PENSION PLAN TERMINATION AND RETIREMENT

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Abstract

Employee termination and retirement probabilities affect the valuation of employee benefit plans and thus are of concern to actuaries. To provide timely experience for the profession, the Society of Actuaries' Non-Mortality Decrement Task Force organized a data collection effort. Thirty-two contributors provided over 1.7 million life years of pension plan turnover data for years 1994–2000. This article summarizes the results of this data collection effort.

Traditionally, the most important determinants of termination and retirement are age, a proxy for attachment to the workforce, and service, a measure of attachment to a firm. This article documents the importance of these traditional quantities using current data and provides tables so that actuaries may quantitatively assess their importance when valuing pension plans.

For the middle working years, ages 25–55, we find female termination probabilities are higher than males, although the differences are smaller than has been true historically. The differences are insignificant for the younger working years or early service years. Moreover, for ages 55 and older, males have higher retirement probabilities than females.

We also document the effect of several plan characteristics: eligibility for postretirement health benefits, benefit formula, hourly/salary and union status, as well as plan size. To assess the effects of plan characteristics while controlling for age, service, and gender, we use multinomial logit analysis, a regression methodology suitable for categorical outcomes. We find that small plans have slightly higher termination probabilities compared to medium and large plans (plan size is our proxy for employer size). Union hourly plans have lower termination probabilities than salaried plans; in turn, salaried plans have lower termination probabilities than nonunion hourly plans. Firms that offer richer benefits enjoy lower turnover.

The data for this study were gathered using a traditional industry experience studies approach. To highlight the strengths and weaknesses of this approach, we compare this data set to several government sponsored probability samples on job turnover. In general, these samples are smaller and thus provide less credible estimates yet they allow the analyst to explore the complex interactions of the effects of several variables on turnover.

1. Introduction

Employee turnover is of general interest to employers because of the costs associated with hiring, screening, and training new (replacement) employees. Governments and public policymakers are interested in turnover because workers contribute to the tax payrolls and nonworkers often require resources through public assistance programs to become reconnected with the workforce. Employee termination and retirement affect the finances of employee benefit plans and thus are of concern to actuaries. Specifically, models for determining contribution levels for, and valuation of, defined benefit plans rely on information about employee turnover (see, for example, Bowers et al. 1997 for an introduction).

By ''employee turnover,'' we mean some type of employee exit from an employment arrangement, and hence a pension plan. In this study, the primary sources of turnover are termination and

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retirement. Termination includes situations other than retirement in which the employment relationship between an individual and employer is ended, or terminated, by either party. It includes vested as well as nonvested termination (here, vesting refers to acquiring rights to pension plan benefits). It also includes voluntary (quits) as well as nonvoluntary (dismissals, layoffs, plant closures, and so forth) terminations.

The purpose of this study is to summarize recent turnover experience in a form that pension actuaries may use in pension plan valuations and contribution studies. Tables that are currently used in practice include the classic ''Sarason T-tables'' (Crocker et al. 1955) as well as the Vaughn (1992) tables. In Canada, the Ontario medium tables are sometimes used (Coward et al. 1961). For comparison, both the Sarason and the Coward et al. tables are relatively old and were created in economic times that differ greatly from today. The Vaughn tables, although more recent, are based on a relatively small sample size (approximately 80,000 life years), representing only three industries (financial institutions, health care providers, and manufacturers).

Regarding plan sponsor characteristics, we are also able to comment on the effects of unionization and firm size; these variables are well-known to be important determinants of turnover (see Section 4). Further, we demonstrate the importance of employee benefit program features such as the pension plan benefit formula and the availability of postretirement health care benefits. We show in Section 4 that firms that offer richer benefits enjoy lower turnover.

The Society of Actuaries' Non-Mortality Decrement Task Force collected the data for this report. Contributors provided more than 1.7 million life years of pension plan turnover data. A prior report, Frees and Gilmore (2003), documented the data assembly and verification procedures used in collecting the data. In addition to documenting the data quality, this report provides substantial univariate analysis of the data such as will be highlighted in Section 2.1. The phrase ''univariate analysis'' means examining turnover in terms of each variable (such as age, service, and so forth) in isolation of the others. This report seeks to provide a more global, multivariate analysis that accounts for the joint effect of several variables on turnover.

The following is the plan for the rest of this article. In Section 2, we summarize some important features of the data in the traditional format of aggregate and select turnover tables. No models are introduced in this section; the data are summarized using traditional smoothing methods. As will be evident from the graphical displays, age and service are important determinants of turnover.

Section 3 introduces our multinomial logit analysis models of turnover. Multinomial logit is an extension of (ordinary) linear regression modeling that allows for discrete outcomes. The models provide a credible basis for deciding whether or not a variable is an important determinant of turnover.

Section 4 establishes the importance of four plan characteristics: eligibility for postretirement health benefits, benefit formula, hourly/salary and union status, as well as plan size. Many actuaries will wish to use the basic tables presented in Section 2 or the parameterized versions in Section 3. However, oftentimes an actuary has knowledge about a plan and will wish to modify the basic valuation table to incorporate this knowledge. Section 4 summarizes the appropriate modifications for these four important variables.

Next, Section 5.1 describes the sampling basis for this inter-company study. To understand the strengths and limitations of this type of study, we compare it to several nationally representative surveys that provide information on job turnover. Actuarial practice and the economics literature also suggest several variables that may influence turnover that were not considered in this study. These are discussed in Section 5.2 where we also briefly summarize the changing role of women in labor force participation.

Section 6 closes with a summary and some concluding remarks.

2. DATA DESCRIPTION

The data for this study were collected using a traditional industry ''experience studies'' approach. Thirty-two pension plan actuaries submitted information on one or more plans, for a total of 112 plans. For each plan, contributors provided one to five years of plan valuation data for years 1994–2000. For each year submitted by a contributor,

information on all pension plan participants was provided.

The unit of analysis in this study is an individual's job turnover experience within a year. The primary focus is on retirement and termination (both vested and nonvested). When editing the data for consistency, we also encountered and report elsewhere (Frees and Gilmore 2003, Frees 2003) on other turnover events including disability, death, and transfers from the plan. Because these are relatively low frequency events, we ignore them here.

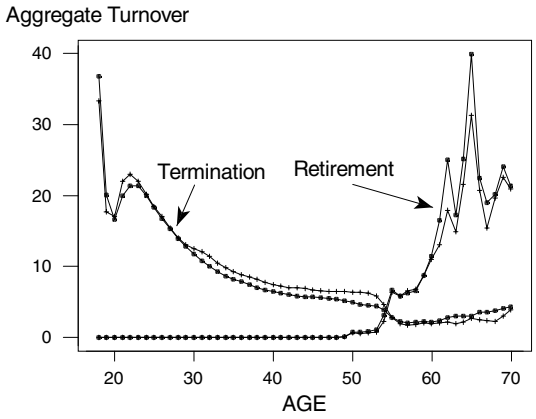
The variables that help us understand turnover occur at both the individual and plan level; we consider each type in Sections 2.1 and 2.2, respectively.

2.1 Summary Statistics—Individual Level Variables

The three individual level variables that turn out to be the most important determinants of turnover are age, service, and gender. Age is taken to be age nearest birthday at the beginning of the plan year. Service is defined to be the number of completed years of service at the beginning of the plan year. Gender is a binary variable representing males and females; for simplicity, we do not consider 15,793 observations reported to us where gender was recorded as either unisex or missing.

To introduce the data, Figure 1 presents basic aggregate probabilities by gender (accounting for age but not for service). The first step in estimating probabilities is to compute the number attaining the end of year status divided by the number beginning of the year in each category. For those that entered employment during the plan year (new hires), the exposure amount is adjusted for the relevant service time. The second step is to use Whittaker-Henderson Type B graduation to smooth termination estimated probabilities. Retirement was not smoothed because one anticipates spikes at selected ages such as 62 and 65; the nonsmooth nature (the spikes) is not due to sampling variability but is a systematic feature of the data. The Whittaker-Henderson Type B graduation method was selected because it is the same method used in another standard pension valuation table, the RP-2000 mortality tables (online at http://www.soa.org/ccm/content/research-publications/experience-studies-tools/the-rp-2000-mortality-tables/). For handling the early and latter parts of each series, the techniques described in Miller (1949, p. 36), see also London (1985) were used. Table 4 in Appendix A provides these estimated probabilities. Alternative smoothing methods, using multinomial logit modeling, are described beginning in Section 3.

Figure 1
Aggregate Turnover Probabilities—Termination and Retirement by Gender

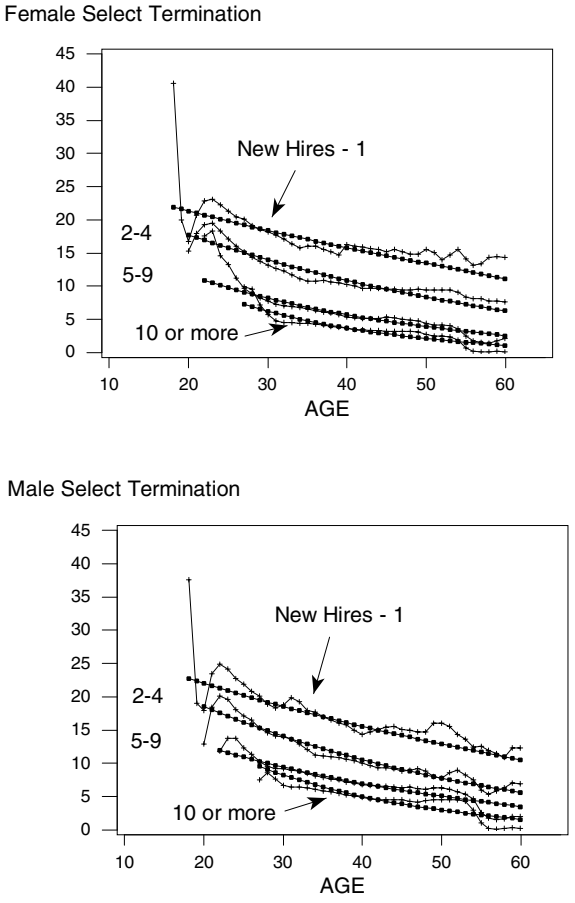


Notes: Estimated probabilities are in percent. Solid circles correspond to male, plus symbols correspond to females. Probabilities are estimated empirically and smoothed via Whittaker-Henderson Type B graduation formula.

Figure 1 shows the pattern of aggregate turnover probabilities by gender and age. For ages 20–54, inclusive, women have higher termination probabilities than men. For other ages, the reverse is true. Except through age 21 (where there is relatively little exposure), the largest difference is 1.71 (percent, at age 52). For all ages above 58, women have lower retirement probabilities than men.

To introduce the effects of service, Figure 2 shows select termination probabilities for females and males. Here and elsewhere, we group service into four categories: less than 2 (new hires, 0 and 1 year of completed service), 2–4 years of service, 5–9, and 10 and over. In addition to our analysis of the data, we made the groupings because of common pension vesting rules. It is common in Canada to fully vest plan participants by 2 years whereas in the U.S., 5 is a more common standard. For virtually all plans that we considered, plan participants are fully vested by 10 years.

Figure 2
Female and Male Select Termination Probabilities for Four Service Categories



Notes: The solid circles are from a multinomial logit fit, the plus symbols from an empirical fit with Whittaker-Henderson Type B smoothing. Estimated probabilities are in percent. The upper panel corresponds to females; the lower panel corresponds to males.

Estimated probabilities graphed with plus symbols are derived using the same technique as aggregate termination—empirical probabilities that have been smoothed using the Whittaker-Henderson Type B graduation formula. The solid plotting circles are produced by a fit of a multinomial logit model that will be described in Section 3.

When we account for service, the difference among termination probabilities by gender becomes smaller than when viewed on an aggregate basis (omitting service). Specifically, for the lower two service categories, new hires to one year of service and two to four years of service, there is little difference in male and female experience. The difference is more pronounced for the higher two service categories; interestingly, for these two categories, the probabilities of termination for males are higher when compared to females. The differences are quite small, however. Because of these small differences, our select Table 5 in Appendix A does not distinguish by gender.

In addition to age, service, and gender, the survey requested several additional variables at the individual level ''if readily available.'' These variables are: annual accrued benefit, annual salary, form of payment, condition of exit, type of hire and past service, and date of exit. Because these variables were provided at the option of the contributor, it turned out that there were large gaps in the database. Frees and Gilmore (2003) provide additional documentation. Thus, these variables are not considered in this article.

2.2 Summary Statistics—Plan Level Variables

In this section, we analyze turnover experience by each of several important plan characteristics. These characteristics are:

- availability of a postretirement health plan
- type of benefit formula
- hourly versus salary and union status
- plan size
- industry.

Table 1 shows the distribution of characteristics among plans, as well as how each plan characteristic is related to retirement and termination.

For postretirement health benefits, contributors were asked whether more than 90% of plan participants were eligible for postretirement health benefits, less than 10%, another mixture, or unknown. Table 1 suggests that plans that offered members postretirement health benefits enjoyed lower termination and retirement probabilities. Johnson et al. (2003) provide a recent investigation on the effects of health coverage on retirement rates using Health and Retirement Study (HRS) data, showing that increased health coverage reduces early retirement rates, even for those with postretirement health insurance.

For type of benefit formula, in addition to traditional final average, career average, and flat dol-

Table 1
Turnover Rates by Plan Characteristic

Plan Characteristic	Number of Plans	End of Year Status		Total Life Years
		Retired	Termination	
Eligible for Postretirement Health Benefits?				
More than 90%	24	0.71	7.24	828,062
Less than 10%	28	1.66	9.47	148,589
Other Mixture	8	1.81	7.87	344,094
Unknown	55	1.02	11.14	431,774
Type of Benefit Formula				
Final Average Pay	56	1.01	8.54	1,296,119
Career Average Pay	8	0.97	6.42	130,813
Hybrid	19	1.20	9.77	137,090
Flat Dollar	29	1.57	8.91	188,497
Hourly/Salary and Union Status				
Salaried	28	1.43	7.22	567,935
Hourly Union	17	1.46	1.8	91,504
Hourly Nonunion	3	0.14	22.7	106,803
Other Combination	21	0.69	7.65	758,307
Unknown	43	1.84	10.69	227,970
Plan Size				
Less than 1,000	68	1.26	9.89	82,489
More than 1,000 but less than 10,000	33	1.50	7.81	439,293
More than 10,000	11	0.92	8.68	1,230,737
Industry				
Manufacturing	49	1.12	7.35	380,001
Services and Trade	17	0.91	8.49	856,813
Services	34	1.11	8.96	382,869
Other	12	2.07	10.75	132,836
Totals	112	1.09*	8.52	1,752,519

*Retirement, like termination, probability estimates are based on all ages.

lar plans, contributors also specified whether a plan was cash balance, life cycle/pension equity, or an ''other'' type. Table 1 shows that 73.2% of life years experience was in the ''Final Average Pay'' group. Based on discussions with the Non-Mortality Decrement Task Force, the last three groups were combined into what we call a ''Hybrid'' group. From earlier work (Frees and Gilmore 2003), we know that the Hybrid group has higher termination as well as retirement rates when compared to either Final Average Pay or Career Average Pay (although not the Flat Dollar) plans. We also note that cash balance plans represent about 76% of the experience of the Hybrid group in terms of life years of exposure. Table 1 shows that final and career average pay plans had lower termination rates when compared to flat dollar plans. Hybrid plans had the highest termination rate. Gustman et al. (1994) provides a survey of the literature and Gustman and Steinmeier (1995) investigate the link between pension coverage and job mobility using the Survey of Consumer Finances (SCF, see Appendix D.2), the Survey of Income and Program Participation (SIPP, see Appendix D.4), and the Panel Survey of Income Dynamics (PSID, see Appendix D.5) data. They too find that pensions decrease turnover.

Frees and Gilmore (2003) reported statistics on plan pay type (more than 90% hourly, more than 90% salaried, other combination, and ''unknown'') as well as plan workforce (more than 90% unionized, more than 90% nonunion, other mixture, and ''unknown''). Because of the strong overlap between these characteristics, a combined category was created to summarize this set of plan characteristics. This variable, called ''hourly/salary and union status,'' consists of five categories:

- salaried (plans with more than 90% salaried workers, unionized or not)
- hourly union (plans with more than 90% union and with more than 90% hourly)
- hourly nonunion (plans with more than 90% hourly and with more than 90% nonunion)

- other combination (plans where either the plan pay type is a combination of hourly and salaried or the plan workforce is a mixture of union and nonunion)
- unknown (plans where either the plan pay type or the plan workforce is unknown).

Table 1 provides a breakdown of turnover rates. This table shows that hourly nonunion plans have the highest termination and lowest retirement rates. Note that the summary statistics in this table do not control for age, service, and gender. Not surprisingly, the low retirement and high termination rates for hourly nonunion plans are in part because younger workers dominate membership in these plans. For example, for the three hourly nonunion plans, the median age is 31, and the 90th percentile is 49. In contrast, for the 17 hourly union plans, the median age is 41, and the 90th percentile is 55. Further, about 75% of the members of the hourly plans (union and nonunion) were males, in contrast to only 42% in the salaried plans. The effects of unionization on job turnover are well-known; for example, using the Current Population Survey (CPS, see Appendix D.1) data, Rebitzer (1986) includes unionization as a control variable in his study of the effects of plant size on job tenure. Not surprisingly, he shows that unionization has a statistically significant positive effect on job tenure.

As a proxy for employer size, the size of the plan was examined. Specifically, the average number of life years of exposure was computed for each plan. Based on this average number of life years, plans were classified as follows:

- large plans, plans with an average of 10,000 or more plan participants per year,
- medium plans, plans with an average of less than 10,000 but greater than or equal to 1,000 plan participants per year, and
- small plans, plans with an average of less than 1,000 plan participants per year.

Even and Macpherson (1996) investigated whether the relationship between firm size and turnover can instead be accounted for in part by size-related differences in the availability, portability, or generosity of pension plans, using the National Longitudinal Surveys (NLS, see Appendix D.6) data. Analyzing data for the years 1973–93, they found that pension coverage was associated with a greater reduction in worker turnover in large firms than in small firms. Thus, it is somewhat surprising in that Table 1 suggests that the size of the plan is not an important determinant of turnover.

One possible explanation is the size categories used. Even and Macpherson (1996) used size categories such as 1–9, 10–24, 25–49, 50–99, 100–249, 250–499, 500–999, and 1,000 or more to categorize the number of people employed by a firm. Thus, in this context, ''small'' may refer to plans that have fewer than 50 participants. In contrast, the size descriptions used in this paper were based on a desire to represent our data using meaningful breakdowns (see Table 1). Thus, the use of the descriptor ''small plan'' may seem at odds with practice where a ''small plan'' is one with 50 or fewer participants. We experimented with alternative definitions yet, as will be seen in Section 4.4, plan size has less influence on turnover than other variables under consideration.

Table 1 also shows the distribution of the data by industry, using the first digit of the SIC code to differentiate industries. (The Standard Industrial Classification (SIC) code is available at the Census Bureau at http://www.census.gov/eped/naics/nsic2ndx.htm.) Not surprisingly, Table 1 shows some strong differences among plan experiences based on industry. This is true for retirement rates but is even more apparent when looking at termination rates. Industry effects are also established in the labor economics literature; see, for example, Valletta (1999) who investigated job security using PSID data. Valletta found that turnover decreases as length of employment increases, even when controlling for several demographic characteristics of workers and industry/regional employment conditions.

In addition to these variables, the survey also provided information on plan organization (single employer, multiemployer, public plan), geography, membership (plan participation based on employment or membership in a group), and the pattern of vesting (cliff or stepped pattern). See Frees and Gilmore (2003) for additional analysis.

3. MULTINOMIAL LOGIT MODEL

A multinomial logit model is a nonlinear regression model that allows for categorical responses. In our case, the response is 1 if the individual retires, 2 for termination, and 3 for any other response (active, death, disability, and other). Like ordinary (linear) regression models, the idea is to fit a parametric model to the data. This parametric model has three important features:

- It allows us to summarize the data with knowledge of only a few parameters and thus provides an alternative to Whittaker-Henderson Type B for smoothing the data.
- It allows us to incorporate additional explanatory variables (see equation 3.1).
- Using well-accepted rules for deciding when an additional variable is important (we will use likelihood ratio tests in Section 4.1), the multinomial logit model allows us to identify whether a variable is an important (or not) determinant of either retirement or of termination.

Like standard linear regression, multinomial logit models are concerned with linear combinations of explanatory variables, called systematic components, of the form:

$$V_{i,j} = \mathbf{x}_i' \boldsymbol{\beta}_j. \tag{3.1}$$

Note here that $\boldsymbol{\beta}_j$ is the corresponding vector of parameters that may depend on type of outcome. Thus, terminations will have a set of regression coefficients, as will retirees.

Because outcomes are not numerical, we cannot model the response y as a linear combination of explanatory variables plus an error. Instead the multinomial logit model employs the probabilities

$$\text{Prob}(y_i = \text{Retirement}) = \frac{\exp(V_{i,\text{Retirement}})}{1 + \exp(V_{i,\text{Retirement}}) + \exp(V_{i,\text{Termination}})} \tag{3.2}$$

$$\text{Prob}(y_i = \text{Termination}) = \frac{\exp(V_{i,\text{Termination}})}{1 + \exp(V_{i,\text{Retirement}}) + \exp(V_{i,\text{Termination}})}. \tag{3.3}$$

Parameter estimates are determined via maximum likelihood, as are standard errors; fitted values come directly from equations (3.2) and (3.3). For readers desiring additional background, there are many introductions to multinomial logit modeling available. See, for example, Greene (2002, Chapter 21), Frees (2004, Chapter 11) or Frees (2003, Appendix B).

3.1 Analysis by Age, Service, and Gender

This multinomial model was estimated using gender, age as a continuous variable, and service as a categorical variable with four components: (1) new hire to 1 year, (2) 2–4 years, (3) 5–9 years and (4) 10 or more years of service. Table 2 summarizes the point estimates of the thirty-two parameters of the model that includes age and service. Table 2 also includes the eight-parameter estimates of an aggregate model that is based on age (but not service).

The coefficients associated with age (labeled as slopes) for different service categories reinforce

Table 2
Multinomial Logit Parameter Estimates by Gender and Service

Service	Male Sample Size	Female Sample Size	Intercept		Slope	
			Male	Female	Male	Female
Termination						
≤1	168,322	114,452	−0.843	−0.938	−0.021	−0.018
2–4	229,797	150,602	−0.820	−0.962	−0.033	−0.029
5–9	257,841	196,264	−1.267	−1.256	−0.033	−0.039
≥10	375,091	260,150	−0.827	−1.065	−0.053	−0.055
Aggregate	1,031,051	721,468	−0.938	−1.075	−0.038	−0.039
Retirement						
≤1			−18.033	−19.610	0.238	0.271
2–4			−18.011	−20.743	0.237	0.285
5–9			−17.394	−20.391	0.245	0.295
≥10			−17.013	−18.905	0.250	0.286
Aggregate			−17.497	−19.805	0.244	0.286

our basic intuition about retirement systems. As anticipated, we see little variation for the retirement slopes (ranging from 0.237 to 0.250 for males and 0.271 to 0.295 for females). In contrast, there is substantial variation for the corresponding termination systematic components (ranging from −0.053 to −0.021 for males and −0.055 to −0.018 for females). Thus, we focus on termination slopes that depend on service, in contrast to retirement probabilities, where the focus is on aggregate rates that do not depend on service.

To interpret the fit, we use minus twice the log-likelihood statistic as our goodness of fit statistic. To illustrate, for the fitted age and service model in Table 3 it turns out to be −2 Log Likelihood = 1,071,940.3. Recall that the likelihood is simply an evaluation of a density at a set of observations and thus, by itself, is meaningless. However, when examining alternative parameterizations, the larger the value of a likelihood, the better is the fit. Similarly, the smaller the value of −2 Log Likelihood, the better the fit.

As another device for assessing the goodness of fit, we can compare the fitted probabilities under the multinomial logit model to our nonparametric estimates, as follows. In Figure 2, the smoothed lines are from the multinomial logit model. These are computed using equations (3.2) and (3.3) for each individual and then averaging over our entire sample. We have not included a sufficient number of parameters in the multinomial formula to capture differences in the parts of the series corresponding to the young ages and to the mid-fifties.

In summary, we find that service is not an important predictor of retirement; for retirement, age is more important than service. For termination probabilities, both age and service are important predictors. For service, there are large discontinuities when moving from (1) the new hire to one year of service category to (2) the two to four year of service to the (3) five to nine year of service categories. There is less of a distinction between the five to nine and the ten or more categories; thus, many plan valuations could use a category such as ''five or more years of service'' as the ''ultimate'' portion of their termination tables. Appendix C provides an additional analysis of only termination; it turns out that service is a better predictor than age of termination.

A likelihood ratio test indicates that gender is a statistically significant variable, although not as important as either age or service. We include gender because it is customary in actuarial studies of rates to produce sex-distinct tables.

Table 3
Summary of Several Model Fits

Model	Variables	Number of Parameters	−2 Log Likelihood	Change (from Model 1) in −2 Log Likelihood	Proportional Change (from Model 1) in −2 Log Likelihood*
1	Age as continuous, service as categorical, gender, interaction terms	32	1,071,940.3	0	0
2a	Model 1 plus postretirement health	38	1,066,790.9	5,149.4	858.2
2b	Model 1 plus postretirement health, interaction terms	128	1,061,538.9	10,401.4	100.0
3a	Model 1 plus benefit formula	38	1,070,182.1	1,758.2	293.0
3b	Model 1 plus benefit formula, interaction terms	128	1,067,229.1	4,711.2	49.1
4a	Model 1 plus hourly/salary and union (five levels)	40	1,053,956.7	17,983.6	2,247.9
4b	Model 1 plus hourly/salary and union, interaction terms	160	1,050,465.5	21,474.8	167.8
5a	Model 1 plus plan size	36	1,071,222.0	718.3	180.0
5b	Model 1 plus plan size, interaction terms	96	1,070,078.6	1,861.7	29.1
6a	Model 1 plus industry	38	1,070,202.6	1,737.7	289.6
6b	Model 1 plus industry, interaction terms	128	1,065,847.8	6,092.5	63.5

**Note:* Proportional change computed as the change in the likelihood (the fifth column from the left) divided by the change in the number of parameters (the third column from the left minus 32).

3.2 Incorporating Plan Characteristics

The analysis in Sections 2.1 and 3.1 yield tables of turnover that are useful for pension plan valuations (provided in Appendix A). Moreover, the summary statistics presented in Section 2.2 suggest that knowledge of certain plan characteristics may also be meaningful determinants of turnover. Regression analysis, such as multinomial logit analysis, has the capability of representing situations where multiple variables may jointly affect a response. There are, however, limitations.

In any regression analysis, one is always concerned with *collinearity*. Collinearity means that linear combinations of explanatory variables may potentially be related to one another. In our application, because plan-level variables take on the same value for all observations within a plan, there is a natural collinearity inherent in the data. This does not mean that we cannot estimate model parameters reliably. It does, however, mean that we do not have as many ''degrees of freedom'' as one would normally expect with a data set of over 1.7 million observations. Thus, caution is needed when introducing explanatory variables into the model because of potential problems of collinearity and of ''empty cells.'' That is, it is not unusual for a combination of variables to uniquely identify a plan or for no plan to exist for a certain combination, hence the term ''empty cell.''

This statistical concern is corroborated by the desire that no model rely on one or a very limited number of plans. We would like to produce models based on data that average over the experience of several plans; in this way, we hope that the model that we produce is more robust and not dependent upon the experience of a single plan.

Because of this data limitation, it is not possible to model the joint effect of several plan characteristics on turnover. The strategy we use, beginning in the next section, is to examine each variable in isolation of the others, but controlling for age, service, and gender.

4. ANALYSIS BY PLAN CHARACTERISTIC

In this section, we analyze experience by each of several important plan characteristics. In part, the analysis will rely on the likelihood statistics as measures of goodness of fit. Later in the section, we also examine the magnitude of plan characteristic effects graphically. Table 3 presents the likelihood statistics, suggesting that the availability of a postretirement health plan and hourly versus salary and union status are important predictors of turnover.

Adding a categorical variable to Model 1 amounts to a constant shift in predicted probabilities. For example, suppose that τ represents an estimate associated with the availability of postretirement health and that $V_{i,1,\text{new}}$ and $V_{i,1,\text{old}}$ represent the systematic components with and without τ, respectively. Thus, if $V_{i,1,\text{new}} = \mathbf{x}_i' \boldsymbol{\beta}_j + \tau = V_{i,1,\text{old}} + \tau$, then from equations (3.2) or (3.3), we have

$$\begin{aligned}
&\text{Prob}_{\text{new}}(y_i = 1) \\
&\quad = \frac{\exp(V_{i,1} + \tau)}{1 + \exp(V_{i,1} + \tau) + \exp(V_{i,2})} \\
&\quad \approx e^{\tau} \frac{\exp(V_{i,1})}{1 + \exp(V_{i,1}) + \exp(V_{i,2})} \\
&\quad = e^{\tau}\, \text{Prob}_{\text{old}}(y_i = 1).
\end{aligned}$$

That is, the new estimate of the probability of termination ($y = 1$) is a constant, e^{τ}, times the old estimate.

The interaction terms consist of crossing the main effects, (age, service, and gender) with each categorical term. For example, for Model 2b, this model essentially contains the 32 parameters of the base Model 1 for each of the four postretirement categories. Because these interaction terms depend on age and service, they change the shape of our turnover curves, thus amounting to what we call a scale shift.

From the likelihood statistics in Table 3 and using likelihood ratio tests, it is evident that each plan characteristic is a statistically significant predictor of turnover. Sections 4.1–4.4 interpret their effects.

4.1 Eligibility for Postretirement Health Benefits

This section explores the effect of the eligibility for postretirement health benefits on plan turnover. Recall from Table 1 that there are four types of postretirement health benefits plans. Further, for each type of eligibility, there are 32 parameters, as in our baseline model in Table 2. In total,

there are $4 \times 32 = 128$ parameters. The parameter estimates are given in detail in Frees (2003, Appendix D.1, Table D.1).

Model 2b summarizes the fit using age, service, gender, and eligibility variables. Not surprisingly, the addition of the eligibility variable improves our model fit in a statistically significant fashion; see Table 3. The proportional change in the likelihood statistics suggests that the increase in model fit is desirable, even when based on the number of parameters.

Figure 3 shows the effect of eligibility for postretirement benefits on aggregate turnover. In the left-hand panel, we see that termination probabilities are lower for plans having more than 90% eligible for a postretirement health benefit. It is interesting that the differential is more apparent for younger ages rather than older. The right-hand panel shows that ''Other mixture'' and ''Unknown'' categories have the highest retirement probabilities. For retirement probabilities, Figure 11 in Appendix B.1 suggests that gender is important for plans without eligibility for postretirement benefits (''Less than 10%'') whereas, for other plans, the type of eligibility for postretirement benefits is more important than gender.

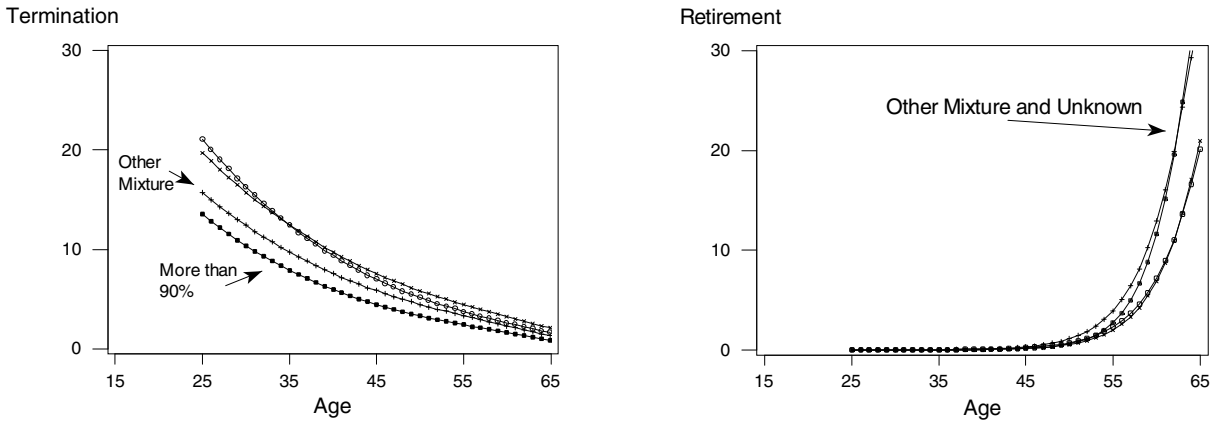
Figure 4 shows the effect of availability of postretirement health benefits on aggregate termination by gender. The right-hand panel shows that females are more sensitive to whether postretirement benefits are offered; here, ''Unknown'' and ''Less Than 10%'' categories exhibit the highest termination rates for young females. For young males, the left-hand panel shows that males are most likely to leave with a plan that has ''Less than 10%'' eligible for postretirement benefits.

Figure 12 in Appendix B.1 shows the effect of eligibility for postretirement health benefits on select termination. For those with less than five years of service, the service effect is more important than the eligibility for postretirement health benefits. For those with 10 or more years of service, there does not seem to be an effect for eligibility for postretirement health benefits on termination probabilities. Interestingly, for those with 5–9 years of service, those in plans with 90% or more eligible for postretirement benefits have lower termination probabilities than the other three categories.

4.2 Benefit Formula

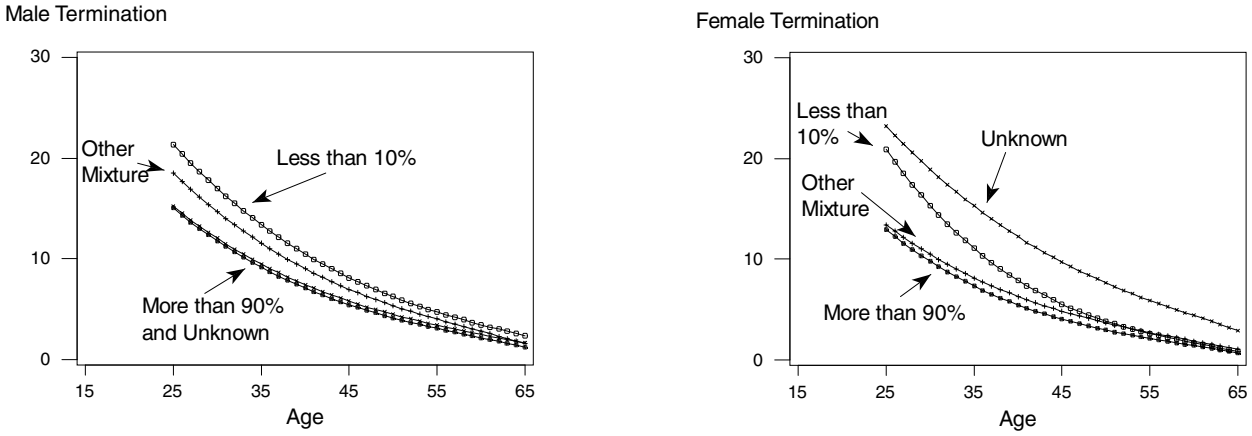
To explore the effects of plan benefit formula on turnover, we define Model 3b to be Model 1 with interaction variables for each benefit formula variable. In total, there are $4 \times 32 = 128$ parameters. The parameter estimates are given in Frees (2003, Appendix D.2, Table D.2). Not surprisingly, the addition of the benefit formula variable improves our model fit in a statistically

Figure 3
Aggregate Turnover Probabilities by Eligibility for Postretirement Health Benefits



Notes: Estimated probabilities are in percent. Rates are derived from a multinomial logit model fit. The left-hand panel gives termination; the right-hand panel gives retirement.

Figure 4
Male and Female Aggregate Termination Probabilities by Eligibility for Postretirement Health Benefits



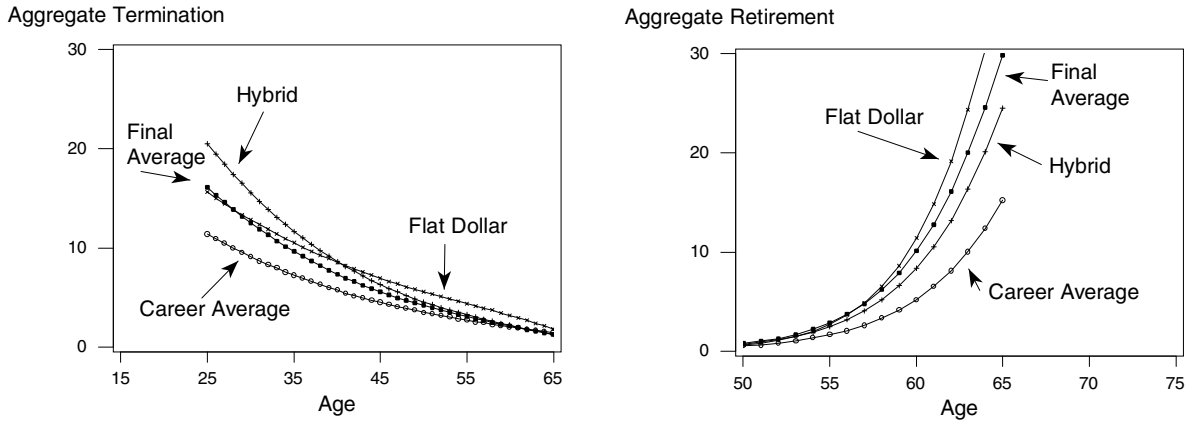
Notes: Estimated probabilities are in percent. The left-hand panel corresponds to males; the right-hand panel corresponds to females.

significant fashion; see Table 3. However, it is not as good a fit as the postretirement health variable.

Figure 5 shows the effect of benefit formula on aggregate turnover. In the left-hand panel, we see that termination probabilities are lower for plans using career average pay; this was anticipated from Table 1. It is interesting that the differential is more apparent for younger ages rather than older. The right-hand panel shows that career average plans have the lowest retirement probabilities. Figure 13 in Appendix B shows that males have a lower probability of retirement than females in career average plans; this is opposite to the general trend of higher male retirement noted in Section 3.1. For other plans, our data suggest that the benefit formula is more important than gender for retirement probabilities, when controlling for age.

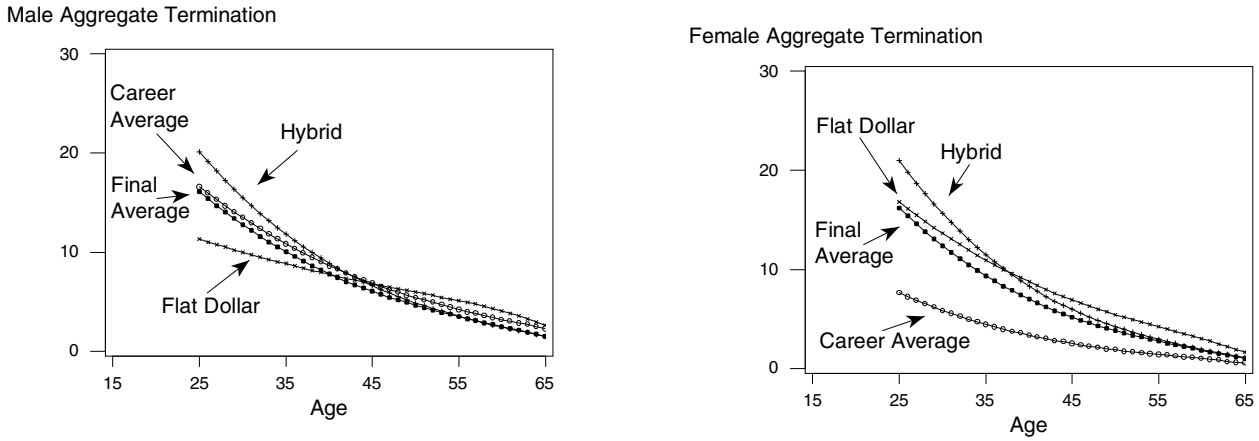
Figure 6 shows the effect of benefit formula on aggregate termination by gender. The left-hand panel shows that young males are less likely to leave a plan that has a flat dollar pay formula but are otherwise not sensitive to the type of benefit

Figure 5
Aggregate Turnover Probabilities by Benefit Formula



Notes: Estimated probabilities are in percent. The left-hand panel gives termination; the right-hand panel gives retirement.

Figure 6
Male and Female Aggregate Termination Probabilities by Benefit Formula



Notes: Estimated probabilities are in percent. The left-hand panel corresponds to males; the right-hand panel corresponds to females.

offered. Comparing the right- and left-hand panels, we see that males and females react similarly to final average and hybrid plans and react differently to career average and flat dollar plans.

Figures 14 and 15 of Appendix B show the effect of benefit formulas on select (2–4 years of service) termination, by gender. As with aggregate probabilities, there is little difference by gender for final average and hybrid plans for select termination probabilities. Career average and flat dollar select probabilities vary dramatically by gender. Although not evident from these two figures, a likelihood analysis shows that the effect of service is more important than the type of benefit formula. For this reason, service was included in the base model (1) in lieu of benefit formula.

4.3 Hourly/Salary and Union Status

Models 4a and 4b in Table 3 summarize multinomial logit model fits that include hourly/salary and union status as well as controls for age, service, and gender. The parameter estimates are in Frees (2003, Appendix D.5, Table D.5.1), based on Model 4b. The likelihood statistics in Table 3 show that the hourly/salary and union status variable is an excellent determinant of turnover, even compared to other variables explored in Sections 4.1 and 4.2.

To understand why the hourly/salary and union status variable is such an excellent predictor of turnover, Figure 7 shows aggregate termination by this variable. This figure shows that the hourly nonunion plans have much higher termination rates and hourly union plans have much lower termination rates.

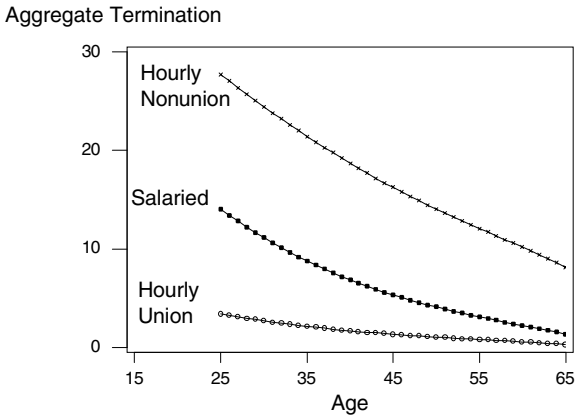
Is this due to gender differences? Figure 8 suggests the answer is not exclusively, at least for termination rates. Figure 16, in Appendix B, also suggests that the answer is no for retirement rates.

4.4 Plan Size

Table 1 suggests that the size of the plan is not an important determinant of turnover; this is surprising given in the work of Even and Macpherson (1996) cited in Section 2.2. Of course, it is possible that differences in plan size are masked by differences in age, service, or gender distributions. Thus, we now define Model 5b to be Model 1 but with interaction variables for each level of the plan size variable. The parameter estimates are given in Frees (2003, Appendix D.4, Table D.4). Not surprisingly, the addition of the plan size variable improves our model fit in a statistically significant fashion; see Table 3. However, it is not as good a fit as the postretirement health benefits, benefit formula, or union/hourly status variables.

Figure 9 shows the effect of plan size on aggregate turnover. In the left-hand panel, we see that termination probabilities are higher for small plans. It is interesting that the differential is con-

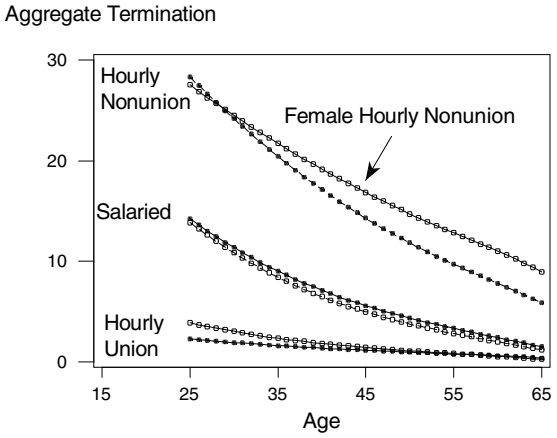
Figure 7
Aggregate Termination Probabilities by Hourly/Salary and Union Status



Notes: Estimated probabilities are in percent.

sistent over age. The right-hand panel shows that large plans have the highest retirement probabilities. It is interesting that this is the opposite of the evidence in Table 1 (where large plans have the smallest overall retirement probabilities). In contrast, Figure 9 is based on the multinomial logit analysis that controls for age, service, and gender, in contrast to the unadjusted statistics in Table 1.

Figure 8
Male and Female Aggregate Termination Probabilities by Hourly/Salary and Union Status



Notes: Estimated probabilities are in percent. The solid circles correspond to males; the open circles correspond to females.

Figure 10 shows the effect of plan size on aggregate termination by gender. The right-hand panel shows that the effect for females appears level over ages. In contrast, the left-hand panel (males) shows that the plan size effect is large for younger ages and diminishes with age. Frees (2003, Appendix E.1) demonstrates how to use the multinomial logit fits to create tables for small plans.

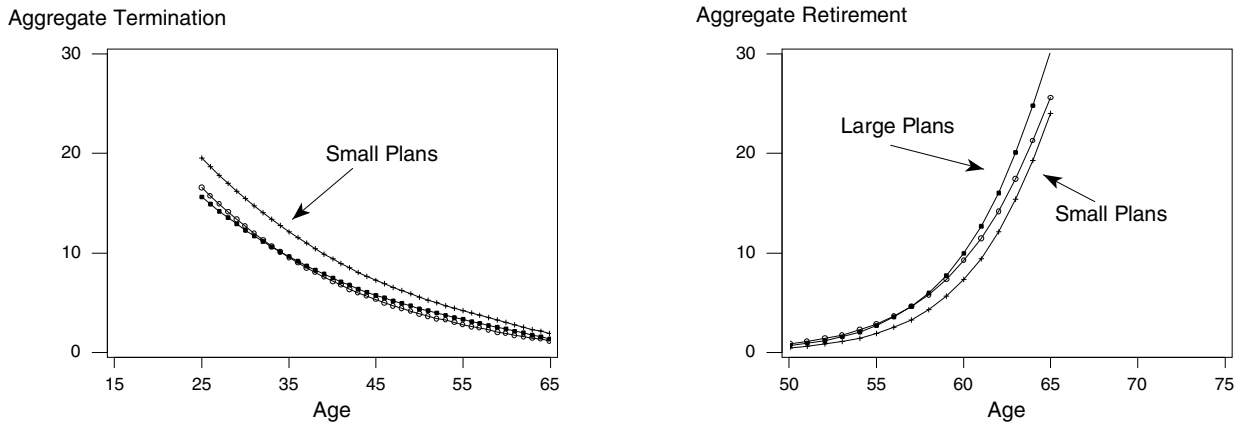
5. SAMPLING ISSUES AND ADDITIONAL CAVEATS

5.1 Sampling Issues and Alternative Sources of Turnover Data

As noted in Section 2, these data were collected using a traditional industry ''experience studies'' approach; there are several strengths of this experience studies approach. First, the final data set was large; we analyze over 1.7 million life years of experience in this article. This is important for determining credible estimates of turnover, particularly when partitioning the data into individual demographic cells (by age, service, and gender) where experience may become sparse. Second, by working with a limited number of plans and contributors, extensive procedures for cleaning and verifying the data could be implemented to assure the accuracy of the data; see Frees and Gilmore (2003) for details. Third, by relying on administrative records, we are using an externally verifiable record of an individual's behavior (job turnover in this case). This is in contrast to some alternative sources described below where survey instruments are used to ask respondents about job turnover, sometimes in the distant past. Fourth, the data set considered here is a proper subset of the population of interest—participants of defined benefit pension plans.

In contrast, nationally representative samples described below consist of a random sample of a nation's population, including many who may not be defined as benefit pension plan participants, and with experiences that will be diverse in many respects from plans. Obtaining a significant sample of defined benefit plan participants can be difficult and also unreliable. Furthermore, nationally representative samples are often longitudinal (i.e., track samples over time) and expensive to collect. Nevertheless, these alternative sources

Figure 9
Aggregate Turnover Probabilities by Plan Size



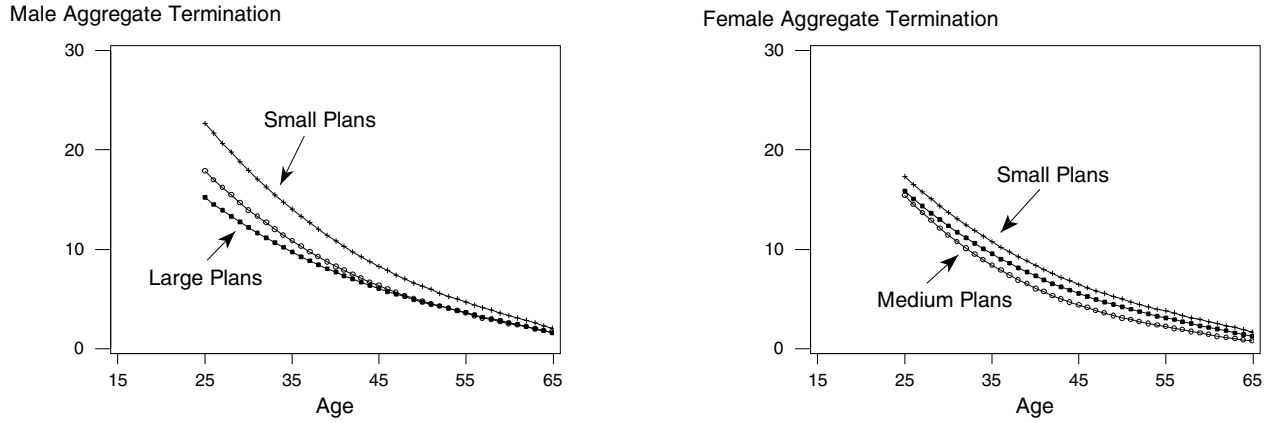
Notes: Estimated probabilities are in percent. The left-hand panel gives termination; the right-hand panel gives retirement.

can be used to augment the experience study findings by providing additional insights into the same or different demographics that impact turnover in the U.S.

To understand the limitations of this experience studies approach, we now describe some alternative sources of job turnover. These descriptions will also help direct actuaries to additional sources of information about turnover that complement the data described here.

The Bureau of Labor Statistics (BLS) is the principal fact-finding agency for the U.S. Federal Government in labor economics. BLS conducts several *establishment-level* surveys pertaining to labor market experience and employee benefits. One BLS survey, the Current Employment Statistics (CES) survey, provides employment information based on a sample of over 400,000 business establishments. A second survey, the National Compensation Survey (NCS), provides incidence and extensive provisions data regarding retirement benefits for both defined benefit and defined contribution components. A third survey, the Job Openings and Labor Turnover Survey

Figure 10
Male and Female Aggregate Termination Probabilities by Plan Size



Notes: Estimated probabilities are in percent. The left-hand panel corresponds to males; the right-hand panel corresponds to females.

(JOLTS), measures employment hires, quits, layoffs, discharges, and other separations. It is based on a sample of 16,000 business establishments.

Actuaries who wish to understand the current job turnover environment can use these surveys. However, establishment-level surveys do not provide information at the individual level worker, such as age, sex, and years of service that are important for pension plan valuations. Thus, this article does not consider them in further detail.

In addition, the U.S. government also conducts several *household-level* surveys relating to labor market experience and employee benefits. These types of surveys do contain individual-level information and thus may be helpful for understanding employee turnover. For our purposes, it is useful to categorize these surveys as either *cross-sectional* or *longitudinal*. Longitudinal surveys identify and follow survey participants from one survey interview occasion to the next; in contrast, cross-sectional surveys do not.

One cross-sectional survey that we consider, the Current Population Survey (CPS), has a much larger sample size compared to the longitudinal surveys. The CPS is a monthly survey of approximately 60,000 households; it includes detailed employment information (see Appendix D.1). A second cross-sectional survey that we cite is the Survey of Consumer Finances (SCF, see Appendix D.2). In contrast to the CPS, this survey is only conducted every three years, with about 4,500 respondents during each interview session. However, the SCF contains detailed information about survey respondent salary and benefit characteristics, information that is lacking in other household surveys.

We also note that this limitation is partially mitigated by longitudinal surveys that follow a relatively small number of individuals over an extended period of time, thus permitting time for a more detailed investigation of seemingly obscure financial characteristics. Appendices D.3–D.6 describe four groups of longitudinal surveys in more detail. These are: the Health and Retirement Study (HRS), the Survey of Income and Program Participation (SIPP), the Panel Survey of Income Dynamics (PSID), and the National Longitudinal Surveys (NLS). The NLS and PSID are annual surveys whereas the HRS is biennial and the SIPP is every four months. They range in sample sizes from approximately 7,400 (PSID) to 36,700 households (SIPP).

Longitudinal surveys are useful because, by following participants over time, they allow researchers to investigate dynamic patterns of labor and retirement behavior. The NLS and PSID are the two oldest and thus most widely investigated sources of longitudinal data (the PSID began in 1968, the NLS surveys in 1969). Labor economists and sociologists have used them both extensively. Although more recent (1984), the SIPP is particularly useful for studying short-term labor movements because of its thrice annual interview cycle. The HRS, begun in 1992, is useful for understanding retirement behavior because of its oversampling of the elderly.

When the experience study approach is compared to household-level surveys, we note two limitations of the former. First, there is the concern of biased sampling. It is quite possible that the contributors provide data that are not representative of the population of interest. In contrast, the household-level surveys are probability-based samples that allow analysts to infer characteristics about a large population. As noted earlier, these surveys are designed to infer behavior about broad segments of the population, not only participants of defined benefit pension plans.

Second, there are a limited number of plans represented in our experience study data. Although our sample size is large with respect to the number of life years considered, it is not a representative sample of the population of active pension plan participants in North America. As one consequence, we have a relatively small number of plans represented (112 in our final sample); inferences to industry-wide trends should not be based on this study. That is, at first glance one may think that with 1.7 million life years of exposure, we enjoy a tremendous amount of statistical significance. This is true, yet statistical significance is based on assumed independence of outcomes and no unobserved variables. There is substantial collinearity among plan characteristics. For example, with only 112 plans, it is difficult to tease out differences among industry effects and region effects, both of which should have strong influences on turnover. We must treat findings about plan characteristics with caution.

5.2 Additional Caveats

When extrapolating the findings of this study to other situations of interest, there are several caveats that the actuary should keep in mind.

Instead of a long-term longitudinal study, we considered only five years of data. Because turnover rates are susceptible to general economic conditions, we are not able to infer how robust our results are to changing economic conditions.

Because of the short time span of our study, we were not able to document changes in female termination rates over time. Fortunately, the closely related concept of female *labor force participation rates* has been summarized in other studies, see, for example, Frees (2002). As noted in that study, women's participation in the labor force changed fundamentally in the latter part of the twentieth century. Unlike men, the trend of labor force participation rates for women continues to increase, although rates of increase for periods 1990–1998 are lower than in prior years (Fullerton 1999).

There are several explanations for increased female labor force participation. These include young women postponing and reducing fertility, reduction of marriage and increases in divorce rates (Olsen 1994, Blau 1998). Other important determinants of female labor force participation rates include education and the presence of young children. It is well documented that levels of education affect labor force participation rates. Although labor force participation rates for less educated males have fallen over the last twenty-five years, female rates have not risen as quickly as other education level groups (Blau 1998). There is also strong evidence that the presence of young children in the household tends to reduce the labor participation of women. Nonetheless, there seems to be a substantial rise in attachment to the labor force among new mothers, particularly married women.

We have also not considered several variables that have been identified in the management and labor economics literature to be important determinants of turnover. These include wages, wage growth, education status, marital status, and prior mobility. See, for example, Mitchell (1982) or Gustman et al. (1994). Of these, wages (and wage growth) are probably most important for actuarial applications. Essentially, the literature has established that employees who earn more and who have enjoyed larger wage increases are less likely to terminate employment. The Society of Actuaries' Non-Mortality Decrement Task Force did request wage data. Unfortunately, because of the many different conventions for reporting salary information by our contributors, a consistent salary variable was not available for this study.

Another variable that is of considerable interest to actuaries is the impact of corporate events such as mergers and acquisitions of plan sponsors, closures of plans, offering of early retirement windows, and so forth. Some analysis of this variable was included in Frees and Gilmore (2003). Unfortunately, because of our limited information, we have little to offer in the way of guidance for handling these types of corporate events.

6. Summary and Concluding Remarks

This report is designed to offer actuaries information about turnover as it pertains to defined benefit pension plans at several different levels.

Section 2.1 provides classic aggregate as well as select and ultimate tables of turnover. Here, we see that age is an important determinant of turnover. Service is also important. For some valuations, actuaries will choose to use select and ultimate tables. For most ages, we found it important to distinguish between service for employees with less than five years of service; we use the categories (1) new hires to less than two years and (2) two to less than five years of completed service. The difference was smaller between the categories (3) five to less than 10 and (4) 10 or more years of completed service. Appendix B provides traditional actuarial tables that may be used directly for valuation purposes.

The Section 2.1 probabilities are nonparametric in the sense that, although smoothed, they cannot be summarized without loss of information. As an alternative, Section 3 provides a parametric model fit using multinomial logit analysis. One advantage of these parametric fits is that both aggregate as well as select and ultimate tables can be produced knowing only the multinomial logit equations (3.2) and (3.3) and the parameter estimates (with the sample size weights for the aggregate tables).

Another important advantage of the multinomial logit fits is that this type of regression analysis provides a systematic way for deciding on whether or nor a variable is

- an important determinant of turnover, and
- whether it is an important determinant of termination, retirement, or both.

Many studies use logit analysis to study either employment termination or retirement. (To illustrate, Appendix C provides an analysis of termination only.) By using the more complex multinomial logit analysis, we are able to more realistically model the choices faced by elderly workers.

As anticipated, the provisions of a pension plan influence retirement probabilities. In this report, we also document that pension plan provisions influence termination rates. Section 4 shows that plans with richer benefits enjoy lower turnover. Specifically, the availability of a postretirement health plan significantly lowers termination probabilities. Moreover, the plans that offer retirement benefits using a final average salary formula enjoy significantly lowers termination probabilities. We also noted that females were more sensitive to the type of benefit offered than males. We remind the reader, however, of the cautionary notes offered in Section 5 on making causal interpretations regarding plan characteristics.

As this article helps actuaries and pension practitioners gain insights into the key factors underlying plan turnover experience, it should also make them aware of macroeconomic and demographic trends that can impact plan turnover and, to the extent applicable, utilize this additional information to corroborate or conduct further research in the process of setting plan turnover assumptions.

APPENDIX A. TURNOVER TABLES

Table 4
Aggregate Turnover by Age and Gender

Age Nearest Birthday	Female			Male		
	Life Years	Estimated Turnover Probabilities, in Percent		Life Years	Estimated Turnover Probabilities, in Percent	
		Retired	Termination		Retired	Termination
18	272		33.37	276		36.81
19	594		17.69	896		20.05
20	1,830		17.00	2,489		16.64
21	4,106		22.03	6,993		19.95
22	6,643		22.95	12,098		21.36
23	8,808		22.04	15,200		21.38
24	11,067		20.15	18,609		19.95
25	13,166		18.47	21,782		18.31
26	14,787		17.04	24,303		16.71
27	16,098		15.42	26,409		15.30
28	17,430		14.01	28,279		13.96
29	18,669		13.03	29,531		12.79
30	19,753		12.56	30,571		11.78
31	20,898		12.11	32,130		10.81
32	22,468		11.38	34,195		10.03
33	23,888		10.45	36,107		9.33
34	24,986		9.78	37,717		8.68
35	25,878		9.26	39,041		8.24
36	26,301		8.87	39,963		7.82
37	26,401		8.52	40,159		7.44
38	26,305		8.14	39,882		7.01
39	26,027		7.81	39,319		6.65
40	25,740		7.43	38,220		6.50
41	25,267		7.20	37,116		6.20
42	24,358		7.01	35,324		6.02
43	23,490		6.97	33,280		5.86
44	22,538		6.88	31,435		5.76
45	21,627		6.70	29,804		5.66
46	20,394		6.54	27,518		5.60
47	19,453		6.45	25,775		5.45
48	18,826		6.44	24,631		5.34
49	17,603	0.06	6.50	22,914	0.12	5.19
50	16,388	0.59	6.38	21,095	0.75	4.93
51	15,016	0.48	6.33	19,181	0.72	4.67
52	13,838	0.61	6.21	17,496	0.83	4.50
53	12,739	0.73	5.78	15,675	1.03	4.37
54	11,765	2.29	4.61	14,243	3.16	3.88
55	11,036	6.36	2.78	12,951	6.68	2.78
56	9,904	5.83	1.92	11,615	5.86	2.24
57	9,026	6.62	1.74	10,369	6.21	2.06
58	8,199	6.77	1.85	9,176	6.54	2.10
59	7,385	8.71	2.07	8,212	8.72	2.24
60	6,481	10.99	1.96	7,207	11.47	2.17
61	5,575	13.08	2.04	6,228	16.53	2.39
62	4,608	17.86	2.14	4,753	25.03	2.79
63	3,640	14.88	1.89	3,328	17.28	3.00
64	3,020	21.59	2.17	2,614	25.10	3.02
65	2,268	31.33	2.64	1,823	39.93	3.02
66	1,476	20.73	2.49	1,027	22.40	3.60
67	1,159	15.44	2.36	741	18.95	3.56
68	975	19.59	2.25	575	20.17	3.81
69	751	22.50	3.01	462	24.11	4.08
70	548	20.90	3.88	314	21.34	4.28
Total	721,468	*5.40	8.85	1,031,051	*5.34	8.45

*Average retirement estimated probability is based on ages 49–70, inclusive.

Table 5

Select Termination by Age, Smoothed, and Weighted

Age Nearest Birthday	Life Years	Estimated Termination Probabilities, in Percent				
		Service < 2	Service = 2, 3, 4	Service = 5–9	Service ≥ 10	Overall
18	574	39.64				35.72
19	1,630	20.23				19.71
20	4,581	17.99	14.19			17.46
21	11,494	22.38	18.19			21.23
22	19,167	24.07	19.60	15.00		22.25
23	24,487	23.85	19.58	15.09		21.82
24	30,178	22.70	18.32	14.25		20.19
25	35,486	21.74	17.14	12.96		18.51
26	39,638	20.95	16.27	11.29		16.99
27	43,077	20.41	15.29	9.97		15.53
28	46,284	19.42	14.52	9.15	8.75	14.15
29	48,744	18.73	13.93	8.69	5.21	13.02
30	50,829	18.61	13.58	8.39	4.84	12.19
31	53,502	18.83	13.09	8.02	5.39	11.44
32	57,144	18.32	12.60	7.76	5.47	10.70
33	60,512	17.39	11.97	7.56	5.30	9.91
34	63,184	16.94	11.33	7.37	5.15	9.25
35	65,421	16.78	11.02	7.15	5.02	8.78
36	66,760	16.69	10.98	6.85	4.87	8.37
37	67,082	16.29	10.99	6.68	4.68	8.00
38	66,642	16.00	10.77	6.44	4.43	7.58
39	65,794	15.36	10.59	6.27	4.32	7.23
40	64,396	15.91	10.35	6.01	4.15	7.00
41	62,816	15.94	10.01	5.89	3.93	6.72
42	60,031	16.05	9.72	5.84	3.86	6.54
43	57,132	15.98	9.71	5.75	3.81	6.43
44	54,333	15.88	9.62	5.77	3.79	6.33
45	51,806	15.48	9.47	5.82	3.73	6.21
46	48,223	15.61	9.54	5.81	3.64	6.10
47	45,537	15.30	9.47	5.61	3.66	5.98
48	43,752	15.15	9.37	5.52	3.70	5.92
49	40,812	15.53	9.02	5.60	3.65	5.85
50	37,755	15.60	8.90	5.32	3.49	5.63
51	34,435	15.35	9.32	5.13	3.38	5.48
52	31,567	14.35	9.52	4.99	3.35	5.35
53	28,642	14.34	9.24	4.70	3.22	5.10
54	26,203	14.17	8.80	4.12	2.37	4.32
55	24,177	13.52	7.82	2.59	0.88	2.92
56	21,708	12.84	7.49	1.84	0.23	2.25
57	19,570	12.66	7.67	1.54	0.11	2.06
58	17,523	12.74	7.68	1.58	0.22	2.12
59	15,718	13.50	7.94	1.92	0.31	2.27
60	13,791	13.63	7.84	2.12	0.20	2.20
Totals	1,722,137	18.52	12.60	6.78	3.59	*8.76

*The overall termination rate is 8.76 for all ages. For ages 18–60, the overall termination rate is 8.83%.

APPENDIX B. ANALYSIS BY PLAN CHARACTERISTICS

Appendix B.1 Analysis by Eligibility for Postretirement Benefits

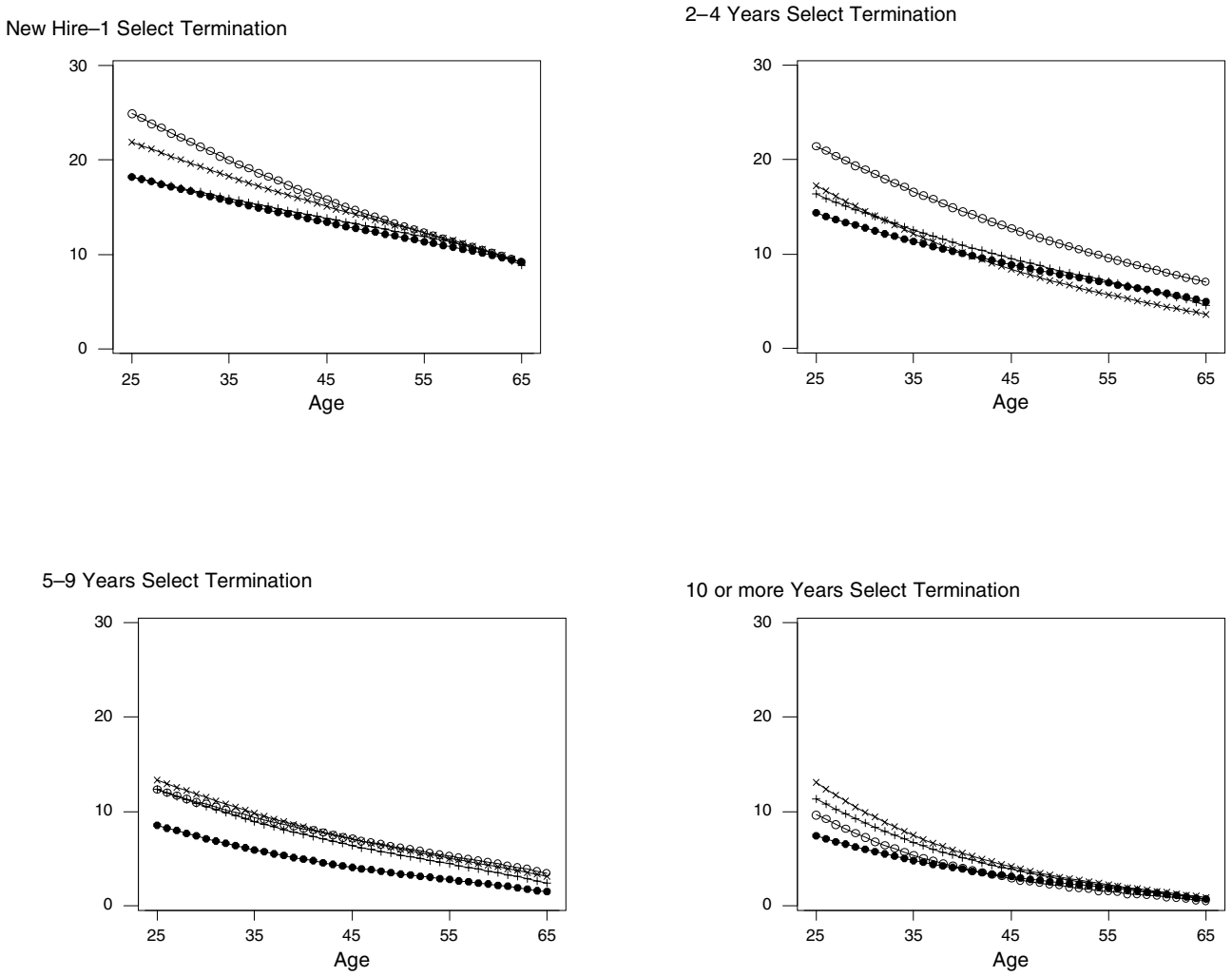
Figure 11

Aggregate Retirement Probabilities by Eligibility for Postretirement Benefits and Gender

Notes: Estimated probabilities are in percent. The solid circles correspond to 'More Than 90% Eligible', the open circles to 'Less Than 10% Eligible', the plus symbols to 'Other Mixture', and the crosses to 'Unknown'.

Figure 12

Select Termination Probabilities by Eligibility for Postretirement Benefits and Service

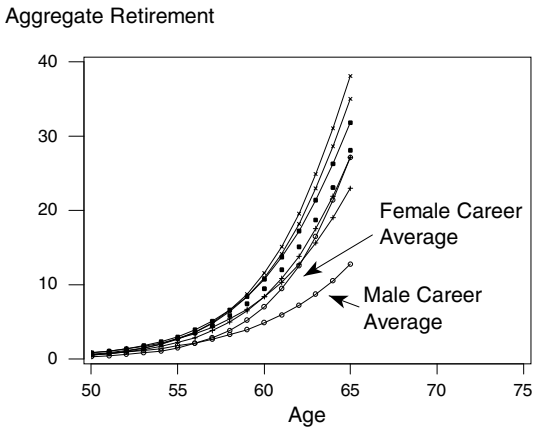


Notes: Estimated probabilities are in percent. The solid circles correspond to 'More Than 90% Eligible', the open circles to 'Less Than 10% Eligible', the plus symbols to 'Other Mixture', and the crosses to 'Unknown'.

Appendix B.2 Analysis by Benefit Formula

Figure 13

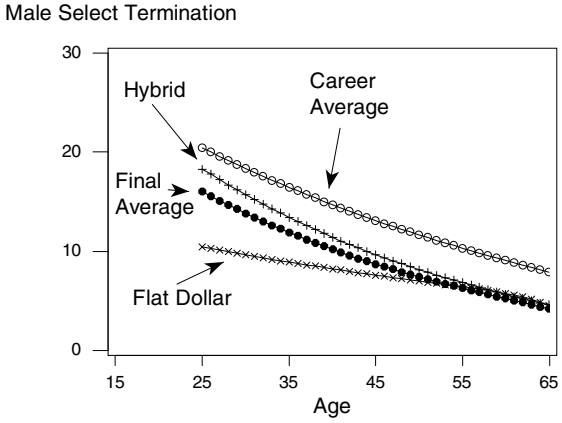
Aggregate Retirement Probabilities by Benefit Formula and Gender



Notes: Estimated probabilities are in percent. The solid circles correspond to final average, the open circles to career average, the plus symbols to hybrid and the crosses to flat dollar. The solid lines correspond to males and the dashed lines correspond to females.

Figure 14

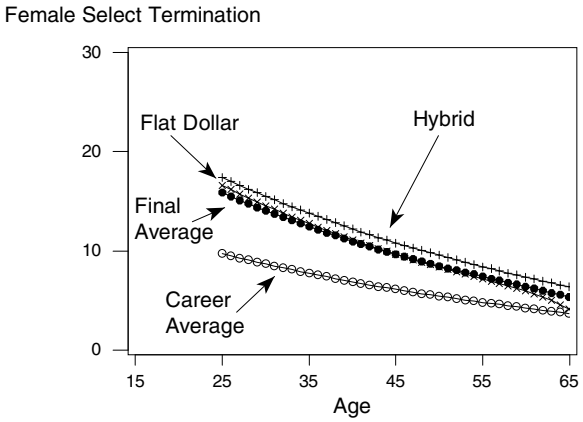
Male Select Termination Probabilities by Benefit Formula, Two to Four Years of Service



Notes: Estimated probabilities are in percent. The solid circles correspond to final average, the open circles to career average, the plus symbols to hybrid and the crosses to flat dollar.

Figure 15

Female Select Termination Probabilities by Benefit Formula, Two to Four Years of Service

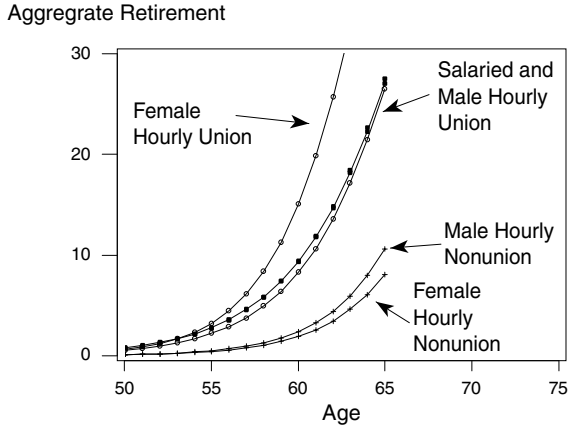


Notes: Estimated probabilities are in percent. The solid circles correspond to final average, the open circles to career average, the plus symbols to hybrid, and the crosses to flat dollar.

Appendix B.3 Analysis by Hourly/ Salary and Union Status

Figure 16

Aggregate Retirement Probabilities by Hourly/ Salary and Union Status



Notes: Estimated probabilities are in percent. The dashed lines correspond to females, the solid lines to males. For hourly union workers, females have higher retirement probabilities than males. For nonhourly and salaried workers, there is little difference between males and females.

APPENDIX C. ANALYSIS OF TERMINATION

Service by itself is not a very good predictor of retirement. Suppose instead that we are only interested in predicting termination. Which is the better predictor, service or age?

To respond to this question, we run several regression fits using termination (zero or one) as the response variable (a logistic regression). Table 6 summarizes the fit of several models. Recall that we are using −2 Log Likelihood as our goodness of fit statistic; a smaller statistic means a better fit.

Models 2–6 summarize the relationship using only one variable. From Table 6, we see that service by itself is a better predictor than either attained age or hire age. This suggests that if the actuary wishes only to use one index, then service may be preferred. We recommend caution on this interpretation because there were plan eligibility difficulties associated with collecting the data (Frees and Gilmore 2003, Section 4.2). It may be that estimated probabilities for the early service years are less reliable than the rest of the data.

Models 7–10 bring in two variables linearly and Models 11 and 12 allow for interactions between the two variables. From the summary statistics, we see that Model 11 is preferred. This model corresponds to the Table 4 select and ultimate table, using (attained) age as the continuous variable. Models 13–16 introduce gender. Overall, the best model is Model 15, corresponding to sex-distinct select and ultimate tables.

APPENDIX D. NATIONAL DATA SETS

To find additional information on important establishment-level surveys, consider:

- Current Employment Statistics (CES) available at www.bls.gov/ces/home.htm.
- National Compensation Survey (NCS) available at www.bls.gov/ncs/home.htm.
- Job Openings and Labor Turnover Survey (JOLTS) available at www.bls.gov/jlt/home.htm.

In this Appendix, we provide an overview of six U.S. data sources that are of use in understanding job mobility and turnover.

Appendix D.1 Current Population Survey (CPS)

The Current Population Survey (CPS, see www.bls.gov/cps/) is a monthly survey conducted jointly by the Census Bureau for the Bureau of Labor Statistics; it is the source of the official

Table 6
Summary of Several Logistic Model Fits Termination is the Response Variable

Model	Variables	Number of Parameters	−2 Log Likelihood	Change (from Model 15) in −2 Log Likelihood
1	Intercept only	1	1,020,745.4	70,285.7
2	Attained age	2	980,942.3	30,482.6
3	Hire age	2	1,019,202.5	68,742.8
4	Service	2	962,348.7	11,889.0
5	Hire age—categorical*	4	1,019,126.5	68,666.8
6	Service—categorical	4	962,296.7	11,837.0
7	Attained age and service, both continuous	3	954,090.3	3,630.6
8	Hire age and service, both continuous	3	954,196.6	3,736.9
9	Attained age as continuous, service as categorical	5	952,530.8	2,071.1
10	Service as continuous, hire age as categorical	5	955,231.3	4,771.6
11	Age as continuous, service as categorical, interaction terms	8	951,304.9	845.2
12	Service as continuous, hire age as categorical, interaction terms	8	953,268.3	2,808.6
13	Model 11 plus gender	9	951,018.7	559.0
14	Model 12 plus gender	9	953,040.9	2,581.2
15	Model 11 plus gender, interaction terms	16	950,459.7	0.0
16	Model 11 plus gender, interaction terms	16	952,513.3	2,053.6

*Hire age is age nearest birthday at hire date. For hire age categories, we used:
Category 1—hire age less than 30
Category 2—hire age greater than or equal to 30 and less than 40
Category 3—hire age greater than or equal to 40 and less than 50
Category 4—hire age greater than or equal to 50

government statistics on employment and unemployment. It is a nationally representative survey of approximately 60,000 households in the United States. The sample is based on the persons living in households but does not include residents of institutions (such as homes for the aged). The data are collected by personal and telephone interviews.

The primary CPS contains substantial demographic information from survey respondents. This includes age, sex, race, Hispanic origin, marital status, family relationship, education, and Vietnam-era veteran status.

Employment information includes occupation, industry, class of worker, hours of work, full- or part-time status, and reasons for working part time. Other important economic variables include occupation, union affiliation, and weekly and hourly earnings.

Employment Turnover Features

The CPS also includes unemployed persons, discouraged workers, and other persons not in the labor force. Substantial information about the unemployed is included, such as occupation, industry, class of worker of last job, duration of unemployment, reason for unemployment, and methods used to find employment.

In addition to this primary survey, there are several periodic supplements to the CPS on topics such as health, education, income, and previous work experience. The annual demographic supplement to the March CPS contains questions on the health insurance status of each person in the prior calendar year.

Another survey related to job turnover conducted by the BLS is the Displaced Worker Survey (DWS). Displaced workers are individuals with established work histories who are involuntarily separated from their jobs by mass layoff or plant closure and have little chance of being recalled to a job with their old employer. The DWS has been administered biennially beginning 1984, with the most recent survey taken in January of 2002. Each person in the primary CPS who was at least 20 years old was asked about job losses in the prior 5 years (1994 and 1996 asked about only 3 years). To illustrate, the first question asked of survey respondents was, ''During the last 3 calendar years, that is, January 1999 through December 2001, did (you/name) lose a job or leave one because: (your/his/her) plant or company closed or moved, (your/his/her) position or shift was abolished, there was insufficient work, or another similar reason?''

Appendix D.2 Survey of Consumer Finances (SCF)

The Survey of Consumer Finances (SCF, see www.federalreserve.gov/pubs/oss/oss2/scfindex.html) is a cross-sectional survey that is nationally representative. It is conducted once every three years by the National Opinion Research Center for the Federal Reserve Board (see www.norc.uchicago.edu/projects/scf/homepage.htm). In the 2001 survey, 4,449 families were interviewed.

The SCF contains information on assets, liabilities, employment history and pensions, income, and demographic characteristics. Specifically, as noted by Herz et al. (2000), respondents to cross-sectional household level surveys may not have sufficient knowledge about an employer-provided pension plan or other employee benefit, particularly when one respondent is the spokesperson for the entire household. The SCF mitigates this limitation by conducting in-depth interviews. The SCF supplements a traditional general random sample with a special random sample of wealthy households, a unique feature of the SCF.

Appendix D.3 Health and Retirement Study (HRS)

The Health and Retirement Study (HRS) is also a longitudinal survey that is nationally representative; it is a biennial survey that began in 1992.

The HRS was first conducted in 1992 with an initial sample of over 12,600 individuals from approximately 7,600 households. It is a nationally representative survey, with an oversampling of Hispanics, Blacks, and Florida residents. It is a sample of 1931–1941 birth cohorts and their spouses (regardless of age). An additional sample was added with the 1998 (fourth) wave from the 1924–1930 and 1942–1947 birth cohorts.

The HRS was designed to examine health, income, and wealth over time. It is concerned with retirement, disability, and institutionalization.

In 1998, the HRS wave was collected jointly with a companion study, the Study of Assets and Health Dynamics Among the Oldest Old

(AHEAD). The AHEAD is a longitudinal study that follows 7,447 respondents aged 70 or more in 1993, the baseline year of the study. AHEAD is concerned with the oldest old; it focuses on later life transitions and the joint dynamics among health, dementia, economic and family resources, and care arrangements.

Employment Turnover Features

The HRS features detailed information on retirement plans and perspectives, demographic background, employment status and job history, job demands and requirements, disability, income and net worth, health insurance, and pension plans. In part, this is due to the linkages to administrative files, including Social Security and surveys of employers (Juster and Suzman 1995).

In particular, the HRS is well suited for answering questions such as how pension plan decisions affect retirement decisions. The questions provide detailed characteristics of both defined benefit and defined contribution plans, with information on early retirement possibilities and incentives.

Appendix D.4 Survey of Income and Program Participation (SIPP)

The Survey of Income and Program Participation (SIPP, see www.sipp.census.gov/sipp/) is a longitudinal survey that is nationally representative and conducted by the Census Bureau. Household, family, and person level information is collected for each of the previous four months on income, labor force activity, program participation (such as AFDC, Food Stamps, and Medicaid), and health insurance status. The value of the SIPP is that it allows analysts to examine dynamic aspects.

The SIPP began in 1984 with a sample of approximately 20,000 households. Households for the 1984 panel were interviewed every four months for two and a half years. Each group of interviews is known as a ''wave,'' so that the 1984 panel was comprised of eight waves.

Subsequently, from 1985–1993, a new panel was selected, with sample sizes of approximately 20,000 households. Each panel was interviewed in three to eight waves. Thus, there was overlap in the interviewing among different panels. In 1996, the SIPP was redesigned to have fewer panels and larger sample sizes, panels followed over longer time periods and to have non-overlapping waves. The 1996 panel had an initial sample size of approximately 40,000 and was followed over four years. The 2000 panel was introduced in February 2000 for two waves. A three-year 2001 panel was introduced in February 2001 consisting of 36,700 households.

Although the SIPP design allows for both longitudinal and cross-sectional data analysis, SIPP is meant primarily to support longitudinal studies. The SIPP's longitudinal features allow the analysis of selected dynamic characteristics of the population, such as changes in income, eligibility for and participation in transfer programs, household and family composition, labor force behavior, and other associated events.

Employment Turnover Features

In contrast to the CPS, the SIPP provides tenure information on respondents who are not employed at the time of the interview.

Appendix D.5 Panel Survey of Income Dynamics (PSID)

The Panel Survey of Income Dynamics (PSID, see psidonline.isr.umich.edu/), conducted by the National Science Foundation, is also a longitudinal survey that is nationally representative; it is an annual survey that began in 1968.

The original focus of the study was on the dynamics of poverty so that the 1968 sample included a disproportionately large number of low-income households. The oversampling of poor families in the late 1960s resulted in a sizable subsample of blacks. Probability-of-selection weights enable analysts to make estimates from the sample that are representative of the non-immigrant U.S. population.

The PSID began with a sample of approximately 4,800 U.S. households in 1968. Since that time, the PSID has traced individuals from those households, whether or not they are living in the same dwelling or with the same people. Adults have been followed as they have grown older, and children have been observed as they advance through childhood and into adulthood, forming families of their own. Each year, information is collected about the PSID's sample members (members of

the PSID's 1968 sample families or their offspring) and their current coresidents (spouses, cohabitors, children, and others living with them), even if those coresidents were not part of original-sample families.

Employment Turnover Features

Gottshcalk and Moffitt (1999) identify a separation in the PSID if the ''months with current employer'' at the time of the interview is less than the difference between interview dates. An alternative includes using responses to the questions regarding ''months in current position.''

The primary advantage of the PSID is that it covers a sufficiently long period to track long-term changes in turnover. However, as pointed out by Gottschalk and Moffitt (1999):

- the tenure questions have changed over time
- answers to tenure questions may be inconsistent (some time relative job tenure responses exceed the length of the interview time)
- questions are asked of only household heads and wives (a disadvantage for studying turnover for younger workers)
- job tenure questions are not asked of the self-employed
- the PSID does not differentiate between first and second jobs (for persons holding multiple jobs).

Appendix D.6 National Longitudinal Surveys

The National Longitudinal Surveys (NLS) are conducted by the Bureau of Labor Statistics (www.bls.gov/nls/). These are nationally representative surveys designed to follow distinct labor markets:

- 5,083 mature women (between 30 and 44 in 1967),
- 5,159 young women (between 14 and 21 in 1968), and
- 12,686 youths (between 14 and 24 in 1979, additional cohorts were added in 1986 and 1997).

Surveys of young men and older men were also conducted for many years but have since been discontinued.

Although these surveys have relatively small sample sizes, the amount of information about each survey respondent is extensive. The list of variables is in the thousands, with an emphasis on the supply side of the labor market. In particular, the data include current labor force status, that is, activity during most of the survey week (employed, unemployed, out of the labor force) as well as for those employed, job characteristics, job satisfaction, and hours worked per week for the current/most recent job. Compared to other surveys such as HRS, less information is available about the employer.

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