Fecundity, fertility, survival and growth: high-growth firms in the UK and their contribution to job creation, a demographic perspective

ERC Research Paper 74

January 2019

Fecundity, fertility, survival and growth: high-growth firms in the UK and their contribution to job creation, a demographic perspective

Michael Anyadike-Danes
Enterprise Research Centre and Aston Business School
1951-2018

Mark Hart
Enterprise Research Centre and Aston Business School
Mark.hart@aston.ac.uk

ABSTRACT

High growth firms (HGFs) have attracted an increasing amount of attention in the last decade as economies begin to emerge from a period of deep recession and policymakers take a renewed interest in firms which generate jobs on a large scale. The origins of the literature on HGFs lie (somewhat improbably) in a late 1970s consultant's report by David Birch which investigated the relative importance of firm migration in accounting for cross-regional variation in job creation. He was surprised to find that a relatively small number of firms– largely *small* firms – accounted for a relatively large proportion of job creation. Although Birch's claim about the extent of the small firm role in job creation proved controversial, the broader conclusion, about the key role of a small number of firms, became widely accepted quite quickly. However, despite the attention given to HGFs by policy-makers and researchers, surprisingly little seems to be known about the longer-term performance of HGFs and, in particular, about their growth outside the period which led them to be classified as HGFs.

The principal contributions of this paper build on the distinction between high-growth *episodes* and high-growth *firms*. The 'birth' of an HGF is marked by its first high-growth episode, but the HGF may (indeed is quite likely to) record further high-growth episodes in subsequent years. We use data on the first 15 years of life of a cohort of UK firms born in 1998 to populate a set of demographic accounts which recognize the episode/firm distinction and track the performance of HGFs from birth, recording their age at subsequent episodes and their chances of survival. Then, by constructing a parallel set of accounts for non-HGFs, we are able to determine the extent to which HGF status improves survival chances and estimate the relative importance of the HGF contribution to job creation. It becomes clear that a failure to recognize the distinction between episodes and firms gives a misleading picture of HGFs, their numbers and their contribution to job creation and potentially confuses the policy debate on scale-ups.

Keywords: high growth firms; birth cohorts; firm demography; job creation

JEL codes: D22; E24; L11; L25; M13

CONTENTS

1. CONTEXT AND MOTIVATION

High-growth firms (HGFs) have attracted an increasing amount of attention in the last decade. Of course it is hardly surprising that as economies begin to emerge from a period of deep recession policymakers would take a renewed interest in firms which generated jobs on a large scale. The origins of the literature on HGFs lie (somewhat improbably) in a late 1970s consultant's report prepared by David Birch which investigated the relative importance of firm migration in accounting for cross-regional variation in job creation (see Birch [1979]). He was surprised to find that a relatively small number of firms – largely *small* firms – accounted for a relatively large proportion of job creation (for an accessible summary see Birch [1981]). Although Birch's claim about the scale of the small firm contribution to job creation proved controversial (see for example Davis et al. [1996]), the broader conclusion became widely accepted quite quickly (see for example the discussion in Storey and Johnson [1987]), and interest in it continues (for three recent contributions see Neumark et al. [2011], Haltiwanger et al. [2013] and Anyadike-Danes et al. [2015]).

Systematic investigation of Birch's findings was long hindered by a paucity of appropriate firm-level data but, particularly since the mid-1990s, as the data deficiency was made good, policymakers began to take an increasingly active interest in HGF research,

> "[We have] the empirical observation that there is typically a small group of firms that are responsible for a large share of new jobs created. These rapidly expanding firms, by way of their supposed or actual potential to generate jobs, have attracted the attention of policy makers, eager to reduce unemployment." Schreyer [2000, p. 6]

This growing interest, in turn, motivated the OECD to initiate a programme of work which aimed both to measure the contribution to job creation of these 'rapidly expanding firms' – which they christened *high growth firms* – and to investigate their differentiating characteristics (see Schreyer [2000], OECD [2002]). One of the by-products of this work was an internationally agreed definition of an HGF (set out below) and a chapter dedicated to HGFs in the Manual of Business Demography

(see EUROSTAT-OECD [2007, Chapter 8]). Although measuring the contribution to job creation played a role in the OECD's choice of definition, its potential for use in international comparisons appears to have been decisive in preferring it to the alternative high growth metric proposed by Birch (see the discussion in Ahmad [2006, p. 57], and for Birch's "growth index", see Birch [1987, pp.36–38]).[1] In 2008, a year after the publication of the Manual of Business Demography, the OECD began publishing data on HGFs (see OECD [2008, Section B]), though not for the UK.

However, despite the availability of an internationally agreed definition, and the attention given to HGFs by policymakers and researchers, surprisingly little seems to be known about the longer term performance of HGFs and, more specifically, about their growth outside the period which led them to be classified HGFs. Indeed, many studies have focused on a relatively short time period and used just a single episode of high growth to identify HGFs. Comparisons of HGF and non-HGF firm characteristics are then made using that single episode as a marker without ever enquiring whether, for example, some of the non-HGFs may, in fact, have been HGFs, perhaps as recently as the previous year. Equally, it is very rarely asked whether HGF status, once acquired in the period under study, is predictive of future performance. In particular, there has been virtually no investigation of the extent to which one high growth episode is followed by another, in the next year, or ever after.

In this paper we explore four tightly interrelated HGF issues: fecundity; fertility;[2] survival; and growth. By 'fecundity' we mean the potential for a firm to be classified as a HGF. First, fecundity and fertility. Each period some firms record their first high-growth episode, and a new sub-cohort of HGFs is born – HGF cohorts within

---

[1] However the "growth index" continues to be used, see for example the study of "high-impact" firms and job creation (Acs et al. [2008]) for the US Small Business Administration, and for a discussion comparing the properties of the growth index formulation with the OECD measure see Hölzl [2014].

[2] Usages of these two terms differ – "'Fertility' in standard English demographic usage, refers to the actual reproductive performance, as measured in live births, of a woman ...'Fecundity' on the other hand, refers to the physiological capability of an individual .. to produce a live child, whether or not such a capability is actually exercised. By contrast, the meaning of the terms 'fertility' and 'fecundity' is reversed ... in biology. 'Fecundity' in that usage thus refers to actual live births and 'fertility' to the ability to procreate." Ross [1982, Volume 1, p.240]
We adopt the demographer's usage.

the birth cohort. Fertility is relevant too, because members of each sub-cohort may record subsequent episodes of high growth. But, necessarily, the size of each new sub-cohort depends on the fecundity of remaining non-HGFs, and how many firms remain in the non-HGF pool. We use data on the first 15 years of life of a cohort of UK firms born in 1998 (cohort98) to populate a set of demographic accounts which recognise the episode/firm distinction and track the performance of HGFs from birth, recording their age at subsequent high-growth episodes and their chances of survival. Then, by constructing a parallel set of accounts for non-HGFs we are able to determine the extent to which HGF status improves survival chances and estimate the relative importance of the HGF contribution to job creation.

The rest of the paper is organised into seven sections. The first four deal with preliminaries: describing the sources of the data; the identification of HGFs; a brief look at the (very) limited literature on HGF persistence; and a description of the key features of cohort98 whose fecundity, fertility, survival and growth we will be analysing. The bulk of the analysis is reported in sections 6 and 7. The first of these deals with fecundity: how many firms record an episode of high-growth? Secondly, with fertility: how many record more than one episode of high-growth?, and thirdly, the question of survival: is high-growth status 'protective'? Section 7 investigates the contribution of HGFs to job creation and to job growth and a final section collects results.

2. DATA SOURCES & CONSTRUCTION

We use the recently released UK Business Structure Database[3] (compiled by the Office for National Statistics[4]) which records annual data on employees for the entire population of firms in the UK. This data is compiled from a series of annual 'snapshots' of the Inter-Departmental Business Register (IDBR), an administrative database which captures information from a range of sources, amongst them VAT

---

[3] For a full, official, account of the Business Structure Database (BSD) and its compilation, see Evans and Welpton [2009]

[4] 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.

returns and employer Pay As You Earn (PAYE) tax and social security records. The unit of analysis is an "employer enterprise" – a business with at least one employee[5] – which we refer to as a firm. Firms may comprise a number of distinct local units (establishments or plants) but our data refer to firm-level employee numbers.

We have linked together the annual 'snapshots' from the BSD using firm-level identifiers to form a longitudinal firm-level database for the UK and have devised algorithms to produce firm-level demographic markers for 'birth' and 'death'. The birth of a firm is dated by the first appearance of non-zero employment and its death is treated symmetrically and dated by the disappearance of the last employee. The data do not distinguish between *de novo* births and those which result from the break-up of an existing firm, similarly the data do not distinguish between the closure of a firm and its disappearance due to merger. Although the data start in 1997, firms alive in 1997 could have been born in any previous year, so the first birth year we can identify with certainty is 1998.[6]

Firms are classified as either 'private' or 'public' sectors and we make this split using the classification by industrial sector. All employees in – public administration and defence; education; and health and social work – SIC92[7] sections L, M, N – are classified as public sector. Of course, some firms in these sectors (in health and/or education for example) are private, and some firms in our private sector are public, but ours is a reasonable approximation and ensures that most typically longer lived public entities (like schools and hospitals) do not distort our age-related calculations.

---

[5] Since an employee can work for more than one firm summing over firms produces an estimate of jobs rather than employment, we ignore this distinction here and use the terms employment and jobs interchangeably.
[6] The database which underpins this study – the Longitudinal Business Structure Database – can be accessed by approved researchers through the ONS Virtual Microdata Laboratory or the UK Data Service Secure Lab.
[7] the UK version of the EU NACE rev.1

3. HIGH-GROWTH FIRMS

3.1 Definition

Here we investigate HGFs using the recommended three year growth period. The Eurostat-OECD metric for identifying an HGF (see EUROSTAT-OECD [2007, Chapter 8]) requires that we count firms which,

- are born before the beginning of the period
- are alive at the end of the period
- have at least 10 employees at the beginning of the period
- **record an annual average growth of 20% in employment[8] over the period[9]**

Note: taken together the first two conditions imply that in each period we will have a 'balanced panel' of firms – the same firms are always present throughout the period.

A little later on, and in a rarely noticed section, **The Manual of Business Demography** continues,

> "The identification of high-growth enterprises on an annual basis may lead to the inclusion of an enterprise in the population of high-growth enterprises in several years. The question arises whether a high-growth enterprise ... should be counted in more than one reference year if it fulfils the given definition. The recommendation is to do so." EUROSTAT-OECD [2007, p.63]

So what we have here is an explicit recognition that when HGFs are to be counted over successive annual – and therefore necessarily overlapping – growth periods

---

[8] Alternatively, an annual average growth of 20% in turnover over the period can be used as the criterion, but only employment is used here.
[9] In 2014 EUROSTAT changed the growth criterion used to define HGFs from 20% per year over three years, to 10% per year over three years. Although there does not seem to be any published rationale for this change, the Statistics Directorate of the OECD confirmed that the HGF threshold was lowered to suit the data requirements of an innovation indicator (OECD[2018]). EUROSTAT still collects data on the 20% criterion, but Member States supply it on a voluntary basis. The OECD publishes data on both definitions, see OECD[2017, pp. 90-93]

a firm may be counted more than once. And this recognition is the starting point for our discussion here.

Specifically, we introduce the distinction between HGFs and high-growth episodes (HGEs). Adapting the terminology of **The Manual of Business Demography**, we define a High Growth Episode (HGE) as a three-year period in the life of a firm over which its job numbers grow by 72.8% from a base of 10 or more. This, in turn, allows us to distinguish the date of a firm's first episode from any subsequent episode. In other words the first HGE is, essentially, the period in which a firm is first categorised (or 're-born') as an HGF.

Obviously, distinguishing between episodes and firms gives some structure to the relationship between HGE numbers and HGF numbers: having experienced one HGE an HGF may (possibly) never experience another, or (more likely) it may experience many more. Consequently, there will no longer be (necessarily) a one-to-one relationship between the numbers in the HGF population and the number of HGEs. So, a key purpose of the measurement framework set out below is to track the evolution of the population of HGFs and, alongside it, the numbers of HGEs they record. However, it should be borne in mind that the number of HGEs is, in fact, the conventional measure of the number of HGFs.

3.2 Implementing the HGF definition

Here we wish to investigate the role of HGFs in cohort98 applying the conventional OECD definition and we use the recommended period of three years (EUROSTAT-OECD [2007, p. 61]) – *the growth period* – for measuring growth. So, starting with 1999 (because HGFs must be at least one year old), there are 12 (overlapping) growth periods – from 1999/2002 to 2010/2013 – in which a firm born into cohort98 might record an 'episode' of high growth. You will notice that we have just introduced the possibility of a distinction between 'high-growth firms' and 'episodes of high-growth':[10] either one might assume that an HGF is to be treated as just a

---

[10] The term an 'episode of high-growth' as used here denotes that both the condition on size, and on growth, are satisfied.

period-specific phenomenon (firm x is an HGF in period y); or one might assume that a firm need only record one episode of high-growth to be classified as an HGF for the rest of its life.[11]

We take the second view – a single episode of high-growth is sufficient for a firm to be classified as a HGF. In fact, emphasising the time-related element, we might describe these firms more precisely as **ever previously** HGFs (abbreviated to HGFs where there is no ambiguity, ever-HGFs where there is) where the rest of the firm population are **not-yet**-HGFs, which (for brevity) we will refer to as **non**-HGFs.[12]

Neither of these methodological choices – overlapping periods *versus* consecutive periods; and high-growth firms *versus* high-growth episodes – seem to have precedents in the (admittedly very sparse) literature on the performance of HGFs over time. The case against consecutive periods is simple. If we have, for example, a pair of consecutive 'growth periods', 1999 – 2002 and 2002 – 2005, any firm which happens to record a high-growth episode in 2000 – 2003 or 2001 – 2004 *will not be classified as an HGF* using the consecutive approach.

The advantage of the overlapping period approach is that all HGF episodes are identified, not just those in consecutive periods, but it has the (possible) disadvantage that it may overestimate the number of high growth episodes. If, for example, a firm records four consecutive years of 20% growth in jobs, it will be counted in our over- lapping periods framework as an HGF with a subsequent episode of high-growth. We explore the extent of this effect by comparing the frequency distribution of HGF episodes across firms with the frequency distribution of strings of HGF episodes.

---

[11] This issue does not seem to have been discussed in the literature on HGFs. Certainly, it is not mentioned in the OECD/EUROSTAT presentation of methodology, but that may be because their statistical publications seem principally concerned with a 'beauty parade' – a cross-country comparison of HGF 'shares' of the stock of firms. See for example, OECD [2011, p. 74].
[12] Notice this is a prospective, 'forward-looking', definition not, a retrospective 'backward-looking' definition. We do not consider the pre-episode history of HGFs.

4. A REVIEW OF THE LIMITED LITERATURE ON HGF 'PERSISTENCE'

The study of HGFs, like the study of firm growth more generally, seems peculiarly afflicted by differences in the definition of indicators used and the scale and scope of data analysed.[13] So, despite the widespread interest shown in HGFs by both researchers and policy-makers, the evidence base still seems quite underdeveloped. This applies particularly to the questions of fecundity and fertility: is HGF status persistent? That is, do HGFs record repeated episodes of high-growth?

There appear to be only three published studies which address this issue and they use differing measures and data from different countries: Dillen et al. [2014] (employees and value-added in Flanders), Hölzl [2014] (employees in Austria) and Daunfeldt and Halvarsson [2015] (employees and sales in Sweden). The key differences between them are,

- Dillen et al. [2014] and Hölzl [2014] use the OECD approach to defining HGF status (although Hölzl [2014] also reports results for an alternative), whilst Daunfeldt and Halvarsson [2015] use quantiles of the firm growth rate distribution to identify fast growing firms

- only Dillen et al. [2014] uses the same 'overlapping' 3-year periods framework as we do, the other two analyse 'consecutive' 3-year periods

- none of the three use birth cohort data, and although Dillen et al. [2014] and Hölzl [2014] do have data on firm age (Daunfeldt and Halvarsson [2015] do not), Dillen et al. [2014] do not track HGF persistence by age, Hölzl [2014] does include firm age in a regression model of persistence.

Although there is a limited overlap between these three studies and ours it is worth rehearsing their key conclusions since they will, at least, provide some context for

---

[13] In the introduction to a 2010 special issue of *Entrepreneurship Theory and Practice* the issue's editors provide a concise summary of the 'state of play': "Even though there has been sustained interest in [firm] growth for almost 50 years, relatively little is known about this phenomenon and much misunderstanding and confusion surrounds it." Leitch et al. [2010, p. 249].

conclusions fairly fully:

> "It appeared that more than half of the firms that were identified as a high-
> growth firm in the period 2000-2009 could only maintain this status for one
> of the seven analysed three-year periods ... Furthermore, it became clear
> that only a very limited number of firms were able to be qualified as a HGF
> in at least four of the seven periods. There is – in other words – a large
> difference between the number of '*one-shot' HGFs* and the number of
> *'persistent HGFs'*." Dillen et al. [2014, p. 315]

Hözl [2014] used a matching estimator – which compared HGFs to an
otherwise comparable "control group" – to provide the foundation for his
conclusions about HGF persistence, which were:

> "Fast-growing firms have a higher probability than a control firm of being a
> fast-growing firm 3 or 9 years after their high-growth event. However, the
> HGF effect is small. Most HGFs are not able to replicate their high-growth
> event and are 'one-hit-wonders.'" Hölzl [2014, p. 225]

Finally, we have the Daunfeldt and Halvarsson [2015] study, but remember that in
their case the results refer to quantiles of a growth rate distribution, not an OECD-
type threshold measure,

> "Our results indicate that rapidly growing firms are likely to show declining
> growth in the next period, irrespective of choice of growth indicator or the
> growth rate cutoff level. The probability that high-growth firms will repeat
> high growth is as low as 0.01, which is the same probability that some
> arbitrary firm would be included in this growth category to begin with."
> Daunfeldt and Halvarsson [2015, p. 362]

---

[14] It is a little surprising to find that the editors of a section devoted to HGFs in a recent
issue of *Industrial and Corporate Change* suggest in their discussion of a list of "Seven
stylized facts about HGFs" that HGF status is not persistent, citing in support just Hölzl
[2014], Daunfeldt and Halvarsson [2015], and a very small-scale (about 100 firms) study
Parker et al. [2010], see Coad et al. [2014, p. 99].

5. INTRODUCING COHORT98

The basic facts of cohort98 can be summarised quite simply and are set out in Table 1. At birth there were 240 thousand firms and just over 1 million jobs, fifteen years later only 26 thousand firms remained alive with about 400 thousand jobs. So, in just 15 years 213 thousand firms died and almost three quarters of a million jobs were lost. One in ten firms survived to 2013, but the number of jobs in the surviving firms more than doubled, so - on average - survivors did grow. The 'growth ratio' for 15 year-old firms, computed as jobs/firm in 2013 divided by jobs/firm in 1998, is equal to 2.41, and implies an annual average growth rate of 6% in jobs/firm (and equal, by definition, to the annual average growth in the stock of survivor jobs).

Some key measures of the evolution of the cohort are plotted on Figure 1 against a log scale so that the relative rates of decrease in firm and job numbers are easier to see. Most of the loss of jobs occurred in the first five years (with a very steep drop in the year after birth). The rate of decline in firm numbers was even steeper, and continuous, but with a falling rate of decline. So, for example, between 1998 and 1999, 40 thousand firms died, whilst just two thousand were lost between 2012 and 2013. The path of jobs/firm shows an initial dip (reflecting the large loss of jobs in the year after birth), after which the average size of firms expanded relatively smoothly, since job numbers were relatively stable and firm numbers fell.

As we have just seen, the definition of HGFs focuses on firms with more than 10 jobs, so the evolution of the firm size distribution is an important part of the background too. Table 2 reports the firm size distribution and the corresponding distribution of jobs for smaller (1–9) and larger (10+) firms. Although a vast proportion of the dramatically shrinking number of cohort98 firms have less than 10 jobs from birth to age 15, the share of smaller firms does change quite systematically. From the table we see that the 1 – 9 size-band share contracts by about five percentage points each five years, from just over 95% at birth to 80% at age 15. This systematic shift is driven by two factors: size-dependent survival effects – smaller firms are more likely to die; and growth – smaller firms (which survive) grow faster than larger firms. Of these two influences, the growth effect is

by far the more important.[15]

The 'jobs' columns of the table complete the account of the size distribution. Whilst the firm size distribution is dominated by a large number of small firms, the distribution of jobs by firm size is dominated by the relatively small number of larger firms. At birth the larger firm share of jobs is just over 60%, by age 15 it is more than 20 percentage points larger. Of course this is hardly surprising given the change in the size distribution of firms.

6. HGFS AND HIGH-GROWTH EPISODES

To describe the evolution of the HGF population we have set up a simple demographic accounting framework which records the key events. The most fundamental event is, of course, the 'birth' of an HGF, the period when a firm records its first high growth episode, and enters the HGF population. We also want to track what happens in the *next* period, and to do so we distinguish three mutually exclusive possibilities,

- death
- a further high-growth episode
- not another high-growth episode

and this classification is applied to all HGFs in each growth period.

We also keep track of the non-HGF population which is also classified each period into three mutually exclusive possibilities each period,

- death
- less than 10 jobs
- 10 or more jobs

The non-HGFs with 10 or more employees are distinguished because they are the group which is 'HGF-eligible': a firm with more than 10 jobs at the beginning of a growth period might have become an HGF; a firm with less than 10 jobs could not.

---

[15] For a detailed discussion of both these factors and their relative importance in cohort98, see Anyadike-Danes and Hart [2018].

In the 12 growth periods spanning the years 1998 to 2013 there were 3,331 cohort98 firms which recorded at least one high growth episode (7,146 episodes in total), however, only 1,912 of these HGFs survived to 2013. Data from cohort98 has been used to populate the accounts which are displayed in Table 3 and provide the background to the following discussion.

6.1 First episode

We start with a simple count of the distribution of HGF births in each period: how many firms become HGFs in each 3-year period? We can see from Figure 2 that in the first period (1999/2002) there are close to 800 (the precise figure, from the first row of Table 3, is 779). The number drops dramatically in the second period, by almost half, to just over 400. After a pause in 2001/2004 the decline resumes, albeit at a slower pace, and continues to fall (though not monotonically) until the last period (2010/2013) in which just 141 new HGFs are born. So, by 2010/2013 HGF births are down to 20% of their 1999/2002 numbers. It is also worth noting that the numbers dip in 2008/2011 and 2009/2012 – two periods particularly affected by the Great Recession (GR) – and then move back up closer to their pre-GR level.

Between birth and age 15 in 2013 90% of cohort98 died. With the non-HGF pool drying up as the cohort ages it is hardly surprising that the number of newborn HGFs falls over time for that reason alone. But, to better understand HGF dynamics, we need to separate changes in the incidence of HGFs per period from changes in the size of the 'population at risk'[16] of recording a first HGF episode.

Firms in the HGF-eligible population have two characteristics: they have not previously experienced a high-growth episode; and they have 10 or more jobs in the first year of the growth period. The first requirement is obvious, it ensures we avoid double-counting new entrants into the HGF population. The second requirement is less obvious, but it is needed to ensure that we include only those firms that could possibly become HGFs in the period. The same logic suggests a

---

[16] We use this term as an alternative, but equivalent, to the term 'risk set': "The set of individuals for which the event of interest has not happened before a given time t..., and who have not been censored before time t, is termed the *risk set* at time t." Aalen et al. [2008, p. 4].

third requirement: the population at risk should include only firms which are still alive at the end of the growth period, that is, only firms in the balanced panel for that growth period.

In 1999 there were 4,970 firms 10+ firms, which survived to 2002 (that is, in the 10+ balanced panel), by the last growth period in 2010 the number had shrunk by a third to 3,249. Evidently the rate of attrition in the size of the population at risk is very much slower than the rate of decline in the number of new HGFs. Let us define the *entry rate* as the number of firms recording their first episode of high-growth (that is non-HGFs) divided by the population at risk (the HGF-eligible members of the non-HGF population with 10+ jobs and in the balanced panel). As you can see from the upper line of Figure 2, the entry rate starts at about 16% and by 2010/13 has fallen to 4%:[17] a firm from the population at risk was four times more likely to become an HGF in the first period than it was in the last. *Clearly fecundity declines with age.* The 'dip' in HGF numbers in the GR period noted earlier is equally evident in the entry rate. From 4% in 2007/10 it drops to 2.5% before recovering to just over 4% in 2010/13. By implication the recession affected the growth of cohort98 firms but not their survival or size-distribution.

6.2 Further episodes

We can describe the distribution of the 'further' high-growth episodes over time in three different, but complementary, ways. The first column of Table 4 records data on the frequency distribution of the 3,331 HGFs by number of episodes, and we can see that more than half of all HGFs record more than one episode of high-growth. Indeed 96 of them record 6 or more episodes. Column (2) displays the frequency distribution of 'strings' of different lengths – the length of the string is the number of consecutive episodes of high-growth. The most common string is of length one of which there are 1,572, and most of those are recorded by the 1,420 firms reporting a single episode. By implication though there are at least 352 firms recording at least one of their multiple episodes as a single isolated episode. We can draw the same conclusion about strings of length two and three: many of these are

---

[17] See Anyadike-Danes et al. [2013, Figure 5.3] for evidence that in each of the UK cohorts born between 1998 to 2007 recorded an HGF entry rate between 12% and 15% in their first growth period.

firms with more than two or three episodes. Equally, at the other end of the distribution, many more firms record six or more episodes of growth than those which record six or more *consecutive* episodes. Finally, the third column shows the distribution of the 7,146 episodes by number of episodes (for all except the 6+ category this is simply the product: firms by episodes). The mean of this distribution is just above two (= 7,146 ÷ 3,331), whilst both the mode and median are three – clear evidence of HGF fertility.

Figure 3 provides some perspective on the distribution of further episodes over time. It displays the number of further episodes per period as bars stacked on top of the bars for the number of first episodes per period. For the first few periods the number of further episodes increases, but from 2003/2006 they decline, though more slowly than first episode numbers. Notably, from 2002/2005 onwards, the number of further episodes exceeds first births and in 2008/11, a GR year, subsequent episodes were more than three times the number of first episodes.

The differing trends in the numbers of first and subsequent episodes, and the predominance of further episodes in later periods, may not be quite as remarkable a finding as it first appears. Consider the different populations at risk. For first episodes (as we know) it is firms with 10 or more jobs, surviving the growth period, and, necessarily, *no previous high-growth episode*; whilst for subsequent episodes it is the number of HGFs alive in the previous period. These two series evolve very differently. We know the population at risk for first episodes shrinks by a third, whilst the number of HGFs alive rises almost continuously (although its growth slows, necessarily, as new HGF births slow down). In the first period there are six times as many firms in the 'pool' of 'non-HGFs' as there are HGFs alive. By 2010/2013 the ratio between the pool and the number of HGFs alive had dropped to 1.5.

The evolution of further episodes as the cohort ages can most easily be visualised if we compute the *'further rate'* – the ratio of HGF further episodes to the population at risk – here, the number of HGFs alive in the previous period. The further rate is plotted on Figure 4, it is the line towards the top of the chart, and the bars along the bottom are the numbers of further episodes (repeated from Figure 3). The rate starts very high at about 50%, and then declines, initially quite steeply, mostly at a decreasing rate, over the next 10 periods. By 2010/2013 it has fallen to 10%. *Fertility, like fecundity, declines with age*.

Although it is not obvious from the data we have presented so far, the incidence of further HGF episodes depends not just on firm age but also on the time since a firm's first high-growth episode. To illustrate this we can compute the further rate separately for each 'sub-cohort', where a sub-cohort is defined by the period in which the first episode was recorded. In our case then, there are 12 sub-cohorts. We have averaged the further rate period by period from first birth for each sub-cohort and the results are plotted in Figure 5. The rate is very high in the first period after the birth of the sub-cohort – about 50% – it is a little lower at the second lag, after which it fluctuates, largely trendlessly between 6% and 9%.[18] An alternative way of interpreting this finding is that for many HGFs the initial period of sustained high-growth lasts longer than three years.

As we saw earlier Dillen et al. [2014], Hölzl [2014] and Daunfeldt and Halvarsson [2015] all took slightly different views about HGF persistence. Obviously, there is a qualitative element in such conclusions, but we have found rather more 'persistence' than any of these studies. Certainly the term 'one-hit wonders' would not seem to accurately describe the fertility of HGFs born into cohort98.

6.3 Survival

The first sub-cohort of HGFs are, by definition, alive in 2002, consequently 2003 is the first year an HGF can die. As we can see from Table 3, of the 779 HGFs born in 1999/02, 76 die in 2003, so the hazard rate[19] is 9.8% (76 /779). Now we can compute a comparable hazard rate for larger non-HGFs – the risk of death in 2003 of non-HGFs with at least 10 jobs in 2002 – and it is 11.5%. So, comparable non-yet-HGFs are one fifth more likely to die in 2003 than are HGFs (alternatively put, the hazard *ratio* is 1.2). These two hazards are plotted on Figure 6. They both decline (almost monotonically) as the cohort ages, albeit slightly bumpily. By 2013 the HGF hazard rate is 3.2%, about one third its value in 2003, the larger non-HGF

---

[18] It is difficult to be precise at the longer lags because there are fewer and fewer sub-cohorts represented in the averages: by the 11th lag there is just one sub-cohort, at lag 10 two, and so on. More over there may be 'period' effects since the GR occurs at periods 9 and 10 for the first sub-cohort and periods 8 and 9 for the second and so on.

[19] The formal definition of this concept is: "The hazard rate $\alpha(t)$ ... is defined by means of a conditional probability ... one looks at those individuals who have not yet experienced the event of interest by time t and considers the probability of experiencing it in the small time interval $[t, t+dt)$. Then this probability equals $\alpha(t)$." Aalen et al. [2008, pp. 5–6]

hazard falls slightly less (by about 40% of its 2003 value), so the hazard ratio has risen (to about 1.4), and the larger non-HGF hazard is about one percentage point larger than the HGF rate.[20] Although the clear conclusion is that an HGF episode is 'protective' – it increases the chance of survival – the size of this effect is quite modest and, as we can see from Figure 6, the hazard rate for HGFs is always very close to boundary of the 95% bounds of the larger non-HGF hazard.[21]

The third hazard rate, at the top of the chart, is for smaller (less than 10 jobs) non-HGFs. Clearly, these firms run a greater risk of dying than either category of larger firm. In 2003 the hazard rate is about 15%, more than five percentage points higher than the HGF rate (and three percentage points above the larger non-HGF rate). Notice too that the 95% bounds around the smaller non-HGF hazard rate are very tight, so this rate is always considerably above that for either category of larger firms. It seems reasonable to conclude that it is size, rather HGF status, which is the more important in improving a firm's chances of survival.[22]

Of the three papers on HGFs discussed earlier only Hölzl [2014] deals explicitly with survival. His approach (as noted earlier) is based on 'matching' and is intended to ensure the sharpest possible contrast between HGFs and non-HGFs. He makes two sets of comparisons. Firstly, he makes an HGF/control comparison on samples matched in the first year of the growth period and he finds a significant positive effect of HGF status on survival. Secondly, he makes a comparison based on an HGF/control match based on the terminal year of the growth period. In the second comparison he finds no significant effect of HGF status on survival. His conclusion is that it is not HGF status which is improving survival chances but the increased size produced by the HGF episode. So, our findings, which rely on an

---

[20] The HGF hazard rate is computed period-by-period so it is, in effect, an average across the collection of the 'sub-cohorts' (defined by date of HGF first episode). However, a careful examination of the sub-cohorts did not reveal any systematic evidence of a 'time since first episode' effect of the kind we found in the frequency distribution of subsequent HGF episodes. The sub-cohort series are quite noisy period-to-period, fluctuating between 5% and 7%, and whilst they generally decline, the very small numbers, especially in the later years when HGF first episodes themselves are small (and fluctuating), make it impossible to draw any more precise conclusions. Certainly, there is no evidence that the average plotted on Figure 6 is not a reasonable estimate.
[21] This shaded region was computed as the region between the bottom 2.5% and upper 95% of the hazard rate distribution using a bootstrap with 1,000 replications.
[22] This is consistent with other findings that in UK cohort98 size is good for survival, see Anyadike-Danes and Hart [2018].

entirely different approach, reach much the same conclusion: an HGF episode is protective but, when compared to larger non-HGFs, only modestly so.

7. JOB CREATING FIRMS, JOB CREATION AND JOB GROWTH

Whilst the OECD definition of HGFs has achieved some degree of acceptance, there has been little discussion of how to measure HGFs' contribution to job creation, and certainly there is no agreed methodology. This lack of agreement is all the more puzzling because the initial rationale for the identification of HGFs was, in fact, their role as prolific job creators. So, our motivation here is simple, to investigate how best to answer the question: what proportion of job creation is contributed by high-growth firms? Accounting for job creation has been considerably simplified in our case by focusing on a single birth cohort. We need not bother about start-ups (born in the initial year of the growth period) or any firm born during the growth period.[23] Of course, our choice of a three-year growth period effectively commits us to a three-year measurement period (t to (t+3)) for our investigation of job creation.

7.1 Firms

Table 5 displays data on the groups and sub-groups of firms of interest here. In the first column we have the total number of firms in cohort98, this is, in fact, a subset of the data plotted on Figure 1. It starts in 1999, the initial year of the first growth period, and runs up to 2010, the initial year of the final growth period. You will notice there is a systematic relationship between the overall firm count in column (1) and the numbers in the balanced panel in column (2). By definition, firms in the balanced panel in column (2) are those alive in the initial year of the growth period which are still alive in the terminal year. So, we record data for firms alive in 2002 against the first growth period 1999/2002 in column (2). Necessarily, this is the

---

[23] For a more comprehensive approach with a fully articulated set of accounts see Anyadike-Danes et al. [2013, Chapter 3]. For a discussion of the construction job creation accounts see the Technical Appendix to Davis et al. [1996].

same number of firms which are recorded against 2002/2005 in column (1) (because we have no start-ups).

The third column is a sub-set of the balanced panel, a count of the number of job creating firms (JCFs). Of more immediate interest than the JCF numbers themselves is their ratio to the size of the balanced panel - (recorded in column (4): although the ratio does fall slightly between the first growth period and the second, it remains quite remarkably constant over the following 11 growth periods, fluctuating just one or two percentage points around its average value of 30%. So, *in each period*, about one-third of the firms which survive a three-year period create jobs.

The data in the remaining columns all refer to 'larger' JCFs – those with 10+ jobs at the beginning of a growth period. The overall numbers are displayed in column (5), whilst column (6) reports their share of all JCFs. Now we know from Table 2, that there is a substantial shift from small to large in the firm size distribution and (unsurprisingly) this is also the case for JCFs, the 10+ share of the JCF total quadruples from about 6% in 1999/2002 to 26% by 2010/2013. Since firms grow by creating jobs, those job creators which start small may, quite quickly, become large. From Figure 7 we can see how the composition of this 'larger' firm category changes (the data are computed from columns (7) to (10) of Table 5). The two lines at the top of the plot show that the shares of non-HGFs and HGFs (the two components of column (6) measured as shares of all job creating firms). The non-HGFs have a slightly larger share over all but one of the periods, whilst in 2010/2013 the shares are roughly equal at 13% each.

The remaining two lines on the plot provide two other measures of HGF importance. The 'HGFcur' series counts all firms which are HGFs in a particular period, whether this is their first episode of high-growth or a subsequent episode; the 'HGFfirst' series is (as the name suggests) a count of those firms recording their first episode. Necessarily the HGFcur series is larger, and although it grows in the first couple of periods (in the first period, by definition it is exactly equal to HGFfirst), the share settles between 4% and 5%, where it remains. There is a

similar degree of stability in the HGFfirst series which accounts for between 1% and 2% of all JCFs.[24]

7.2 Jobs

We have compiled the data on the actual number of jobs in Table 6, and for each of the categories of firms in Table 5, we have recorded two columns. The first of each pair is the 'initial' jobs – the jobs in the first year of the growth period, and the second column in each pair is the difference in jobs between the initial and terminal years of the growth period ('diff').

The first category is all firms, and the 'diff' column – always negative – confirms what we saw on Figure 1: overall job numbers in cohort98 fall continuously, but at a slightly declining rate. The contrast with the 'balanced panel' (columns (3) and (4)) is clear. If we focus on firms which survive three years then it is hardly surprising that they record (at least overall) an increase in jobs over three years. Equally, if we then exclude firms whose job numbers decline (or remain the same) over a three-year period – that is we consider only job creating firms (columns (5) and (6)) – then the increase over each three-year period will be even larger. Now we have seen already (from Table 2) that the share of jobs in larger firms increases disproportionately as the cohort ages, and as we can see by comparing column (8) – the increase in jobs in larger JCFs – with column (6) – the increase in all JCF jobs – this is true of JCFs too. In the first period larger JCFs contributed less than half the job increase (= $102.8 \div 246.7$), by 2010/2013 the proportion has risen to two-thirds (= $59.4 \div 75.9$).

Our particular interest here is the remaining columns which divide the larger JCFs into different sub-categories. As with the firms data we have plotted some key proportions, as shares of total job creation (the overall change in JCF jobs) and they are displayed on Figure 8. Notice first of all that the non-HGFs' contribution

---

[24] The HGFcur series is, of course, the number which is picked up in conventional measures of HGF importance. However, it is equally conventional to express that number as a ratio to larger JCFs, rather than all JCFs. The ratio of HGFcur to larger JCFs here varies considerably as we might infer from the relative slopes of the curves for larger firms, which slope upwards quite steeply, and the HGFcur series which is essentially flat. The ratio HGFcur to larger JCFs halves: in 1999/2002 it is about one third, by 2010/2013 it is about 15%.

is very small and almost constant, around 10%. Quite different to the firm picture in Figure 7, where the corresponding firm share climbed steadily from 3% to 13%. In strong contrast, the ever-HGF series rises steeply (but somewhat unevenly) from its starting value of 30%, doubling by 2010/2013. Much of the 'ever' amount is contributed by current period HGFs, however, this series does not rise after the first few periods By 2001/2004 it has reached 40% and that it is, roughly, where it stays for the next 10 periods (though it does fluctuate through the GR period).

From the comparison of the evolution of these two series we can infer that the accumulating number of firms which have previously recorded an HGF episode, but are not currently HGFs, continue to create jobs on a significant scale. Their contribution is, of course, the difference between the ever-HGF curve and the HGFcur curve: it widens gradually (remember at the beginning most HGFs are current period HGFs), and from 2008/2011 onwards it is around 30 percentage points. About one-third of jobs created by HGFs are being created by HGFs which are *not currently* experiencing an HGF episode. The further implication is that the conventional measure of HGFs' contributions to job creation, which is (typically) a single snapshot of the HGFcur series, leaves out of account entirely the contributions of HGFs outside the current episode.

Finally, notice that the first episode curve runs along the bottom of the chart with a share that falls (even though the HGFfirst share of firms does not), and for the last five or so periods newborn HGFs account for around 5% of job creation.

7.3 Job growth

Historically the interest in HGFs stemmed from their contribution to job creation. However, the algorithm for identifying them relied on their rate of growth, so it seems appropriate to close the discussion by investigating the growth rates of the different categories of 'large' (10+ job) JCFs. We have calculated average jobs per firm for each three-year growth period and then used those averages to compute a 'growth ratio' – the ratio of jobs/firm in the terminal year to jobs/firm in the initial year – the lower bound for an HGF episode is of course 1.728 (20% annual growth compounded three times). The series are plotted on Figure 9.

The growth ratios of the HGFcur and HGFfirst series are (of course) at the top of the chart, and although there is very little difference between the two series, the

average growth in subsequent episodes of high growth is virtually always about one percentage point higher than in first episodes (a 'learning' effect dominates a 'fatigue' effect). After a sharp drop following the first period, both rates decline continue to fall, albeit very gradually (but with a temporary 'blip' in 2002/2005). Whilst the rates remain (necessarily) above the threshold, it appears that even the average growth of HGFs does decline slightly with age.[25] However, even in the last period, annual average HGFcur growth is about 36%, almost twice the HGF threshold. This seems a quite striking finding: as the cohort ages, although first episode numbers fall, and with them subsequent episode numbers, even though there is some age-related slight slackening in growth, exceptional growth can be recorded at any age.

For the first few periods the growth of ever-HGFs is dominated by recent (first and early subsequent) episodes of high-growth. The growth ratio declines quite steadily as the cohort ages, and in 2005/2008, it drops slightly below the HGF threshold. By the final growth period, 2010/2013, the annual average rate is down to 14%. Whilst ever-HGFs taken together account for about one third of job creation, they are not growing very quickly. However, another striking result is that the ever-HGFs – remember these are firms which had at some time in the past recorded an HGF episode, but are not currently doing so – by the last period were growing at an average rate very little faster than non-HGFs, firms which had never recorded a high-growth episode (and whose average annual growth is never more than 10%). The implication is clear: having recorded a high-growth episode seems to confer little long-term growth advantage over non-HGFs of a comparable size (that is non-HGFs with ten or more jobs).

Perhaps surprisingly, none of the three papers on HGFs explore the impact of HGFs on job creation.

8. WHAT HAVE WE LEARNED?

Our first important finding is that of the 239,000 UK firms born in 1998 just 3,331 had recorded episodes of high-growth by 2013. But these HGFs, taken together, recorded 7,146 high-growth episodes. So, on average, each HGF recorded about

---

[25] For evidence on growth for the cohort as a whole see Anyadike-Danes and Hart [2018].

two episodes[26]. The rate at which HGFs were born (their fecundity) declined as the cohort aged, but even in the last period we consider (2010/2013) about 4% of the eligible population recorded a first episode. By 2013 50% more HGF episodes were being recorded by existing HGFs than there were new-born HGFs. Certainly, judging by these figures, the HGFs of cohort98 were not 'one hit wonders'. Moreover, whilst fertility (like fecundity) declines with firm age, it is also a decreasing function of time since the first HGF episode. Half of all HGFs have a further episode of high-growth in the next growth period, but three periods later the repeat proportion is down to 10%.

These findings illustrate very clearly the value of a cohort approach and an appropriate accounting framework in teasing out the, evidently, very complex dynamics of HGF performance. The key is, in fact, the ability to identify the appropriate 'population at risk' when making HGF/non-HGF comparisons. This also applies to determining the 'protective' effect of HGF status. As we have seen, another characteristic of HGFs is that they have only a moderately better chance of surviving than other firms of comparable size. Survival chances for HGFs, like those of firms more generally, improve with age but the chance of death for HGFs by 2013 was 3.2%, for similar- sized firms which had not yet experienced an HGF episode it was 4.4%.

Finally, we have a set of results for job creation and job growth. The scale of the contribution made to job creation by HGFs depends, unsurprisingly, on how we define the HGF category. Here we offer three alternatives, together with statistics for the 2010/2013 growth period:

- ever-HGFs (firms which recorded a high-growth episode in the past, but not currently having an HGF episode): 13% of JCFs; 63% of JCF jobs; and average annual job growth of 14%

- current period HGFs (firms recording a first *or* subsequent high-growth episode): 5% of JCFs; 32% of JCF jobs; annual average job growth of 36%

---

[26] For clarity, this could obviously be a six year continuous 'high-growth' period.

- new-born HGFs (firms recording their first high-growth episode): 2% of JCFs; 5% of JCF jobs; annual average job growth of 34%

The second of these three – current period HGFs – is closest to the conventional measure of the HGF share of job creation.[27] Indeed, the gross 'disproportionality' between the share of JCFs and the share of JCF jobs – in this case 5% *versus* 32% – which first attracted attention to the phenomenon we now call HGFs is clearly evident. Moreover, we have also seen that the 'disproportionality' result holds pretty consistently, even as the cohort ages and shrinks. The ratio between the HGF share of job created and the HGF share of job creating firms – an 'index of disproportionality' – hovers around eight for most of the 12 growth periods. An even more striking finding, given the (apparently common) 'one hit wonder' view of HGF fertility, is that subsequent HGF episodes play a key role in maintaining this disproportionality. In 2010/2013 new-born HGFs account for less than one sixth of the jobs associated with HGFs, the other five sixths are contributed by firms recording their second, or third (or more) HGF episode.

The final results worth noticing concern growth rates. First, HGF average growth declines with age, albeit very slowly, with older 'repeat' HGFs systematically growing a little faster than those recording a first episode. Rather more unexpectedly though, the average growth of ever-HGFs slows markedly with age, and by last period this group is not only recording a growth rate below the HGF threshold, but their rate of growth is not very much faster than that of comparable non-HGFs. Evidently with growth, as with survival chances, having recorded a high-growth episode in the past does not appear to confer a sizeable long-term advantage.

Aside from these substantive, empirical, conclusions we have also learned some methodological lessons. These findings all concern the biases which can result from studying HGFs over a few time periods. Results on the size distribution of HGFs, their age distribution and their fertility (whether or not they are 'one hit wonders'), all depend on where in a firm's life cycle HGFs are being identified and how long they are being followed. In other words, reporting statistics which average

---

[27] For a more extended analysis of the UK data see Anyadike-Danes et al. [2013, Chapter 3]

over different birth cohorts may not provide unbiased answers to questions about HGF characteristics.

Many policymakers have been very enthusiastic about the scope for intervention which HGF research might uncover. Whilst that hope continues, we should perhaps take more seriously the rather more sanguine view expressed by the 'father' of HGF studies,

> "We know that smaller, volatile firms are the major replacers of lost jobs, but we have no experience in identifying and assisting them in large numbers. Because they are small, we must reach many of them to have a measurable effect. Because they are volatile, we must monitor each individual firm's performance carefully if we are to gain maximum benefit from our invested dollars (on the high side) and avoid scandal (on the low side). From this researchers viewpoint it seems like a very difficult problem to solve administratively. A massive bureaucracy would be required to monitor individual small businesses on the scale required ..." Birch [1979, p. 4]

A more productive approach to HGF research might be to regard it not as an end itself, but rather as a means of making some progress on the broader question of understanding firm growth. For example, as we have shown, the average growth of the cohort slows with age, not only because faster growing firms grow very much more slowly, but because the proportion of firms recording exceptional growth declines.

Table 1: cohort98, firms and jobs summary, birth to age 15

	birth	survivors at birth	age 15	summary statistics	
firms '000	239.6	26.2	26.2	survival ratio (%)	10.9
jobs '000	1123.7	163.4	394.9	net job creation '000	231.5
jobs/firm	4.69	6.25	15.09	growth ratio	2.41

Notes:
'survival ratio' is the ratio of firm numbers at age 15 to firm numbers at birth
'net job creation' is the cohort jobs at age 15 less survivor jobs at birth
'growth ratio' is the ratio of jobs/firm at age 15 to jobs/firm in survivors at birth

Table 2: cohort98, firm size distribution, firms & jobs, selected ages, shares (%)

	firms		jobs	
age	1–9	10+	1–9	10+
birth	95.8	4.2	38.7	61.3
5	90.3	9.7	31.2	68.8
10	84.3	15.7	21.0	79.0
15	79.7	20.3	16.0	84.0

Table 3: HGFs demographic accounts, 1999/02 – 2010/13

(a) HGFs	1999/02	2000/03	2001/04	2002/05	2003/06	2004/07	2005/08	2006/09	2007/10	2008/11	2009/12	2010/13
first episode	779	426	430	342	245	205	209	200	163	89	102	141
further	0	391	387	422	436	382	373	373	334	285	224	206
no further	0	312	650	934	1163	1335	1411	1491	1586	1666	1699	1704
death	0	76	92	111	99	127	138	129	144	132	117	113
(b) HGFs summary:												
alive	779	1129	1467	1698	1844	1922	1993	2064	2083	2040	2025	2053
dead	0	76	168	279	378	505	643	772	916	1048	1165	1278
ever	779	1205	1635	1977	2222	2427	2636	2836	2999	3088	3190	3331
(c) non-HGFs:												
10+	4191	4180	4161	4198	4109	3853	3753	3622	3523	3412	3434	3108
10+death	3390	2639	2364	1915	1456	1096	896	828	757	679	622	520
1-9	88176	73546	60240	51068	44747	39977	35090	31310	28067	25436	22994	21001
1-9death	95851	59931	46157	33988	26397	18783	14868	12482	10911	8864	7528	6629
Memo:												
10+ balanced panel	4970	4606	4591	4540	4354	4058	3962	3822	3686	3501	3536	3249

Table 4: cohort98, HGFs frequency distribution of episodes and strings

episode length	firms (1)	strings (2)	episodes (3)
1	1420	1572	1420
2	799	810	1598
3	678	752	2034
4	211	126	844
5	127	43	635
6+	96	28	615
sum	3331	3331	7146

Note: for explanation see text.

Table 5: job creating firms by category, 1998/01 – 2010/13 (number of firms)

	all (1)	balpan (2)	JCF (3)	JCFsh % (4)	all (5)	allsh (6)	JCF size:10+ jobs nHGF (7)	evHGF (8)	HGFcur (9)	HGFfirst (10)
1999/02	192387	93146	32570	35.0	2079	6.4	1300	779	779	779
2000/03	141502	78855	25839	32.8	2273	8.8	1266	1007	817	426
2001/04	114557	65868	19654	29.8	2427	12.3	1270	1157	817	430
2002/05	93146	56964	16144	28.3	2502	15.5	1328	1174	764	342
2003/06	78855	50700	13966	27.5	2560	18.3	1376	1184	681	245
2004/07	65868	45752	13275	29.0	2490	18.8	1354	1136	587	205
2005/08	56964	40836	12027	29.5	2483	20.6	1308	1175	582	209
2006/09	50700	36996	11761	31.8	2486	21.1	1301	1185	573	200
2007/10	45752	33673	10416	30.9	2319	22.3	1201	1118	497	163
2008/11	40836	30888	8718	28.2	1990	22.8	986	1004	374	89
2009/12	36996	28453	8237	28.9	1929	23.4	1038	891	326	102
2010/13	33673	26162	7628	29.2	2015	26.4	1034	981	349	141

Table 6: job creating firms by category (1), 1998/01 – 2010/13, (jobs - '000s)

	all		balpan		JCF		JCF 10+		nHGF		evHGF		HGFcur		HGFfirst	
	initl (1)	diff (2)	initl (3)	diff (4)	init (5)	diff (6)	initl (7)	diff (8)	initl (9)	diff (10)	initl (11)	diff (12)	init (13)	diff (14)	initl (15)	diff (16)
1999/02	745.5	-138.4	438.6	168.5	168.2	246.7	100.8	102.8	75.9	27.8	24.9	75.0	24.9	75.0	24.9	75.0
2000/03	655.8	-79.2	438.6	138.0	183.3	202.1	122.6	91.5	76.5	20.0	46.1	71.5	33.4	67.0	16.0	28.5
2001/04	655.7	-113.4	460.1	82.3	200.0	155.3	151.0	91.6	90.6	19.4	60.4	72.2	32.3	62.7	11.2	18.5
2002/05	607.1	-109.5	436.1	61.5	180.3	129.1	139.3	79.9	76.8	14.5	62.5	65.3	24.7	55.0	6.8	13.9
2003/06	576.6	-87.3	430.5	58.8	162.6	122.1	127.0	75.6	58.5	17.2	68.5	58.4	26.6	47.1	5.5	8.3
2004/07	542.4	-68.3	425.5	48.6	160.2	115.0	125.8	72.9	52.2	13.2	73.6	59.8	27.1	47.7	4.2	6.7
2005/08	497.6	-37.3	411.3	49.0	171.2	111.0	140.2	74.2	48.7	13.6	91.5	60.6	26.4	46.3	5.2	8.4
2006/09	489.3	-50.2	402.1	37.0	161.3	99.0	130.8	69.2	49.3	9.4	81.5	59.8	25.9	45.4	4.2	6.3
2007/10	474.1	-59.2	392.3	22.6	153.0	82.1	125.7	57.8	47.3	8.9	78.4	48.9	23.6	34.5	3.4	4.9
2008/11	460.3	-64.9	387.0	8.4	144.0	71.5	121.7	52.9	29.7	6.6	91.9	46.3	15.9	24.4	1.8	2.9
2009/12	439.1	-49.6	377.8	11.7	137.1	74.1	115.8	57.5	30.6	6.3	85.2	51.3	21.7	32.8	1.8	2.3
2010/13	414.9	-20.0	366.2	28.8	156.3	75.9	136.1	59.4	36.9	11.6	99.2	47.8	16.0	24.2	2.5	3.5

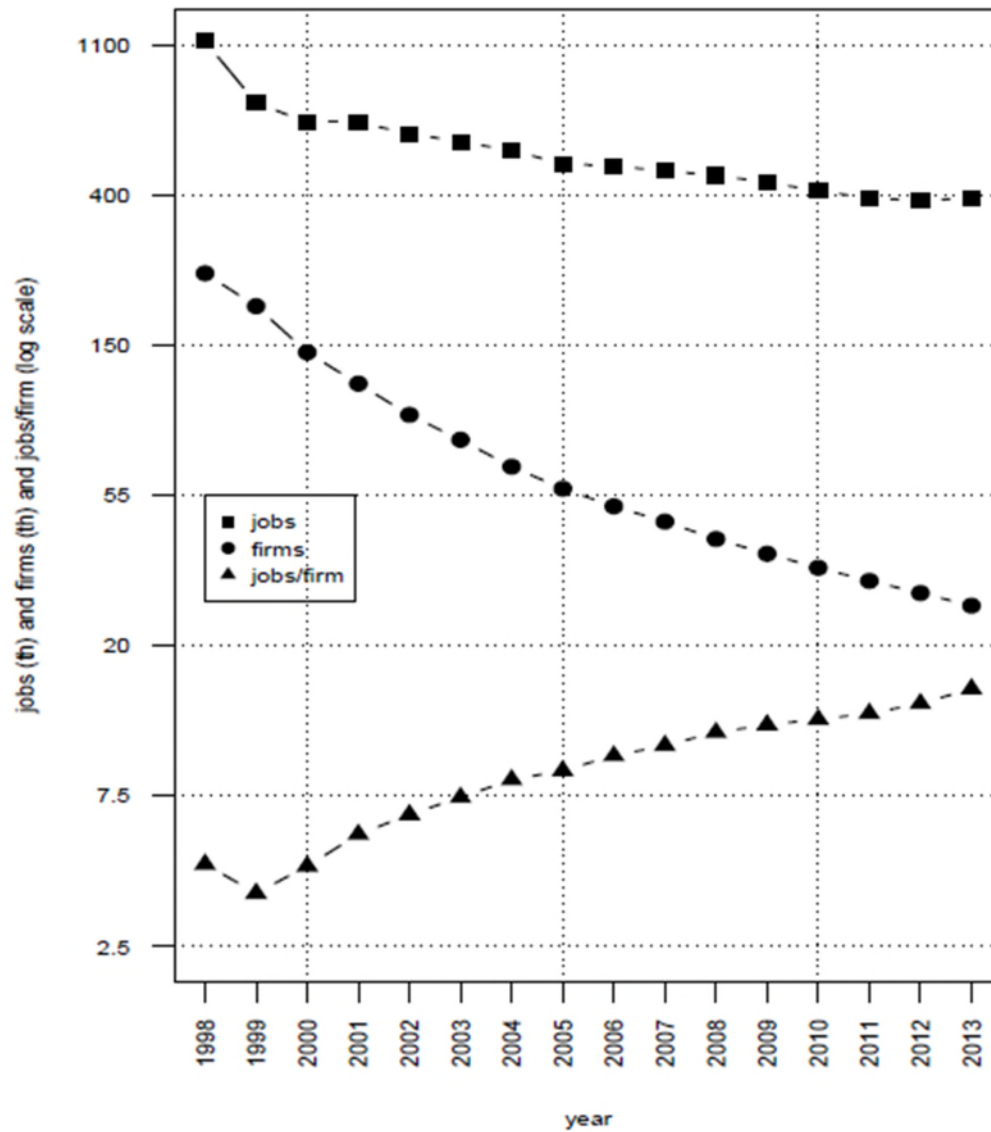**Figure 1: cohort98: firms, jobs & jobs/firm, 1998 - 2013 (log scale)**

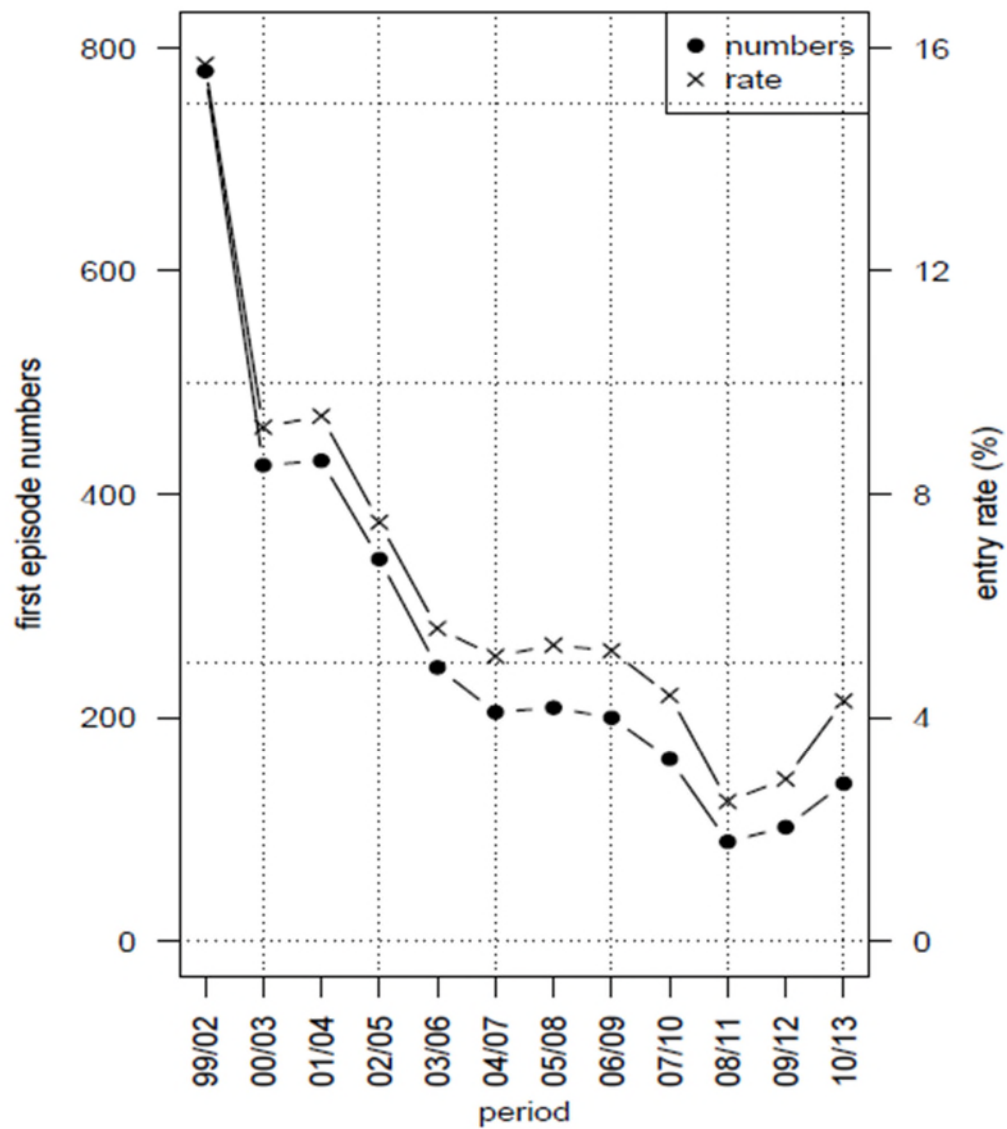**Figure 2: cohort98 HGFs: first episode, numbers & entry rate (%), 1999/02 to 2010/13**

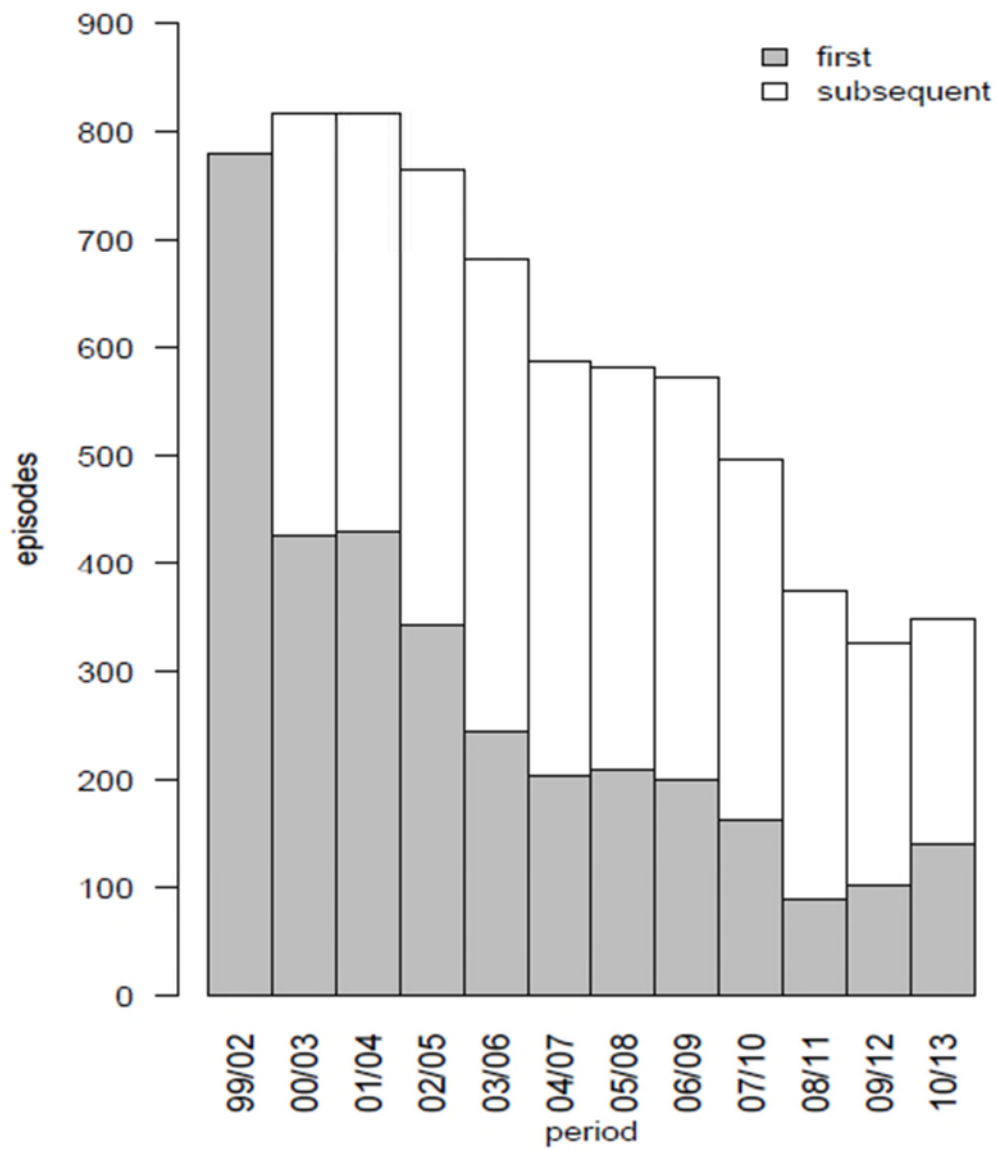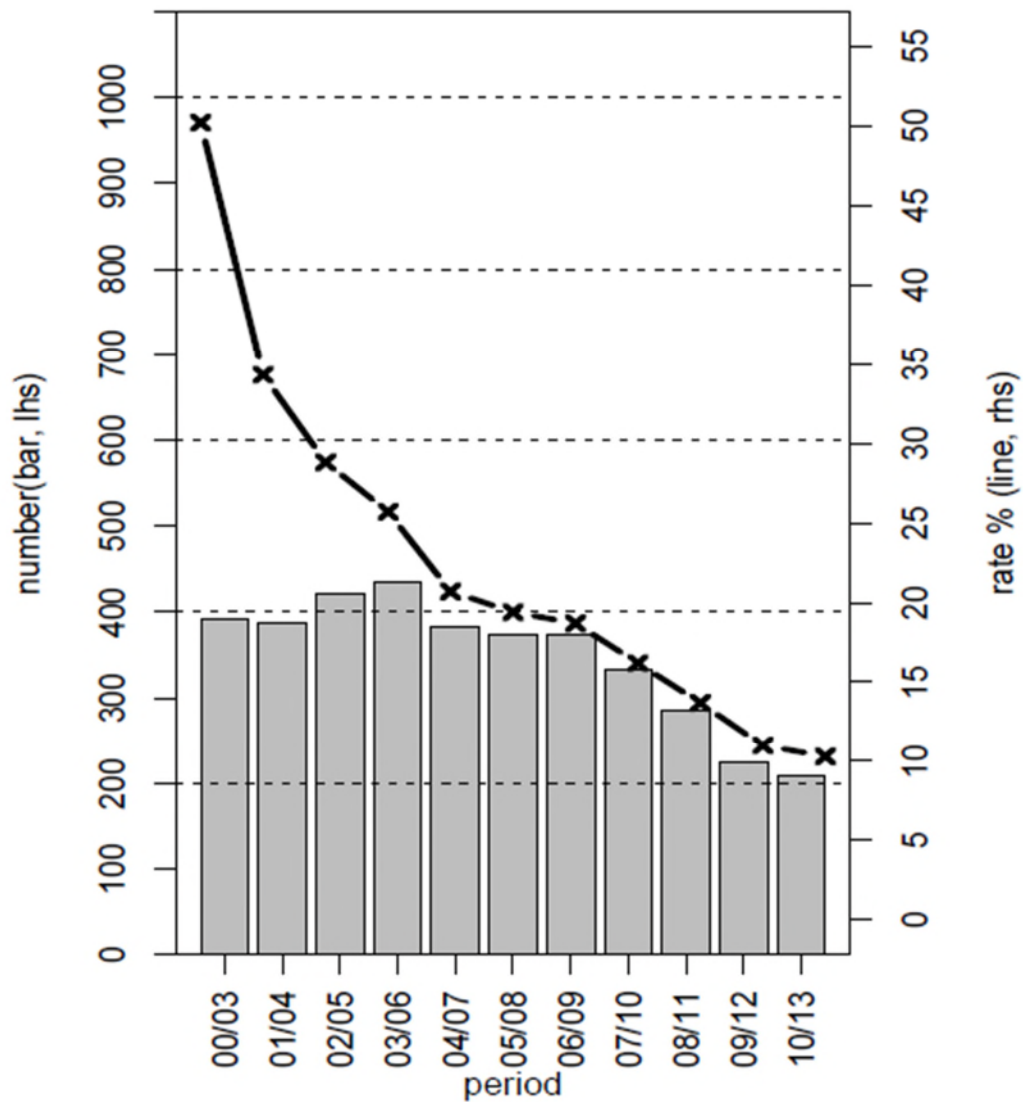**Figure 3: cohort98 HGFs: first and subsequent episodes, numbers, 1999/02 to 2010/13**

Figure 4: cohort98 HGFs: further episodes, number & further rate (%), 1999/02 to 2010/13

Note: the bars are the number of further episodes (left hand scale), the line is the further entry rate (right hand scale); see text for definition.

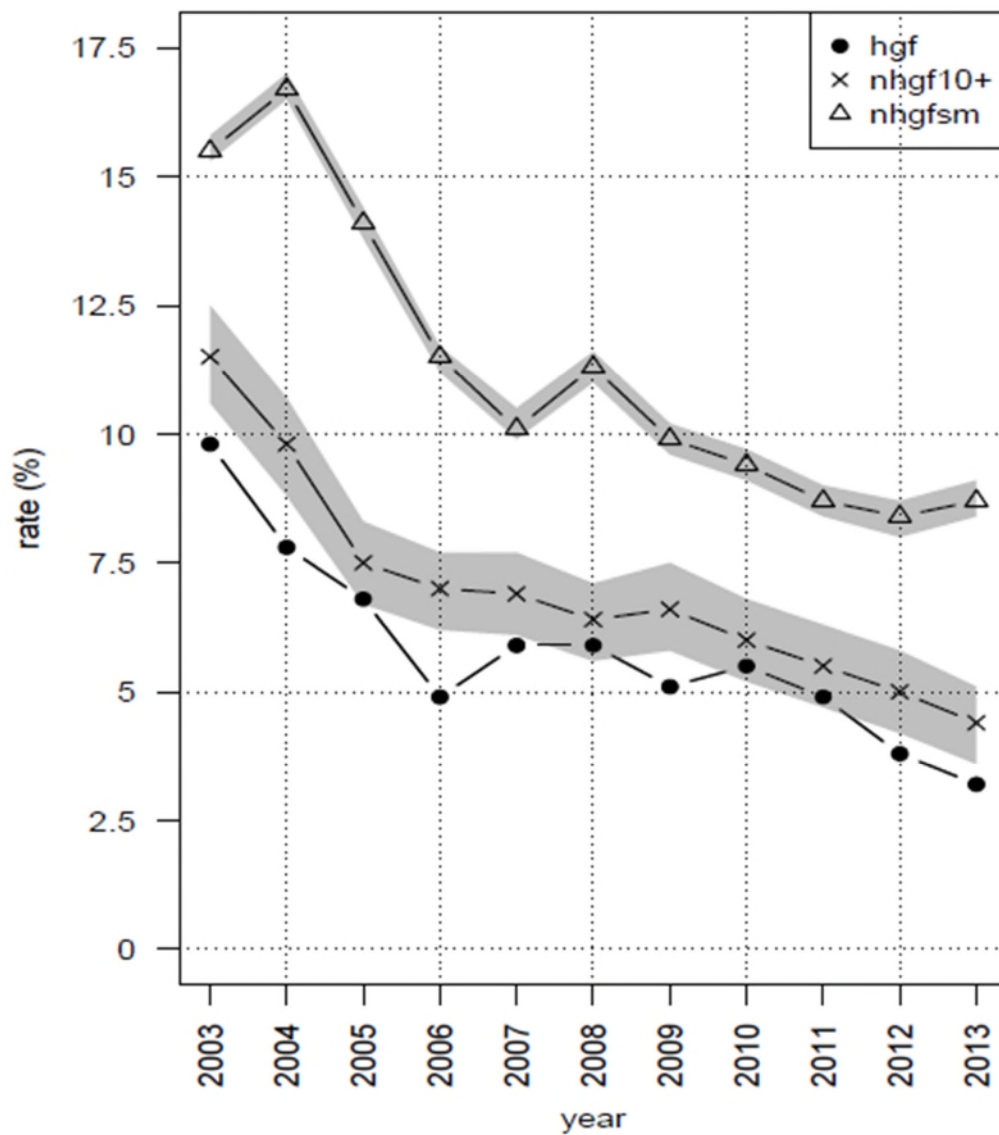**Figure 5: cohort98 HGFs: lag between first and subsequent episodes, years (average over sub-cohorts), proportion (%)**
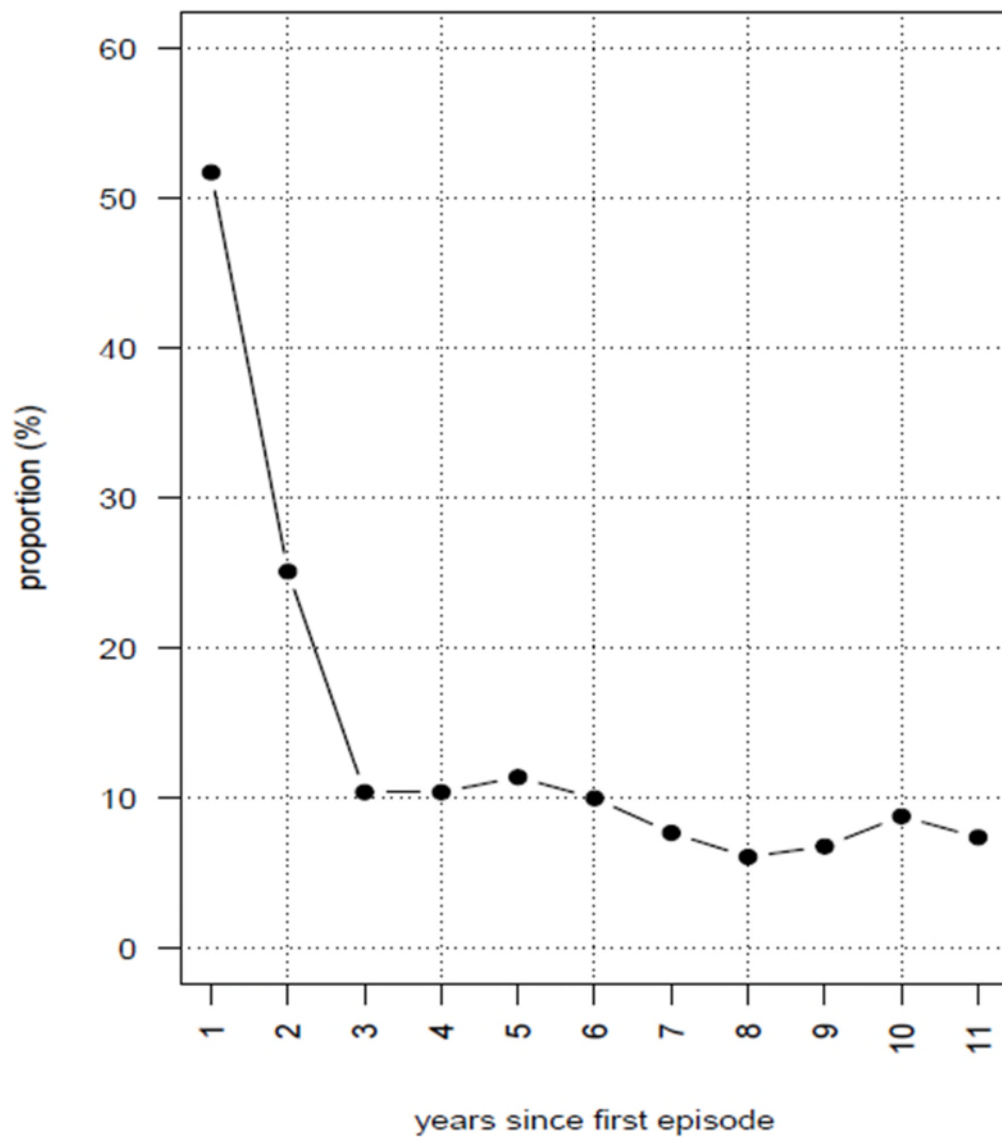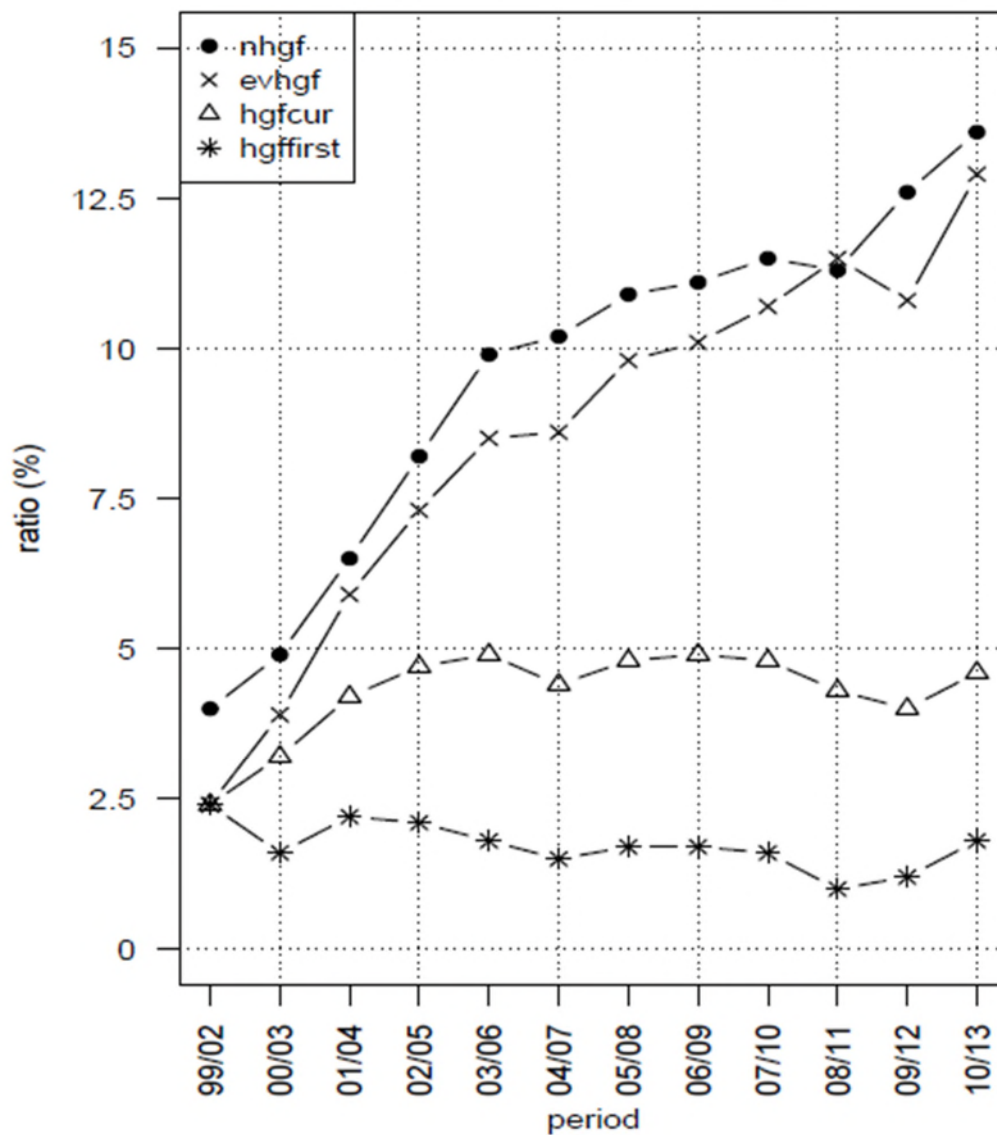
**Figure 6: cohort98 HGFs and non-HGFs: hazard rates (%) with 95% bands**

Note: the shaded regions are computed as the central 95% of the hazard rate distributions computed from 1,000 bootstrap replications.

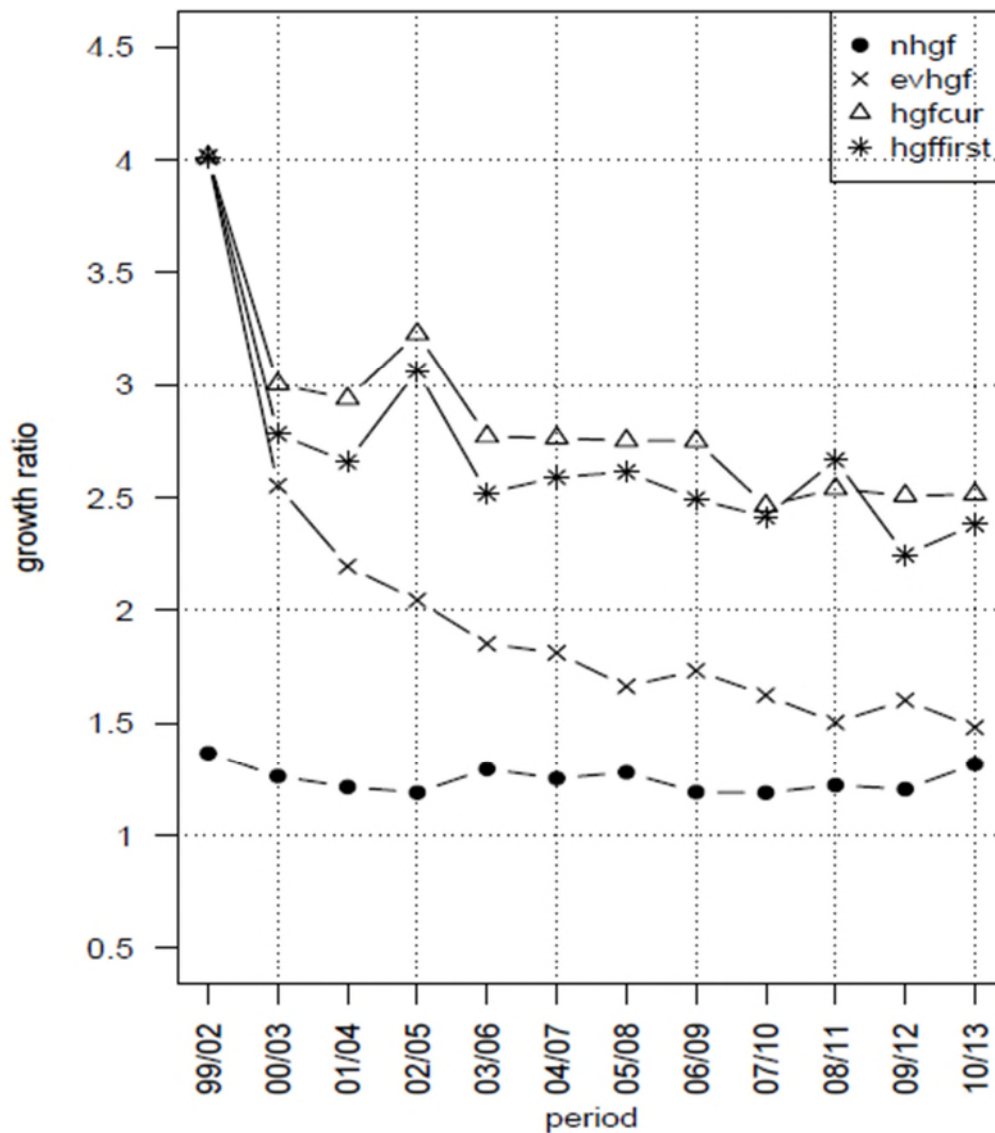**Figure 7: cohort98 10+ JCFs by category, ratio to all JCFs (%)**

Note: nhgf, non high-growth firms; evhgf, ever high-growth firms; hgfcur, high-growth episode in the current period; hgffirst, firms recording their first high-growth episode; for full definitions see text.

Figure 8: cohort98 10+ JCFs jobs by category, ratio to all JCFs (%)
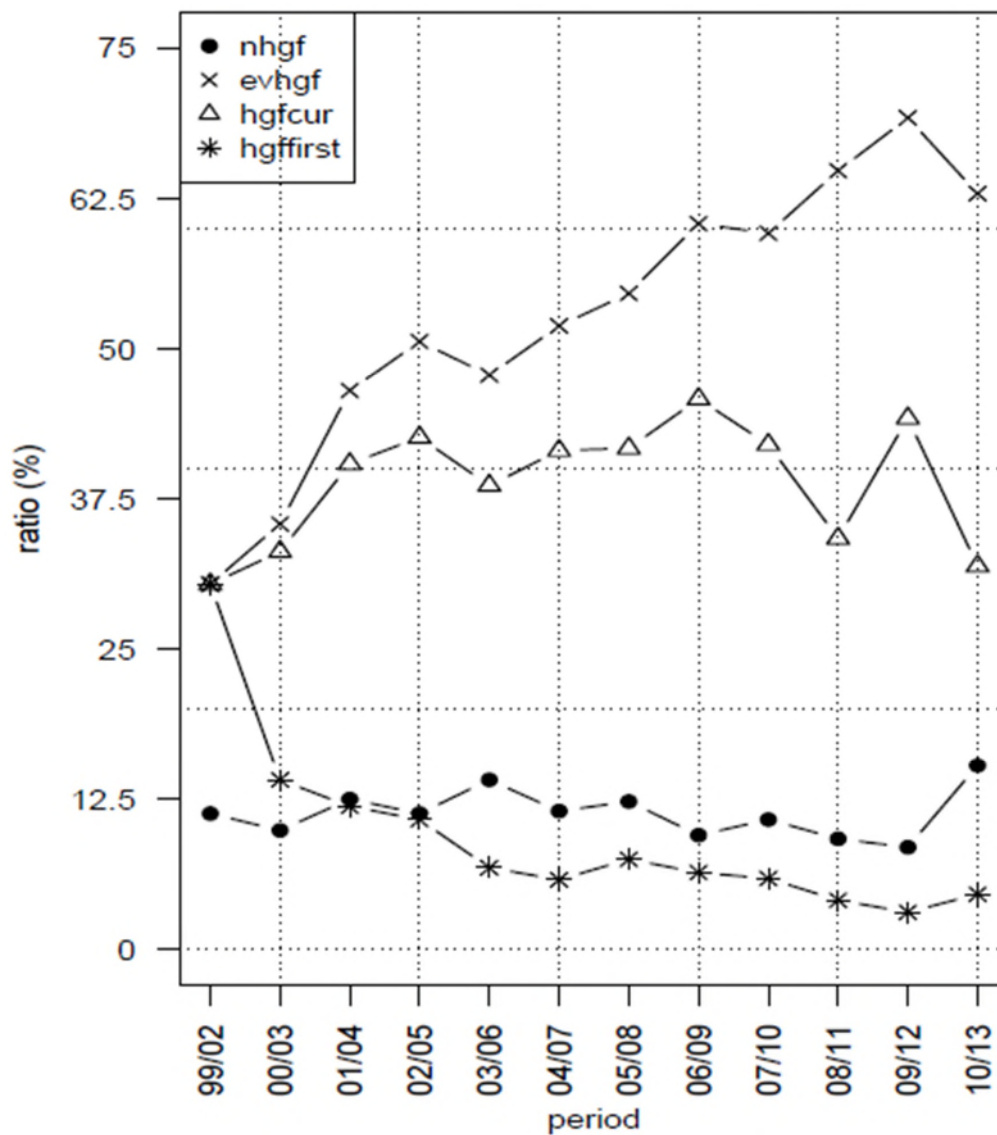
Note: nhgf, non high-growth firms; evhgf, ever high-growth firms; hgfcur, high-growth episode in the current period; hgffirst, firms recording their first high-growth episode; for full definitions see text.

Figure 9: cohort98 10+ JCFs jobs by category, 3 year growth ratio

Note: nhgf, non high-growth firms; evhgf, ever high-growth firms; hgfcur, high-growth episode in the current period; hgffirst, firms recording their first high-growth episode; for full definitions see text.

REFERENCES

Aalen, Odd, Ornulf Borgan, and Hakon Gjessing (2008) *Survival Analysis and Event History A Process Point of View*, New York: Springer.

Acs, Zoltan, William Parsons, and Spencer Tracy (2008) "High-Impact Firms: Gazelles Revisited," Research Report 328, SBA Office of Advocacy.

Ahmad, Nadim (2006) "A Proposed Framework For business Demography Statistics," OECD Statistics Working Papers 2006/3, OECD Publishing.

Anyadike-Danes, Michael, Carl-Magnus Bjuggren, Sandra Gottschalk, Werner Hölzl, Dan Johansson, Mika Maliranta, and Anja Myrann (2015) "An international cohort comparison of size effects on job growth," *Small Business Economics*, Vol. 44, No. 4, pp. 821–844.

Anyadike-Danes, Michael, Karen Bonner, and Mark Hart (2013) "Exploring the incidence and spatial distribution of high growth firms in the UK and their contribution to job creation,"Working Paper 13/05, NESTA.

Anyadike-Danes, Michael and Mark Hart (2018) "All grown up? The fate after 15 years of the quarter of a million UK firms born in 1998." *Journal of Evolutionary Economics* Vol. 28, No 1, pp 45 – 76.

Birch, David L (1979) "The Job Generation Process," research report, MIT Program on Neighborhood and Regional Change, Cambridge, MA.

------(1981) "Who Creates Jobs?" Public Interest, Vol. 65, pp. 3–14.

------(1987) Job Creation in America, New York: New York: Free Press.

Coad, Alex, Sven-Olov Daunfeldt,Werner Hölzl, Dan Johansson, and Paul Nightingale (2014) "High-growth firms: introduction to the special section," *Industrial and Corporate Change*, Vol. 23, No. 1, pp. 91–112.

Daunfeldt, Sven-Olov and Daniel Halvarsson (2015) "Are high-growth firms one-hit wonders? Evidence from Sweden," *Small Business Economics*, Vol. 44, No. 2, pp. 361–383.

Davis, Steven, John Haltiwanger, and Scott Schuh (1996) *Job Creation and Destruction*, Cambridge, MA: MIT Press.

Davis, Steven J, John Haltiwanger, and Scott Schuh (1996) "Small Business and Job Creation: Dissecting the Myth and Reassessing the Facts," *Small Business Economics*, Vol. 8, No. 4, pp. 297–315.

Dillen, Yannick, Eddy Laveren, Rudy Martens, Sven De Vocht, and Eric Van Imschoot (2014) "Growth persistence and profile robustness of high-growth firms," *International Journal of Entrepreneurial Venturing*, Vol. 6, No. 4, pp. 299–330.

EUROSTAT-OECD (2007) EUROSTAT OECD *Manual on Business Demography Statistics*, Luxembourg: EUROSTAT.

Evans, Peter and Richard Welpton (2009) "Methods explained – Business Structure Database," *Economic and Labour Market Review*, Vol. 3, No. 6, pp. 71–75.

Haltiwanger, John, Ron Jarmin, and Javier Miranda (2013) "Who creates jobs? Small vs Large vs Young," *Review of Economics and Statistics*, vol. 95, No 2, pp. 347- 361.

Hölzl,Werner (2014) "Persistence, survival, and growth: a closer look at 20 years of fast-growing firms in Austria," *Industrial and Corporate Change*, Vol. 23, No. 1, pp. 199–231.

Leitch, Claire, Francis Hill, and Helle Neergaard (2010) "Entrepreneurial and Business Growth and the Quest for a "Comprehensive Theory": Tilting at Windmills?," *Entrepreneurial Theory and Practice*, Vol. 34, No. 2, pp. 249–260.

Neumark, David, Brandon Wall, and Junfu Zhang (2011) "Do Small Businesses Create More Jobs? New Evidence for the United States from the National Establishment Time Series," *The Review of Economics and Statistics*, Vol. 93, No. 1, pp. 16–29.

OECD (2002) "High-Growth SMEs and Employment," OECD report, OECD.

------ (2008) "Measuring Entrepreneurship A Collection of Indicators 2008 Edition,"

OECD(2017) "Entrepreneurship at a Glance", OECD Publishing, Paris

OECD(2018) "Personal Communication", e-mail, OECD, Paris

OECD-EUROSTAT Entrepreneurship Indicators Programme Publication, OECD Statistics Directorate.

------(2011) "Entrepreneurship at a Glance, 2011," OECD-EUROSTAT Entrepreneurship Indicators Programme Publication, OECD.

Parker, Simon, David Storey, and Arjen Witteloostuijn (2010) "What happens to gazelles? The importance of dynamic management strategy," *Small Business Economics*, Vol. 35, No. 2, pp. 203–226.

Ross, John (1982) *International Encyclopedia of Population*, New York: The Free Press.

Schreyer, Paul (2000) "High-Growth Firms and Employment," OECD Science, Technology and Industry Working Papers 2000/3, OECD Publishing.

Storey, David and Steven Johnson (1987) *Job Generation and Labour Market Change*, Basingstoke, Hants: Macmillan.

Centre Manager
Enterprise Research Centre
Warwick Business School
Coventry CV4 7AL
CentreManager@enterpriseresearch.ac.uk

Centre Manager
Enterprise Research Centre
Aston Business School
Birmingham, B4 7ET
CentreManager@enterpriseresearch.ac.uk

www.enterpriseresearch.ac.uk