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## Stylised facts about Slovenian high-growth firms

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### ABSTRACT

The paper analyses high-growth firms in Slovenia over two three-year periods: 2007–2010 and 2011–2014. The analysis has been carried out for four stylised facts on high-growth firms established in the literature: (1) growth-rate distributions are heavy-tailed; (2) different growth indicators select different high-growth firms; (3) a small share of high-growth firms generates a large share of jobs; and (4) high-growth firms are not more common in high-tech industries. The results find the growth-rate distributions to be heavy-tailed, but also somewhat asymmetric and thicker than the Laplace tails. The paper shows that different indicators indeed select different high-growth firms, which is especially evident when comparing employment- and revenue-based selected firms. Furthermore, Slovenia has a smaller share of high-growth firms compared to more developed countries like the United Kingdom and Sweden; however, this smaller share of firms does contribute to a large share of jobs created, but the effect is not as large as in more developed countries. The analysis also confirms the significant effect of micro, small and medium-sized enterprises on overall job creation. Finally, only a small portion of high-growth firms can be found in high-tech sectors in Slovenia.

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## 1. Introduction

Policymakers around the world have focused their policies on providing a supportive environment for small and medium-sized enterprises (SMEs), as they represent 99% of all firms (OECD, 2016a). Besides the total number of firms, in the European Union (EU) they account for around two-thirds of total employment, ranging from 53% in the United Kingdom to 86% in Greece and they contribute 57% of value-added created in the EU (eurostat, 2015). Indeed, many policymakers focus on the SMEs because of their effect on employment; however, empirical research found that the majority of jobs in contemporary economies are created by a small number of firms, called high-growth firms (HGFs) (Birch, 1979; Henrekson & Johansson, 2010).

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This very fact has prompted researchers and policymakers to devote increasing attention to the characteristics of HGFs and policy instruments to assist them.

Seven stylised facts on HGFs were presented in an introduction to a special issue on HGFs in *Industrial and Corporate Change* (Coad, Daunfeldt, Hölzl, Johansson, & Nightingale, 2014). The research has found that HGFs tend to be younger than the average firm, have difficulties sustaining high growth (Coad & Hölzl, 2009; Daunfeldt & Halvarsson, 2015), are not necessarily high-tech (Hölzl, 2009) and that it is difficult to predict *ex ante* which firms are going to grow (Coad et al., 2014). Furthermore, the choice of growth indicator seems to matter for which firms will be classified as high-growth and which not.

Stylised facts have been found to hold for several country datasets; however, Mason, Brown, Hart, and Anyadike-Danes (2015) find that Scottish HGFs differ from HGFs in the rest of the UK and state that Scottish HGFs are unlikely to be the same as those in other small countries like Finland or New Zealand. The previous paper gives the motivation to investigate the stylised facts for Slovenia, which have not yet been tested; in addition, existing research conducted on HGFs from Slovenia does not apply the widely used Eurostat-OECD (2007) definition for selecting HGFs.

The financial data on Slovenian firms is underutilised in research on HGFs. Research on Slovenian HGFs have so far mostly been based on just a subsample of HGFs and not on data for all firms, which has the potential for selection bias (Crnogaj & Širec, 2014; Širec & Močnik, 2013). The financial data on Slovenian firms has been used to investigate various topics (e.g., innovation and export). For example, Zajc Kejžar, and Ponikvar (2011) examined the data on Slovenian manufacturing firms for the period 1994–2003. They found that extensive growth is more persistent in younger and more productive firms. Intensive growth is characterised by an inverted U-shaped relationship with its size. Drnovsek (2004) examined job creation and found that small firms have been the most significant employer in the transition period from a labour-managed system to a market-based economy. Širec and Močnik (2016) have shown that the use of leverage (debt) for growth decreases profits for both male- and female-owned Slovenian firms. In another study of 782 Slovenian HGFs, Širec and Močnik (2014) found that sales growth is negatively related to both profitability and firm size. Initial descriptive analysis of HGFs based on full financial data on the total population of Slovenian firms was conducted by AJPES (2015). However, this dataset has not been thoroughly used to examine HGFs up to this point.

We aim to check whether several stylised facts are consistent with financial data on Slovenian firms for the two three-year periods: 2007–2010 and 2011–2014. We chose these two periods to analyse firm growth in the post-crisis period and one later period. We examine the following four stylised facts: (1) growth-rate distributions are heavy-tailed; (2) different indicators select different firms as HGFs; (3) a small number of HGFs create a large share of new jobs; and (4) HGFs are not more common in high-tech industries. We use descriptive statistics, as well as non-parametric and parametric approaches to check the above-stated facts.

This paper is the first to conduct a thorough analysis of Slovenian HGFs based on the AJPES dataset with financial data on all Slovenian firms for the periods 2007–2010 and 2011–2014. The paper is critical towards the usage of the Eurostat-

OECD (2007) definition of HGFs and the corresponding impact of these firms on job creation in smaller countries like Slovenia. The parametric and non-parametric approaches on growth-rate distribution finds them to be heavy-tailed, somewhat asymmetric and thicker than in Laplace distribution. A small portion of HGFs in the overall number of firms is a major contributor to job creation; however, this effect seems smaller than is the case in more developed countries. Finally, the paper finds HGFs to be a rare phenomenon in high-tech industries, even smaller than is the case in more developed countries. Thus, this research confirms the four stylised facts, but also points to several differences when compared to more developed countries.

## 2. Theoretical background

### 2.1. Stylised facts about HGFs

#### 2.1.1. SF 1: growth-rate distributions are heavy-tailed

Growth-rate distribution has been an important research avenue as it deals with the statistical regularities of industry dynamics. The starting point in research on growth-rate distribution has been Gibrat's *Law of Proportionate Effect* (Gibrat, 1931). The main point of this *law* is that firm growth rates are independent and identically distributed variables, which implies that the firm's growth does not depend on the firm's previous size (Mansfield, 1962). The law can also be interpreted as a firm's growth not being dependent on one, but on many, different factors specific to the firm, which makes a firm's growth stochastic (Dobbs & Hamilton, 2007). During the course of the last 50 years, testing *Gibrat's Law* attracted substantial intellectual attention (e.g., Audretsch, Santarelli, & Vivarelli, 1999; Giotopoulos & Fotopoulos, 2010; Lotti, Santarelli, & Vivarelli, 2003), with results confirming the law, rejecting the law or confirming the law for firms above the industry's minimum efficient scale (see Bottazzi, Cefis, & Dosi, 2002; Coad, 2009; Sutton, 1997).

An interesting feature of Gibrat's Law is that under the central-limit theorem the growth rates should be well described by a Gaussian distribution (Bottazzi et al., 2002). However, Gaussian distribution of growth rates has been strongly rejected on several occasions (Bottazzi, Coad, Jacoby, & Secchi, 2011; Bottazzi & Secchi, 2003; Lunardi, Micciché, Lillo, Mantegna, & Gallegati, 2014; Reichstein & Jensen, 2005). In particular, a kind of tent-shaped distribution of growth rates has been found to characterise the US manufacturing industry (Bottazzi & Secchi, 2003; Stanley et al., 1996), the worldwide pharmaceutical industry (Bottazzi, Dosi, Lippi, Pammolli, & Riccaboni, 2001) and Italian manufacturing (Bottazzi et al., 2002; Bottazzi & Secchi, 2003), implying that firm growth dynamics are more complex than stated by Gibrat. Bottazzi et al. (2002) investigate Italian manufacturing sectors and use the Subbotin family of distributions (Subbotin, 1923) to confirm the growth-rate distribution as being a *fat-tailed* distribution, in particular as being Laplace (double exponential) distribution (which is a special case of the Subbotin family of distribution).

These analyses have been conducted on an aggregate level as well as on disaggregated data, whereby Bottazzi and Secchi (2003) on a dataset of Italian manufacturing firms point to growth-rate distributions of most disaggregated sectors as tending towards the Laplace distribution shape. Reichstein and Jensen (2005) analysed four

Danish manufacturing industries and found that both the kurtosis and skewness of the growth-rate distributions deviated from the normality; more concretely, most industries had growth-rate distributions significantly leptokurtic and significantly asymmetric (right-skewed). Asymmetry is particularly important, as for Danish manufacturing industries, the distribution had a fatter right tail, in comparison to the left, which implies that it is more likely to experience higher positive growth rates. Thus, Reichstein and Jensen (2005) find fatter right tails, while left tails were more similar to a Gaussian distribution.

Afterward, Bottazzi et al. (2011) investigated French manufacturing industries<sup>1</sup> and found that Laplace does not replicate actual growth-rate distribution shapes in all industries. Bottazzi et al. (2011) find that the fat tails in French manufacturing industries (aggregate) are fatter than is the case with Laplace. Like Reichstein and Jensen (2005) the fat tail was more pronounced on the right side, pointing to a relatively higher frequency of high-growth events in the French manufacturing industries. At a disaggregated level, all sectors show growth rates that are particularly fat-tailed, although there is heterogeneity between sectors (Bottazzi et al., 2011, p. 113). While these results point to similar shapes of growth-rate distribution, as was the case with the Danish dataset (Reichstein & Jensen, 2005), they pointed to some differences between French manufacturing industries and previous results in the US (Stanley et al., 1996) and Italy (Bottazzi, Cefis, & Dosi, 2002). Therefore, Bottazzi et al. (2011, p. 115) concluded: 'It seems that the distribution of growth rates is a subject ripe for future investigations.'

Building on the work of Bottazzi et al. (2011), Lunardi et al. (2014) – using the panel of US and European publicly quoted manufacturing firms – find no typical shape of the growth-rate distributions for the sectoral level (e.g., manufacturing; NAISC 2 digit level); however, they find a common distribution shape for the subsectoral level, with smaller differences. In particular, at the sectoral level there is no distribution shape belonging to the Subbotin family of distributions, nor the Gaussian. However, for most of the subsectors Laplace distribution is a useful approximation of the growth-rate distributions. This is why Lunardi et al. (2014, pp. 155) conclude: 'This paper confirms that the empirical characterisation and the theoretical modelling of the growth rates distribution of individual firms and of a panel of firms are still an open and challenging subject.' In sum, the research on growth-rate distributions found that most firms do not grow, with only a few firms having high growth or high decline (Bottazzi & Secchi, 2003; Reichstein & Jensen, 2005) implying these distributions have fat tails. Therefore, we expect the *fat-tailed* growth-rate distributions to hold for the dataset of Slovenian firms.

### **2.1.2. SF 2: the use of different growth indicators selects a different set of firms**

One of the key questions in the inquiry about economic development is why some firms grow, while others do not (Hart & Mcguinness, 2003). While many advances in growth research have been achieved, Roper and Hart (2013, 11) still conclude that 'growth remains something of an enigma.' At the core of researching this 'enigma' is the mere measurement of growth. Since Birch's (1979) influential paper, many studies have used quite different growth-measurement indicators, e.g., firms' employees,

revenue, market share, profits or asset growth in absolute or relative terms (Delmar, Davidsson, & Gartner, 2003), which makes studies using different growth indicators hard to compare.

The most frequently used growth indicators are the number of employees and amount of revenue (Daunfeldt, Elert, & Johansson, 2014). Coad et al. (2014) categorise the growth indicators into two basic categories: first, the share of firms in terms of population (e.g., the top 5% of firms); and, second, a growth ratio above a certain threshold (e.g., an employment growth rate of 20% over three consecutive years). The main challenge with the first category of growth indicators is the difficulty in making international comparisons of HGFs, which is one of the reasons why the second category is often suggested by international organisations (see Eurostat-OECD, 2007). One of the most used definitions for HGFs from the second group of growth indicators is the Eurostat-OECD (2007) definition (for more details see Section 4.2.).

Delmar, Davidsson, and Gartner (2003) give extensive elaboration on why different growth indicators exist, while Coad (2009) highlights ‘pervasive heterogeneity’ as the key reason behind the existence of different indicators. In other words, different indicators select different firms because growth is, in essence, a ‘multi-dimensional rather than uni-dimensional process’ (Delmar, Davidsson, & Gartner, 2003). First, different growth indicators, like sales, employment, assets or profits, can lead to different firms being selected, because growth depends on the firms’ specific situation and industry. Namely, high-tech firms might first grow in assets and employment and then later potentially grow in sales; some firms could first grow in sales, and after several years grow in employment and assets; and still others could grow in sales and not grow in employment at all. Secondly, absolute measures of growth favour larger firms, whereas relative measures favour smaller firms, as these firms can more easily reach higher percentage growth.

Theoretically, growth is a heterogeneous process: different firms have different growth patterns, therefore focusing on one growth indicator instead of another can lead to the selection of firms with a particular growth pattern. Empirically, Weinzimmer, Nystrom, and Freeman (1998) found a weak correlation between different growth indicators, while Shepherd and Wiklund (2009, pp. 121) find ‘low concurrent validity among many of the different measures of growth, but do find high and moderate concurrent validity among select few growth measures’. Finally, Delmar, Davidsson, and Gartner (2003) conclude that selecting HGFs strongly depends on the growth indicator, thus, relying on one indicator excludes a number of other HGFs potentially selected by other indicators. The implication of different growth indicators selecting different HGFs is important for scientific progress because of the comparability of studies on growth phenomenon and has important implications for adequate replicability of scientific papers.

### ***2.1.3. SF 3: a small number of HGFs create a large share of new jobs***

Dennis (2011, pp. 92) stated, ‘the basic issue for policymakers is jobs. Policymakers need jobs; smaller firms produce jobs; so small business remains a central focus for many policymakers.’ The recent recession has strengthened the policy-makers’ focus on job creation; thus, it is no wonder that many supra-national and national policies

(European Commission, 2010) develop broad entrepreneurship policies and narrower SME policies (Lundstrom & Stevenson, 2006). The focus on small firms began to take shape since Birch's (1979) paper which found that it is the small firms who are the main job creators in the United States.

Some 15 years later, the same author found that it is not just the small firms that are the most important job creators, but the small proportion of the so-called gazelles irrespective of their size (Birch & Medoff, 1994). The gazelles were primarily defined as firms growing rapidly and as significant net job creators. Gazelles were contrasted to mice: the large proportion of small firms which did not contribute much to new jobs. Finally, gazelles were also contrasted to elephants, which were a small number of large firms that employed many employees, but contributed only marginally to new jobs (Henrekson & Johansson, 2010, 228). Thus, the policy focus started to shift towards a small subset of gazelles, sometimes (although there are differences) also known as HGFs or high-impact entrepreneurship (Acs & Mueller, 2008). This policy shift was strengthened by the influential paper by Shane (2009), which raised the question of the efficiency of support measures for small firms that will most likely fail, and instead calls for supporting the small portion of firms with high growth potential. Coad et al. (2014) on the other hand questions the mere possibility of governments supporting HGFs. Regardless of these critiques, national policies in the United States (Acs, 2008), the UK and Sweden (Mason & Brown, 2014) particularly highlight HGFs, as well as the supra-national European Strategy for Smart, Sustainable and Inclusive Growth. Lately, Mason and Brown (2013) highlighted differences between HGFs in small economies like Scotland and Finland or New Zealand, recommending the need to customise policies to the environment of a particular country in question. Mason et al. (2015) find that Scottish HGFs differ from the HGFs in the rest of the UK in many aspects; in particular, they differ in the creation of employment. While Scottish HGFs are substantial job creators, this is on lower levels of job creation as opposed to UK HGFs.

Nonetheless, the hypothesis of HGFs as strong job creators has been confirmed by a large number of studies (Henrekson & Johansson, 2010). Henrekson and Johansson (2010, 240) stated 'a few rapidly growing firms generate a disproportionately large share of all new net jobs compared with non-high-growth firms. This is a clear-cut result.' With the Eurostat-OECD definition of HGFs, the NESTA (2009) paper selected 6% of a total number of firms in the UK, which accounted for around 50% of total new jobs 2002–2008. Storey (1994) found that 4% of firms created 50% of all jobs, while Daunfeldt, Johansson, and Halvarsson (2015) found that 6% of firms account for 42% of the jobs created in Sweden 2005–2008.

#### **2.1.4. SF 4: HGFs are not more common in high-tech industries**

Innovation is considered to be the most important source of economic growth in Europe (European Commission, 2010; OECD, 2016b). Thus, in trying to elaborate on the difference between the growth rates of European economies and those of United States, R&D expenses have been claimed as one of the influential factors, although the relationship between R&D and economic growth has been found to be far from

perfect (Grilli & Murtinu, 2014). What has been challenging the European policy-makers is that successful high-tech firms seemed to systematically avoid Europe as the continent to nest and contribute through job creation (European Commission, 2010). Somehow, successful high-tech firms like Microsoft, Facebook, IBM, Apple or Samsung have not been growing in the European Union and public policies during the course of last 20 years have aimed at fostering high-tech firms (Mason and Brown, 2013). Policymakers have considered high-tech industries to be the key ingredient in the 'magic formula' for more jobs (Coad & Reid, 2012) and economic growth (Colombo & Grilli, 2007).

Macroeconomic theory finds technological development to be a principle factor and antecedent of economic growth and development (Aghion & Howitt, 1992; Arrow, 1962; Romer, 1990; Solow, 1957). The public policies targeting these high-tech firms usually aim at developing new technology-based firms or established technology-based firms (Brown & Mason, 2014). Colombo, Grilli, and Piva (2006) conclude that valuable innovative projects might not be realised without public subsidies and they give a rationale for government intervention in market failures: first, research and development (R&D) spillovers which lead to less than socially optimum levels of R&D investment; and, second, financial constraints in front of new technology-based firms. Brown and Mason (2014) sum up the reasons for believing that it is the high-tech that should be receiving particular attention: first, it somehow became received wisdom that high-tech industries are the engine of economic growth; second, examples such as Silicon Valley were presented as evidence of such wisdom; third, technology development further enables entrepreneurial opportunities; and finally, most countries strongly support high-tech firms through industrial and entrepreneurship policy frameworks.

Brown and Mason's (2014) findings in Scotland show that the economic significance of technology firms is quite a bit lower than it is commonly assumed; in addition, these firms often have not secured intellectual property rights. These authors go further and question the necessity for the special status of these industries, which they describe as 'high-tech fantasies' and 'growth myopia'. Brown and Mason (2014) go along with NESTA (2010) who question the policy logic for supporting high-tech firms from 'technology push' to 'market orientation'. This change in support was raised because HGFs feature the so-called 'hidden innovations' (Mason & Brown, 2013) which are innovations in business models, organisational forms and those stemming from the firms' ability to link with the customers and end-users (NESTA, 2010) or supply chain partnership (Wynarczyk & Watson, 2005). Bleda, Morrison, and Rigby (2013) found that HGFs are not more likely to be in the high-tech sectors in several countries, while in the UK, Brown and Mason (2012) found that only 15% of HGFs are in the high-tech sectors. Hinton and Hamilton (2013) find that HGFs in New Zealand seldom had the product/service first to the market. Several researchers have found that HGFs are not overrepresented in high-tech industries (Coad et al., 2014). If anything can be claimed, it is that HGFs are more common in service industries (Henrekson & Johansson, 2010).

### 3. Data and methods

The AJPES database was used for the purpose of the research. Firms of all sizes and types registered in Slovenia are obliged to deliver their annual financial statements to AJPES. The database provides text files with annual financial data, whereas the final sample encompassed a total of 85,179 unique firms in Slovenia for the period 2007–2014, creating a balanced panel with 681,432 observations. To check whether the data were consistent with the stylised facts, descriptive statistics were used, while for the first stylised fact we used parametric and non-parametric with a particular focus on the Subbotin family of distribution. Although methods used in the three other stylised facts were descriptive statistics, it is worth mentioning that each stylised fact featured several choices authors had to make in order to check the consistency of data with the stylised facts. Detailed elaboration of the methods used to check each stylised fact are given below.

#### 3.1. SF 1: growth-rate distributions are heavy-tailed

As the analysis of each industry would be too burdensome, we follow the approach by Reichstein and Jensen (2005) and present analysis of several industries.<sup>2</sup> When selecting the industries to conduct the analysis, several ideas were kept in mind: i) the analysis followed previous work and was conducted on a NACE 2-digit level for comparability (Reichstein & Jensen, 2005); ii) services were underrepresented in the current research field which is why services were included (Lunardi et al., 2014); iii) sectors with different technologies and learning modes were used for analysis (Bottazzi & Secchi, 2006); and iv) industries had to have at least 100 firms. Four NACE sectors are analysed: Manufacture of food products (Low-tech sector; NACE 2-digit - 10); Manufacture of computer, electronic and optical products (High-tech sector; NACE 2-digit - 26); Wholesale trade, except of motor vehicles and motorcycles (Less knowledge intensive sector; NACE 2-digit - 46) and Computer programming, consultancy and related activities (Knowledge-intensive sector; NACE 2-digit - 62).

Following previous empirical analysis (e.g., Reichstein & Jensen, 2005; Bottazzi & Secchi, 2006) we use sales and employment as a definition of firm size. Where  $S_{i,j}(t)$  is sales or employment of the  $i$ th firm, belonging to the  $j$ th sector at time  $t$ . Here  $j \in \{1,2,3,4\}$  and if  $N_j$  is the number of firms in the  $j$ th sector, we have  $i \in \{1,2,3,4\}$ . In order to eliminate possible trends we consider normalised log sales and log employment.<sup>3</sup>

$$s_{i,j}(t) = \log(S_{i,j}(t)) - \frac{1}{N_j} \sum_{i=1}^{N_j} \log(S_{i,j}(t)), \quad (1)$$

Growth is then calculated by subtracting size in time  $t$  from firm size in time  $t-1$ .

$$g_{i,j}(t) = s_{i,j}(t) - s_{i,j}(t-1). \quad (2)$$

In examining growth-rate distribution, Bottazzi and Secchi (2003), Bottazzi, Coad, Jacoby, & Secchi (2011) and Reichstein and Jensen (2005) as well as Lunardi et al.

(2014) among others, rely heavily on the kernel density estimate, which is a non-parametric approach to estimating a probability density function of a random variable. It can be considered a smoothed version of the histogram, obtained by counting the observations in the different bins as the width of the bins varies (Bottazzi, Coad, Jacoby, & Secchi, 2011). This estimate requires the provision of two objects: the kernel function  $K$  and the bandwidth  $h$  of the bin. Formally we have:

$$f(x, t; h) = \frac{1}{nh} \sum_{i=1}^n K\left(\frac{x-s_i(t)}{h}\right) \quad (3)$$

where  $s_1(t), \dots, s_n(t)$  are the observations in each sector,  $h$  is a bandwidth parameter controlling the degree of smoothness of the density estimate, and where  $K$  is a kernel density. As noted by Guidoum (2015), the choice of kernel is ‘a problem of less importance’ as different functions produce good results, while the choice of bandwidth parameter is critical, as if the bandwidth is small, we will obtain an under-smoothed estimator, with high variability. On the contrary, if the value of  $h$  is big, the resulting estimator will be over smooth and farther from the function that we are trying to estimate. Choosing  $h$  is a complex endeavor, which is sometimes even described as a ‘black art’ (Stark, 2008), as there are many different ways of calculating the bandwidth parameter  $h$  (Deng & Wickham, 2011; Guidoum, 2015; Silverman, 1986). We follow Bottazzi et al. (2011) and choose the normal kernel function and bandwidth parameter  $h$  based on the Silverman (1986) procedure.<sup>4</sup> Figure 1 gives kernel estimates of the growth-rate distributions from four selected sectors for the periods 2009–2010 and 2013–2014.

In particular, we follow Reichstein and Jensen (2005) and use the *subbotools* package<sup>5</sup>, considering a flexible family of probability densities, known as the Subbotin family (Subbotin, 1923), that includes as a particular case the Laplace. More concretely, we adopt the less asymmetric density of the asymmetric power exponentials, with the two scale parameters, set equal, that is  $a_l = a_r$ . The Subbotin density, centered in  $g=0$ , is characterised by two parameters: a scale parameter  $a$  and shape parameters  $b$ , where by  $l$  stands for left and  $r$  for right shape parameter:

$$f(x; b_l; b_r; a; m) = \frac{1}{C} e^{-\left(\frac{1}{b_l} \frac{|x-m|^{b_l}}{a} \theta(m-x) + \frac{1}{b_r} \frac{|x-m|^{b_r}}{a} \theta(x-m)\right) b, b_l} \quad (4)$$

The normalisation constant now reads  $C = a(b_l^{1/b_l-1} \Gamma(\frac{1}{b_l}) + b_r^{1/b_r-1} \Gamma(\frac{1}{b_r}))$  where  $\Gamma(x)$  is the Gamma function. The lower the shape parameters  $b_l, b_r$  the fatter the density tails. For  $b < 2$ , the density is leptokurtic and is platikurtic for  $b > 2$ . If  $b = 2$ , the density is Gaussian and for  $b = 1$  it is Laplace. If the  $b_l$  and  $b_r$  are the same, the distribution is symmetric, while if they are different, the distribution is asymmetric. For the four industries we compute the density that best fits the data among those belonging to this family. We estimate the  $a, b_l$  and  $b_r$  parameters for each industry, maximising the likelihood of observations.

### 3.2. SF 2: the use of different growth indicators selects a different set of firms

In regards to the second stylised fact, the primary growth indicators for selecting HGFs in the research were two Eurostat-OECD (2007) indicators: whereas one refers to employment growth, the second refers to revenue growth. The Eurostat-OECD indicators employ a minimum threshold of 10 employees in the first year; for a firm to be selected as an HGF it is necessary that that firm to have an average annualised growth greater than 20% per annum, over a three-year period. Growth can be measured by the number of employees or by turnover (Eurostat-OECD, 2007). Thus, the HGFs looks formally:

$$E_{t-3} \geq 10 \quad (4)$$

$$\left( \frac{E_t}{E_{t-3}} \right)^{1/3} - 1 \geq 20\% \quad (5)$$

In the first equation  $E_{t-3}$  is the minimum size of the firm in terms of the number of employees. The second equation shows  $E_t$  as the number of employees or revenues of the firm in time  $t$ , while  $E_{t-3}$  points to the number of employees or revenues of the firm in time  $t-3$ .

As some firms match both criteria, a third indicator is directed towards those firms that satisfy both employment and revenue criteria. Furthermore, top 5% indicators with regard to absolute and relative employment and sales growth were adopted. These top 5% indicators were carried out using two different minimum thresholds of employees, namely, the 2 employee cut-off and the 10 employee cut-off. The first minimum threshold of employees criteria was adopted in order for analysis not to be inflated with firms with one employee or less, as these firms could easily achieve high relative employment growth. The second minimum threshold of employees criteria was adopted as the Eurostat-OECD (2007) definition also uses a 10 employee cut-off in the first year; this therefore makes a comparison between indicators more sound. Finally, an indicator was added for those firms that match top 5% relative and absolute employment or revenue growth. All the indicators measured three-year periods (2007–2010 and 2011–2014).

### 3.3. SF 3: a small number of HGFs create a large share of new jobs

For the analysis of the third stylised fact – *a small number of HGFs create a large share of new jobs* – we adopted the calculation of net employment change rate, job destruction and job creation (Haltiwanger, Lehmann, & Terrell, 2003). Gross job creation is defined as the sum of all employment gains in all expanding firms including entering firms, while gross job destruction is the sum of all employment losses in all contracting firms including exiting firms in an economy or sector. Net employment changes are measured as the difference between gross job creation and destruction. Additional analysis was conducted for the net employment change rate, job destruction and job creation with regard to the size of the firms, whereby the paper relayed one of the three European Commission's (2005) definitions of firm size. The indicator

of the firm size used was the employee criterion; thus, micro-firm represents a firm with 1–9 employees; small firm 10–49; medium firm 50–249; and large firm 250+ employees.

### 3.4. SF 4: HGFs are not more common in high-tech industries

For the fourth stylised fact – *HGFs are not more common in high-tech industries* – we adopted the OECD classification of industries (OECD, 2011). We classified firms into eight different groups of industries: low-tech (LT); mid-low tech (MLT); mid-high tech (MHT); high-tech (HT); less knowledge-intensive services (LKIS); knowledge-intensive services (KIS); construction; and public sector. A word of caution should be said for the interpretation of the results on the fourth stylised fact. This classification does not give an answer on whether a firm is a high-tech firm, but whether a firm is in a high-tech industry. For example, a textile firm might be very high tech, using the newest nanotechnology; however, this textile firm will not be selected as a firm within a high-tech industry, because textile is classified as a mid-low tech. This classification uses R&D intensity (R&D/turnover ratio) to identify high-tech industries, with the idea behind this approach being using R&D as a key input for innovation. The classification of industries is derived from the sample of OECD member-states, which opens up potential for selection bias. Namely, some countries might not have developed every high-tech industry. In particular, while Slovenia is an OECD member-state, the R&D expenditure structure is more concentrated among industries, as opposed to the USA, UK or Sweden where it is more heterogeneous (Abdal, Torres-Freire, & Callil, 2016). Finally, we use the Eurostat-OECD (2007) definition of HGFs for the fourth stylised fact because of comparison to the existing literature.<sup>6</sup>

## 4. Results

### 4.1. SF 1: growth-rate distributions are heavy-tailed

Table 1 gives the descriptive statistics of firm growth rates for the years 2010 and 2014 in four selected NACE sectors. Skewness is mostly different from zero, whereas wholesale trade, except motor vehicles and motorcycles and computer programming, consultancy and related activities have skewness mostly less than 1; the manufacture of food products and manufacture of computer, electronic and optical products have skewness mostly higher than 1. Kurtosis measures are very high in all sectors; this, together with skewness, suggests a departure from normality, as noted by Bottazzi and Secchi (2003), Bottazzi et al. (2011) and Reichstein and Jensen (2005).

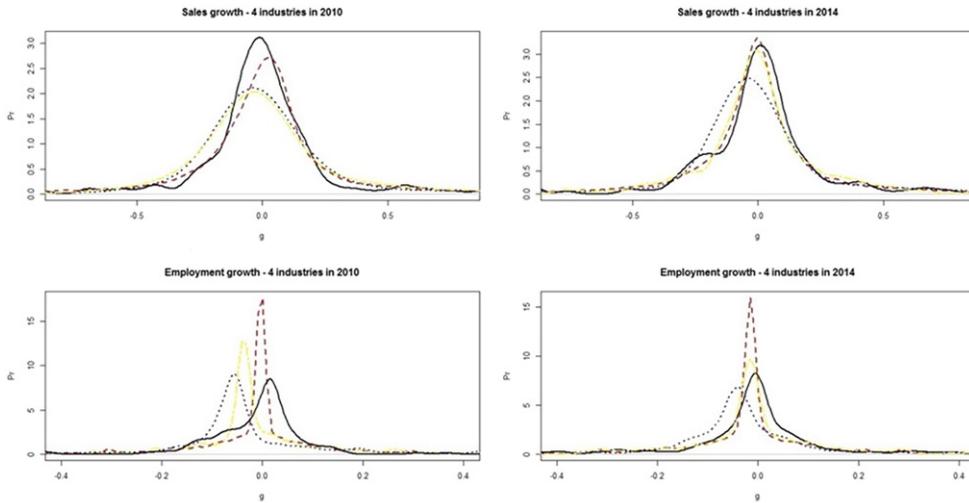
Figure 1 suggests heterogeneity among industries, which is particularly evident when using employment as a proxy for growth; sales proxy gives a less heterogeneous picture. However, in order to quantify whether the distributions follow Laplace, we adopt a parametric approach (Reichstein & Jensen, 2005; Bottazzi & Secchi, 2003).

The shape parameters of the four industries in 2010 and 2014 are reported in Table 2, indicating the distributions to be leptokurtic. The distributions are fat-tailed and they are somewhat asymmetric ( $b_l$  and  $b_r$  being different), as pointed by Reichstein and Jensen (2005), although in some industries being close to symmetric.

Table 1. Data structure of the four industries in terms of firm growth (normalised data).

Description	2010				2014			
	Manufacture of food products (N = 490)	Manufacture of computer, electronic and optical products (N = 210)	Wholesale trade, except of motor vehicles and motorcycles (N = 8901)	Computer programming, consultancy and related activities (N = 1583)	Manufacture of food products (N = 573)	Manufacture of computer, electronic and optical products (N = 222)	Wholesale trade, except of motor vehicles and motorcycles (N = 9477)	Computer programming, consultancy and related activities (N = 2027)
Identified firms	318	181	6,640	1,211	395	188	6,886	1,613
Median	-0.033	-0.010	0.008	-0.030	-0.039	0.002	-0.005	-0.006
Standard deviation	0.353	0.287	0.383	0.365	0.314	0.297	0.401	0.319
Skewness	3.0693	3.2566	0.7308	0.5431	1.1525	-1.2298	0.2467	1.4096
Kurtosis	28.4855	21.2944	17.0735	13.9923	17.7400	14.7643	18.2428	23.8344
Identified firms	303	158	5,401	985	366	161	4,716	1,115
Median	-0.053	0.017	-0.003	-0.037	-0.041	-0.007	-0.015	-0.015
Standard deviation	0.303	0.144	0.229	0.242	0.250	0.200	0.260	0.240
Skewness	1.2964	4.3821	0.07260	0.9013	0.5295	4.4294	0.6058	0.7580
Kurtosis	10.4013	33.9697	20.8392	18.0040	9.4711	41.8024	16.9033	15.152

Source: Author's calculations based on AJPEs data.



**Figure 1.** Kernel estimates of the growth-rate density<sup>11</sup> in 2010 and 2014 of four industries.  
Source: Author's calculations based on AJPES data

In the four sectors analysed, the highest  $b_r$  is 0.6002 in 2014 for the manufacture of computer, electronic and optical products. On the other hand, the same industries in 2010 had the left tail close to Laplace ( $b_l=1.0772$ ). Overall, the majority of sectors had the left and right tail fatter than it is in the Laplace distribution, ranging from 0.3569 to 0.7263 (when we exclude the highest  $b_l$  reported in the manufacture of computer, electronic and optical products). A fat tail represents a probability distribution which predicts movements of three or more standard deviations more frequently than a normal distribution, thus it represents the statistical distributions which describe the higher probability of a high firm growth rate or a high firm decline rate. The four sectors analysed in Slovenia show tails to be quite a bit fatter than the tails characterised by the Laplace distribution, thus with higher probability of having high growth and high decline.

#### **4.2. SF 2: the use of different growth indicators selects a different set of firms**

Table 3 presents the number of HGFs in Slovenia for the period 2007–2010 according to different growth indicators. Different employment-based indicators select different firms when compared to firms selected with the revenue-based indicators. In particular, from 152 HGFs selected with Eurostat-OECD employment-based indicators in 2010, only 47 identical HGFs were selected with the top 5% absolute revenue growth indicator, which is a 31% match. Furthermore, when comparing Eurostat-OECD employment-based indicator selected HGFs with the Eurostat-OECD revenue-based indicator selected HGFs, the match is 62%.

Reversing the comparison, one can observe that from 294 HGFs selected with the Eurostat-OECD revenue-based indicator, only 105 identical HGFs were selected with the top 5% absolute employee-growth indicator, which is a 36% match. Furthermore, from 294 HGFs selected with the Eurostat-OECD revenue-based indicator, only 94



**Table 2.** Maximum likelihood parameter estimates of the Subbotin parameters (normalised data).<sup>10</sup>

NACE sector	2010					2014				
	$b_l$	$b_r$	$a$	$\mu$	LL	$b_l$	$b_r$	$a$	$\mu$	LL
Manufacture of food products (10)	0.3569	0.4007	0.1010	-0.0371	-0.1980	0.5196	0.4021	0.1000	-0.0174	-0.2750
Manufacture of computer, electronic and optical products (26)	1.0772	0.4862	0.1591	0.1909	-0.0873	0.4843	0.6002	0.1210	0.0123	-0.1482
Wholesale trade, except of motor vehicles and motorcycles (46)	0.5910	0.5233	0.1566	0.0782	0.0927	0.5187	0.5441	0.1560	0.0050	0.1109
Computer programming, consultancy and related activities (62)	0.7263	0.5364	0.1627	0.0287	0.0726	0.5647	0.5573	0.1485	0.0052	0.0410

Source: Author's calculations based on AJPEs data.

**Table 3.** The number of high-growth firms in Slovenia for the period 2007–2010 by different criteria.

	Eurostat-OECD definition (1)		Top 5% employee definition with 2 employee cut-off (2)		Top 5% employee definition with 10 employee cut-off (3)		Top 5% revenue definition with 2 employee cut-off (4)		Top 5% revenue definition with 10 employee cut-off (5)		
	Eurostat-OECD Employees Revenue	Eurostat-OECD Employees Revenue	Top 5% absolute employee growth	Top 5% relative employee growth	Top 5% absolute employee growth	Top 5% relative employee growth	Top 5% absolute revenue growth	Top 5% relative revenue growth	Top 5% absolute revenue growth	Top 5% relative revenue growth	
Number of firms	152	296	840	840	280	280	158	840	274	280	100
Matched firms of OECD-Eurostat and top 5% firms definitions											
Eurostat-OECD employees	152	94	151	151	118	151	118	92	61	47	39
Eurostat-OECD revenue	94	296	104	163	105	126	100	190	145	105	100
Eurostat-OECD employees and revenue	94	94	94	94	77	94	77	71	74	40	39

Source: Author's calculations based on AJPEs data.

identical HGFs were selected also with the Eurostat-OECD employment indicator, which is 32%. From Table 4 it can be seen that from the 330 Eurostat-OECD revenue-based indicator selected HGFs, only 91 of the same HGFs were selected by the Eurostat-OECD employment-based indicator, thus 28%. Therefore, we can say that the stylised fact 3 (different growth indicators select a different set of firms) is consistent with our data. The analysis in Slovenia for the period 2007–2010 showed the percentage match varied depending on the growth indicators applied.

We also analyse persistent growth based on two HGF definitions.<sup>7</sup> First, the top 5% relative growth and, second, the top 5% absolute growth definition, both with the cut-off set at two employees. HGFs identified based on the employees and revenue criteria were summed together. Afterwards, we look for the probability that the HGFs in 2007–2010 will have the same status in 2011–2014. As can be seen from Table 5, there is rather low probability of persistent high growth among HGFs in Slovenia identified with the relative growth definition. Only 6% of HGFs in the period 2007–2010 enjoyed the same status in 2011–2014, similar to the findings of Holzl (2014). We also look for the probability that a micro, small, medium or large HGF in the period 2007–2010 becomes an HGF in the subsequent period.<sup>8</sup> This probability is highest for micro HGFs, followed by small HGFs, and it appears to be very low probability for medium HGFs, and non-existent for large HGFs. Looking at the probability of the non-HGF in the first period becoming HGF in the second period we find probabilities to be rather balanced.<sup>9</sup> On the other hand, using the absolute growth criteria, results show 20% more persistent HGFs. The reason for such results is that the absolute growth definition favours larger firms, therefore medium and large HGFs from the first period analysed had a much higher probability of enjoying HGF status in the 2011–2014 period.

### **4.3. SF 3: a small number of HGFs create a large share of new jobs**

We first analysed total job destruction and job creation for the two periods, 2007–2010 and 2011–2014. As can be seen from Table 6, job losses in the first period equal 102,682 jobs, while in the second, 99,705 jobs were lost. Job creation in the first period equals 85,847 new jobs and 83,753 new jobs in the second. This gives us negative net employment changes of 16,835 jobs in the first period and 15,952 jobs in the second. Once this analysis was carried out, we analysed job creation and job destruction depending on firm size. Net employment change over the periods 2007–2010 and 2011–2014 is depicted in Table 6. Slovenia has had an overall negative job turnover over both periods; whereas the first period had a negative 16,835 difference between jobs created and destroyed, the second period had a negative 15,952 difference.

Table 7 shows gross job creation in Slovenia for the period 2007–2010 divided by the size of the firms. In the first period micro firms created 44.71% of the overall jobs created, small firms contributed with 24.74%, medium-sized firms contributed with 17.42% and large firms with 13.13%. Furthermore, Table 7 also depicts job creation by firm size for the period 2011–2014. It can be seen that the number of jobs created by micro firms has further increased in recent years, thus contributing to



**Table 5.** Transition probabilities for fast growth (in %).

	Is HGF in 2011–2014 - All	Micro	Small	Medium	Large
	Top 5% relative growth with 2 employee cut-off				
HGF 2007–2010	6.14	7.80	5.21	0.96	0.00
Non-HGF 2007–2010	3.34	3.53	3.25	1.32	2.30
	Top 5% absolute growth with 2 employee cut-off				
HGF 2007–2010	26.00	13.13	19.03	33.03	45.87
Non-HGF 2007–2010	3.28	1.09	7.32	22.77	31.67

Source: Author's calculations based on AJPES data.

49.92% of overall job creation. Small firms contributed with 23.59%, medium-sized firms contributed with 14.47% and large firms with 12.02% of the overall job creation in Slovenia for the period 2011–2014.

Table 8 presents gross job destruction according to firm size in Slovenia over the period 2007–2010 and 2011–2014. In the first period, 26.46% of the overall job destruction happened through the vehicle of micro-sized firms. Small firms were responsible for 22.16% of the overall job destruction, medium-sized firms for 26.85% and large firms for 24.53%. The second period, however, shows a significantly different landscape. In the second period, 39.17% of the overall job destruction happened through the vehicle of micro-sized firms, which is a significant increase in comparison to the first period. In addition, small firms contributed to job destruction more in the second period than in the first; more concretely, small firms contributed to 25.38% of the overall job destruction in the second period. The second period also features a smaller contribution of medium- and large-sized firms to the overall job destruction, 20.18 and 15.27% respectively. What can be concluded from Table 7 and Table 8 is that only micro firms had a positive net employment change.

Table 9 provides data on HGF contribution to overall job creation in Slovenia in the 2007–2010 and 2011–2014 periods. We have analysed HGFs through two definitions; the Eurostat-OECD and top 5% of firms in absolute employee growth (with 2 employee cut-off). In the first period, HGFs by Eurostat-OECD have contributed to 9.84% of overall job creation, whereby the top 5% of firms in absolute employee growth (with 2 employee cut-off) have contributed to 28.18% of the overall job creation. In the second period, HGFs by the Eurostat-OECD definition had contributed 16.82% of overall job creation, whereas the top 5% of firms in absolute employee growth (with 2 employee cut-off) had contributed 34.89% of overall job creation.

Stylised fact 3 states the following: '[a] small number of HGFs create[s] a large share of new jobs'. From Table 9 one can observe that HGFs by the widely credited Eurostat-OECD definitions have selected an overall number of 353 unique firms that match either employee or revenue criterion in the first period and 390 firms in the second, which is equivalent to 0.84% and 0.83% of the overall number of firms in Slovenia for the periods. These 353 HGFs in the first period contributed with 8445 new jobs (9.84%), while the 390 HGFs in the second period contributed with 14,088 new jobs (16.82%). This being said, HGFs selected with the Eurostat-OECD method do represent a small number of the firms overall; however, this is even more evident when one applies the top 5% definition with the 2-employee cut-off. Applying the previous definition selects 2.01% (in the first three-year period) and 1.90% (in the

**Table 6.** Net job turnover, gross job creation and destruction for the periods 2007–2010 and 2011–2014.

	Net job turnover 2007–2010	Net job turnover 2011–2014	Gross job creation 2007–2010	Gross job creation 2011–2014	Gross job destruction 2007–2010	Gross job destruction 2011–2014
Number of employees	–16,835	–15,952	85,847	83,753	–102,682	–99,705

Source: Author's calculations based on AJPES data.

**Table 7.** Gross job creation by firm size.

	Micro	Small	Medium	Large	Total
Job creation 2007–2010	38,378	21,239	14,952	11,268	85,838
Percentage of job creation 2007–2010	44.71%	24.74%	17.42%	13.13%	100%
Job creation 2011–2014	41,807	19,757	12,119	10,064	83,748
Percentage of job creation 2011–2014	49.92%	23.59%	14.47%	12.02%	100%

Source: Author's calculations based on AJPES data.

**Table 8.** Gross job destruction by firm size.

	Micro	Small	Medium	Large	Total
Job destruction 2007–2010	–27,163	–22,747	–27,560	–25,171	–102,643
Percentage of job destruction 2007–2010	26.46%	22.16%	26.85%	24.53%	100%
Job destruction 2011–2014	–39,047	–25,299	–20,121	–15,221	–99,690
Percentage of job destruction 2011–2014	39.17%	25.38%	20.18%	15.27%	100%

Source: Author's calculations based on AJPES data.

**Table 9.** Gross job creation of HGFs for the periods 2007–2010 and 2011–2014.

	2007–2010		2011–2014	
	HGFs (Eurostat-OECD)	HGFs (Top 5% employee)	HGFs (Eurostat-OECD)	HGFs (Top 5% employee)
Number of firms	353	840	390	891
% of firms	0.84%	2.01%	0.83%	1.90%
Number of employees	8,445	24,191	14,088	29,222
% of overall gross job creation	9.84%	28.18%	16.82%	34.89%

Source: Author's calculations based on AJPES data.

second three-year period) of firms as HGFs from the overall number of firms. In addition, these HGFs generated 28.18% (in the first three-year period) and 34.89% (in the second three-year period) of overall gross job creation. Thus, we can conclude that stylised fact as validated; however, this share of new jobs is quite a bit less than is the case in the United Kingdom or Sweden (NESTA, 2009; Daunfeldt et al, 2015).

#### 4.4. SF 4: HGFs are not more common in high-tech industries

In the total sample of firms in Slovenia for the periods 2007–2010 and 2011–2014, high-tech firms represent the smallest proportions, being just 0.46%: 192 firms for the first period and 213 for the second (Table 10). On the other hand, LKIS represent the largest proportion in the total sample of firms in Slovenia for the two periods: 41.37 in the first period and 40.47% in the second. LKIS are followed by KIS, which

**Table 10.** High-growth firms (by Eurostat-OECD criteria, either employees or revenue) in Slovenia by sector classification.

	2007–2010 (HGFs 2010)				2011–2014 (HGFs 2014)					
	Number of HGFs	Proportion of all HGFs (%)	Number of all firms	Proportion of firms (%)	Ranking	Number of HGFs	Proportion of all HGFs (%)	Number of all firms	Proportion of all firms (%)	Ranking
High-tech	6	1.70	192	0.46	8	9	2.31	213	0.46	8
Mid high-tech	17	4.82	877	2.09	6	25	6.41	919	1.97	6
Mid low-tech	33	9.34	2,365	5.65	4	64	16.41	2,633	5.64	4
Low-tech	30	8.50	2,261	5.40	5	23	5.90	2,354	5.04	5
Construction	47	13.31	4,740	11.32	3	75	19.23	4,924	10.54	3
Public sector	15	4.25	412	0.98	7	9	2.31	763	1.63	7
Knowledge intensive services	89	25.21	13,703	32.73	2	108	27.69	16,004	34.26	2
Less knowledge intensive services	116	32.86	17,322	41.37	1	77	19.74	18,906	40.47	1
Total	353	100.00	41,872	100.00		390	100.00	46,716	100.00	

Source: Author's calculations based on AJPEs data.

represent 32.73% in the first period and 34.26% in the second. Mid-high tech represents 2.09 in the first period and 1.97% of a total number of firms in the second. The public sector grew from 412 firms (0.98%) in the first period to 763 firms (1.63%) in the second. Construction grew from 4740 firms in the first period to 4924 firms in the second. Mid low-tech firms stayed in the same proportion, although the absolute number of firms from mid-tech industries grew in the second period. Finally, low-tech firms grew in absolute terms from 2365 in the first period to 2633 firms in the second, while in relative terms the proportion of low-tech firms shrank from 5.40 in the first period to 5.04% in the second.

Table 10 shows proportions and absolute numbers of HGFs in Slovenia for the periods 2007–2010 and 2011–2014 by classification of industries. As can be seen in Table 10, proportions of sectors in the sample of total firms as well as proportions of HGFs are ranked in the same order in the first period. Thus, HGFs are most common in LKIS (32.86%) in the first period, followed by KIS, construction, mid-low tech and, in fifth place, low tech. HGFs in mid-high tech are ranked sixth, public-sector seventh and high-tech last – with eighth place (1.70%) in regards to the proportion allocation of HGFs. The second period (2011–2014) features a change in rankings of HGFs according to the proportion allocation among HGFs. Namely, HGFs are most common in KIS industries, followed by LKIS. Construction and mid-low tech come third or fourth. However, in the second period, mid-high tech comes fifth, low-tech sixth, while seventh and eighth rank is shared between the public-sector and high-tech firms (2.31%).

High-tech firms were not very common in Slovenia in both 2007–2010 and 2011–2014; there were 192 high-tech firms in the first period and 213 (0.46%) in the second. However, high-tech HGFs are also not common: in the first period only six firms were high-tech HGFs (1.70%) and nine in the second (2.31%). Thus, we agree with fourth stylised fact: HGFs are not more common in high-tech industries. Nonetheless, high-tech HGFs represent less than 3% of HGFs in both periods.

## 5. Discussion

Given the increased interest by academics and policymakers in high-growth firms, this paper joins research efforts on high-growth firms in other developed countries like the United States, Sweden, Italy, France and the United Kingdom. The paper gives an in-depth analysis of the high-growth firms; more concretely, it examines whether the Slovenian firm-level dataset for two three-year periods (2007–2010; 2011–2014) is consistent with the four stylised facts about high-growth firms. Of course, examining each of the four stylised facts could be written as four separate research papers; however, we managed to check the consistency of the critical parts of the stylised facts with the Slovenian dataset and have reported on it in this article. The results find the growth-rate distributions to be heavy-tailed in Slovenia; different growth indicators indeed selected different firms in Slovenia; high-growth firms are major contributors of new jobs in Slovenia and high-growth firms are not more common in Slovenian high-tech industries. We now turn to each stylised fact.

First, the Slovenian dataset show growth-rate distribution to be leptokurtic, heavy (fat) tailed; therefore, it departs from Gibrat's Law under which the distribution should be the normal Gaussian, under the central-limit theorem. We adopted a parametric and non-parametric approach and found the tails to be much fatter than the Gaussian, but also fatter than the Laplace tails. Bottazzi, Cefis, Dosi, and Secchi (2007) and Bottazzi and Secchi (2003) find the tails to replicate Laplace distribution tails ( $b = 1$ ); however the empirical analysis of Slovenia departs from this distribution in three of four sectors analysed with sales growth as proxy for growth rates and in all four sectors analysed with employment growth as proxy for growth rates. Furthermore, this paper departs from the previous papers (Bottazzi et al., 2007; Bottazzi and Secchi, 2003) in regards to the symmetry of the tails. Our analysis finds the left and right tail to be somewhat different; thus we go along with Bottazzi et al. (2011) who analysed the French manufacturing industry and Reichstein and Jensen (2005) who found the asymmetry in tails for the four Danish manufacturing industries, which is in line with our findings. Kernel density estimates reported in the article point to the heterogeneous nature of growth rates among the four NACE 2-digit sectors analysed. It should be noted that this analysis in Slovenia departs from the existing papers due to the more comprehensive dataset used. Namely, French (Bottazzi et al., 2011), Italian (Bottazzi & Secchi, 2006) and Danish (Reichstein & Jensen, 2005) datasets were limited to only those firms with over 20 employees, which is a limitation that we overcame; however, this hinders comparison as smaller and younger firms have been found to have higher growth rates. In addition, we encompass four NACE 2-digit sectors, from which two are manufacturing while two are service sectors. Future research could encompass all manufacturing sectors as well as service sectors and check the consistency of growth-rate distributions also at the NACE 3-digit level. However, it seems like the heavy-tailed distribution is not questionable, but the asymmetry of left and right tails is a subject ripe for more research: in particular, what leads to, and under which conditions, is the right tail fatter than the left and vice versa?

Secondly, we checked whether the usage of different high-growth firm definitions selects different firms. The growth indicators used in the paper were: OECD-Eurostat HGF definition (with both revenue and employee criteria); the growth criteria – top 5% of firms in revenue (both absolute and relative); and the growth criteria – top 5% firms in employment (both absolute and relative). Following Shepherd and Wiklund (2009) this paper concludes that high-growth firms selected by different indicators match modestly; in particular, the percentage match is the lowest when comparing high-growth firms selected by revenue and employment-based criteria (Table 3 and Table 4). This selection of different firms with different high-growth firm definitions points to the difficulty of choosing one growth indicator due to the heterogeneous nature of the underlying processes for growth in different sectors and contextual factors, as proposed by Delmar, Davidsson, and Gartner (2003). Some firms first grow in number of employees and assets (for example, firms producing hardware manufacturing) and then potentially grow in sales; whereas others might first grow in sales and then potentially grow in employees (for example, firms producing software). The underlying growth process depends on the sector in which the firm operates, the

contextual factors and the firms' business model, making the use of one growth indicator modestly correlated with other growth indicators. Finally, choosing relative or absolute growth definition paints different pictures as to which firms will be identified as high-growth firms. This is probably the most evident when analysing the transition probabilities of high growth, whereby relative growth favoured micro and small firms, and absolute growth favoured medium and large firms.

Third, while high-growth firms are major contributors to new jobs, the Eurostat-OECD definition of high-growth firms is overly restrictive as it selects only firms with 10+ employees at the beginning of the analysed period. This restricted set of firms is not as significant a job creator in the overall economy as it is when we relax the criterion to high-growth firms with 2+ employees and adopt the top 5% growth criteria. More concretely, high-growth firms selected by Eurostat-OECD definitions encompassed less than 0.9% of the overall number of firms in Slovenia in both three-year periods and these firms were responsible for 9.84% (2007–2010) and 16.82% (2011–2014) of overall gross job creation in Slovenia. Using the Eurostat-OECD definition NESTA (2009) selected 6% of the total number of firms in the UK, which accounted for around 50% of the total number of new jobs 2002–2008, which evidently departs from Slovenia's experience. Developing models to explain the differences in the number of HGFs between countries is evidently beyond the scope of this research, but future researchers are encouraged to invest intellectual efforts in developing such models. However, once we loosened the employee threshold from 10 to 2 employees and adopted the growth criteria as the top 5% of firms in employment growth, the percentage of overall firms grew to approximately 2% and increased the percentage of overall gross job creation to 28.18% in the first and 34.89% in the second three-year period. Therefore, we go along with the critique of the Eurostat-OECD definition (Daunfeldt, Johansson and Halvarsson, 2015), which might especially hold in smaller countries like Slovenia. In addition, we conducted the analysis of job creation by firm size and we confirmed the well-known statement that micro, small and medium-sized firms are responsible for the majority of job creation. It is worth stressing that when analysing job creation by size, only micro firms had a positive net employment in both three-year periods in Slovenia, which was especially evident in the crisis period 2007–2010 where large firms, as well as medium and small firms, were shedding jobs. Future researchers are encouraged to make more intellectual effort investigating the job creation of an even smaller subset of persistent high-growth firms.

Fourth, high-growth firms in high-tech industries represent only a small proportion of the overall number of high-growth firms (selected with the Eurostat-OECD definition). It should be noted that this analysis does not state that a particular firm is not using advanced technology, but that it is not part of the high-tech industries as defined by the OECD classification. Although high-growth firms are slightly overrepresented in high-tech industries, the total number of high-growth firms in the population of high-growth firms is so small that it is insignificant in the larger picture. Thus, our findings go along with the previous research of Brown and Mason (2012) and Coad et al. (2014) who highlight a small proportion of high-growth firms in high-tech industries. It is worth stressing that the share of high-growth firms in high-

tech industries is lower in Slovenia than is the case for more developed countries like the UK where 15% of high-growth firms came from high-tech sectors (Brown & Mason, 2012). A reason might partly be found in the size of Slovenia's economy, as well as its specialisation in a few high-tech industries; however, this is an area for future research. We also go along with Henrekson and Johansson (2010) and find high-growth firms to be represented the most in service sectors, in particular, the less knowledge-intensive service sectors and knowledge-intensive service sectors. During the first period (2007–2010 which encompasses recession), the less knowledge-intensive service sectors had the highest proportion of high-growth firms (32.86%), while this percentage dropped in the second three-year period (2011–2014) to 19.74%. On the other hand, knowledge-intensive service sectors grew in the same period from 25.21% to 27.69%. In addition, the second period featured a significant increase in the number of high-growth firms within the mid-low tech sectors and construction sectors, which is a potential research avenue.

## 6. Limitations and conclusion

This paper – as with any scientific research – is subject to limitations. First, due to length limitations and complexity we were able to analyse just four stylised facts. Second, our analysis is limited to two three-year periods. The first of them was severely influenced by the financial crisis. Third, we used relatively simple methods: descriptive statistics, as well as non-parametric and parametric approaches to analysing the data. Finally, our research presents the stylised facts, but the data does not allow us to dig deeper into the causes of these findings.

To sum up, four high-growth firms' stylised facts do hold for a Slovenian firm-level dataset; however, analysis of each stylised fact shows several differences when compared to research on high-growth firms in more developed countries. Our research can be seen as a baseline paper on high-growth firms in Slovenia, which calls for additional investigations necessary to answer the fundamental question motivating many scholars researching the growth phenomena: that is, what can policymakers do to support HGFs? Answering this question will necessarily involve additional quantitative, but also qualitative, research efforts. Future research should use full financial data on Slovenian companies to dig deeper into the characteristics of Slovenian HGFs. The data is very rich and allows for longitudinal exploration of the growth phenomena. Studies could also look at comparative characteristics of similar Central and Eastern European economies. Alternatively, studies should limit the focus to specific sectors that have distinct characteristics. Our results show that HGFs are a smaller contributor to job creation than in Western European countries. Future research should investigate the causes of this finding.

## Notes

1. It is worth stressing that Bottazzi and colleagues in all papers use the minimum criteria of 20 employees for a firm to be selected in their balanced panel.
2. It should be noted that the analysis of all NACE 2-digit industries does not change the conclusions for Stylised Fact 1.

3. We use the logarithm base 10.
4. Authors have attempted several different kernel functions and different strategies for selecting the smoothing parameter  $h$ . Following the comparison, authors find the Silverman procedure to best capture the data. The Silverman procedure was conducted in statistics programme R, using the function *density*.
5. We thank Giulio Bottazzi for making the package *subbotools* available for wider academic community. The package can be found at: <http://cafim.sssup.it/~giulio/software/subbotools/#orgheadline7>
6. We also analyse HGFs (based on 5% highest growth in revenues) in high-tech industries. The overall picture does not change to a large extent. Due to space constraints we do not report these results here.
7. We thank an anonymous referee for pointing out the persistent high-growth firms topic.
8. Here we divide the number of persistent micro/small/medium/large HGFs with the number of micro/small/medium/large HGFs in the period 2007–2010.
9. The percentages are lower given the higher number of non-HGFs in the first period.
10. We do not report parameters for employment growth as a growth proxy because the employment data caused an overflow.
11. The x-axis cut-off has been modified in order to have a more sound visual representation.

## Disclosure statement

No potential conflict of interest was reported by the author.

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