On the Growth of Micro and Small Firms: Evidence from Sweden

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ABSTRACT. The relationship between the size, age and growth rate of firms is examined for a large sample of micro and small firms in Sweden. These firms have between 1–100 employees and operate in a geographically concentrated area. Micro and small firms are dominant in the industrial structure and thus their growth patterns are crucial to the economic growth of the region. The period of study is of particular interest because it allows us to evaluate the effects of various regional development policy programs on the growth and formation of firms. The data is an unbalanced panel covering the period 1993–1998. We allow for the exit and entry of firms. The growth rate is defined in terms of the number of employees, sales and assets. In the estimation of the growth rate we control for various factors characterizing the sample firms, their capital structure, performance, human capital, and local labor market conditions. Our results show that the relationship between the growth, size and age of firms is very sensitive with respect to the method of estimation, functional form and definition of growth and size.

1. Introduction

The relationship between the growth and size of firms, summarized as Gibrat's law, has frequently been a major issue in the theoretical as well as in the empirical literature about the formation and growth of firms. This law asserts the independence of growth and size (Hart and Prais, 1956; Simon and Bonini, 1958; Hymer and Pashigan, 1962). The law states that the growth of firms is proportional to their size, and all firm growth occurs at the same rate over an interval of time, regardless of their initial size. A number of empirical studies suggest a negative relationship between growth and size, indicating that smaller firms have higher and more variable growth rates, which reduce their survival rate (Mansfield, 1962; Du Reitz, 1975; Hall, 1987; Mata, 1994), while other studies (Singh and Whittington, 1975) have found a positive relationship.

To explain the discrepancy between the theory of Gibrat's proportional growth law and empirical evidence, Jovanovic (1982) proposes the theory of "noisy" selection. This theory emphasizes managerial efficiency and learning by doing as the key factors determining a firm's growth dynamics. Efficient firms grow and survive, while inefficient firms decline and fail. Size differences are explained not only by the fixity of capital but also by the production efficiency of firms. Firm growth and survival are linked to the firm's size, age and initial production efficiency, implying that younger firms tend to grow faster than older ones. Based on these theories, firm size and age are considered to be determinants of growth. Evans (1987a, b), Audretsch (1995a, b), Dunne and Hughes (1994) and Liu et al. (1999) find negative relationships between the growth, age, and size of firms in the U.S., U.K. and Taiwan. Thus entry, growth, and exit behavior agrees with the empirical evidence. However, Das (1995) finds age and growth to be positively related using Indian computer hardware industry firms.

The empirical literature indicates that firm characteristics other than size and age may also play important roles in the growth of firms. The characteristic factors include ownership structure (Variyam and Krybill, 1992), research and development activities (Hall, 1987), capital structure (Lang et al., 1996), human capital and export activities (Liu et al., 1999). To our knowledge the literature often emphasizes medium-sized and

Final version accepted on March 22, 2001

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Small Business Economics **17**: 213–228, 2001.

large firms. Empirical analysis has neglected micro, and to some extent, small firms. Meyer (1998), in his contribution to the present and future roles of banks in small business finance, regards small business as a vital and energetic part of the economy. Small businesses play a key role in the generation of jobs, new ideas and encouragement of entrepreneurial activity, and are a major contributor to the well-being of nations. The growth of micro and small firms is thus important to the evolution of firms and regional development.

The main contribution of this paper is its exploration of the growth patterns of micro and small firms. The relationship between firm size, age and growth rates is examined for a large sample of micro and small firms in Sweden. These firms have between 1 and 100 employees and operate in the county of Gävleborg. The data is an unbalanced panel data set covering the period 1993–1998. Three definitions of growth rate, in terms of the number of employees, sales and assets, are used. The models are estimated using various estimation methods that account for the heterogeneity among firms not reflected in their age and size differences. In the estimation of the growth rate we control for various factors characterizing the sample firms, their performance, human capital, and local labor market conditions. Gävleborg is a region where small firms dominate the industrial structure, and the pattern of growth of micro and small firms is thus crucial to the economic growth of the region. The period of study covers a time of major changes in the region's industrial policy. Our evaluation is also an attempt to highlight the effects of various regional development policy programs on the growth and formation of firms. Our results from a large sample of firms show that the relationship between the growth, size and age of firms is highly sensitive to the method of estimation, functional form and definition of growth and size.

The remainder of this paper is organized as follows. Section 2 provides some empirical evidence found in the literature addressing institutional setting, financial structure and industrial policy as they relate to micro and small enterprises. In Section 3 the data is described. Sections 4 and 5 are devoted to the specification and estimation of the growth models. Empirical results are presented in Section 6. The final section concludes our analysis.

2. Factors important to the growth of micro and small firms

For the classification of firms by size we use the definition applied by the European Community (Eurostat, 1994), where micro firms have 0–9 employees and small firms have 10–99 employees. There are a number of factors that are found to be crucial to the growth of firms in many empirical studies. In this section we briefly review a few but important pieces of research highlighting the impact of institutional factors on the size distribution of firms, employment structure, financial structure, banking crises, consolidation of the banking industry, the existence of supply and demand constraints on the growth of firms, the relationship between leverage and the growth opportunities of firms and the influence of human capital and organizational resources on the performance of firms.

Henrekson and Johansson (1999) argue that the size distribution of firms may largely be determined by institutional factors. The size distribution of firms in Sweden between 1968–1993 is analyzed. Firms are divided into nine classes. The data shows evidence of heterogeneous development by size class, possibly reflecting the effects of inhomogeneous institutions and rules determining entrepreneurial and business conditions. Conditions have been unfavorable for small firms, start-ups, less capital-intensive firms and family-owned businesses, resulting in a reduction of their growth potential. Among the institutional factors mentioned affecting the size distribution of firms are: the tax system, regulated credit market conditions, employment security laws, low wage dispersion due to wage setting institutions, and the public sector monopolization of the production of key services.

Small and large firms differ in their financial structure. Smaller businesses have a lower fixed to total assets ratio, a higher ratio of trade debt to total assets and a higher proportion of current liabilities to total assets; they are heavily reliant on retained profits to fund investment flows and are financially more risky (Cressy and Olofsson, 1997a). Other explanations for the financial structure disparities are fixed investment, product market power, the growth potential of smaller firms together with the learning curve of the owners and the financial scale disadvantages of smaller firms. Smaller firms face supply-side finance constraints in an imperfect capital market. Access to external venture capital or a sizable flow of retained earnings is found to be crucial to the growth of small businesses (Johansson, 1997). Cressy and Olofsson (1997b), in their survey of directors' attitudes based on 510 businesses in 1991–1993, show that the most important constraint on small and medium-sized enterprises is not simply finance as such, but the package of finance and expertise, including the provision of management skills and market knowledge. The main sources of constraint are found to be management, labor skills, access to finance and information flow. Brush and Chaganti (1998) find that the combination of owner resources, commitment, and organizational resources is important to positive cash flow, performance, and the growth of small firms.

The effects of capital structure can differ with respect to the size of the firm, as firms face differing restrictions that determine their ability to finance growth by issuing debt in the competitive capital market. Lang et al. (1996) show that there is a negative relationship between leverage and the future growth at the firm level, and for diversified firms, at the business segment level. This negative relationship holds for firms with a low Tobin's q ratio, firms whose growth opportunities are not recognized by the capital markets, or firms with insufficiently valuable growth potential to offset the effects of their debt overhang to finance positive net present valued projects. Another factor causing the negative relationship is the management's information about future growth opportunities.[1]

Some researchers argue that the consolidation of the banking industry may reduce the supply of credit to small business. Meyer (1998) finds commercial banks to be an important source of external credit to small firms. In addition to supplying credit, nearly all banks provide transaction and deposit services. This relationship is very important in that banks can gain information that can be used in decision making and for pricing credit. Technological and institutional changes, banking consolidation, and modernization of the banking and financial markets will not have major negative affects on the core relationship between small business and local banks. Governmental intervention in the financial markets, to support and supply credit to small business, is a necessary response to negative changes in the financial markets.

Recent financial crises in some industrialized countries such as Finland, Norway, Sweden, and Japan have contributed to a decline in economic activity through reduced spending and business closures. There are two mechanisms through which financial intermediation may affect production and employment: the balance sheet of firms and households and the bank lending mechanisms (see Holmström and Tirole, 1997). Financial crises weaken firm profitability and household income prospects; combined with high indebtedness, this results in weakened borrower quality. Credit losses squeeze bank capital, affecting bank behavior. While Gibson (1995), using Japanese data, finds that a firm's investment depends on the financial health of the firm's main bank, Vale (1996) finds that inventory investment by Norwegian firms was not affected by their relationship with a problem bank during the banking crisis. Kinnunen and Vihriälä (1999) focus on the effects of financial factors on small business closures during the Finnish financial crisis of 1991–1993. The results show that financial factors affect real outcomes not only through the balance sheets of firms and households but also through bank behavior.

A number of factors mentioned above that are important to the growth of firms are proxied by measures of labor productivity, capital intensity, indebtedness, research and development intensity, vacancy and unemployment rates, human capital and regional support variables presented in detail in the next section.

3. The data

The data used in this study was obtained from Market Manager's database.[2] It has been further supplemented with additional information obtained from the regional Labor Market Office, the Swedish National Board for Industrial and Technical Development (NUTEK) and other periodical publications from Statistics Sweden. All firms listed in the Swedish Central Register of Enterprises and Establishments[3] with a taxable turnover exceeding SEK 10,000 for each year they appear in the sample are included in the data set. Thus, it includes the entire population of both private and public firms observed from 1993 to 1998. Each sample firm is observed for at most four years.[4] The data includes the exit and entry of firms but it has not been possible to distinguish between exits, mergers and what may be non-responses.

The basic data is based on the firms' financial accounts. We have introduced a number of restrictions regarding the inclusion of firms in the analysis. First, for the empirical part of this paper the data is limited to active liability companies operating in the county of Gävleborg with an annual turnover exceeding SEK 1 million and a minimum of 1 employee. Second, in the final analysis a further restriction imposed is that the firms should be observed for four consecutive periods. Third, the sample firms include only micro and small firms and should have average employment of between 1–100 employees for the period of study.

The first restriction imposed was aimed at limiting the data to a homogenous class of firms, located in a county that has been subject to extensive governmental regional support, in an effort to evaluate the impact of such support on the development of entrepreneurial and business conditions in the region. Part-time firms or firms with no data or missing data on the number of employees were excluded, because employment is one of the key dependent (growth) variables. Hence the introduction of this restriction was unavoidable. It was necessary to exclude firms not observed for four periods given the dynamic nature of the model and the panel data techniques employed. The last restriction was introduced to minimize the impact of firms with a large number of employees. An additional restriction was that at the firm level the average change in employment was limited to between 80% contraction and 400% expansion. All observations outside this range are excluded from the sample. Unusual changes due to mergers and acquisitions might otherwise arise.

The dependent variable is defined in terms of the growth in employment, sales and assets.[5] These definitions are frequently used in the empirical analysis of the growth of firms and will allow a sensitivity analysis of the results for different definitions of growth. The number of employees is not adjusted to give part-time employment a full-time equivalent. Thus, the expansion or contraction in the number of hours does not necessarily have any implication for the number of employees, especially in the case of very small firms. Sales are defined as total net sales and assets as total net assets. The dependent variables are given as a growth rate, in logarithmic form. All monetary values are transformed into fixed 1995 prices using the consumer price index.

The independent variables are divided into two sets, namely main explanatory variables (age and size) and another set that we call environmental variables. Age is measured in the number of years from the birth of the firm to the time of the survey. Size is measured in all three models as the number of employees, which has implications for expectations about the sign of the coefficient and its interpretations. Both age and size variables are given in logarithmic form. The environmental variables are divided into two groups, those specific to firms and those specific to communities. The first group which is specific to firms are: debt equity ratio, net sales per employee, capital per employee, net profit per employee, and R&D expenditures. Sales and capital per employee indicate the productivity of labor and the capital intensity of the firms. Debt equity ratios and profit per employee are indications of external and internal financing options by which firms may expand their activities. R&D, given in SEK, indicates whether firms undertake research and development investment. Labor productivity, capital intensity, profitability and R&D expenditures are given in logarithmic forms. Included in the group of environmental variables, which vary depending on the community the firms are located in, are: the ratio of people unemployed to the number of vacancies, average length of education for people registered as unemployed, the percentage of the population aged 25–64 with higher education, and regional development support to promote entrepreneurial activities. The labor market and education variables are crucial for the expansion opportunities of firms located in regions with a low industrial concentration and a low population structure.

A non-significant relationship between size, age and the growth of firms is an indication that Gibrat's proportional growth law holds, while a negative relationship is a rejection of Gibrat's law and at the same time a validation of Jovanovic's managerial efficiency theory. The latter asserts that efficient firms survive and grow while inefficient firms decline and fail. Recent evidence shows that though younger and smaller firms face restrictive external finance market constraints, they grow faster by using internal finance (Du Reitz, 1975; Lang et al., 1996; Henrekson and Johansson, 1999). Their growth rate is much higher and more variable (Mansfield, 1962). We expect a positive relationship between capital intensity, labor productivity, research and development investment, various types of regional support and the growth of firms. The effects of education and access to labor with appropriate education are also expected to have positive effects on the expansion opportunities of firms.

In addition, a number of dummy variables are used to control for heterogeneity among firms, industrial sectors, and municipalities. A statistical summary of the variables used in the regression analysis is reported in Table I. Looking at the summary statistics we find major differences in the mean and dispersion of the key dependent variables (employment, assets and sales) in the two samples (Tables 1A and B). However, the differences as measured by the age of firms and their indebtedness are very small. The two samples differ in the restrictions imposed to extract a sample of micro and small firms. The restrictions involve 31.3% of the total sample. The sample average (dispersion) of growth variables shown on Table 1B is as follows: employment 2.1% (39.2%), assets 4.3% (58.0%) and sales 3.8%

TABLE I
Summary statistics, firm level data, the county of Gävleborg 1994–1998

Variable	Definition	Mean	Std. Dev.	Minimum	Maximum
A *Probit model data set, 1994–1998, NT = 11481 observations.*					
PARTICIP	Participation variable	0.652	0.476	0.000	1.000
AGE	Age of firm	13.422	14.647	1.000	101.000
DERATIO	Debt/Equity ratio	0.775	0.206	0.000	1.025
CAPEMPL	Capital intensity	1294.105	10215.802	0.247	748783.734
PROEMPL	Profitability	44.375	289.481	0.000	18789.983
UTBAR	Average length of education	10.605	0.114	10.400	10.800
HOGUTB	% with a university degree	7.174	1.968	3.100	10.400
B *Growth models data set, 1994–1998, NT = 7884 observations.*					
EMPL	Employment	6.777	9.508	1.000	112.000
ASSETS	Total assets	4998.036	16458.592	26.676	359786.000
SALES	Total sales	9223.143	27195.056	12.000	773477.789
AGE	Age of firm	14.682	13.684	1.000	101.000
DERATIO	Debt/Equity ratio	0.777	0.191	0.000	1.000
SALEMPL	Labor productivity	1350.398	2144.308	12.000	98537.869
CAPEMPL	Capital intensity	910.330	3814.726	0.497	167357.000
PROEMPL	Profitability	37.102	152.088	0.011	6740.030
ARBVAK	Unemployed/vacancy ratio	33.102	17.059	11.900	112.300
UTBAR	Average length of education	10.605	0.114	10.400	10.800
HOGUTB	% with a university degree	7.109	1.960	3.100	10.400
SUPPORT	Regional support	4.834	12.040	0.000	275.737
LAMBDA	Selection variable	1.246	0.308	0.099	2.107
DEMPL	Growth in employment	0.021	0.392	–1.609	1.609
DASSETS	Growth in assets	0.043	0.580	–4.826	3.762
DSALES	Growth in sales	0.038	0.312	–2.637	4.672

Notes: All monetary values are in 1995 prices.

(31.2%). The large dispersion compared to mean growth is an indication of heterogeneous growth patterns. We find a positive and significant correlation among the key dependent variables.

4. The growth model

The model of firm growth following Jovanovic (1982) and Evans (1987a, 1987b) implies that the growth variable of interest at time $t + 1$ is a function of size and age at time t. This relationship in logarithmic form is expressed as:

$$\ln Y_{it+1} = \ln F(A_{it}, S_{it}) + u_{it}, \tag{1}$$

where Y_{it+1} is the growth variable of interest of firm i ($i = 1, 2, \ldots, N$) in period $t + 1$ ($t = 1, 2, \ldots, T$), S_{it} and A_{it} are the size and age of firm i at time t, and u_{it} is the error term. The error term can be broken down into a firm-specific (μ_i), a time-specific (λ_t) and a random error term (v_{it}) as:

$$u_{it} = \mu_i + \lambda_i + v_{it}. \tag{2}$$

Using a flexible translog functional form for $F(.)$ the relation is written as:

$$\ln Y_{it+1} = \alpha_0 + \alpha_S \ln S_{it} + \alpha_A \ln A_{it} + \alpha_{SS} (\ln S_{it})^2 + \alpha_{AA} (\ln A_{it})^2 + \alpha_{SA} \ln S_{it} \ln A_{it} + u_{it}. \tag{3}$$

The model can be written in the form of the firm growth equation by subtracting $\ln Y_{it}$ from both sides and adding environmental and heterogeneity variables as follows:

$$\Delta \ln Y_{it+1} = \alpha_0 + \alpha_Y \ln Y_{it} + \alpha_S \ln S_{it} + \alpha_A \ln A_{it} + \alpha_{SS} (\ln S_{it})^2 + \alpha_{AA} (\ln A_{it})^2 + \alpha_{SA} \ln S_{it} \ln A_{it} + \beta X_{it} + u_{it}. \tag{4}$$

where the left hand variable is defined as (i) $\Delta \ln Y_{it} = (\ln Y_{it+1} - \ln Y_{it})$ or alternatively as (ii) $\Delta \ln Y_{it} = (\ln Y_{it+\tau} - \ln Y_{it})/\tau$, where τ is the distance between the two time periods of interest.[6] The matrix $X_{it} = (Z_{it}, MR_{it}, Z_{Mt}, D_{SIC})$ is a vector of variables characterizing the firms (Z_{it}), selection bias (MR_{it}), municipalities of location, labor market conditions, regional support (Z_{Mt}), and industrial sector (D_{SIC}) effects. The variable MR_{it} is the inverted Mill's ratio obtained from a probit model to capture the effects of selection bias due to the exclusion of some firms for the reasons mentioned previously as well as for the market entry and exit of firms. The subscripts M and SIC denote municipality and industrial sector classification.

5. Estimation

In matrix form the model in Equation (4) can be rewritten as:

$$y_{it} = \beta_0 + \beta x'_{it} + u_{it}, \tag{5}$$

where y_{it} is the log growth rate of firm, x_{it} is the log of the corresponding matrix of explanatory variables and β is a vector of unknown parameters to be estimated. The variables included in the x-vector with the exception of labor market and regional support variables vary both across firms and over time.

The error term, v_{it}, represents those effects which cannot be controlled by the firm, such as business cycles, quality of and access to labor, labor market conflicts, measurement errors in the dependent variable, and other explanatory variables that have been omitted. It is assumed to be independently and identically normally distributed with zero mean and constant variance, σ_v^2. The firm- and time-specific effects, μ_i and λ_t, are factors representing firm efficiency and the exogenous rate of technical change respectively and are assumed to be independent of each other and of x_{it} and v_{it}.

Depending on the type of assumptions made regarding the correlation between the effects and the explanatory variables, the parameters β, μ_i, λ_t, σ_v^2 are then to be estimated. In empirical applications the time effects, λ_t, are often replaced with a time trend or a vector of time dummies. The latter is more appropriate in cases with very short panels such as the current data set. In panel data literature, the estimation of the model in (5) has been developed in two directions – first, the fixed effects (FE) model, where μ_i is assumed to be fixed and correlated with the explanatory variables, and second, the random effects (RE) model, where μ_i is assumed to be random and not correlated with the explanatory variables.[7] Efficiency, unbiasedness and consistency are properties affecting the choice of FE or RE treatment of the μ_i and λ_t effects. In this study, we use both types of model specifications. In RE instead of μ_i the variance, σ_v^2, is estimated. In an FE model, the number of firm-specific effects, μ_i, depends on the sample size, resulting in the large number of parameters to be estimated. On the other hand in an RE model, the number of parameters associated with μ_i is reduced to only two, the mean and variance, σ_μ^2. One of the advantages of an RE model is that time-invariant regressors can be included in the model specification. On the other hand, the desirable feature of the FE model is the inclusion of firm- and time-specific effects in the growth model to capture unobservable effects, such as managerial differences and policy changes.

The model in Equation (5) can be estimated ignoring the panel nature of the data using the pooled ordinary least square (OLS) method or between estimation method neglecting the within variations as:

$$\bar{y}_i = \beta_0 + \beta\bar{x}_i' + \bar{u}_i, \tag{6}$$

or using the within estimation method by eliminating the between variations as:

$$y_{it}^w = x_{it}^{w\prime}\beta + x_{it}^w, \tag{7}$$

where $y_{it}^w = (y_{it} - \bar{y}_i)$, $x_{it}^w = (x_{it} - \bar{x}_i)$ and $u_{it}^w = (u_{it} - \bar{u}_i)$. Treating μ_i and v_{it} as random (see Baltagi, 1995), the following distributional assumptions on the error components are imposed: (i) $\mu_i \sim i.i.d.\ N(0, \sigma_\mu^2)$, (ii) $v_{it} \sim i.i.d.\ N(0, \sigma_v^2)$, (iii) μ_i and v_{it} and are independent of each other and of the explanatory variables. The GLS estimates of β are equivalent to the least square estimates with the following transformed variables

$$y_{it}^* = y_{it} - \theta\bar{y}_i \quad \text{and} \quad x_{it}^* = x_{it} - \theta\bar{x}_i, \tag{8}$$

where $\bar{y}_i = \sum_t y_{it}/T$, $\bar{x}_i = \sum_t x_{it}/T$, and $\theta = [1 - \sqrt{(\sigma_v^2/(T\sigma_\mu^2 + \sigma_v^2))}]$. The model in Equation (5) is rewritten as

$$y_{it}^* = \beta_0^* + \beta x_{it}^{*\prime} + u_{it}^*. \tag{9}$$

The variance components, σ_μ^2 and σ_v^2, are unknown and have to be estimated. A multi-step generalized least square (GLS) estimation procedure is used. First, consistent estimates of the variance components are obtained. Second, the estimated variance components are used to transform the data and least square regression is applied to the transformed data. The overall estimation procedure has the following steps.

Using a probit model we estimate the survival or probability of belonging to the micro and small sized class of firms written as:

$$z_{it}^* = \gamma' w_{it} + \eta_{it}, \tag{10}$$

and then using the parameter estimates calculate the inverted Mill's ratio, $M\hat{R}_{it} = \phi(\hat{\gamma}' w_{it}/\hat{\sigma}_\eta)/\Phi(\hat{\gamma}' w_{it}/\hat{\sigma}_\eta)$. Mill's ratio is then introduced in a regression based on only the surviving micro and small firms, where y_{it} in Equation (5) is observed only when $z_{it}^* > 0$:

$$(y_{it}|z_{it}^* > 0) = \beta_0 + \beta x_{it}' + \beta_{MR} M\hat{R}_{it} + u_{it}. \tag{11}$$

We regress the within mean transformed y_{it}^w on the within transformed x_{it}^w to get the within parameter estimates and the mean squared error, which are unbiased and consistent estimates of the variance, σ_v^2,

We ignore the firm-specific effects and regress the y_{it} on the x_{it} variables without any transformation to obtain the pooled OLS residuals, u_{it}, and estimate $\text{var}(u_{it}) = \sigma_u^2 = T\sigma_\mu^2 + \sigma_v^2$, where T is the number of periods a firm is observed for, which is equal for all firms in the balanced final sample of surviving firms.

The firm-specific variance, σ_μ^2, can be obtained as $\sigma_\mu^2 = (\sigma_u^2 - \sigma_v^2)/T$ by using steps b and c, and then calculating the transformation parameter, θ.

Given θ, transform the y and x variables as in Equation (8) and then regress y_{it}^* on $(1 - \theta)$ and x_{it}^* by using OLS to get generalized least square (GLS) estimates of the parameters of the model. If $\theta = 0$, the estimator collapses to the OLS estimator and if $\theta = 1$, it collapses to the within estimator. Hence, in GLS, θ is within the interval 0 and 1.

The growth equations are non-linear in the age and size variables. The partial derivatives of growth or elasticity with respect to a percentage change in size and age are calculated as:

$$E_{AGE} = \partial\Delta\ln Y/\partial\ln A = \alpha_A + 2\alpha_{AA}\ln A + \alpha_{SA}\ln S$$
$$E_{SIZE} = \partial\Delta\ln Y/\partial\ln S = \alpha_S + 2\alpha_{SS}\ln S + \alpha_{SA}\ln A \tag{12}$$

which are both firm- and time-variant. Standard errors for the age and size elasticity are obtained from the square root of the diagonal elements of the following relations:

$$STD_{AGE} = (\partial\Delta\ln Y/\partial\ln A)(\mathrm{Cov}(Y, X, Z))(\partial\Delta\ln Y/\partial\ln A)'$$
$$STD_{SIZE} = (\partial\Delta\ln Y/\partial\ln S)(\mathrm{Cov}(Y, X, Z))(\partial\Delta\ln Y/\partial\ln S)' \quad (13)$$

The three growth models are each estimated using five estimation methods, namely: a pooled ordinary least square (OLS), between, within, generalized least square (GLS) and a dynamic adjustment model and are tested against each other to select the model specification finally accepted. White's heteroscedasticity consistent estimator of the covariance matrix is used to correct for heteroscedasticity due to a negative relationship between the variance of growth and age and the error term for individual firms, which might be correlated within industries.

A number of hypotheses regarding the sample selection, functional form and firm-specific variance component can be performed: (i) absence of selectivity, (ii) no firm-specific variance component, (iii) a homoscedastic variance component, (iv) random or fixed treatment of the firm-specific error component, and (v) functional form.

6. Empirical results

Since we have a large number of parameters to estimate, one could expect multicollinearity to be a problem. A simple measure of its degree can be obtained by regressing each of the explanatory variables on the remaining explanatory variables. The R^2 obtained can then be taken as a measure of the degree of multicollinearity. The R^2 values were as follows: age (0.13), size (0.10), indebtedness (0.24), labor productivity (0.37), capital intensity (0.42), profitability (0.29), vacancy (0.08), level of education (0.28), percentage of the labor force with a university degree (0.38), and regional support (0.22). The correlation coefficients among the explanatory variables vary between –0.13 and 0.60. From the regression results and the correlation coefficients we can draw the conclusion that multicollinearity is not a major problem.

The regression results for the survival and growth models, where growth rate is defined based on employment, total sales and assets, are presented in Tables II.A–II.B and III.A–III.C. The survival model was estimated using the probit maximum likelihood method. The growth models are each estimated using pooled OLS, between, within and GLS estimation methods. The model with initial condition is also estimated using the least square method. Since the square of age and its interaction with size in some models was found to be insignificant, we have estimated a model with only the first order terms. The results were found to be sensitive to the lag level of dependent variables on the right hand side. For use in the sensitivity analysis the simpler functional form was also estimated without the lag level of the dependent variable. Hence, an analysis of the results will be based on three model specifications: (i) a general model (Model I) with both second order terms and lag dependent variable, (ii) a medium model (Model II) without the second order terms but with a retained lag level of dependent variable, and finally (iii) a restricted model (Model III) excluding both second order and lag dependent variables. Various *F*-tests conducted show Model I to be the appropriate model specification. The combination of three growth variables (employment, assets, sales), five estimation methods (pooled OLS, within, between, GLS, initial condition) and three specifications (Models I, II, III) resulted in a total of 45 models estimated and tested.

6.1. *The survival model*

Because the construction of a sample based on a balanced sample of firms ignores data on firms that have been in operation only part of the time, given the market exit and entry of firms, and because it excludes firms as a result of low turnover, this raises the issue of sample selection bias. The probit estimation results for correcting possible selection due to the restrictions imposed[8] regarding the inclusion of firms in the analysis are presented in Table II.A. If firms of a certain size are more likely not to survive, then an analysis of the growth rate based only on surviving firms will be biased, affecting the age-size-growth relationship. Thus, in addition to the variables determining the growth of firms, we take into account their differences in survival probabilities. The dependent variable is defined for fulfillment of the survival conditions listed above.

TABLE II.A
Probit model parameter estimates (NT = 11481)

Parameter	Variable	Estimate	Std. Error	Chi-square	Prob > Chi
α_0	Intercept	–5.1980	1.4250	13.3056	0.0003
α_A	Log age	1.8362	0.0535	1179.3050	0.0001
α_{AA}	Log age squared	–0.3481	0.0114	929.1532	0.0001
α_{DE}	Debt/Equity ratio	0.2561	0.0708	13.0935	0.0003
α_{CE}	Log capital intensity	–0.1525	0.0135	128.1999	0.0001
α_{PE}	Log profitability	0.0489	0.0062	62.0715	0.0001
α_{ED}	Average length of education	0.4386	0.1374	10.1939	0.0014
α_{HE}	% with high education	–0.0158	0.0083	3.6265	0.0569
α_{1995}	Dummy 1995	0.0431	0.0878	0.2406	0.6238
α_{1996}	Dummy 1996	0.0177	0.0884	0.0403	0.8409
α_{1997}	Dummy 1997	–0.3743	0.0889	17.6960	0.0001
α_{1998}	Dummy 1998	–0.8371	0.0898	86.8891	0.0001
LogL	Log likelihood value				–6269.0818

TABLE II.B
Predictive probabilities

Frequency (Percent)		Observed values		
		0	1	Total (%)
Predicted values	0	2312 (57.93)	680 (9.08)	2992 (26.06)
	1	1679 (42.07)	6810 (90.92)	8489 (73.94)
	Total (%)	3991 (34.76)	7490 (65.24)	11481 (100.00)

The age of firms is positively related to the participation probability but at a decreasing rate. Capital intensity and the share of the population of working age have negative associations with the survival probability of firms, while degrees of indebtedness, profitability and average length of education are found to have a positive effect on the survival probability of firms. The time effects are negative, indicating a lower participation probability over time compared to the reference period, 1995. The predictive probabilities calculated show that the model performs quite well. The frequency of correct predictions of participation and non-participation is 79.5% (see Table II.B).

Using probit parameter estimates, the Mill's ratio was calculated and used as an extra explanatory variable in the growth regression models. The latter is based only on firms fulfilling the participation conditions. We find somewhat different selection effects depending on the growth variable and estimation method employed. The coefficient of selection is found to be statistically significant only in the pooled OLS, within and GLS models when the employment and sales growth equations are considered. It is positive in the employment growth model, negative in the sales model and insignificant in the total assets model. This is interpreted as meaning that as the employment and sales growth patterns of the final sample considered differ systematically from the eliminated portion, the differences must be taken into account to correct for the presence of selection bias.

6.2. *The employment growth model*

The employment growth model is specified using age and size variables as was suggested (see Table III.A).[9] However, empirical evidence shows that a number of other variables should appear in the deterministic part of the growth model. Furthermore due to temporal patterns of growth, the size and age variables might not be sufficient statistics for the unobserved growth differences across firms. A pooled OLS is not an appropriate

TABLE III.A
Employment growth model parameter estimates

Parameter	Variable/Estimation method	Between	Pooled OLS	Within	GLS	Adjustment
A. *Parameter estimates:*						
α_0	Intercept	0.5079	1.0143	–	1.3236c	–0.2486
α_{EMPL}	Log lag employment	–	–	–	–	–
α_A	Log age	0.0233	–0.3130	–0.3638c	–0.5091b	0.1854
α_S	Log size	–0.1908a	–0.2382a	–0.2884a	–0.2356a	–0.2291a
α_{AA}	Log age squared	–0.0083	0.0615	0.2339a	0.0981b	–0.0368
α_{SS}	Log size squared	0.0335a	0.0497a	0.0420a	0.0504a	0.0417a
α_{AS}	Log age × log size	0.0029	–0.0132c	–0.2877a	–0.0128c	–0.0011
α_{DE}	Debt/Equity ratio	0.0842b	0.0391	–0.1260	0.0229	0.0749
α_{SE}	Log labor productivity	–0.0095	0.0047	–0.0001a	–0.0001a	–0.0018
α_{CE}	Log capital intensity	0.0081	0.0460b	0.1570a	0.1079a	–0.0041
α_{PE}	Log profitability	0.0091	–0.0007	–0.0085	–0.0060	0.0076
α_{UV}	Log (unemployed/vacancy)	0.0315	0.0229	0.0311	0.0276c	0.0145
α_{ED}	Average length of education	–0.0524	–0.1126	–0.1453	–0.1662b	0.0316
α_{HE}	% with high education	0.0056	0.0049	–0.0121	0.0108a	–0.0006
α_{RS}	Log regional support	–0.0139	–0.0050	–0.0027	–0.0026	–0.0042
α_{LAMBDA}	Selection effect	0.0275	0.2752c	0.3225a	0.3966a	–0.0945
α_{1996}	Dummy 1996	–	–0.0111	0.0206	–0.0121	–
α_{1997}	Dummy 1997	–	–0.0416	0.0228	–0.0501c	–
α_{1998}	Dummy 1998	–	0.0045	0.0529b	0.0406	–
B. *Specification tests:*						
Adj R^2	Adjusted R^2	0.1189	0.0853	0.2786	0.1433	0.1980
RMSE	Root mean square error	0.2071	0.3754	0.2783	0.3539	0.1934
F-test	H0: slopes are 0	19.9830a	33.4300a	135.3270a	55.9670a	35.7300a
F-test	H0: lag dep. var. is 0	–	–	–	–	–
F-test	H0: squ. & inter. are 0	19.9803a	38.0708a	53.6430a	38.0672a	35.4468a
F–test	H0: squ. & inter. & lag are 0	–	–	–	–	–
NT	Number of observations	1971	5913	5913	5913	1971
C. *Age elasticity:*						
E_{AGE}	Unrestricted Model I	–0.0110	–0.0468	–0.3638b	–0.1126b	0.0230
E_{AGE}	Restricted Model II	–0.0172a	–0.0115c	0.0368a	–0.0137c	–0.0101
E_{AGE}	Restricted Model III	–0.0172a	–0.0115c	0.0368	–0.0137c	–0.0101
D. *Size (log employment) elasticity:*						
E_{SIZE}	Unrestricted Model I	–0.0867a	–0.1243a	–0.2884a	–0.1296a	–0.1142a
E_{SIZE}	Restricted Model II	–0.0650a	–0.0949a	–0.8134a	–0.0889a	–0.0901a
E_{SIZE}	Restricted Model III	–0.0650a	–0.0949a	–0.8134a	–0.0889a	–0.0901a

Notes: Significant at less than 1% (a), 1–5% (b) and 5–10% (c) levels of significance.
In the unrestricted Model I squares and interactions of age and size and the lag dependent variable are included. In the restricted Model II the square and interactions of age and size are excluded, while in Model III lag dependent variables are excluded as well.

estimator of the parameters of the growth equation. Hence pooled OLS is used as a starting point, and we estimate the model assuming the same specification but introduce firm and time effects to control for unobservable policy, technology, production and other characteristics. The results for pooled OLS, GLS and adjustment models differ. The adjustment model is simply a cross-sectional model that incorporates the initial level of efficiency, while the common time-variant effects on firms are neglected.

Various test statistics indicate the presence of unobserved firm-specific effects. Hence the pooled OLS is rejected in favor of a model incorporating firm-specific effects. The unobserved firm-specific heterogeneity effects omitted in the pooled OLS result in an over/under-prediction of employment growth. Furthermore, the test results indicate that the firm-specific effects are not correlated with the explanatory variables, indicating that a random effect approach (GLS) is an appropriate method of estimation.

The results from the GLS models are expected to show that age and size in the absence of fixed costs are sufficient statistics to explain the unobservable differences among firms as was suggested by Jovanovic's model. The age and size elasticity evaluated using the mean sample are negative and in accordance with the expected signs. The negative relationship between growth and size suggests that Gibrat's law does not hold for micro and small firms, while the negative relationship between growth and age is consistent with Jovanovic's model when growth in employment is considered. The time effect indicates weakly significant growth in employment over time.

The capital intensity, the ratio of people unemployed per vacancy and the percentage of the population with a university degree are found to have positive effects, while the degree of indebtedness and the level of education have negative effects on the growth rate of employment. With the exception of the level of education, the signs are as expected. Profitability and regional support were not found to have any positive effects on employment growth. Large differences in model performances and significance levels among the estimation methods are observed. The overall results signify that age and size variables do not capture all unobserved heterogeneity in employment growth among micro and small firms. The results in the adjustment model are not very close to the panel model specifications. Differences in the size of elasticity and the lack of significance of coefficients indicate the importance of the loss of information due to the use of only the first and last years of data.

In sum, the employment growth model in general, and elasticity of age and size in particular, are found to be sensitive to the choice of functional form and estimation method. The exclusion of squares and interaction terms of age and size variables results in sizable changes in the elasticity. In general the age elasticity is small, negative and weakly significant while the size elasticity is significant and negative with a large impact on the growth rate. Among the characteristic variables, labor productivity and capital intensity have major impacts on employment growth. Unexpectedly, indebtedness and profitability are found to be less important to the growth patterns of micro and small firms. We expected a positive correlation between profitability and growth in employment, indicating that access to credit and high profitability enhance growth in employment. The time effects are negative, which is interpreted as regressive growth development compared to the reference year of 1994. This might be due to the effects of the financial crisis in Sweden and the consolidation of the banking sector.[10] It should be noted that the model performance in terms of the coefficient of determination is low and this result should be interpreted with caution.

6.3. *The assets growth model*

The second model, the assets growth model, is specified using age and size variables as well as a number of production characteristic variables, reported in the previous sub-section, to control for unobservable factors (see Table III.B). Unlike for the employment model we do not expect a negative relationship between assets and size, defined as the number of employees. A positive (negative) sign indicates increasing (decreasing) assets intensity per employee. Again, the test results indicate that the pooled OLS is not an appropriate estimator of the parameters of the growth equation, and it is used simply as a starting point for the analysis.

Only one out of five age or size coefficients is statistically significant in the pooled OLS model. The coefficient of lag assets is negative and significant, indicating that fixed factors are important deterrents of growth. With the exception of the within model (–1.02), the coefficient varies between –0.17 and –0.34. The indebtedness variable is negative but profitability is positive; this can be interpreted as meaning that micro and small firms facing credit restrictions rely on internal investment sources for growth. Other environmental variables are insignificant. The model in general does not perform well. Various test statistics indicate the presence of unobserved firm-specific effects. Hence the pooled OLS is rejected in favor of a model incorporating firm-specific effects.

TABLE III.B
Assets growth model parameter estimates

Parameter	Variable/Estimation method	Between	Pooled OLS	Within	GLS	Adjustment
A. *Parameter estimates:*						
α_0	Intercept	0.5681	1.0915	–	1.3118	–0.2486
α_{EMPL}	Log lag employment	–0.2023	–0.1981a	–1.0203a	–0.1735b	–0.3374a
α_A	Log age	–0.2150	–0.2424	0.4164	–0.3308	0.1854
α_S	Log size	–0.0018	–0.0063	0.7308a	–0.0254	0.1083a
α_{AA}	Log age squared	0.0321	0.0424	0.0999	0.0586	–0.0368
α_{SS}	Log size squared	0.0264a	0.0313a	–0.0517b	0.0305a	0.0417a
α_{AS}	Log age × log size	0.0191b	0.0057	–0.2127a	0.0066	–0.0012
α_{DE}	Debt/Equity ratio	0.0616	–0.1451b	–0.3487a	–0.1634b	0.0749
α_{SE}	Log labor productivity	–0.0200	0.0084	–0.0001a	–0.0001a	–0.0018
α_{CE}	Log capital intensity	0.0884	0.0428	0.0543	0.0486	–
α_{PE}	Log profitability	0.0141c	0.0026	0.0092	–0.0002	0.0076
α_{UV}	Log (unemployed/vacancy)	0.0106	–0.0150	–0.0263	–0.0133	0.0145
α_{ED}	Average length of education	0.0424	0.0279	0.0351	–0.0003	0.0316
α_{HE}	% with high education	0.0055	0.0001	–0.0356	0.0033	–0.0006
α_{RS}	Log regional support	0.0021	0.0097	0.0054	0.0111	–0.0042
α_{LAMBDA}	Selection effect	0.1208	0.1689	–0.0408	0.2232	–0.0945
α_{1996}	Dummy 1996	–	–0.0440	0.0139	–0.0444	–
α_{1997}	Dummy 1997	–	–0.0593	0.0483c	–0.0627	–
α_{1998}	Dummy 1998	–	–0.0344	0.0043	–0.0183	–
B. *Specification tests:*						
Adj R^2	Adjusted R^2	0.1440	0.0767	0.1989	0.0882	0.6867
RMSE	Root mean square error	0.2954	0.5577	0.4338	0.5478	0.1934
F-test	H0: slopes are 0	23.0930a	28.2970a	82.583a	31.0940	309.4040a
F-test	H0: lag dep. var. is 0	2.4613	5.8896a	153.5546a	4.5575b	175.3208a
F-test	H0: squ. & inter. are 0	8.7406a	7.9745a	17.5747a	7.4761a	35.4468a
F–test	H0: squ. & inter. & lag are 0	7.0966a	7.3047a	51.3246a	6.5949a	517.4952a
NT	Number of observations	1971	5913	5913	5913	1971
C. *Age elasticity:*						
E_{AGE}	Unrestricted Model I	–0.0384	–0.0374	0.4164	–0.0625	0.0230
E_{AGE}	Restricted Model II	–0.0154	–0.0099	0.4807a	–0.0111	–0.0101
E_{AGE}	Restricted Model III	–0.0155	–0.0101	0.4333a	–0.0115	–0.1053a
D. *Size (log employment) elasticity:*						
E_{SIZE}	Unrestricted Model I	0.1192c	0.0979c	0.7308b	0.0737c	0.2232a
E_{SIZE}	Restricted Model II	0.1249	0.1070	0.1320	0.0856	0.2219a
E_{SIZE}	Restricted Model III	–0.0645	–0.0803a	–0.8069a	–0.0749a	–0.0486a

Notes: Significant at less than 1% (a), 1–5% (b) and 5–10% (c) levels of significance.
In the unrestricted Model I squares and interactions of age and size and the lag dependent variable are included. In the restricted Model II the square and interactions of age and size are excluded, while in Model III lag dependent variables are excluded as well.

The firm-specific effects are not correlated with the explanatory variables, indicating the GLS methods are the appropriate methods for estimation. The results from the three GLS models show both similarities and dissimilarities with respect to the key variables of age and size and other additional characteristic variables. Again the negative sign indicates that assets are increasing towards their optimal level. We do not observe any systematic time effects concerning the growth rate of assets over time. Among the production characteristic variables, we find that indebtedness and labor productivity affect asset growth. The selection effect is negative and not significantly different from zero.

The overall results show evidence of the absence of any age effects, and a negative and weakly significant size effect. The latter indicates declining asset intensity as the size of firm increases in terms of the number of employee. According to the GLS results, the age and size variables are not sufficient statistics to detect all unobserved heterogeneity in asset growth among micro and small firms. Unlike with the pooled OLS and GLS methods, we observed significant size effect in the adjustment model. Like with employment model, the assets growth model is found to be sensitive to the choice of functional form. The exclusion of squares and interaction terms of age and size variables results in changes in the sign, significance, and size of elasticity. The age elasticity is small and weakly significant compared to the size elasticity, which is significant and negative with a large impact on the growth rate of assets. Indebtedness and profitability are not found to be important to the capital formation of firms.

6.4. *The sales growth model*

Growth in total sales is the third growth model specified (Table III.C). The coefficient of the lag value of sales is negative and highly significant in all models, indicating the importance of fixed factors deterring growth in sales. The magnitude of the coefficient varies with respect to the estimation method and model specification. The sales growth model is specified using age, size and other firm characteristic variables. The pooled OLS used as a starting point shows that age and size, and their squares and interaction, together with indebtedness, profitability, unemployment per vacancy, level of education and the time effects all matter. The pooled model however was rejected in favor of a model incorporating unobservable firm heterogeneity effects. Again the test results indicate that the firm-specific effects are incorporated and not correlated with the explanatory variables, indicating that a random effect approach is an appropriate method of estimation.

The age elasticity in models incorporating a lag level of the dependent variable is found to be positive, while the size elasticity is negative, significant and consistent with expected outcomes. Here a negative (positive) size effect is interpreted as meaning there are increasing (decreasing) returns to scale or, alternatively, increasing (decreasing) productivity of labor. Unlike the employment growth model, the age and size elasticities are close in magnitude. Among the characteristic variables, the degree of indebtedness, profitability, unemployment per vacancy, and level of education are found to affect the growth in sales positively, indicating that access to credit and internal financial sources enhance growth in sales. Capital intensity and regional support do not have an impact on sales growth. The time effects are negative and significant in all models. In the within and dynamic adjustment models we observe the impact of regional support on the growth of sales. This is primarily due to a lack of data with high coverage of regional support provided through different regional development agencies and programs. The current support variable covers only a few firms, and these are not individually identifiable in each community receiving regional support, which is provided by NUTEK, and thus is far from full coverage.

To sum up, the sales growth model and elasticity of age and size are found to be very sensitive to the choice of functional form. The exclusion of squares and interaction terms of age and size variables results in major changes in the size of elasticity. Their significance and their signs also change. In general, the age and size elasticity are significant and positive with a large impact on the growth rate. Indebtedness and profitability are important to the sales growth of firms.

7. Summary and conclusions

This paper aims to contribute to the exploration of the growth patterns of firms. The relationship between firm size, age, and growth rate is examined for a large sample of micro and small firms in Sweden. These firms have 1–100 employees and operate in the county of Gävleborg. Micro and small firms dominate the industrial structure of the region and are important to the region's economic development. The data covers the period 1993–1998.

Three definitions of growth rate – in terms of the number of employees, sales and assets – are used. The models are estimated using various estimation methods accounting for heterogeneity among firms not reflected in their age and size differences. In the estimation of the growth rate we control for various factors characterizing the

TABLE III.C
Sales growth model parameter estimates

Parameter	Variable/Estimation method	Between	Pooled OLS	Within	GLS	Adjustment
A. *Parameter estimates:*						
α_0	Intercept	0.5897	–0.5202	–	–0.3749a	0.3905
α_{EMPL}	Log lag employment	–0.0617a	–0.1333a	–0.9437a	–0.1691a	–0.0915a
α_A	Log age	0.0592	0.6912a	0.4713a	0.6965a	0.1700
α_S	Log size	–0.0345b	–0.0041	0.3470a	0.0105	–0.0355b
α_{AA}	Log age squared	–0.0171	–0.1356a	–0.0557	–0.1357a	–0.0361
α_{SS}	Log size squared	0.0201a	0.0289a	0.0347a	0.0335a	0.0267a
α_{AS}	Log age × log size	0.0054	0.0027	–0.1016a	0.0017	0.0019
α_{DE}	Debt/Equity ratio	0.0801b	0.1233a	0.2375a	0.1213a	–0.0013
α_{CE}	Log capital intensity	0.0004	–0.0107	0.1259a	0.0061	0.0047
α_{PE}	Log profitability	0.0160a	0.0182a	0.0063c	0.0153a	0.0074
α_{UV}	Log (unemployed/vacancy)	0.0103	0.0226c	0.0003	0.0237c	0.0103
α_{ED}	Average length of education	–0.0149	0.1407b	0.0140	0.1425b	0.0299
α_{HE}	% with high education	0.0018	0.0025	–0.0094	0.0039	0.0016
α_{RS}	Log regional support	0.0094	–0.0030	–0.0108a	–0.0050	0.0123b
α_{LAMBDA}	Selection effect	–0.0702	–0.5470a	–0.1515c	–0.5521a	–0.1441
α_{1996}	Dummy 1996	–	–0.0112	0.0070	–0.0154	–
α_{1997}	Dummy 1997	–	–0.0918a	0.0175	–0.0964a	–
α_{1998}	Dummy 1998	–	–0.2600a	–0.0277c	–0.2717a	–
B. *Specification tests:*						
Adj R^2	Adjusted R^2	0.0841	0.0890	0.4580	0.1117	0.1747
RMSE	Root mean square error	0.1628	0.2979	0.1926	0.2788	0.1545
F-test	H0: slopes are 0	13.9250a	34.9810a	294.5910a	42.3270a	30.7920a
F-test	H0: lag dep. var. is 0	76.1253a	353.0906a	373.6235a	431.0832a	217.6335a
F-test	H0: squ. & inter. are 0	12.2964a	27.6005a	13.8603a	27.0516a	23.9987a
F–test	H0: squ. & inter. & lag are 0	27.5316a	106.7707a	943.8684a	125.6335a	71.5733a
NT	Number of observations	1971	5913	5913	5913	1971
C. *Age elasticity:*						
E_{AGE}	Unrestricted Model I	–0.0121	0.0666a	0.4713a	0.1992a	0.0149
E_{AGE}	Restricted Model II	–0.0227a	–0.0218a	0.1905a	–0.0196a	–0.0169a
E_{AGE}	Restricted Model III	–0.0227a	–0.0221a	0.1509b	–0.0219a	–0.0172a
D. *Size (log employment) elasticity:*						
E_{SIZE}	Unrestricted Model I	0.0363b	0.0861b	0.3470a	0.0895c	0.0436b
E_{SIZE}	Restricted Model II	0.0484a	0.1015a	0.2064a	0.1277a	0.0584a
E_{SIZE}	Restricted Model III	–0.0134a	–0.0321a	–0.5114a	–0.0327a	–0.0344b

Notes: Significant at less than 1% (a), 1–5% (b) and 5–10% (c) levels of significance.
In the unrestricted model I squares and interactions of age and size and the lag dependent variable are included. In the restricted Model II the square and interactions of age and size are excluded, while in Model III lag dependent variables are excluded as well.

sample firms, their performance, human capital and local labor market conditions. Evaluation of the effects of regional development policy programs is very important in order to highlight their effects on the growth and formation of firms. Our results based on a large sample are as follows.

First, we find evidence of the presence of significant selection effects, the size of which differs depending on the definition of the growth variable, the estimation method, and the model specifications used. The coefficient is positive in the employment growth model while it is negative in the assets model and insignificant in the sales model. It is important to proceed with the two-step procedure in order to correct for selection bias.

Second, in the accepted GLS results the hypothesis of independence between firm size and firm growth, known as Gibrat's law, is rejected. The relationship is found to be negative in the employment model, while it is positive in the sales models. The latter finding indicates the presence of scale effects when sales are considered. The size effect in the assets model is insignificant.

Third, the negative relationship between the age and growth of firms predicted by Jovanovic is found to hold in the employment model, while it is positive in assets and sales growth models.

Fourth, the direction of changes in the expected growth rate of variables of interest, due to changes in the age and size of firms, is not always in accordance with the expected (negative) outcome. Employment, assets and sales do not necessarily develop in the same direction for a given firm and do not necessarily have the same relationship to the age and size of firms. The positive relationships might be due to the relatively young age of the firms, the fact that large and older firms have the advantage of having established finance, goods and services. Infant industries are in a learning stage of their evolution and differ from mature industries in their behavior and responsiveness. A positive relationship between growth in sales and the size of firms defined in terms of the number of employees indicates that the presence of scale effects improves labor productivity.

The GLS estimation method suggests a much stronger impact on the expected growth rate than the pooled OLS and adjustment models. Among the firm-characteristic variables, we found that indebtedness negatively (positively) affects the growth rate of assets (sales), while it has no impact on employment. Log profitability is found to have a positive impact on sales growth. Labor market and human capital variables show little positive impact on the growth of firms. The partial measure of regional support was not found to stimulate growth when the average firm was considered. However, it might have positive effects on the growth of individual firms receiving development support.

Smaller firms generate proportionally more jobs, suggesting support given to stimulate employment should be directed at newly established micro firms. Subsidies to improve capital structure and sales have more of an impact on large and older firms. The results support previous findings that firms of different sizes differ in their financial structure. Various institutional factors might have made the conditions unfavorable for very small firms, start-ups, less capital-intensive firms and family-owned businesses, thus reducing their growth potentials.

Acknowledgements

Financial support from The Swedish Council for Research in the Humanities and Social Sciences (HSFR) and Service Research Forum (TjänsteForum) is gratefully acknowledged. Mats Näslund, Anna Persson, Robert Brandt and Margareta Östmark have kindly provided different parts of the data. I would like to thank Erik Ruist and participants of the seminar held at the Stockholm School of Economics and the Office of Labour Market Policy Evaluation (IFAU) for their helpful comments and suggestions.

Notes

[1] Lang et al. (1996) in their study of firms' leverage, investment and growth defined three growth measures in terms of the growth rates of net investment, capital expenditure and employment. Brush and Chaganti (1998) used financial soundness (see also Sharpe, 1994).

[2] Market Manager contains information on 250,000 active Swedish limited companies and 95,000 non-active companies. The information covers the last 4 years. The database is updated 4 times a year. Information about access to the database can be acquired from MM Partner AB, +46 8 6744000.

[3] Centrala företags- och arbetsställeregistret (CFAR). For information on CFAR, see http://www.scb.se/.

[4] The starting date for balancing the books determines the year of observation. The first year of observation starts in 1993–1994 while the fourth year of observation refers to 1997–1998.

[5] Inclusion of micro firms with very few employees has the disadvantages that the percentage change in employment is a highly negative function of size.

[6] Das (1995) in addition to the age and size-related growth uses the lag of size, $\ln S_{it-1}$, to account for the impact of fixity of capital. However, this approach has the disadvantage of losing one year of observation, which can be very important in short panels.

[7] For reviews of various approaches to the estimation of error component models, see Hsiao (1986) and Baltagi (1995).

[8] The restrictions imposed involved turnover above SEK 1 million, 1–100 employees, 4 years of consecutive observation, and contraction and expansion of employees limited to between –80% and +400%, respectively.

[9] It should be noted that in the case of the employment growth model no lag employment is used because the size variable is defined in terms of employment in the previous year. Consequently, the lag employment in levels and size variable are basically the same.

[10] We have no firm level data available covering the period prior to the Swedish banking crisis to compare our post-crisis growth with pre-crisis growth.

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