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Abstract

Prior studies have defined high-growth firms (HGFs) in terms of sales or employment, and analyzed their contribution to employment growth. We define HGFs by employment and sales and add definitions of value added and productivity. We examine the contribution of HGFs to employment growth, economic growth, productivity growth, and sales growth. All HGFs give a disproportionately large positive contribution to economic growth and most also give large positive contributions to growth in employment, productivity and sales. Although HGFs of different definitions are usually not the same firms, young firms are more likely to be HGFs irrespective of definition.

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1. Executive summary

The bulk of all new jobs has been shown to be created by a small number of *high-growth firms* (henceforth HGFs). However, no earlier study has analyzed the contribution of HGFs to economic growth or productivity. Furthermore, when their economic contribution is analyzed, HGFs have previously without exception been defined using growth in sales or employment as growth indicators. By growth indicator we refer to the variable in terms of which firm growth is defined. No previous study examining the contribution of HGFs has defined HGFs on growth in value added or productivity.

The purpose of this paper is to add definitions of HGFs in terms of value added and productivity, and analyze how much the different types of HGFs contribute to employment growth, economic growth, productivity growth and sales growth, if the same firms are included among HGFs irrespective of definition, and whether firm age and size influence the likelihood of a firm being a HGF when different definitions are applied.

We thus apply four different growth indicators: growth in employment, sales, value added and productivity. Each growth indicator is measured in both absolute and relative (percentage) numbers. Following previous literature, growth in firm employment is also measured using a combination of absolute and relative numbers. Hence, we arrive at nine different definitions of HGFs: absolute employment-HGFs, relative employment-HGFs, composite employment-HGFs, absolute sales-HGFs, relative sales-HGFs, absolute value added-HGF, relative value added-HGFs, absolute productivity-HGFs and relative productivity-HGFs.

The analysis is based on a comprehensive data-set covering all limited firms in Sweden during the period 1997-2005. HGFs are defined as the one percent fastest growing firms in the population. The population is continuing firms, i.e., firms existing throughout a particular time period. Firm growth is calculated over three, five and seven years. The total growth of firms is studied, i.e., the sum of organic and acquired growth.

In general, the correlation between the nine groups of HGFs is low, suggesting that different firms are included among HGFs depending on definition. This difference is explained less by the choice of growth indicators, and more by measuring firm growth in absolute and relative numbers. While HGFs defined in absolute numbers will to a certain extent be the same firms, those defined in relative terms will not. We also find that firms that are fast growing in relative terms tend to be younger and smaller than those that are fast growing in absolute terms.

Irrespective of definition, HGFs give disproportionately large positive contributions to economic growth. Most, but not all types of HGFs, give large positive contributions to growth

in employment, productivity and sales. Fast growers in employment give small or negative contributions to productivity growth, while fast growers in productivity give insignificant or even negative contributions to employment growth and sales growth, implying at least a short term trade-off between these concepts.

A probit regression model is estimated in order to analyze how firm age and size affect the likelihood of being a HGF. The analysis confirms that firm age and size affect the probability of a firm becoming any type of HGF. Larger firms are more likely to be HGFs measured in absolute numbers and less likely when HGFs are measured in relative numbers. Firm age has a significant negative impact on the likelihood of being a HGF in almost all regressions, indicating that young firms are more likely to be HGFs irrespective of how HGFs are defined. Thus, new firm formation and early growth of firms seem crucial for the prevalence of HGFs and therefore to economic performance.

2. Introduction

A small number of *high-growth firms* (henceforth HGFs) have received an increasing amount of attention in the literature in recent years. This is because they generate the bulk of – or all – new jobs (e.g., Birch and Medoff, 1994; Henrekson and Johansson, 2010; Storey, 1994). The purpose of this paper is to examine whether HGFs defined in different ways are equally important to the growth in different economic outcome variables, if they are the same firms irrespective of definition, and, finally, how firm age and size influence the probability of a firm becoming a HGF depending on definition.

While prior research analyzing the economic contribution of HGFs has identified them as fast growers in terms of growth in firm employment or firm sales, we also identify HGFs by growth in firm labor productivity and firm value-added.³ We thus employ four different indicators of firm growth. We furthermore measure firm growth in both absolute and relative (percentage) terms. HGFs based on employment as a growth indicator are also defined using a combination of absolute and relative numbers. The one percent of firms exhibiting the highest growth rates are then defined as HGFs in each of these nine cases.

Correlation analysis is used to determine to what extent the nine types of HGFs are the same firms. The contribution of each group of HGFs to the economic outcome variables

³ The value added of a firm equals its value of production minus the value of the intermediate inputs it uses in the production, i.e., it is the value a firm adds in the production process. Simplified, the sum of all firms' value added in an economy during one year defines GDP, and the change in total value added defines economic growth.

aggregate economic growth, aggregate employment growth, aggregate productivity growth and aggregate sales growth is then analyzed. To study whether firm age and size influence the likelihood of being a HGF defined by different growth indicators and growth measurements, a probit regression model is estimated. Our analysis is based on a comprehensive data-set covering all limited companies in Sweden from 1997 to 2005.

We begin by reviewing the empirical literature on HGFs in Section 3. The data and the descriptive statistics are described in Section 4. In Section 5, the contribution of HGFs to different outcome variables is investigated. The influence of firm age and size on the likelihood of being a HGF is studied in Section 6. In Section 7, we summarize and draw conclusions.

3. Previous research

Birch (1979) is generally considered to have provided the igniting spark to the area of small business research (e.g., Acs et al., 2008; Landström, 2005). He did so by empirically demonstrating that small firms generated most new jobs in the U.S. economy, which went against the prevailing view at that time. The interest in HGFs originates from this research, as further investigations showed that most small firms did not grow at all, and that job growth emanates from a small number of fast growing firms. In an analogy with the animal kingdom, Birch labeled the fast growing firms “Gazelles”, the majority of small firms that did not grow “Mice”, and the big firms with a large employment share, but generating little new employment, “Elephants” (e.g., Birch and Medoff, 1994).

Delmar and Davidsson (1998) and Delmar et al. (2003) systematize the literature on rapid firm growth, concluding that measuring firm growth requires addressing four issues: the indicator of growth, the measurement of growth, the time period studied, and the process of growth. Growth indicator refers to the variable over which growth is observed, and the measurement of growth concerns a choice between absolute and relative numbers. The process of growth concerns organic and acquired growth.⁴

Henrekson and Johansson (2010) survey the empirical literature on HGFs as job creators. They find that employment and sales are always used as growth indicators, and that growth is measured in absolute numbers and/or relative numbers. Employment growth is also sometimes measured in a combined way of absolute and relative numbers. Growth is usually measured

⁴ Organic growth is growth through new appointments in a firm, while acquired growth is growth through acquisitions and/or mergers. Organic growth and acquired growth may also be denoted internal growth and external growth, respectively.

over three- or four-year periods. With few exceptions, total growth (i.e., the sum of organic and acquired growth) is studied, due to lack of data.

HGFs are identified in either of two ways. First, as the share of firms in a population which has the highest growth during a particular time period, for instance, the one or five percent of firms with the highest growth rate in the studied period. Second, as firms growing at or above a particular pace, measured either in terms of growth between a start and end year, or as annualized growth over a specific number of years. The studied population is either continuing firms (also called permanent firms or ongoing firms), i.e., firms existing throughout the studied period; or new firms, i.e., one or several cohorts of new firms established during the studied period; or all firms, i.e., continuing firms as well as new firms established during the studied period.

Despite the apparent heterogeneity across the studies, Henrekson and Johansson (2010) ascertain that some general findings emerge. While small firms are overrepresented among HGFs, they come in all sizes, and large firms are important job creators in absolute terms, an especially noteworthy finding considering that it originates from research concerning small businesses. Furthermore, HGFs appear to always be younger on average than the general population. Lastly, HGFs appear to exist in all industries.

We update their survey, extending its scope to examine the contribution of HGFs to other outcome variables as well. Eight additional studies are found (Anyadike-Danes et al, 2009; Bjuggren et al., 2010; Coad and Hözl, 2010; Hözl, 2008; Hözl and Friesenbichler, 2010; López-Garcia and Puente, 2009; Moreno and Casillas, 2007; Stangler, 2010). In total, 28 studies are identified (Table 1)⁵. The studied outcome variables are stated in the last column.

⁵ Stam et al (2010) investigate whether the rate of HGFs has an effect on subsequent macroeconomic performance in a sample of low- and high-income countries during the period 2002-2005. As they do not concern themselves directly with the contribution of HGFs, we do not include their study in our overview.

Table 1. Growth indicators and growth measurements used in previous studies to identify HGFs, and outcome variables considered.

Study	Employment			Sales		Process of growth ^a	Time period studied	Outcome variables ^b
	Absolute	Relative	Composite	Absolute	Relative			
Birch and Medoff (1994)	0	0	0	1	1	T	1988-1992	Emp
Kirchhoff (1994)	0	1	0	0	0	T	1977/78-1984	Emp
Storey (1994)	1	1	0	0	0	T	Different	Emp
Birch et al. (1995)	0	0	0	1	1	T	1990-1994	Emp
Picot and Dupuy (1998)	1	1	0	0	0	T	1978-1992, 1983-1986	Emp
Autio et al. (2000)	0	0	0	1	1	T	1994-1997	Emp
Brüderl and Preisendörfer (2000)	1	1	0	0	0	T	1985/86-1990	Emp
Schreyer (2000), Canada	0	0	1	0	0	T	1990-1996	Emp
Schreyer (2000), France	0	0	1	0	0	T	1985-1994	Emp
Schreyer (2000), Germany	0	1 ^c	0	0	0	T	1992-1995	Emp
Schreyer (2000), Italy	0	0	1	0	0	T	1990-1995	Emp
Schreyer (2000), Netherlands	0	0	1	0	0	T	1989-1994	Emp
Schreyer (2000), Spain	0	0	1	0	0	T	1990-1994	Emp
Delmar et al. (2003) ^d	1	1	0	1	1	T, O, A	1987-1996	Emp
Littunen and Thomo (2003)	0	0	0	1	1	T	1990-1997	Emp
Fritsch and Weyh (2006)	1	0	0	0	0	T	1984-2002	Emp
Halabisky (2006)	0	1	0	0	0	T	1985-1999	Emp, W
Moreno and Casillas (2007)	0	0	0	0	1	T	1998-2001	Sales
Acs and Mueller (2008)	0	1	0	0	0	T	1990-2003	Emp
Acs et al. (2008)	1	1	0	0	1	T	1994-2006	Emp, Rev
Deschryvere (2008)	1	1	0	0	0	T, O	2003-2006	Emp
Hölzl (2008)	0	0	1	0	0	O	1995	Emp
López-García and Puente (2009)	0	0	1	0	0	T	1996-2003	Emp
Bjuggren et al. (2010)	1	1	0	0	0	T	1993-2006	Emp
Anyadike-Danes et al (2009)	1	1	0	0	0	T	2002-2008	Emp
Coad and Hölzl (2010)	0	1	0	0	0	T	1995-2005	Emp

Hölzl and Friesenbichler (2010)	0	0	1	0	0	O	1998-2000	Emp
Stangler (2010)	0	1	0	0	0	T	2007	Emp
Total	9	14	8	5	7			

Note: ^aT=Total, O=Organic, A=Acquired. ^bEmp=Employment, W=Wages, Rev=Revenue. ^cSchreyer (2000), Germany used the logarithmic annual average rate of growth (AARG). ^dSchreyer presents seven studies on HGFs. The Swedish study in Schreyer, Davidsson and Delmar (2003, 2006) and Delmar et al. (2003) use similar data and draw similar conclusions, we therefore report on them jointly. The composite index is calculated as the Birch index $m = (x_{t1} - x_{t0}) * (x_{t1}/x_{t0})$, where x_{t1} and x_{t0} denote employment size at the beginning and end of the period.

Source: Henrekson and Johansson (2010, Table 1), updated. This table only reproduces elements of Henrekson and Johansson's table that are directly relevant to our paper.

The table reveals that no previous study has used productivity growth or growth in value added as growth indicators to define HGFs when their economic contribution has been analyzed.⁶ Productivity has been discussed in the literature on HGFs prior to this paper (Acs et al., 2008; Fritsch and Mueller, 2004; Littunen and Thomo, 2003). However, little has been made of this observation. Fritsch and Mueller (2004) stress the difficulties in gathering data on productivity, which can explain why no previous study has explicitly addressed this issue. Furthermore, while most studies discuss the contribution of HGFs to employment, no study has discussed the contribution of HGFs to either economic growth or productivity.

4. Data and descriptive statistics

All limited firms in Sweden are legally bound to submit an annual report to the Swedish Patent and Registration Office (PRV). This study uses data collected from MM (Market Manager)-Partner, now merged with PAR, a Swedish consulting firm that gathers economic information from PRV. This information is primarily used by decision-makers and stakeholders in Swedish commercial life. Our data comprise all Swedish limited companies active at some point between 1997 and 2005, in total 288,757 firms, and include all variables that can be found in the annual reports, e.g., profits, number of employees, salaries, fixed costs and liquidity.

To allow for feasible comparisons, we define HGFs as the one percent of firms with the highest growth over three different time periods, three, five and seven years. We considered other shares of the firm population, such as the five or ten percent of firms with the highest growth. However, besides the one percent definition, it was not possible to apply precise cut-off levels, since a great many firms showed the growth required to enter as the last firm using other thresholds. This would necessitate including some of these firms among HGFs arbitrarily and excluding the rest of them. Moreover, it became clear that when the span was widened growth fell off rapidly. For example, when applying the ten-percent definition over a seven-year period, firms would be included that had only added four employees over the entire time period.

In the following, all tables present the results for HGFs identified over seven years. Relevant differences with regards to the groups based on the two other time periods are also

⁶ López-García and Puente (2009) use growth in value added to identify HGFs. However, this is only as a test of robustness of their regression model with HGFs defined by growth in employment. As their study did not consider the contribution of HGFs defined by value added, we do not include their use of value added as a growth indicator in our survey of the previous literature.

reported. The population is continuing firms in these time periods. Since we cannot distinguish organic from acquired growth, we study total growth. In order to relate to previous literature, we use employment and sales as growth indicators, yet in addition we introduce productivity and value added.⁷ Productivity growth is defined as growth in value-added based labor productivity, which is the single most frequently used productivity statistic (OECD, 2001 p. 12). Labor productivity is a key determinant of living standards and of significant policy relevance, and also a good starting point for productivity analysis, which later can be extended to multifactor productivity (MFP) measures (OECD, 2001, p. 15, 20). In cross-country comparisons, the OECD defines labor productivity as GDP in constant prices per hour worked (OECD, 2010). Since our data do not report the number of hours worked, we define labor productivity as value added divided by the number of employees.

It has long been realized that while absolute measures of firm growth lead to a bias towards large firms, relative growth measures lead to a bias towards small firms (Acs et al., 2008; Schreyer, 2000). Due to the wide-spread use of the absolute and relative measures, we use these two measures for all growth indicators in the empirical analysis. We also apply the so-called composite index, i.e., the combination of employment growth measured in absolute and relative numbers, as growth measurement in order to relate to previous literature (see table 1).

To summarize, we use three definitions of growth for employment, two definitions for sales, two for productivity, and two for value added. We thus arrive at a total of nine groups of HGFs: absolute employment-HGFs, relative employment HGFs, composite employment-HGFs, absolute sales-HGFs, relative sales-HGFs, absolute productivity-HGFs, relative productivity-HGFs, absolute value added-HGFs and relative value added-HGFs.⁸ These types are defined over three distinct time periods (three, five and seven years), resulting in 27 different ways of defining HGFs.

In the econometric analysis firm age and size are included as independent variables, the goal being to investigate their influence on the probability of a firm being a HGF, and whether these results are sensitive to the choice of growth indicator, growth measurement, or time

⁷ Firms with negative value added are excluded to avoid outliers. This does not affect the general results.

⁸ Absolute employment-HGFs are defined measuring the growth in employment in absolute numbers; relative employment-HGFs are defined measuring the growth in employment in relative numbers; composite employment-HGFs are defined measuring the growth in employment using a combination of relative and absolute numbers; absolute sales-HGFs are defined measuring the growth in sales in absolute numbers; relative sales-HGFs are defined measuring the growth in sales in relative numbers; absolute value added-HGFs are defined measuring the growth in value added in absolute numbers; relative value added-HGFs are defined measuring the growth in value added in relative numbers; absolute productivity-HGFs are defined measuring the growth in labor productivity in absolute numbers; relative productivity-HGFs are defined measuring the growth in labor productivity in relative numbers.

period. Firm size is measured as the two-period lag of the number of employees, and firm age is defined as the year of observation minus the registered start year. Note, however, that the data on the start year is truncated. The earliest registered start year is 1972, implying that firms in the data-set cannot be over 33 years of age. We remedy this shortcoming by including a dummy variable (*D72*) that controls for all registered startups in 1972. To control whether firms in an enterprise group are more likely to be HGFs, a dummy variable taking the value one if the firm belongs to an enterprise group is included in the analysis. Means and standard deviations of all variables included in the empirical analysis are given in Table 2.

Table 2. Means and standard deviations of independent variables and growth indicators in the dataset used to define HGFs.

Variable	Mean	s.d	Min	Max	N
Firm age	18	8	7	33	141,277
Firm size ^a	18	204	1	27,625	141,277
Sales ^b	45,345	731,755	1	104,570,000	141,277
Value added ^b	12,290	197,637	0	27,431,542	141,277
Value added/employee	75	172	0	9,580	141,277
Dgroup	0.28	0.451	0	1	141,277
D72	0.18	0.383	0	1	141,277

Note: ^aMeasured as number of employees. ^bMeasured in 1000s of SEKs.

Tables 3 and 4 present differences in mean values for number of employees and firm age for different HGFs defined over a seven year period. The tables indicate, for example, that HGFs identified in terms of absolute employment growth on average have almost 600 more employees and are six years older than productivity-HGFs. There are significant differences in mean values between most growth indicators, the most pronounced being between HGFs defined in absolute and relative measurements. HGFs defined in relative terms are always younger than HGFs defined in absolute terms. HGFs defined in absolute terms are larger than HGFs defined in relative terms, with the exception of absolute productivity-HGFs. HGFs based on absolute growth in sales are on average oldest, whereas HGFs based on absolute growth in value added are on average largest. HGFs based on relative productivity are on average youngest, while relative value added-HGFs are on average smallest. This indicates that the characteristics of HGFs differ depending on the choice of growth indicator and growth measurement.

Table 3. Differences in mean age between HGFs based on different growth indicators and measurements. HGFs are defined over a growth period of seven years.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Absolute employment-HGFs	-	6.79***	3.00***	-2.27***	6.53***	2.54***	6.12***	-1.91***	6.98***
(2) Relative employment-HGFs	-6.79***	-	-3.79***	-9.06***	-0.27	-4.26***	-0.67	-8.70***	0.18
(3) Composite employment-HGFs	-3.00***	3.79***	-	-5.27***	3.53***	-0.46	3.12***	-4.91***	3.98***
(4) Absolute sales-HGFs	2.27***	9.06***	5.27***	-	8.80***	4.81***	8.39***	0.36	9.25***
(5) Relative sales-HGFs	-6.53***	0.27	-3.53***	-8.80***	-	-3.99***	-0.40	-8.43***	0.45
(6) Absolute productivity-HGFs	-2.54***	4.26***	0.46	-4.81***	3.99***	-	3.58***	-4.45***	4.44***
(7) Relative productivity-HGFs	-6.12***	0.67	-3.12***	-8.39***	0.40	-3.58***	-	-8.03***	0.86**
(8) Absolute value added-HGFs	1.91***	8.70***	4.91***	-0.36	8.43***	4.45***	8.03***	-	8.89***
(9) Relative value added-HGFs	-6.98***	-0.18	-3.98***	-9.25***	-0.45	-4.44***	-0.86**	-8.89***	-

Note: ***, ** and * denote differences that are statistically significant at the 1%-, 5%- and 10%-level, respectively.

Table 4. Differences in mean size (number of employees) between HGFs based on different growth indicators and measurements. HGFs are defined over a growth period of seven years.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Absolute employment-HGFs	-	486.69***	87.85	-103.17	532.99***	565.88***	601.23***	-115.81	527.63***
(2) Relative employment-HGFs	-486.69***	-	-398.84***	-589.85***	46.31	79.20**	114.54***	-602.50***	40.94
(3) Composite employment-HGFs	-87.85	398.84***	-	-191.02**	445.14***	478.03***	513.38***	-203.66**	439.78***
(4) Absolute sales-HGFs	103.17	589.85***	191.02**	-	636.16***	669.05***	704.39***	-12.64	630.79***
(5) Relative sales-HGFs	-532.99***	-46.31	-445.14***	-636.16***	-	32.89	68.23**	-648.80***	-5.37
(6) Absolute productivity-HGFs	-565.88***	-79.20**	-478.03***	-669.05***	-32.89	-	35.34**	-681.69***	-38.26
(7) Relative productivity-HGFs	-601.23***	-114.54***	-513.38***	-704.39***	-68.23**	-35.34**	-	-717.04***	-73.60**
(8) Absolute value added-HGFs	115.81	602.50***	203.66**	12.64	648.80***	681.69***	717.04***	-	643.44***
(9) Relative value added-HGFs	-527.63***	-40.94	-439.78***	-630.79***	5.37	38.26	73.60**	-643.44***	-

Note: ***, ** and * denote differences that are statistically significant at the 1%-, 5%- and 10%-level, respectively.

To further examine how well our different types of HGFs correspond to each other, a correlation analysis is presented in Table 5. In general, a significant positive yet low correlation between the different groups of HGFs can be found. In most cases it is close to zero. The correlation is higher between the HGFs based on absolute measurements, with the exception of absolute productivity-HGFs; whereas there is less correlation between HGFs based on relative measurements (except between relative value-added and relative productivity-HGFs). Furthermore, the correlations between HGFs based on absolute and relative measurements of the same growth indicators are rather small, confirming previous findings (Delmar et al., 2003). The result suggests that HGFs defined in different ways are not the same firms.

Table 5. Correlations between HGFs of different definitions over a seven-year time period, N=141,277.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Absolute employment-HGFs	1	0.206***	0.659***	0.507***	0.098***	0.615***	0.087***	0	-0.003
(2) Relative employment-HGFs	0.206***	1	0.491***	0.103***	0.352***	0.126***	0.326***	-0.002	0.019***
(3) Composite employment-HGFs	0.659***	0.491***	1	0.375***	0.223***	0.453***	0.195***	0.001	0.002
(4) Absolute sales-HGFs	0.507***	0.103***	0.375***	1	0.088***	0.635***	0.057***	0.053***	0.001
(5) Relative sales-HGFs	0.098***	0.352***	0.223***	0.088***	1	0.073***	0.442***	0.058***	0.202***
(6) Absolute value added-HGFs	0.615***	0.126***	0.453***	0.635***	0.073***	1	0.069***	0.083***	0.008***
(7) Relative value added-HGFs	0.087***	0.326***	0.195***	0.057***	0.442***	0.069***	1	0.077***	0.520***
(8) Absolute productivity-HGFs	0	-0.002	0.001	0.053***	0.058***	0.083***	0.077***	1	0.193***
(9) Relative productivity-HGFs	-0.003	0.019***	0.002	0.001	0.202***	0.008***	0.520***	0.193***	1

Note: *** denotes that the correlation is significant at the 1%-level.

5. The economic contribution of HGFs

Table 6 presents the contribution of different groups of HGFs to economic growth (measured as percentage change in aggregate value added), employment growth (measured as percentage change in aggregate employment), productivity growth (measured as percentage change in aggregate value added per employee) and sales growth (measured as percentage change in aggregate sales). By aggregate, we refer to the totals of our population of firms. The contribution during a seven year period is measured by comparing the total growth in the outcome variable in question to the total contribution to the outcome variable made by the group of HGFs in question. The same computations were undertaken for growth periods of five and three years. The results rarely differ, apart from those reported below.

The contributions of HGFs can be both positive and negative and amount to more than 100 percent of the aggregated numbers (which are always positive). The magnitudes of many of

these contributions are large. For example, the one-percent fastest growing firms in terms of absolute employment growth and absolute value-added growth contribute to more than 100 percent of the growth in total employment.

HGFs based on the same growth indicator have the same sign on their contributions, with the exception of the contribution of productivity-HGFs to sales. The three types of employment-HGFs contribute to the bulk or more than all of the total net job growth in the population. They also give substantial contributions to the total economic growth and sales growth of the firm population during the study period. The contribution to productivity growth is negative or close to zero. However, when the growth period is only three years, both absolute and relative employment-HGFs give positive contributions to productivity growth (six and ten percent, respectively).

The productivity-HGFs, on the other hand, make disproportionately large contributions to total productivity growth and to economic growth. Both absolute and relative productivity-HGFs give negative contributions to employment growth, while relative productivity-HGFs also give a slightly negative contribution to sales growth. These findings suggest that, at least in the short-run, there is a trade-off between productivity increases and employment growth.

The two types of sales-HGFs make large positive contributions to all four outcome-variables, but more to employment, sales and value added than to productivity. The value added-HGFs also give disproportionately positive contributions to all four outcomes. Hence, all HGFs give disproportionately positive contributions to economic growth.

Table 6. The contribution of seven-year-HGFs to economic growth, employment, productivity and sales.

	Percentage contribution to			
	Economic growth	Employment growth	Productivity growth	Sales growth
Absolute employment-HGFs	62.9	133.5	-0.1	56.2
Relative employment-HGFs	14.6	51.3	-1.1	12.6
Composite employment-HGFs	56.7	125.7	-0.7	47.8
Absolute sales-HGFs	69.7	94.3	2.9	79.7
Relative sales-HGFs	8.6	30.7	4.7	9.9
Absolute productivity-HGFs	20.1	-18.8	30.5	9.9
Relative productivity-HGFs	1.7	-4.2	12.4	-0.2
Absolute value added-HGFs	81.1	103.2	4.9	66.4
Relative value added-HGFs	9.9	34.0	7.0	8.2

6. Firm age, firm size and HGFs

Following recent studies (Bjuggren et al., 2010; López-Garcia and Puente, 2009), a probit regression model is estimated to study the influence of firm age and size on the probability of a firm being a HGF. The estimated model is specified as:

$$Pr(HGF_{it} = 1) = F(\alpha_1 SIZE_{it-2} + \alpha_2 SIZE_{it-2}^2 + \alpha_3 AGE_{it} + \alpha_4 AGE_{it}^2 + \alpha_5 D72_{it} + \alpha_6 DGROU_{it} + \alpha_I + \varepsilon_i) \quad (1)$$

where the dependent variable HGF_{it} takes the value 1 if firm i can be classified into the one percent fastest growing firms in the population in period t ; $SIZE_{it-2}$ is firm size measured as absolute employment in year $t-2$ ⁹; AGE_{it} is firm age; squares of both size and age are included to control for nonlinearity; $D72_{it}$ is a dummy variable that takes the value one if the start year for firm i is classified as 1972; $DGROU_{it}$ is a dummy variable indicating whether the firm belongs to an enterprise group or not; α_I is an industry-specific fixed effect¹⁰, and ε_i is a random error term. The marginal effects acquired from the estimation of Eq. (1) are presented in Table 7.¹¹

⁹ Firm size is lagged two periods to avoid endogeneity problems.

¹⁰ All the firms in the data base are denoted with five-digit SNI-codes. Based on these, the firms have been sorted using three-digit SNI-codes into 213 different industries to control for industry-specific heterogeneity in the presence of HGFs. The estimated coefficients for each of these industry dummies are not presented in this paper to save space, but are available from the authors upon request.

¹¹ Note that the variables $D72$ and $DGROU$ are not presented in Table 7 in order to save space, but are available from the authors upon request. The enterprise group dummy is always positive and significant (in line with previous research), except in the regressions where HGFs based on productivity function as basis for the dependent variable, where it is insignificant. The dummy for being registered as a startup in 1972 is only occasionally significant.

Table 7. Results from probit regressions on HGF_{it} . Marginal effects coefficients and z-values for independent variables.

Growth period t is 7 years								
Dependent variable $HGF_{it} = 1$ if firm i is HGF in terms of:	Independent variables							
	Firm size		Firm size ²		Firm age		Firm age ²	
Absolute employment growth	0.00001***	(6.8)	-1.23E-09***	(-5.52)	-0.0005**	(-2.2)	0.00001**	(2.02)
Relative employment growth	-0.0001**	(-2.52)	6.30E-09**	(2.48)	-0.001***	(-2.59)	0.00002	(1.53)
Composite index growth	0.00001***	(7.33)	-1.19E-09***	(-5.29)	-0.001***	(-3.24)	0.00002***	(2.7)
Absolute sales growth	0.00001***	(5.7)	-7.44E-10***	(-4.63)	-0.0003*	(-1.96)	6.01E-06*	(1.85)
Relative sales growth	-0.0001**	(-2.08)	1.06E-08**	(2.07)	-0.0004	(-1.29)	6.98E-06	(0.75)
Absolute value added growth	0.00001***	(5.91)	-8.89E-10***	(-5.62)	-0.0003**	(-2.18)	6.44E-06**	(1.97)
Relative value added growth	-0.0002***	(-7.17)	1.16E-08***	(7.2)	-0.0002	(-1.26)	3.08E-06	(0.8)
Absolute productivity growth	4.57E-06***	(2.84)	-6.58E-11	(-0.40)	-0.0008**	(-2.19)	0.00002**	(2.15)
Relative productivity growth	1.01E-06	(0.28)	-1.15E-11	(-0.07)	0.00005	(0.10)	-4.83E-06	(-0.39)
Growth period t is 5 years								
Dependent variable $HGF_{it} = 1$ if firm i is HGF in terms of:	Independent variables							
	Firm size		Firm size ²		Firm age		Firm age ²	
Absolute employment growth	9.90E-06***	(12.57)	-9.32E-10***	(-9.4)	-0.0001	(-0.78)	1.43E-06	(0.48)
Relative employment growth	-0.00004*	(-1.80)	2.02E-09*	(1.81)	-0.0008***	(-2.77)	0.00001*	(1.75)
Composite index growth	0.00001***	(13.98)	-1.18E-09***	(-9.77)	-0.0007***	(-3.49)	0.00001***	(2.6)
Absolute sales growth	9.40E-06***	(10.67)	-8.05E-10***	(-8.23)	-0.0002**	(-2.09)	3.81E-06*	(1.82)
Relative sales growth	-0.0002***	(-5.02)	1.09E-08***	(4.98)	-0.0006***	(-2.66)	0.00001*	(1.88)
Absolute value added growth	5.00E-06***	(8.58)	-3.17E-10***	(-6.37)	-4.78E-06	(-0.08)	-6.94E-08	(-0.05)
Relative value added growth	-0.0003***	(-7.95)	1.50E-08***	(7.9)	-0.0004*	(-1.95)	7.27E-06	(1.43)
Absolute productivity growth	1.77E-06**	(2.10)	-3.57E-11	(-0.59)	-0.0003	(-1.28)	6.35E-06	(1.20)
Relative productivity growth	-3.68E-06	(-0.84)	1.96E-10	(0.81)	-0.0001	(-0.34)	-2.13E-06	(-0.29)
Growth period t is 3 years								
Dependent variable $HGF_{it} = 1$ if firm i is HGF in terms of:	Independent variables							
	Firm size		Firm size ²		Firm age		Firm age ²	
Absolute employment growth	0.00001***	(10.34)	-8.57E-10***	(-4.90)	-0.0003***	(-6.95)	6.89E-06***	(5.14)
Relative employment growth	-0.0001***	(-2.83)	4.28E-09***	(2.84)	-0.001***	(-12.38)	0.00002***	(6.53)
Composite index growth	0.00001***	(12.56)	-8.39E-10***	(-6.03)	-0.0005***	(-8.87)	9.92E-06***	(5.6)
Absolute sales growth	8.20E-06***	(12.50)	-6.23E-10***	(-6.45)	-0.0001***	(-4.43)	2.58E-06***	(3.5)
Relative sales growth	-0.0003***	(-9.11)	1.29E-08***	(9.08)	-0.0003***	(-5.1)	4.96E-06***	(2.66)
Absolute value added growth	7.86E-06***	(12.83)	-5.51E-10***	(-6.62)	-0.0001***	(-4.76)	3.28E-06***	(4.23)
Relative value added growth	-0.0002**	(-2.02)	1.08E-08**	(2.02)	-0.0004***	(-3.76)	7.24E-06***	(2.87)
Absolute productivity growth	4.24E-08	(0.05)	7.41E-11	(1.28)	-0.0003***	(-4.39)	6.55E-06***	(3.15)
Relative productivity growth	-0.00002	(-1.60)	1.00E-09*	(1.67)	-0.0002***	(-2.96)	3.86E-06	(1.43)

Note: ***, ** and * denotes significance at the 1%-, 5%- and 10%-level, respectively. Z-values are within parenthesis.

The results for the three different time periods we investigated are largely quite similar. Firm size, when growth is measured in absolute terms, always has a positive impact on the probability of a firm becoming a HGF. This finding also corresponds to composite

employment-HGFs. The opposite relationship holds when HGFs are defined in relative terms. In this case, the results indicate that smaller firms are more likely to be HGFs.

Firm age has a negative impact on the likelihood of being a HGF in 20 of 27 studied regressions (and not statistically significant from zero in the remaining seven regressions), indicating that young firms are more likely to be HGFs irrespective of how HGFs are defined. The age coefficient is negative and statistically significant in at least one time-period for each type of HGF.

Our study confirms the findings of Delmar et al. (2003) who conclude that firm age, rather than firm size, determines rapid growth and, hence, that firm age is crucial for net employment growth. In accordance with, for instance Davidsson and Delmar (2006), and Jackson et al. (1999), our results suggest that economic renewal is critical for firm growth as well as for growth in the whole economy.

7. Discussion and conclusions

Previous studies have used growth in sales or in employment as growth indicators when defining HGFs in order to analyze their economic contribution. This paper introduces growth in value added and productivity growth as additional indicators. These four growth indicators are measured in both absolute and relative (percentage) terms. For employment, a combination of absolute and relative measurements labeled the composite index is also applied. This has in total resulted in nine different types of HGFs. In our analysis, we have asked the following questions:

- i) Are the same firms defined as HGFs irrespective of definition?
- ii) Do HGFs contribute as much to aggregate economic growth, productivity growth and sales growth as they have previously been shown to do to aggregate employment growth, and is the contribution the same irrespective of definition?
- iii) Does firm age and size have the same influence on the likelihood of being a HGF irrespective of definition?

We find that the correlations among the nine groups of HGFs are generally low, indicating that different firms are included in the different groups. Three out of four groups of HGFs defined using absolute measurements show higher correlation, while HGFs defined using relative measurements show low correlation in general.

When examining the contribution of these types of HGFs to economic outcome variables, we find that all nine give disproportionately positive contributions to economic growth, albeit

with different magnitudes. All HGFs, except productivity-HGFs give a positive contribution to employment growth and sales growth. In most cases, the magnitudes of these contributions are large. For example, the one-percent fastest growers in terms of employment and value-added, respectively, contribute to more than 100 percent of the total growth in employment. In addition, besides employment-HGFs, all HGFs are also associated with a disproportionately positive contribution to productivity growth. The results seem to indicate a trade-off (at least in the short run) between employment growth and productivity growth.

Our probit model shows that firm age and size affect the probability of a firm becoming any type of HGF. Firm size has a positive effect on the probability of a firm becoming a HGF based on absolute measurement, while it has a negative effect on the probability of a firm becoming a HGF based on relative measurement. Irrespective of how HGFs are defined, younger firms are more likely to experience rapid growth. Moreover, HGFs defined in relative terms are always younger than HGFs defined in absolute terms. They are also smaller than the HGFs defined in absolute terms, with the exception of absolute productivity-HGFs. These results hold for all time periods studied.

Our results suggest that new firm formation and early growth of new firms are vital for the prevalence of HGFs. They also imply that economic policy promoting younger firms and entrepreneurship, for instance by lowering corporate taxes, removing entry barriers and increasing contestability on markets previously closed for private entrepreneurship like health care, care of children and elderly, and education (cf., Henrekson and Johansson, 2009; Sobel, 2008), will not necessarily have a clear-cut positive effect on outcome variables other than economic growth. For instance, while the promotion of younger firms will most likely spawn more employment-HGFs giving positive contributions to employment growth, it will also result in more productivity-HGFs, whose contribution to employment growth is negative. Indeed, the positive effect on employment growth from employment-HGFs is substantially larger than the negative effect from productivity-HGFs. We cannot be sure, however, of how many productivity-HGFs or employment-HGFs will result from a given increase in the number of young firms. In the long run it is nonetheless plausible that the net effect on employment will be positive. The same argument can be made for policies intent on promoting growth in productivity and sales. However, as all nine groups of HGFs have been found to give positive contributions to economic growth, the same concern does not appear to exist when pursuing this outcome variable. We conclude, in line with previous studies, that renewal seems to be critical for economic performance.

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