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THE RELATIONSHIP BETWEEN FIRM GROWTH, SIZE, AND AGE: ESTIMATES FOR 100 MANUFACTURING INDUSTRIES

by

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A sample of all firms operating in 100 manufacturing industries is used to examine the relationships between the survival and growth of a firm and its initial size and age. The first major finding is that age is an important determinant of firm dynamics. Firm growth, the variability of firm growth, and the probability that a firm will fail decrease with firm age. The second major finding is that firm growth decreases at a diminishing rate with firm size even after controlling for the exit of slow-growing firms from the sample. Gibrat's Law therefore fails although the severity of the failure decreases with firm size.

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I. Introduction

This article examines some dynamic aspects of firm behavior for all firms that operated in a sample of 100 manufacturing industries between 1976 and 1980. It examines the relationship between three aspects of industry dynamics--firm growth, firm dissolution, and the variability of firm growth--and three key characteristics of a firm--its size, its age, and the number of plants it operates. It presents estimates of these relationships based on data pooled across all industries. It then presents a summary of the relationships found for each of the industries.

A number of studies have examined the relationship between firm growth and firm size. Hart and Prais's [1956] pioneering study of the growth of British companies was followed by studies by Hymer and Pashigian [1962], Mansfield [1962], and Hall [1987] for the United States and Singh and Whittington [1975] and Kumar [1985] for the United Kingdom. This paper makes three contributions to this literature.

First, it examines the relationship between firm age and firm dynamics. Except for my earlier paper [1986b] and Brock and Evans [1986], previous studies have not examined the lifecycle aspects of firm growth. Second, it relies on a larger and more comprehensive sample of firms and reports results for more detailed industry groups than have previous studies. With the exception of Mansfield [1962], researchers have relied on samples of publicly traded (and therefore generally large) companies and have not disaggregated these samples below the 2-digit industry level. This paper uses data on the complete size distribution of firms in the manufacturing industries considered and summarizes results for separate 4-digit industries. Third, unlike previous studies except for Hall [1987] and myself, it controls for sample selection bias and heteroskedasticity. Little hinges, however, on the statistical novelties.

The study finds several interesting relationships. First, firm growth decreases with firm size and firm age at the sample mean and for most of the firms in the interindustry sample. The negative relationship between growth and size holds for 89 percent of the industries and the negative relationship between growth and age holds for 76 percent of the industries. Second, the probability of firm survival increases with firm size and firm age at the sample mean and for most of the firms in the industry industry sample. The positive relationship between survival and size holds for 81 percent of the industries and the positive relationship between survival and age holds for 83 percent of the industries. Third, the variability of firm growth decreases with firm age at the sample mean and for most of the firms in the inter-industry sample. The negative relationship holds for 85 percent of the indus-tries. The relationship between the variability of firm growth and firm size is less clear. There is a negative relationship between variability and size for 80 percent of the industries. However, there is some evidence from the interindustry sample that the negative relationship between variability and size varies with age and with the number of plants operated by the firm.

The study therefore finds that firm age is an important determinant of firm growth, the variability of firm growth, and the probability of firm dissolution. Notably, the age relationships found are broadly consistent with the predictions of Jovanovic's theory firm growth in which entrepreneurs learn about their abilities over time.[1] Further empirical and theoretical work on the lifecycle dynamics of firms may hold some promise.

Gibrat's Law that firm growth is independent of firm size is rejected for this sample. The departures from Gibrat's Law decrease as firm size increases. Mansfield [1962] reached a similar finding and speculated that it was due to the exit of slow-growing small firms from the sample. The departures found here remain, however, after controlling for sample censoring arising from firm exit. This finding is of interest because several theories either assume or imply Gibrat's Law for the full size range of firms in homogeneous-product industries.[2]

Section II describes the data used in this study. Section III presents the statistical framework. Section IV reports the estimates. Section V summarizes the major results.

II. The Data

The sample of firms analyzed in this study were drawn from the Small Business Data Base (SBDB), which was constructed by the Office of Advocacy of the U.S. Small Business Administration from information originally collected by Dun and Bradstreet.[3] Data are available on firm employment, age, the 4-digit SIC code in which the firm primarily operates, and the number of plants.[4] The dataset includes most manufacturing firms with employees.

The fact that a firm has data on a file for a particular year does not necessarily mean that the data apply to that year. Because of reporting and collecting delays, the data for some firms are older than the data for other firms. Generally, current data are available for most larger and older firms. In order to examine firm dynamics over roughly the same phase of the business cycle and for roughly the same amount of time, observations for which data were more than two years old in the relevant years were deleted.[5]

Firm age is reported by year for firms that were six years old or younger in 1976. Firm age is reported for four age intervals for firms that were seven years or older in 1976: 7-20, 21-45, 46-95, and 96+. Estimates are reported separately for young firms and for old firms. For old firms, age is measured by an estimate of the average age of firms in the interval.[6] Separate estimates are reported for firms six years old or younger in 1976--hereafter referred to as young firms--and firms seven years or older--hereafter referred to as old firms.

There are several other drawbacks to this dataset. First, no data on mergers or acquisitions are available.[7] Second, although firms are identified by 4-digit SIC codes such identification is problematic for diversified (usually large) firms. Third, as of this time no systematic comparison of the SBDB data with alternative data sources has been made. But the number of firms identified by SBDB as operating in an industry differ, sometimes greatly, from the corresponding Census figures. Given the amount of judgement that is required to determine the industry classification of a firm, this disparity is disconcerting but not surprising.[8]

The SBDB is relied upon here because it is the most comprehensive micro dataset on firms and the only dataset that contains age informtion.[9] On the one hand, the results reported here are sufficiently promising to warrant the development of more refined panel datasets containing financial information as well as age data. On the other hand, given the potential problems with these data, considerable caution in evaluating the findings is advisable until they have been replicated on more refined datasets.

A sample of 100 4-digit manufacturing industries was selected randomly from the population of 450 4-digit industries. The 100 industries comprise 22.2 percent of all 450 manufacturing industries. They contribute 24.2 percent of value added and account for 25.9 percent of employment. The ratio of capital to sales was .33 for the sample and .35 for all manufacturing industries. Thus the sample is reasonably representative of the manufacturing sector. For a list of the industries included and summary information see Evans [1986c].

Data on all firms operating in these 100 industries were extracted from the SBDB. There were 105,186 firms operating in the sample of industries in 1976. The vast majority of these firms have fewer than 20 employees. In order to reduce the amount of data to be analyzed, only 25 percent of these small firms were included in the study.[10] Two industries had unusually large numbers of firms--SIC Code 2752 had 23,132 firms and SIC Code 3599 had 18,425 firms. In order to reduce the amount of data and in order to prevent these two industries from dominating the interindustry regression results, only 25 percent of the firms in these industries were included. These exclusions together with the ones discussed below reduced the sample to 42339 firms.

Because the economy was in a severe recession in 1982, growth and dissolution were examined between 1976 and 1980.[11] Firm growth is defined as

$$Growth=Ln[S_{t'}/S_t]/[t'-t]$$

where S is employment size, t' is the date to which the 1980 data apply, t is the date to which the 1976 data apply, and t'-t is the number of years between these two dates. Observations were excluded if t' was less than 1978 or if t was was less than 1974. Growth can only be calculated for firms that did not dissolve between 1976 and 1980. About a third of the young firms and about 15 percent of the old firms dissolved. The sample available for estimating the determinants of growth is therefore censored, a problem that will be dealt with below. No information is available on mergers. Thus, there is no way to distinguish between internal growth and growth through mergers.

Firm survival was coded as a 1 if a firm was on the dataset in both 1976 and 1980 and as a 0 if a firm was on the dataset in 1976 but not in 1980. The fact that a firm is not on the dataset in 1980 may mean several things. It may have failed (i.e. filed for bankruptcy), it may have voluntarily dissolved itself, it may have merged with another firm, or it may have been acquired by another firm. It is impossible to distinguish between these possibilities with the SBDB. Although information on some mergers and acquisitions could be obtained from auxiliary datasets, the large number of firms and industries included in the sample and limited resources precluded such an undertaking. An analysis of firms in the food manufacturing industries by MacDonald [1986] found that mergers and acquisitions accounted for approximately 13 percent of all dissolutions on the SBDB for firms with more than 20 employees. Mergers and acquisitions are probably less frequent for firms with fewer than 20 employees. Thus, while the data for the survival analysis may be contaminated with some "false" dissolutions, the degree of contamination is probably not too severe.[12]

In order to estimate the variability of firm growth the growth rate was calculated for 1976-1978, 1978-1980, and 1980-1982 and the standard deviation of these three growth rates was calculated. While the variability of firm growth is estimated imprecisely for each firm, there is some hope that the large number of observations available will enable reasonably precise estimates of the effect of size and age on this variability. Observations were deleted if the data were more than a year old in any one of the years. Because of dissolutions and lack of current data, an estimate of the variability of firm growth was available for only half of the firms that were on the dataset in 1976. The sample for estimating the determinants of variability is censored, a problem considered below.

Table I reports summary information on the variables used in the statistical analysis. Further details are in Evans [1986c].

III. Statistical Framework

This section outlines the estimation framework.[13] Firm growth is represented by the following regression equation.

$$(1)\quad [\ln S_{t'} - \ln S_t]/d = \ln g(A_t, S_t, B_t) + u_t$$

where A, S, and B denote age, size, and the number of plants respectively, t'>t, d=t'-t, g is a growth function which we shall approximate by taking a second-order expansion in the logs, and u is a normally distributed disturbance term with mean zero and possibly nonconstant variance across observations. Growth is observed only for firms that are in the sample in both t' and t. The probability that a firm will survive from t to t' is represented by the following probit equation. Let I=1 if a firm survives and 0 if it fails. The conditional expectation of I given the initial age, size, and number of plants is

$$(2)\quad E[I|A_t, S_t, B_t] = Pr[e_t > -V(A_t, S_t, B_t)] = F[V(A_t, S_t, B_t)]$$

where V can be thought of as the value (in excess of opportunity cost) of remaining in business, e_t is a normally distributed disturbance with mean zero and unit variance, F is the cumulative normal distribution function unit variance). Equation (2) is a standard probit regression.[14] V is approximated by a second-order logarithmic expansion.

Equations (1) and (2) form a standard sample-selection model. (See, e.g., Amemiya [1984].) It is possible to obtain consistent estimates of the parameters of the probit and regression functions using maximum likelihood. It is also possible to obtain consistent estimates of the standard errors of these parameters in the face of heteroskedasticity in the disturbance term of the growth equation using the procedure suggested by White [1982].[15]

The variability of growth equation is represented by

(3) $LnStdDev(g)=\ln h(A_t, S_t, B_t)+w$

where StdDev(g) is the estimate of the standard deviation of growth described in the previous section, h is a regression function which will be approximated by a second-order expansion in the logs, and w is a mean-zero error term with possibly non-constant variance. The sample upon which (3) is estimated is censored because, for a variety of reasons including failure, the variance of firm growth is not observed for part of the sample. In order to correct for this problem, we can posit an probit equation similar to (2) for the probability of sample inclusion and estimate (3) and the sample-inclusion equation jointly using maximum likelihood. The sample-inclusion equation is ad hoc and has no economic interpretation.

IV. Statistical Tests and Estimation Results

Second-order logarithmic expansions of the growth function, survival function, and variability of growth functions were estimated separately for young firms (for which continuous age information was available) and old firms (for which age was imputed from categorical age information). As discussed below, some of the higher-order regressors were dropped because they were highly insignificant or because multicollinearity hindered convergence of the maximum-likelihood function.

Table II reports the results for young firms. Table III reports the values of the partial derivatives of the survival, growth, and variability of growth functions with respect to size, age, the number of plants at the sample mean and over the sample. The results show that the probability of survival increases size and age.[16] At the sample mean, the a 1 percent change in firm size leads to a 7 percent change in the probability of survival; a 1 percent change in age leads to a 13 percent change in the probability of survival. The positive coefficient on the product of size and age implies that the probability of survival increases with size more rapidly for older firms and that the probability of survival increases with age more rapidly for larger firms.[17]

Firm growth decreases with size and age. In order to characterize the relationship between firm growth and firm size and age it is useful to look at the elasticity of ending-period size with respect to beginning-period size and beginning-period age.[18]

The estimates imply at the sample mean that over a ten year period, a 1.00 percent increase in beginning-period size leads to a .68 percent increase in ending-period size. Thus firm growth is considerably less than proportionate to firm size at the sample mean. The departure from Gibrat's Law decreases with size and age. The negative coefficient on the crossproduct of the number of plants and firm size indicates that the departure from Gibrat's Law is greater the more plants operated by the firm. This result is consistent with a negative relationship between growth and size at the plant level: smaller plants grow more rapidly than larger plants so that firms whose size is split among more plants grow more rapidly than firms whose size is split among fewer plants.

The estimates also imply that over a ten year period, a 1.00 percent increase in beginning-period age leads to a 1.42 percent decrease in ending-period size. Thus firm growth is smaller for older firms. The results also show that firm growth increases with the number of plants operated by the firm, although this growth is smaller for larger firms.

Firm growth increases with the number of plants holding firm size and and age constant at the sample mean. A 1 percent increase in the beginning-period number of plants leads to .6 percent increase in ending-period size. Thus firm growth is greater when firm size is spread across a larger number of plants.

The positive correlation coefficient for the growth and survival equations indicates, as one would expect, that failures tend to have unusually low growth rates. But the correlation coefficient is small and not statistically significant. This result is consistent with my previous work (Evans [1986a], Evans [1986b], and Brock and Evans [1986]) and with the study by Hall [1987].

The results for the variability of growth should be viewed with some caution. The dependent variable for these regressions is based on just three firm-growth observations and is therefore measured very imprecisely. Moreover, the dependent variable is missing for more than half of the cases. The delicacy of the correction for sample-selection in these kinds of models should make us circumspect in giving the results recorded below too much weight.

The variability of firm growth decreases with firm age.[19] A 1.00 percent increase in firm age leads to a .13 percent decrease in the standard deviation of firm growth. For single-plant firms--most of the firms in our sample of young firms--there is little evidence that firm growth depends upon firm size: the coefficients on the size variables are small and not statistically significant. For multiple-plant firms there is evidence that the variability of firm growth decreases with firm size and that the rate of decrease is greater for firms with more plants.[20]

Table IV reports the results for old firms. Table V summarizes the relevant partial derivatives. Results are generally similar to those for young firms, although there is some evidence that the relationships deteriorate for very old firms. A 1 percent change in firm size leads to a 6 percent increase in the probability of firm survival and a 1 percent increase in firm age leads to a 2 percent increase in the probability of firm survival. The probability of survival decreases with firm size for very old firms (about 21 percent of the sample).[21]

Firm growth is roughly independent of age at the sample mean. Firm growth decreases with firm age for younger firms (about 75 percent of the sample of old firms) but then eventually increases with firm age for older firms (about 25 percent of the sample of old firms). Firm growth decreases with firm size at the sample mean and for almost all of the sample. Over a ten year period, a 1 percent increase in beginning-period firm size leads to a .85 percent increase in ending-period size at the sample mean. The departure from Gibrat's Law decreases with size and age and increases with the number of plants. As with young firms, firm growth increases with the number of plants. A 1 percent increase in the initial number of plants leads to a 1.18 percent increase in ending-period size over a ten year period.

The same caveat as above applies to the variability of growth equation. The variability of firm growth decreases with firm age. At the sample mean a 1.00 percent increase in firm age leads to a 0.19 percent decrease in the standard deviation of firm growth. The variability of firm growth increases slightly with firm size. A 1 percent increase in firm size leads to a .04 percent increase in the standard deviation of growth at the sample mean. The rate of increase is smaller the larger the number of plants operated by the firm. This result is not consistent with previous studies which have found that firm growth decreases with firm size. It is also not consistent with the separate industry results reported below.

In order to summarize the relationships for each industry first-order logarithmic expansions of the growth, survival, and variability of growth functions were considered.[22] No corrections were made for sample selection. Thus the results for variability of firm growth should be viewed with caution. The probability of survival results are based on ordinary least squares estimates of the linear probability model. The significance tests are based on a five-percent level using the regression standard errors.[23]

Table VI summarize the results for size and age. Results at the industry level are imprecisely estimated for most industries. This lack of precision may reflect the poor quality of the data, including industry misclassification, or the collinearity between age, size, and the number of plants at the industry level. Nevertheless, the directions of the relationships are broadly consistent with the inter-industry results reported above. Firm survival increases with firm size for 81 percent of the industries and with firm age for 83 percent of the industries. Firm growth decreases with size in 89 percent of the industries and with firm age in 76 percent of the industries. The variability of firm growth decreases with firm age for 80 percent of the industries and with firm size for 85 percent of the industries.

V. Conclusions

The first key finding of this study is that firm age is an important determinant of firm dynamics. The probability of firm failure, firm growth, and the variability of firm growth decrease as firms age. These patterns are consistent with the predictions of the learning model developed by Jovanovic [1982].[24]

The second key finding is that firm growth decreases at a diminishing rate with firm size even after controlling for the selection of firms out of the sample. Gibrat's Law fails. The departures from Gibrat's Law are severe for small firms but become less severe for larger firms. This pattern is broadly consistent with previous studies which tend to show severe departures from Gibrat's Law for small firms--e.g. Mansfield [1962]--and no or less severe departures for large firms--e.g. Hymer and Pashigian [1962], Hall [1987], Kumar [1985], and myself [1986a].

The importance of these departures from Gibrat's Law depends upon the use to which this Law is put. Gibrat's Law is not an unreasonable assumption for the very large firms which do, at any point in time, contribute most industrial output. The departures from Gibrat's Law found by studies using recent data are around 10 percent over a ten-year period.[25]

A theory that seeks to explain short-run changes in the growth and size distribution of the largest firms in the economy may not go too wrong by maintaining Gibrat's Law. But many of our industrial organization theories are meant to apply to the complete size distribution of firms in narrowly defined industries, not to interindustry samples of large firms. Gibrat's Law is not a reasonable assumption for the smaller firms which account for the vast majority of firms in most industries and from which the large firms of the future will come.

The data behind these findings are crude. Replication of these results with more refined datasets is crucial before they are accepted. Nevertheless, this study (along with related work by Evans [1986b] and Brock and Evans [1986] that yield similar results) provides a starting point for further theoretical and empirical work on industry dynamics. For theoretical work, it suggests that theories that incorporate age hold some promise. It also indicates caution in maintaining Gibrat's Law for theories, such as Lucas [1978], that are meant to apply to the complete size distribution of firms. For empirical work, it suggests the importance of age as a factor in determining industry dynamics. Longitudinal datasets containing experience information on firms (and on the managers and entrepreneurs associated with the firms) should be developed. Such datasets would help researchers disentangle the effects of alternative forms of learning from each other and from the effects of capital accumulation.

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FOOTNOTES

[1] See Evans [1986b] and Brock and Evans [1986] for more on this point.

[2] See the models developed by Lucas [1967, 1978] and special cases of the model developed by Jovanovic [1982].

[3] See Executive Office of the President [1983, pp. 405-428] for further details. Interested researchers can obtain a copy of the data from the Office of Economic Research of the Small Business Administration.

[4] In the results reported below the number of plants includes the headquarters of the company.

[5] Because the variability of firm growth is calculated from observations on firm growth for three two-year periods, observations for which data were more than one year old were deleted for the variability analysis.

[6] The estimate is based on fitting a lognormal distribution to the age data. The estimates are 13 years for firms between 7 and 20, 27 years for firms between 21 and 45, 63 years for firms between 46 and 95, and 103 years for firms older than 95 years.

[7] This problem afflicts all previous studies of industry dynamics with the exception of the recent study by Kumar [1985].

[8] See Evans [1986c] for details.

[9] Other the generally available datasets, such as Compustat orthe Longitudinal Establishment File of the Census Bureau, do not have age information.

[10] General results are similar when these firms are included. The main difference is that nonlinearities in the relationships become less pronounced.

[11] The results are consistent, however, with the results for 1976-1982 reported by Evans [1986b].

[12] This contamination poses no problem for the sample selection correction so long as the sample-inclusion equation is otherwise correctly specified.

[13] The interested reader may consult my earlier paper [1986c] for details.

[14] See Amemiya [1984] for further discussion. The unit-variance assumption is a simple normalization that arises from the fact that the value function v (and the regression coefficients) are identified only up to a constant of proportionality.

[15] A critical assumption here is that the disturbance term of the probit equation is homoskedastic. If it is not, standard errors and coefficient estimates of both equations are inconsistent. As an informal test of misspecification I compared the regular and White standard errors for the probit equation. The fact that they differ by less than one percent suggests that heteroskedasticity is not a problem here. A difficult problem that arises in this sort of study is identifying sample selection from nonlinearities. I [1986b] discuss this problem in more detail and present evidence that suggests that the main relationships between growth, size, and age are not an artifact of sample selection.

[16] Preliminary results found that the number of plants was always insignificant. Consequently, the plant variables were excluded from the

final estimates.

[17] The probability of firm survival was found not to depend upon the number of plants in preliminary work and these variables were consequently deleted to make the maximum likelihood estimation easier.

[18] Let g_s and g_a denote the partial derivatives of growth with respect to log size and log age respectively. Then the elasticity of ending-period size with respect to beginning period size is $1+dg_s$ and the elasticity of ending-period size with respect to beginning age is dg_a where d is the length of time considered.

[19] I was unable to obtain convergence when the quadratic terms in age and plants were included.

[20] Previous studies have found that the variability of firm growth decreases with firm size. Because these studies did not consider age or the number of plants--both of which are positively correlated with firm size--the results found here are consistent with these studies. See Mansfield [1962] and Hymer and Pashigian [1962].

[21] While this finding might reflect senescence of firms, it might also reflect an increased probability of acquisition.

[22] The lack of precision at the industry level and the high collinearity between the first and second-order terms made the inclusion of the second-order terms pointless.

[23] Resource constraints prevented me from correcting the standard errors for heteroskedasticity. The significance results should therefore be viewed with caution.

[24] Note, however, that these relationships appear to break down for very old firms in the interindustry results.

[25] Kumar [1985] using net assets finds that the departure over a 10-

year period is about 10 percent based on United Kingdom data for 1960-1976. See Kumar [1985, Table II and note 10, p. 333]. Using book value of assets I [1986a, Table 4) also find that the departure is about 10 percent based on Fortune 500 data for the United States for 1958-1984. Hall [1987] using employment finds that the departure is also about 10 percent over a 10-year period based on Compustat data for the United States for 1976-1983. Studies based on data for the late 1940's and 1950's show a positive relationship between growth and size while studies based on pre-1940 data typically show a negative relationship. See Hymer and Pashigian [1962], Singh and Whittington [1975], and the summary in Prais [1975, Table D.2, p. 205]. None of these studies, with the exception of Hall [1987] and myself, tests for nonlinearities in the growth-size relationship. The differing estimates may depend partly on having different size ranges in the samples.

TABLE I: SUMMARY STATISTICS ON VARIABLES USED IN REGRESSION ANALYSIS (Std. Dev.)

Young Firms

Variable	Survival	Growth	Variability
Survival	0.671 (0.470)	-	-
Growth	-	0.029 (0.149)	-
Log[Standard Deviation of Growth]	-	-	-1.749 (1.015)
Log[Employment]	2.261 (1.144)	2.351 (1.159)	2.605 (1.160)
Log[Age]	1.258 (0.571)	1.301 (0.557)	1.319 (0.549)
Log[Plants]	0.067 (0.268)	0.073 (0.285)	0.090 (0.323)
No. of observations:	13735	9221	6195

Old Firms

Variable	Survival	Growth	Variability
Survival	0.848 (0.359)	-	-
Growth	-	-0.010 (0.012)	-
Log[Standard Deviation of Growth]	-	-	-2.220 (0.930)
Log[Employment]	3.224 (1.251)	3.304 (1.230)	3.510 (1.146)
Log[Age]	2.982 (0.491)	2.299 (0.494)	3.014 (0.502)
Log[Plants]	0.199 (0.552)	0.207 (0.565)	0.231 (0.596)
No. of Observations:	28604	24244	19569

[a] Growth is measured as the annual logarithmic growth rate between 1976 and 1980. The standard deviation of growth is based on three observations of annual logarithmic firm growth between 1976 and 1982.

Table II:
FIRM SURVIVAL, GROWTH, AND VARIABILITY OF GROWTH YOUNG FIRMS

Variable	Survival	Growth	Variability of Growth
	1976-1980		1976-1982
Size	0.1779*** [0.0437]	-0.0721*** [0.0071]	-0.0402 [0.0311]
Age	-0.0262 [0.0741]	-0.0341*** [0.0118]	-0.1724*** [0.0495]
$Size^2$	-0.0203*** [0.0071]	0.0054*** [0.0012]	-
Age^2	0.0762* [0.0320]	-0.0560 [0.0485]	-
Size*Age	0.0351* [0.0176]	0.0142*** [0.0029]	0.0195 [0.0203]
Plants	-	0.0860*** [0.0255]	0.3605 [0.1951]
$Plants^2$	-	0.0423 [0.0375]	-
Plants*Size	-	-0.0252*** [0.0057]	-0.0997*** [0.0328]
Plants*Age	-	0.0197 [0.0148]	0.2196* [0.1041]
Constant	-0.0349 [0.0629]	0.1687*** [0.0117]	-2.2510*** [0.1453]
Sigma	-	0.1453*** [0.0020]	0.9451*** [0.0389]
Correlation	-	0.0189 [0.0144]	0.5997*** [0.0730]
Observations	13735	9221	5493
Log-Likelihood[a]	-	-3843.5	-15407.2

[a] The first log-likelihood is for the survival-growth system. The second log-likelihood is for the variability of growth system. The selection equation for the variability of growth equation is available from the author upon request. All regressors are measured in logs. Thus size is the log of employment, age is the log of age, branch is the log of the number of branches.

* Significant at the 5.0 percent level.
** Significant at the 1.0 percent level.
*** Significant at the 0.1 percent level.

Table III:
THE EFFECTS OF FIRM SIZE, AGE, AND NUMBER OF PlantsES ON FIRM DYNAMICS

YOUNG FIRMS

Partial Derivative of[a]	Survival	Growth	Variability of Growth
with Respect to			
Size			
Mean	0.047	-0.032	-0.022
Standard Deviation	0.019	0.016	0.028
Fraction Positive	0.990	0.023	0.000
Fraction Negative	0.010	0.977	1.000
Age			
Mean	0.084	-0.142	-0.133
Standard Deviation	0.030	0.064	0.060
Percent Positive	0.990	0.028	0.066
Percent Negative	0.010	0.972	0.934
Plants			
Mean	-	0.060	0.087
Standard Deviation	-	0.033	0.155
Percent Positive	-	0.961	0.733
Percent Negative	-	0.039	0.267

[a] Partial derivative of the regression function on the horizontal with respect to the logarithmic value of the variable on the vertical.

Table IV:
FIRM GROWTH AND SURVIVAL OLD FIRMS 1976-1980

Variable	Survival	Growth	Variability of Growth
	1976-1980		1976-1982
Size	0.2767***	-0.0327***	-0.0385
	[0.0451]	[0.0064]	[0.0487]
Age	0.6470**	-0.0754***	-0.2004***
	[0.2291]	[0.0199]	[0.0608]
$Size^2$	-0.0334***	0.0009	0.0145**
	[0.0043]	[0.0010]	[0.0055]
Age^2	-0.1219***	0.0078*	-
	[0.0377]	[0.0034]	
Size*Age	0.0496**	0.0052*	-0.0005
	[0.0160]	[0.0022]	[0.0166]
Plants	-	0.0006***	0.3922***
		[0.0001]	[0.0915]
$Plants^2$	-	0.0085***	-
		[0.0018]	
Plants*Size		-0.0198***	-0.0817***
	-	[0.0029]	[0.0128]
Plants*Age	-	0.0597	0.0685*
		[0.0470]	[0.0299]
Constant	-0.6816	0.1853***	-2.2821***
	[0.3549]	[0.0304]	[0.1667]
Sigma	-	0.1453***	1.0720***
		[0.0020]	[0.0096]
Correlation	-	0.0193	0.6871***
		[0.0144]	[0.0143]
Observations	28604	24244	16155
Log-Likelihood[a]	-	4049.8	-39454.10

[a] The first log-likelihood is for the survival-growth system. The second log-likelihood is for the variability of growth system. The selection equation for the variability of growth is available from the author upon request. All regressors are measured in logs. Thus size is the log of employment, age is the log of age, branch is the log of the number of branches.

* Significant at the 5.0 percent level.
** Significant at the 1.0 percent level.
*** Significant at the 0.1 percent level.

TABLE V:
THE EFFECTS OF FIRM SIZE, AGE, AND NUMBER OF PlantsES ON FIRM DYNAMICS

OLD FIRMS

Partial Derivative of[a] with Respect to	Survival	Growth	Variability of Growth
Size			
Mean	0.049	-0.015	0.037
Standard Deviation	0.032	0.010	0.047
Fraction Positive	0.993	0.001	0.852
Fraction Negative	0.007	0.999	0.148
Age			
Mean	0.016	0.000	-0.188
Standard Deviation	0.025	0.038	0.038
Percent Positive	0.790	0.251	0.992
Percent Negative	0.210	0.749	0.008
Plants			
Mean	-	0.118	0.333
Standard Deviation	-	0.033	0.097
Percent Positive	-	0.998	0.999
Percent Negative	-	0.002	0.001

[a] Partial derivative of the regression function on the horizontal with respect to the logarithmic value of the variable on the vertical.

Table VI:
SUMMARY OF INDUSTRY REGRESSIONS[a]

		Dependent Variable					
		Growth		Survival		Variability of Growth	
		Number of Industries with Coefficient Sign					
Independent Variable							
Age		+	-	+	-	+	-
	Significant	4	31	48	1	1	26
	Insignificant	20	45	35	15	17	54
	Total	24	76	83	16	18	80
Size							
	Significant	1	61	37	3	1	26
	Insignificant	10	28	44	15	12	59
	Total	11	89	81	18	13	85

[a] Estimates based on a regression of the dependent variables described in the text against the log of age, size, and the number of plants. There were insufficient observations to perform the regression for 1 industry for survival and 2 industries for the variability of growth. Significance level is 5 percent.