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Detecting Involuntary Layoffs in Teacher Survival Data: The Year of Leaving Dangerously

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In this paper, we present an exploratory methodology for detecting and documenting an influence on the duration of teacher employment which has heretofore eluded empirical quantification—the involuntary layoff. Using data on the lengths of employment of more than 14,000 teachers hired between 1969 and 1981 in the St. Louis metropolitan area, we show that over and above the effects that previous researchers have identified (such as high early dropout rates and gender differences), there were certain years in which many more recently hired teachers were likely to leave their districts than might have been expected. We then present documentary evidence indicating that these unusual years were ones in which several of the districts under study implemented sizable mandated staff reductions. We conclude by discussing how ignoring involuntary layoffs may lead researchers to erroneously attribute some inter-individual variation in employment duration to other influences such as entering cohort. Viewed in its entirety, our paper presents a methodology for the improved analysis of teacher survival data that allows researchers to uncover not only involuntary layoffs but other predictors of employment duration as well.

Educational researchers have long been interested in investigating the length of time that teachers remain employed in particular school districts and identifying background variables that are systematically related to inter-individual variation in employment duration (Mark & Anderson, 1978, 1985; Murnane, 1981, 1984). As the need for qualified teachers grows and the competition with other professions increases, our need to understand employment patterns escalates (Murnane, 1987; Murnane, Singer, & Willett, 1988). The soon-to-be-seen increase in public school enrollment will further intensify this need (Gerald, 1985).

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Most researchers analyzing teacher employment data have focused on the extent to which characteristics of individuals predict the length of employment, thereby making an implicit assumption that teachers' voluntary behavior is being modeled. For example, Whitener (1965) examined the lengths of employment of 937 teachers who entered 10 Missouri school districts from 1951 until 1953 and she concluded that: (a) the probability of leaving a district was high immediately after entry, but diminished over time, leveling off approximately four to five years later; and (b) the length of employment differed as a function of the age and gender of the entering teachers. Charters (1970) replicated these results using data on 2,064 teachers who began working in Oregon in 1962. Mark and Anderson (1978, 1985) studied the lengths of employment of 14,827 teachers who were hired by districts

in the St. Louis, Missouri area between 1969 and 1981. They concluded that, in addition to the well-established early dropout rates and gender differences, there was a year-of-entry effect—teachers who were hired during the early 1970s remained employed for longer periods than did teachers who were hired during the late 1960s or the mid-to-late 1970s.

But as labor economists (e.g., Feldstein, 1976; Jovanovic, 1979a, 1979b) and industrial psychologists (e.g, Mobley, Griffeth, Hand, & Meglino, 1979; Mowday, Porter, & Steers, 1982) point out, not all employment terminations are voluntary. Although rising school enrollments in the 1950s and 1960s may have prevented involuntary layoffs from perturbing Whitener's or Charter's data, Mark and Anderson suggested that the shorter employment periods for teachers hired in the mid-to-late 1970s may have been due to the tendency of financially constrained school districts to lay off recently hired, nontenured teachers.

The identification of involuntary layoffs as a factor that may influence employment duration raises at least two questions about the valid analysis of teacher survival data. First, if what appear to be year-of-entry effects are attributable, entirely or partially, to layoff policies, should it not be possible to uncover evidence in the data to support this conjecture? Strong evidence of a layoff would be provided if it could be shown that more teachers left their districts in a given year than would have been expected on the basis of the other variables associated with employment duration. Second, if the duration of teacher employment is influenced by a districtwide policy such as a layoff, should it not be necessary to control for this effect when assessing the influence of other variables on length of employment? For example, if a layoff abruptly decreased the length of employment for newly hired teachers in a given year or period of years, we might incorrectly conclude that new teachers are more likely to be leaving early in their careers (with the implicit assumption that it is their free choice, not one forced upon them), rather than attributing the effect to a districtwide policy.

Thus, the identification of involuntary layoffs as an influence on employment duration suggests that there may not be just one, but two, distinct processes generating the pattern of survival that is observed in any entering cohort of teachers. The first process is that of individual choice, under which any termination observed is assumed to be voluntary. By focusing primarily on characteristics of individuals that are associated with length of employment, most researchers of teacher survival to date have implicitly assumed that individual choice is the primary, if not the only, process affecting employment duration. If the districts under study have experienced involuntary layoffs during the data collection period, however, not every termination observed is the result of individual choice; rather, some are the results of a second process: districtwide mandates beyond the individual's control. If we are to understand fully the factors associated with employment duration, each of these two processes must be examined.

In this paper, we present a methodology for detecting and documenting the presence of involuntary layoffs in teacher survival data. Reanalyzing Mark and Anderson's most recent published data (1985), we show that there were certain years in which many more recently hired teachers were likely to leave their districts than might otherwise have been expected. In addition, we present documentary evidence that indicates that these unusual years were ones in which several of the districts under study experienced sizable staff reductions. Finally, we discuss how ignoring the effects of involuntary layoffs may lead researchers to incorrectly attribute changes in employment duration to other effects.

Methods

Data

Our analyses were conducted using data presented by Mark and Anderson (1985) on the lengths of employment of 14,827 teachers who were newly hired in each year from Fall 1969 to Fall 1981 by any of the over 50 school districts in the St. Louis, Missouri area.[1] The data were stratified by year of

entry (1969, 1970, etc.) and gender. Data collection ended in 1982; as a result, there are many teachers for whom we have incomplete information on how long they remained in these school systems. For example, for those teachers who were hired in Fall 1980 and were still employed in Fall 1982, we do not know the *total* length of employment, but only that they remained in these districts *at least* two years. Such observations are right-censored. The data set contains 5,644 (38.1%) such observations.

Throughout our presentation, the word "year" refers to a school year, with the year given indicating the start of the period (e.g., 1969 refers to the 1969–1970 school year). Employment duration is measured as the number of full school years completed in any of the districts under study. If a teacher left a school district but was hired by another within the St. Louis area, the transfer has no effect on the total length of employment. If a teacher left a district in the middle of a school year and was not hired by another district within the area, that fraction of a year does not contribute to his or her duration value. When duration data are analyzed as whole numbers of years completed, the data are said to be discrete.

Statistical Analysis

Any analysis of teacher survival data that ignores right-censoring or the discrete nature of the observations may be seriously biased (Allison, 1982, 1984; Willett & Singer, 1988). To eliminate such bias, the statistical analyses presented in this paper rely on a set of techniques developed by actuaries and biostatisticians to address similar problems when modeling human lifetimes (Gross & Clark, 1975; Lee, 1980; Namboodiri & Suchindran, 1987).

The survival distribution function provides the foundation of our analyses. The survival distribution function evaluated at time t is the population probability that a teacher will remain employed ("survive") in these districts for at least t years:

$$S(t) = \text{Prob}[\tau \geq t],$$

where τ is a random variable denoting employment duration (Gross & Clark, 1975). Because no more teachers can survive through year t than survived through year $(t - 1)$, $S(t)$ is a monotonically nonincreasing, and usually decreasing, function of time. Because the data are discrete, $S(t)$ is a step-function.

We have used the median total lifetime as an informative single-number summary of the survival distribution function $S(t)$. Defined as the time at which the population survival probability is one half, the median total lifetime is the time at which exactly one half of the teachers are still employed. Median total lifetimes were estimated for each entering cohort, overall and separately for men and women, thus facilitating the examination of year-of-entry and gender effects. In addition, median total lifetimes were estimated for subgroups of teachers who had already survived one and two years, thereby providing a simple method for describing the average length of employment among teachers who had survived these critical early time periods.

To have survived at least t years requires that a teacher has also survived through all earlier years. As a result, the survival probability for year t confounds cumulative information on survival for all of the preceding t-1 years with specific information on survival in year t. Because our interest was in investigating the risk of leaving these school districts during *particular* years, given survival through previous years, we also examined another quantity related to the survival distribution function: the hazard function.

With discrete data, the hazard function evaluated at year t is the population probability that a teacher will leave the pool of districts in that year, given that he or she has survived until the beginning of that year:

$$h(t) = \text{Prob}[\tau = t | \tau \geq t-1].$$

Because $h(t)$ evaluated at year t represents the probability of leaving these school districts in year t *conditional* on having remained through the end of year $t-1$, the estimation of $h(t)$ for all available time periods allows us to determine whether there were certain years in which the risk of leaving was especially high.

The estimated survival distribution func-

tions, median total lifetimes, and hazard functions presented in this paper were obtained using the life table method of Berkson and Gage (1950) and Gehan (1969) rather than by the product-limit method (Kaplan & Meier, 1958). The former was chosen over the latter (both are maximum likelihood estimators; see Cox & Oakes, 1984, pp. 48–56) because the data were discrete and available only in aggregate form (Gross & Clark, 1975; Lee, 1980). All computations were conducted with the LIFETEST procedure available in SAS Version 5 (1985).

Results

The Overall Pattern of Teacher Survival

Table 1 presents a life table for all teachers, regardless of year of entry or gender. The columns labeled "number of cases" show the total number of teachers in this sample who were in the districts at the beginning of each year, the number who left at the end of each year and the number whose data were censored at the end of each year. The next three columns present the estimated survival distribution function $S(t)$, estimated hazard function $h(t)$ and estimated median total lifetimes.

An estimated 77.7% of all teachers were still employed at the end of their first year, 66.4% were still employed at the end of their second year, and 52.0% were still employed at the end of their fourth year. The decline in the percentage of teachers who remained employed then tapers off, with only a slight decrease during each of the next ten intervals. After 13 years, 30.3% of the teachers were still employed.

Examination of the estimated hazard function in the fifth column of Table 1 shows that the risk of leaving teaching is especially high during the first year (.25), is still elevated during each of the next five years (between .10 and .16), but is very small (.05 or below) by the end of year 9. Thus, among the teachers who are going to leave their districts, more will do so during the first few years of their careers; providing they survive the initial "break-in" period, most teachers will remain employed for several additional years.

The difference between the "early leavers" and the "long stayers" is illustrated clearly by the estimated median total lifetimes pre-

TABLE 1

Life table estimates of teacher survival

	Number of cases					
Time interval (years)	at start of year	who left at end of year	censored	Estimated survival function S(t)	Estimated hazard function h(t)	Estimated median total lifetime
0 to 1	14,831	3,308	0	.7770	.2510	4.41
1 to 2	11,523	1,650	358	.6639	.1569	6.97
2 to 3	9,515	1,174	404	.5802	.1345	9.83
3 to 4	7,937	810	312	.5198	.1098	—
4 to 5	6,815	620	408	.4711	.0984	—
5 to 6	5,787	579	344	.4225	.1087	—
6 to 7	4,864	388	383	.3874	.0866	—
7 to 8	4,093	238	321	.3640	.0624	—
8 to 9	3,534	184	447	.3438	.0572	—
9 to 10	2,903	110	452	.3296	.0420	—
10 to 11	2,341	70	606	.3183	.0349	—
11 to 12	1,665	36	547	.3101	.0262	—
12 to 13	1,082	20	498	.3026	.0243	—
13 to 14	564	0	564	—	—	—

sented in the first three rows of the final column of Table 1. As shown in the first row, among all entering teachers, the estimated median total lifetime is 4.41 years. The next two rows display the estimated median total lifetimes for those teachers who have survived the first year and the second year, respectively. There are dramatic differences among the three entries. Surviving the first year augurs well for the persistence of employment; among those teachers who remained at their job beyond their first year, the estimated median total lifetime rises to 6.97 years. Among these teachers who survived the first two years of teaching the estimated median total lifetime is 9.83 years. No median total lifetime is presented for teachers surviving the first three years and beyond because, due to the distribution of censored observations and the limited duration of data collection, these parameters cannot be estimated.

Differences by Year of Entry and Gender

Having examined the survival experience of the entire sample of teachers, it is informative to investigate variations in the experience by entering cohort and gender. Figure 1 displays the estimated median total lifetime of teachers as a function of year of entry. Across the 13 years under study, we see evidence of a cyclical pattern: the estimated median total lifetime increased during the late 1960s through the early-to-mid 1970s and then began to decrease after 1975. On average, teachers hired from 1972 until 1975 stayed one to two years longer than did their colleagues hired before or after that time.

Figure 2 illustrates how the time trends in employment duration differ by gender, highlighting an interesting interaction between year of entry and gender. Among those teachers hired before 1975, men stayed an average of 1.4 years longer than women (the estimated median total lifetime is 4.3 years for women as compared with 5.7 years for men), whereas among those teachers hired in 1975 or later, women stayed an average of 1.1 years longer than men (4.4 versus 3.3 years). Thus, the gender differential in esti-

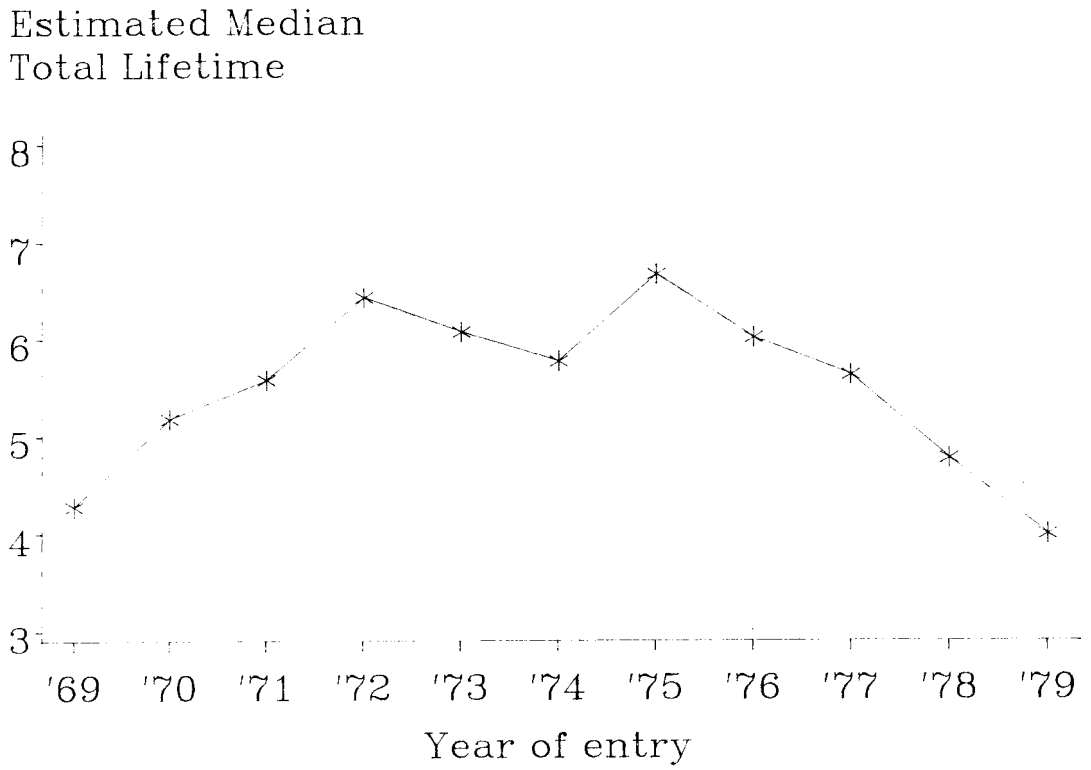

FIGURE 1. *Estimated median total lifetime by year of entry*

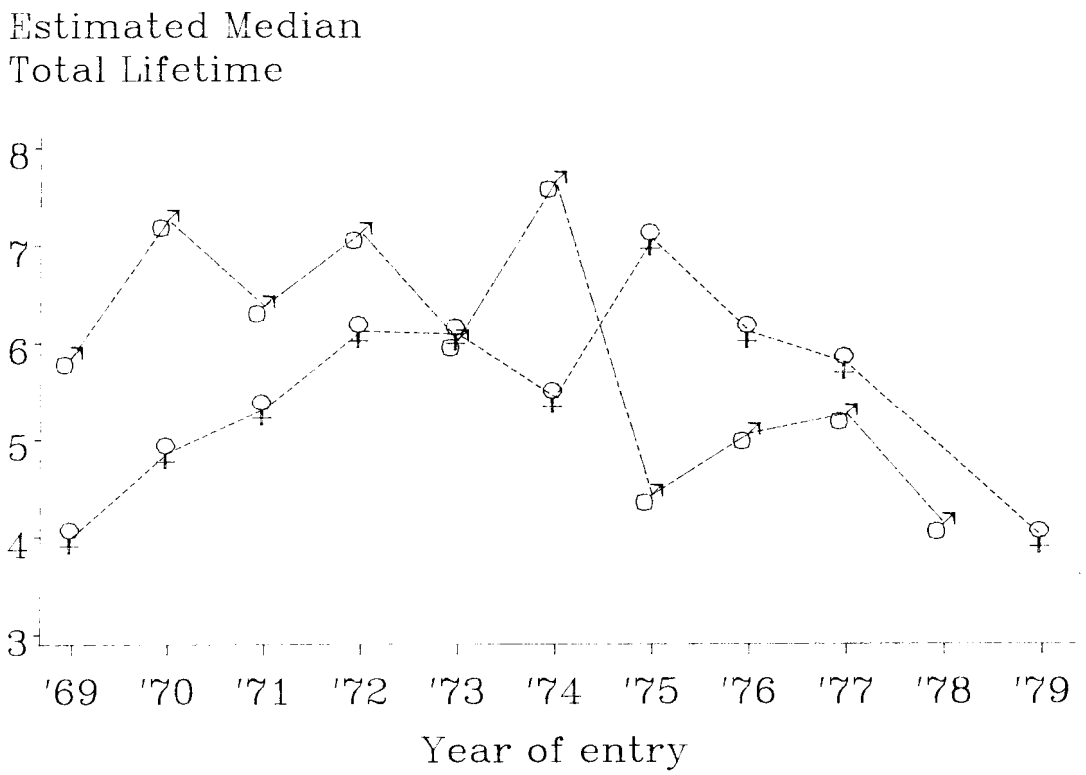

FIGURE 2. *Estimated median total lifetime by year of entry and gender*

mated median total lifetime observed in this sample was reversed during the mid 1970s. Moreover, additional analysis reveals that this gender reversal persists among those teachers who survived the first year. The estimated median total lifetimes for these latter groups were higher as expected, but even at the higher level, among those hired before 1975, men survived for a longer period than women (8.7 vs. 5.7 years) and among those hired in 1975 or later, men survived for a shorter period than women (4.7 vs. 5.3 years).

If the effect of year-of-entry differs by gender, which year-of-entry effect is captured by the estimated median total lifetimes computed on the pooled sample as displayed in Figure 1? Because many more teachers in this sample are female (73.9%), the plot for the entire sample is dominated by, and therefore appears most like, the behavior of the female subsample. If gender effects are ignored and these data are analyzed without regard to gender, then (by default) the findings will be most descriptive of employment patterns for women.

Uncovering Especially "Hazardous" Years

Table 2 presents estimated hazard functions for each entering cohort, separately for men and women. Examination of the estimated hazard functions in each of the 26 groups (13 entering cohorts by two genders) reveals the same general functional form found in the overall sample as presented in Table 1: estimated hazards are highest in year 1, remain elevated in years 2 through 5, and taper off around year 6.

However, closer examination of the estimated hazard functions for teachers who were hired in 1975 or later reveals a disruption in the general pattern: the usual tapering off of the hazard function is interrupted by a sharp increase during the last time interval. For example, among men hired in 1976, the estimated hazard function generally decreases (from a high of .23 in year 1 to .06 in year 5), but then it suddenly increases (to

TABLE 2

Estimated hazard functions, by gender and year of entry

Gender	Year of entry	n	Number of years after entry												
			1	2	3	4	5	6	7	8	9	10	11	12	13
Male	'69	530	.37	.14	.07	.08	.03	.06	.05	.07	.06	.09	.04	.05	.02
	'70	389	.30	.13	.09	.04	.07	.02	.09	.06	.11	.03	.05	.01	
	'71	429	.25	.16	.10	.05	.11	.06	.03	.12	.01	.04	.03		
	'72	473	.18	.10	.11	.06	.10	.14	.15	.04	.03	.03			
	'73	379	.20	.18	.06	.13	.12	.10	.06	.06	.09				
	'74	319	.19	.12	.09	.11	.09	.05	.06	.09					
	'75	232	.20	.20	.22	.17	.00	.07	.21						
	'76	271	.23	.18	.20	.08	.06	.33							
	'77	193	.26	.11	.11	.14	.28								
	'78	197	.41	.20	.04	.31									
	'79	162	.38	.05	.26										
	'80	189	.30	.41											
	'81	111	.66												
	Median		.26	.15	.10	.10	.09	.07	.06	.07	.06	.04	.04	.03	.02
Female	'69	1485	.33	.19	.17	.12	.07	.11	.05	.07	.08	.07	.00	.03	.04
	'70	1273	.25	.19	.16	.11	.12	.12	.08	.03	.11	.02	.05	.04	
	'71	1202	.25	.14	.15	.12	.10	.13	.06	.07	.00	.04	.08		
	'72	1184	.20	.13	.11	.11	.12	.14	.12	.01	.05	.04			
	'73	835	.17	.12	.14	.12	.14	.10	.04	.07	.08				
	'74	838	.19	.14	.16	.15	.13	.03	.06	.15					
	'75	646	.18	.15	.13	.09	.03	.10	.30						
	'76	735	.19	.15	.17	.08	.08	.25							
	'77	556	.20	.16	.09	.10	.20								
	'78	664	.27	.10	.13	.19									
	'79	463	.25	.19	.25										
	'80	563	.27	.35											
	'81	489	.47												
	Median		.25	.15	.15	.11	.12	.11	.06	.07	.08	.04	.05	.03	.04

.33 in year 6). Among women hired in this same year, the estimated hazard function also generally decreases (from a high of .19 in year 1 to .08 in year 5), but then it, too, suddenly increases (to .25 in year 6). Thus, among teachers hired in 1975 or later, the first year of teaching was not always the most "hazardous"; in fact, for these teachers, it was the last time period that carried the highest risk.

What does this last time period represent? Reflection on the meaning of the diagonal elements of each panel in the table suggests a meaningful construct: each diagonal contains the estimated hazard in a common *year of exit*. For example, for each panel in the table, the final diagonal corresponds to the last year of data collection, 1982. The diagonals directly above these final diagonals correspond to 1981, with successive diagonals corresponding to earlier years. Thus, the especially high estimated hazards on the final diagonals of Table 2 for teachers who were hired in 1975 or later suggest that 1982 was an especially high risk year for this group. Many more of these teachers left these districts in 1982 than we would have expected given the general pattern of teacher survival.

To examine further the year-of-exit effect, and how it differs as a function of year of entry, we need to better document consistent patterns along the diagonals of Table 2. In doing so, however, it is important to control for the general trends in teacher survival over time—the elevated year 1 hazards, fol-

lowed by the tapering off at each successive time interval—and the differences by gender. To achieve this control, we have obtained what might be considered the "typical" hazard function, separately for men and women (shown in the last row of each panel of Table 2). Each typical hazard function was computed as the gender-specific median estimated hazard within each column. For example, the typical hazard for men remaining nine years after entry is 0.06, the median value of the five elements making up the ninth column in the upper panel of the table. This process was repeated for each column in both panels, interpolating where necessary.

Then, in the spirit of exploratory data analysis (Mosteller & Tukey, 1977; Tukey, 1977), we "detrended" the estimated hazards for each year-of-entry by subtracting the appropriate "typical" hazard from each row in both panels of Table 2. For example, the detrended estimated hazard for women who were hired in 1969 and left in 1970 (year 1) is .33 − .25 = .08. The detrended estimated hazard for women who were hired in 1969 and left in 1971 (year 2) is .19 − .15 = .04.

Table 3 reorganizes the detrended estimated hazards and displays them by gender, year of entry, *and* year of exit rather than by gender, year of entry, and the number of years after entry (as in Table 2). The final row and column of each panel contain the median detrended estimated hazards for a given year of entry (row) and a given year of exit (column) obtained by the method de-

TABLE 3

Detrended estimated hazards, by gender, year of entry, and year of exit

Gender	Year of entry	Year of exit '70	'71	'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	Median
Male	'69	.10	.01	−.03	−.01	−.07	−.00	−.01	.00	−.00	.05	−.00	.02	−.00	−.00
	'70		.04	−.02	−.01	−.05	−.02	−.04	.03	−.00	.05	−.00	.00	−.02	−.01
	'71			−.01	.01	−.00	−.05	.02	−.01	−.03	.06	−.06	.00	−.01	−.01
	'72				−.09	−.05	.01	−.04	.01	.07	.09	−.03	−.03	−.01	−.02
	'73					−.06	.03	−.04	.03	.03	.03	−.00	−.01	.03	.03
	'74						−.07	−.03	−.01	.01	.00	−.02	−.00	.02	−.01
	'75							−.06	.05	.12	.07	−.09	.00	.15	.05
	'76								−.04	.03	.10	−.01	−.03	.26	.01
	'77									.00	−.04	.01	.04	.18	.01
	'78										.15	.05	−.06	.21	.10
	'79											.12	−.10	.16	.12
	'80												.04	.26	.15
	'81													.39	.39
	Median	.10	.02	−.02	−.01	−.05	−.01	−.04	.01	.01	.06	−.00	.00	.15	
Female	'69	.08	.04	.03	.01	−.05	−.00	−.01	−.00	−.00	.03	−.05	−.01	.00	−.00
	'70		.00	.04	.02	−.01	−.00	.00	.02	−.04	.03	−.03	−.00	.01	.00
	'71			.00	−.00	.00	.01	−.02	.01	.00	.00	−.08	.00	.03	.00
	'72				−.04	−.02	−.03	−.00	.00	.02	.05	−.06	−.02	−.00	−.01
	'73					−.08	−.03	−.01	.00	.02	−.01	−.02	.00	.00	.00
	'74						−.06	−.01	.01	.03	.01	−.08	−.00	.08	−.02
	'75							−.07	.00	−.02	−.02	−.09	−.01	.24	−.02
	'76								−.06	−.00	.02	−.03	−.04	.14	−.02
	'77									−.05	.01	−.06	−.02	.08	−.02
	'78										.02	−.05	−.01	.08	.00
	'79											.01	.04	.10	.04
	'80												.02	.20	.11
	'81													.23	.23
	Median	.08	.02	.03	.00	−.02	−.01	−.01	.00	−.00	.02	−.05	−.01	.08	

scribed earlier. The pattern found in the median detrended estimated hazards by year of entry (last column of each panel) reflects effects seen in earlier analyses: the risk of leaving a district is higher for those teachers hired in the mid-to-late 1970s than it is for those hired in the early 1970s and is higher for men than for women.

Examination of the median detrended estimated hazards for each year of exit (last row in each panel) points toward two years that manifest elevated risks: 1970 and 1982. Because data collection began in 1969, the 1970 effect can be investigated in only one entering cohort; as a result, we cannot comment on the generalizability of this effect. The 1982 exit effect, in contrast, is manifested in *six* entering cohorts: each of the groups hired between 1975 and 1981. Indeed, the detrended estimated hazards for the 1982 exit year for both men and women in each of these six cohorts are the highest entries in the entire table.

If we were to divide the full sample of teachers into two groups, those hired in 1975 or later and those hired before 1975, the 1982 exit effect would be very pronounced in the former group and barely present in the latter group. In Figure 3, we have made this division and we have plotted the detrended estimated hazards by year of exit for the two groups of teachers: those who were hired before 1975 (Panel A) and those who were hired in 1975 or later (Panel B). To simplify the display, estimates for men and women have been combined (the main effect of gender having been removed by the detrending). Rather than plotting the separate detrended hazard estimates from Table 3, we have displayed their *distributions* schematically as box plots. If all years of exit were equally hazardous, the plots shown in Figure 3 would be centered near zero (the dashed line), with random and approximately equal variation about this center. Among those teachers who were hired before 1975 (Panel A), this is indeed the pattern we observe; there appears to be no year-of-exit effect for this group. Among those teachers who were hired in 1975 or later (Panel B), however, the detrended estimated hazards do differ by exit year; in particular, the detrended estimated hazards for the 1982 exit year are much higher than those for any other time period. It is this differential, shown clearly in Figure 3, which provides strong empirical evidence of a year-of-exit effect.

Why was 1982 an especially hazardous year for teachers hired in 1975 or later? In Spring 1982, federal budget cuts in aid to local school districts were beginning to take their toll. For example, in the St. Louis School District, the largest of the districts under study, a loss of approximately 20 million dollars was anticipated. To offset the revenue loss, the school board sought a property tax increase, but this proposal was defeated in a local referendum. Although the cuts in federal aid were not as dramatic as anticipated, the St. Louis School District nevertheless laid off 1,260 employees—approximately 18% of its staff—including 790 teachers in summer 1982 (Vespereny, 1982). Sixteen of the other 23 school districts in St. Louis county also experienced layoffs (Barrett, 1982). Under Missouri law, the layoffs had to be made according to seniority; hence, 1982 was a very hazardous year, especially for recently hired teachers.

Discussion

Our research sheds light on two issues in the investigation of teacher survival. First, we document the existence of an influence on the duration of teacher employment which has heretofore been ignored: the involuntary layoff. Although some researchers have alluded to the potential impact of layoffs when discussing teacher employment data, they have not been able to locate the "smoking gun"—empirical evidence which strongly suggests that it is a layoff which is creating the effect. In this paper, we have outlined an analytic method for uncovering such effects and have found evidence of its presence in a large data set.

Having documented the effect, we feel it is now incumbent upon researchers to control for the potential effects of involuntary layoffs when analyzing teacher employment data. It is only when the effects of involun-

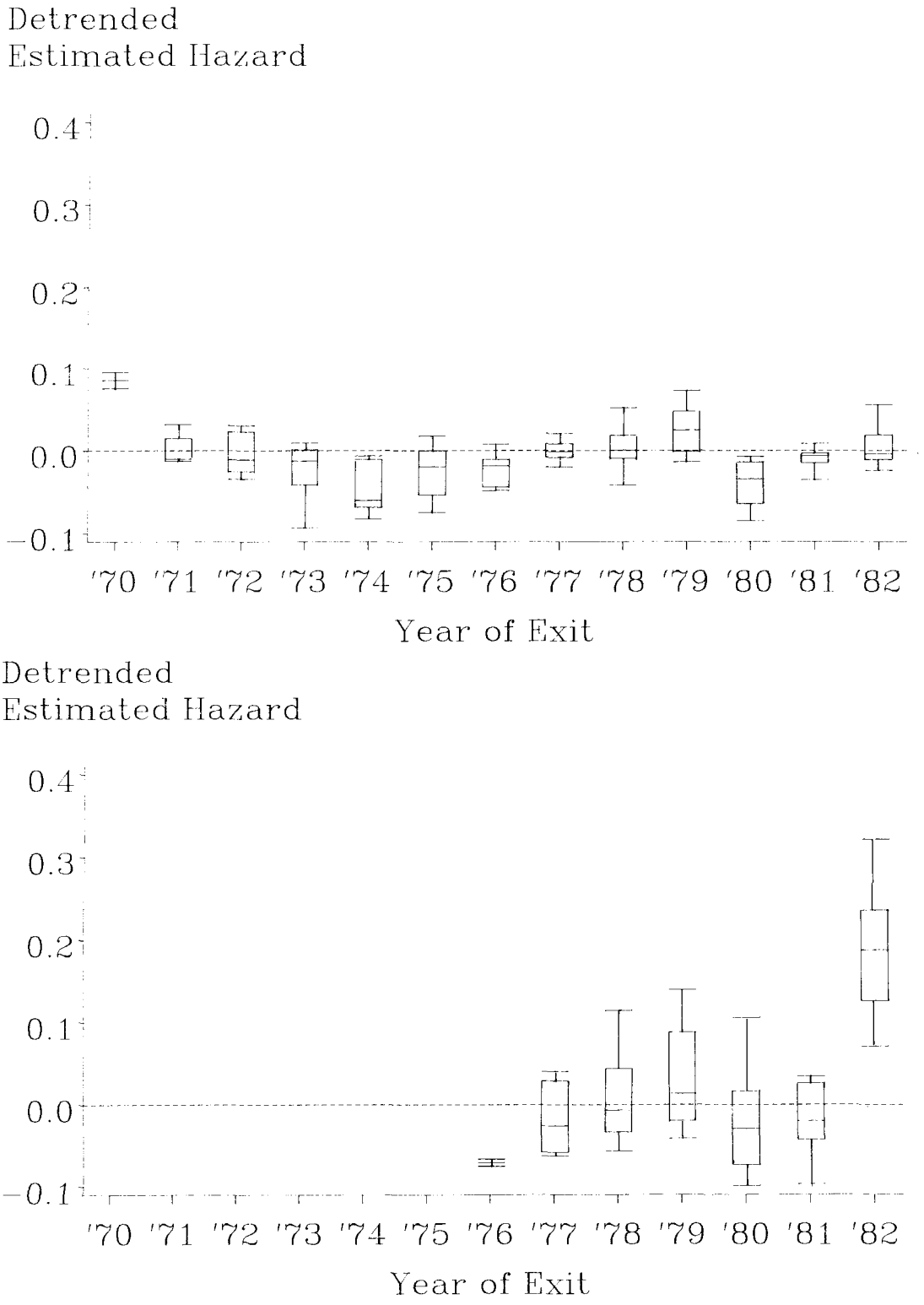

FIGURE 3. *Schematic plots of detrended estimated hazards by year of exit, among teachers hired before 1975 (panel A) and teachers hired in 1975 or later (panel B)*

tary layoffs are controlled for that the impact of other variables on teacher survival can be investigated. If statistical control is not possible, researchers should at least demonstrate that these effects have not distorted their conclusions about teacher employment patterns. This need becomes greatest when analyzing data collected within school districts that may have been experiencing involuntary staff reductions.

Have involuntary layoffs distorted our understanding of year-of-entry effects? Are the shorter employment periods found among those teachers hired during the mid-to-late 1970s not attributable to year-of-entry effects at all, but rather to involuntary layoffs? In this particular data set, we think not. Figure 3 provides strong visual evidence that it is only 1982 which was a particularly unusual exit year; it is only the detrended estimated hazards for the 1982 exit year for teachers hired in 1975 or later that reflect the year-of-exit effect. Examination of the first, second, and third year estimated hazards for teachers hired in 1975 or later (as displayed in Table 2) reveals risks that are higher than those found for the first few years of teaching among teachers hired during the early 1970s. Thus, we do believe that the year-of-entry effects identified by Mark and Anderson (1985) are indeed present in these data. Note, however, that the dramatically elevated estimated first year hazards for teachers hired in 1981 are probably due, in large part, to the 1982 layoff, as opposed to being solely attributed to a 1981 entry effect.

The issue of whether the effects of involuntary layoffs have undermined previous conclusions is an important one. Researchers analyzing teacher employment data have tended to focus on the extent to which characteristics of individuals predict the length of employment, with the implicit assumption that they are modeling a teacher's free choice (Murnane, 1981, 1984). However, we have documented the presence of a second process—a mandated layoff—which may have as much, if not more, explanatory power than the characteristics of individuals. For this particular data set, we have shown that the conclusions reached by Mark and Anderson (1985) still hold after controlling for involuntary layoffs; for other data sets, the conclusions may differ.[2]

Our research also demonstrates the need to go beyond the examination of simple estimated survival distribution functions when describing teacher employment patterns. Estimated median total lifetimes are succinct and intuitive summaries of survival experience that can be used to facilitate comparisons among subgroups of teachers. Moreover, the estimation of median total lifetimes for subgroups of teachers who have survived critical time periods such as the first, very hazardous, year highlights the heterogeneity in teacher survival. Although many teachers are likely to leave early in their careers, those that do survive the "break-in" period are likely to remain in the profession for a long time.

But estimated median total lifetimes are also incomplete descriptors of survival experience. They, too, confound effects occurring at several points in time, making it difficult to determine precisely when teachers are most likely to leave. The estimation of the hazard function fills this void. Examination of estimated hazard functions allows the researcher to identify those years when the risk of leaving is especially high, conditional on survival until the end of the previous year. If estimated hazard functions do not display the smooth gradual decline typical of teacher employment data, researchers should treat this deviation as a signal of additional effects that might be as yet uncovered in the data. In our analyses, it was only through the estimation of hazard functions that a previously undetected effect due to year of exit was revealed.

Notes

[1] Because we recreated the data set from the aggregate data on the number of teachers entering each year and the proportion surviving each year (which was rounded), our data set has 14,831 observations, four more than the original data set. This should have no effect on our findings. In addition, we corrected an apparent error in the published summary table on the 5th year survival of men entering in 1973. The correction was made by using information on the proportion surviving in this time interval for the overall

sample and for women. Note that the 321 teachers who were hired in 1982 were not included in our analyses because no data were available on the *duration* of their employment. This exclusion is reflected in the 0 entry in the first row of Table 1.

[2] As Lortie (1975) pointed out, many teachers' career paths follow an "in-and-out" pattern. The initial "first spell" of teaching may be interrupted by layoff or personal choice, but the teacher may subsequently return for a second or even third spell. For example Murnane et al. (in press) found that, among elementary school teachers who began teaching in Michigan between 1972 and 1973, 32% of those who left returned within eight years. In this data set, teachers may also leave and return, but they rejoin their entering cohort and are indistinguishable from teachers who never left (Mark & Anderson, 1985, p. 415). As a result, we are unable to analyze multiple spells separately and cannot comment on the "in-and-out" pattern.

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