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Patterns and Dependencies of Firms Growth

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Abstract

The overall framework of this paper is based on the importance of high growth firms. Firm growth is perhaps one of the most studied economic phenomenon that we have not yet found a conclusive theory about. You might ask why we should be concerned about this particular empirical observed phenomenon. At present we will simply highlight the benefits of the high growth firms in terms of direct job creation effects as well as indirect spin-off effects.

We test a regression model in which firm growth, measured by growth in turnover and number of employees, is explained by several variables. Firm size, firm age, geographical location of the firm, the industrial market structure of the industry to which the firm is associated and the characteristics of the industry are all explanatory variables included in a regression model. Using the NewBiz Firm Database we test the model using nearly 9.000 observations.

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1 Introduction

A large part of the economic environment is determined by the performance of firms. Macroeconomic growth rates, unemployment and standards of living, just to mention a few, is highly correlated with the economic performance of firms. To explain the performance of the economy in general we have to analyse the composite, and hence the microeconomic agents, of the economy.

This paper analyse the economic performance of firms. Using the term performance may refer to two combined things. It may refer to profitability or it may refer to firm growth (Geroski 1994). It is the latter of these we wish to investigate further. The term performance should in this paper therefore be perceived as another term for firm growth.

It will be highlighted that although theory implies firms should grow at a rate proportionate to size and as a random walk (e.g. Gibrat's Law), a large amount of empirical studies has shown a statistically significant relationship between firm growth and a number of other variables. This paper investigates such variables as firm size, firm age, the geographical location of the firm, the market concentration of the specific industry, and last but not least, the characteristics of the industry to which the firm is associated. We are questioning the value of the acceptance of viewing the firm growth process as completely stochastic.

The outline of the paper is as follows. Section 2 will build the theoretical foundation of the variables in the model. Section 3 aims at building the formal model to be tested. Section 4 describes the data used and their structure. Section 5 presents the regression equation to be tested as well as the results. Finally section 6 concludes the article.

2 Firm Growth and Factors of Dependence

Geroski (2000) summarised the stylised facts that we at present are faced with concerning the firm growth process. These stylised facts gives four implications. First, changes in firm size are driven by unexpected shocks, which may occur when firms do not know what will happen or when it will happen. From this it is evident that the growth rates of firms are random shocks. Further more these randomly determined growth rates are not serially correlated.

Second and perhaps more important, unexpected shocks have permanent effects on the size of the firm. This means that growth in size is a path dependent process, since the size of a firm at any time is the sum of the entire history of shocks which the firm has experienced.

Third, growth rates appear to be idiosyncratic, since empirical studies indicate that the growth of different firms are uncorrelated. This is opposite to common sense, which suggests the growth of firms to be correlated with the growth of the economy or industry. This means that the growth of firms is history dependent with every firm having its own history.

Fourth, the growth rates are not smoothed. This is motivated by evidence that firms do not adjust costs according to eventual shocks - not even partially. Firms are not fully able to anticipate shocks and therefore they cannot begin reacting before the shocks occur.

The four points give no direct support to our intentions in this article. By characterising firm growth as a random walk, these stylised facts leaves little to be explained concerning growth. The purpose of this article is not to directly oppose these four points. We question whether or not it is correct that firm growth solely may be described by the four statements. It leaves nothing for the policy makers and perhaps even less for the business managers, because the firm growth process is entirely stochastic according to these four points. We believe some variables may be singled out as having some saying for the growth of the firm. Even though a growth process may seem to be stochastic on the surface, we may still find a few variables that has an influence on this process. We should look at firm growth as a stochastic process on which deterministic elements has a significant effect. We would like to view the process as partly stochastic and partly deterministic.

It is with the above considerations in mind we test the explanatory power of several variables in a firm growth context. Hence we have chosen to build a regression model explaining firm growth with a range of explanatory exogenous variables. We have no intension of directly implementing path dependent perspectives into the regression equation. As a result we may expect a fairly low overall explanatory power of the model. Some of the arguments used in the article for selection of explanatory variables goes directly against one or more of the points summarised by Geroski. To the extent the model will show significant results, we may abolish the idea of firm growth solely being stochastic. Also the overall fit of the model may give some indications as to what degree the process may be stochastic and to what degree it may be deterministic.

2.1 Size

Early studies found no relationship between the growth rate of a firm and its size. The fact that the two characteristics are independent of each other imply that firms should grow at a rate proportionate to their size. This is often referred to as Gibrat's Law

(Jovanovic 1982).

It has been argued though, that Gibrat's Law only may be valid when viewed in relation to larger firms. Including small firms in the considerations, Gibrat's Law becomes invalid (Evans 1987a, Evans 1987b). Nevertheless Evans (1987a) showed that firm growth decrease with firm size (Evans 1987a). These findings were reinforced by Hart & Oulton (1996). In a study based on firm data 1989-93 they found that smaller firms generated proportionately more jobs than larger firms.[1]

Similar to these findings Geroski (2000) points out that the estimates of the slope of a size variable in a growth model are pretty small and negative, which indicates 'mean reversion', where small firms tend to show a proportionately higher growth than larger firms. The differences in firm size are levelled out, which leads to a limited overall increase in the variance of firm sizes.

Hall (1987) and Dunne & Hughes (1994) have presented similar results. Hall showed that smaller firms grow four percentage points faster than larger firms on average. Dunne & Hughes generated results which were more ambiguous. They showed that the larger firms grew more rapidly in the 60's, but smaller firms had a higher growth rate in the 80's. This may be an indication of a time dependent relationship between firm size and firm growth.[2]

According to Nelson & Winter (1982), firm growth is related to the ability to innovate. Therefore we would expect firm growth rates to be serially correlated. They explain this by referring to the fact that technological advantage today will have a high probability of being a technological advantage tomorrow. This may be referred to as technological path dependency. Nelson & Winter proposed that the average growth rates of firms would first increase and then flatten out or decrease with firm size. This framework is bounded in the rationality that although larger firm innovate more and therefore should grow more rapidly, their perceived market power puts a strain on their desired investment. Intensive expansion policies in large firms will result in falling prices, keeping them from being aggressive investors. Consequently we will experience a lower growth rate for large firms relative to small firms.

It seems that there are some disagreements concerning the relationship between firm growth and firm size. Not only whether there is a relationship, but also whether it is a linear, convex, skewed or a normally distributed relationship. This gives in itself an

[1] Keep in mind that smaller firms generally also are more vulnerable indicating a higher rate of exit.

[2] One factor that may be important in these findings are the structure of the economy at these specific points in time. In the sixties the western economies, and especially United States, experienced a general tendency toward higher concentration rates in the industries, while the picture was somewhat reversed in the eighties. This pattern may have had a significant effect on the results of the study by Dunne & Hughes.

incentive to investigate this causality.

2.2 Age

By sorting the firms into intervals related to their age, Evans (1987a, 1987b) showed that firm age is an important factor when explaining the firm growth.[3] Firm growth seems to decrease with age. Similar results were given by Dunne & Hughes (1994). They concluded that young firms grew more rapidly when analysing a specific size class of firms.[4]

The ability of young firms to grow faster have puzzled economists for some years. A contribution by Jovanovic (1982) stresses that the negative relationship must be linked to the learning of firms. The life cycle pattern of the firm determines to which extent it will be able to grow. Jovanovic's model includes a selection mechanism. The decision of firms concerns the level of output determined with respect to maximisation of expected level of profits. All firms are assumed to be small and unable to effect prices, and therefore the expectations of the firms are concerning the level of total costs. As the expected total costs increase the level of output decreases and vice versa. When the firm gets older the variance of the firm expectations on total cost becomes smaller. You may say that the firm learns to give more precise predictions about their level of cost as time goes by. Firms with higher expected costs has a lower chance of staying in business. Therefore a huge part of the young firms leave the market, and the remaining young firms get a higher level of profit on average when the firm size is left out of the equation.

In short you may say that maturity adds to the stability of firm growth rates, because firms learn more about their cost structure and efficiency level. This tends to stabilise the investment plans in mature firms due to fewer surprises in earnings. At the end of the day when exits are left out of the equation, young firms may have a higher growth rate on average.

2.3 Geographical Location

Theoretically it has been argued that there is a strong relation between firm localisation and growth. Lower production costs is traditionally used as the main argument for increased growth rate in a specific geographical location. The best place for a firm to be located, is the region with access to the cheapest production factors and the largest market for the firm's final goods, at the lowest transportation costs. Clearly in

[3]The firms aged less than seven years are given their own age respectively. Otherwise the firms are put into the intervals 7-20 years old, 21-45 years old, 46-95 years old and firms older than 96 years.

[4]Again it must be emphasised, that young firms to a certain degree are more unstable resulting in a lower survival rate.

this type of framework there would be a concentration of firms near the metropolitan regions. These regions are not necessarily those with the largest populations, but the regions where the firms gain the best access to the highest demand for its final good (Krugman 1991b).

In addition a firm would get an advantage by being located in regions which already have a large production of similar products. The advantage is to be close to specialised suppliers and potential customers. This concentration is self-reinforcing, since firms choose to produce in regions with good access to large markets. But access to markets tend to be good in regions in which many firms chose to produce (Krugman 1991a, Krugman 1998). From this point of view firms located in regions with many producers and easy access to large markets will be more likely to experience high growth than firms located elsewhere.

However, factor prices and access to markets and production are no longer the main parameters in this theoretical area (Porter 1990). Two additional interconnected concepts should be considered, when examining firm growth and geography. First, the growth of a firm is highly influenced by the capabilities and institutional set-up of the local environment. This mechanism is driven by the need for firms to access tacit knowledge, which cannot be acquired from the market. In order to acquire this type of knowledge firms have to engage in interactive learning process' (Maskell et al. 1998). For this reason a firms choice of location is determined by the local capabilities and institutional set-up of the regions in question and not only by factor prices and market size (Porter 1990).

Second, new innovative firms, which often experience the highest growth rates, tend to emerge in the geographical proximity of firms of the same kind forming a concentration of these firms in single regions (Maskell et al. 1998). This will contribute to local capabilities, when the new innovative firms produce new competencies. Such local capabilities will especially be valuable for these types of firms. Krugman (1991b) adds to this by saying that concentration will form a pooled market for qualified and specialised labour, indicating that these firms will perform better than similar firms in other regions.

Above we see a number of reasons why we should include some kind of geographical specialisation index. One possibility of measurement is the revised Balassa index[5], which shows in which industry a specific region is specialised. The formal measure is calculated by using equation 1. The measure is referred to as the Revealed Comparative Advantage

[5]The original index was first introduced by Balassa (1965). It was used to measure a country's international trade specialisation in specific industries. The index was called the Revealed Comparative Advantage (RCA).

index (RCA).

$$RCA = \frac{\frac{Employment_{ri}}{Employment_r}}{\frac{Employment_i}{Employment}} \quad (1)$$

The subscripts i and r refer to the specific industry and the specific region respectively. The numerator of the RCA indicates to which degree the specific industry is a major participant of the specific region. The denominator measures how large the same industry is compared to the entire economy. All in all RCA measures to what extent the specific region is relatively more or less specialised in a specific industry than the entire economy (more specialised than the weighted average region in the specified industry). So we emphasise the argument of local capabilities.

We would like to suggest that instead of looking at the relationship between regional specialisation and its implication for firm growth, we should focus on the change in specialisation in a region and its effect on the growth of the firms located in this area. We think it is more plausible that firms gains more from being located in a region that are evolving toward becoming more in the specific industry in question rather than being located in a region that historically has build up a specialisation in the same industry. It seems more relevant to be located in a somewhat dynamic region, which is booming in the specific industry, rather than a region in which the industry has matured and are rather static or perhaps even declining. Therefore we will use the growth rate of the specialisation index as a explanatory variable. We will refer to this as Regional Specialisation Growth (RSG).

2.4 Market Structure

There may be a trade-off between short run allocative gains from increased price competition in a specific market and the long run welfare gains from a higher rate of innovation often related to a more concentrated market structure (OECD 1996). As a consequence market structure must be included when analysing firm growth. The composition of firms in a specific market may have some effects on the performance of the firms in this market (Hart and Prais 1956).

$$MCI = \frac{1}{N}\sum_{i=1}^{n}\left(\log\frac{E_i}{E}\right)^2 - \frac{1}{N^2}\left(\sum_{i=1}^{n}\log\frac{E_i}{E}\right)^2 \quad (2)$$

Equation 2 is known as the Hart & Prais concentration index or as the variance of the logarithms of firm size. E refers to the number of employees in the industry. E_i is a vector that refers to the number of employees in each of the n firms in the specific

industry.[6] The measure gives an estimation of how the firms varies in size in each industry. If there is one single large and a few small firms the index would become fairly high. If all the firms has the same size the index will be zero.

The measure has a disadvantage. In the case of a perfect monopoly the index will be zero. We would on the contrary want a high index when referring to a monopoly. Nevertheless we have chosen to use this index. Besides being a measure of market concentration we believe it brings yet another perspective into account. The index is a combination of concentration and competition. Although theory implies that a monopoly invests in technological change, we believe its effort will become higher if the market structure changes from being a monopoly with a possible entry to a situation in which the entry has taken place. This way of interpreting the concentration/innovation index will loosen up the problem of measurement in the case of perfect monopoly.

This leads us to formulate our expectations concerning the market concentration index. A higher market concentration will stimulate the general technological change in the industry (Geroski 1994). Thinking back to the writings of Schumpeter it is easy to acknowledge this theory. Schumpeter's MARK II theory suggest that industries with a high concentration level also would be more inclined to bring about a higher level of innovative activity. The reason being that firms in these industries would be more likely to have the funding needed to engage in formal R&D projects. These additional fundings stem from a higher profit margin. The higher technological change will lead to a high growth of the industry. Therefore we expect concentration of the market to have a positive effect on the growth of firms in the specific industry.

Another way to explain a positive correlation between market concentration and firm growth is by referring to a coordination problem in a market with a handful of firm with equal market power. This would give an uncertainty concerning the future state of the industry and therefore the firms would probably be more reserved in their growth ambitions and hence their investments.

2.5 Industrial Distribution

To a large degree industrial differences have a significant effect on the economic performance. Even though Geroski (2000) points to the stylised facts concerning the idiosyncratic nature of firm growth rates, e.g. that firm growth rate patterns are independent of the general state of the industry to which the single firm is associated, we nevertheless include a industry dummy in the analysis.

The technological foundation of the firms differ between industries and there are

[6] In the original context the index were calculated using sales as the independent variable - not the employment.

large differences in how technological change effect the industries (Salter 1969). This may have an important effect on the individual firm growth. If not directly then through productivity improvement.

Pavitt (1984) acknowledged the differences in technological change between industries. He constructed a taxonomy that describes the patterns of technological development in various industries. His taxonomy divides the manufacturing industry up into four groups, i.e. Supplier Dominated, Scale Intensive, Specialised Suppliers and Science Based. We expect to find a significant relationship between firm growth and the specific industrial distribution.

Considering the size of the Service industry in Denmark we have also chosen to disaggregate this industry to four different groups. Following Laursen & Foss (2000) and Laursen & Mahnke (2000) we have divided Services into Wholesale Trade, Specialised Services, Scale Intensive Services and ICT Intensive Services.[7]

We also use the industry variable as a control variable. This will give an indication of whether or not there are significant differences between the industries. We would expect specifically Scale Intensive firms to have a significant correlation between the dependent variable and firm size. Laursen and Christensen (1996) points out there are some important relations between the science based firms and the university environment. The RSG does not give us the full effect of the Universities. This is yet another reason why we are inclined to distinguish between industries

3 Building a Model

We here built a model, which can be tested on empirical data. It is important to realise that the relationships between firm growth and firms size, on the one hand, and firm age, on the other, often has been proved to be non-linear. In fact mostly it is argued that the relationship is a decreasing convex function. Said in another way the growth rate of the firm decreases at a diminishing rate as the firm becomes larger or older. Therefore we model them as log-linear relations. The model has the following structure:

$$FirmGrowth = F(\log(Size), \log(Age), RSG, MCI, Sec^i) \tag{3}$$

Where $\log(Size)$, $\log(Age)$, RSG and MCI refer to the logarithm of firm size, logarithm of firm age, growth of the regional specialisation and market concentration. Sec^i is a vector referring to industry dummies.

[7] We do not distinguish the Construction industries as a Service industry. In the papers cited Construction industry is called Crafts and viewed as a Services based industry

We apply two measures as dependent variables. Both Turnovers and Employment are analysed. In the case of employees the formal calculations of the firm growth rates are:

$$AAG(Emp) = \frac{\log(\frac{employment_t}{employment_{t-n}})}{n} \quad (4)$$

Where $AAG(Emp)$ is the Average Annual Growth rate measured by employment and n is the number of years the analysis covers. We will use $AAG(Tur)$ to refer to the Average Annual Growth rate measured using turnovers.

Indicators of the independent variables are straight-forward. As the size variable we have chosen the number of employees in the first year. This might give some problems as it is a discrete variable. Especially concerning smaller firms.[8] Firm age has been measured as the present year less the year of establishment. Firms that was established before 1975 have been assigned the value 25.[9] RSG and MCI are calculated using equations 1[10] and 2 respectively. In the case of RSG the industry aggregation applied in the analysis is used[11], while a rather disaggregated level of about 600 industries are used when calculating the MCI.

Some of the variables may change their signs from one industry to another, e.g. the importance of a geographical localisation may vary between industries, as it may be an advantage for the firms in some industries to be located in areas with less industry population and not in a area of high activity, as a positive sign would suggest. Also the significance of the variables may differ between industries, as some variables are not equally important for the explanation of growth in all industries.

4 Data Structure

The database used is the NewBiz database from Dansk Markeds Information A/S. It covers all Danish limited liability companies, partnerships and limited partnerships. NewBiz contains for instance name, addresses, number of employees, industry, various economic data and the year of birth. The economic data available from 1993 to 1997

[8] The number of employees does not refer to full time equivalents. These are not reported in the database. This might give a biased result when considering the the lack of distinction between part-time and full-time workers.

[9] This has been necessary due to some problems with the data coverage. Many of the firms established before 1975 are not represented by a specific year of establishment. Often the phrase 'before 1975' appears in the dataset.

[10] Once again it should be noted that equation 1 is the calculations of the absolute values. We will use the growth rates of the RCA (RSG).

[11] The rather high level of aggregation is needed to avoid the increase in either of the variables to be due to the single firm in the specific region and hence cause a 100% fitin the specifc case

are updated quarterly. Weighting the importance of number of years and the number of observations available we only use the years 1994–1996.

It should be noted that the period under investigation is characterised as a boom period in Denmark. This may influence the general level of the growth rates, but surely also the dispersion. Therefore the pattern found in this paper may be highly dependent on the years of investigation. Surely the level effect will not have an effect on the significance of the regressions. But the, hopefully lesser, dispersion effect may prove to have a considerable effect. Our greatest concern is the fact that the general selection mechanism of the market will not be as strong during a boom. Consequently we may include observations in the analysis that under lesser fortunate circumstances would have exited the marked. At the moment we merely acknowledge the fact that pro-cyclical movements may have a significant effect on the results, but not directly take it into account in the analysis.

We have had to leave out some of the observations. The reduction of the number of observations is mainly due to lack of information on some of the chosen variables. There are considerable number of firms in the database for which there are no information on the number of employees, data on turnovers, industry or year of establishment and which we have been forced to leave out of the analysis. Other observations have been left out due to extraordinary growth performance. A limited number of observations has been left out due to their categorisation as outliers.[12] As a result we end up with 8739 observations.

Considering first the growth rates in terms of turnovers($AAG(Tur)$), table 1 shows that the firms on average grows at a 5% rate in the period of investigation. With a standard deviation on 0.21 we acknowledge the fact that some firms are witnessing a decline in turnovers during the years of investigation. This conclusion is strengthened by the fact that the distribution of the growth rates on the surface seems to be close to normal.[13] The very same may be said when looking at the growth rates measured using employment data ($AAG(EMP)$). An interesting distinction between the two different measures of annual average growth rates is found by studying the mean and the standard deviation of the two. The annual average growth rate is only 2% on the mean when looking at employment data. Also the standard deviation is a bit smaller at 0.17. Being a bit bold in respect to concluding from this single result one may wonder

[12] The criteria concerning which observations that may be categorised as outliers are at a growth rate higher than 100% or lower than -100% yearly.

[13] A left skewness in the distribution of growth rates could have indicated no firms had negative growth rates. However the coefficient of skewness reveals that the distribution of growth rates is nearly 50% on each side of the mean. Hence there are a considerable number of firms that has a negative growth even though the Danish economy is experiencing a boom in the period.

Table 1: Structure of Variables of interest (n=8739)

	AAG(Tur)	AAG(Emp)	Size	Age	RSG
Min.	-0.98	-0.99	1.00	4.00	-0.16
Med.	0.04	0.00	6.00	17.00	0.06
Max	0.98	0.97	11787.00	25.00	0.44
Mean	0.05	0.02	52.78	17.09	0.08
Std. Dev.	0.21	0.17	293.15	6.48	0.08
Skewness	-0.10	-0.13	22.89	-0.03	0.79
Kurtosis	3.88	5.77	707.60	-1.51	3.27

Source: NewBiz Database, Version 98,4 – Plus X

if this might be a sign of a higher rigidity on the labor market than on the commodity market. We may also contribute the divergence between growth in turnover and growth in employment as an increase in productivity. A relatively high productivity increase in one industry may result in a relatively higher level of growth in terms of turnover while leaving the relative growth rate in term of employment unaltered. But the difference between the two may be attributed to price movements as well. Increases in the relative price levels has a positive effect on relative turnover growth rates while the employment growth rates may be left unchanged.

The mean values indicate that the average size of the firms are approximately 53 employees and the average age of the firms is about 17 years.[14] From the skewness measure one may conclude that the distribution of firms with respect to size is right skewed. Also the high Kurtosis value indicate that the number of observations is centred around a specific size, resulting in a somewhat 'peaked' distribution. Finally one may conclude from the positive mean RSG, that the Danish regions on average have become more specialised.

Table 2 depict a detailed picture of the distribution of firms across industries and regions. Starting with industry distribution we note that a considerable share of the firms are service firms, 57%. The manufacturing industry counts for about 23%. Manufacturing is distributed between the four Pavitt industries. The largest of these are the scale intensive industry with just about 47% of the manufacturing firms. But looking at the annual average growth rate in terms of either turnovers or employment the Science Based industry has by far the highest growth rate at 6.9% and 5.3% respectively. Notably this is even the highest when taking non-manufacturing industries into considerations.

Between the four service industries, Specialised services is the largest with about 20%

[14]Keeping in mind that when firm are older than 25 years, the age variable is set to 25. This causes the calculated average age of the firms to be smaller than the actual average age.

of the total number of observations. Looking at the annual average growth rates it is interesting to see that the four service industries position themselves at different relative level depending on the variable used in the calculations. While it is the Scale Intensive services that has the lowest annual average growth rate in terms of turnovers, it is the ICT Intensive Services in terms of employment. One may attribute the latter of these results to be due to a mismatch on the labor market, a difference in the development in productivity or a divergence in the price changes between the industries. In the case of ICT Intensive Services it is worth noticing that especially these industries has exprienced a productivity increase[15] which may explain the bad growth pattern in terms of employment.

We have chosen not to disaggregate Construction and Primary industry as we have done with Manufacturing and Services. Especially the Primary industry is too small for such a disaggregation with 261 observations, which is only 3% of the total number of firms. The Construction industry holds 17% of the total observations. The Construction industry also distinguish itself as a relative high growth industry.

The growth rates varies from firm to firm. Not only across industries but also inter-industrial. Especially the Primary and the Service industries seem to have a high dispersion of growth rates across firms. Even though the Scale Intensive industry is one of the largest, it is still one of the industries with the smallest level of dispersion of growth rates. Only the Supplier Dominated industry have a distribution of growth rates with a lower level of standard deviation in terms of turnovers. In terms of employment it is only the Supplier Dominated and the Specialised Suppliers that has a lower level of dispersion.

By multiplying the growth rates with the relative number of employees in the industries we get an estimate of how much each industry has contributed to the general growth. The two columns marked Cont. in table 2 shows the estimates. Due to large number of firms in the Service industry it is primarily this industry that has contributed to the general growth. About 2.5% of the 5% in terms of turnovers is contributed to the Service industry while 1.1% of the 2.5% in terms of employment may be attributed to the Service industry. Otherwise it is the Construction industry and the Scale Intensive firms that contribute the most. A high contribution level does not necessary mean it is a large industry relatively speaking. The Supplier Dominated industry is far from the smallest industry. But the contribution from this industry is rather weak. Especially when considering employment growth.

[15]For an analysis of the ICT Intensive Services of Denmark, see Dahl and Dalum (2001).

Table 2: Industrial and geographical Distribution of the Firms (n=8739)

	No. of Obs.	Share	Industry Share	AAG(Tur)	Std.Dev.	Cont.	AAG(Emp)	Std.Dev.	Cont.
Industries									
All Firms	8739	100	-	0.0503	0.2087	-	0.0248	0.1714	-
Primary Industry	261	3.0	100.0	0.0497	0.2141	0.0015	0.0248	0.1772	0.0007
Manufacturing	2012	23.0	100.0	0.0542	0.1813	0.0125	0.0307	0.1554	0.0071
Supplier Dominated	449	5.1	22.3	0.0405	0.1645	0.0021	0.0179	0.1516	0.0009
Scale Intensive	950	10.9	47.2	0.0551	0.1755	0.0060	0.0281	0.1524	0.0031
Specialised Suppliers	272	3.1	13.5	0.0555	0.1796	0.0017	0.0330	0.1468	0.0010
Science Based	341	3.9	16.9	0.0689	0.2159	0.0027	0.0530	0.1727	0.0021
Construction	1488	17.0	100.0	0.0634	0.1914	0.0108	0.0316	0.1839	0.0054
Services	4978	57.0	100.0	0.0449	0.2230	0.0256	0.0204	0.1733	0.0116
Wholesale Trade	1297	14.8	26.1	0.0471	0.2200	0.0070	0.0220	0.1606	0.0033
Specialised Services	1760	20.1	35.4	0.0462	0.1908	0.0093	0.0207	0.1649	0.0042
Scale Intensive Services	352	4.0	7.1	0.0245	0.2259	0.0010	0.0217	0.1950	0.0009
ICT Intensive Services	1569	18.0	31.5	0.0461	0.2559	0.0083	0.0183	0.1870	0.0033
Regions									
All Regions	8739	100	-	0.0503	0.2087	-	0.0248	0.1714	-
Copenhagen Area	3041	34.8	-	0.0501	0.2188	0.0174	0.0213	0.1812	0.0074
Frederiksborg County	854	9.8	-	0.0579	0.2132	0.0057	0.0234	0.1800	0.0023
Roskilde County	410	4.7	-	0.0447	0.2123	0.0021	0.0190	0.1560	0.0009
Western Sealand	398	4.6	-	0.0532	0.1901	0.0024	0.0217	0.1757	0.0010
Storstrom County	255	2.9	-	0.0577	0.1999	0.0017	0.0251	0.1740	0.0007
Bornholm County	38	0.4	-	0.0319	0.1377	0.0001	0.0004	0.1121	0.0000
Fyn County	647	7.4	-	0.0502	0.1795	0.0037	0.0259	0.1678	0.0019
Southern Jutland	379	4.3	-	0.0585	0.2133	0.0025	0.0345	0.1547	0.0015
Ribe County	251	2.9	-	0.0504	0.2122	0.0015	0.0256	0.1772	0.0007
Vejle County	543	6.2	-	0.0400	0.1940	0.0025	0.0378	0.1582	0.0023
Ringkobing County	323	3.7	-	0.0536	0.2026	0.0020	0.0241	0.1599	0.0009
Aarhus County	822	9.4	-	0.0549	0.1931	0.0052	0.0276	0.1648	0.0026
Viborg County	248	2.8	-	0.0421	0.1795	0.0012	0.0181	0.1608	0.0005
North Jutland	530	6.1	-	0.0390	0.2192	0.0024	0.0325	0.1574	0.0020

Source: NewBiz Database Version 98,4 – Plus X

Geographically we have divided the firms into the Danish counties. There are 16 counties in Denmark. The Copenhagen Area, which normally consists of 3 counties, has been aggregated to one. The number of geographical areas is therefore 14. This will give us 140 different values in the RSG variable.[16]

The very first thing we should notice in the numbers are the concentration of firms in the Copenhagen region. Nearly 35% of the firms are locate din this area. Surely this may be seen from the contribution columns. The Copenhagen area significantly contributes a lot more in a growth perspective than the other regions. From the region part of table 2 it should also be noted that the growth performance of regions differs depending on the measure we apply. Considering North Jutland the growth rate in terms of turnovers is relatively low, while the growth rate in terms of employment is rather high. This perspective is graphically displayed in figure 1 and 2.[17] The figures show a graphical illustration of the annual average growth rates of the country in terms of turnovers (figure 1) and in terms of employment (figure 2). The illustration reveals that the very same pattern exists for Vejle County in the middle of Jutland. In terms of turnover the county is doing rather badly, while in terms of employment its growth performance is relatively good.

One region represent the out-lier in one end of the scale. Bornholm County, which is the small white island in the top of figure 1 and 2, is inhabited by firms that on average has an extremely low growth rate. In terms of employment Bornholm exhibits an annual average growth rate at 0.04%. In terms of turnover it is also doing rather bad. The annual average growth rate is at about 3%, the lowest level of all the counties. Viborg County also exhibit a rather bad growth pattern in terms of both employment and turnovers.

Looking at the other end of the scale it depends on the measure we use in the calculations which county that seems to have the highest growth performance. In terms of employment Northern Jutland, Vejle County and Southern Jutland seems do do rather well as may be seen from figure 1 and 2. The same figures reveals that in terms of turnovers it is Frederiksborg County, Storstrom County, Aarhus County and still Southern Jutland that has the highest growth level on average.

The high growth performance of North Jutland in terms of employment may be attributed to a high unemployment rate. The unemployment rate has been fairly high in this region relative to others. With a higher rate of unemployment the firms might find it easier to get the qualified workers that fits their wants and needs. But Storstrom and

[16] We have 10 different industries and 14 different regions. This causes equation 1 to calculate 140 different combinations for 1994 and 1996. This gives 140 different Regional Specialisation Growth rates

[17] An explanatory version of figure 1 and 2 may bee seen in Appendix A, figure A-1.

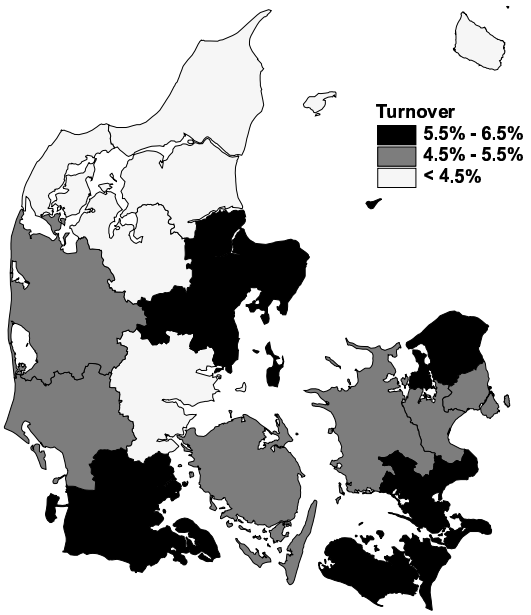

Figure 1: Graphical Illustration of the Danish Counties and their Annual Average Growth Rates in terms of Turnover

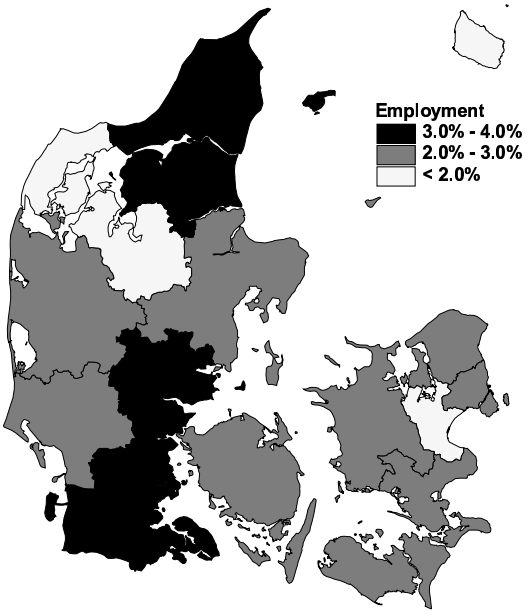

Figure 2: Graphical Illustration of the Danish Counties and their Annual Average Growth Rates in terms of Employment

Bornholm Counties has had similar high levels of unemployment. This would indicate that the unemployment explanation for regional high average firm growth is rather far-fetched.

Due to the large amount of firms in the Copenhagen Area the contribution to the overall growth of employment is fairly high. Approximately 1.7% of the 5% growth of turnovers and about 0.7% of the 2.5% growth in employment may be attributed to this area. Even though Aarhus County has a larger number of firms, North Jutland and Vejle County almost has a contribution rate that matches Aarhus County in terms of employment growth. North Jutland has a contribution rate at 0.20%, Vejle County has one at 0.23% and Aarhus County 0.26%.

Considering the relative small differences in the standard deviation, you would expect it would be a good idea to relocate to an area with a higher growth potential. Only you have to take into account that the relocation of firms from one region to another would change the level of competition in the specific industry and region. Theoretically (Schumpeter MARK II) one would expect that this would cause the average growth rate to decline in that region due to the decline in the concentration index. The results of the regressions would give some idea whether or not this also holds in practise.

5 Testing the Model

In order to regress the model of equation 3 we have to use a semi-log linear functional form. The transformed model is as follows:

$$AAG = \alpha_1 Log(Size) + \alpha_2 Log(Age) + \alpha_3 RSG + \alpha_4 MCI + \alpha_5 Sec^i + \varepsilon \qquad (5)$$

If α_1 is negative the firm growth (AAG) is a convex decreasing function of firm size. If α_1 has a value between zero and one the firm growth increases with a decreasing rate as firm size increases. Finally, if α_1 is greater than one the firm growth will increase at an increasing rate as firm size becomes larger. The very same may be said concerning the relation between firm growth and firm age and the level of the estimated α_2. When taking the theoretical and empirical evidence into account we would expect α_1 and α_2 to be negative.

The results of the regressions are shown in table 3. The first two columns are regressions on all 8739 observations using equation 5. The two columns refers to the regressions using turnovers and employment as a growth measure respectively. From the table it can be established that the significance of the variables are rather high in general. Especially when using employment growth as the dependent variable. All in all it should be noted that the sign of the estimated coefficients correspond to our

expectations. Only the $\log(Size)$ variable in the regression using turnover growth as the dependent variable gives a somewhat surprising significant positive estimate between 0 and 1. This indicate that the relationship is concave increasing. Looking at the α_1 estimates in the $AAG(Emp)$ regressions we acknowledge that he estimates are rather close to zero. This would indicate that Geroski's stylised facts concerning mean reversion exists in the case of Danish industries. All the dummies seems to be highly significant. We have chosen to interpret this as an indication of differences between industries. The estimates are to some degree rather different from each other.

However, we are concerned about the general high level of significance of the estimates. A White test reveals that the model is suffering from heteroscedasticity.[18] As a remedy for heteroscedasticity we have chosen to redefine some of the variables. An analysis of the $\log(Size)$ variable shows that it has a different effect on firm growth depending on the industry in question. The standard error of the variable differs greatly between the industries. By multiplying the size variable with the industry dummies we get different coefficients attached to the size variable for each industry. Also we have included an intercept to the function. The regression results of the revised model are presented in column 3 and 4 in table 3.

First it should be noted that the heteroscedasticity more or less has vanished. Consequently the level of significance of the included explanatory variables has decreased. Some interesting features still does submerge though. The $\log(Age)$ variable is still significant correlated negatively with both dependent growth variables indicating that young surviving firms tends to have a higher growth rate than older established firms. It would seem Jovanovic's proposed theoretical perspectives on learning to read its cost structure as well as the market has some justification.

Also it should be noted that the regional variable seems to have some significant role in explaining firm growth. It seems that it is an advantage to be located in a region that are increasing its specialisation in the specific industry. A firm should be located in a region in which other firms in the same industry are moving toward or at least are expanding. The level of significance seems to be slightly higher in the employment growth regressions though. The employment growth regressions also reveals that it is an advantage to be in an industry with a high concentration rather than in one with a low. The turnover regression does not support this though. The $\log(Size) * industry$ variables show less significant results giving some support to Gibrat's Law. It is worth

[18] The heteroscedasticity is more severe in the regression using employment as a growth variable. But the problem surely also exists in the turnover growth regression as well. This problem causes the ordinary least square method (OLS) to underestimate the variances of the coefficients. This in turn effects the t-statistics positively. The consequence may be to accept a variable as significant, even though it isn't.

noticing though, that the significant estimates in the employment growth regressions all correspond to our expectations of a negative correlation. The negative estimates are rather small which would suggest Geroski's theory about mean reversion holds in some industries. Still the turnover growth regressions shows the puzzling positive relationship in those that are significant.

The last four columns in table 3 refers to the same regressions as the first four only with the alteration of the number of observations. In these we have excluded the observations of firms that in 1994 had less than 10 employees. The number of observations consequently falls to 3512.

In general the results of these regressions confirms the ones from the first four columns. Only the standard deviation of some of the variables has dropped causing the estimates to be less significant. Doing the regressions on the original model still exhibits some heteroscedasticity. So the last two columns are the most relevant in this respect.

Especially the $\log(Age)$ variable has lost its significance. Now the estimates aren't significant at all. This might suggest that there were a correlation between firm age and firm size. But a correlation analysis reveals that the correlation between the explanatory variables are rather weak.[19] Yet it may be the consequence of deleting the young firms when deleting the firms with less than 10 employees, causing the variance of the variable to drop considerably.

In respect to the other variables the significance concerning RSG and MCI is still very strong and positive. The $\log(size)*industry$ variable exhibits rather mixed results. The turnover growth regression has no significance left at all. But the employment growth regression still have some significant negative estimates. The Primary Industry, the Supplier Dominated Industry, the Construction Industry and the Scale Intensive Services all exhibits the negative convex relationship between firm growth and firm size. Still we may put our faith in the mean reversion explanation and the Gibrat's Law depending on the industry in question.

[19] Analysing the matrix of variance and covariance, the matrix of correlation of the estimated coefficients and the Variance Inflation Factor (VIF), we are able to rule out problems with correlation and multicollinearity.

Table 3: Regression Results of the Firm Growth Regression Model

Dependent Variable	AAG(Tur)	AAG(Emp)	AAG(Tur)	AAG(Emp)	AAG(Tur)	AAG(Emp)	AAG(Tur)	AAG(Emp)
log(*Size*)	⋆⋆⋆ 0.0040	⋆⋆-0.0031	-	-	-0.0024	⋆-0.0038	-	-
log(*Age*)	⋆⋆⋆-0.0310	⋆⋆⋆-0.0302	⋆⋆⋆-0.0305	⋆⋆⋆-0.0302	⋆-0.0128	-0.0042	-0.0123	-0.0038
RSG	⋆ 0.0571	⋆⋆⋆ 0.0947	⋆⋆ 0.0630	⋆⋆⋆ 0.0957	⋆⋆⋆ 0.1114	⋆⋆⋆ 0.1903	⋆⋆⋆ 0.1140	⋆⋆⋆ 0.1916
MCI	0.0017	⋆⋆⋆ 0.0051	0.0008	⋆⋆⋆ 0.0055	⋆⋆ 0.0068	⋆⋆ 0.0049	⋆⋆ 0.0068	⋆⋆ 0.0052
Primary Industry	⋆⋆⋆ 0.1239	⋆⋆⋆ 0.1034	-	-	⋆⋆ 0.0602	0.0035	-	-
Supplier Dominated	⋆⋆⋆ 0.1076	⋆⋆⋆ 0.0987	-	-	⋆⋆⋆ 0.0720	0.0190	-	-
Scale Intensive	⋆⋆⋆ 0.1248	⋆⋆⋆ 0.1034	-	-	⋆⋆⋆ 0.0887	⋆⋆ 0.0402	-	-
Specialised Suppliers	⋆⋆⋆ 0.1230	⋆⋆⋆ 0.1110	-	-	⋆⋆⋆ 0.0847	⋆ 0.0384	-	-
Science Based	⋆⋆⋆ 0.1317	⋆⋆⋆ 0.1228	-	-	⋆⋆⋆ 0.1009	⋆⋆ 0.0433	-	-
Construction	⋆⋆⋆ 0.1322	⋆⋆⋆ 0.1030	-	-	⋆⋆⋆ 0.0809	0.0180	-	-
Whole sale Trade	⋆⋆⋆ 0.1186	⋆⋆⋆ 0.0971	-	-	⋆⋆⋆ 0.0808	⋆⋆ 0.0336	-	-
Specialised Services	⋆⋆⋆ 0.1176	⋆⋆⋆ 0.0942	-	-	⋆⋆⋆ 0.0721	0.0240	-	-
Scale Intensive Services	⋆⋆⋆ 0.0901	⋆⋆⋆ 0.0913	-	-	⋆⋆ 0.0604	0.0170	-	-
ICT Intensive Services	⋆⋆⋆ 0.1150	⋆⋆⋆ 0.0890	-	-	⋆⋆⋆ 0.0879	⋆ 0.0328	-	-
Primary ∗ log(*Size*)	-	-	0.0044	⋆⋆-0.0098	-	-	-0.0044	⋆-0.0085
Supplier ∗ log(*Size*)	-	-	0.0015	⋆-0.0037	-	-	-0.0038	⋆⋆-0.0055
Scale ∗ log(*Size*)	-	-	⋆⋆ 0.0047	0.0004	-	-	-0.0015	-0.0014
Specialised ∗ log(*Size*)	-	-	0.0045	0.0006	-	-	-0.0016	-0.0018
Science ∗ log(*Size*)	-	-	⋆⋆ 0.0082	0.0023	-	-	0.0017	-0.0010
Construction ∗ log(*Size*)	-	-	⋆ 0.0052	⋆⋆-0.0045	-	-	-0.0020	⋆-0.0058
Whole sale Trade ∗ log(*Size*)	-	-	0.0040	-0.0020	-	-	-0.0025	-0.0026
Specialised Services ∗ log(*Size*)	-	-	0.0022	-0.0035	-	-	-0.0036	-0.0039
Scale Intensive Services ∗ log(*Size*)	-	-	-0.0006	⋆-0.0052	-	-	-0.0049	⋆-0.0062
ICT Intensive Services ∗ log(*Size*)	-	-	0.0044	⋆⋆-0.0044	-	-	0.0007	-0.0016
Intercept	-	-	⋆⋆⋆ 0.1196	⋆⋆⋆ 0.0969	-	-	⋆⋆⋆ 0.0777	0.0250
Number of Observations	8739	8739	8739	8739	3512	3512	3512	3512
R^2	0.0611	0.0314	0.0052	0.0108	0.0992	0.0486	0.0071	0.0159
$Adj.R^2$	0.0596	0.0298	0.0037	0.0093	0.0956	0.0448	0.0034	0.0122

Source: NewBiz Database, Version 98,4 – Plus X

Note: The Stars indicate to which degree the estimate is significant. ⋆⋆⋆: Significant at a 1% level. ⋆⋆: Significant at a 5% level. ⋆ significant at a 10% level.

Note: The difference between the first four regressions and the last is the number of observations. In the last our regressions firm with less than 10 employees are left out.

All in all we are able to confirm the foundation of the variables. Considering the R^2-values together with the significant estimations of specific variables we may conclude that the stylised facts summarised in the introduction should be reviewed. The firm growth process cannot be categorised as a pure stochastic process. We are able to explain up to 9% of the total variation. It should be noted that the highest R^2 values are in those obtained in the regressions with heteroscedasticity. Hence the foundation of this conclusion may be a bit rugged. But one might argue that what we have found are the industry specific patterns and not firm specific ones. Consequently we have made the regressions on all the industries separately as well.

Table 4 and table 5 summarises the results of the regressions on industry level. While table 4 refers to the regressions on all firms in the dataset, table 5 refers to regressions done on firms with more than 10 employees in 1994. The upper half of the tables refers to the regression in which turnover growth is the dependent variable while the lower half refers to the case where employment growth is the dependent variable.

With respect to the $\log(Size)$ variable, table 4 shows a somewhat more blurry picture. A rather limited number of the estimates are significant. Only the Construction industry show the expected negative significant estimate in both regressions. In the employment growth regression the Primary industries and the Supplier Dominated Industry also has the expected results. But they are not supported by the turnover growth regression. Here three of the Service Industries rather surprisingly have positive significant estimates. That the Science Based, Specialised Suppliers and Scale Intensive firms do not exhibit the expected negative estimates could be explained by the growth ambitions of these type of firms. In order to be able to compete in these industries, that for some are characterised by high technical change, the firms have to get employees no matter the size of the firm. The firms that are categorised as Specialised Suppliers or Science Based has to compete on knowledge. Knowledge is to some extent embedded in employees. In order to reach their goals they have to employ highly qualified labour and improve their skills. The apparent negative relationship between firm size and firm growth seems to be less obvious in high technology industries. With respect to the Scale Intensive industry one would be inclined to highlight the fact that economies of scale plays an important role in their competitiveness.

Table 4: Industry wise Regression Results (All Firms)

	Intercept	log(*Size*)	log(*Age*)	RSG	MCI	R^2	*Adj.*R^2	N
Dependent Variable=AAG(Tur)								
Primary Industry	⋆⋆ 0.2221	0.0050	⋆-0.0596	0.1848	-0.0085	0.0243	0.0090	261
Manufacturing								
Supplier Dominated	⋆ 0.0926	0.0057	-0.0254	0.0583	-0.0022	0.0078	-0.0011	449
Scale Intensive	⋆⋆ 0.1075	0.0015	⋆-0.0253	0.1026	0.0045	0.0044	0.0002	950
Specialised Suppliers	-0.0234	-0.0007	0.0232	0.0031	0.0065	0.0060	-0.0088	272
Science Based	0.0522	0.0070	-0.0138	⋆⋆ 0.2545	0.0010	0.0194	0.0077	341
Construction	⋆⋆⋆ 0.1051	⋆⋆-0.0086	⋆-0.0226	0.1280	⋆⋆ 0.0160	0.0097	0.0070	1488
Services								
Wholesale Trade	⋆⋆⋆ 0.1821	⋆ 0.0077	⋆⋆⋆-0.0428	0.0099	⋆-0.0153	0.0091	0.0060	1297
Specialised Services	⋆⋆⋆ 0.1267	0.0035	⋆⋆-0.0262	-0.0352	-0.0080	0.0048	0.0025	1760
Scale Intensive Services	-0.0039	⋆ 0.0112	-0.0181	0.2824	0.0094	0.0315	0.0204	352
ICT Intensive Services	⋆⋆⋆ 0.1425	⋆ 0.0083	⋆⋆⋆-0.0528	0.0489	⋆ 0.0157	0.0104	0.0079	1569
Dependent Variable=AAG(Emp)								
Primary Industry	0.1094	⋆⋆⋆-0.0221	-0.0168	⋆⋆ 0.2551	0.0023	0.0702	0.0557	261
Manufacturing								
Supplier Dominated	0.0009	⋆⋆-0.0081	0.0129	0.1038	0.0013	0.0145	0.0056	449
Scale Intensive	0.0392	-0.0001	-0.0140	⋆⋆ 0.3214	0.0049	0.0095	0.0053	950
Specialised Suppliers	0.0243	-0.0019	-0.0048	0.1272	0.0079	0.0144	-0.0004	272
Science Based	⋆ 0.1091	-0.0051	-0.0260	⋆⋆ 0.2047	0.0030	0.0221	0.0104	341
Construction	⋆⋆⋆ 0.1137	⋆⋆⋆-0.0143	⋆⋆-0.0273	0.0590	0.0090	0.0142	0.0116	1488
Services								
Wholesale Trade	⋆⋆⋆ 0.1460	0.0027	⋆⋆⋆-0.0457	0.0271	-0.0014	0.0135	0.0104	1297
Specialised Services	⋆⋆⋆ 0.1338	-0.0013	⋆⋆⋆-0.0486	⋆ 0.0700	⋆⋆⋆ 0.0137	0.0230	0.0208	1760
Scale Intensive Services	0.0869	-0.0043	-0.0195	⋆ 0.1773	-0.0064	0.0147	0.0034	352
ICT Intensive Services	⋆⋆ 0.0789	-0.0003	⋆⋆⋆-0.0305	0.0245	0.0113	0.0061	0.0036	1569

Source: NewBiz Database, Version 98,4 – Plus X

Note: The Stars indicate to which degree the estimate is significant. ⋆⋆⋆: Significant at a 1% level. ⋆⋆: Significant at a 5% level. ⋆ significant at a 10% level.

Table 5: Industry wise Regression Results (More than 10 Employees)

	Intercept	log($Size$)	log(Age)	RSG	MCI	R^2	$Adj.R^2$	N
Dependent Variable=AAG(Tur)								
Primary Industry	0.2213	0.0197	-0.0917	⋆ 0.3650	-0.0002	0.0753	0.0291	85
Manufacturing								
Supplier Dominated	⋆ 0.1270	0.0009	-0.0350	0.0970	0.0041	0.0146	0.0022	321
Scale Intensive	⋆⋆ 0.1123	⋆⋆-0.0166	-0.0042	0.2338	0.0083	0.0234	0.0159	526
Specialised Suppliers	-0.0357	-0.0095	0.0411	0.1314	0.0016	0.0148	-0.0059	195
Science Based	0.1468	-0.0078	-0.0250	0.1888	0.0077	0.0231	0.0038	207
Construction	0.0255	-0.0063	-0.0003	⋆⋆ 0.3176	0.0145	0.0113	0.0030	481
Services								
Wholesale Trade	⋆⋆ 0.1271	-0.0067	-0.0140	0.1638	-0.0068	0.0071	-0.0000	559
Specialised Services	-0.0348	0.0072	0.0183	-0.0339	0.0074	0.0065	-0.0008	546
Scale Intensive Services	-0.0197	0.0077	-0.0148	0.2929	⋆ 0.0177	0.0566	0.0329	164
ICT Intensive Services	⋆ 0.1361	0.0073	-0.0403	-0.1143	0.0085	0.0086	-0.0007	428
Dependent Variable=AAG(Emp)								
Primary Industry	-0.0404	0.0033	0.0136	0.1920	-0.0090	0.0527	0.0054	85
Manufacturing								
Supplier Dominated	-0.0330	-0.0048	0.0143	⋆⋆⋆ 0.2214	0.0057	0.0348	0.0226	321
Scale Intensive	0.0140	⋆-0.0088	0.0102	⋆⋆⋆ 0.4205	-0.0001	0.0251	0.0177	526
Specialised Suppliers	0.0059	-0.0096	0.0141	⋆⋆ 0.2543	0.0032	0.0395	0.0193	195
Science Based	0.0583	-0.0118	0.0006	⋆⋆ 0.2354	0.0051	0.0343	0.0152	207
Construction	-0.0096	-0.0017	-0.0030	0.1946	0.0150	0.0088	0.0005	207
Services								
Wholesale Trade	⋆ 0.0880	-0.0092	-0.0188	⋆⋆ 0.2652	0.0064	0.0198	0.0127	559
Specialised Services	-0.0135	0.0047	0.0007	⋆ 0.1160	0.0066	0.0108	0.0034	546
Scale Intensive Services	-0.0779	-0.0110	0.0329	⋆ 0.2775	0.0067	0.0295	0.0051	164
ICT Intensive Services	0.0921	0.0037	⋆-0.0340	⋆-0.0775	0.0091	0.0100	-0.0006	428

Source: NewBiz Database, Version 98,4 – Plus X
Note: The Stars indicate to which degree the estimate is significant. ⋆⋆⋆: Significant at a 1% level. ⋆⋆: Significant at a 5% level. ⋆ significant at a 10% level.

This explanation far from correspond to the points summarised by Geroski concerning the firm growth process. But looking at the $adj. - R^2$ values of the industry wise regressions also indicate otherwise. The level of overall explanatory power has increased considerably in some of the regressions. Especially the Primary Industry as well as the Scale Intensive Services shows a higher level of explanatory power (3%). The increase in the $adj. - R^2$ values points at the nessecity for further studies on the subject. Additional variables should be included. Considerations on the composite of the firm in terms of employee skills and competences as well as the technological level of the firm/product may prove to be important. Also it seems that the level of explanatory power increases as the level of investigation becomes more detailed. Said in another way we may find a even higher overall fit if we disaggregated the regressions even more.

Considering table 4 and 5 again, we may point to yet another explanation for the lack of significant negative correlation between firm size and growth. Many of the industries categorised as Scale Intensive, Specialised Suppliers or Science Based could be characterised as Schumpeter MARK II industries, in which case we would expect a positive correlation. These two explanations are forces pulling in each direction leaving us with an insignificant estimate. If this is the explanation for these results, it is surprising that the estimation of the concentration index only is significant for the Science Based industries in both regressions and significant for the Scale Intensive in the employment growth regression only. Of cause again we may attribute this to the composition of the Pavitt taxonomy. A further analysis like the one of Malerba and Orsenigo (1997) would clarify these questions.

Looking at the estimates of the Service industries the main costs stem from the employees. This would be the main account for a cutback, when a firm needs to lower its costs, e.g. in a situation with strong competition. This could explain why the $\log(Size)$ estimates are rather weak in relation to employment growth. Some significant positive correlation does emerge in the turnover growth regression in Wholesale Trade, Scale Intensive Services and ICT Intensive Services. The large discrepancy between the estimates of the $\log(size)$ variable across industries confirms the operation we implemented in order to take the heteroscedasticity into account.

Taking a look at the $\log(Age)$ variable especially the Service industries shows the expected negative significant estimates. But to some degree the Construction industry also shows a negative convex correlation between firm growth and firm age.

The RSG variable shows some rather interesting results as well. Those of the estimates that are significant are also positive. Looking at the two regressions in table 4 only the Science Based industry shows supporting results. This would indicate that it is an advantage to be located in a region which is increasing its share of Science

Based firms more than the average region. The significant estimates of the Science Based industry can be explained by the clustering of these firms in regions, where there are other firms of the same industry located. This gives the firms access to specially localised capabilities and knowledge spillovers.

Table 5 shows some rather weak results. One should note though that the Scale Intensive industry shows the expected negative estimates in both regressions with respect to $\log(Size)$. Also when considering the employment growth regressions one cannot ignore the highly significant positive estimates of the RSG variable. Only one of the significant estimates is negative - namely the ICT Intensive service estimate. Only two industries, Primary and Construction, has insignificant estimates. Surprisingly enough it is these two industries that has a significant estimate in the turnover growth regressions.

6 Concluding Remarks

This paper has shown that firm growth cannot be characterised as a pure stochastic process. We find several significant variables by regressing against a simple average growth variable. By applying the proposed regression analysis on a lower level of aggregation we even find a higher level of overall explanatory power. This suggest that growth pattens of firms, apart from being firm specific, also has some specific industry dependencies. This is directly opposed the view that firm growth patterns are idiosyncratic.

We are able to confirm some of the existing empirical studies in terms of firm size and firm age. It should be highlighted though, that the results are rather blurry considering the industry wise regressions. Some industries seems to confirm the proposed patterns while others do not – pointing toward firms not being a pure idiosyncratic process. The results does point toward some of the same empirical results found by other studies though. In terms of the size variable it is worth noticing that the correlation disappears when considering the correlation only using firms over 10 employees. It would seem that the basic statement of Gibrat's Law does apply in this respect.

The problem of heteroscedasticity as well as our effect-full remedy for the statistical problem suggest that the variance of the firm growth rates decreases with size. Additionally we would like to state that the significant estimates considering age suggests that Jovanovic may be right in his proposition concerning firm learning to read their cost structure. A closer look at the correlation between firm size and firm age may enlighten whether or not the two processes is the very same.

We did not consider the idea of firm growth being a simple autoregressive process. But the significance of the variables would suggest that some path dependence in growth rates may exist. In some cases, we were able to find a significant relation to the geograph-

ical location of the firm. Every significant measure related to this variable is positive, indicating that it is positive to be located in a region that is expanding its share of industrial activity in the specific industry. We may link to the dynamic factors working n the specific region industry wise. This is a highly path dependent process, which would suggest some path dependency in firm growth patterns. These arguments may be related to the arguments put forward by Nelson & Winter in terms of innovativeness. Whether or not the growth rates are serially correlated was not tested directly though.

All in all we abolish the idea of firm growth being a pure random walk. We do not acknowledge the properties of the random walk as being the right functional form to describe firm growth. We find several interesting close related variables that may be linked to firm growth, which suggest that there are deterministic elements. To what degree is still uncertain. We suggest further studies in which more sophisticated variables are taken into account and in which the level of aggregation is somewhat lower.

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A Appendix

Figure A-1: Explanatory figure refering to figure 1 and 2.

Danish Research Unit for Industrial Dynamics

The Research Programme

The DRUID-research programme is organised in 3 different research themes:

- The firm as a learning organisation
- Competence building and inter-firm dynamics
- The learning economy and the competitiveness of systems of innovation

In each of the three areas there is one strategic theoretical and one central empirical and policy oriented orientation.

Theme A: The firm as a learning organisation

The theoretical perspective confronts and combines the resource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human resources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

Theme B: Competence building and inter-firm dynamics

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

Theme C: The learning economy and the competitiveness of systems of innovation.

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

The main empirical and policy issues are related to changes in the local dimensions of innovation and learning. What remains of the relative autonomy of national systems of innovation? Is there a tendency towards convergence or divergence in the specialisation in trade, production, innovation and in the knowledge base itself when we compare regions and nations?

The Ph.D.-programme

There are at present more than 10 Ph.D.-students working in close connection to the DRUID research programme. DRUID organises regularly specific Ph.D-activities such as workshops, seminars and courses, often in a co-operation with other Danish or international institutes. Also important is the role of DRUID as an environment which stimulates the Ph.D.-students to become creative and effective. This involves several elements:

- access to the international network in the form of visiting fellows and visits at the sister institutions
- participation in research projects
- access to supervision of theses
- access to databases

Each year DRUID welcomes a limited number of foreign Ph.D.-students who wants to work on subjects and project close to the core of the DRUID-research programme.

External projects

DRUID-members are involved in projects with external support. One major project which covers several of the elements of the research programme is DISKO; a comparative analysis of the Danish Innovation System; and there are several projects involving international co-operation within EU's 4th Framework Programme. DRUID is open to host other projects as far as they fall within its research profile. Special attention is given to the communication of research results from such projects to a wide set of social actors and policy makers.

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