Life Tables: A New Perspective on Teacher Career Patterns

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This note demonstrates how life tables can be adapted from demography to studies of teachers' careers. We provide an example using data from the Schools and Staffing Survey to compare teachers across rural, urban, and suburban locales. Using life tables, we estimate both retention rates and how long we expect teachers to remain at their school depending on their level of experience and find no difference across locales. This methodology could be applied to predict future school staffing needs.

There is a robust literature focused on predicting teacher turnover and retention, especially for the first five years of teachers' careers (Boyd, Lankford, Loeb, Ronfeldt, & Wyckoff, 2011; Hughes, 2012; Kirby, Berends, & Naftel, 1999). Yet much less is known about teachers' careers beyond that time period, such as the length of time teachers stay at a school or their career length. In this research note, we demonstrate how life tables, a technique used in demography, can be applied to extend the descriptive studies of school staffing.

Life tables have advantages over regression analyses, which are more common in teacher attrition research. Rather than predicting the length of time a teacher will stay in the profession, life tables provide insight into how the risk of leaving their school changes as teachers spend more time at the school. This method further allows us to estimate the average number of years that teachers will continue to work in their school given a set level of teaching experience. Thus, life tables can provide insight into "school expectancies," the average number of years we expect a teacher to remain in their current school.

Using data from the Schools and Staffing Survey (SASS) and the Teacher Follow-up Survey (TFS) we compare the life tables of teachers across rural, urban, and suburban locales. We demonstrate how life tables can be used to address the following types of questions:

1. For teachers with different levels of experience in rural, urban, and suburban locales, what is the rate of leaving their school?
2. Given a set level of experience, how long should we expect teachers in each locale to remain in their schools?
3. Are the lengths of teaching school careers the same or different for teachers across locales?

LITERATURE REVIEW

To describe teaching career patterns, we rely on the life table, an analytic method developed by demographers to describe mortality and life expectancy. Although not commonly used in education research, life tables summarize variation in the odds of experiencing a specific event over time, making them easily adapted to phenomenon other than death (Naboodiri & Suchindran, 1987). For example, they have been used to examine marriage length, length of native language retention, and length of time receiving welfare (Harris, 1996; Krishnamoorthy, 1979; Rumbaut, Massey, & Bean, 2006). Utilizing data on teachers with varying levels of teaching experience, we adapt this demographic technique to calculate the rate of teachers leaving their school based on their teaching experience at the school.

Our example focuses on differences in teacher career patterns by locale and compares teachers from rural, urban, and suburban areas. We chose this example because the relationship between quality of education and school locale has been of growing concern in recent decades. There has been particular attention given to the quality of education in rural and urban areas—settings that often perform worse than their suburban counterparts (U.S. Department of Education, National Center for Educational Statistics, 2014). Furthermore, research has demonstrated that locales are associated with how teachers get sorted into schools and teacher attrition. For example, a prior study that draws on national data finds that urban schools have higher teacher turnover rates than rural schools, but are not different from suburban schools (Ingersoll, 2001). However, two state-level studies on rural and urban attrition have found higher attrition in rural areas (Cowen, Butler, Fowles, Streams, & Toma, 2012; Miller, 2012).

DATA AND METHODS

DATA

The data for this analysis come from the Schools and Staffing Survey (SASS) and its supplement the Teacher Follow-up Survey (TFS). Both surveys use a national, stratified random sample of teachers and are designed to provide data on the experiences of American teachers. We use seven rounds of the SASS: 1987-88, 1990-91, 1993-94, 1999-00, 2003-04, 2007-08, and 2011-12. The TFS is administered the year following the SASS to a sample of respondents and is used to determine the number of teachers who stayed at the same school, moved schools, and left the profession.

KEY VARIABLES

Leaving the School (Death)

In our analysis, we examine the rate at which teachers leave their school. In the TFS, respondents are asked if they remained at their school, left their school and moved to a teaching position at another school, or left their school and did not move to another school. We define "leavers" as both those teachers who leave the profession and teachers who leave their school.

Teaching Experience (Exposure)

While traditional life tables use age as their measure of exposure, we use teacher experience within a school. To calculate teacher experience, we subtract the year that teachers report beginning teaching at their school from the year in which they participated in the SASS survey administration. This does not account for the fact that some teachers take leave from their school (e.g., to raise children).

Locale Definitions

We compare teacher career patterns in rural, urban, and suburban locales. To define the school locale, we rely on the SASS measures of locale from the year the data were collected.

ANALYSIS

In the life tables, we show separate statistics for each of the first ten years of teaching experience and then group teachers into three-year experience groups. Within each level of teaching experience, we estimate the rate of

teachers leaving by dividing the number of leavers by the total number of teachers with that level of experience. Using these rates, we simulate teacher attrition and estimate how long they will remain at their school.

In our life tables following simulated career patterns, we begin with a hypothetical population of 100,000 teachers. We use the rate at which teachers left their schools to estimate the number of teachers who would leave at the end of each experience interval. We then calculate the total number of years that all of the teachers who entered the interval taught within the interval. Next, we add the number of years taught within this interval and all future intervals to estimate the total school years remaining to be taught by the population that enters the interval. Finally, we divide the total years remaining by the number of teachers that entered the interval to estimate the average number of additional years that a teacher is expected to remain at their school when they enter the interval.

Like all analytic techniques, life tables require certain assumptions. First, they assume that death is permanent. In our example exploring teacher career patterns, we make the assumption that when teachers leave their school the move is permanent.

Second, when teachers leave their schools, we have to make assumptions about how much "exposure" to award them. In our TFS data, we know which teachers were not teaching at the same school, but we do not know the exact dates when teachers left their positions. We assume that within any interval of teaching experience teachers stay through the entire school year; thus, we include a final full year of experience when calculating experience for leavers. As a result, when teachers leave mid-year we slightly overestimate their tenure.

A third assumption in life tables focuses on the open interval, the group of teachers with the most exposure. In a typical life table, this is the interval in which all of the remaining people die, and in our example, it is the interval where all remaining teachers leave their schools. Our open interval includes teachers with 41 or more years of experience at their school. Because not all teachers leave at the same time in this interval, we make assumptions about how to calculate the years of exposure during this period. We tested possible assumptions we could make about school tenure in the open interval: (1) that the career expectancy in the open interval is the reciprocal of the leaving rate for the next youngest interval (Preston, Heuveline, & Guillot, 2000) and (2) that the rate of leaving continues to increase by a rate similar to those with 26 to 40 years of experience . Although the school expectancy for teachers in the open interval varies widely with these assumptions, there are so few teachers in our open interval that the results for teachers in the first years are consistent across models.

Finally, we assume that the patterns of leaving hold across years. This allows us to create a period life table for teachers across these years rather than a cohort life-table that would follow new teachers through their careers.

FINDINGS

Table 1 describes the sample's distribution across locales and the number of years a teacher has taught at their current school. Columns 1, 3, and 5 report the number of teachers observed in rural, urban, and suburban schools, respectively. Columns 2, 4, and 6 report the rate these teachers leave their schools. For all locales, the rate at which teachers leave their schools follows a U-shaped curve. Approximately one-quarter of teachers leave their school after their first year. The rates of leaving decline in all locales such that by the end of the tenth year at their school between eight and 12 percent of teachers do not return the following year. For rural and urban locales, the rates of teachers leaving their school begin to increase after 20 years at their school. In contrast, teachers in suburban locales have a marked increase in leaving after 29 years at their school.

disadvantaged students.

Table 1. School Leaving Rates in Rural, Urban, and Suburban Locales

	Rural		Urban		Suburban		P-value difference between rates locales		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Years Taught	Teachers with school experience	School leaving rate	Teachers with school experience	School leaving rate	Teachers with school experience	School leaving rate	Rural-Suburban t-tests	Urban-Suburban t-tests	Rural-Urban t-tests
1	764,226	0.26	954,553	0.27	1,360,565	0.26	0.79	0.71	0.54
2	534,121	0.21	684,966	0.23	1,030,257	0.19	0.44	0.06	0.31
3	462,119	0.19	548,351	0.19	797,392	0.16	0.11	0.09	0.97
4	433,110	0.16	484,579	0.19	695,889	0.15	0.70	0.14	0.29
5	330,662	0.15	436,563	0.14	552,131	0.16	0.77	0.41	0.60
6	323,460	0.10	342,151	0.14	519,200	0.12	0.29	0.47	0.12
7	257,354	0.13	292,015	0.14	434,248	0.09	0.24	0.10	0.85
8	235,923	0.09	227,441	0.13	379,452	0.11	0.25	0.34	0.05
9	222,753	0.10	220,024	0.11	325,603	0.12	0.37	0.67	0.71
10	204,553	0.08	209,492	0.12	306,617	0.09	0.60	0.23	0.10
11-13	482,163	0.11	495,082	0.10	700,092	0.09	0.42	0.52	0.79
14-16	446,353	0.07	342,099	0.09	562,243	0.12	0.00	0.12	0.19
17-19	329,938	0.06	265,319	0.08	411,837	0.12	0.00	0.08	0.15
20-22	272,076	0.10	208,775	0.14	314,746	0.11	0.79	0.41	0.34
23-25	204,307	0.15	162,010	0.10	265,274	0.09	0.06	0.79	0.11
26-28	120,660	0.14	112,875	0.15	195,482	0.11	0.51	0.44	0.85
29-31	100,040	0.14	79,286	0.11	144,082	0.17	0.53	0.17	0.38
32-34	56,442	0.22	28,772	0.22	87,822	0.18	0.56	0.63	0.98
35-37	17,187	0.28	22,393	0.12	38,217	0.28	0.97	0.11	0.13
38-40	3,259	0.95	6,304	0.17	7,807	0.42	0.00	0.21	0.00
41+	16,543	0.25	10,411	0.34	20,394	0.15	0.27	0.09	0.41

Note: Teachers in school is the weighted total number of teachers from all TFS survey rounds based on school experience. The school leaving rate is the ratio of teachers who left their school to the number of teachers with a given level of school experience. Columns 1 through 6 report the number of teachers and school leaving rates for teachers in rural, urban, and suburban locales. Columns 7 through 9 report the p-values from test of differences in the rate of leaving between locales.

Columns 7, 8, and 9 report the p-value for t-tests in differences in the rates of leaving the school across locales. Column 7 shows that the rates at which rural and suburban teachers leave their schools are not statistically different for the first 13 years at their school. However, suburban teachers with 14 to 19 years of experience are more likely to leave their school than their rural counterparts. Column 8 shows that at the beginning of their school careers, urban teachers are more likely to leave their school than suburban teachers with the same level of experience. This difference is only statistically significant for teachers with two, three, and seven years of experience. Column 9 shows that through most of the first thirty years of teaching, urban teachers leave their school at higher rates than rural teachers; however, this difference is not substantively meaningful for most years and only approaches statistical significance at eight and ten years of teaching experience.

We next move to life tables presenting the hypothetical cohort of teachers. While Table 1 reports the observed statistics, Tables 2a, 2b, and 2c extend those statistics to the hypothetical cohort of 100,000 simulated teachers. This assumes that at each stage in the hypothetical teachers' careers, they leave their school at rates equal to those observed in the TFS. This feature of the life table analysis is what allows us to estimate the time teachers will remain at their school.

Table 2a Life Table of School Patterns for Simulated Cohort of 100,000 Teachers in Rural Locales

Years Taught	(1) Population	(2) Leavers	(3) Years taught in interval	(4) Total years remaining	(5) School expectancy
1	100,000	25,537	100,000	653,828	6.5
2	74,463	15,503	74,463	553,828	7.4
3	58,960	11,204	58,960	479,365	8.1
4	47,756	7,677	47,756	420,405	8.8
5	40,079	6,074	40,079	372,649	9.3
6	34,005	3,465	34,005	332,570	9.8
7	30,540	4,065	30,540	298,565	9.8
8	26,475	2,254	26,475	268,025	10.1
9	24,221	2,372	24,221	241,550	10.0
10	21,849	1,660	21,849	217,328	9.9
11-13	20,189	5,633	52,118	195,479	9.7
14-16	14,556	2,701	39,617	143,361	9.8
17-19	11,855	1,822	32,833	103,744	8.8
20-22	10,033	2,611	26,183	70,912	7.1
23-25	7,422	2,706	18,206	44,729	6.0
26-28	4,716	1,628	11,705	26,522	5.6
29-31	3,087	1,101	7,611	14,818	4.8
32-34	1,986	982	4,487	7,207	3.6
35-37	1,005	600	2,114	2,721	2.7
38-40	405	405	607	607	1.5
41+	0	0	0	0	

Table 2b. Life Table of School Patterns for Simulated Cohort of 100,000 Teachers in Urban Locales

Years Taught	(1) Population	(2) Leavers	(3) Years taught in interval	(4) Total years remaining	(5) School expectancy
1	100,000	26,764	100,000	582,167	5.8
2	73,236	16,978	73,236	482,167	6.6
3	56,258	10,643	56,258	408,931	7.3
4	45,615	8,649	45,615	352,673	7.7
5	36,966	5,112	36,966	307,058	8.3
6	31,854	4,535	31,854	270,092	8.5
7	27,320	3,847	27,320	238,237	8.7
8	23,473	3,103	23,473	210,918	9.0
9	20,370	2,229	20,370	187,445	9.2
10	18,141	2,232	18,141	167,075	9.2
11-13	15,909	4,220	41,396	148,934	9.4
14-16	11,689	2,740	30,956	107,538	9.2
17-19	8,949	1,851	24,069	76,582	8.6
20-22	7,098	2,401	17,691	52,513	7.4
23-25	4,697	1,172	12,332	34,822	7.4
26-28	3,525	1,284	8,648	22,490	6.4
29-31	2,241	625	5,786	13,841	6.2
32-34	1,616	804	3,642	8,055	5.0
35-37	812	247	2,065	4,413	5.4
38-40	565	228	1,353	2,348	4.2
41+	337	337	995	995	3.0

Table 2c. Life Table of School Patterns for Simulated Cohort of 100,000 Teachers in Suburban Locales

Years Taught	(1) Population	(2) Leavers	(3) Years taught in interval	(4) Total years remaining	(5) School expectancy
1	100,000	26,054	100,000	650,078	6.5
2	73,946	14,249	73,946	550,078	7.4
3	59,697	9,316	59,697	476,132	8.0
4	50,381	7,640	50,381	416,436	8.3
5	42,740	6,781	42,740	366,055	8.6

6	35,959	4,480	35,959	323,315	9.0
7	31,480	2,951	31,480	287,355	9.1
8	28,529	3,095	28,529	255,876	9.0
9	25,434	3,146	25,434	227,347	8.9
10	22,288	1,964	22,288	201,913	9.1
11-13	20,324	4,867	53,671	179,625	8.8
14-16	15,457	4,715	39,297	125,954	8.1
17-19	10,741	3,211	27,407	86,657	8.1
20-22	7,530	2,059	19,502	59,250	7.9
23-25	5,471	1,291	14,478	39,748	7.3
26-28	4,180	1,222	10,709	25,270	6.0
29-31	2,959	1,230	7,031	14,561	4.9
32-34	1,729	738	4,079	7,530	4.4
35-37	991	584	2,096	3,451	3.5
38-40	407	315	748	1,355	3.3
41+	92	92	607	607	6.6

Note: Tables 2a, 2b, and 2c present life tables for teachers' school expectancies in rural, urban, and suburban locales. Population is the size of the simulated cohort that is teaching at the beginning of the interval in the years taught column. Leavers is the simulated number of teachers predicted to leave teaching during that interval given the school leaving rates in Table 1. Years taught in interval estimates the collective number of years that the teachers who began the interval taught during the interval whether or not they left their school. Total years remaining estimates the collective number of years the teachers who began the interval are expected to continue teaching at their current school. School expectancy estimates the total number of years an individual teacher who begins an interval is expected to continue teaching at their school, including the years within the interval. In Table 1, we observe rural teachers with 41+ of experience at their school, but our hypothetical cohort of rural teachers do not remain at their schools that long. This is likely a function of cohort differences in school leaving experiences.

Column 1 of each life table begins with the hypothetical population of 100,000 teachers in their first year at their school. We use the school leaving rates from Table 1 to estimate the number of teachers that left their school —between 25,000 and 27,000 first-year teachers in each locale—reported in Column 2. The next row of Column 1 then subtracts the number of leavers from the population in order to report the number of teachers who remain at their schools to teach a second year. We follow this process in Columns 1 and 2 to estimate the size of the cohorts across locales.[1]

We can use the population at each level of experience to see the cumulative percentage of teachers who have left their school. For example, using the population of those who began year six, we estimate that 66 percent of rural teachers, 68 percent of urban teachers, and 64 percent of suburban teachers left their school in the first five years.

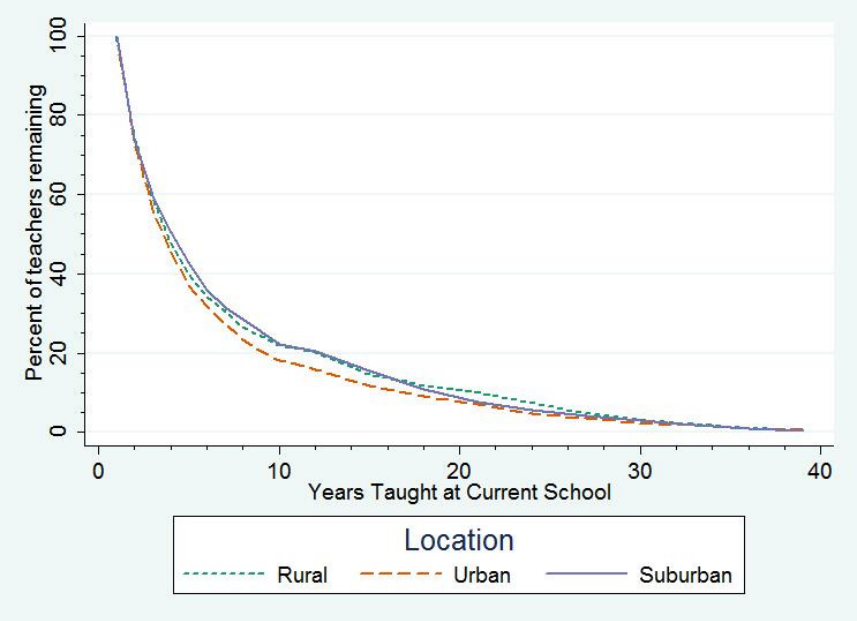
The data presented in Columns 3 and 4 of each life table are not meaningful by themselves but are critical for estimating the school expectancy in Column 5. Column 3 estimates the number of years taught within each interval. In our case, we make the assumption in the one-year intervals that all teachers complete the school year. As a result, the number of years taught in the interval is equal to the population entering the interval. In the three-year intervals, we attribute three years of teaching to teachers who complete the interval and 1.5 years of teaching to those who do not. In the final open interval, we calculate the school expectancy as the reciprocal of the rate of leaving (Preston et al., 2000).

Column 4 reports the cumulative number of years that we expect the hypothetical cohort to continue teaching. In the open interval, the cumulative number of years is equal to the school expectancy. For teachers with 38 to 40 years of experience in their school, we add the years taught during that interval to the total number of years remaining in the open interval. We follow this iterative process to complete the column.

Column 5 reports the number of years that we expect a teacher entering that interval to continue teaching at their school. This is calculated by dividing Column 4 by Column 1. The school expectancy follows an inverse U-curve. Across locales, teachers in their first year at their school have their school expectancy of between 5.8 years and 6.5 years. School expectancy increases through the first several years of teaching. For example, a rural teacher entering their fifth year at their school is expected to stay an additional 9.3 years, for a total school career length of 13.3 years. The exact timing of the peak school expectancy varies across locales with the longest expectancy being observed for teachers with seven to 13 years of experience.

Figure 1 provides an example of visual output that can be created from the life table. This visualization, called a survival curve, shows the percent of the hypothetical cohort who remain at their school given their level of school experience. Like the life table, this shows the high rates of leaving early in a school career that decline with more experience.

Figure . Percent of Teachers Remaining in their School by Locale



APPLICATIONS

Through the use of life tables, we are able to calculate school expectancies. Prior studies have predicted whether a teacher will leave, but they do not provide information on how much longer a teacher will stay. School expectancies have practical applications for school administrators and their partners. For example, teacher preparation programs could use life tables from districts in their region in order to predict needs and match the preparation of teachers to those needs. Similarly, administrators can use life tables to compare their attrition rates to national patterns and those of similar locales. Although individual principals may have a personal sense of these career patterns, it has not been documented before.

While these are clear purposes for the life table, it is not appropriate for every question. Most importantly, life tables are limited in the number of control variables that can be considered. For example, in this paper, we control for locale by creating separate tables. When researchers are concerned about many controls, this would be an overly burdensome process and comparisons would no longer be straightforward. Although this is a disadvantage of the life table methodology, we benefit from the insight into larger career patterns that are otherwise obscured by regression analyses.

Note

1. The number of leavers is based both on the school leaving rate and the number of years in the interval. We calculate the probability of leaving as: $p = 1-[n * m/(1+(n-a)*m)]$, where n is the number of years in the interval, m is the school leaving rate, and a is number of years in interval divided by 2. The calculation for a reflects an assumption that the leaving is evenly distributed across the three-year interval.

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