

The Demography of Business Closings

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ABSTRACT. This study shows that establishment dissolution declines with age and that age at dissolution differs for broad industry and geography groups, establishment affiliation status, and establishment size. These findings, largely confirming results presented elsewhere, are drawn from age-specific dissolution ratios and establishment life tables calculated for select establishment sub-populations. The paper uses Bureau of the Census Standard Statistical Establishment List datasets, a census of establishments with employment for the United States for the 1987 and 1988 years.

1. Introduction

"A search of the literature produces a picture of small business mortality rates that remains somewhat obscure and punctuated with gaps in our knowledge. Although much is written about small business failure, reliable information about who fails, why, and at what rate is hampered by differences in definitions, data sources, and methodologies. In particular, the absence of comprehensive data on the business population that includes their mortality, and their firm characteristics, especially age and size, makes comparisons across studies difficult at best. The myriad studies of business mortality, with their various conceptions of dissolution and different purposes and research designs, speak to the subject with a babble of tongues.

Ideally, an agency like the Census would collect and publish comprehensive and regular data on the business population that would allow researchers several options in analyzing the data . . ."

A. B. Cochran, 1981, p. 59.

Although almost a decade and a half have passed since Cochran's observations, the availability of comprehensive and consistent information on business closings, or dissolutions, remains limited. Recent empirical studies reflect a growing interest in this subject by economists, students of

business and entrepreneurship, and sociologists, yet this body of work all too often suffers from John Freeman's "samples of opportunity" comment (Freeman, 1986, p. 26). That is, they are based upon different databases, periods of time, business units, business populations, and research designs and hence, it is difficult to compare findings on the relation between age and dissolution across studies. This study addresses this concern through use of the Bureau of the Census 1987 nation-wide and industry-wide business register.

The spirit of this paper is expository. Its content is about measurement and specification issues associated with the delineation of stylized facts on business closings by age, generated from large business census data bases. Hence, the techniques used, those associated with the construction of life tables, reflect this purpose. The finding that dissolution declines with age is the working hypothesis of this study.

The paper makes three contributions to the empirical literature on business dissolution. One, the descriptive statistics constitute a "benchmark" overview of establishment dissolution for populations defined by age, affiliation status (that is whether an enterprise owns a single establishment or a number of establishments), industry, size, and geographic area. Two, age-specific dissolution rates – within these populations – provide information on the relation between their age structure and their dissolution rates. Three, the similarity of dissolution patterns is assessed by comparing the cumulative survival distributions obtained from establishment life tables.

The paper is divided into the following sections: 1) an overview of empirical work on business survival; 2) a discussion of data source and methods; 3) a presentation of cross-section dissolution rates; 4) the construction of establish-

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ment life table survival distributions for affiliation status, industry, size class, and region sub-populations and the comparison of their cumulative survival distributions; 5) summary and conclusion.

2. Business dissolution: Empirical overview

That business dissolution declines with age in the years following business formation is the most widely reported and most generally accepted empirical finding about business dissolution (Audretsch, 1994 and 1995; Bruderl and Schussler, 1990; Carroll, 1983; Fichmann and Levinthal, 1991; Joel Popkin and Company, 1991; King and Wicker, 1988; Lane and Shary, 1991; Mahmood, 1992; Mata and Portugal, 1994; Pakes and Ericson, 1989a; Phillips and Kirchoff, 1988; Reynolds and Miller, 1988; Stinchcombe, 1965; Wagner, 1994). Fichmann and Levinthal (1991) argue that the shape of the relation between age and dissolution is an (inverted) U-shape, or dissolution declines non-monotonically with age. Thus, the hazard to dissolution increases in the first years after formation and then declines monotonically. To quote Bruderl and Schussler (1990, p. 533), "there are two reasons why the highest risk of disbandment should not be found at the very beginning of an organizational life. The first reason is that organizations can survive because there is an initial stock of resources on which they can rely for some time. The second reason is that they will not be abandoned by at least minimally rational actors unless a sufficient amount of negative information about their performance is gathered." Empirical evidence supporting this conjecture is available from a variety of sources.

King and Wicker (1988, Figure 1), Pakes and Ericson (1989b, Table I), and Reynolds and Miller (1989, Exhibit 6) show that age-specific rates of dissolution increase immediately after formation and then decrease in subsequent years for a hypothetical formation cohort of retail and service "establishments" drawn from a Southern California sales tax register; manufacturing, wholesale, and retail Wisconsin firms born in 1979; and retail and "other" Minnesota firms formed in 1984, respectively. The Bruderl and Schussler (1990) model of dissolution among German businesses formed in 1980 in "industry,

trade, and services" shows an increase in the hazard in the first year with a decline in subsequent years. Wagner (1994) shows similar results for a population of Lower Saxonian manufacturing firms formed between 1979 and 1982 and surviving to 1990.

The second most widely reported finding, particularly in the economics literature, is that business dissolution declines with business size, where size is determined by the number of business employees (Dunne, Roberts and Samuelson, 1989; Evans, 1987; Hall, 1987; Mata and Portugal, 1994; Pakes and Ericson, 1989a; Troske, 1992).

Many studies report that autonomous establishments have higher dissolution rates than affiliated establishments (Bruderl, Preisendorfer and Ziegler, 1992; Dunne, Roberts and Samuelson, 1988; Preisendorfer and Voss, 1990) while other studies show that the dissolution rates differ across industries (Audretsch, 1994; Bruderl, Preisendorfer and Voss, 1992; Mata and Portugal, 1994; Pakes and Ericson, 1989b; Phillips and Kirchoff, 1988; Reynolds and Miller, 1989) and divisions (Lane and Shary, 1991, Table III; Joel Popkin and Company, 1990, Table II-4:C).

Thus, businesses operating in manufacturing and wholesale are less likely to close than those located in mining, construction, finance, insurance, and real estate, retail, and services industries. And dissolution rates of establishments operating in the Pacific, Mountain, and West South Central regions are higher than those of establishments operating in the New England, Middle Atlantic, East North Central, and West North Central areas.

These results "make sense" if we view the variables affiliation status, industry, and division as proxies for access to human and financial capital, differing start-up conditions (e.g. capital requirements, barriers to entry, non-profit status), and growth, respectively. Thus, for example, an affiliated establishment is more likely to survive than an autonomous one as it is able to draw upon human and financial resources from its parent enterprise, an advantage not available to autonomous establishments. Start-up costs of establishments in manufacturing industries are widely conceded to be higher than those in other sectors. Hence, manufacturing establishments are likely to have an initial "buffer" against dissolu-

tion, the result of a selection process which favors the formation of “likely to survive” establishments. Region may distinguish between growing and non-growing parts of the country where the former represents increased demand for goods and services – and more business start-ups – relative to the latter. Hence, there are likely to be larger numbers of new establishments formed to satisfy increased demand in growing divisions, which are subject to higher rates of dissolution.

The relation between size and dissolution is more controversial, not because there is no agreement on the empirical relation between the two. There is broad agreement that large establishments are less likely to disband than small establishments. The controversy stems from what do we mean by “size” and is inextricably caught up in the literature on employment growth by employment size class (Baldwin and Picot, 1995; Davis, Haltiwanger and Schuh, 1996). The approach used in the following is not likely to resolve this controversy. For our purposes, the size of an establishment represents its “minimum size of efficiency” and remains constant across an establishment’s life span. That this is patently not the case is largely due to transaction costs associated with startup and shutdown costs. Further, since employment, generally used as a measure of size, is an input factor, the level is subject to macro-economic, micro-economic, and idiosyncratic shocks, and to changes in technology for long-lived establishments.

How does business age affect these findings? There are few studies of the American business population comparing age-specific dissolution rates by affiliation status, industry, size, and division. The work by Churchill (1955) is the most comprehensive, although with limitations.

Churchill’s findings, based upon firms operating over the period 1944–1954, show that the (“averaged”) conditional probability of survival increases with firm age. This pattern of survival increasing with age is roughly the same for firms in different industries. However, there are two types of differences. One, the level of the survival probability is different across industries. Hence, wholesale firms are more likely to survive than retail ones. Two, the amount of difference in the survival probabilities across adjacent ages is larger at younger ages than at older ages. Thus, retail

firms are less likely to survive to an age of one year than wholesale or manufacturing firms while the chance that manufacturing, retail, or wholesale firms survive to an age of 10 years, given survival to an age of nine years is virtually the same (Churchill, 1955, p. 15). Construction and wholesale firms are most likely to survive 10 years while retail firms are least likely (Churchill, 1955, Table III). Thus, industry differences in survival rates are largest in the first years after formation and any difference diminishes with age.

The following observations, drawn from this review, serve as a guide to the following data presentations on business dissolution. Dissolution decline with age and size. Establishments in more “capitalized” sectors, be they manufacturing, wholesale, transportation and utilities, or affiliated, are less likely to close than establishments in less “capitalized” ones such as retail and autonomous sectors. Lastly, the evidence on geography is unclear, suggesting a weak relation showing lower dissolution rates in “older” areas and higher ones in “younger” ones.

3. Data and methods

The SSEL: Data source and variables

The results in this paper are based upon the Bureau of the Census Standard Statistical Establishment List (SSEL), an annual register of establishments first assembled in 1973 (Bureau of the Census, 1979). It is a datafile consisting of all businesses with payroll¹ operating in the 50 states, the District of Columbia, Puerto Rico, and other territories (e.g. Guam) for a given year.

The strengths of the SSEL are many. First, the SSEL population is a comprehensive picture – for a given year – of all establishments with payroll operating in the 50 states and the District of Columbia for private, non-agricultural industries. Businesses operating at more than one location are surveyed for information about each location. Second, the SSEL contains affiliation status, industry, and geography information for all establishments, in addition to data on employment and wages.² Third, information is available for three business units: establishment, entity (tax unit), and enterprise.

Fourth, establishments surviving across suc-

cessive SSEL registers may be identified through their identification numbers. Hence, a set of consecutive SSEL datasets constitutes a continuous population register, a business population file recording the formation, re-organization, and dissolution experience of population members over that period. An investigation of the longitudinal properties of the SSEL are part of an ongoing study of SSEL files for the past four-five years (Trager and Moore, 1995). The business age variable has not been used in studies drawn from a single SSEL.³

There are weaknesses when using a single SSEL register. First, the annual SSEL registers do not list establishments without wages. Thus, it is not possible to address empirically some of the most interesting questions about the “early” processes of formation and dissolution. It also implies that businesses appearing on an SSEL register are the survivors of these early “gestation” processes and, to the extent that dissolution rates are higher in this earlier period, are less likely to dissolve.

Second, while reorganization of affiliated establishments is followed in the SSEL, reorganization of autonomous establishments due to changes in ownership or legal form of organization (e.g. from sole proprietorship to corporation) may not be.⁴ When such events “trigger” a change in the establishment identification number, what results is a dissolution of the establishment prior to the event and formation of “another” establishment after the event. This is likely to yield dissolution rates for autonomous establishments which are higher than in fact do occur and consequently, age distributions are likely to be skewed toward younger ages.⁵

Third, the survey of businesses with more than a single location is a census enumeration during economic census years only. During non-economic census years, the survey is a census of large, currently identified affiliated businesses and is a sample of small affiliated enterprises. Hence, businesses which become affiliated between economic censuses are treated as autonomous until the next census. Presumably, they are properly identified as affiliated through the census’ survey of large, autonomous establishments. This implies that the increase in the number of affiliated establishments during economic census years is in part artifact and consequently, the age of newly formed

affiliated establishment “births” may be skewed toward younger ages. Fourth, it is not possible to identify establishments’ affiliation status at formation for those which are affiliated at formation and subsequently become autonomous (i.e. a type of divestiture). The effect of this phenomenon is unclear. If the formerly affiliated establishments retain traits of their cohort after becoming autonomous, they are likely to be less likely to dissolve than similarly situated, autonomous establishments. Thus, the dissolution rates for autonomous establishment will be “slightly” elevated. (Slightly because the instances of such divestitures are likely to be rare.)

Fifth, the SSEL registers have been assembled for years since 1973. Thus, it is not possible to distinguish among establishments of different ages for years prior to 1973. This has two implications. One, it is not possible to test hypotheses from the population ecology literature in sociology which study changes in density over a fairly long period of time (Hannan and Freeman, 1989). Two, it is not possible to assign an “age” to establishments formed prior to 1973, limiting the questions addressed about large, old establishments.

The study population are SSEL establishments active in 1987, operating in private, non-agricultural industries (i.e. not in agricultural production and services, government, and an unclassified grouping), and reporting addresses located in the 50 states and the District of Columbia. The unit of analysis for this study is an establishment, a physical location producing goods or providing services. The population of businesses active in 1987 is defined as establishments with any wages during 1987, where wages is the amount of total earnings (in thousands of dollars) to employees during 1987 reported by establishments to either the IRS or the Bureau of Census. A 1987 business dissolution is an active 1987 business which reports *no* payroll in 1988.⁶

Age is an ordinal measure, with values from zero to ten (open-ended) years, and is the year for which the business first reported payroll and appeared on the SSEL.⁷ It is likely that age is biased downward, given the problems documented above and in endnote six. Age at zero years corresponds to formation in the economic census year 1987. Age at one year corresponds to formation during the year 1986. Age at ten years is

an open-ended age interval and represents businesses formed in year 1977 and in prior years.

The affiliation status variable is nominal, has two values (autonomous and affiliated), is derived from business identification codes assigned by the Bureau of Census survey processing upon first appearance in the SSEL.⁸ An autonomous establishment is a business operating at a single, physical location. An affiliated establishment is owned by a business operating at more than a single location.

Industry is a nominal variable with eight values. It is derived from the Standard Industrial Classification (SIC) code assigned to establishments and is based upon Census Bureau surveys and/or SIC coding at the Internal Revenue Service and Social Security Administration. This paper uses the traditional eight economic sectors mining, construction, manufacturing, transportation and public utilities, wholesale, retail, finance and insurance and real estate (FIRE), and services. Excluded sectors are agricultural production and services, government, and an unclassified (by industry) grouping.

Establishment size, based upon March 12th, 1987 employment, is an ordinal variable with nine values. These size classes are "zero employees", "1-4 employees", "5-9 employees", "10-20 employees", "21-49 employees", "50-99 employees", "100-249 employees", "250-499 employees", and "500 and more employees". An establishment is assigned a size class value from its 1987 March employment. (An active establishment may have zero employees in March and positive payroll during later months.)

Region is a nominal variable with nine values. The nine regions are New England, Middle Atlantic, South Atlantic, East South Central, West South Central, East North Central, West North Central, Mountain, and Pacific.

Methods: Dissolution rates, life tables

Dissolution rates are calculated as the number of business closings during year 1987 divided by the number of active businesses for 1987. Dissolution rates by age are the number of business closures of a given age divided by the number of active businesses at that age. For this paper, there are 11 age-specific dissolution rates, for age values zero

through 10 (dissolution schedule). These age-specific rates are empirical estimates of the conditional probability of dissolution during age x , given survival to age x .

The life table technique, widely used in the study of mortality in natural and artificial populations, serves an exploratory role. Establishment life tables describe the dissolution experience of a hypothetical cohort of establishments formed in an arbitrary year. A life table provides information on the number of active and closed establishments, the conditional probability of dissolution, the survival distribution, and life expectancy.⁹ Information on the establishment population by age and the number of dissolutions by age for 1987 are the basis of a life table. We assume that dissolution (and formation) schedules are stationary in time and that dissolution rates equal formation rates.¹⁰ If this is the case, then each of the age-specific rates (say, for age two) has the same value in 1987 as in, say, 1980. Further, if dissolution and formation rates are the same, the population does not grow. The age-specific dissolution rates are equivalent to the corresponding conditional probabilities of dissolution and are used in constructing the lifetime dissolution experience from an arbitrarily sized formation cohort, conventionally a value of 100,000.

For example, given a dissolution rate at age one of 0.20 and a hypothetical cohort size of 100,000 establishments at age zero, the number of establishments "surviving" to age one is 80,000, or a survival probability of 0.80. Survival probabilities at subsequent ages are calculated recursively from the establishment population at age $x + 1$ and the dissolution rate at age x . The population life table of Table II illustrates the procedure. Establishment life tables are constructed for the populations defined by affiliation status, industry, size, and region.¹¹

How similar is the mortality experience for two distinct life tables (e.g. manufacturing and wholesale)? The log rank statistic is a test of the similarity of two life tables, follows a chi square distribution, and has one degree of freedom.¹² The test assumes that two survival distributions are the same at each age and large values of the statistic, produced by the curves differing at many ages, reject this hypothesis. The statistics are presented in a fashion similar to a variance-covariance

matrix for each characteristic (e.g. industry), where each entry is a comparison of two industries. (Such a matrix is symmetric and hence, only the upper half is presented.)

4. Results

Descriptive statistics: Cross-sectional dissolution rates

The 1987 business population of this paper comprises 5,727,985 active establishments, of which 12 percent (705,473 establishments) close during 1987. Approximately one-third exceed 10 years of age while a little less than 15 percent were formed in 1987. The percentage of establishments declines consistently from under nine percent at age six to over two and three-quarter percent at age six and then increases steadily at age seven from over three and a half percent to over five and a quarter percent at age nine. The age pattern of active establishments resembles an asymmetric, U-shaped curve (Table I).

Autonomous establishments dominate the active population at 80 percent of the total while a third operate in service industries and a quarter in retail industries. The number of establishments decreases sharply and consistently from class 1–4 employees to class 500 and more employees, while the class zero employees constitutes 10 percent of establishments. Region divides the active establishment population into two groups, those over ten percent (Middle Atlantic, East North Central, South Atlantic, West South Central, Pacific) and those less than ten percent (New England, West North Central, East South Central, Mountain).

The distribution of the number of dissolving establishments, while similar in pattern to that of active establishments, is more concentrated. Thus, the largest percentage of dissolving establishments are of age zero and are autonomous. Further, the largest percentages of dissolving establishments operate in retail and services industries, belong to size class 1–4 employees, and operate in the Middle Atlantic, East North Central, South Atlantic, West South Central, and Pacific division.

The dissolution rates of Table I decline in value with age, though non-monotonically. Autonomous establishments are almost twice as likely to close as affiliated ones. Establishments operating in

manufacturing and wholesale industries have the lowest dissolution rate (10) while establishments operating in the mining and construction industries have the highest dissolution rate (15). The surprise is the relatively low dissolution rates for establishments operating in finance, insurance, real estate, and the services industries (11–12), possibly due to the inclusion of tax-exempt establishments. Dissolution rates decline with size, with the largest size class approximately one third the value of the (non-zero) smallest size class. The West South Central and Mountain area have the highest dissolution rates (14), followed by that of the Pacific area (13).

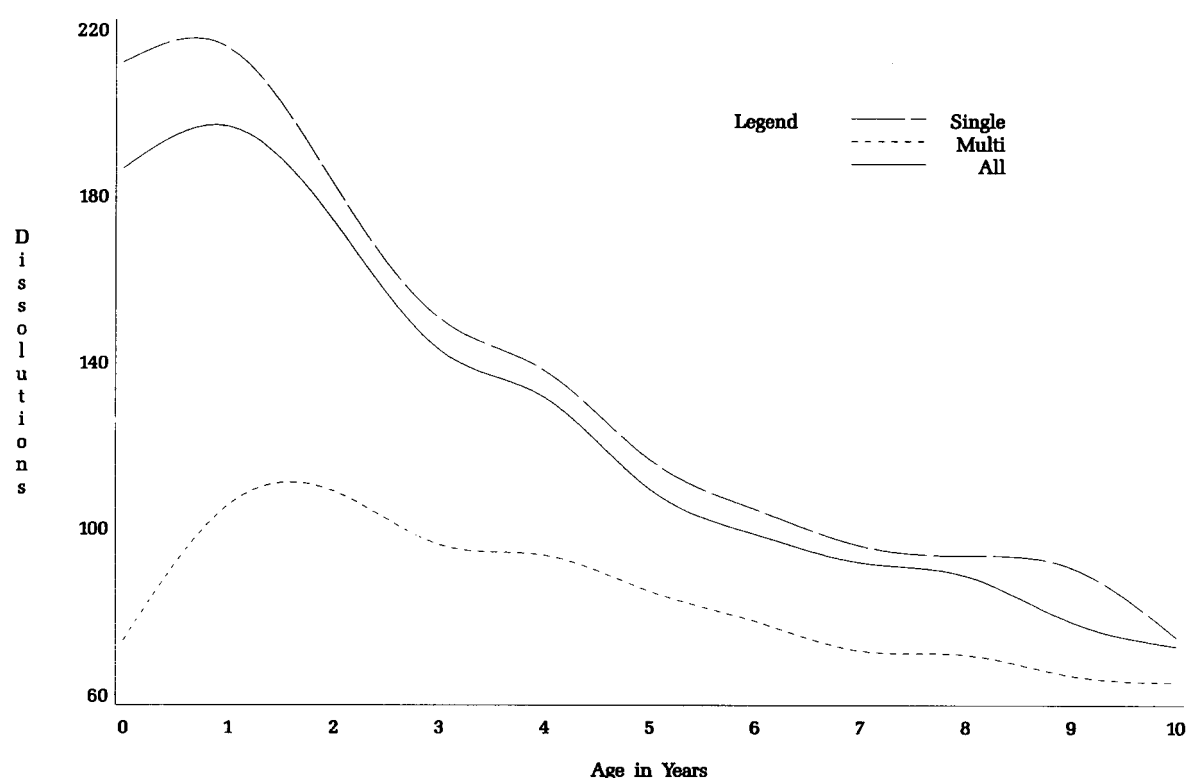
The age structure of these populations follows predictable patterns, expected from that of the dissolution rates discussed above. Thus, affiliated establishments are older than autonomous one (6.7 to 4.2) and manufacturing and wholesale establishments are older than construction and transportation and public utilities ones (5–6 to 3). Further, the oldest establishments are the largest ones while the median age of the smallest (non-zero) size class is about four. Establishments operating in East North Central, Middle Atlantic, and West North Central have the largest median age (5) while establishments operating in the Mountain and West South Central have the smallest (3–4).

These findings, for the most part, confirm those reported elsewhere in the literature and, with the possible exception of the finding for the services industry, are not surprising. Dissolution declines non-monotonically with age, regardless of affiliation status, industry, most size groupings, and region (Figure 1).¹³ Further, the variability of the rates declines with age. For example, young, autonomous establishments are far more likely to close than are young, affiliated establishments, although the difference in dissolution rates erodes over the years. Similarly, industry dissolution rates are higher and more variable in early years than in later ones, the mining sector aside. Size divides the establishment population into two groupings: 1) a population consisting of the two smallest size classes (zero and one to four employees) with relatively high and variable rates; 2) the remaining size classes with low and progressively less variable dissolution rates. The region rates move together, begin at values between 0.17 and 0.22

TABLE I
1987 SSEL establishments, proportion of total active and closing establishments dissolution rate

	Establishment		Median age dissolution		
	Active	Closing	Active	Close	Rate
<i>Formation age (years)</i>					
0	14.75	22.52			18.8067
1	8.75	14.00			19.6975
2	8.44	11.95			17.4270
3	7.82	9.08			14.2967
4	6.80	7.26			13.1547
5	6.76	6.01			10.9425
6	2.83	2.26			9.8429
7	3.64	2.71			9.1870
8	3.63	2.61			8.8782
9	5.33	3.34			7.7200
10	31.26	18.26			7.1953
	100.00	100.00			
<i>Affiliation status</i>					
Autonomous	79.75	87.66	4.16	4.93	13.5374
Affiliated	20.25	12.34	6.70	6.67	7.5068
	100.00	100.00			
<i>Economic sector</i>					
Mining	0.58	0.73	5.32	5.37	15.6661
Construction	9.85	12.37	3.41	3.64	15.4683
Manufacturing	6.50	5.43	7.30	7.88	10.2952
Transportation, public utilities	4.01	4.50	3.83	3.10	13.8221
Wholesale	8.15	6.91	6.31	6.01	10.4419
Retail	26.59	28.26	4.35	4.35	13.0894
Finance, insurance, real estate	9.42	9.31	5.19	6.00	12.1677
Services	34.90	32.48	4.35	4.03	11.4636
	100.00	100.00			
<i>Size (1987 employment)</i>					
Zero Employees	10.03	17.55	0.25	0.13	21.5622
1–4 Employees	44.45	55.71	4.01	4.41	15.4356
5–9 Employees	20.16	13.52	5.99	5.22	8.2570
10–20 Employees	12.34	6.91	7.42	7.67	6.8951
21–49 Employees	8.04	4.14	8.41	8.20	6.3387
50–99 Employees	2.81	1.25	8.84	8.87	5.4613
100–249 Employees	1.52	0.64	9.04	9.59	5.1947
250–499 Employees	0.39	0.18	9.11	9.15	5.5428
500 and more employees	0.26	0.11	9.16	9.26	5.3368
	100.00	100.00			
<i>Geographic division</i>					
New England	6.12	5.74	4.50	4.08	11.5535
Middle Atlantic	15.74	14.38	5.01	5.52	11.2464
East North Central	15.92	13.95	5.27	5.56	10.7891
West North Central	7.60	6.97	5.36	5.46	11.2913
South Atlantic	17.37	17.85	4.04	4.83	12.6561
East South Central	5.39	5.43	4.58	4.98	12.4067
West South Central	10.33	12.25	4.39	4.33	14.5970
Rocky Mountain	5.73	6.74	3.91	3.92	14.4865
Pacific	15.79	16.70	4.08	4.99	13.0270
	100.00	100.00			

Source: 1987 SSEL, Special Tabulations Center for Economic Studies, Spring, 1996.



Source: Special Tabulations, 1987 SSEL Center for Economic Studies, Spring, 1996.

Figure 1. Dissolutions per 1000 establishments – by age and affiliation status.

and decline, non-monotonically in variability and value.

Descriptive statistics: Period cohort survival rates from establishment life tables

The data of Table II are a life table from the 1987 establishment universe and display values for survival probability, life expectancy, and hazard.¹⁴ The life table conditional probability of dissolution during interval n , given survival to age x , declines non-monotonically with age from a value of 0.19 to 1.0. The (unconditional) survival probability declines from a value of 1.0 at age zero to a value of 0.25 at age 10. The partial life expectancy, ${}_pe_x$, values decline from a value of 4.7 years at age zero to a value of 0.96 years at age nine. (The more traditional life expectancy data, e_x , show that life expectancy increases with age.)

What are the chances an establishment survives one, five or 10 years? We obtain these survival probabilities (l_x) from establishment life tables by selecting l_x values for $x =$ one, five and 10. Affiliated establishments are more likely to survive than autonomous establishments at each age with probabilities at five years of 0.611 and 0.401, respectively (Table III). Industry survival rates show that the probability a wholesale establishment survives one year is 0.847 (the highest), followed by manufacturing, FIRE, and services establishments. Construction establishments have the lowest one-year survival rate, 0.771. Ten years later, the pattern remains much the same with two exceptions. Manufacturing, wholesale, and services establishments have the highest values at about 0.27. Mining establishments have the smallest ten-year survival rate, 0.135, and FIRE establishments no longer appear among the most

TABLE II
Establishment life table (functions)

	Active (1)	Closings (1)	${}_n m_q$ (3)	${}_n q_x$ (4)	p_x (5)	l_x (6)	d_x (7)	L_x (8)	T_x (9)	e_x (10)	$e_{x'}$ (11)
Total	5,727,985	705,473									
Age											
0	844,616	158,844	0.18807	0.18807	0.81193	100000	18807	90597	813853	8.14	4.72
1	501,364	98,756	0.19698	0.19698	0.80302	81193	15993	73197	723256	8.91	4.70
2	483,645	84,285	0.17427	0.17427	0.82573	65200	11362	59519	650059	9.97	4.73
3	448,190	64,076	0.14297	0.14297	0.85703	53838	7697	49989	590540	10.97	4.63
4	389,419	51,227	0.13155	0.13155	0.86845	46141	6070	43106	540551	11.72	4.32
5	387,286	42,379	0.10942	0.10942	0.89058	40071	4385	37879	497445	12.41	3.89
6	161,881	15,934	0.09843	0.09843	0.90157	35686	3513	33930	459567	12.88	3.31
7	208,228	19,130	0.09187	0.09187	0.90813	32174	2956	30696	425637	13.23	2.62
8	207,675	18,438	0.08878	0.08878	0.91122	29218	2594	27921	394941	13.52	1.83
9	305,366	23,574	0.07720	0.07720	0.92280	26624	2055	25596	367020	13.79	0.96
10	1,790,315	128,829	0.07196	1.00000	0.00000	24568	24568	341424	341424	13.90	0.00

Source: Special Tabulations, 1987 SSEL Center for Economic Studies, Spring, 1996.

TABLE III
Survival rates at one, five, and ten years

	L ₁	L ₅	L ₁₀
<i>Affiliation status</i>			
Single	0.786	0.367	0.216
Multi	0.927	0.611	0.420
Total	0.812	0.401	0.246
<i>Industry</i>			
Mining	0.794	0.298	0.135
Construction	0.771	0.335	0.185
Manufacturing	0.819	0.425	0.271
Transportation, public utilities	0.811	0.377	0.212
Wholesale	0.847	0.442	0.277
Retail	0.819	0.394	0.232
Finance, insurance, RealEstate	0.786	0.376	0.235
Services	0.819	0.427	0.272
<i>Size</i>			
Zero employees	0.815	0.208	0.041
1-4 employees	0.772	0.339	0.177
5-9 employees	0.865	0.527	0.375
10-20 employees	0.882	0.563	0.418
21-49 employees	0.889	0.577	0.424
50-99 employees	0.896	0.620	0.471
100-249 employees	0.888	0.606	0.461
250-499 employees	0.870	0.549	0.410
500 and more employees	0.842	0.503	0.379
<i>Region</i>			
New England	0.824	0.430	0.274
Middle Atlantic	0.827	0.432	0.274
East North Central	0.830	0.444	0.286
West North Central	0.816	0.419	0.262
South Atlantic	0.810	0.395	0.246
East South Central	0.800	0.392	0.243
West South Central	0.786	0.336	0.185
Rocky Mountain	0.791	0.348	0.198
Pacific	0.808	0.392	0.237

Source: Special Tabulations, 1987 SSEL Center for Economic Studies, Spring, 1996.

likely to survive. Establishments of size 50-99 employees have the highest one-year and 10-year survival rates, while establishments of size one-four employees have the lowest one-year survival rates and establishments of zero employees have the lowest 10-year survival rate. Establishments located in the east north central region have the highest one-year and 10-year survival rates while establishments located in the west south central region have the lowest one-year and ten-year survival rates.

Descriptive statistics: Comparison of establishment life tables

The log rank statistics show that relatively few industry and size class survival distributions are similar, with a partial exception for the division results. The manufacturing and services and FIRE and TPU log rank values indicate that the respective survival distributions are virtually indistinguishable, while the manufacturing and wholesale and FIRE and retail log rank values, although not statistically similar, show smaller chi square values than the remaining comparisons (Table IVA). The log rank statistic value for the size class comparison - 10-20 and 21-49 - indicate that the respective survival distributions are virtually indistinguishable, while log rank values for the two comparisons - five to nine and 500 plus, 50-99 and 100-249, although not statistically similar, show smaller chi square values than the remaining comparisons from a possible 36 combinations groupings (Table IVB). Three division comparisons - New England-Middle Atlantic, South Atlantic-Pacific, and East South Central-Pacific - indicate that the respective survival distributions are virtually indistinguishable, while log rank values for a number of other comparisons, although not statistically similar, show smaller chi square values than the remaining ones (Table IVC).

5. Summary and conclusion

The results presented in this paper show that dissolution declines non-monotonically with age and that a similar pattern appears for most affiliation status, industry, size, and region sub-populations. There is substantial variability in dissolution rates by age, size, and to a lesser extent, industry. Affiliated establishments and large establishments are far less likely to close than autonomous establishments or small establishments. Establishment life table survival probabilities are different for sub-populations defined by affiliation status, industry, size and region.

What remains to be studied is substantial. The present study can be extended relatively easily. More detailed industry, say at a two-digit level, is likely to uncover results reflecting the diverse character of these industries. A different geog-

TABLE IVA
Log Rank Statistics, by sector

Sector	Mining	Construction	Manufacturing	TPU	Wholesale	Retail	Fire	Service
Mining	0.00	356.83	3561.49	1395.92	4522.81	2169.17	1547.92	3561.15
Construction	0.00	0.00	1557.44	301.64	2148.01	693.77	409.56	1558.65
Manufacturing	0.00	0.00	0.00	523.10	37.48	191.27	348.00	0.00
TPU	0.00	0.00	0.00	0.00	872.39	84.39	11.89	525.54
Wholesale	0.00	0.00	0.00	0.00	0.00	412.09	629.67	36.58
Retail	0.00	0.00	0.00	0.00	0.00	0.00	29.15	192.54
FIRE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	348.67
Services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

One sided p -value < 0.001 ($X^2 \geq 15$)

Source: Special Tabulations, 1987 SSEL Center for Economic Studies, Spring, 1996.

TABLE IVB
Log Rank Statistics, by size

Size	Zero employees	1–4 employees	5–9 employees	10–20 employees	21–49 employees	50–99 employees	100–249 employees	250–499 employees	500+ employees
New England	0.00	4051.86	22991.5	28111.5	29981.0	36020.8	33592.1	25130.6	19084.4
1–4 employees	0.00	0.00	6893.30	9597.54	10425.0	13752.6	12584.2	8360.75	5636.63
5–9 employees	0.00	0.00	0.00	218.94	332.14	1108.07	836.71	93.18	20.50
10–20 employees	0.00	0.00	0.00	0.00	11.07	338.35	199.76	24.46	353.98
21–49 employees	0.00	0.00	0.00	0.00	0.00	230.69	119.45	68.38	489.46
50–99 employees	0.00	0.00	0.00	0.00	0.00	0.00	17.04	532.49	1333.31
100–249 employees	0.00	0.00	0.00	0.00	0.00	0.00	0.00	354.02	1040.56
250–499 employees	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	192.82
500+ employees	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

One sided p -value < 0.001 ($X^2 \geq 15$)

Source: Special Tabulations, 1987 SSEL Center for Economic Studies, Spring, 1996.

TABLE IVC
Log Rank Statistics, by size

	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific
New England	0.00	0.23	30.29	28.26	173.75	235.31	1644.53	1160.05	252.04
Middle Atlantic	0.00	0.00	25.41	33.68	187.41	251.18	1691.67	1198.67	268.61
East North Cent	0.00	0.00	0.00	116.83	348.08	432.17	2125.56	1567.79	457.83
West North Cent	0.00	0.00	0.00	0.00	61.48	100.59	1231.67	819.59	110.39
South Atlantic	0.00	0.00	0.00	0.00	0.00	5.05	733.85	426.35	6.70
East South Cent	0.00	0.00	0.00	0.00	0.00	0.00	609.01	334.12	0.12
West South Cent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.66	608.84
Mountain	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	331.09
Pacific	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
One sided p -value < 0.001 ($X^2 \geq 15$)									

Source: Special Tabulations, 1987 SSEL Center for Economic Studies, Spring, 1996.

raphy (e.g. metropolitan status) may uncover results not available from the relatively coarse geographic areas presented above. We need to expand the type of establishment from affiliation status to include their tax (e.g. sole proprietorship, tax exempt corporation), auxiliary (e.g. payroll, research and development), and foreign ownership status.

A different extension is to investigate the relative effects of the five characteristics, age, affiliation status, industry, size, and division. Calculating life tables for all possible combinations of the latter four characteristics provides the information for a discrete time hazard model and the ability to assess the relative values of the five characteristics, different specifications for age, and the introduction of interactions (e.g. affiliation status-industry).

The last extension is replication. Calculation of age-specific dissolution rates and the construction of life tables for other economic census years ought to provide the information to confirm the empirical results presented here. Further, such replication offers the opportunity to control for the business cycle effects on the calculation of age-specific dissolution rates.

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Notes

¹ When a business starts is an issue. The definition used in this paper is the hire of a business' first employee (legally). It is not possible to identify businesses without employees or business start-ups which precede the hiring of employees. Related work by Center staff has addressed this issue (McGuckin and Nucci, 1991).

When a business exits is also an issue. Lane and Shary (1991) report that "simple discontinuances . . . occur 28 times

more frequently than do business failures . . ." This paper uses the broader definition of a business exit, called here a "business closing" or "business dissolution."

² The types of data available on each year's SSEL include prior year and current (reference) year employment, prior year and current year quarterly wages, industry and geography, form of business (e.g. corporation), type of business (e.g. single establishment), age and a variety of identification numbers associated with each establishment (owner I.D., IRS taxpayer I.D. (EIN), physical location I.D.).

Internal Revenue Service (IRS) administrative records are the source of information for autonomous (read single) establishments and affiliated entities while the Bureau of the Census Annual Organization Survey responses are the source of information for affiliated (read multi-) establishments.

³ The Bureau of the Census in its annual survey operations emphasizes the relation between current and prior year employment, etc. A similar comparison is performed across adjacent economic censuses establishment populations.

The Bureau of the Census is working with the Small Business Administration in creating a panel dataset for the period 1989–1994 from the 1989 through 1994 SSEL's. Tabulations of establishment formation and dissolution for the 1989–1993 period are available from the Small Business Administration, Office of the Advocacy and a more abbreviated form, from the Census Bureau's Web Site.

⁴ The previously cited work (endnote 3) for the Small Business Administration is the first attempt at the Census Bureau to ascertain the extent of this problem and to provide "fixes".

⁵ The data project for the SBA referred to in endnote 3 proposes several remedies for this problem. They basically reduce to matching closing establishments in one year to new establishments in a subsequent year on geography, industry, and payroll. This procedure reduces the dissolution rate eight to 10 percent from that reported in this study.

⁶ The 1987 SSEL does not contain 1988 wages. Therefore, an active establishment's 1988 wages is obtained from a match of the 1987 dataset to the 1988 dataset on business I.D. Thus, an active 1987 business that survives throughout 1987 is defined by the presence of 1988 wages. An active business that is a dissolution in 1987 is one that 1) does not have match on business I.D. from the 1988 dataset; 2) has a 1988 match on business I.D. but has zero wages in 1988.

Since the paper studies the dissolution experience of businesses based upon the adjacent years 1987 and 1988, the difference between ownership and location ought to be small. This project is studying how accurate this statement is for multi-establishments. More troubling are reorganizations of businesses not captured in the Bureau of the Census multi-establishment program (e.g. a single-establishment switch of ownership from parent to child or from proprietorship to corporation).

This paper occupies an intermediate position between defining a continuing business based upon ownership and defining a continuing business based upon physical location, regardless of ownership change. The business ownership I.D. is used in a first stage match of 1987 and 1988 establishments, and non-matched 1987 establishments ownership I.D.'s are matched to non-matched 1988 establishments prior year

business I.D.'s. This two stage matching operation has a bias toward matching multi-establishments and not matching single establishments. This is because of the annual survey operation at the Bureau of the Census for multi-establishments.

About 778,000 establishments of the 6,000,000 1987 establishments with positive payroll and a matching 1988 ownership I.D. show no positive payroll in 1988. About 53,000 establishments with positive 1987 payroll do not match to 1988 SSEL establishments and about 42,000 of these match to a 1988 establishment's prior year I.D. and show positive payroll in 1988. About 78 percent are multi-establishments.

⁷ Establishments with no age value or inaccurate values (about 230) were grouped separately and were distributed among those establishment with a valid age based upon their frequency. About 4,700 establishments showed an age value of "1988". This paper treated these establishments as formed in 1987 and recoded their value to 1987. Assuming similar numbers were "misplaced" in the other years, a proportion of each year's establishments (using the 1987 proportion) were remove from each year and placed in the prior year until the open-ended age category 10.

⁸ Affiliated establishments were identified from a permanent location variable (called the "permanent plant number"). This variable, first used in the 1977 economic censuses, identifies those establishment which have changed ownership over this period and provides information on the affiliation status of the original (if any) owner as of 1977. Thus, the re-organization experience of establishments before 1977 is not captured.

⁹ Life tables are used to describe period and generational cohorts. A period cohort is based upon cross-sectional data by age and a generational cohort is based upon longitudinal data. The establishment life tables of this paper are period ones.

The information in a life tables is presented by what are called "functions." This basically means that different columns represent different types of population, rates and distribution information:

- age-specific dissolution rate – ${}_n m_x$
- the conditional probability of dissolution during period n , given survival to age x – ${}_n q_x$
- number of establishments surviving from a hypothetical cohort of 100,000 at age 0 – l_x
- life table establishment dissolutions – d_x
- number of establishment years active, by age – L_x
- life expectancy – e_x
- partial life expectancy – ${}_f e_x$

Life tables of human populations are usually based upon central mortality rates drawn from population census and vital statistics data. Further, the maximum human life span is usually assumed known.

There are two basic differences in technique in the establishment application. One, the establishment life tables of this paper are based upon matching 1987 and 1988 SSEL files to obtain the active population and the number of closings. Two, the life span of surviving establishments is not known. To quote Smith (1992, p. 92), "... the life expectancy e_x cannot be estimated, either because the life table spans only part of the survival distribution or because no satisfactory estimate of ${}_w - {}_f L_f$, the time lived in the final age or duration interval is available. In that event, in place of e_x the partial life expectancy to age f may be used." (Smith, 1992, pp. 92–93)

¹⁰ Demographers make a third assumption. The population is closed to migration. The concept of migration has received little attention in the formal literature on business demography and we are thus in the awkward position of not knowing how to define, let alone measure, this phenomenon.

How reasonable are these assumptions? In the virtual absence of information on age-specific dissolution rates, assessing the reasonableness of the stationarity assumption relies upon findings by many studies of similar pattern of these rates, if not identical values. It is also difficult to assess whether dissolution and formation rates are equal. Again, there is little information available. What is available indicates that formation rates are higher than dissolution rates, though not dramatically so.

¹¹ To the extent that 1987 values measures are those of the business at its startup, the values for these variables are age-independent. This should be the case for division values and is assumed to be so for size. Businesses may change affiliation status from autonomous to affiliated status or shift from manufacturing to wholesale industries over their life span. The affiliation status value is derived from either 1) the current status where there is no indication of a change or 2) the status prior to the current one, where there has been a change in status. We assume that establishments rarely move from one industry (e.g. manufacturing) to another, although this may not be the case for more detailed industries (e.g. food processing).

¹² It is calculated in two steps: 1) the difference between the expected number of dissolutions minus the observed number divided by the expected number; 2) the sum of the differences for each of two life tables. See Kramer (1988), pp. 248–253, for a brief overview of the calculations. Smith (1992), pp. 113–117, discusses the use of the similar Mantel-Haenzel test.

¹³ Figure 2, Figure 3 and Figure 4, plots of industry, size, and division age-specific dissolution ratios, are available from the author.

¹⁴ The individual affiliation status, industry, size, and division life tables are available from the author or the Census internet.

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