The empirical analysis of the growth rate on Small and medium size Enterprises(SMEs) in Korea

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Abstract

This paper relates recent empirical research on the growth. Smaller and younger firms have been growing more quickly than larger and older firms, thus, generating proportionately more new jobs. It is not difficult to understand why small and medium firms receive so much attention. Because SMEs provide about 80 percent of private sector employment so SMEs performance is an important economic and social factor. Despite this, they are subject to higher risk and mobility than those at the large firms. This paper is analyzes the relationship between firm growth measured as growth in employment, sales and production and firms age, size and R&D investment. The growth and its relationship with the determinants is linked to industrial policy in Korea. Empirical results are based on an unbalanced panel data covering period 1999-2002. Results show significant relationship between growth, size and age of firm.

Key words : SMEs, Firm growth, Size, Firm age, Employment, Gibrat' s law
JEL Classification Numbers

I. INTRODUCTION

Firm and industry growth is critical to the economy, perhaps more critical to a developing rather than a developed economy. How does growth vary in terms of the size of firms, sales, capital formation and age. We further look at the effects of various types of policy and support on their survival and growth rates. Do small firms grow faster than large firms? Do new firms grow faster than old firms? The relationship between growth and size has traditionally been a major

issue in the theoretical as well as empirical literature on firm growth.

In general small and medium size enterprises(SMEs), are conducive to production expansion, income increase, job creation and development of technology. They are playing various and critical roles not only in enhancing regional development, but also boosting free market. Up until now, Korean SMEs have been playing a vital role in creating jobs and increasing income, as well as contributing to the rapid economic growth through incessant technological innovation and the production of quality products.

After the financial crisis in 1998, Korean government emphasizes on the increase of venture business through the Venture Designation policy. The reasons are that SMEs play an important role in creating jobs and they are building a flexible adaptable base for an internationally competitive economy.

The performance of small and medium size enterprise(SMEs) or venture business or start-ups in terms of industrial renewal, employment creation, export growth and productivity is thus a matter of interest to policy maker and the way that it affects various support packages to enhance their growth and domestic and international competitiveness.

The main objective of study is to analyze the growth of SME including venture business or start-ups on the base of the theories of firm growth. The relationship between the growth of firms, their size and age is summarized as Gibrat's law suggesting that all firm growth with the same rate and there is no relationship between size and age of firms and the rate of growth. The theory has been tested and empirical results show however a negative relationship between growth and size and age of firms. Through the analysis of the relationship between growth and age and size of firms, in addition we look at the effects of various types of policies on growth of firms. In this paper the number of the employment is less than 100. We are concerned that whether or not the growth rate of SMEs in Korea also has the same pattern as the Gibrat's law. Through this research, this paper presents a contrasting econometric analysis of small and medium size enterprises. Although the current study has been motivated of SMEs in terms of less than 100 employments, the factors identified are applicable to SMEs more than 100 employment of SMEs.

The remainder of this paper is organized as follows. In Section 2 we introduce the definition of SMEs and provide the background of the theory. Empirical

evidence found in the literature is reviewed. In the section 3 the data is described. Section 4 outline growth models and discuss estimation of the models. In the section 5 we analyze the results. The discussions of the results are continued in Section 6.

Ⅱ. THE GROWTH-AGE-SIZE RELATIONSHIPS

2.1 SMEs definitions

In general, firms are classified as SMEs if the number of employees in a firm does not exceed 300. Firms are considered as micro if their number of employees is with 1~10 employees. Firms with an employment size of 10~100 are labeled as small, and those between 100~300 medium. This paper focuses on the small and medium enterprise(SMEs). To avoid changes in the size over time we use the average employment over 3 years in the classification firms into size classes due to the high mobility of firms. In the case of getting out of the above standard, a three-year grace period is granted(Framework Act on Small and Medium size Enterprises). In terms of the number of employees due to the expansion of scale, the company is regarded as SMEs for three years.

2.2 The theory of growth-age-size relationships

In the economic theory, all kinds of firms have a long run average cost curve; U shape graph. Firms grow until they reach the size corresponding to minimum average cost. There in no incentive to grow beyond this size. Thus, the dispersion of firm's sizes will be very small, attributable to disequilibrium or mistakes, and this dispersion will reduce over time as firms converge towards the equilibrium size. We can assume that there are a negative relationship between growth of firms and scale at specific time in the long run. In general, small firms were located at the period of optimal scale of economy, but large firms were located at the period of diseconomy of scale.

The U-shaped average cost curve of a firm is purely a theoretical concept: obviously a firm would avoid growing large enough to encounter increasing

average costs and so we cannot expect to observe such cases unless the firms make mistakes. Empirical cost curves are likely to be L-shaped, with firms of widely different sizes beyond minimum efficient scale.

In more recent years, research on the faster growth of smaller companies has shown that growth may also be the result of production environmental as well as of various government policies and financial market characteristics which foster the growth of small firms.

2.3 Firms of size

The theoretical issues of relationship between the growth of firms, size and age have been kept going on in the center of Gibrat's law of proportionate effect as well as in the empirical literature about the formation and growth of firms. According to the Gibrati's theory, the growth rate of firms is proportional to the scale(size, age). They assert that all firms' growth occurs at the same rate over an interval of time, regardless of their initial size. Hart and Prais(1956); Simon and Bonini(1958); Hymer and Psahigan(1962) are same assert. Empirics show two types of results related to the above issues. A number of empirical studies show negative and positive findings.

To explain the discrepancy between the theory of Gibrat's proportional growth law and empirical evidence, Jovanovic(1982) emphasizes on the growth of firms and survival related to the age as the key factors determining a firms' growth dynamics. According to the Jovanovic's assert, efficient firms grow and survive, while inefficient firms decline and fail.

Results in Mansfield(1962) and Mata(1994) suggest that there is a negative relationship between the growth of firms and size. These suggestions can be interpreted in terms of Gibrat's law of proportionate effect as the small firms are inclined to higher disappearance than large firms. Sigh and Whittington's (1975) show that the large firms are inclined to higher growth rate than growth of small firms by studying manufacturing, construction, services and distribution industry in England. Evans(1987a, 1987b), Dunne and Hughes(1994) and Liu, Tsou and Hammitt(1999) find negative relationships between the growth, age, and size of firms in the US, UK and Taiwan.

2.4 Age of firms

Jovanovic(1982) suggest that the relationship between growth of firms and age is negative. According to Jovanovic's idea, new firms are inclined to grow faster and higher than old firms when output is a decreasing convex function of managerial inefficiency. Based on these theories, firm size and age are considered to be determinants of growth. However, Das(1995) finds age and growth to be positively related using Indian computer hardware industry firms. It is to be noted that pattern of growth in computer industry been different than other mature industries explaining the positive relationship.

2.5 Other factors

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, Of and Stulz, 1996) Heshmati 2002) human capital and export activities(Liu, Tsou and Hammitt, 1999), and regional state support(Heshmati 2002).

In Appendix A we present a selection paper with important contribution to the above relationships. These research present results from application of the above model to manufacturing in different countries, different periods, sample size, the type of growth studied, and found effects with respect to age, size, productivity, technology, capital structure and export activities. Majority of the studies use panel data growth in employment.

This paper by using the gained experience from above studies contributes to the exploration of the growth pattern of SMEs Korea and relates growth to age and size determinants as well as other characteristics.

Ⅲ. THE DATA

The data used in this paper was obtained from Korea Information Service

(KIS). It covers the time period from 1999 to 2002. The data allows for the exit and entry of firms. It has not been possible to distinguish between exits, mergers and what may be non-responses. The total number of firms is 1243. The size of firms is limited to below an average of 100 employees for the period studied.

The growth rate as dependant variable is defined in three different ways: (1) growth in sales (2) growth in employment, and (3) growth production. These three definitions are used to investigate the relationship between growth and firm size, age. The summary statistics of the data and variables is presented in Table 1. Firms on average have 23 employees with 18 employees as dispersion. The sales show low dispersion while capital intensity, value added per employee and labor productivity show large dispersions.

We use export activity represented by a dummy variable, capital intensity measured as capital per employee and a set of time dummy variables representing years of observation as added variable to age and size and initial value of the dependent variables.

In most studies of the relationship between growth, size and age, sample selection bias arises because of the use of a balanced panel. The reason is that a balanced panel ignores data on firms that have been in operation only during a part of the sample period because of entry and exit. Here, we include the data on any surviving firm be it an entrant or a slow-growing firm that exit later. Hence panel is unbalanced.

In Appendix B we present classification of SMEs by the type industrial sector size intervals. In Appendix C we show the frequency of firm by their R&D activities and over time. There is little variation in R&D performance over the short period of time. Appendix D shows the development of export activities. There is a sharp increase in exporting in 2001 and decline back to the same level in 2002. The age distribution of firms shown in Appendix E suggests that majority of firms(65%) less than 10 years been are established.

The data contains only manufacturing industries(see Appendix G). The industry sectors included in the sample are: Publishing(336), Wearing apparel(153), Machinery & Equipment(138), Electrical Machinery(120), Radio & Communication(104), Medical & precision(68), Instrument watches(82), office & computing(43) Textiles(13), Pulp & paper(34), Basic Metals(11),

Motor vehicle(10), wood & Product(1), and Semi-trailers(1). The numbers in parenthesis is the number of firms in each sector.

Ⅳ. GROWTH MODEL AND ESTIMATION PREOCEDURES

4.1 The Model

As shown in above the data consists of a cross section of firms each observed a number of time periods. The time dimension of the data is very short-4 years. After computing growth rate in the dependent variable, 3 years or 3 observations per firm is used in regression analysis. Such models can be viewed as two-way designs with covariates:

Where N is the number of cross sections, T is the length of the time series for each cross section, and K is the number of exogenous or independent variables.

Jovanovic's model(1982) implies that size at t+1 depends on size at t and Evans(1987) the growth variable at time t+1 is a function of size and age at time t in log forms is:

(1) $\ln Y_{it+1} = \ln F(A_{it}, S_{it}, P_{it}, X_{it}) + U_{it}$

The error term u_{it} following the tradition in the panel data literature (Baltagi 2001 and Hsiao 2003) can be decomposed into a firm-specific (μ_i), a time-specific (λ_t) and a random error term (ν_{it}) as:

(2) $u_{it} = \mu_i + \lambda_t + \nu_{it}$.

Using a translog Functional form for F (.) the relation is written as:

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

The relation in (4) can be rewritten in forms of the firm growth by subtracting

$\ln Y_{it}$ form both sides and adding environmental and heterogeneity variables represented by the vector X variables:

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

The left hand side variable is defined as:

$$(5)\ \Delta \ln Y_{it} = (\ln Y_{it+1} - \ln Y_{it}) \text{ or } \Delta \ln Y_{it} = (\ln Y_{it+1} - \ln Y_{it})/\tau,$$

Where τ measures the distance between two time periods. Here the distance is 1 year. By this definition one can use incomplete series with interruptions because of non-response.

4.2 Estimation Procedure

The time effects, λ_t, are often replaced with a time trend or time dummies. Thus the model reduced to two way error component model. In panel data literature, estimation of the model has been developed in two directions: the fixed effects(FE) model, where μ_i are assumed to be fixed and correlated with the X-variables, the random effects(RE) model, where μ_i is assumed to be random and not correlated with the X. The variances σ^2_μ and σ^2_ν, are unknown and must be estimated using multi-step GLS procedure.

In the fixed effects model the firm specific effects are assumed to be correlated with the explanatory variables, while in the random effects they are not so, is included the error component. The former is estimated using least squares dummy variable or with estimation method, while the later by generalized least squares method. In the case least square dummy variables the effects are estimated by including dummy variables. In within estimation of the relationship the data is transformed into deviations from own mean to wipe out the individual and time effects. In GLS the parameters of the distribution of the effects are unknown and must be estimated using pooled and with residuals before transforming the data. Least square regression of transformed data produces feasible GLS estimates. The inclusion of fixed firm and time effects in

fixed or random effects forms is tested using Chow and Lagrange Multiplier tests, while the choice of fixed or random effects can be tested using Hausman test. For details on these issues see Baltagi(2001) and Hsiao(2003).

In order to the research, fixed model is used. Because each firms is related with the explanatory variable. thus μ_i is not zero. $u_{it} = \mu_i + \lambda_t + \nu_{it}$. Where the μ_i and λ_t are nonrandom,

In matrix form the model in (5) can be rewritten as:

(6) $y_{it} = \beta_0 + \beta x_{it} + u_{it}$

y_{it} is the log growth rate of firm, x_{it} is the log of explanatory variables, β is vector of unknown parameters, ν_{it} are effect not controlled by the firm.

Since the parameters of the translog model because of squares and interaction terms are not directly interpretable we compute the total elasticity. Growth elasticity with respect to a percentage change in size and age are:

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

In order to evaluate the significance of the point elasticities one cane compute standard errors for the age and size elasticity obtained from:

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

The computed standard error will guide whether the point elasticities are different from zero or not. If the computed p value(significant probably) is lower than the critical value the null hypothesis of zero elasticity is accepted.

V. EMPIRICAL RESULTS

We now discuss the results, which are based on the fixed effects estimates.

We can find the all the coefficients from Table 2 to Table 4. Too many parameters to estimate, multicollinearity can be a problem. Regress each x on the remaining x-variables. The R^2 is a measure of the degree of multicollinearity from the regression results and the correlation coefficients we can draw the conclusion that multicollinearity is not a problem

5.1 The sales Growth Model

The sales growth model is specified using age, size and other firm characteristic variables. The test results indicate that the firm specific effects should be incorporated and not correlated with other explanatory variables. This indicates that a random effect approach is an appropriate method of estimation. The estimation results are presented in Table 2.A and the age and size elasticities in Table 2.B.

The coefficient of the lag value of sales is negative and highly significant in the model indicating the importance of fixed factors deterring growth in sales. The age elasticity in models incorporating a lag level of the dependent variable is found to be positive. Here a positive size effect is interpreted as there are decreasing returns to scale or increasing productivity of labor. The reason why the elasticity is not enough to estimate is due to a small and lack of data covered. In general the age and size elasticity are significant and positive with a large impact to the growth rate. The results from model show that the firms which have low sales intend to grow fast and higher, and the firms which have R&D intend to grow fast and higher also. In other word, among the characteristic variables, the R&D and capital intensity are found to affect the growth positively. The time effects are significant, indicating, the growth in 1999 is higher than that of 2001.

5.2 The Employment Growth Model

The employment growth model is specified using age and size variables the results from models are expected that age and size in the absence of fixed costs are sufficient statistics to explain the unobservable differences among firms

from suggestion of Jovanovic's model. The estimation results are presented in Table 3.A and the mean elasticities in Table 3.B.

The mean values of age and size elasticity are very small. Thus, the difference between minimum to maximum is not statistically significant. It is impossible to determine whether Gibrat's law or Jovanovic's model applies. If the elasticity is negative relationship between growth and size, it suggests that Gibrat's law does not hold for micro and small firms. While the negative relationship between growth and age is supported with Jovanovic's model. When growth in employment is considered, the results from model show that the firms which have less employment intend to grow fast and higher, and the firms which have R&D intend to grow fast and higher also. In other word, among the characteristic variables, the degrees of R&D and capital intensity are found to affect the growth positively. The time effects are significant indicating the growth in 1999 is higher than that of 2001.

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 in employment of micro and small firms.

5.3 The production Growth Model

Estimation of a model based on production is due to the presentation of inequality between production and sales. We have no information about changes in stock of goods. This was the main reason for estimation of the model based on both definitions. The estimation results are presented in Table 4.A and the mean elasticities in Table 4.C.

The production growth model is specified age and size variable and same characteristics like the employment and sales models. However, empirical evidence shows that a number of other variables should appear in the deterministic part of the growth model. The test result shows that the coefficient of lag production is negative and significant, indicating that fixed factors are important deterrents of growth. 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. The degrees of R&D and capital intensity are found to affect the growth positively.

It is inappropriate to assert that the time effects are significant indicating, the growth in 1999 is higher than that of 2001. When it comes to production models, result explained evidence of the absence of any age and effects, and a negative and weakly significant effect. According to the results, the age and size of firm sufficient statistics to detect all unobserved heterogeneity in production growth model is found to be sensitive to choice of function form. The age elasticity is small and weakly significant compared to the size elasticity, which is significant and negative with impact on the growth rate of production.

VI. DISCUSSION OF THE RESULTS

The main purposes of this paper are to help in the exploration of the growth patterns of small and medium size enterprises(SMEs) in Korea. The information can be useful in evaluation of support to such class of firms and the design of such policy to enhance growth of firms and creation of more jobs. The contribution of small and medium size enterprises(SMEs) to employment is important in a structural sense and in a dynamic sense.

Three definitions of growth rates in terms of: sales, number of employees, and production value are used. The models are estimated using panel data regression techniques. In the estimation of the growth rate we control for various factors characterizing the sample firms, such as R&D investment, export activities, and capital intensity. Results based on empirical data are as follows.

First, the hypothesis of independence between firm size and firm growth is rejected. The relationship is found to be negative in the employment model while it is positive in the sales models.

Second, fining of a negative relationship between the age and growth of firms is in support of the Jovanovic's models suggesting that small forms growth much faster than larger firms in attaining their optimal size.

Third, the effect of R&D investment on growth in employment and sales are positive, while it is negative in the production model.

Fourth, the effect of export on job creation is not significant in all models formulations.

As expected, the capital intensity affects positively and significantly growth in all models. Micro and small firms generate proportionally more jobs suggesting support given to stimulate employment should be given to younger micro firms. The direction of changes in growth rates due to changes in age and size is not always in accordance with the expected outcome. Based on the empirical results of the determinants of the growth of small firms, R&D is crucial for growth rate in the small and micro firms.

As mentioned previously, the purpose of this research is not only to confirm of growth theory based on Gibrat's law in Korea but also to provide the information for policy decision making in to enhance the growth of SMEs. This is not quite the same as the generation of employment, because this may be increased by extending overtime rather than by hiring more employees. There are many reasons why firms may prefer to grow without increasing the number of jobs, such as avoiding various non-wage labor costs. These do not feature in the theory of growth of firms but they are nevertheless important for employment policy.

Firms may also grow if they have much capital. Firms may also grow through the effort of innovative activities in terms of R&D. So government has to try to make policy to foster the small and micro firms.

The strong positive effect of age on growth is perhaps the most striking result of this study. It suggests that policy makers should be concerned the creation of infant firms to pursue the economic development in Korea.

It is expected that export is positive the growth, but according to the empirical results export doesn't affect the firm growth. SMEs are regarded as being job creation, at providing a major source of competitive renewal for an industrial structure. SMEs are also a significant source of exports. Government faces two policy problems. The first is the creation of jobs. The second is the creation of an internationally competitive industrial structure. These two problems are closely linked. Job creation is often necessary to replace destructed jobs. It is fact that up until now government supports the SEMs as the survival of SEMs, such as financial, law of protecting the risk surrounding the SMEs. Of course, they are necessary. The more important thing is that

government has to help SMEs which are trying to effort the R&D for technological innovation, so only innovative firms will be supported by government. The difficulties of R&D procedure in SMEs are short staffs who have a ability to research, so government need to make a design the program linking between the university and SMEs in terms of cooperative research and information.

Overall, SMEs tend to introduce lower value innovations than large firms. Although it is very difficult to measure such contributions, it has long been recognized that one of the most important contributions of small firms to innovation is through the provision of specialized equipment which enhance the production. Thus, government has to design the policy to help the SME because SMEs do not have access to sufficient capital to have specialized equipment. To increase the capita of SME, government has to implement much strong policy to change the flow of capital to small firms instead of large firms. Since SMEs tend to have a high risk of failure, many investors are reluctant to invest in small firms. Various forms of venture funds and credit guarantees will promote investment to SMEs and thereby job creation is increased. Innovative or technology based new and small firms are more likely to create employment than similar firms that don' t act the technological innovation.

In addition, governmental policies put emphasis on constructing a system in which rewards are made through fair market competition and creating an atmosphere in which SMEs and venture enterprises armed with creativity can lead the nation' s economy.

The significance for SMEs in Korean economy has become greater and greater than before. In most industrial sectors, SMEs are expected to make great progress. In particular, many technology and knowledge intensive SMEs are expected to be established and to grow rapidly in areas accelerating technological innovation and amalgamation such as information technology, communications, new materials and life science. The outcomes of economic activities performed by companies rely on diverse economic policies, institutions and other structures in the society to which each company belongs.

This paper has a lot of limitation including the relationship between firm size or industry concentration and the adoption of new technology by a firms is

subject to many of the same considerations as the relation of these factors to innovation. Since many kinds of industries are used to research this paper tends to contain the low depth.

In comparison of the previous study and this one, the relationship between the growth of firms, size and age is different depending on the nation, time of study, explanatory variable. In the future, this kind of study will be implemented with many samples in order to increase the meaningful.

REFERENCES

Audretch, D. B.(1995), "Innovation, Growth and Survival", *International Journal of Industrial Organization* 13, pp.441~457.

Bruce, S. Tether.(2000), "Small firms, Innovation and Employment creation in Britain and Europe A question of expectations", Technovation 20, pp.109~113.

Chrisman, J.J, J. Leslie(Spring 1989), "Strategic Administrative and Operating Problem: The Impact of outsiders on Small Firm Performance", *Entrepreneurship Theory Practice*, pp.37~51.

Chris Hall, Charles Harvie(Fall 2003), "A comparison of the performance of SMEs in Korea and Taiwan", *The Journal of the Korean Economy*, Vol.4. No.2, pp. 225~260.

Das, S., "Size Age and Firm Growth in an Infant Industry: The computer Hardware Industry in India", *International Journal of Industrial Organization 13*, pp. 111~126.

Dunne, T., A. Hughes(1994), "Age Size, Growth and Survival; UK companies in the 1980s", *Journal of Industrial Economics*, 42, pp.115~140.

Geroski, P. A.(March 1999), "The Growth of Firms in theory and practice", *centre for Economic Policy Research, Discussion Paper*, No.2092.

Hart, P. E.(2000), "Theories of Firms", *Growth and the Generation of Job, Review of Organization*, 17, pp.229~248.

Heshmati, Almas.(2000), "On the Growth of Micro and Small firms, Department of Economic Statistics", *Stockholm School of Economics, SSE/EFI working Paper*

Series, No.396.

Jovanovic, B.(1982), "Selection and the Evolution of Industries", *Econometrica, 50*, pp. 649~670.

Liu, J. T., M. W Tsou, J hammitt(1999), "Do small plants grow faster? Evidence from the Taiwan Electronics Industry", *Economics Letter*, 5, pp.121~129.

Mata, J.(1994), "Firm Growth during Infancy", *Small business Economics, 6*, pp.27~39.

Mcpherson, M. A.(1996), "Growth of Micro and small Enterprises in southern Africa", *Journal of development Economics*, 48, pp.253~277.

Penrose, E. T.(1980), "*The theory of the growth of the firms*", Oxford Blackwell.

Sung, Ho Young(1999), "A study of firm growth between size and age: Manufacturing of korea" *The research of industrial organization*, pp.71~85.

Wijewardena, H., S. Cooray(1995), "De terminants of Growth in small japans Manufacturing Firms : survey Evidence from Kobe", *Journal of Small Business management*. Vol.33. No.4, pp.87~92.

World Bank(1993), "The East Asian Mirale: Economic Growth and Public Policy", *A world Bank Policy Research Report*.

Zahra, S. A.(1996), "Technology Strategy and New venture performance: A study of corporate-Sponsored and Independent Biotechnology ventures", *Journal of Business Venturing*, 11, pp.289~321.

Table 1. Summary statistics of the firm level data, 1999~2002, NT=1243 obs.

VARIABLE	definition	Mean	Std dev	Minimum	Maximum
SALES	TOTAL SALES	15.6436042	13.283636	1	91
Employment	TOTAL EMPLOYMENT	23.494	18.389	4	100
CAPITAL	CAPITAL/EMP	384.619	1327.21	20	31664
VALUEADDED	VALUE/EMP	1304.94	2597.10	1	72197
PRODUCTION	PROD/EMP	3008.40	5062.84	97	104161

Table 2.A Parameter estimates from sales growth model, NT=1234 obs.

Variable	Estimates	Standard Error	t-ratio	Pr>| t |
Intercept	1.06987	0.1391	7.69	<.0001
l_sales	-0.51036	0.0215	-23.71	<.0001
age	-0.00573	0.00579	-0.99	0.3224
l_emp	-0.14225	0.0944	-1.51	0.1320
Age^2	0.000046	0.000106	0.44	0.6612
l_emp^2	0.05636	0.0154	3.65	0.0003
l_emp_age	0.002514	0.00159	1.58	0.1134
rnd	0.125124	0.0232	5.38	<.0001
export	-0.04447	0.0227	-1.96	0.0503
cap_int	0.000865	0.000204	4.24	<.0001
d1999	0.096723	0.0155	6.25	<.0001
d2000	0.006516	0.0155	0.42	0.6739

Table 2.B Elasticity of sales growth with respect to age and size of firms.

	Mean	Std dev	Minimum	Maximum
elas_age	0.0026	0.0021	-0.0018	0.0101
elas_size	0.2147	0.0879	0.0266	0.4925

Table 3.A Parameter estimates from employment growth model, NT=1243 obs.

Variable	Estimates	Standard Error	t-ratio	Pr>| t |
Intercept	0.986837	0.0671	14.71	<.0001
l_emp	-0.32597	0.0200	-16.32	<.0001
Age	0.00032	0.00415	0.08	0.9385
l_sales	-0.15581	0.0415	-3.75	0.0002
age^2	0.000081	0.000087	0.94	0.3491
l_sales^2	0.04343	0.00860	5.05	<.0001
l_sales_age	-0.00048	0.00119	-0.41	0.6834
Rnd	0.081201	0.0189	4.31	<.0001
export	-0.00424	0.0184	-0.23	0.8175
cap_int	0.000526	0.000166	3.16	0.0016
d1999	0.079687	0.0125	6.37	<.0001
d2000	0.009235	0.0125	0.74	0.4599

Table 3.B Elasticity of employment growth with respect to age and size of firms.

	Mean	Std dev	Minimum	Maximum
elas_age	0.0009	0.0014	-0.0016	0.0080
elas_size	0.0543	0.0679	-0.1650	0.2941

Table 4.A Parameter estimates from production growth model, NT=1243 obs.

Variable	Estimates	Standard Error	t-ratio	Pr>| t |
Intercept	3.44824	0.1915	18.01	<.0001
l_pro	-0.46949	0.0156	-30.14	<.0001
Age	-0.01705	0.00741	-2.30	0.0216
l_emp	-0.16794	0.1164	-1.44	0.1492
Age^2	0.000069	0.000136	0.51	0.6130
l_emp^2	0.070243	0.0195	3.61	0.0003
l_emp_age	0.004152	0.00203	2.05	0.0405
rnd	0.047172	0.0289	1.63	0.1025
export	0.045262	0.0284	1.59	0.1112
cap_int	0.0012	0.000260	4.61	<.0001
d1999	0.061666	0.0192	3.21	0.0013
d2000	-0.03051	0.0190	-1.60	0.1091

Table 4.B Elasticity of production growth with respect to age and size of firms.

	Mean	Std dev	Minimum	Maximum
elas_age	−0.0034	0.0034	−0.0106	0.0084
elas_size	0.2880	0.1133	0.0476	0.6700

Table 5. Performance of different growth models.

	sales	employee	Production
R2	0.2036	0.1585	0.2252
variance component for cross section	0.0752	0.0499	0.1278
variance component for error	0.1043	0.0664	0.1550

Note: Significant at less that 5−10% levels of significance

Appendix A. Summary of empirical findings on the growth, size−age relationships.

Researcher	Nation	Year	Sample	Dependant Variable	Explanatory variable						
					size	age	productivity	technology	capital	export	
Audtetsch (1995)	US	1976 ~ 1978	8,300	employment	(−)	−	−	(+)	−	−	
Doms, Dunne, Roberts (1995)	US	1987, 1991	6,090	employment	(−)	(−)	(+)	(+)	(+)	−	
Borei, Bellmann (1995)	Germayr	1978~ 1992	New firms	employment	−	(−)	−	Non−relative		−	
Audretsch, Santarelli, Vivarelli (1999)	Italia	1987~ 1993	1,576	equtityy	(−)	−	−	−	−	−	−
Dunne, Hughes(1994)	UK	1975~ 1985	2000	net equtity	(−)	(−)	−	−	−	−	−
Liu, Tsou Hammitt (1999)	Taiwan	1990, 1992, 1993, 1994,	915	employment	(−)	(−)	−	(+)		−	
Almas Heshmati	sweden	1994~ 1998	manufacturing11481	employment	(+)	(−)					
Wijewardena, Tibbits (2000)	Australia	1990~ 1994	maunfacturing500	employment	(+)	(−)	−			−	

Appendix B. Classification of small and medium size(SME) enterprises.

	Small and medium enterprise		Small enterprise
	Employees	Assets amounts	
Manufacturing	300 or fewer emp.	less than 80 billion won	50 or fewer emp.
Transportation	300 or fewer emp.	no standard	50 or fewer emp.
Construction	300 or fewer emp.	〃	30 or fewer emp.
Commerce,	20 or fewer emp.	〃	10 or fewer emp.
Other Services			

Appendix C. Research and Development(R&D) behavior of SME firms.

YEAR	0(DONE)	1(NOT DONE)
2000	1061(85.36%)	181(14.64%)
2001	1048(84.31%)	195(15.69%)
2002	1047(84.23%)	196(15.27%)

Appendix D. Export activities of SME firms.

YEAR	0(DONE)	1(NOT DONE)
2000	993(79.89%)	250(20.11%)
2001	1175(94.53%)	68(5.47%)
2002	1180(94.93%)	63(5.07%)

Appendix E. Age distribution of SME firms.

YEAR	1~4	5~10	11~20	More than21	Total
Number of firms	403	403	265	172	1243
Ratio	32.42	32.42	21.32	13.84	100

Appendix F. Size distribution of SME firms by employment.

	<10	11~20	21~50	51~100	Total
Number of firms	315	416	407	105	1243
Ratio	25.34	33.47	32.74	8.45	100

Appendix G. Distribution of SME firms firms by industry sector.

SECTOR	NUMBER	RATIO	CUMULATIVE NUMBER	CUMULATIVE RATIO
TEXTILES	13	1.05	13	1.05
WEARING APPAREL	153	12.31	166	13.35
LEATHER & LUGGAGE	12	0.97	178	14.32
WOOD & PRODUCT	1	0.08	179	14.40
PULP & PAPER PRODUCT	34	2.74	213	17.14
PUBLISHING	336	27.03	549	44.17
CHEMICALS & PRODUCTS	15	1.21	564	45.37
RUBBER & PLASTICS	32	2.57	596	47.95
OTHER NON-METALLIC PRODUCTS	12	0.97	608	48.91
BASIC METALS	11	0.88	619	49.80
FABRICATED METAL PRODUCTS	58	4.67	677	54.47
MACHINERY & EQUIMENT	138	11.10	815	65.57
OFFICE & COMPUTING	43	3.46	858	69.03
ELECTRICAL MACHINERY	120	9.65	978	78.68
RADIO & COMMUNICATION	104	8.37	1082	87.05
MEDICAL & PRECISION	68	5.47	1150	92.52
MOTOR VEHICLES	10	0.80	1160	93.32
SEMI-TRAILERS	1	0.08	1161	93.40
INSTRUMENT WATCHES	82	6.60	1246	100