High-growth Firms in Sweden 1997–2007

Characteristics and development patterns

Björn Falkenhall and Fredrik Junkka

The Swedish Agency for Growth Policy Analysis

growth analysis

Foreword

This report has studied rapidly growing firms in Sweden during the period 1997–2007. The main aim has been to analyse whether there are any characteristics that distinguish gazelles, apart from the contribution they make to growth. Earlier studies show that gazelles are very important in creating jobs and economic growth. The fact that they grow more rapidly than other firms indicates that in some way they differ from other firms. For this reason, it is of interest to follow these firms over a longer period and develop the analysis of rapidly growing firms, their characteristics and what the implications are for determining growth policy. One principal focus has been to study the growth of gazelles throughout the period in relation to firms that were not classified as gazelles.

It can be stated that gazelles are clearly overrepresented among young firms, and this is in line with the findings from earlier studies. Employees in gazelle firms also have a significantly higher level of education compared to those in other firms. In addition, the analysis shows that gazelles account for a disproportionately large proportion of increases in employment and growth of value added. Gazelles defined as 10 per cent of firms with the highest index values accounted in total for the whole of the increase in employment during the period studied. Independent gazelles accounted for slightly more than 10% of the growth in GDP during the last period of 2004–2007. When analysing firms that are part of a group, we have found major differences compared with independent firms, and this serves to confirm that it is necessary to draw a distinction between these two types in the analysis. It turns out that the proportion of gazelles is substantially higher among firms in groups, and particularly among firms in international groups.

Finally, it is not possible to forecast which firms will become gazelles during the following period, but the probability is somewhat higher that a gazelle compared to other firms will be a gazelle during the next period. Of all "continuing" gazelles, close to 40 per cent moved from being an independent firm into part of a group, or from belonging to a Swedish group and becoming part of an international group. This means that gazelles which have succeeded in following the growth path are often acquired and become part of a larger constellation.

It is clear that gazelles are of crucial importance for entrepreneurship, innovation and growth. The Swedish Agency for Growth Policy Analysis (Growth Analysis) will thus in the future analyse in greater detail the strategies of these firms and the growth policy instruments that could support such strategies.

The report has been authored by Björn Falkenhall (project leader) and Fredrik Junkka. Ann-Sofie Karlsson and Torbjörn Lindquist took part in the introductory phase of the project. Valuable comments and views have been submitted by Barbro Widerstedt (Growth Analysis), Roger Svensson (IFN) and Dan Johansson (Ratio). Brian Turner**,** IMC-English Training & Translations, has been very helpful and done the translation of the original Swedish study.

Östersund, December 2009

Dan Hjalmarsson
Director-General

Table of Content

Summary

This report has studied rapidly growing firms in Sweden during the period 1997–2007. The main aim has been to analyse whether there are any characteristics that distinguish gazelles, apart from the contribution they make to growth. Earlier studies show that gazelles are very important in creating jobs and economic growth. The fact that they grow more rapidly than other firms indicates that in some way they differ from other firms. It is thus of interest to follow gazelles over a longer period and further develop the analysis of rapidly growing firms, their characteristics and what the implications are for thinking on growth policy. One principal focus has been to study the growth of gazelles throughout the period in relation to firms that were not classified as gazelles. What does the development pattern look like? Is it a question of continuous growth, or do these firms have a period of rapid growth which is preceded by and then succeeded by periods of weak or stagnating growth?

The analysis is quantitative and based on the IFDB database at Growth Analysis, which contains data on both firms and individuals. The 10 per cent of firms with the highest index values during the period were classified as gazelles. This means that the proportion can vary over the years as a consequence of differences in the business cycle. A Birch index, which is intended to take account of both absolute as well as relative changes in employment, is used.

It can be stated that gazelles are clearly overrepresented among young firms, and this is in line with the findings from earlier studies. The proportion of gazelles increases with firm size, but the largest number of gazelles can be found among smaller firms. The construction of the Birch index, however, does mean that a small percentage increase in the number of employees is required for a large firm to be classified as rapidly growing. This, it could be argued disadvantages smaller firms. Moreover, gazelles are relatively evenly distributed geographically, even though the largest numbers are to be found in metropolitan counties. Gazelles are also somewhat overrepresented in construction and growth industries such as business services. On the other hand, they are not clearly more capital intensive than other firms. However, employees in the first mentioned firms have a significantly higher level of education compared to those in other firms.

In addition, the analysis shows that gazelles account for a disproportionately large part of increases in employment and growth in value added. The distribution is highly skewed and this 10 per cent of firms account in total for all of the increase in employment and between 65 and 100 per cent of growth in value added depending on the period. Independent gazelles accounted for slightly more than 10 per cent of growth in GDP during the last period of 2004–2007. Among gazelles the smallest firms account for the majority of the growth in employment, and the same applies to the youngest firms. Young firms, however, are particularly important in adding new jobs since the overall reduction in employment among the group of "Other firms" is much smaller for young firms compared with smaller firms. The relationships are similar when changes in value added are studied, newness as could be expected is a distinguishing characteristic of firms undergoing rapid growth.

When analysing firms that are part of a group, we have found major differences compared with independent firms, and this serves to confirm that it is necessary to draw a distinction between these two types in the analysis. It turns out that the proportion of gazelles is significantly higher among the former, and particularly among firms that are part of

international groups. There may be a number of reasons for this. One may be the transfer of physical resources to a firm from other parts of the group enabling rapid growth. Another is transfer of technology and other knowledge such as marketing and production know-how. In particular, firms that are part of international groups enjoy as a result competitive advantages providing scope for rapid growth. Finally, it is not possible to forecast which firms will become gazelles during the following period, but the probability is somewhat higher that a gazelle compared to other firms will be a gazelle during the next period. However, the relationship is not particularly strong and there may be other explanations. Of all "continuing" gazelles, close to 40 per cent moved from being an independent firm into part of a group, or from belonging to a Swedish group, and becoming part of an international group. This means that gazelles which have succeeded in following a growth path are often acquired and become part of a larger constellation.

The fact that it is difficult to predict winners is evident, and there does not appear to be any clear growth path dependence forwards in time. In other words, rapidly growing firms have not succeeded in following a growth path during subsequent periods, but have been replaced by other gazelles, which in their turn have been replaced by yet other firms. It should nevertheless be emphasised that this process is very important. Of course, it is a part of a natural process of ongoing structural transformation or creative destruction, where winners on the market are selected in accordance with the theory of competence blocks. This selection takes place in a number of phases or levels where new firms are started, and from which one third disappear after three years. Some become rapidly growing firms whilst the majority exhibit a more normal pattern of development. A large proportion of rapidly growing firms disappear as a result of being bought up. They are particularly interesting for established firms as acquisition targets since they have passed the first test on the market in terms of their technology and business model. A larger firm can then go further in its development at the same time as the acquired firm can contribute know-how which assists the development of the acquiring firm. This process gives rise to a transfer of knowledge.

Newness and knowledge are two keywords which are also fundamental to and related to the concept of innovation. It could be said that the most rapidly growing gazelles and those experiencing continuous growth *are* innovative in some respect. To illustrate the relationship between innovation and entrepreneurship, rapidly growing firms are of particular and enduring interest, even though this phenomenon is multifaceted and difficult to explain.

New rapidly growing firms in particular have aroused great interest on the part of politicians and policymakers in recent times, and in the public debate it has been argued that growth policy initiatives should be directed to this target group. What is relevant for growth policy from this perspective still remains unclear. The reason is the difficulty of forecasting firm growth. This particularly applies to the growth of smaller firms which is significantly more irregular compared to that of larger firms, which display a much more even pattern of growth.

This serves to underline the importance that general institutional settings are well-designed. Rapidly growing firms and economic players necessary for generating and commercialising new knowledge appear to be particularly dependent on the incentives created by institutional settings. Recruitment of competent personnel is important both for the transfer of knowledge and the growth of gazelles, which are more knowledge intensive. This presupposes a mobile labour force.

Labour market legislation and the social insurance system should not be allowed to create unnecessary barriers to this mobility. Low barriers to entry and contestable markets are also important for the development of high-growth firms. Finally, it is important that tax rules are neutral in the sense that they neither create disadvantages nor advantages for the sale of a gazelle firm, or indeed a less successful firm.

1   Background

The ITPS report "The State of Business and Industry 2007" had the theme of ambitious entrepreneurship.[1] The report analysed, amongst other things, the contribution to increases in employment and productivity in Sweden of rapidly growing firms or "gazelles". It turns out that the 10 per cent of firms with the largest total growth increased the number of their employees by slightly more than 120 000 persons during the period 2002–2004. At the same time the number of employees decreased by about 104 000 persons for the remaining 90 per cent. The pattern was similar for changes in value added. Gazelles increased value added by about SEK 160 billion, whilst the other 90 per cent of firms showed a total reduction of slightly more than SEK 60 billion during the same period. There is a highly skewed distribution where a smaller proportion of firms account for a disproportionately large part of economic growth and increases in employment. Even though the periods examined are short, the analysis indicates that gazelles are very important in creating jobs and economic development. Similar results have been found in other studies looking mainly at changes in employment, even though the design of these studies and definitions of rapidly growing firms differ somewhat.[2] The fact that gazelles are growing more rapidly than other firms indicates that in some substantive way they differ from other firms. It is thus of interest to follow gazelles over a longer period and develop analytical approaches for studying rapidly growing firms, their characteristics and implications for determining growth policy. The Ministry of Industry, Employment and Communications has also expressed interest in such an analysis.

This report studies rapidly growing firms in Sweden during the period 1997–2007. The main aim is to analyse whether there are any special characteristics distinguishing gazelles apart from their contribution to growth. A principal focus has been to study the growth of gazelles throughout the period in relation to firms that were not classified as gazelles. What are the characteristics of their development pattern? Do these firms have continuous growth, or a period of rapid growth which is both preceded by and succeeded by periods of weak or stagnating growth? Gazelles will be analysed with respect to distribution by firm size, age, regional and industrial category, as well as capital intensity.

The analysis is quantitative and based on the IFDB database at Growth Analysis and contains data on both firms and individuals. A somewhat different approach to that taken by the OECD was used for defining gazelles, in our study 10 per cent of the firms with the highest index values during the period were classified as gazelles. This means that the overall proportion of gazelles within any part of the time period can vary as a consequence of differences in the economy. A Birch index is used as this takes account of both absolute as well as relative changes in employment. This measure is thus relatively neutral with respect to firm size. The analysis covers all firms, except for those with fewer than three employees or an annual turnover of less than SEK 1 million. In addition, groups were excluded. Concerning groups, there is a lack of knowledge about their real size and the scope of their operations abroad. It is also misleading to analyse firms that are members of a group in this context, since their expansion may be a consequences of transferring operations from other parts of the group. However, this may lead to some degree of underrepresentation of large firms in the data.

---

[1] *ITPS (2007)*

[2] *See, for instance, Henrekson & Johansson (2008)*

The study is organised such that the theoretical framework, and earlier empirical studies of gazelles are reviewed (Chapter 2). The material used in this study and the method of analysing the data is then described (Chapter 3). The section on results, shown in Chapter 4, starts with descriptive statistics of gazelles by size categories, age, industry and regional division, as well as capital intensity. Thereafter the contribution of firms to changes in employment and value added are analysed, as is the development pattern of gazelles over time. Finally, conclusions are drawn from the results, and the implications for growth policy are discussed (Chapter 5).

2 Theoretical framework and earlier empirical studies

2.1 Is it large firms, small firms or gazelles which mainly create employment?

Is it just a few large firms, or the entry of new and growing small firms that generate new jobs and economic growth? David Birch was one of the first researchers who tried to answer these questions. He identified a special group of firms as growing rapidly. Usually these firms were small and generated many new jobs. Often they are referred to as gazelles.[3] The Birch definition of gazelles was that firms should have at least 20 per cent growth over a five-year period. Birch calculated rapidly growing firms based on changes in the number of employees, value added or a combination of these measures. An alternative to this definition is to study firms which have doubled their employees over five years. It can be argued that both of these definitions are arbitrary, since there is a lack of support for determining that a certain rate of growth should lead to a firm being classified as a gazelle. Another alternative is to take the distribution as the starting point and use the 10 per cent of firms with the highest index values. This implies a smaller element of arbitrariness. In addition, if the classification is based on the 90th percentile during a specific period, the proportion may be larger or smaller within the period depending on the state of the economy.

In market terms, what does it mean to say that a firm is growing rapidly? Does it mean that a firm competes and wins market shares, or competes successfully against other similar firms by offering products and services that do not already exist on the market? It is, of course, possible to determine if a firm has been bought by a competitor, but it is very much more difficult to determine if a firm's growth is due to competing effectively against others, or is the result of growth in the overall market. Davidsson & Delmar, however, try to distinguish between organic growth or genuinely new jobs from firms that have grown through acquisition.[4] However, they admit that their definition does not distinguish between whether organic growth has led to a firm gaining market share from competitors, or whether the whole market has grown. Small and medium-sized firms mainly generate organic growth in contrast to large firms which often have a small proportion of organic growth. Moreover, they find that it is mainly among medium-sized firms (50–249 employees) where there is a large proportion of gazelles. Henrekson & Johansson summarise their results as follows: growth appears to be more organic for new and small firms compared with older and larger firms which grow mainly through acquisitions and mergers.[5] The former thus provide a larger contribution to the net addition of new jobs.

Henrekson & Johansson in a meta analysis of research into gazelles and job creation took as their starting point four hypotheses or propositions. They find support for the proposition that relatively few, rapidly growing firms generate a disproportionately large share of the net addition of new jobs compared to other firms. In addition, they find clear support for the proposition that gazelles tend to be younger than the average firm. And that they may also be of different sizes. Small firms are overrepresented among gazelles, but

---

[3] *Birch (1979), Birch & Medoff (1994)*

[4] *Davidsson & Delmar (2006)*

[5] *Henrekson & Johansson (2008)*

larger gazelles are important in creating jobs in absolute numbers, and this applies particularly to a small subset of "super" gazelles. It appears that "newness" is a more important factor than firm size. The conclusions are similar irrespective of whether organic or total growth is studied, the results tend to be more explicit when organic growth is studied, even though most studies have in fact looked at total growth.

2.2   Age

Acs et al launch the concept of "High-Impact Firms" (HIF) in a later study based on American data to denote firms with both significant growth in turnover and increases in employment.[6] The results are consistent with the work of Birch and similar studies, namely that HIFs account for the major part of growth in employment and turnover in the economy. Growth in employment is in principle equally distributed between small and large HIFs (more than 500 employees). A surprising result is that the average age of HIFs is about 25 years, i.e. a relatively mature firm that has existed quite a long time before having a significant impact on the economy. However, this is not in line with most of the studies in the area, even though HIFs are younger than "Low-Impact Firms". Davidsson & Delmar, for instance, find in an older study based on Swedish data that growth firms are clearly overrepresented among young firms.[7] Their study covers the period 1988 – 1996 and 62 per cent of growth firms were created during the period 1987 – 1995, which is more than twice as high a proportion compared to other firms.

2.3   Industry

Henrekson & Johansson find no support for the proposition that gazelles are overrepresented within the high-tech sector. Gazelles exist in all industries, although they may be overrepresented in service industries. Acs also state that HIFs exist in all industries. Davidsson & Delmar's results agree with this, but they find significant overrepresentation of growth firms in modern, growing industries. Representation of the professional service sector in the 10 percentile growth elite is twice as large compared with its share of the population. Even though high-tech manufacturing is small in absolute numbers, this industry category is highly overrepresented among growth firms.

2.4   Regional affiliation

Acs & Mueller in a study of gazelles in the USA have shown that regional affiliation is very important for gazelles. Small firms (mice) and large firms (elephants) can locate anywhere, whilst gazelles only grow as gazelles if they are in a gazelle region, otherwise they grow as "mice".[8] A gazelle region is usually a larger town or city. In another study, Acs have found that gazelles exist in nearly all regions in the USA. In contrast to the above, they find that 23 per cent of HIFs were located in (*rural areas*).[9] In the ITPS study, metropolitan regions had the largest number and highest proportion of gazelles compared to other regions. Davidsson & Delmar also find a significant overrepresentation of growth firms in the region of Greater Stockholm.

---

[6] *Acs et al (2008)*

[7] *Davidsson & Delmar (2006)*

[8] *Acs & Mueller (2008)*

[9] *Acs et al (2008)*

2.5 Capital and human capital intensity

According to neoclassical theory, production factors are mainly made up of labour and real capital. In the long-term total factor productivity (TFP), or technological development in a broad sense is what drives economic growth. The existence of fundamental or generic technologies is the most important factor in the development of TFP in the long term. IT is an example of such a fundamental technology, and research shows it lies behind a large part of strong productivity developments in recent decades. At the same time IT is relatively knowledge intensive, and thus sufficient human capital is required in the firms that will use this technology. This means that human capital and IT complement each other and firms that are both IT and human capital intensive can thus be expected to have larger growth potential.

2.6 Development over time of gazelles

Two interesting questions addressed in the study by Acs et al, was from where do High-Impact Firms (HIF) originate, i.e. what did these firms look like before they became HIFs, and what happens to them after their growth phase? Earlier these questions have seldom been addressed. It appears that HIFs cannot be identified during the period which preceded the period when they were classified as HIFs. Slightly more than 50 per cent of these firms showed no change in employment or turnover during the *preceding* four year period, while slightly more than 30 per cent were so-called *mixed decliners,* i.e. declined during one of the two-year periods, and grew or remained unchanged during the second two-year period.

Of significant importance for development during a *subsequent* four year period was if the firm had been an HIF during the previous four years. This effect is also more evident when firm size increases. The proportion of HIFs which maintain high rates of growth is 8 per cent of firms with more than 500 employees, which is twice as large a proportion compared to firms in the smaller size categories. Nearly half of the largest firms experienced constant or mixed growth over the following years. Of the smallest firms (1–19 employees) about 10 per cent cease to exist within four years, while 60 per cent do not show any change. Results for medium-sized firms are similar except that the proportion of *exits* is lower and that nearly 30% show constant or varying growth during the subsequent period. In other words, there appears to be some degree of "growth path dependence" for HIFs during subsequent periods, whilst firms which will grow cannot be forecast accurately.

2.7 Our hypotheses and questions

The ITPS study mentioned earlier analysed the contribution of rapidly growing firms to growth during a short period 2002 – 2004. Our material now enables us to study this phenomenon over a much longer time series from 1997 to 2007, which also covers the short economic downturn that took place immediately after the new millennium. The earlier study by Davidsson & Delmar was methodologically creative and a highly rigorous empirical study. However, it was based on the period 1987 – 1996, which must be regarded as an extraordinary period covering the recession when Sweden had negative growth over three consecutive years. For this reason, it would be interesting to replicate this study on data which is 10 years newer and a period where economic conditions were closer to normality. However, it should be pointed out that the studies are not comparable since they differ in a number of respects, including their focus. Davidsson & Delmar studied workplaces with at least 20 employees, but in the current study firms with more

than three employees or a turnover of more than SEK 1 million have been studied. Finally, the development of independent firms over time will be analysed to determine their growth path dependence, that is their growth before and after the growth period.

Given the background above, the empirical analysis will test the following seven hypotheses or propositions:

1. Gazelles are younger compared to other firms.

2. Gazelles exist in all size categories even though the number of growth firms is higher among small and medium-sized firms.

3. Gazelles exist in all industries, but are somewhat overrepresented in growth industries such as business services.

4. Gazelles exist in all types of regions even though the County of Stockholm dominates as regards number of growth firms.

5. Gazelles are more capital and human capital intensive compared to other firms.

6. Gazelles account for a disproportionately large part of increases in employment and value added.

7. It is not possible to forecast which firms will become gazelles during a subsequent period. On the other hand, the probability is somewhat higher that a gazelle compared to other firms remains a gazelle, or at least a firm with a certain growth, also during the next period.

3   Description of data and method

3.1   Method

In order to answer the question on the importance of gazelles in terms of growth requires in the first instance a definition of the concept of "gazelle". A gazelle is a rapidly growing firm, and this requires two further definitions. What does "rapidly growing" mean, and what is a "firm"?

A firm is defined here as an independent firm if it is not part of a group or a special hybrid. Firms which are either hybrids[10], part of a group, foreign owned[11] or Swedish firms owning firms abroad have been excluded from the gazelles. However, firms making acquisitions, but which remain registered as independent firms, are included. An analysis of firms not included was done to study whether there were any systematic differences between firms belonging to groups and independent firms. All firms irrespective of firm form are included in the data. IFDB contains duplicates of firms during the period 1997–2002. These duplicates are at most 0.3 per cent of all firms, and in this study have been removed. The focus of the analysis is thus firms and not workplaces. The main reason is the higher degree of uncertainty associated with studying workplaces. The analysis is based on data from Statistics Sweden and their statistics at the workplace level are derived from firms, and as a result are more suitable for analysis at the firm level. Finally, the very smallest firms which only function as a sideline or as hobby projects have been excluded. It is necessary to make these simplifications and limit the sample to firms where employees earn their living from its operations. The study thus includes all firms which during the first year in the different periods have at least:

- three employees
- SEK 0.3 million in value added
- SEK 1 million in net turnover

During the last year of the different periods, the requirement is that the firm is registered irrespective of size, and that it remains an independent firm. This means that independent firms that have closed down, become part of a group, become Swedish or foreign owned, are excluded from the data. Data was used from Business Economic Statistics (FEK) containing information about the number of employees, value added, net turnover, county, industry, capital and ownership category for the years 1997–2007. In addition, data was obtained on the number of employees, and also gender and education from the register for labour market statistics (RAMS). Data on the number of employees in FEK compared to RAMS will not be the same due to the fact that in RAMS data is based on the number of gainfully employed (employed and self-employed) in November each year, whilst FEK contains data on annual employee equivalents. When employees are reported, this is based on FEK, whilst data on gender and education level of employees is obtained from RAMS. Some of the firms studied were not included in the report, for example a partnership run by a number of owners, or a firm which *was part of a* larger firm. These were included in the study, but it is not possible to obtain the same detailed information about them for all years since information about the firms existed in FEK, but not in RAMS.

---

[10] *Companies with consolidated annual reports.*
[11] *Swedish companies owned by a company in another country*

Rapidly growing firms were defined as the 10 per cent of firms with the highest Birch index. The reason for using the Birch index is that the criteria for inclusion should take account of both absolute and relative change, and thus be relatively neutral with respect to firm size. If absolute differences in employment alone were studied, only large firms would be classified as gazelles. At the same time, using percentage change would not be appropriate, since this would mean that mainly small firms would be classified as gazelles. The Birch index can be calculated in three ways; based on the number of employees, value added, or a combination of these variables. In this analysis the Birch index is based on the number of employees, and this is the approach most frequently used in other studies of rapidly growing firms. A sensitivity analysis was also carried out using value added.

The Birch index (BI) was calculated based on the difference between the number of employees during the first year in time period (s_0), and the number of employees after three years of growth (s_3), where account is taken of both relative and absolute growth of employees during the period.

Birch index

$$BI = (s_3 - s_0)\left(\frac{s_3}{s_0}\right)$$

The period studied was four years, and this means three years of growth. This is in line with recommendations from the OECD. The Birch index for the 90th percentile is the traditional demarcation boundary for gazelles, and the value of the 90th percentile is thus derived. Firms which have an index value higher or equivalent to the 90th percentile are defined as gazelles. This means that the proportion of gazelles will vary during the period, but overall will be 10 per cent for the period studied. The number of employees which firms of different sizes need to increase in order to be classified as gazelles is shown in the table below.

Number employees t0	Increase in employees to t3 to be a gazelle
3–6 employees	3 employees
7–32 employees	4 employees
+33 employees	5 employees

As regards larger firms, an increase in the number of employees by five persons represents a relatively small increase. It can be questioned whether the term "rapidly growing" or "gazelles" is appropriate for a firm that has e.g. 500 employees and increases its employees by 1 per cent over four years. The relatively low absolute increase in the number of employees required to be a rapidly growing firm means that further studies on methods for classifying rapidly growing firms on the basis of the BI formula and its threshold values is desirable. In addition, difficulties arise when calculating the Birch index when the number of employees or value added is zero, or in the last mentioned case negative. In these cases

adjustments have been made to the Birch index calculations, see Appendix 1 for further details. For firms with a positive number of employees or value added year t_4, the traditional calculation of rapidly growing firms according to BI has been used in the report, but the reader should note that for larger firms, only a small percentage increase in the number of employees is needed for it to be classified as a rapidly growing firm.

When a time series for gazelles is reported for a given period, a four-year moving average is used which means that eight different growth periods or cohorts are used for the period 1997 – 2007 studied. Firm age is not registered, but Statistics Sweden have developed a method for determining a firm's age by monitoring its workplaces over time (FAD).[12] If more than half of the employees are the same for two consecutive years, the workplace is assumed to be the same even though its name or industry category may have changed. The method has been used since 1986, and this means that no firm can have a start year prior to 1986. Changes which lead to a new start year could, for instance, be acquisitions.[13] The firms studied in the first year 1997 can thus be at most 11 years old, which is why firms are divided into the following age groups; 5 years or younger, 6–10 years, and 11 years or older.

The firms have been divided into four groups based on the number of employees; 3–19, 20–49, 50–249 and 250 or more, which corresponds to small, medium-sized and large firms according to the definition generally applied within the EU. The industry classification consists not only of a higher level of aggregation with 12 industry categories according to the Ohlsson-Vinell classification, but also a more disaggregated classification using two digit SNI codes. The Ohlsson-Vinell system has been chosen since it enables the study of possible differences between different service industries, and work, capital, knowledge and R&D intensive industries. Counties have been used as the unit for regional distribution instead of the more abstract category of region type. Distribution by county also means to some extent different types of regions, such as large metropolitan counties (Stockholm), counties with universities, and the more sparsely populated counties with regional centres. Capital intensity is measured as fixed assets per employee. Finally, education level of employees has been used as an approximation for human capital in the firms.

---

[12] *Dynamics of companies and workplaces*
[13] *Statistics Sweden www.scb.se*

4   Results

4.1   Introduction

This section reports the most interesting results from the analysis, and possible confirmation for the propositions set out in Chapter 2. To begin with the proportion of gazelles will be reported by county, industry and size categories. Based on a review of the theory and earlier empirical studies, some differences can be expected in these respects, but it is primarily firm age that is of importance. In addition, the importance of gazelles for economic growth and job creation will be analysed. These firms can be expected to account for a disproportionately large part of the increase in employment and value added. Finally the development patterns of these firms over time will be studied to determine if there is any form of growth path dependence.

4.2   The proportion of gazelles by industry, region, size and age

Table 4.1 shows gazelles for all counties during the period studied. From the column on the far right, it is clear that there are small differences between counties in the proportion of gazelles. It is worth noting that the Counties of Norrbotten and Stockholm have the highest proportion of gazelles. The Counties of Uppsala and Västra Götaland are above the national average. One explanation for this relationship could be that metropolitan regions have a wider range of industries. The relatively high proportion of gazelles in the county of Norrbotten coincides with substantial investments made in the mining industry during the latter part of the period. The lowest proportion of gazelles are in the Counties of Kalmar and Gotland.

The differences are somewhat clearer when the proportion of gazelles by different industry categories are studied according to the Ohlsson-Vinell[14] classification system (Table 4.2). These firms are overrepresented in construction and business services, see the column far right. The proportion is also higher than the average for the industry categories of energy, water and waste, but there are few firms in this category. On the other hand, the proportion of gazelles is lower than the average in the categories of Private household services and Miscellaneous services, and also in Primary industries. Service industries are a heterogeneous group, consisting mainly of business services that have experienced positive change in number of hours worked, and growth in value added in recent years.[15] One reason for this is outsourcing from manufacturing firms. It is thus not surprising that the proportion of gazelles is larger in this industry category. It can be noted that the proportion of gazelles among different industry categories is essentially the same and similar to the average for all industry groups.

---

[14] *See Appendix 2*
[15] *ITPS (2008)*

Table 4.1 Proportion of firms in each county which were gazelles during different four-year periods between 1997 and 2007, in per cent

County	1997-2000	1998-2001	1999-2002	2000-2003	2001-2004	2002-2005	2003-2006	2004-2007	Average
Norrbotten	10	11	11	11	9	11	13	15	11.5
Stockholm	13	13	12	10	9	9	11	14	11.4
Uppsala	12	12	13	11	9	9	10	11	11.0
Västra Götaland	13	11	11	9	9	9	11	12	10.6
Örebro	10	9	10	9	10	10	10	13	10.1
Skåne	11	11	10	9	9	9	10	12	10.0
Gävleborg	10	10	9	9	9	8	11	13	9.9
Kronoberg	10	11	9	8	8	9	11	14	9.9
Västerbotten	10	9	8	9	9	10	10	13	9.8
Halland	10	10	10	9	9	9	10	12	9.8
Södermanland	10	10	11	10	8	9	10	11	9.8
Värmland	9	9	10	9	9	8	11	12	9.7
Jönköping	10	10	9	9	8	8	11	12	9.6
Östergötland	11	10	10	10	9	7	9	10	9.5
Blekinge	12	10	10	8	6	8	8	13	9.3
Västmanland	9	10	10	9	8	8	9	11	9.2
Dalarna	10	10	9	9	8	9	9	10	9.2
Västernorrland	9	9	8	8	8	9	9	11	9.0
Jämtland	8	8	9	8	9	10	9	10	9.0
Kalmar	9	8	9	8	9	8	9	10	8.7
Gotland	10	9	10	9	8	7	6	9	8.2
County code unavailable	32	28	10	0	0	15	20	24	19.3
National	**11**	**11**	**10**	**9**	**9**	**9**	**10**	**12**	**10.3**

22

Table 4.2 Proportion of firms in each industry category according to the Ohlsson-Vinell classification which were gazelles during different four-year periods between 1997 – 2007, in per cent

Industry category	1997–2000	1998–2001	1999–2002	2000–2003	2001–2004	2002–2005	2003–2006	2004–2007	Average
Farming and forestry, fishing	6	6	6	5	6	6	6	6	6
Mining	9	14	6	8	10	7	12	13	10
Labour intensive industry	12	11	10	8	7	8	10	12	10
Capital intensive industry	12	9	9	6	9	9	13	15	10
Knowledge intensive industry	14	14	11	10	8	9	12	15	11
R&D intensive industry	10	10	10	9	8	7	11	12	10
Energy, water, waste	10	10	10	15	15	33	13	13	12
Construction	14	14	13	11	10	11	13	16	13
Business services	14	13	13	11	10	10	12	15	12
Miscellaneous services	7	7	7	7	7	8	8	8	7
Private household services	8	8	8	8	7	7	8	10	8
Public household services	10	11	12	12	12	11	11	11	11
Industry code unavailable	*	*	*	*	*	11	6	0	11
National	**11**	**11**	**10**	**9**	**9**	**9**	**10**	**12**	**10**

Table 4.3 shows the industries which had the highest proportion of gazelles during the period 1997 – 2007. This industry classification is more disaggregated compared to Table 4.2 and thus better illustrates the type of activities where gazelles are particularly prominent. Gazelles are mainly concentrated in transport and communication industries (SNI code 60 – 64) and also computer consultancy, research and development institutions, and other firm services (SNI Code 72 – 74). These service industries are marked in the table. There is a relatively large number in education. Industry categories with a high proportion of gazelles are vehicle, mining, manufacture of radio, television and communication equipment.

Table 4.3 Industries with the highest proportion of gazelles and the number of gazelles in these industries during period 1997 – 2007, two digit SNI code

SNI Code	Description of industry category	Average proportion of gazelles in all time periods (%)	Number gazelles
64	Post and telecommunications firms	28	93
62	Air transport	22	35
34	Manufacture of motor vehicles, trailers and semi-trailers	17	170
37	Recycling	17	55
72	Computer and related activities	16	888
80	Education	14	853
32	Manufacture of radio, television and communication equipment and apparatus	14	79
73	Research and development	14	83
60	Land transport; transport via pipelines	14	4404
24	Manufacture of chemicals and chemical products	13	93
90	Sewage and refuse disposal, sanitation and similar activities	13	95
91	Activities of membership organizations n.e.c.	13	85
63	Supporting and auxiliary transport activities; activities of travel agencies	13	512
45	Construction	13	7524
74	Other business activities	12	5038
15	Manufacture of food products and beverages	12	632
27	Manufacture of basic metals	12	64

Note Categories with 3 or fewer gazelles are not included.

Table 4.4 clearly shows that the proportion of gazelles increases with firm size. The construction of the index, however, means that the number of employees only has to increase by five persons for a firm with more than 33 employees to be classified as a gazelle, see Chapter 3. This means that a small percentage increase in the number of employees is required for a larger firm to qualify for inclusion in the group of rapidly growing firms. At the same time, it should be emphasised that relatively few firms in our statistical material belong to the largest size categories. The absolute majority of the total number of firms that were gazelles are in the smallest size categories. During the last four year period the smallest firms accounted for about 85 per cent of all gazelles, see the column far right.

Table 4.4 Proportion of firms in each size category which were gazelles during different four-year periods between 1997 – 2007 (per cent), and also the number of firms during the period 2004 – 2007

Number employees	1997–2000	1998–2001	1999–2002	2000–2003	2001–2004	2002–2005	2003–2006	2004–2007	Average	Number
3–19	10	10	9	8	8	8	9	11	9	5 473
20–49	32	28	30	27	24	24	28	34	28	713
50–249	41	39	41	35	35	37	41	47	40	178
250 or more	36	33	58	31	33	24	52	61	42	14
All	**11**	**11**	**10**	**9**	**9**	**9**	**10**	**12**	**10**	**6 378**

Another clear pattern is that the proportion of gazelles is clearly higher among younger firms (Table 4.5). Only firms that are five years or younger have a higher proportion of gazelles than the average. A firm's age is thus of great importance in determining its capacity to grow. Of all gazelles during the period 2004 – 2007, the youngest firms accounted for about 65 per cent, see the column far right.

Table 4.5 Proportion of firms in each age category which were gazelles during different four-year periods between 1997 – 2007 (per cent) and also the number of firms during the period 2004 – 2007

Age	1997–2000	1998–2001	1999–2002	2000–2003	2001–2004	2002–2005	2003–2006	2004–2007	Number
0–5 year	18	18	18	16	14	14	16	20	4 168
5–10 year	10	10	10	8	8	10	10	12	946
11 years or older	8	8	8	6	6	6	8	10	1 236
Start year unavailable	8	6	4	6	6	6	6	8	28
All	**14**	**14**	**12**	**12**	**10**	**10**	**12**	**14**	**6 378**

Figure 4–1 shows capital intensity of gazelles compared to other firms. During most of the period studied there is no difference related to capital intensity, measured as fixed capital per employee. Capital intensity of all firms increases and a substantial difference exists between gazelles and other firms during the last two periods. Most of the increase in capital intensity during the period 2003–2006 is due to increases in the number of gazelles in the highly capital intensive industries of property management and metal extraction. Another cause of this major change could be the reorganisation of statistics between 2002 and 2003 which led to a change in the population sampled.

25

However, there is one difference throughout the period studied where the index is based on changes in value added as opposed to changes in employment, see Figure 4-2. Gazelles are thus more capital intensive in comparison to other firms when the index is based on value added. Similarly, the industry categories "capital intensive industry" and "mining" have a higher proportion of gazelles than the average when this index measure is used, but not when the index is based on changes in employment.

Figure 4.1 Capital intensity measured as fixed assets per employee for gazelles and other firms during different four-year periods between 1997 – 2007, index based on changes in employment, SEK thousands.
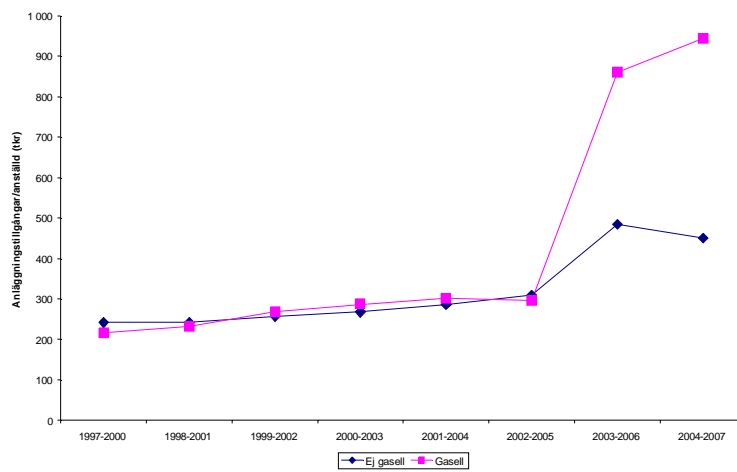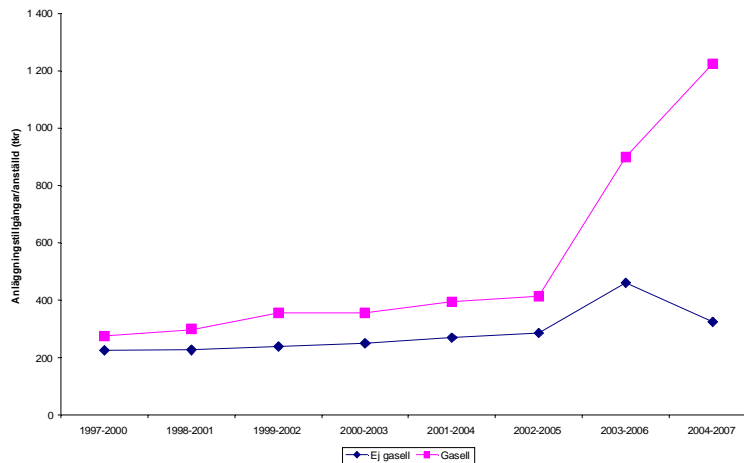

Figure 4.2 Capital intensity measured as fixed assets per employee for gazelles and other firms during different four-year periods between 1997 – 2007, index based on changes in value added, SEK thousands.

Gazelles are not clearly more capital intensive than other firms, but this depends on the index measure used. On the other hand, are they more intensive in terms of human capital? Table 4.6 shows that 8 per cent of employees in gazelles have longer post upper secondary education compared to 6 per cent for other firms. The difference may appear to be small although clearly significant, but it does mean that the proportion of persons with higher education is about a third higher for gazelles compared to other firms. Finally, it is worth noting that there is no difference related to gender, i.e. the proportion of women employed is the same in principle in gazelles compared to other firms.

Table 4.6 Education background and gender of employees in gazelles and other firms during period 1997 – 2007, per cent

Education/gender	Gazelles	Non-gazelles	Difference	P
Pre Upper Secondary	23.9	27.0	-2.9	<0.001
Upper secondary	57.9	58.0	-0.1	<0.001
Post upper secondary < 3 years	10.0	8.9	1.1	<0.001
Post upper secondary>= 3 years	8.2	6.3	1.9	<0.001[a]
Men	65.4	64.7	0.7	<0.001
Women	34.6	35.3	-0.7	<0.001

a = Tested for the assumption on variances of different groups, and rejected for all variables apart from post upper secondary education >=3 years. This relationship has been taken into account in the subsequent T test.

In summary, it can be stated that gazelles are clearly overrepresented among young firms, and this is in line with findings from earlier studies. The proportion of gazelles increases with firm size whilst the largest number are to be found among smaller firms. They are relatively evenly distributed geographically, although the largest numbers are in metropolitan counties. However, the proportion of gazelles is somewhat higher in the Counties of Stockholm, Uppsala, Västra Götaland and Norrbotten. Finally, gazelles are overrepresented in construction and growth industries such as business services. Gazelles exist in all industries but are mainly concentrated in transport and communication, computer consulting, research and development institutions, as well as other business services. Gazelles are not clearly more capital intensive than other firms, but employees in gazelles have a somewhat higher level of education compared to other firms. These results are relatively robust irrespective of whether the Birch index is based on changes in employment or changes in value added. The only exception is that gazelles are more capital intensive and that the proportion of gazelles is somewhat higher in capital intensive industries.

4.3   Importance of gazelles in creating growth and employment

In the following section, the analysis focuses on the importance of gazelles in terms of growth and job creation. It should be emphasised that we report relative and not absolute changes for the number of employees and value added. The dominance of growth firms is not as prominent as regards the latter. On the other hand, gazelles accounted for all of the growth in employment during the period studied (Table 4.7). The distribution is highly skewed. The group "Others" which makes up 80 per cent of the firms during the whole period, however, decreased their employees during each period. There may be some firms in this group which increased employment during one of the time periods. The construction of the index can lead to a situation where a firm with large reductions in employment and value added (more than half) will still end up in the group of "Other firms", see Appendix 2. This means that changes in the firm categories "Other firms" and the "Bottom 10" should be interpreted with caution. The growth in employment accounted for by the smallest gazelles was about 70 per cent during the period. At the same time most workplaces disappear from smaller firms. One explanation for this, as mentioned earlier, is that the largest number of firms are in this group. Finally, it can be noted that during four separate time periods, the total change in employment was negative for firms in our data material.

Table 4.7 Change in number of employees by size category in different periods grouped by gazelles, other firms and firms with the worst development (Bottom 10)

Firm category	Number employees	1997–2000	1998–2001	1999–2002	2000–2003	2001–2004	2002–2005	2003–2006	2004–2007
Gazelles	3–19	31 496	32 544	30 008	27 243	24 703	24 702	28 667	36 719
	20–49	7 359	7 254	6 931	7 475	7 113	6 947	7 111	8 775
	50–249	2 896	3 751	4 212	2 779	2 792	3 307	4 416	5 166
	>250	565	870	1 885	325	599	66	3 463	2 535
	Total	**42 316**	**44 419**	**43 036**	**37 822**	**35 207**	**35 022**	**43 657**	**53 195**
Other firms	3–19	-6 871	-8 342	-6 954	-10 057	-11 129	-9 572	-7 074	-5 327
	20–49	262	-237	-261	-297	-201	-74	93	-30
	50–249	2	-76	-30	-183	15	10	-505	-172
	>250	0	0	-1	3	-308	4	-320	0
	Total	**-6 607**	**-8 655**	**-7 246**	**-10 534**	**-11 623**	**-9 632**	**-7 806**	**-5 529**
Bottom 10	3–19	-15 879	-21 204	-18 022	-19 453	-20 816	-19 683	-18 583	-18 749
	20–49	-6 145	-10 620	-6 614	-7 686	-8 697	-8 623	-7 895	-6 465
	50–249	-2 709	-4 267	-2 900	-3 219	-3 558	-4 015	-3 230	-3 328
	>250	-1 096	-1 807	-476	-1 277	-893	-3 074	-1 402	-1 276
	Total	**-25 829**	**-37 898**	**-28 012**	**-31 635**	**-33 964**	**-35 395**	**-31 110**	**-29 818**
All groups	**Total**	**9 880**	**-2 134**	**7 778**	**-4 347**	**-10 380**	**-10 005**	**4 741**	**17 848**

Gazelles also account for the lion's share of growth in value added. The proportion varies between about 65 and 100 per cent for the different periods, see Table 4.8. The group of "Other firms" also had positive growth in value added apart from two periods. A very high proportion of growth in value added takes place in smaller firms. In conclusion, it can be noted that gazelles accounted for slightly more than 10 per cent of the growth in GDP over the last period 2004 – 2007. GDP increased by about SEK 287 billion whilst value added for gazelles increased by about SEK 30 billion during this period.

Table 4.8 Change in value added (SEK millions) by size category in different periods grouped by gazelles, other firms and firms with worst development (Bottom 10)

Firm category	Number employees	1997–2000	1998–2001	1999–2002	2000–2003	2001–2004	2002–2005	2003–2006	2004–2007
Gazelles	3–19	15 324	14 149	12 554	13 755	10 013	11 037	11 533	19 128
	20–49	3 845	3 715	3 251	4 080	3 083	3 400	2 277	5 451
	50–249	1 814	1 507	1 662	1 491	1 303	1 616	2 006	3 037
	>250	808	235	251	-25	308	206	7 339	2 288
	Total	**21 792**	**19 607**	**17 718**	**19 301**	**14 707**	**16 259**	**23 155**	**29 904**
Other firms	3–19	9 656	4 652	2 623	8 659	-1 125	1 761	-4 058	11 448
	20–49	1 171	566	230	819	199	658	330	1 088
	50–249	190	102	-24	-284	208	105	152	202
	>250	0	15	8	15	-275	18	0	0
	Total	**11 016**	**5 335**	**2 837**	**9 210**	**-993**	**2 542**	**-3 577**	**12 739**
Bottom 10	3–19	-4 090	-5 205	-5 883	-6 367	-7 522	-6 387	-7 414	-5 255
	20–49	-1 360	-1 600	-1 979	-2 153	-2 776	-2 219	-2 659	-1 331
	50–249	-590	-958	-686	-702	-1 033	-410	-881	-79
	>250	-104	-231	43	-475	316	-143	275	-376
	Total	**-6 144**	**-7 995**	**-8 506**	**-9 698**	**-11 016**	**-9 159**	**-10 678**	**-7 041**
All groups	**Total**	**26 664**	**16 947**	**12 049**	**18 813**	**2 699**	**9 643**	**8 900**	**35 601**

It can be seen from Table 4.9 that new firms are very important in creating employment. Firms which are five years or younger account for approximately two thirds of growth in employment in the group of gazelles, which similar to Table 4.7 accounts for all the new jobs created. The proportion of the youngest firms is essentially the same for smaller gazelles, see also Table 4.7. On the other hand substantially fewer jobs disappear among younger firms, particularly in the group of "Other firms" compared to the smallest firms in this group. In other words, new firms are more important than small firms in creating new jobs.

Table 4.9 Change in number of employees by each age category in different periods grouped by gazelles, other firms and firms with worst development (Bottom 10)

Firm grouping	Age	1997-2000	1998-2001	1999-2002	2000-2003	2001-2004	2002-2005	2003-2006	2004-2007
Gazelles	5 years or younger	28 449	31 812	29 773	26 425	23 833	24 369	29 206	35 926
	6-10 years	6 315	6 008	6 649	5 088	4 447	4 229	5 800	6 841
	11 years or older	6 392	6 358	6 521	6 134	6 730	6 262	8 435	10 125
	Data unavailable	1 160	241	93	175	197	162	216	303
	Total	**42 316**	**44 419**	**43 036**	**37 822**	**35 207**	**35 022**	**43 657**	**53 195**
Others	5 years or younger	-4 063	-4 446	-4 124	-6 466	-7 986	-6 044	-4 503	-3 716
	6-10 years	-953	-1 274	-940	-1 502	-1 236	-1 218	-995	-259
	11 years or older	-1 281	-2 436	-1 576	-1 960	-1 923	-1 939	-1 822	-1 096
	Data unavailable	-310	-499	-606	-606	-478	-431	-486	-458
	Total	**-6 607**	**-8 655**	**-7 246**	**-10 534**	**-11 623**	**-9 632**	**-7 806**	**-5 529**
Bottom 10	5 years or younger	-14 030	-16 663	-15 500	-18 134	-19 524	-19 676	-17 377	-16 164
	6-10 years	-3 953	-4 935	-3 686	-3 930	-4 687	-4 778	-4 084	-4 086
	11 years or older	-7 238	-15 233	-7 745	-8 308	-8 658	-9 482	-7 993	-8 500
	Data unavailable	-608	-1 067	-1 081	-1 263	-1 095	-1 459	-1 656	-1 068
	Total	**-25 829**	**-37 898**	**-28 012**	**-31 635**	**-33 964**	**-35 395**	**-31 110**	**-29 818**
All groups	**Total**	**9 880**	**-2 134**	**7 778**	**-4 347**	**-10 380**	**-10 005**	**4 741**	**17 848**

The youngest gazelles accounted for slightly more than 60 per cent of growth in value added among gazelles during the period studied (Table 4.10). On the other hand, the change in value added is relatively evenly distributed across different age categories in the group of "Other firms". This relationship illustrates that age is a distinguishing characteristic of rapidly growing firms.

Table 4.10 Change in value added (SEK millions) by age category in different periods grouped by gazelles, other firms and firms with worst development (Bottom 10)

Firm grouping	Age	1997-2000	1998-2001	1999-2002	2000-2003	2001-2004	2002-2005	2003-2006	2004-2007
Gazelles	5 years or younger	13 685	13 215	12 245	12 589	9 257	10 670	11 963	18 656
	6-10 years	3 280	2 882	2 426	2 744	1 899	1 927	2 318	4 281
	11 years or older	3 540	3 398	3 017	3 872	3 484	3 575	8 804	6 776
	Data unavailable	1 287	112	31	96	68	87	69	190
	Total	**21 792**	**19 607**	**17 718**	**19 301**	**14 707**	**16 259**	**23 155**	**29 904**
Others	5 years or younger	4 785	2 290	1 005	3 489	-1 188	578	-1 564	4 994
	6-10 years	2 703	1 507	912	2 442	-71	604	-917	2 618
	11 years or older	3 577	1 724	1 115	3 445	404	1 488	-989	5 277
	Data unavailable	-48	-186	-196	-166	-139	-128	-106	-151
	Total	**11 016**	**5 335**	**2 837**	**9 210**	**-993**	**2 542**	**-3 577**	**12 739**
Bottom 10	5 years or younger	-3 200	-4 417	-4 512	-5 570	-6 437	-4 711	-5 231	-3 914
	6-10 years	-1 092	-1 088	-1 450	-1 029	-1 549	-1 388	-1 650	-804
	11 years or older	-1 679	-2 203	-2 206	-2 673	-2 626	-2 462	-3 107	-1 827
	Data unavailable	-172	-287	-338	-425	-404	-597	-691	-496
	Total	**-6 144**	**-7 995**	**-8 506**	**-9 698**	**-11 016**	**-9 159**	**-10 678**	**-7 041**
All groups	**Total**	**26 664**	**16 947**	**12 049**	**18 813**	**2 699**	**9 643**	**8 900**	**35 601**

31

In summary, in this part the analysis shows that gazelles account for a disproportionately large part of increases in employment and growth in value added. The distribution is highly skewed and this 10 per cent of firms account in total for all of the increase in employment and between 65 and 100 per cent of growth in value added depending on the period. Gazelles accounted for slightly more than 10 per cent of growth in GDP during the last period 2004 – 2007. Among gazelles, the smallest firms account for the majority of growth in employment and the same applies to the youngest firms. However, these are particularly important in creating new jobs since the total reduction in employment among the group of "Other firms" is substantially less for new firms compared to smaller firms. The relationships are similar when changes in value added are studied, and newness is a distinguishing characteristic of firms undergoing rapid growth.

4.4   Special analysis of firms belonging to groups

In this section, we analyse firms that are part of groups and which were not included in the earlier analysis. It is thus of some interest to study this "exclusion" in order to determine if firms that are part of a group differ systematically in some respect from independent firms. It appears from Table 4.11 that the proportion of gazelles is substantially higher among firms that are part of a group. On average the proportion amounts to 15 per cent for all firms during the period studied. This can be compared with a figure of 10 per cent for independent firms, whilst the proportion of gazelles among firms which belong to wholly-owned Swedish groups is 19 per cent, and as high as 31 per cent for international groups. In principle the proportion is the same irrespective of whether they are Swedish owned groups with operations abroad, or foreign-owned groups, which is why only the latter are reported as international groups.

Regarding the proportion of gazelles by firm size, the pattern is similar for firms that are members of groups and for independent firms. The proportion of gazelles increases with firm size, and with the exception of the smallest firms, the proportions are broadly the same irrespective of whether the firm belongs to a group or not. It can also be noted that the number of firms that are members of a group in the larger size categories is higher compared with independent firms.

Table 4.12 shows the importance of gazelles, as members of a group or as independent firms, in creating jobs. Similar to Table 4.7, the group of gazelles alone account for all the growth in employment during the period studied. This applies to all firm categories. The major part of the increase in employment from gazelles comes from firms that are members of international groups. A very large number of jobs disappear among firms with the worst development (Bottom 10), and in two periods the total number of employees decreases.

Table 4.11 Proportion of firms in each size category which were gazelles during different four-year periods between 1997 – 2007 by independent firm, and firms part of Swedish groups, and international groups, per cent

Firm category	Number employees	1997-2000	1998-2001	1999-2002	2000-2003	2001-2004	2002-2005	2003-2006	2004-2007	Average
Independent firms	3-19	10	10	9	8	8	8	9	11	9
firms	20-49	32	28	30	27	24	24	28	34	28
(t1 and t4)	50-249	41	39	41	35	35	37	41	47	40
	more than 250	36	33	58	31	33	24	46	52	40
	All	**11**	**11**	**10**	**9**	**9**	**9**	**10**	**12**	**10**
Wholly Swedish	3-19	18	17	15	14	12	13	14	17	15
Groups (1)	20-49	34	32	32	30	27	28	31	36	31
(t1 or t4)	50-249	43	38	41	38	35	36	42	48	40
	more than 250	44	35	44	52	45	42	40	50	44
	All	**22**	**21**	**19**	**18**	**16**	**17**	**18**	**22**	**19**
International groups (2)	3-19	29	28	26	21	18	19	23	23	23
groups (2)	20-49	42	39	39	32	29	30	34	39	35
(t1 or t4)	50-249	46	44	41	33	31	35	39	45	39
	more than 250	47	46	42	36	36	38	42	51	42
	All	**37**	**36**	**33**	**27**	**25**	**26**	**30**	**33**	**31**
All irrespective of ownership form and size		**17**	**16**	**15**	**14**	**13**	**13**	**15**	**17**	**15**

N.B. 1. Belonged to wholly Swedish groups some time during the period (t1 or t4)
2. Belonged to international groups some time during the period (t1 or t4)

Table 4.12 Change in number of employees by type of ownership during different periods grouped by gazelles, other firms, and firms with worst development (Bottom 10) during period 1997 -2007

Comp-any category	Ownership form	1997	1998	1999	2000	2001	2002	2003	2004
Gazelle	Independent	42 316	44 472	43 036	37 822	35 299	35 099	44 206	54 069
	Swedish groups	62 083	60 026	55 415	54 819	53 898	53 789	66 944	105 549
	International groups	191 089	198 804	181 516	205 812	166 066	158 656	141 585	152 472
	All	**295 488**	**303 302**	**279 967**	**298 453**	**255 263**	**247 544**	**252 735**	**312 090**
Others	Independent	-6 607	-8 653	-7 247	-10 534	-11 622	-9 632	-7 807	-5 529
	Swedish groups	-1 723	-2 534	-1 556	-1 897	-2 273	-3 526	-2 393	-2 621
	International groups	-3 552	-13 470	-1 868	-3 384	-1 503	-7 756	-4 164	-5 038
	All	**-11 882**	**-24 657**	**-10 671**	**-15 815**	**-15 398**	**-20 914**	**-14 364**	**-13 188**
Bottom 10	Independent	-25 829	-37 900	-28 012	-31 655	-34 033	-35 395	-41 175	-37 045
	Swedish groups	-38 702	-49 768	-41 284	-52 467	-50 790	-52 257	-53 855	-57 232
	International groups	-139 587	-137 139	-150 657	-188 109	-188 723	-184 239	-133 162	-106 245
	All	**-204 118**	**-224 807**	**-219 953**	**-272 231**	**-273 546**	**-271 891**	**-228 192**	**-200 522**
All irrespective of ownership form and growth category		**79 488**	**53 838**	**49 343**	**10 407**	**-33 681**	**-45 261**	**10 179**	**98 380**

N.B. Swedish groups refers to firms which belonged to such a group some time during the period (t1 or t4). International groups refers to firms which were members of such a group some time during the period (t1 or t4). Independent firms have had this status throughout the period (t1 and t4).

These results show that there are major differences between independent firms and firms which were part of a group, and thus the necessity of distinguishing between them in the analysis. The fact that the proportion of gazelles is higher among the latter is not surprising, and there may be a number of different causes. One may be the transfer of physical resources to a firm from other parts of the group enabling it to grow rapidly. Another is transfer of technology and other knowledge such as marketing and production know-how. In particular, firms that are part of international groups enjoy as a result competitive advantages providing scope for rapid growth. International firms are not restricted to the Swedish capital market, and groups also have greater financial strength,

which is particularly important for rapid growth. There are a number of advantages in belonging to a group of firms. On the other hand, the proportion of gazelles increases with firm size for all firms irrespective of ownership form, and with the exception of the smallest firms, the proportions are similar. As mentioned earlier, however, the construction of the index is such that a small percentage increase in the number of employees is all that is required for a larger firm to be classified as a gazelle. Another shared characteristic is that gazelles account for all of the increase in employment.

4.5 Development of gazelles over time

4.5.1 Growth path dependence

An interesting question that has only received relatively little attention is the development of gazelles over time. We have chosen to study this by dividing the period studied into three separate periods, 1998 – 2001, 2001 – 2004, and 2004 – 2007. Table 4.13 shows the development of firms which were gazelles during the middle period i.e. 2001 – 2004. The table shows the distribution of firms identified as gazelles in period (2001 – 2004), both before this period (1998 – 2001) and after the gazelle period (2004 - 2007). Lack of data on a firm means that it was probably started, split up, merged or closed down during the period.

If the development of all firms is studied (the bottom part of Table 4.13), the distribution was basically similar with respect to the growth that firms had in the previous period. Gazelles during the middle period come from all groups with virtually the same proportions since these are around 25 per cent. In principle, the probability of having the *lowest* growth in the earlier period (Bottom 10) is almost the same as the probability of being a gazelle during the previous period. Based on this data, there does not appear to be a higher probability that a gazelle during one period was also a gazelle during a previous period.

"Continuing gazelles" i.e. firms that are gazelles over a number of periods, are overrepresented in the category of firms belonging to a group, and particularly those belonging to international groups. 40 per cent of the latter were also gazelles during the previous period (the table section, second lowest from the bottom in Table 4.13). When the development of gazelles during *the next* period 2004 – 2007 is examined, the pattern is similar but not equally clear. What can be stated is that firms which have been gazelles have a lower probability of reducing their employment or closing down operations, but they have just as high a probability of being defined as a gazelle as belonging to the category of "Other firms". Independent firms appear to have a lower probability of remaining as gazelles.

One way of determining whether there is any systematic pattern with regard to a firm defined as a gazelle in two periods is to test whether firms defined as gazelles in one period are a random sample of firms. As a result the following hypothesis was formulated, as stated in the propositions earlier(7):

H_0: The number of firms identified as gazelles in both periods is consistent with gazelles in the second period being a random sample of firms.

H_1: The number of firms identified as gazelles in both periods is not consistent with gazelles in the second period being a random sample of firms.

Table 4.14 shows firm population by gazelle status 1998 - 2001, and also 2001 - 2004. The relative distribution of gazelle status is shown in the bottom part of the table. About 13 per cent of firms in the different periods were defined as gazelles. Approximately 3 per cent were gazelles in two periods. It is not possible to reject the hypothesis that the outcome is consistent with firms that were defined as gazelles in 2001-2004 are a random sample of firms.[16] This serves to confirm the view presented in Table 4.13, i.e. there is no form of "growth path dependence" backwards in time.

Table 4.13 Gazelles' development over time for firms classified as gazelles during 2001 – 2004 by independent firms, firms that are part of Swedish and international groups, and all firms, per cent

Independent	1998-2001	2001-2004	2004-2007
Gazelle	18	100	28
Others	33		44
Bottom 10	23		20
Data unavailable	27		7

Swedish groups	1998-2001	2001-2004	2004-2007
Gazelle	30	100	36
Others	29		31
Bottom 10	24		25
Data unavailable	17		8

International groups	1998-2001	2001-2004	2004-2007
Gazelle	40	100	41
Others	17		18
Bottom 10	25		33
Data unavailable	18		9

All firms	1998-2001	2001-2004	2004-2007
Gazelle	27	100	34
Others	28		34
Bottom 10	24		25
Data unavailable	21		8

---

[16] *Against the alternative outcome "not being a gazelle". Mann-Whitney U=-1.47, p=0.14*

Table 4.13 indicated that firms which were gazelles 2001 - 2004 had a lower probability of reducing or closing down operations during the next period. Thereafter the test is repeated, replacing firms during the period 1998 – 2001 with firms which were gazelles during the period 2004-2007. Table 4.15 shows the population of firms by gazelle status 2001 – 2004 and 2004 - 2007. It can be seen from the relative distribution that 13 per cent of the firms in the different periods were defined as gazelles. Approximately 4 per cent of all firms are gazelles during both these periods. In this case, the hypothesis can be rejected that the observed outcome is consistent with firms defined as gazelles in 2004 - 2007 are a random sample of firms.[17]

There is thus a slightly higher probability of remaining a gazelle during the next period, given that the firm was a gazelle during the previous period. However, it should be pointed out that the probability is not lower than the threshold value of 0.01 at the highest level of significance (99 per cent). Macroeconomic factors may lie behind this relationship, since the middle period covered a short downturn in the economy whilst the last period was characterised by four years of uninterrupted growth.

Table 4.14 Pivot table for all firms by gazelles and non-gazelles for the periods 1998 – 2001 and 2001 – 2004, numbers and relative proportions

		Gazelle 2001-2004		
		Yes	No	Total
	Yes	2760	8199	10959
Gazelle 98-01	No	7499	63560	71059
	Total	10259	71759	82018
	Yes	3 %	9 %	13 %
Gazelle 98-01	No	10 %	77 %	87 %
	Total	13 %	87 %	100 %

---

[17] *Against the alternative outcome "not being a gazelle". Mann-Whitney U=-2.41, p=0.016*

Table 4.15 Pivot table for all firms by gazelles and non-gazelles for the periods 2001 – 2004 and 2004 – 2007, number and relative proportions

		Gazelle 2004-2007		
		Yes	No	Total
	Yes	3463	6796	10259
Gazelle 01-04	No	6863	64896	71759
	Total	10326	71692	82018
	Yes	4 %	8 %	13 %
Gazelle 01-04	No	8 %	79 %	87 %
	Total	13 %	87 %	100 %

4.5.2   Gazelles with continuous growth

This section focuses on a subset of gazelles which succeeded in maintaining continuous growth and qualifying as gazelles during all three periods 1997 – 2000, 2000 – 2003 and 2003 – 2006. Of these continuous gazelles, 18 per cent were independent firms during all three periods (Table 4.16). An equally large proportion belonged to a Swedish group, and nearly the same proportion belonged to an international group during the whole of the period studied. In this respect there were thus no major differences related to whether a firm was independent, or a member of a Swedish or international group. It should be observed that about 25 per cent of firms went from being an independent firm into becoming a member of a group during the period. In addition, about 12 per cent of the firms belonging to a Swedish group became part of an international group. This serves to illustrate that gazelles which succeeded in following a growth path were often acquired and became part of a larger constellation. Gazelles are particularly interesting as acquisition targets since they were selected as winners and their technology and business model passed the market test. This is a logical development, but at the same time it does mean that newly started independent gazelles cannot be expected to grow into large firms, and that a more normal development pattern is that they are acquired by an established firm.

Table 4.16 Firms classified as gazelles in all three periods 1997 – 2000, 2000 – 2003 and 2003 - 2006 by ownership category, number and relative proportions (per cent)

Ownership category	Number	Proportion (%)
Independent firm all years	213	18.0
From independent firm to Swedish group	182	15.4
From independent firm to international group	113	9.5
Swedish group all years	213	18.0
From Swedish group to international group	144	12.2
International group all years	190	16.0
Others	130	11.0
Total	**1 185**	**100.0**

N.B. The category "Other firms" contains firms which changed their status at some point during the period, and at the same time went from being part of a group to an independent firm, or from an international group to a Swedish group, i.e. they descended the hierarchy.

Final discussion and conclusions

4.6   Conclusions

Gazelles have been studied on the basis of a number of variables such as regional affiliation, industry, size, age and capital intensity. In addition, their importance for economic growth and job creation has been analysed. Their development patterns have been studied over time to determine if there is any kind of growth path dependence. The seven hypotheses or propositions identified at the beginning of the study were the following:

- Gazelles are younger compared to other firms.

- Gazelles exist in all size categories even though the number of growth firms is higher among small and medium-sized firms.

- Gazelles exist in all industries, but are somewhat overrepresented in growth industries such as business services.

- Gazelles exist in all counties although they exist in greater numbers in metropolitan regions.

- Gazelle are more capital and human capital intensive compared to other firms.

- Gazelles account for a disproportionately large part of increases in employment and value added.

- It is not possible to forecast which firms will become gazelles during a subsequent period, but the probability is somewhat higher that a gazelle compared to other firms remains a gazelle, or at least a firm with a certain growth, also during the next period.

In conclusion, it can be stated that gazelles are clearly overrepresented among young firms, and this is in line with findings from earlier studies. The proportion of gazelles increases with firm size, whilst the largest number are to be found among smaller firms. The construction of the Birch index, however, does mean that only a small percentage increase in the number of employees is all that is required for a large firm to be classified as a gazelle, and this it could be argued disadvantages smaller firms. Gazelles are also distributed relatively evenly geographically, even though the largest numbers are to be found in metropolitan counties. They are also somewhat overrepresented in construction, and growth industries such as business services. Gazelles on the other hand are not clearly more capital intensive than other firms. However, employees in the first mentioned firms have a significantly higher level of education compared to those in other firms. These results are relatively robust irrespective of whether the Birch index is based on changes in employment or changes in value added. The only exception is that gazelles are more capital intensive and that their proportion is somewhat higher in capital intensive industries in the last mentioned case.

In addition, the analysis shows that gazelles account for a disproportionately large proportion of increases in employment and growth of value added. The distribution is highly skewed and this 10 per cent of firms account in total for all of the increase in employment and between 65 and 100 per cent of growth in value added depending on the period. Independent gazelles accounted for slightly more than 10 per cent of the growth in

GDP during the last period of 2004- 2007. Among gazelles the smallest firms account for the majority of the growth in employment, and the same applies to the youngest firms. Young firms, however, are particularly important in adding new jobs since the overall reduction in employment among the group of "Other firms" is much smaller for young firms compared with smaller firms. The relationships are similar when changes in value added are studied, and newness is a distinguishing characteristic of firms undergoing rapid growth.

When firms belonging to a group are analysed, we have found major differences compared to independent firms, which serves to confirm that it is necessary to draw a distinction between them in the analysis. It turns out that the proportion of gazelles is significantly higher among the former, and particularly among firms that are part of international groups. There may be a number of reasons for this. One explanation may be the transfer of physical resources to a firm from other parts of the group which means that it grows rapidly. Another is transfer of technology and other knowledge such as marketing and production know-how. In particular, firms that are part of international groups enjoy as a result competitive advantages providing scope for rapid growth. In addition, international firms have access to a wider range of capital, and groups also have greater financial resources, two factors which are of particular importance for rapid growth over a longer period. Finally, it is not possible to forecast which firms will become gazelles during a subsequent period, but the probability is somewhat higher that a gazelle compared to other firms will be a gazelle during the next period. However, the relationship is not particularly strong and there may be other explanations. Of all "continuing" gazelles, close to 40 per cent moved from being an independent firm into part of a group, or from belonging to a Swedish group and becoming part of an international group. This means that gazelles which have succeeded in following a growth path are often acquired and become part of a larger constellation.

What are the implications of these results? It can be stated that gazelles are clearly younger than other firms. They account for the whole of the increase in employment and young firms are particularly important in creating new jobs. Among firms belonging to a group, there is a significantly higher proportion of gazelles, especially in international groups. In addition, the proportion of gazelles increases with firm size irrespective of type of ownership. In other respects such as regional location, industry and capital intensity, the pattern is not nearly as clear even though some minor differences exist. The fact that it is difficult to predict winners is evident, as there does not appear to be any clear growth path dependence forwards in time. In other words, rapidly growing firms have not succeeded in following a growth path during subsequent periods, but have been replaced by other gazelles, which are then replaced by other firms.[18] This situation can be compared to a large number of parallel relays where the leading contenders are constantly shifting.

---

[18] *See, among others Coad (2007)*

It should be emphasised that the process or phenomena which have been studied despite the difficulties of unravelling the patterns is very important. In fact, this process is a part of ongoing structural transformation or creative destruction, a process where winners on the market are selected in accordance with the theory of competence blocks.[19] Selection takes place in a number of phases or levels when new firms are started, and from which one third disappear after three years.[20] Some become rapidly growing firms whilst the majority exhibit a more normal pattern of development. A large proportion of rapidly growing firms disappear as a result of being bought up. They are particularly interesting for established firms as acquisition targets since their technology and business model has already passed the first test on the market. A larger firm can then go further in its development, at the same time as an acquired firm can contribute know-how which assists the development of the acquiring firm. This process gives rise to a transfer of knowledge.

Even though the explanatory factors or specific characteristics of gazelles are largely unknown, the fact that firms become winners and take market shares means that in some important respects they differ from other firms. We know that new firms are overrepresented among gazelles and that the education level of their employees is higher. Newness and knowledge are thus two keywords which are also fundamental to and related to the concept of innovation. It can also be stated that the most rapidly growing gazelles in particular, and those experiencing continuous growth *are* innovative in some respect. In understanding the relationship between innovation and entrepreneurship, rapidly growing firms are of particular and enduring interest, even though the underlying reasons for the phenomenon are multifaceted and difficult to explain.

4.7　Policy implications

New and rapidly growing firms in particular have aroused great interest on the part of politicians and policymakers in recent times, and in public debate the argument is put forward that growth policy initiatives should be directed to this target group. Based on the results of this and other studies, however, the conditions for intervention through selective measures are not particularly favourable. The reason being that firm growth is difficult to forecast. This applies particularly to the growth of smaller firms which is significantly more irregular compared to that of larger firms, which display a much more even pattern of growth.[21]

This means that it is important that the general institutional conditions are well-designed. Rapidly growing firms and economic players that are necessary for generating and commercialising new knowledge appear to be particularly dependent on the incentives created by institutional settings.[22] Recruitment of competent personnel is important, both for the transfer of knowledge and also the growth of gazelles, which have shown themselves to be more knowledge intensive. This presupposes mobility on the part of the labour force. Labour market legislation and the social insurance system should not be allowed to create unnecessary barriers to such mobility. Lundh states that for employees with longer periods of employment, the principle of seniority in the Employment

---

[19] *The competence block defines the minimum set of actors with different but complementary competencies necessary to generate, identify, select, expand and leverage business ideas to large scale economic development, see for example Eliasson & Eliasson (1996)*

[20] *ITPS (2008)*

[21] *Coad (2007)*

[22] *Henrekson & Johansson (2009)*

Protection Act (LAS) has reduced the incentive to change jobs.[23] This means that the opportunity cost may be high for labour with longer employment to change from a relatively safe workplace to a riskier situation, either as an entrepreneur or an employee in a newly started growth firm.

Low barriers to entry and contestable markets are important for the development of high-growth firms. According to Henrekson & Johansson, public production monopolies provide the greatest obstacle to rapidly growing firms. Their view is that high taxes and labour market regulations have an impact on the creation of well functioning competence blocks and thus the emergence of high-growth firms, but they consider there is some scope for reducing taxation and circumventing labour market rules. They conclude that these three groups of institutions give rise to disturbances which disadvantage in particular firms that are overrepresented among rapidly growing firms i.e. young and small firms in the service sector.[24]

Given the background above, and based on the dynamics of firm development, it is important that tax rules are neutral in neither disadvantaging nor favouring the sale of a gazelle, or indeed a smaller successful firm. Structural transformation involves the reallocation of resources from less efficient to more efficient firms. In the ongoing process of selecting firms on the market, it could be best for a firm's development that it be sold to an industrialist or larger firm that will further develop the firm and take it to the next level. Otherwise an entrepreneur who has established a firm may wish to continue owning and operating the firm, and although he may well be the person most suited to do this, the entrepreneur's decision should not be based on the merits of the relative taxation benefits of the alternatives.

4.8   Proposals for further studies

There is great need to deepen our knowledge of rapidly growing firms in different respects. Possible areas for further studies may be:

- Methods for developing an index which more effectively takes account of both relative as well as absolute change i.e. is more neutral with respect to firm size. Such development at the same time requires international support, from the OECD for instance, if comparability between countries is to be achieved.

- Development of quantitative models for both explanatory variables and also growth path dependence, i.e. development of gazelles over time.

- Focused studies of the few firms that are continuous gazelles, or the most rapidly growing gazelles. Quantitative analyses of "super gazelles" could with advantage be combined with qualitative analyses, such as in-depth interviews to acquire greater knowledge of these unique and innovative firms.

- Research concerning institutions and the effects of rules on firms and their development.

- The importance of individual mobility in disseminating knowledge and growth of firms.

---

[23] *ITPS (2005)*
[24] *Henrekson & Johansson (2009)*

5   References

Acs, Z.J. and Mueller, P. (2006), *Employment Effects of Business Dynamics: Mice, Gazelles and Elephants,* Discussion Paper 2006-23 on Entrepreneurship, Growth and Public Policy, Max Planck Institute of Economics.

Acs, Z.J., Parsons, W. & Tracy, S. (2008), *High-Impact Firms: Gazelles Revisited*, SBA Office of Advocacy.

Birch, D.L. (1979), *Job Generation Process*, Cambridge, MA: Joint Center for Neighbourhood and Regional Development, MIT.

Birch, D.L. & Medoff, J. (1994), *"Gazelles"*, *Labor Markets, Employment Policy and Job Creation*, Solomon, L.C. & Levenson A.R. (ed.), Westview Press.

Coad, A. (2007), *Firm Growth: A Survey*, Max Planck Institute of Economics.

Davidsson, P. and Delmar F. (2006), *High-Growth Firms And Their Contribution To Employment: The Case Of Sweden 1987 – 96*, *Entrepreneurship and the Growth of Firms*, Elgar, E. (ed.)

Delmar, F., Davidsson, P, & Gartner W.B. (2003) *Arriving at the high-growth firm*, Journal of Business Venturing 18, pages 189-216.

Eliasson, G. and A. Eliasson (1996), 'The biotechnical competence bloc'. *Revue d'Economie Industrielle* 78(1), 7–26.

Henrekson, M. and Johansson, D. (2009) *Competencies and Institutions Fostering High-growth Firms*, Foundation and Trends in Entrepreneurship, vol. 5, No 1.

Henrekson, M. and Johansson, D. (2008) *Gazelles as Job Creators – A Survey and Interpretation of the Evidence,* IFN Working Paper No. 733.

ITPS (2005) Arbetsrätt, rörlighet och tillväxt, forskarantologi, red. Rauhut, D. och Falkenhall, B., A2005:016.

ITPS (2007) Näringslivets tillstånd 2007: Det ambitiösa entreprenörskapet, A2007:015.

ITPS (2008) Uppföljning av 2003 års nystartade företag - tre år efter start, (Follow-up study of newly started firms 2003 – three years after start), S2008:001.

ITPS (2009) Näringslivets tillstånd 2008: Tjänsteparadox skapar tillväxt, A2008:012.

6 Appendix 1 Analysis of Birch index

6.1 The Birch index for firms which are declining

The rationale for using the Birch index is that it should take account of both absolute and relative change, and thus be relatively neutral with respect to firm size. If only the absolute difference in employment were studied, only large firms would be classified as gazelles. At the same time, it is not entirely appropriate to study percentage change as this would mean that mainly small firms would be classified as gazelles. The Birch index can be calculated in three ways; based on number of employees, value added, or a combination of these variables. In this analysis the Birch index is based on the number of employees, and this is the approach most frequently taken in other studies of rapidly growing firms. A sensitivity analysis has also been carried out using value added.

The Birch index (BI) is calculated based on the difference between the number of employees during the first year in time period (s_1) and the number of employees after three years of growth (s_4). Both absolute and relative growth of employment are taken into account during the period.
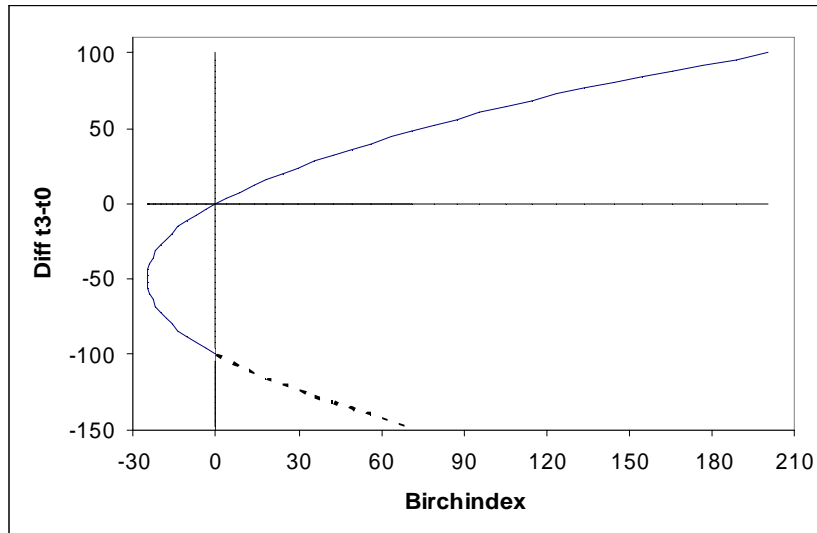
Birch index:

$$BI = (s_4 - s_1)\left(\frac{s_4}{s_1}\right)$$

A corresponding formula is used when the BI is calculated using value added, as employees are replaced by value added during the start year (VA_1) and after three years growth (VA_4):

$$BI = (VA_4 - VA_1)\left(\frac{VA_4}{VA_1}\right)$$

If we examine more closely what happens to the Birch index for a firm which in year t1 has 100 employees and where the number of employees in year t4 is varied, the BI decreases until the labour force is half that of the start year, and thereafter starts to increase, and for zero employees, a value of zero is given (Figure 1). A firm reducing the number of its employees to zero during the period receives the same BI as a firm which has as many employees during the start and end year in the period, produces a result that is difficult to interpret.

Where the value added of rapidly growing firms was analysed, and a firm has a value added of 100 during the start year. the BI is identical if the firm's value added increases to 200, or decreases to –100. If the problem of a negative value added in year t4 for the period is not taken into account, this means that on average 32 firms (0.6 per cent of gazelles) are classified each year as gazelles, despite having a large negative value added. The fact that value added is negative is an extreme situation for a firm, and means that the firm is reducing the value of its inputs. Firms with negative BI have been recoded to a fixed negative value which gives them the lowest BI of all firms.

Figure 1: The Birch index for 100 employees year t1

For firms where value added or the number of employees decreased to 0 during year t4, the BI formula has been reworked so that only the absolute change is taken into account when calculating the index.

Adjusted Birch index formulae:

BI by employees:

$$Oms_4 > 0 \Rightarrow BI = (s_4 - s_1)\left(\frac{s_4}{s_1}\right)$$

$$Oms_4 = 0 \Rightarrow BI = (s_4 - s_1)$$

BI by value added:

$$Omva_4 > 0 \Rightarrow BI = (va_4 - va_1)\left(\frac{va_4}{va_1}\right)$$

$$Omva_4 = 0 \Rightarrow BI = (va_4 - va_1)$$

$$Omva_4 < 0 \Rightarrow BI = -999999000$$

When a firm decreases the number of employees during t_4 to close to 0, the Birch index is the same as for a firm which has made only minor reductions in the number of employees. As regards this problem, no adjustments have been made in the Birch index calculations. Caution should thus be exercised when interpreting the results for firms that are not gazelles, i.e. the group of "Other firms" and the "Bottom 10" in the report.

6.2   The Birch index for firms which are growing

The definition of gazelles is the 10% of firms that perform best in accordance with the Birch index during a given period. The idea is that the Birch index should take into account both relative and absolute change, so that both large and small firms can be defined as gazelles.

Figure 2: The Birch index for employees 1997 - 2007
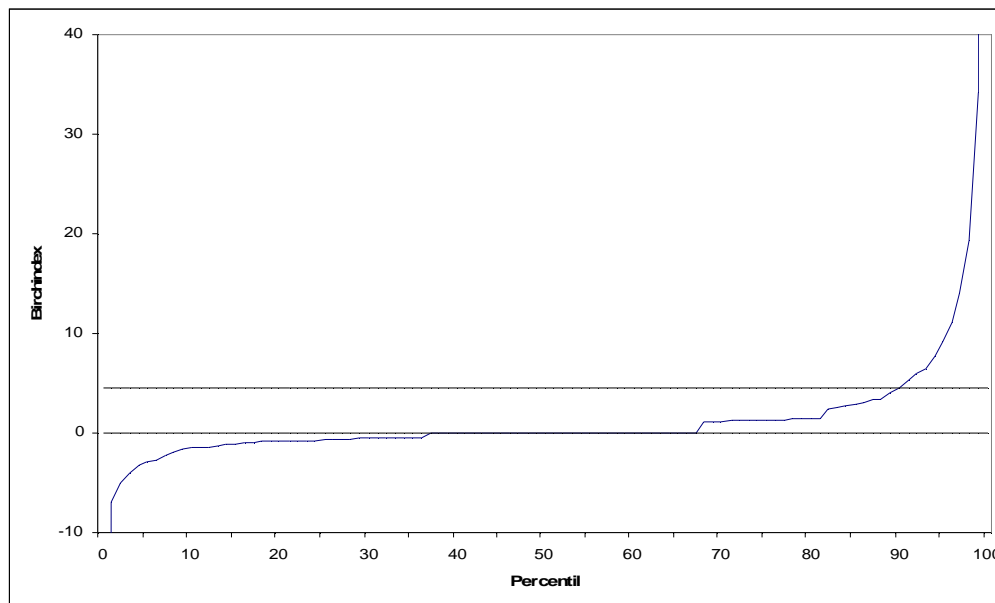
From Figure 2, it can be seen that the level to be classified as a gazelle is a Birch index of at least 4.5. If we transpose this to how large an absolute increase in employment is needed for each size category, then an increase is required in the number of employees of 3 to 5 persons to be classified as a gazelle, see Table 1. As regards a larger firm, an increase in the number of employees by five persons over four years is a relatively small increase. It can be questioned whether the term "rapidly growing" or "gazelles" is applicable to a firm with for instance 500 employees, and which increases its employees by 1 per cent over four years.

Table 1: Increase in the number of employees to be classified as a gazelle

Number employees t1	Increase in employees to t4 to be classified as a gazelle
3-6 employees	3 employees
7-32 employees	4 employees
+33 employees	5 employees

The problem with the traditional calculation of the Birch index is the non-desirable results for firms that have negative growth and that this gives a small difference between absolute and relative growth for large and small firms. In the modified BI formula below, firms with negative employment growth are also assigned a negative proportional index value. The relationship between absolute and relative growth can also be adjusted for small and large firms by adjusting the value for X. This formula has not been used since the development of a new definition for gazelles needs to be tested, both nationally and internationally.

Proposal for developing the formula for calculating the Birch index:

$$BI = \left(s_4 - s_1\right)\left(\frac{\left(s_1 + |s_4 - s_1|\right)}{s_1}\right)^x$$

7 Appendix 2 Industrial classification

The study used the following industry categories based on the Swedish Standard Classification of Economic Activities 2002 (SNI 2002) and 1992 (SNI 92).[25]

Group Name	SNI 2002	SNI 92
1 Agriculture, forestry, fishing	01–05	01–05
2 Mining	10–14	10–14
3 Labour intensive industry	17-19	17-19
	201-203, 205, 212.151-153, 251, 281-285, 355-366, 372	201-203, 205, 212.151-153, 251, 281-285, 355-366, 372
	15511, 15512, 15620, 15810, 15821, 15841, 15842, 15860-15890, 22122, 22130, 22150, 22222-22250, 25220-26132, 26150-26400, 27330, 28630, 28710, 28740- 28759, 29130, 29720, 31501, 31502, 31520, 33500, 35120,	15511, 15512, 15620, 15810, 15821, 15841, 15842, 15860-15890, 22122, 22130, 22150, 22222-22250, 25220-26132, 26150-26400, 27330, 28630, 28710, 28740- 28759, 29130, 29720, 31501, 31502, 31520, 33500, 35120,
4 Capital intensive industry	154, 157, 159-160, 204, 211, 231-242, 247, 265-275 (except 27330), 371	154, 157, 159-160, 204, 211, 231-242, 247, 265-275 (except 27330), 371
	15520-15612, 15822, 15830, 15850, 22210, 22221, 25210, 26140, 28720, 28730	15520-15612, 15822, 15830, 15850, 22210, 22221, 25210, 26140, 28720, 28730
5 Knowledge intensive industry	243, 312-314, 334, 352, 354, 22110-22121, 24510-24640, 24660, 28610-28629, 29110, 29120, 29140-29719, 34100-35110,	243, 312-314, 334, 352, 354, 22110-22121, 24510-24640, 24660, 28610-28629, 29110, 29120, 29140-29719, 34100-35110,
6 R&D intensive industry	223, 244, 300-311, 316-333, 353, 22140, 24650	223, 244, 300-311, 316-333, 353, 22140, 24650
7 Energy, water, waste	40, 41, 90	40, 41, 90
8 Construction	45	45

---

[25]The grouping is based on a proposal worked out by Jan Andersson at Statistics Sweden AM/FRS with a higher level of disaggregation for manufacturing industry based on production factors from Ohlsson-Vinell

9 Business services	51, 72–74,	51, 72–74,
	555, 603, 631, 634, 713, 911, 6024,	555, 603, 631, 634, 713, 911, 6024
	55102, 61102, 62300, 65210, 65231,	55112, 61102, 62300, 65210, 65231,
	67110, 70110, 70120, 70202, 70203,	67110, 70110, 70120, 70202, 70203,
	70329, 71210–71230, 80425, 93011	70329, 71210–71230, 80425, 93011
10 Private household services	52, 92, 95,	52, 92, 95,
	552–554, 633, 714, 912, 913, 6021–6023,	552–554, 633, 714, 912, 913, 6021–6023,
	70201, 70204, 70209, 70321,	70201, 70204, 70209, 70321,
	93012–93050	93012–93050
11 Public household services	8532, 75300, 80100–80424,	8532, 75300, 80100–80424,
	80426–80429, 85111–85316	80426–80429, 85110–85316
12 Misc. services	50, 64–67 (except 65210, 65231, 67110),	50, 64–67 (except 65210, 65231, 67110),
	99, 601, 612, 622, 632, 751, 752,	99.601, 612, 622, 632, 751, 752,
	55101, 55103, 61101, 62100, 70310, 71100	55111, 55120, 61101, 62100, 70310, 71100
13 Unknown industry categories	00000	00000