THE DURATION OF EMPLOYMENT OPPORTUNITIES IN U.S. MANUFACTURING

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Abstract—Long-duration employment opportunities are a necessary condition for workers to hold lifetime jobs. This paper uses longitudinal data on individual U.S. manufacturing plants from 1963–1982 to estimate the age and completed spell distributions for employment positions. The results indicate that, of the employment opportunities in progress in the U.S. manufacturing sector in 1982, 30.0% were at least 19 years old and 59.6% would have a completed length of at least 20 years. High rates of turnover in employment positions coexist with a large number of long-duration employment opportunities because the turnover tends to be concentrated within a subset of the producers.

I. Introduction

HIGH rates of turnover characterize U.S. employment from both the perspective of the worker (Hall (1972), Perry (1972), and Clark and Summers (1979)) and the employer (Leonard (1987) and Dunne, Roberts, and Samuelson (1989)). These high turnover rates contribute to the fact that, on average, completed employment spells are of short duration.

Short average employment spells do not imply that most employment in progress *at a point in time* is occurring in short duration spells.[1] Akerlof and Main (1981, p. 1007) illustrate this distinction. In the case of white, male workers, they estimate that the average length of all employment spells ending over the 1968–1972 period was 3.9 years. However, for the same category of workers, the estimated average completed length of all spells in progress in 1968 was 18.3 years. Hall (1982) constructs estimates of the distribution of the completed length of employment spells in progress in 1978. He finds a median completed spell length of 7.7 years and that 28% of the spells in progress were expected to last at least twenty years. Using data from Great Britain, Main (1982) reports the average completed spell of manufacturing jobs in progress in 1968 was 20 years and that 43% of spells would last twenty years. Even though employment turnover rates are high, these papers suggest that at any point in time a substantial portion of U.S. workers are holding, to use Hall's term, lifetime jobs.

The empirical work on employment duration utilizes sample data on individual workers. In this case, employment spells reflect the duration of the worker–employer match and can end due to a voluntary quit or an involuntary separation arising from a firing, a plant employment cutback, or closing. This paper measures the duration of employment from the demand side of the labor market by examining employment levels over time for individual plants in the U.S. manufacturing sector. The focus is on the duration of the *employment opportunity* provided within the plant. As defined here, an employment spell reflects an ongoing employment opportunity in the plant. Spells end because of reductions in the plant's workforce or closing of the plant.

The presence of long-duration employment opportunities is a necessary condition for lifetime jobs. The goal of this paper is to quantify the extent to which the employment opportunities present at a point in time represent long-duration opportunities. This issue cannot be addressed by examining rates of plant employment turnover. The high turnover rates reported by Leonard (1987), Dunne, Roberts, and Samuelson (1989) and others can coexist with a large number of long-duration employment opportunities if the

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[1]This point was made with respect to unemployment spells by Clark and Summers (1979). They demonstrate that while most unemployment spells are quite short, most time in unemployment is spent in spells of longer than average duration. The former statement examines the duration of all spells which are completed during some time interval. This includes a large number of short spells. The latter statement examines the eventual completed duration of all spells in progress at a point in time.

turnover is consistently concentrated in a subset of the employers rather than being widely dispersed across all employers.

To measure the duration of employment opportunities this paper utilizes a panel data set on all U.S. manufacturing plants present in the 1963, 1967, 1972, 1977, or 1982 Census of Manufactures. The empirical results indicate that a substantial proportion of employment opportunities in the U.S. manufacturing sector are of long duration. In 1982, the median age of the employment opportunities in progress was over 10 years and 30.0% were at least 19 years old. When the distribution of the completed length of employment opportunities is estimated the evidence of long-term employment is even stronger. We estimate that 59.6% of the manufacturing employment opportunities in progress in 1982 will have a completed length of at least 20 years.

There is significant variation in the duration of employment opportunities with plant characteristics such as industry, region, plant age, and plant ownership. Employment retention rates are systematically higher for older plants and plants owned by multiplant firms. This leads to a higher proportion of the long-duration employment opportunities being concentrated in these plants. Employment retention rates are lower and expansion rates are higher for younger plants that are owned by single-plant firms and this is the source of much of the employment turnover which occurs.

The next two sections of this paper outline the methodology for measuring the age distribution of employment opportunities using plant cohort data and summarize the census data set. The fourth section summarizes the retention and expansion rates of individual plants. The fifth section estimates the distribution of expected completed spell lengths for employment opportunities in progress in 1982. The final section provides a summary and conclusions.

II. Measurement Issues

To measure the age distribution of employment opportunities at a point in time it is necessary to disaggregate the level of employment in the time period into the surviving flow of employment added in each earlier time period. Consider a group of plants with a set of characteristics z which first begin operation in time period t_0. The characteristics could include the industry of operation, geographic region in which the plant is located, and type of ownership. Suppose that time-series observations are available for each of these plants over the period $(t_0, t_0 + 1 \ldots t-1, t)$. The total employment for this group of plants in year t is denoted by $L_t(z, t_0)$. Let $E_t(z, t_0, t-1, t)$ and $E_{t-1}(z, t_0, t-1, t)$ denote, respectively, the period t and period $t-1$ employment for the plants which expand employment between periods $t-1$ and t. Similarly, let $C_t(z, t_0, t-1, t)$ and $C_{t-1}(z, t_0, t-1, t)$ denote the period t and $t-1$ employment for the plants which contract between the two periods. In each case the time subscript applies to the period in which employment is measured and the time periods in parentheses denote the interval over which the plant was observed to expand our contract. The gross flow of new employment added in expanding plants with characteristics z and t_0 between periods $t-1$ and t is defined as

$$\Delta E(z, t_0, t-1, t) \equiv E_t(z, t_0, t-1, t) - E_{t-1}(z, t_0, t-1, t). \tag{1}$$

Given plant-level data, this can be measured by summing the employment added in each expanding plant over the time interval.

The employment retention rate, the proportion of total period $t-1$ employment which survives until period t, is defined as

$$R(z, t_0, t-1, t) \equiv \frac{E_{t-1}(z, t_0, t-1, t) + C_t(z, t_0, t-1, t)}{L_{t-1}(z, t_0)}. \tag{2}$$

The numerator of (2) is the beginning-period employment in all plants which expand over the interval plus the ending-period employment in the plants which contract. This represents the total number of stable employment opportunities provided by these plants over the time period.

The period t employment level for this group of plants can be written as the sum of the gross flow of new employment opportunities added between periods $t-1$ and t and the level of period

$t-1$ employment opportunities which survive until period t:

$$L_t(z,t_0) = \Delta E(z,t_0,t-1,t) + L_{t-1}(z,t_0) \cdot R(z,t_0,t-1,t). \quad (3)$$

Substituting for L_{t-1} and earlier time periods allows period t employment to be written as the weighted sum of the gross flows of new employment opportunities added in these plants in each earlier time period. The weight attached to the new employment flow from an earlier period is the product of the retention rates from that period until period t. Suppressing the z and t_0 notation, period t employment for these plants can be written as

$$L_t = \Delta E(t-1,t) + \Delta E(t-2,t-1) \cdot R(t-1,t) + \Delta E(t-3,t-2) \cdot [R(t-2,t-1) \cdot R(t-1,t)] + \cdots + \Delta E(t_0-1,t_0) \cdot [R(t_0,t_0+1) \cdot \cdots \cdot R(t-1,t)]. \quad (4)$$

Each of the terms in (4) is the number of new employment opportunities from an earlier time period that survive until period t. Equivalently each term in (4) represents the number of period t employment opportunities of a given age.[2] Notice that while (4) applies to a single cohort of plants, so that all plants are the same age in period t, there is a distribution of employment ages due to the variation in expansion and retention rates over time.

One assumption made in deriving equation (4) is that the employment retention rate between each pair of adjoining periods varies only with the time periods and plant characteristics, including plant age, and not with the employment age. This implies that a given percentage reduction in the plant's total employment implies an equal percentage reduction in the level of employment of each age within the plant. Equivalently, the age distribution of employment opportunities within the plant is assumed to be unaffected by the reduction in plant employment.[3]

Measurement of the age distribution of period t employment opportunities using (4) requires the period-by-period retention rates and level of employment expansion, both disaggregated by plant characteristics. These are summarized in section IV.

III. Data Issues

The data requirements for the measurement of the age distribution and duration of employment opportunities are demanding. The data set must include both comprehensive cross-sectional coverage of individual plants and sufficiently long time-series coverage so that the duration of employment opportunities can be measured. The data set which underlies the calculations in this paper consists of all U.S. manufacturing establishments with five or more employees in the 1963, 1967, 1972, 1977, or 1982 Census of Manufactures.[4] These account for between 60% and 70% of the total number of plants but over 99% of manufacturing employment in each census year.[5] The individual plants have been linked across the five census years which allows identifi-

[2] The last expansion term in equation (4), $\Delta E(t_0-1,t_0)$, is the level of employment when the plants began operation. If the data are left censored so that the available observations begin in period t_0 while some plants begin operation before that then the last expansion term must be replaced by the total t_0 employment in those plants. The last term in equation (4) will then equal the amount of period t employment which is at least $t-t_0$ years old.

[3] One alternative would be to assume that all plant contraction comes from the youngest employment opportunities in the plant and would result in an older age distribution than our method. Another alternative would assume contractions all come from the oldest opportunities and would result in a higher proportion of young jobs. The fact that individuals with less job tenure are often the first to be laid off when plant employment is reduced does not have any implications for the age of the positions which are lost.

[4] The Census Bureau defines a manufacturing establishment as a single plant or factory in which manufacturing operations are performed. The data cover all manufacturing, fabricating, and assembling operations conducted within the plant and exclude sales offices, research facilities, retail stores, and administrative offices if they are operated as separate facilities. The construction of the data set is discussed in Dunne, Roberts and Samuelson (1988).

[5] Plants with less than five employees are deleted because of concerns about data accuracy. Their deletion has no effect on the results discussed below because their contribution to both total employment and total employment turnover is extremely small. Total employment in the sample varies from a low of 16.01 million in 1963 to a high of 18.33 million in 1977.

cation of the new plants, failing plants, and continuing plants in each census year.[6]

A major strength of the data is that it permits calculations to be based on tracking plant cohorts over time. This allows us to avoid any assumptions about steady-state employment flows when measuring the age distributions. A second strength of the data is that the multiple time-series observations on each plant's employment levels allow us to measure the distribution of employment ages within each plant. This allows us to distinguish the distribution of employment by plant age from the distribution of employment by employment age.

Two limitations of the data exist. First, because the census is only taken at five-year intervals it is impossible to measure the year-to-year employment changes within the plant. Because it is possible for plant employment in the intercensus years to fall below the observed employment level in the census years, what appears in the data as a continuing position may actually be two shorter positions. This problem will be minimized somewhat by the fact that two of the census years, 1972 and 1982, had significantly lower levels of manufacturing employment. Employment opportunities which ended because of the manufacturing sector contractions in these years, but were restarted in the subsequent expansion, will not be mismeasured as long-duration positions.[7] The second data limitation is that, while total plant employment is reported in each census year, it is not possible to tell if a given level of employment reflects the same jobs in each year. It is therefore not possible to measure the effect of occupational restructuring within the plant on the age or duration of the plant's employment opportunities. While this is a potentially important factor which reduces employment durations and contributes to employment turnover, available evidence suggests that contractions or closings of plants are substantially more important as a source of worker job loss.[8] When combined with the findings of plant-level studies, which indicate that employer turnover creates substantial gross flows of total employment positions, this suggests that measurement of the age and completed spell distributions using total plant employment should provide the major insights into the relationship between employer turnover and the duration of employment opportunities.

IV. Retention Rates and Expansion Rates for Plant Employment

In order to assess the durability of employment opportunities in the U.S. manufacturing sector we first measure the age distribution in each census year. As shown in equation (4) the necessary elements are the employment retention rates and levels of expansion for individual plants over time.[9]

In order to summarize how the retention rates vary with plant characteristics a regression model using grouped data is estimated. Plants are grouped into data cells defined over the 20 two-

[6] The process of matching individual plants across census years is discussed in Dunne, Roberts, and Samuelson (1988). While substantial effort was devoted to tracking plants across time despite changes in plant ownership, some administrative changes, such as sale of the plant or legal reorganizations, could result in a failure to identify an ongoing plant across census years. These matching errors will then appear as the exit of an existing plant, and the end of its employment opportunities, followed by the entry of a new plant. Exclusion of the smallest plants, which are most likely to be affected by these errors, mitigates this problem to some extent. These errors will result in a downward bias in the measured age and completed spell distributions. Our main finding that a substantial proportion of employment opportunities are of long duration would be further strengthened if the measurement error could be reduced.

[7] Because the plants are observed at five-year intervals it is also not possible to estimate accurately the unconditional distribution of completed spells. The time between censuses results in length-biased sampling, the systematic undercounting of short-duration positions. However, this sampling bias does not affect estimates of the conditional age or completed spell distributions for employment opportunities *in progress in the census years* which are the focus of this paper. Clark and Summers (1979), Akerlof and Main (1981), and Hall (1982) all focus on the distribution of unemployment or employment spells conditional on being in progress at a point in time.

[8] Flaim and Sehgal (1985) report that, of the 5.1 million surveyed workers who lost a job between 1979 and 1983 because of "a plant closing, an employer going out of business, a layoff from which the worker in question was not recalled, or other similar reasons," 49.0% were due to plant closings and 38.7% were due to slack work. The latter category approximately reflects jobs lost due to employment contractions in ongoing plants. The remaining 12.4% of the workers were displaced because their position or shift was abolished. This category presumably includes occupational restructuring which was not accompanied by a contraction in plant employment.

[9] If a plant's employment in the intercensus years falls below that observed in the census years then the measured retention rate will be an upper bound on the true retention rate between the two years. The aggregate employment retention rates for the four time periods 1963–1967, 1967–1972, 1972–1977, and 1977–1982 are 0.814, 0.684, 0.741, and 0.702, respectively.

digit SIC industries, 9 geographic regions, 2 ownership categories (owned by a single-plant firm (SP) or a multiplant firm (MP)), and 10 combinations of the census year in which it first appears in operation and the year of observation. There are 3513 cells which contain employment observations. Within each cell the employment retention rate is constructed using equation (2) and the expansion rate is constructed, using equation (1), as $\Delta E(z, t_0, t-1, t)/L_{t-1}(z, t_0)$.

The dependent variables in the regression model are the cell retention and expansion rates and the explanatory variables include 20 industry dummy variables, 8 regional dummies, and an ownership dummy. Because the age of plants present in the 1963 Census cannot be determined, separate regressions for those plants and the plants which enter in either the 1967, 1972, or 1977 censuses are estimated. For the 1963 plants three time-period dummy variables are included to control for time and age effects. For the other plants two age dummy variables and two time-period dummies are included.[10]

The coefficient estimates for the retention rate regressions are reported in table 1. In each of the two regressions the base group for comparison is a plant owned by a multiplant firm in the Northeast region between 1967 and 1972. The industry intercepts are substantially higher for the firms present in 1963 than for the later entrants indicating that the older plants have higher retention rates over the 1967–1972 period than does an otherwise comparable group of new entrants. The regional dummy variables indicate that the mid-Atlantic states (New York, Pennsylvania, and New Jersey) and Pacific coast states have lower employment retention rates than the Northeast while the other regions generally have higher retention rates. The significant coefficient on the ownership dummy variable indicates that plants which are owned by single-plant firms have employment retention rates which are between 12 and 16 percentage points lower than plants owned by multiplant firms. The time-period dummy variables indicate that retention rates in the 1963–1967, 1972–1977, and 1977–1982 periods are higher than in 1967–1972. This base period was one of overall contraction of manufacturing employment. The age dummy variable coefficients indicate that employment retention rates rise as the plant ages. Plants which are 6–10 and 11–15 years old have retention rates which are 9 and 14 percentage points higher, respectively, than plants 0–5 years old.

In table 2 coefficient estimates for the employment expansion rates are presented.[11] The results indicate that the expansion rates for the plants present in 1963 are less than the rates for later entrants. The Southwest, Mountain, and Pacific regions have expansion rates that are slightly higher than in the Northeast. Plants owned by single-plant firms have expansion rates which are approximately three percentage points higher than plants owned by multiplant firms. The time-period variables for the 1963 plants indicate larger expansion rates in the 1963–1967 period and lower rates in the 1977–1982 period relative to the 1967–1972 base period. The later entrants have lower expansion rates in 1972–1977. Finally, expansion rates show a significant decline with plant age.

Overall, the regression results indicate that employment retention and expansion rates vary significantly with plant characteristics, particularly with the type of plant ownership and plant age. Both of these factors have important implications for the age and completed spell distributions. Rates of employment expansion tend to be higher, but rates of employment retention are lower, in young, single-plant firms. This evidence suggests that it is possible to have high rates of employ-

[10] Weighted least squares is used to estimate the retention rate equation. In this case it is equivalent to the minimum chi-square estimation method (Maddala (1983), p. 28). Within each cell the variance of the retention rate used to construct the weighted least squares estimates is

$$[R(z, t_0, t-1, t)(1 - R(z, t_0, t-1, t))]/L_{t-1}(z, t_0).$$

[11] The equation is estimated with ordinary least squares. Unlike the retention rate, the expansion rate cannot be treated empirically as the proportion of successful draws of a zero-one random variable because the size of the pool being drawn from (the group of potential new employment opportunities) is not observable. As a result, the procedure used to construct weighted least squares estimates of the retention rate regression equation is not applicable here. The expansion rate regressions are for summary purposes only and the estimation results are not used to construct the age distribution or the distribution of completed employment opportunities.

TABLE 1.—EMPLOYMENT RETENTION RATE COEFFICIENT ESTIMATES
(standard errors in parentheses)

	1963 Plants	1967, 1972, 1977 Entrants
Industry Intercepts		
SIC 20	.705 (.009)[a]	.597 (.013)[a]
21	.729 (.025)[a]	.658 (.059)[a]
22	.732 (.010)[a]	.500 (.014)[a]
23	.670 (.010)[a]	.535 (.012)[a]
24	.661 (.014)[a]	.503 (.014)[a]
25	.747 (.013)[a]	.580 (.017)[a]
26	.777 (.010)[a]	.700 (.015)[a]
27	.772 (.010)[a]	.659 (.013)[a]
28	.761 (.010)[a]	.651 (.014)[a]
29	.801 (.016)[a]	.632 (.030)[a]
30	.737 (.012)[a]	.630 (.014)[a]
31	.704 (.015)[a]	.638 (.020)[a]
32	.719 (.012)[a]	.562 (.016)[a]
33	.778 (.009)[a]	.646 (.015)[a]
34	.741 (.009)[a]	.605 (.012)[a]
35	.752 (.008)[a]	.627 (.012)[a]
36	.734 (.009)[a]	.613 (.012)[a]
37	.755 (.008)[a]	.592 (.013)[a]
38	.758 (.012)[a]	.652 (.014)[a]
39	.754 (.014)[a]	.595 (.016)[a]
Regional Dummy Variables		
Region 2	−.018 (.007)[a]	−.073 (.010)[a]
3	.014 (.007)	−.039 (.010)[a]
4	.026 (.009)[a]	.006 (.011)
5	.035 (.008)[a]	.018 (.010)
6	.048 (.009)[a]	.013 (.011)
7	.043 (.009)[a]	.008 (.011)
8	.043 (.013)[a]	.019 (.014)
9	−.033 (.008)[a]	−.057 (.010)[a]
Ownership Dummy Variable	−.164 (.005)[a]	−.115 (.005)[a]
Time Period Dummy Variables		
1963–1967	.125 (.004)[a]	
1972–1977	.067 (.005)[a]	.079 (.007)[a]
1977–1982	.021 (.005)	.054 (.007)[a]
Plant Age Dummy Variables		
Age = 6–10 years		.089 (.005)[a]
Age = 11–15 years		.141 (.007)[a]
Base:	Plant owned by a Multi-Plant Firm in Region 1 in 1967–1972	Plant owned by a Multi-Plant Firm in Region 1 in 1967–1972 with Age = 0–5 years
Number of observations	1404	2065

[a] Significantly different from zero at the 0.01 significance level using a two-tailed test.

ment turnover coexisting with a large proportion of employment opportunities being of long duration. Rather than being evenly dispersed across plants of all ages, much of the turnover arises from the expansion, contraction, and replacement of young plants, which must contain relatively young, short-duration employment opportunities. These plants coexist with a group of older plants which provide long-duration employment opportunities.

V. The Age and Completed Spell Distribution for Employment Opportunities

As shown in equation (4), the level of employment in any time period can be disaggregated by

TABLE 2.—EMPLOYMENT EXPANSION RATE COEFFICIENT ESTIMATES
(standard errors in parentheses)

	1963 Plants	1967, 1972, 1977 Entrants
Industry Intercepts		
SIC 20	.078 (.013)[a]	.310 (.040)[a]
21	.022 (.014)	.228 (.055)[a]
22	.074 (.013)[a]	.338 (.040)[a]
23	.071 (.013)[a]	.246 (.040)[a]
24	.073 (.013)[a]	.240 (.040)[a]
25	.093 (.013)[a]	.286 (.040)[a]
26	.068 (.013)[a]	.365 (.040)[a]
27	.098 (.013)[a]	.355 (.040)[a]
28	.108 (.013)[a]	.389 (.040)[a]
29	.105 (.013)[a]	.370 (.040)[a]
30	.135 (.013)[a]	.420 (.040)[a]
31	.085 (.013)[a]	.320 (.040)[a]
32	.068 (.013)[a]	.266 (.040)[a]
33	.070 (.013)[a]	.396 (.040)[a]
34	.106 (.013)[a]	.318 (.040)[a]
35	.139 (.013)[a]	.407 (.040)[a]
36	.150 (.013)[a]	.467 (.040)[a]
37	.144 (.013)[a]	.330 (.040)[a]
38	.161 (.013)[a]	.486 (.040)[a]
39	.114 (.013)[a]	.309 (.040)[a]
Regional Dummy Variables		
Region 2	−.013 (.010)	−.050 (.029)
3	−.013 (.010)	−.039 (.029)
4	.011 (.010)	.020 (.030)
5	.012 (.010)	.010 (.029)
6	.015 (.010)	.011 (.029)
7	.036 (.010)[a]	.027 (.030)
8	.067 (.010)[a]	.142 (.030)[a]
9	.034 (.010)[a]	.007 (.029)
Ownership Dummy Variable	.030 (.005)[a]	.032 (.014)[a]
Time-Period Dummy Variables		
1963–1967	.081 (.007)[a]	
1972–1977	.001 (.007)	−.060 (.022)[a]
1977–1982	−.019 (.007)[a]	−.046 (.022)
Plant Age Dummy Variables		
Age = 6–10 years		−.117 (.017)[a]
Age = 11–15 years		−.152 (.022)[a]
Base:	Plant owned by a Multi-Plant Firm in Region 1 in 1967–1972	Plant owned by a Multi-Plant Firm in Region 1 in 1967–1972 with Age = 0–5 years
Number of observations	1418	2095

[a] Significantly different from zero at the 0.01 significance level using a two-tailed test.

age. Because of the discrete nature of the available census data and the 1963 starting date for the data set, it is only possible to classify each census year's employment into age categories which reflect the number of censuses since 1963. The 1982 employment opportunities can be disaggregated into five age groups; employment which survives from the 1963 census (is at least 19 years old), 1967 census (15–18 years old), 1972 census (10–14 years old), 1977 census (5–9 years old) and employment added since the 1977 census (0–4 years old).[12] Calculation of the age distribu-

[12] The left-censoring in the data prevents us from drawing inferences about the age distribution for employment opportunities more than 19 years old. Because of the large proportion of employment which falls in the upper tail of the age distribution, any attempt to estimate the mean age of the employment opportunities will be sensitive to assumptions

tion of employment opportunities in 1982 indicates that 30.0% of the positions are at least 19 years old. The proportion of 1982 employment in each of the remaining age categories is 10.4 (15–18 years old), 13.9 (10–14 years old), 18.8 (5–9 years old), and 26.9 (0–4 years old). The median age in 1982 is thus slightly over 10 years.[13]

The age distribution summarizes only the length of employment opportunities in progress up to the survey date and not the distribution of eventual completed employment spells. If employment opportunities in progress are relatively young then either retention rates are low, so that few survive until old age, or the group of plants has recently undergone growth and expansion of their total employment. The first explanation would lead to relatively short completed spells while the latter case would lead to long completed spells if retention rates are high. In order to assess the ability of manufacturing plants to provide long-term stable employment opportunities, we next examine the distribution of completed employment opportunities.

Salant (1977) and Akerlof and Main (1981) provide a link between the age and completed spell distributions. They show that if the duration of an employment spell is independent of the starting date of the spell and if the starting dates of spells in progress are uniformly distributed over an interval which is at least as long as the longest possible spell then the mean length of completed spells for jobs in progress at a point in time equals twice the mean age of jobs. In our case the doubling rule is inappropriate because both conditions are likely to be violated. The first because of cyclical fluctuations and the second because the possible starting dates for employment in progress at the survey date are truncated due to characteristics of the plants.[14] In particular, it is not possible to observe old employment opportunities in progress in plants which are young. Equivalently, the data on the age of employment opportunities in young plants are not randomly sampled from the whole distribution of employment ages.

The basic issue we face in estimating the distribution of completed spells concerns how to project the remaining length of the employment opportunities observed in progress in 1982. We rely on the empirical model of employment retention rates discussed in section IV to make these projections. Let $E_t(A, z, t - t_0)$ equal the period t employment opportunities of age A in plants with characteristics z and plant age $t - t_0$. Let $R(z, t - t_0)$ be the predicted employment retention rate for this group of plants from the regression model in section IV. The level of period t employment which is predicted to survive until period $t + 1$ is the product of the period t employment level and the retention rate for plants with the same characteristics and period t age:

$$\begin{aligned} E_{t+1}&(A + 1, z, t + 1 - t_0) \\ &= E_t(A, z, t - t_0) \cdot \hat{R}(z, t - t_0). \end{aligned} \tag{5}$$

Notice that in $\hat{E}_{t+1}$ both the age of the employment and the age of the plant have increased by one period over their period t values. The hat is used on E_{t+1} to indicate it is an estimated value. The same process can be used to construct predicted employment levels for additional future periods so that for the period $t + n$:

$$\begin{aligned} \hat{E}_{t+n}&(A + n, z, t + n - t_0) \\ &= \hat{E}_{t+n-1}(A + n - 1, z, t + n - 1 - t_0) \\ &\quad \cdot \hat{R}(z, t + n - 1 - t_0). \end{aligned} \tag{6}$$

As projections are made beyond period t the retention rates are updated to reflect the in-

about the shape of the upper tail. Because of this we do not estimate mean age of employment or the mean length of completed employment spells and instead focus on the proportion of employment in each age category as well as the median of the distribution.

[13] In Dunne and Roberts (1990) we provide the age distribution in each census year as well as the 1982 age distribution disaggregated by industry, region, ownership type, and plant age. The age distribution is very stable across census years but varies significantly with plant characteristics. A particularly large difference is found with plant ownership types. In 1982 35.4% of total employment in multiplant firms is at least 19 years old while only 13.9% of single-plant firm employment falls in this age category. In terms of employment levels, for every old position in a single-plant firm there are 7.7 old positions in multiplant firms.

[14] Violation of this second condition is what led Hall (1982) to develop an alternative methodology for estimating the length of completed jobs using sample data on the tenure of jobs in progress for individual workers. Hall's concern arises because young workers cannot be observed in long-tenure jobs. This worker-age/job-age issue is analogous to the plant-age/employment-opportunity-age issue we discuss. Because Hall does not have cohort data on individuals, he infers job retention rates from unmatched cross-sections of individuals. We do not use this methodology because our longitudinal data set allows direct measurement of the employment retention rates for each cohort of plants.

creased age of the plant. As seen in section IV the predicted values of the retention rates increase as the plants age. In the final step the length of completed employment opportunities is constructed as the sum of the age of the employment spell at period t and the predicted length of the employment spell beyond period t.

In addition to varying with plant age and other characteristics, the predicted employment retention rates vary with the year of observation because time-period dummy variables are included in the estimating model. We use the predicted values from the 1977–1982 period because this is the only time period in which we have retention rate data for plants that are more than 15 years old.[15] Finally, to project employment levels beyond 1982, retention rates for plants more than 15 years of age are needed. We assume retention rates are constant once the plants pass 15 years of age.

The first five columns of table 3 summarize the estimated distribution of completed employment opportunities for employment in progress in 1982. The overall picture is one of long-term employment opportunities. It is estimated that 59.6% of the employment opportunities in progress in the U.S. manufacturing sector in 1982 will ultimately have a completed length of at least twenty years. The median length of a completed employment opportunity in the manufacturing sector is thus more than twenty years.

We are only aware of one other estimate of the duration of employment opportunities. Using annual data for plants in Wisconsin from 1977–1982, Leonard (1987) estimates that the average completed length of all spells that begin over this period is 9.1 years. It can be shown that twice this estimate, 18.2 years, is an estimate of the mean completed length of all positions in progress at a point in time.[16] While we estimate the median length in U.S. manufacturing sector to be over twenty years the mean length in our data will be higher than this because the employment retention rate is not constant, but rather rises, with the age of the plant. Overall, however, the measures of employment durations from the two data sets are similar.

As expected, these estimates of the duration of the employment position are longer than the estimates of the duration of the worker in the job constructed by Hall (1982), Akerlof and Main (1981), and Main (1982). Hall reports a median job duration of 7.7 years with 28% of jobs lasting at least twenty years. Akerlof and Main report mean job durations of 18.3 and 19.5 years for male workers in durable and nondurable manufacturing, respectively. Main reports a mean of 20 years with 43% of jobs lasting at least that long.

When disaggregated by the age of the plant the difference in the ability of old versus young plants to provide long-duration employment opportunities is clear. As shown in table 3, for the oldest group of plants present in 1982, it is estimated that 79.1% of their 1982 employment level will have a completed length of at least twenty years. This percentage falls steadily as we move to younger plants. In the youngest group of plants, the 1982 entrants, it is estimated that 21.2% of their 1982 employment will ultimately last at least twenty years. In contrast, it is estimated that 42.0% of their 1982 employment level would not survive until 1987. This contrast between young and old plants arises, not because the age of the employment opportunities observed in 1982 differs, but rather because the younger plants have lower employment retention rates. It is the characteristics of the plants, not the age of the employment opportunities in progress, that determine this outcome.

The distribution of completed employment spells also differs substantially with plant ownership. For plants owned by single-plant firms it is estimated that 19.7% of the employment opportunities will last less than five years and 33.8% will last more than twenty years. The same per-

[15] The mean predicted retention rates across all cells in 1977–1982 are 0.592 for plants 0–5 years old, 0.682 for 6–10 year old plants, 0.733 for 11–14 year old plants, and 0.697 for plants more than 15 years old. The slight decline in the mean predicted retention rate for the oldest group of plants reflects the more extensive contractions experienced by the oldest plants in this time period.

[16] Following Salant (1977), define the random variable T as the length of spells in progress at the survey date t_S. Define the random variable S as the completed length of all spells that begin (or end) between time periods t_0 and t_E, where $t_0 < t_S < t_E$. In the steady state, T and S are both exponentially distributed if the hazard rate, λ, for a spell is constant. In this case, $E(T) = E(S) = 1/\lambda$. This is what Leonard relies upon when he estimates $E(S)$ as the inverse of the death rate of jobs in his sample. Under the steady state assumptions, Akerlof and Main (1981) show that the mean completed length of all spells in progress at the survey date, $E(S/\text{in progress at } t_S) = 2E(T)$. With a constant hazard rate this equals twice the inverse of the death rate.

TABLE 3.—DISTRIBUTION OF COMPLETED SPELL LENGTHS FOR EMPLOYMENT SPELLS IN PROGRESS IN 1982

	0–4 Years	5–9 Years	10–14 Years	15–19 Years	≥ 20 Years	Proportion of 1982 Employment Opportunities ≤ 19 Years Old Which Will Have Completed Lengths > 20 Years
Total	.094	.104	.103	.104	.596	.423
Plant Entry Cohort						
1963 Plants	.027	.048	.058	.076	.791	.526
1967 Cohort	.051	.083	.119	.196	.552	.552
1972 Cohort	.054	.107	.215	.164	.460	.460
1977 Cohort	.114	.270	.164	.125	.328	.328
1982 Cohort	.420	.184	.101	.083	.212	.212
Ownership Type						
Single-Plant	.197	.182	.152	.132	.338	.231
Multi-Plant	.060	.078	.086	.094	.681	.506
Geographic Region						
1. New England	.089	.104	.101	.109	.596	.414
2. Mid Atlantic	.101	.111	.106	.103	.581	.361
3. E. N. Central	.062	.081	.086	.093	.678	.461
4. W. N. Central	.075	.094	.099	.107	.625	.473
5. S. Atlantic	.087	.095	.100	.103	.615	.462
6. E. S. Central	.076	.090	.097	.101	.636	.492
7. W. S. Central	.107	.113	.107	.105	.569	.455
8. Mountain	.125	.122	.115	.108	.529	.433
9. Pacific	.148	.147	.128	.119	.458	.327
Industry						
SIC 20	.090	.105	.109	.108	.589	.396
21	.034	.052	.066	.067	.768	.512
22	.071	.087	.093	.082	.665	.428
23	.153	.152	.137	.121	.437	.289
24	.155	.170	.155	.123	.397	.265
25	.107	.117	.119	.107	.550	.395
26	.045	.057	.067	.086	.745	.553
27	.107	.108	.106	.108	.571	.426
28	.058	.074	.082	.092	.695	.523
29	.056	.060	.060	.054	.770	.530
30	.102	.117	.121	.120	.540	.419
31	.080	.095	.099	.109	.617	.392
32	.093	.109	.109	.100	.589	.382
33	.038	.053	.058	.070	.781	.546
34	.095	.111	.109	.112	.573	.412
35	.105	.114	.106	.109	.567	.428
36	.103	.107	.103	.108	.580	.432
37	.066	.079	.079	.092	.685	.499
38	.097	.110	.104	.108	.581	.448
39	.121	.130	.125	.111	.513	.372

centages for plants owned by multiplant firms are 6.0 and 68.1.

Systematic differences also exist across geographic regions and industries. Median completed employment length is highest in the E.N. Central region and lowest in the Mountain and Pacific regions. Only the Pacific region has a median completed employment duration of less than twenty years. Most of the two-digit industries have median durations of more than twenty years. The only exceptions are Apparel (SIC 23) and Lumber (SIC 24), while Furniture (SIC 25), Rubber and Plastics (SIC 30), and Miscellaneous Manufactures (SIC 39) have median durations of approximately twenty years.

The extent to which young employment opportunities reflect recent growth rather than low retention rates can be assessed by examining the final column of table 3. This reports the proportion of 1982 employment opportunities less than 19 years old which are estimated to ultimately last at least 20 years. A relatively low proportion reflects low employment retention rates.

In total it is estimated that 42.3% of the employment opportunities less than 19 years old in 1982 will last at least 20 years. This proportion, however, varies substantially with plant characteristics. This is illustrated most clearly by the regional and industry variation. For example, the Mountain and Pacific regions both have relatively young employment opportunities. In the Mountain region, 83.0% of the 1982 employment opportunities are less than 19 years old while the same figure in the Pacific region is 80.5%. However, it is estimated that 43.3% of these young opportunities will ultimately survive at least 20 years in the Mountain region but only 32.7% in the Pacific region. This reflects the larger average retention rate in the Mountain region as evidenced by the regional dummy variables reported in table 1. A large contrast between the age and completed spell distributions is also seen for the Mid-Atlantic region. The low retention rate for this region results in only the sixth highest median completed spell length despite the second highest median age of employment.

The across-industry variation in the proportion of young employment opportunities which will have long lifetimes is also substantial, varying from a low of 26.5% in Lumber (SIC 24) to a high of 55.3% in Paper (SIC 26). In some cases this can lead to sizeable differences in the distribution of completed spells for industries with similar age distributions. For example, the Apparel (SIC 23) and Rubber and Plastics (SIC 30) industries both have relatively young employment opportunities; 80.2% of employment is less than 19 years old. When examining the completed spell distributions, Apparel has 43.7% of the opportunities lasting at least 20 years while Rubber has 54.0%. The difference occurs because the employment retention rate is approximately ten percentage points higher in Rubber than in Apparel.

Overall, the results in table 3 suggest that a substantial portion of U.S. manufacturing employment opportunities can be viewed as lifetime opportunities. The duration of these opportunities differs systematically with observable plant characteristics particularly plant age and ownership type but also industry and region.

VI. Summary and Conclusions

This paper presents new evidence on the duration of employment opportunities in the U.S. manufacturing sector. The finding that a large proportion of employment opportunities are of long duration complements the findings of Hall (1982), Akerlof and Main (1981), and Main (1982) that suggest a substantial proportion of individuals are employed in lifetime jobs. In contrast to the conclusions drawn from examining gross flow or employment turnover statistics, this suggests that the employment opportunities in progress at any point in time in the U.S. manufacturing sector are quite durable. It is estimated that 59.6% of the employment opportunities in progress in 1982 will last at least twenty years. In contrast, approximately 9.4% of the employment opportunities are estimated to last less than five years.

The fact that high turnover rates coexist with a large number of old or long-duration employment opportunities occurs because much of the stable employment is concentrated in older plants, usually owned by multiplants firms, while turnover often occurs in younger, single-plant firms. In effect, new plants tend to replace young plants, yielding continual turnover in employment opportunities while older plants tend to provide more long-lasting employment opportunities. This conclusion is reinforced by the fact that, of the 1982 employment opportunities in plants which first enter in the 1982 census, 42.0% are expected to last less than 5 years. Only 21.2% of these employment opportunities are estimated to last at least 20 years. In contrast, 79.1% of the 1982 employment opportunities in plants which were in operation in 1963 are expected to last at least 20 years. This difference arises, not because the age of the employment opportunities observed in 1982 differ between young and old plants, but rather because the younger plants have lower employment retention rates.

This point can also be seen more clearly by comparing the shares of total turnover and total employment concentrated in young versus old plants. In each of the three time periods 1967–1972, 1972–1977, and 1977–1982, the turnover arising from the opening of new plants and the expansion, contraction, and closing of plants in the youngest existing cohort accounts for 42.5%, 48.0% and 40.0% of total turnover in each of the three periods. These same plants account for only 27.0%, 28.9%, and 25.7% of manufacturing employment in 1972, 1977, and 1982, respectively. In contrast, the expansion, contraction, and closing of the plants which were in operation in 1963 is responsible for 57.5%, 43.7%, and 39.9% of total turnover in the three time periods but the plants account for 73.0%, 63.0%, and 53.6% of employment at the end of each period.

A given degree of aggregate turnover can arise from many different patterns of plant turnover and these plant patterns can have different implications for the duration of employment opportunities. Our finding that the concentration of turnover in younger plants is greater than the concentration of employment emphasizes the fact that inferences about employment stability cannot be drawn from aggregate turnover statistics but rather must be based on knowledge of the age or completed spell distributions.

REFERENCES

Akerlof, George A., and Brian G. M. Main, "An Experience-Weighted Measure of Employment and Unemployment Durations," *American Economic Review*, 71 (Dec. 1981), 1003–1011.

Clark, Kim, and Lawrence Summers, "Labor Market Dynamics and Unemployment: A Reconsideration," *Brookings Papers on Economic Activity* (1, 1979), 13–72.

Dunne, Timothy, Mark J. Roberts, and Larry Samuelson, "Patterns of Firm Entry and Exit in the U.S. Manufacturing Industries," *The Rand Journal of Economics*, 19 (Winter 1988).

———, "Plant Turnover and Gross Employment Flows in the U.S. Manufacturing Sector," *Journal of Labor Economics* 7 (Jan. 1989) 48–71.

Dunne, Timothy, and Mark J. Roberts, "The Duration of Employment Opportunities in U.S. Manufacturing," The Pennsylvania State University (1990).

Flaim, Paul O., and Ellen Shegal, "Displaced Workers of 1979–83: How Well Have They Fared?" *Monthly Labor Review* 108 (1985) 3–16.

Hall, Robert E., "Turnover in the Labor Force," *Brookings Papers on Economic Activity* (3, 1972), 709–756.

———, "The Importance of Lifetime Jobs in the U.S. Economy," *American Economic Review* 72 (Sept. 1982), 716–724.

Leonard, Jonathan S., "In the Wrong Place at the Wrong Time: The Extent of Frictional and Structural Unemployment," in Kevin Lang and Jonathan S. Leonard (eds.), *Unemployment and the Structure of Labor Markets* (New York: Basil Blackwell Inc., 1987), 141–163.

Maddala, G. S., *Limited-Dependent and Qualitative Variables in Econometrics* (Cambridge: Cambridge University Press, 1983).

Main, Brian G. M., "The Length of a Job in Great Britain," *Economica* 49 (Aug. 1982) 325–334.

Perry, George L., "Unemployment Flows in the U.S. Labor Market," *Brookings Papers on Economic Activity* (2, 1972), 245–278.

Salant, Stephen W., "Search Theory and Duration Data: A Theory of Sorts," *Quarterly Journal of Economics* 91 (1977), 39–57.

LINKED CITATIONS

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Timothy Dunne; Mark J. Roberts; Larry Samuelson
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[7] **Labor Market Dynamics and Unemployment: A Reconsideration**
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Brookings Papers on Economic Activity, Vol. 1979, No. 1. (1979), pp. 13-72.
Stable URL:
http://links.jstor.org/sici?sici=0007-2303%281979%291979%3A1%3C13%3ALMDAUA%3E2.0.CO%3B2-U

[7] **An Experience-Weighted Measure of Employment and Unemployment Durations**
George A. Akerlof; Brian G. M. Main
The American Economic Review, Vol. 71, No. 5. (Dec., 1981), pp. 1003-1011.
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Robert E. Hall
The American Economic Review, Vol. 72, No. 4. (Sep., 1982), pp. 716-724.
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http://links.jstor.org/sici?sici=0002-8282%28198209%2972%3A4%3C716%3ATIOLJI%3E2.0.CO%3B2-N

[14] **The Importance of Lifetime Jobs in the U.S. Economy**
Robert E. Hall
The American Economic Review, Vol. 72, No. 4. (Sep., 1982), pp. 716-724.
Stable URL:
http://links.jstor.org/sici?sici=0002-8282%28198209%2972%3A4%3C716%3ATIOLJI%3E2.0.CO%3B2-N

[16] **Search Theory and Duration Data: A Theory of Sorts**
Stephen W. Salant
The Quarterly Journal of Economics, Vol. 91, No. 1. (Feb., 1977), pp. 39-57.
Stable URL:
http://links.jstor.org/sici?sici=0033-5533%28197702%2991%3A1%3C39%3ASTADDA%3E2.0.CO%3B2-Y

[16] **An Experience-Weighted Measure of Employment and Unemployment Durations**
George A. Akerlof; Brian G. M. Main
The American Economic Review, Vol. 71, No. 5. (Dec., 1981), pp. 1003-1011.
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References

An Experience-Weighted Measure of Employment and Unemployment Durations
George A. Akerlof; Brian G. M. Main
The American Economic Review, Vol. 71, No. 5. (Dec., 1981), pp. 1003-1011.
Stable URL:
http://links.jstor.org/sici?sici=0002-8282%28198112%2971%3A5%3C1003%3AAEMOEA%3E2.0.CO%3B2-U

Labor Market Dynamics and Unemployment: A Reconsideration
Kim B. Clark; Lawrence H. Summers; Charles C. Holt; Robert E. Hall; Martin Neil Baily; Kim B. Clark
Brookings Papers on Economic Activity, Vol. 1979, No. 1. (1979), pp. 13-72.
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Robert E. Hall; Aaron Gordon; Charles Holt
Brookings Papers on Economic Activity, Vol. 1972, No. 3. (1972), pp. 709-764.
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LINKED CITATIONS

The Importance of Lifetime Jobs in the U.S. Economy
Robert E. Hall
The American Economic Review, Vol. 72, No. 4. (Sep., 1982), pp. 716-724.
Stable URL:
http://links.jstor.org/sici?sici=0002-8282%28198209%2972%3A4%3C716%3ATIOLJI%3E2.0.CO%3B2-N

The Length of a Job in Great Britain
Brian G. M. Main
Economica, New Series, Vol. 49, No. 195. (Aug., 1982), pp. 325-333.
Stable URL:
http://links.jstor.org/sici?sici=0013-0427%28198208%292%3A49%3A195%3C325%3ATLOAJI%3E2.0.CO%3B2-E

Unemployment Flows in the U.S. Labor Market
George L. Perry; Robert E. Hall; Charles Holt; Hyman Kaitz
Brookings Papers on Economic Activity, Vol. 1972, No. 2. (1972), pp. 245-292.
Stable URL:
http://links.jstor.org/sici?sici=0007-2303%281972%291972%3A2%3C245%3AUFITUL%3E2.0.CO%3B2-X

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Stephen W. Salant
The Quarterly Journal of Economics, Vol. 91, No. 1. (Feb., 1977), pp. 39-57.
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