sector achieving high growth status between 2007-2010. Given the problems confronting the financial services industry during this time this performance seems remarkably robust. However, the very small number of overall companies in this sector (49) suggests that this should be viewed with a certain amount of caution.

Conversely, there are sectors with relatively low levels of HGFs (Figure 4). Sectors which have a relatively low proportion of HGFs (i.e. less than 10%) include: printing and publishing, hotels and restaurants, retail and car repairs. Other sectors which are below the Scottish average of 13.5% are food and drink, forestry and transport. So, while some sectors have considerable numbers of HGFs, for example hotels and restaurants (129), the large number firms in these sectors results in a 'conversion rate' (the proportion within the sector that achieve high growth) that is below the Scottish average. What is also of note is that the high tech sectors which are traditionally the focus for public sector support (software, manufacturing, medical devices, chemicals etc) appear to display quite strong incidence levels of HGFs while sectors which are not traditionally assisted, such as retail and hospitality, show a lower propensity for firms to become high growth.

Figure 4: Percentage of HGFs within Different Sectors, 2007-2010



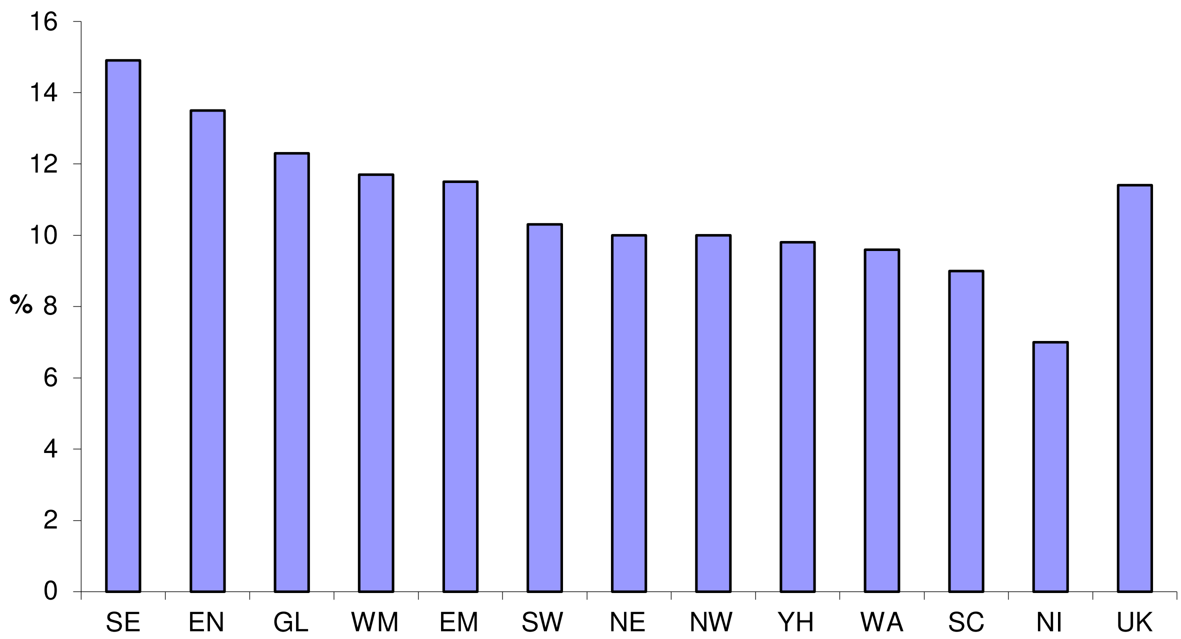
Source: Hart et al (2011) for Scottish Enterprise

In terms of their spatial distribution Scottish HGFs can be found across the whole of Scotland. However, their distribution is spatially concentrated in Scotland's major urban conurbations of Aberdeen (229), Edinburgh (168) and Glasgow (232). While Glasgow has the largest aggregate proportion of Scottish HGFs, Aberdeen is the top performer in per capita terms. This is attributable to the strong role played by the oil and gas sector in the local economy. Other areas with relatively high numbers of HGFs include Aberdeenshire, Fife and North/South Lanarkshire. Less economically prosperous (e.g. Inverclyde, West Dunbartonshire) and more remote or rural areas (e.g. Western Isles, Scottish Borders) contribute much less in terms of the overall HGF population.

5. High-Tech, High Growth Firms in Scotland

Research suggests that high-tech firms are not over-represented amongst HGFs (Henrekson and Johansson, 2010; Mason and Brown, 2010). To explore this in more detail for Scotland, ONS data was analysed using a standard classification of technology-based firms (see section 2 above). One of the most significant findings from this analysis is the fact that Scotland, along with Northern Ireland, has one of the lowest proportions of businesses that are in high-technology sectors (Figure 5). Over the 2007-10 period, there were 7,462 high-tech firms in Scotland of which 1,021 had 10+ employees (accounting for 8.6% of all 10+ employee firms in Scotland). While it might be expected that Greater London and South East England would have high proportions of enterprises that were high tech, the differences between Scotland and parts of England such as the West Midlands and North East is a less expected finding. The reasons for this are hard to ascertain but may arise from Scotland's historic reliance on large scale employers in traditional industries (and low levels of corporate spin-offs) coupled with the strong role played by inward investment since the mid-1950s (Brown and Mason, 2012).

Figure 5: Proportion of enterprises (10+ employees) that are high technology, UK Regions (2007-10)



Source: ONS Business Structure Database

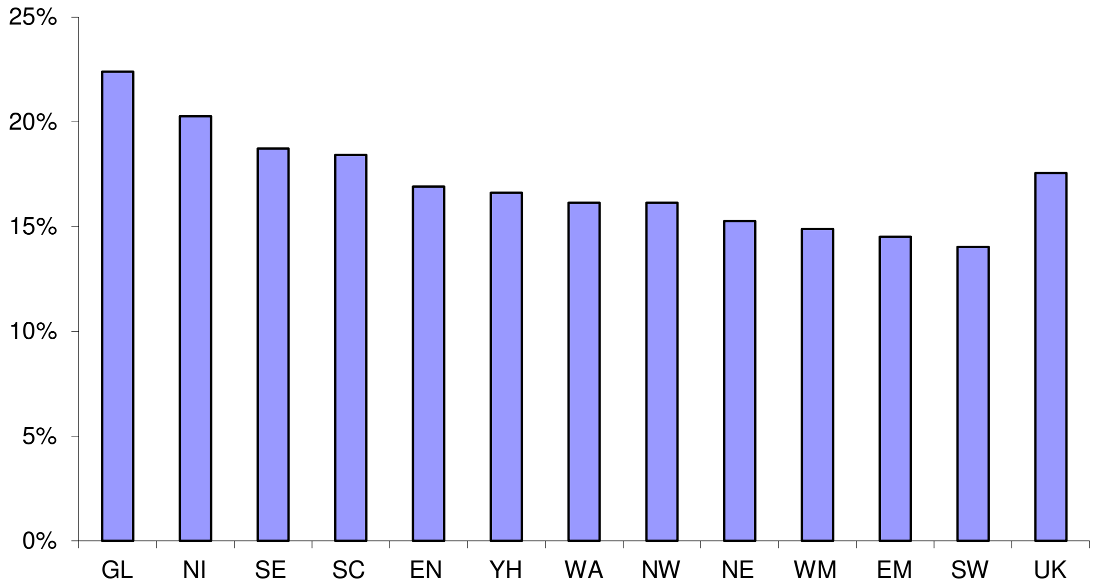
Despite this weak overall showing in terms of the proportion of firms that are high-tech, the proportion of high-tech enterprises achieving high growth status (18.4% – or 188 firms) is in line with the UK average (Figure 6). In fact, only three other regions (Greater London, Northern Ireland and South East England), are above the Scottish figure. This suggests that Scotland is better than many other regions at 'converting' its high tech businesses into high growth businesses. This also suggests that having a small population of high tech firms is not a direct impediment to the emergence of rapid growth high tech firms.

For each UK region, the proportion of high tech enterprises that are also high growth is significantly higher than the proportion of non-high tech enterprises that are high growth. This suggests that incidence levels of HGFs are higher in high tech sectors than non-high tech areas (Anyadike-Danes et al, 2012). This seems is particularly the case in

Greater London, South East England, Northern Ireland, and Scotland (Figure 6). In other words, high tech firms have a stronger 'conversion rate' to high growth than non-high tech firms and this holds for all parts of the UK.

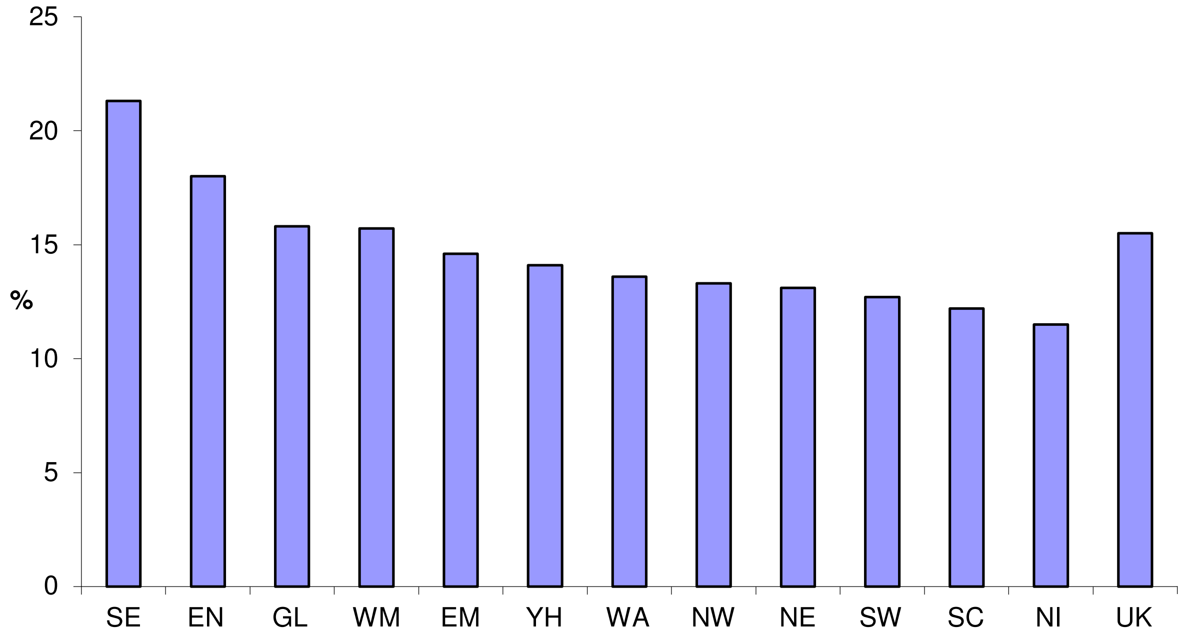
Nevertheless, in most UK regions, high tech firms are a low proportion of the HGF population. For example, in Scotland only 12.2% of Scotland's HGFs are high tech. This is a lower proportion than most UK regions (Figure 7). This would appear to be attributable to Scotland's low stock base of high technology enterprises as highlighted earlier which imposes a constraint on the number of high tech HGFs which it generates, especially because high-tech HGFs often emanate from such existing businesses (Mason and Brown, forthcoming). However, more evidence is needed to provide a fuller explanation for this finding.

Figure 6: Proportion of high tech enterprises (10+ employees) that are high growth, by region



Source: ONS Business Structure Database

Figure 7: Proportion of high growth firms that are in high technology, UK regions (2007-10)



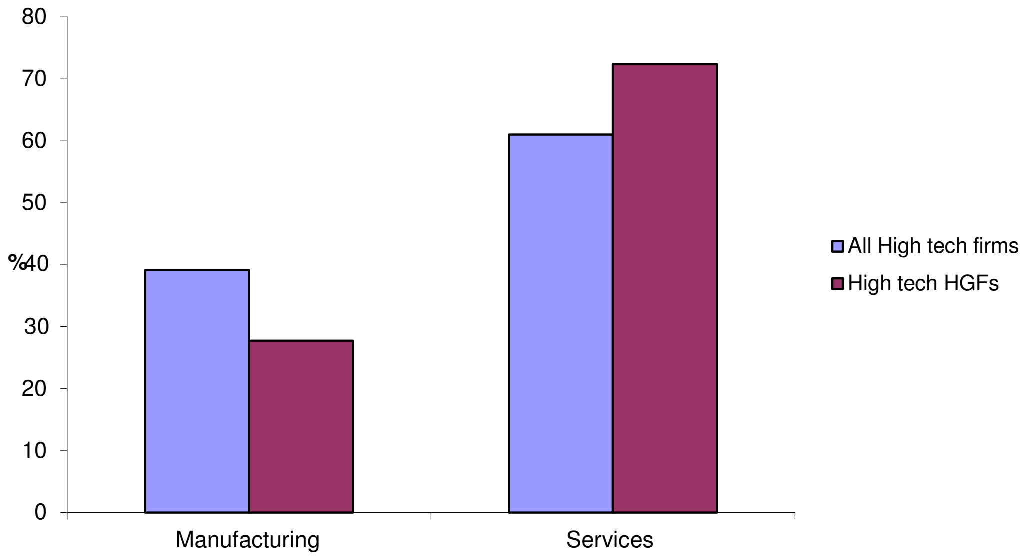
Source: ONS Business Structure Database

6. Characteristics of High-Tech High Growth Firms

Scottish high-tech HGFs tend to be younger and smaller than the overall population of Scottish HGFs. With regard to the size distribution, there are more smaller high-tech HGF employing between 10 and 19 employees (19.3%) than the overall population of Scottish HGFs (12.6%). Similarly, there are fewer large (100+ employees) high-tech high growth enterprises (9.8%) than in the overall high growth population (12.3%). Also of note is the fact that there is a greater proportion of high-tech HGFs (13.8%) which are more than 10 years old than the population of HGFs as a whole (10.3%). This suggests that technology-based firms may take a longer period of time before they embark upon a period of rapid growth than the business population as a whole. This certainly corresponds to the long time to market for some technology products such as life sciences where time consuming regulatory approval is often required before a firm can achieve significant turnover growth.

Because of the disclosure constraints stipulated by the ONS, the precise sectoral distribution of the Scottish high growth high-tech firms cannot be disclosed. However, we are able to make a distinction between service and manufacturing high-tech HGFs. Of the population of 1,012 high-tech firms with 10 or more employees, 39% are manufacturing firms and 61% are service-based firms. Manufacturing companies are therefore heavily over-represented in terms of their contribution to the population of high tech firms. Of all the 188 high-tech HGFs, 27.7% are manufacturing firms are 72.3% are service firms (Figure 8). Although service firms dominate the overall population of high-tech HGFs in volume terms, by contributing nearly one-third of the high-tech high growth cohort, manufacturing firms are strongly over-represented compared to services. Analysis of some of the larger high-tech TBFs in Scotland revealed that the majority of these businesses are foreign-owned (Mason and Brown, forthcoming).

Figure 8: High tech companies and high tech HGFs by broad sector (2007-10, 10+ employees, %)



Source: ONS Business Structure Database

The population of Scotland's 188 high-tech HGFs is highly spatially concentrated. Only five local authority areas in Scotland have more than 10 high-tech HGFs: Aberdeen, Edinburgh, Glasgow, South Lanarkshire and Fife. Again, this highlights the importance of urban economies as generators and hosts of HGFs (Mason and Brown, 2010).

7. Qualitative Analysis of High Growth Technology Based Firms

In-depth interviews were conducted with 20 TBFs as part of this research to add further insight into Scotland's indigenous technology sector. In summary, the findings from this part of the study endorse the findings from other research on HGFs, with certain important caveats (Mason and Brown, forthcoming). Most of the businesses interviewed had been established by people with high levels of human capital, with the majority being graduates or postgraduates. Scottish founders who had worked previously within industry (sometimes the same industry) strongly benefited from this experience, especially the 'insider' knowledge to make contacts and knowing what was required to grow a business within their area of expertise. Entrepreneurs who had previously worked in larger firms also seemed more ambitious than those from smaller business backgrounds. This suggests that there may be 'untapped' sources of entrepreneurial talent locked up within existing larger firms in Scotland.

The one area where the Scottish experience seemed to be somewhat contradictory to wider research findings surrounds the area of entrepreneurial orientation and growth ambition. Many of the successful Scottish TBFs were driven by ambitious entrepreneurs but some seemed to place 'ceilings' on their overall growth ambitions. Despite the fact that they were growing rapidly, some considered that they had peaked in terms of their growth capacity while others felt that they needed to 'exit' the business for it to achieve its full potential. Clearly, levels of growth ambition differ between individuals and not all people want to grow their turnover and employment to become a significant company of scale.

Similar to the population of HGFs as a whole (Mason and Brown, 2010), the companies interviewed exhibit considerable diversity in terms of their age, size and the nature of their business, with many far removed from the 'white coats' stereotype of a technology business. They were predominantly small and medium sized businesses, typically with less than £10m in sales and less than 50 employees. Most were engaged in B2B activities and a wide variety of business models were in evidence. The majority are end-user and customer focused with close links to customers for feedback and as a source of innovation. Most had overseas sales and a significant proportion derivemost or all of their sales from overseas exports. Several of the larger companies have international operations which reduces their Scottish economic footprint.

High tech companies typically compete on the basis of their technical and domain knowledge, capabilities and offering. Both IP and formalised R&D activity were less common than might have been expected. Universities are of minor importance as a source of innovation. Only two companies could be classified as university spin-outs and neither has any remaining links with their former institution. Two other companies emerged from failed university ventures and only one company has strong research links with a local university.

Most of the interviewed companies have been growing, many quite fast, but some were hit hard by the economic downturn in the late 2000s and are only now resuming growth. The majority are anticipating further growth, albeit at varying rates. However, some are at, or anticipate hitting, growth ceilings which, in some cases arise from financial constraints.

In the main, the companies interviewed were based in Scotland because that was where their founder was living. There were few significant advantages of a Scottish location, except for companies selling into the North Sea oil and gas sector. The distance from customers, restricted airline routes and lack of indigenous markets were seen as the biggest disadvantages of a Scottish location. Many of the companies had been approached by potential buyers and several owner-managers seemed likely to sell in the foreseeable future. This raises questions about the pros and cons of the acquisition of Scottish technology companies, the size of the companies that get acquired, and the benefits of growing more companies of scale.

8. Summary

Scotland performs well in relation to the rest of the UK in terms of the presence of high growth businesses. However, Scotland performs less well in terms of high growth, high-tech firms. The primary reason for this most probably owes to the fact that Scotland's proportion of high tech firms in its business base is the second lowest amongst UK regions. As a consequence, the overall proportion of its high tech businesses that are high growth is low.

However, the proportion of high tech firms in the UK which achieve high growth is greater than non-high tech firms. This is particularly the case for Scotland. Therefore, contrary to what seems to have been reported previously (Henrekson and Johansson, 2010), incidence rates of HGFs are 'detectably higher in a number of hi-tech and knowledge intensive services' (Anyadike-Danes et al, 2012). On the face of it, this would appear to justify the emphasis which policy-makers give to technology-based firms as a source of HGFs.

High tech-high growth firms in Scotland tend to be smaller than the overall population of HGFs, and there are relatively few large firms. They are also younger, although the proportion of high growth-high tech firms over 10 years old is higher than that for the proportion of HGFs as a whole. This suggests that high tech firms take time to mature before they can become 'growth-oriented' businesses. The research also revealed that the oil and gas industry plays a vital and disproportionate role in fuelling the growth of Scottish high tech HGFs.

The qualitative element of the research revealed that many of the smaller HGF high tech firms encounter growth constraints in relation to recruitment, access to both debt and equity finance, and distance from major markets. One of the responses is to sell to a larger international company. And, indeed, many Scottish high-tech firms become acquired in recent years. Therefore, the issue of corporate acquisition and its impact on the Scottish economy seems worthy of further empirical investigation.

Endnotes

[1]Throughout the remainder of this paper we use the terms high tech and technology based firms (or TBFs) interchangeably.

[2]The statistical data used here is from the Office of National Statistics (ONS) and is Crown copyright and reproduced with the permission of the controller of HMSO and Queens Printer for Scotland. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. The analysis upon which this report is based uses research datasets which may not exactly reproduce National Statistics aggregates.

[3]The main data source used for the initial work on high growth firms in Scotland used the business dataset: financial analysis made easy (FAME) (see Mason and Brown, 2010). However, owing to the nature of FAME it tends to underreport firms who are ineligible to lodge their accounts with Companies House. Therefore, FAME tends to under-represent smaller firms who achieve significant levels of growth.

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