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3 The Military Pension, Compensation, and Retirement of U.S. Air Force Pilots

John Ausink and David A. Wise

Econometric models of job exit are of interest for at least two reasons. There has been a significant decline in the civilian labor force participation of older Americans for the past twenty years (Wise 1985). During the same period, private pension coverage has increased markedly, and Social Security benefits have risen. The study of relationships between the two trends is of interest to economists attempting to explain the incentives that pension plans may provide in encouraging workers to change jobs or stop working, and is also important to firms who may want to affect employee retirement behavior by changing the provisions of their pension plans.

In the military, there is a slightly different perspective. The armed forces must maintain adequate numbers of trained and experienced personnel without the realistic possibility of lateral job entry to replace losses. A shortage of experienced military pilots cannot be eliminated by hiring pilots from another military, for example. The absence of this remedy for the loss of personnel means that shortfalls in any cohort are difficult to correct, and the potential incentive effects of changes in compensation must be considered before they are made.

Both the civilian trend and the military problem are sufficient to have encouraged extensive research. The military, through research at the RAND Corporation, the Center for Naval Analyses, and the Pentagon, has been refining models of military retirement since 1975. Indeed, Baldwin (Baldwin and

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Daula 1985) states that the economics of military manpower emerged as a branch of defense economics with the end of the draft.

In this paper, we use the option value model of retirement behavior developed by Stock and Wise (1990) to examine the effects of changes in compensation on the decision of Air Force pilots to leave the military. Section 3.1 provides background information. We start with a brief discussion of the problem of pilot retention in the Air Force and the compensation changes that have been suggested to solve it. Because a large part of career military compensation is in the form of pension benefits, we discuss the value of these benefits. In section 3.2, after a description of the data used in this study, we describe the option value model and highlight how it differs from other models that have been used to study this topic. Section 3.3 presents graphical displays of the predictive accuracy of the option value model and compares these to the accuracy of competing models. Of particular interest is that the option value model, which can be viewed as a simplified dynamic programming specification, predicts complicated military retirement patterns much better than the dynamic programming formulation to which it is compared. The effects on the distribution of the pilot population (by years of service) of selected changes in compensation are discussed in section 3.3.2.

3.1 Background

3.1.1 Pilot Compensation

Military pilots have received extra pay ever since the Army Appropriation Act of 2 March 1913, which provided an increase of 35% in pay and allowances for Army officers flying heavier-than-air craft. According to Bartholomew (1982, 93), the pay was strictly to compensate pilots for the extremely hazardous duty they were undertaking. The Career Compensation Act of 1949 initiated a change in philosophy for the special pay, saying "the incentive to engage and remain in hazardous occupations provided a more realistic and practical basis for determining the rates of special pay than the theory of recompense for shorter career expectancy. The recompense or replacement concept, although promoted for many years as the sole argument for hazard pay, was found wanting for several reasons" (Bartholomew 1982, 94). In other words, instead of trying to make their shorter lives happier because of higher pay, the government should pay pilots enough to make them prefer employment in the military to employment in civilian positions. The incentive pay structure adopted by the Career Compensation Act provided extra pay that depended only on the rank of the member who was flying.

By 1955, the services were having difficulty recruiting pilots and retaining younger pilots who had completed their service obligation, and the incentive pay system was changed so that flight pay depended not only on grade, but on years of service.

Another change in philosophy occurred in 1974, when Congress decided that flight pay should be more than compensation for actual flying duties. Instead, because of the large investment made by the military in the training of its pilots, it was felt that extra pay should be structured so that a pilot has the incentive to remain in the service for a full career. The Aviation Career Incentive Pay (ACIP) Act was an effort to do this.

As the 1980s drew to a close, it became apparent that ACIP was no longer sufficient to retain enough pilots to meet projected defense needs. According to the 17 January 1989 Report of the Secretary of Defense, the armed forces were losing one experienced fighter pilot per day in 1988, and this represented a cost of more than $2.5 million to the government (Department of Defense 1988, 103). The DoD annual report for 1989 echoes the concern that high pilot losses jeopardized combat readiness of the armed forces (Department of Defense 1989a, 125). Assuming the low 1989 retention rates continued from 1991 to 1994, the Air Force predicted that "shortfalls" of pilots in the groups with one to fourteen years of service would rise from 895 in fiscal year 1989 to over 2,100 in 1994 (Department of Defense 1988, 6-24).

The major reason for the loss of pilots is increased hiring by commercial airlines. A surge of pilot hiring in the 1960s, which translated into a large retirement rate of commercial pilots in the 1990s, has led to another surge of hiring. According to the Department of Defense, 37% of the commercial jet pilot force (approximately forty-three thousand) will need to be replaced in the 1990s (Department of Defense 1988, 2-5). Despite turmoil in the airline industry because of the Persian Gulf crisis in 1990, many major airlines continued the aggressive hiring practices that contributed to the fact that, for the third year in a row, Air Force pilot losses exceeded production by more than eight hundred.

The desire of military pilots to leave the service to fly for commercial airlines is understandable when potential earnings are considered. For example, a married Air Force pilot with eight years of service in 1989 would be earning slightly more than $45,000 annually, and could look forward to making over $61,000 per year (using 1989 pay tables) by the time he or she reached twenty years of service. If this same pilot left the Air Force after eight years of service and landed a job with a major airline, annual salary could be well over $100,000 after ten years. (These figures are based on table 2-4 of Department of Defense 1988.)

According to the *Department of Defense Aviator Retention Study*, "When faced with the choice between an 'average' private sector job and a military flying career, the military career competes favorably with its challenging jobs, security, job satisfaction, and opportunities for travel, advanced education, and service to country. The evidence is overwhelming, however, that lucrative airline pilot careers, when readily available, are preferred and account for the majority of military pilot separations" (Department of Defense 1988, 2-8).

With continuing Navy pilot shortages and increasing losses of Air Force pilots, Congress authorized a new bonus program in 1988 called Aviator Continuation Pay (ACP). In the Air Force, this program provides bonuses that depend on the pilot's years of service and require that the pilot agree to serve for a total of fourteen years in order to receive the money. For example, a pilot with six years of service can receive an annual bonus of $12,000 by agreeing to remain in the service until completing fourteen years of service; the bonus will not be received without incurring the obligation. The size of the bonus decreases with seniority, until a pilot who has completed twelve years of service will be offered $6,500 per year to remain through fourteen years of service (Bowman 1990). In 1989, the cost of this program from fiscal year 1990 through fiscal year 1994 was anticipated to be approximately $94 million.

While the added compensation from ACP and ACIP is substantial, the advantage of remaining in the military long enough to earn retirement benefits (benefits that are available to pilots and nonpilots alike) must also be considered. Compared to most civilian pension plans, the military pension is simple to calculate and extremely generous, although it does have the disadvantage, from the military member's point of view, of having cliff vesting (with a vengeance): pension benefits are not available until a person serves for twenty years; anyone who leaves the military before twenty years of service receives no pension benefits.

3.1.2 The Military Pension

The structure of the military pension system has remained relatively unchanged since 1916, when an act of Congress (Public Law 64-241, *U.S. Statutes at Large* 39 [1916]: 579) established the formula that retired pay would equal 2.5% of monthly pay per year of service up to a maximum of 75% at thirty years of service (Bartholomew 1982, 235). Most changes since then have dealt with the nature of cost of living adjustments (COLAs) that are part of the pension, what type of pay is used for the calculation of the benefit, and when retirement is authorized. Probably the most complicated aspect of the pension now is the fact that, depending on when individuals entered the service, they may be covered by one of three different plans. Table 3.1 describes the differences among them, and which military members are affected by them. Using 1988 pay tables, a typical lieutenant colonel retiring after twenty years of service would have an annual pension of approximately $22,152 under the first plan, $21,000 under the second, and $17,000 under the third. The DoD estimates that the present values of the pension benefits at the time of retirement would be $595,000, $553,000, and $445,000, respectively.

3.2 The Data and Models

3.2.1 The Sample

The Air Force maintains the Longitudinal Cohort File, a file of information on Air Force personnel that is updated in October every year and includes data

Table 3.1 **Characteristics of Current Retirement System**

Date of Entry	Calculation of Benefit	Cost of Living Adjustment
Before 8 Sept. 1980	After 20 years of service, 50% of final basic pay. Benefit increases 2.5% for each additional year served, up to 75%.	Annual COLA to match inflation.
Between 8 Sept. 1980 and 1 Aug. 1986	After 20 years of service, 50% of the average basic pay of the highest 3 earnings years. Benefit increases 2.5% for each additional year served, up to 75%.	Annual COLA to match inflation.
After 1 Aug. 1986	After 20 years of service, 40% of the average basic pay of the highest 3 earnings years. Benefit increases 3.5% for each additional year served, up to 75%.	Annual COLA 1% below consumer price index (CPI) until age 62. At age 62, pension is recalculated to be what it would have been if entry was before 8 Sept. 1980. After age 62, annual COLA is again 1% below CPI.

Source: Information is from Air Force Regulation 35-7, chap. 7.

from 1974 to 1991. From this file, the Air Force Military Personnel Center (AFMPC) produced a random sample of five thousand male pilots who in 1987 had completed between six and twenty-seven years of commissioned service. Individuals who had served as enlisted personnel before being commissioned as officers were excluded from the sample, because historically, departure patterns for those with prior service have been different from those of officers without prior service.

Officers in the file are recorded as being present or not present in the Air Force when the file is updated annually. We have no record of actual employment after leaving the Air Force, but we assume that departures are voluntary and that the decision to leave is made based on a comparison of future compensation from the military to potential compensation from a civilian airline position. The file lists the Air Force Command to which the pilot belongs, and the model parameter estimates in this paper are based on the 1,803 officers who were in the Strategic Air Command (SAC) or Military Airlift Command (MAC). Pilots in these two commands had fairly similar departure rates from 1987 to 1989, and the "heavy" aircraft flown in these commands require skills similar to those needed in civilian airline positions. For the purposes of calculating income, the first full year of civilian pay or pension receipt was considered to be the year after an individual was recorded as not present. For example, a pilot present in 1987 but absent in 1988 receives the first full year of civilian pay (and pension benefits, if entitled to them) in 1989.

3.2.2 The Option Value Model

Following Stock and Wise (1990), in any given year s, an Air Force pilot may expect to earn Y_s dollars in the Air Force and, if he or she leaves the military, a salary C_s in a new civilian job plus any retirement benefits B_s that have been earned as a result of military service. If we say that the individual indirectly derives utility $U_M(s)$ from military income in year s and utility $U_C(s)$ from civilian employment plus military pension benefits, we can develop an expression for the utility of working until different times in the future. Suppose that no one lives beyond year T, that individuals discount future earnings by a factor β, and that r is the first year in which civilian earnings and/or retirement benefits are received. For an individual in year t considering being out of the Air Force in year r, the value of that decision is

$$V_t(r) = \sum_{s=t}^{r-1} \beta^{s-t} U_M(s) + \sum_{s=r}^{T} \beta^{s-t} U_C(s), \tag{1}$$

that is, the discounted sum of the utility of working in the Air Force from now until year $r - 1$ plus the discounted sum of the utility of working elsewhere and receiving pension benefits (if any) from year r until death.

Similarly, the value of leaving the Air Force now, in year t, is

$$V_t(t) = \sum_{s=t}^{T} \beta^{s-t} U_C(s). \tag{2}$$

The expected gain in utility from delaying departure until year r is given by

$$G_t(r) = E_t V_t(r) - E_t V_t(t). \tag{3}$$

It will be to the person's advantage to delay the decision to leave the military until year r if the expected gain in utility is greater than zero. We will assume that an individual will leave the Air Force if, when considering all future departure dates, the maximum gain possible is less than or equal to zero, that is, if $G_t(r^*) \leqq 0$, where r^* is the potential departure year with the maximum gain.

Assume that an individual's utility has a constant relative risk aversion form.

$$U_M(s) = Y_s^{\gamma} + \omega_s \quad \text{and} \quad U_C(s) = (C_s(r) + kB_s(r))^{\gamma} + \xi_s \tag{4}$$

The potential civilian income $C_s(r)$ may, and the retirement benefits $B_s(r)$ will, depend on the year r that the individual is first in a civilian position, and so they are shown as functions of the departure year. Additionally, the coefficient k is introduced to account for the possibility that a person may value military pension earnings differently than earnings that require labor. The error terms are meant to capture unobserved determinants of departure. For example, they could reflect individual preferences for work versus leisure. They could also account for differing tastes for military life, variable tax filing status that will change the effect of nontaxable portions of military income, differing assessments of potential for military advancement, and variable unobserved wealth. For a given individual in the military, there should be considerable persistence in these random effects over time, and so the error terms are assumed to follow a first-order Markov process.

$$\omega_s = \rho\omega_{s-1} + \varepsilon_{\omega s} \qquad E_{s-1}(\varepsilon_{\omega s}) = 0 \tag{5}$$

$$\xi_s = \rho\xi_{s-1} + \varepsilon_{\xi s} \qquad E_{s-1}(\varepsilon_{\xi s}) = 0$$

At time t, the individual knows both ω and ξ, but not the values that evolve over time. With these specifications, the expected gain from postponing departure until year r can be written

$$\begin{aligned} G_t(r) &= \sum_{s=t}^{r-1}\beta^{s-t}E_t(Y_s^\gamma + \omega_s) + \sum_{s=r}^{T}\beta^{s-t}E_t[(C_s(r) + kB_s(r))^\gamma + \xi_s] \\ &\quad - \sum_{s=t}^{T}\beta^{s-t}E_t[(C_s(t) + kB_s(t))^\gamma + \xi_s] \qquad (6) \\ &= g_t(r) + \phi_t(r). \end{aligned}$$

The function ϕ contains the random effects, and the function g contains the rest. We must also take into account the likelihood that an individual will survive to receive the earnings anticipated. If we let $\pi(s \mid t)$ represent the probability that a person will be alive in year s given he or she is alive in year t, and assume this probability is independent of the individual error effects, the functions $g_t(r)$ and $\phi_t(r)$ become

$$\begin{aligned} (7) \quad g_t(r) &= \sum_{s=t}^{r-1}\beta^{s-t}\pi(s \mid t)E_t(Y_s^\gamma) + \sum_{s=r}^{T}\beta^{s-t}\pi(s \mid t)E_t[(C_s(r) + kB_s(r))^\gamma] \\ &\quad - \sum_{s=t}^{T}\beta^{s-t}\pi(s \mid t)E_t[(C_s(t) + kB_s(t))^\gamma] \end{aligned}$$

and

$$\phi_t(r) = \sum_{s=t}^{r-1}\beta^{s-t}\pi(s \mid t)E_t(\omega_s - \xi_s).$$

Under the Markov assumption for the individual specific errors, the expectation at time t can be written $E_t(\omega_s) = \rho^{s-t}\omega_t$ and $E_t(\xi_s) = \rho^{s-t}\xi_t$, and so the function ϕ takes the form

$$(8) \qquad \phi_t(r) = \sum_{s=t}^{r-1}\beta^{s-t}\pi(s \mid t)\rho^{s-t}(\omega_t - \xi_t) = K_t(r)\nu_t,$$

where

$$K_t(r) = \sum_{s=t}^{r-1}\beta^{s-t}\pi(s \mid t)\rho^{s-t} \quad \text{and} \quad \nu_t = \omega_t - \xi_t.$$

The term $K_t(r)$ cumulates the deflators that yield the present value in year t of the future expected values of the random components of utility. The further r is in the future, the larger is $K_t(r)$. That is, the more distant the potential retirement age, the greater the uncertainty about it, yielding a heteroskedastic disturbance term. Finally, then, the expected gain in year t from postponing departure from the Air Force until year r is

$$G_t(r) = g_t(r) + K_t(r)\nu_t. \tag{9}$$

If we let R be a random variable representing the year of departure, the probability that an individual will be gone in year t is given by

$$\begin{aligned} Pr[R = t] &= Pr[G_t(r) \leq 0] \\ &= Pr[g_t(r) + K_t(r)\nu_t \leq 0] \\ &= Pr\left[\frac{g_t(r)}{K_t(r)}\right] \leq -\nu_t \qquad \forall\ r \in [t+1, \ldots, T] \\ &= Pr\left[\frac{g_t(r^*)}{K_t(r^*)}\right] \leq -\nu_t, \end{aligned} \tag{10}$$

where r^* is the future year that gives the largest value for the gain from remaining in the Air Force.[1]

3.2.3 Other Models

An alternative model has been used by the military for some time to study retirement behavior, and we compare the predictive validity of that model with the option value model discussed above. It is also of interest to consider how the option value model compares with a more complex stochastic dynamic programming model. Lumsdaine, Stock, and Wise (1992) have done this for civilian employees. The cumulating evidence from their work suggests that the more economically accurate stochastic dynamic programming model does no better than the simpler option value model at approximating the actual decisions of employees. The military pension structure offers a particularly good test of the predictive validity of these models, and we present such comparisons in this paper. We describe a popular DoD model and a dynamic programming model.

The Annualized Cost of Leaving Model

The annualized cost of leaving (ACOL) model was developed by John T. Warner (1979) and was the analytical basis for the *Fifth Quadrennial Review of Military Compensation*'s study of changes in the military pension system (Department of Defense 1984). It is used frequently enough by the Air Force Personnel Analysis Center to have been incorporated in an interactive computer program called the Compensation Model for determining the effects of various changes in compensation policies (Norris 1987). The *Department of Defense Aviator Retention Study* (1988) and the Congressional Budget Office (1989) also relied on the model, either directly or indirectly, to predict the effects of the 1989 pilot bonus program.

1. The analysis presented in this paper is based on retirement decisions in a single year. Stock and Wise (1990) describe an extension of the model to accommodate repeated observation for the same person over time. Estimates based on more than one consecutive year are presented in Ausink (1991), and the results are virtually the same as those presented here.

The description here is intended to bring out the relationship between the ACOL and the option value models. Assume that individuals are risk neutral ($\gamma = 1$), that military compensation and pension benefits are valued the same (the k in the option value model is one), and that individuals have unobserved random taste Γ for military employment. In year s, the utilities associated with Air Force work and with civilian employment are then

$$U_M(s) = Y_s + \Gamma \quad \text{and} \quad U_C(s) = C_s(r) + B_s(r). \tag{11}$$

In year t, the expected value of beginning civilian employment in year r is

$$V_t(r) = \sum_{s=t}^{r-1} \beta^{s-t}\pi(s \mid t)(Y_s + \Gamma) + \sum_{s=r}^{T} \beta^{s-t}\pi(s \mid t)(C_s(r) + B_s(r)), \tag{12}$$

and the value of leaving the Air Force for a new job now is

$$V_t(t) = \sum_{s=t}^{T} \beta^{s-t}\pi(s \mid t)(C_s(t) + B_s(t)). \tag{13}$$

In year t, the cost of leaving instead of remaining until year r, $COL_t(r)$, is the benefit forgone by making the decision to leave in year t,

$$\begin{aligned} COL_t(r) &= V_t(r) - V_t(t) \\ &= \sum_{s=t}^{r-1} \beta^{s-t}\pi(s \mid t)Y_s + \sum_{s=r}^{T} \beta^{s-t}\pi(s \mid t)(C_s(r) + B_s(r)) \\ &\quad + \Gamma\sum_{s=t}^{r-1} \beta^{s-t}\pi(s \mid t). \end{aligned} \tag{14}$$

This description has the same form as equation 9, $G_t(r) = g_t(r) + K_t(r)\nu_t$, in the option value model, with the random taste term replacing the Markov error structure.

A person retires if, when considering all future departure dates, the maximum of

$$ACOL_t(r) = \left[\sum_{s=t}^{r-1} \beta^{s-t}\pi(s \mid t)\right]^{-1} \left[\sum_{s=t}^{r-1} \beta^{s-t}\pi(s \mid t)Y_s + \sum_{s=t}^{r-1} \beta^{s-t}\pi(s \mid t)(C_s(r) + B_s(r))\right] + \Gamma \tag{15}$$

is less than zero,[2] or if $ACOL_t(r^*) = g_t(r^*)/K_t(r^*) + \Gamma < 0$, using the option value definitions (equation 10).

In practice, the model is estimated using the logit formulation

$$y = \alpha_0 + \alpha_1 ACOL^* + \varepsilon \tag{16}$$

with $ACOL^*$ calculated based on an assumed discount rate.[3]

2. This term is also equal to the annualized cost of leaving, which gives rise to the model name.
3. This is similar to a probit specification used in Lumsdaine, Stock, and Wise (1992), comparing the predictive validity of more and less complex models.

A Stochastic Dynamic Programming Specification

We use the stochastic dynamic programming specification used by Lumsdaine, Stock, and Wise (1992), which is a variant of the model proposed by Daula and Moffitt (1989) to study Army enlisted behavior, which is in turn a variant of the Gotz and McCall (1984) dynamic programming model of retention behavior for Air Force officers. When estimating retirement in one period, the Gotz-McCall model is the same as the Daula-Moffitt model.

The main conceptual difference between the option value model and the dynamic programming approach is that in the option value model an individual compares the utility of leaving the military now with the maximum value of expected future utilities. In the dynamic programming models, the decision is based on the expected value of the maximum of current versus future options. An example will help clarify the difference.

For Air Force officers, retirement is mandatory (with few exceptions) after thirty years of service. After the twenty-ninth year of service, the separation decision is thus based on comparing the utility of leaving with the utility of serving one more year and retiring after thirty years of service. At this point, the decision rule for the option value model and the dynamic retention model are the same: the option value model decision maker compares the expected value of retiring with the expected value of working one more year and then retiring, and makes the choice with the maximum value. The dynamic decision maker does the same thing, and we will call the value of this decision W_{29}.

After twenty-eight years of service, the decision rules are different. The option value decision maker compares the expected values of separating after twenty-eight, twenty-nine, and thirty years of service, and makes the decision based on the maximum of these. The dynamic programming rule has the decision maker comparing the value of leaving after twenty-eight years of service with the value of serving one more year and then making decision W_{29}. Since in year twenty-eight the actual circumstances of the twenty-ninth year are not known, the decision is based on the expected value of W_{29}, which is the maximum of two random variables. For any year $t < 28$, an individual can in theory calculate recursively the value of remaining in the service and receiving W_{t+1} from future "correct" decisions.

Again, analogous to the option value specification, assume that an individual's utility from Air Force employment in year s is

$$U_M(s) = Y_s^\gamma + \Gamma + \varepsilon_{1s}, \tag{17}$$

and utility from leaving for a new job is

$$U_C(s) = [C_s(r) + kB_s(r)]^\gamma + \varepsilon_{2s}. \tag{18}$$

The term Γ is a random additive taste for military employment, and is assumed to be distributed as $N(0, \lambda^2)$. If $\lambda = 0$, as we will assume in this paper, there is no random taste factor. The disturbance terms are random perturbations to the utilities in a given year of service, and are assumed to be known to the individual at time t. Unlike the option value errors, these are assumed to be independent over time. The estimation procedure is described in the appendix.

3.3 Results

3.3.1 Parameter Estimates and Comparisons

Table 3.2 shows the utility function parameters obtained for the three models of retirement behavior. An easy way to compare the results of the three models is to graph the actual and predicted voluntary loss rates for the pilot population under consideration.[4]

Figure 3.1a shows the actual and option value predicted 1988 voluntary loss rates of pilots in the sample. Figure 3.1b shows the implied cumulative voluntary loss rates. Both panels include a 95% confidence interval around the actual rates.

The option value model predictions fall outside the 95% confidence interval only at seven, eight, nine, and twenty-three years of service. The model underestimates the departure rates at seven and eight years of service; pilots in these years are just completing their initial service obligations for pilot training, and many may be leaving because they realize that military flying is not to their liking. A difference in the characteristics of the pilot population still within a year or two of completion of the initial service obligation and the population that remains after the initial obligation would help explain the inability of the model to pick up the large initial departures.

Promotion to the rank of major occurs sometime after the eleven-year point in an officer's career. Those who accept promotion are obligated to remain in the service for two more years; those who refuse promotion will leave, and those who do not receive the promotion may decide to leave rather than try for promotion at a later date. The jump in actual departures at the twelve-year point seems to be a result of those who are leaving after not accepting (or not receiving) the promotion to major. The model may not pick up this increase because the decision made here involves nonpecuniary factors such as lack of desire to be committed beyond twelve years of service.

It is striking that the model captures rather well the wide jumps in departure rates between twenty and twenty-eight years of service.

By way of comparison, figures 3.2 and 3.3 show the predicted voluntary loss rates using the dynamic programming and ACOL models. Although the dynamic programming formulation matches the data about as well as the op-

4. The voluntary loss rate in year t is the percentage of pilots without any service obligation in year t who are not present in year $t + 1$.

Table 3.2 Parameter Estimate Summary

	Option Value Model		Dynamic Programming Model		
Parameter	(1)	(2)	(1)	(2)	ACOL
γ	1[a]	1.82	1[a]	1.81	
k	3.32	3.28	1.59	1.44	
	(.032)	(.020)	(.238)	(.184)	
ρ	1[a]	1[a]	—	—	
β	.948	.896	.852	.852	
	(.005)	(.006)	(.012)	(.012)	
σ[b]	.893	.754	.413	1.39	
	(.012)	(.028)	(.031)	(.351)	
α_0					.669
					(.075)
α_1					5.01
					(.007)
Summary statistics					
−log likelihood	505.9	496.4	509.3	501.1	529.9
χ^2[c]	50.9	29.3	72.3	52.7	70.0

Notes: Estimation is by maximum likelihood. Numbers in parentheses are asymptotic standard errors. Monetary values are in $100,000 (1986 dollars).

[a]Parameter fixed.

[b]Note that σ for option value model and dynamic programming model are not comparable.

[c]For the above table, the χ^2 goodness-of-fit statistic is calculated as

$$\chi^2 = \sum_{j=7}^{j=28} n_j \frac{(r_{aj} - r_{pj})^2}{r_{pj}},$$

where r_{aj} is the actual departure rate for those with j years of service, r_{pj} is the predicted departure rate for those with j years of service, and n_j is the number of individuals who have completed j years of service.

tion value for persons with less than twenty years of service, it underpredicts the large increase in departures at twenty years, and is much less successful at following retirement patterns after twenty years of service. The ACOL model substantially overpredicts loss rates in the early years of service, does not pick up the large increase in departures after twenty years of service, and does not follow at all the pattern of changes in departure rates after twenty years of service.

We have two "out-of-sample" tests of the predictive power of the models investigated here. The first uses the parameters for the MAC and SAC pilots to predict the loss rates for Tactical Airlift Command (TAC) pilots in the initial sample; the second uses the 1988 parameters to predict 1989 SAC and MAC loss rates after the introduction of ACP.

Figure 3.4a compares the actual voluntary loss rates of TAC pilots in 1988 with the predicted rates using the option value and dynamic programming

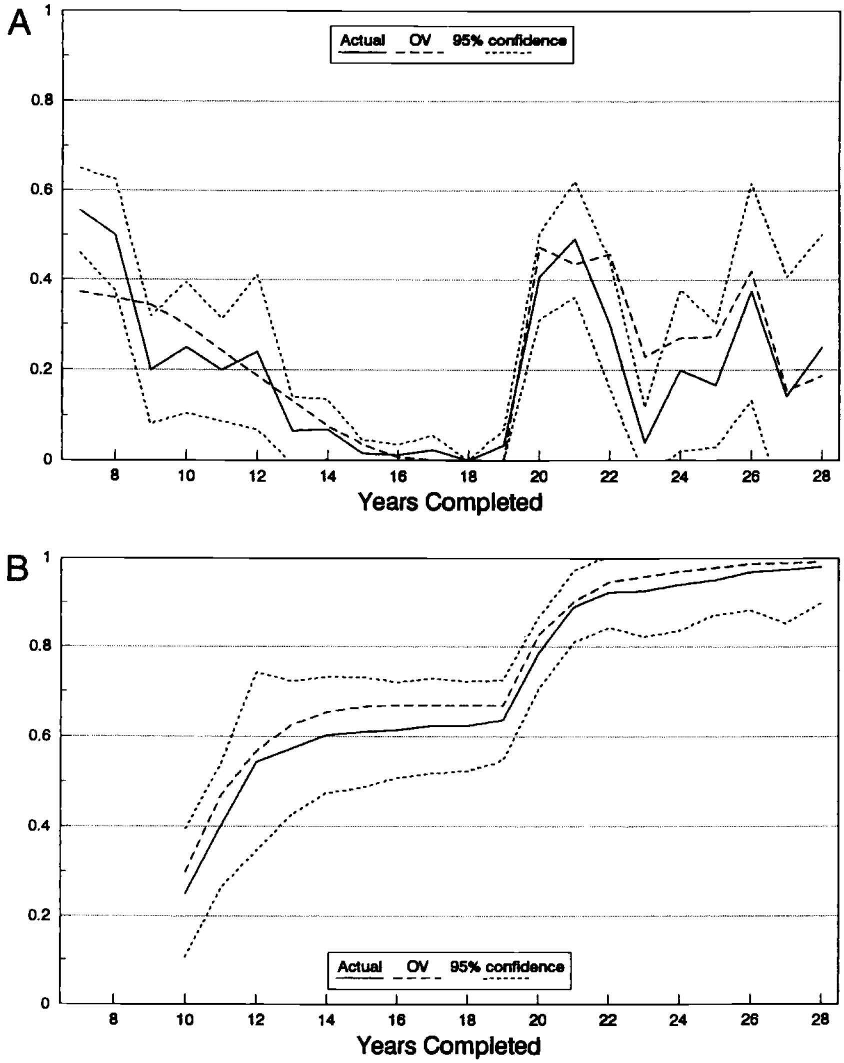


Fig. 3.1 Actual and predicted 1988 voluntary loss rates, option value model

models. Figure 3.4b compares the predictions of the option value and ACOL models. As with the in-sample comparisons, the option value and dynamic programming models yield very similar predictions before twenty years of service, but after twenty years of service the option value model follows the actual departure pattern much better than does the dynamic programming model. The ACOL model predictions are much worse than the other two.

Figures 3.5 and 3.6 compare the predicted 1989 departure rates using 1988

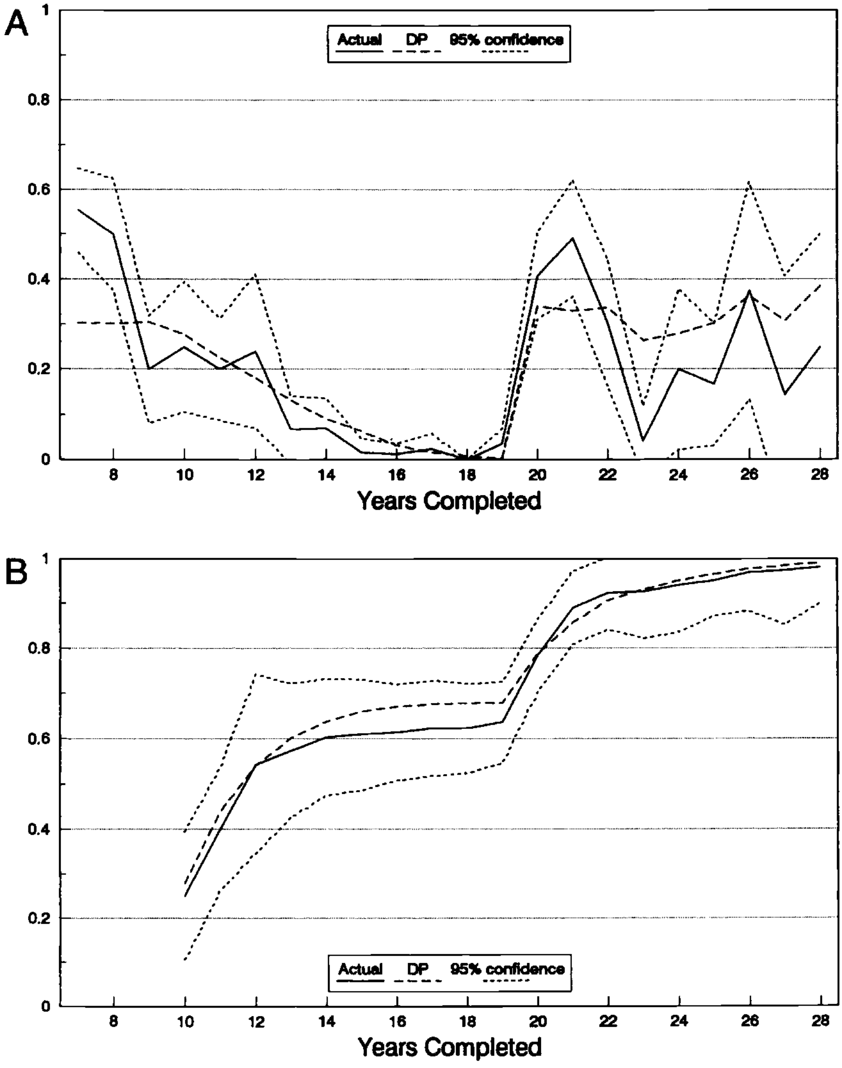


Fig. 3.2 Actual and predicted 1988 voluntary loss rates, dynamic programming model

parameter estimates. The top graph in each figure shows the option value model predictions (both with and without the introduction of the bonus). Again, the option value and dynamic programming models are very similar until the twenty-year point, after which the option value predictions are much closer to the actual departure rates. The ACOL predictions are the farthest from the actual rates. In addition, the ACOL model predicts a much larger reduction

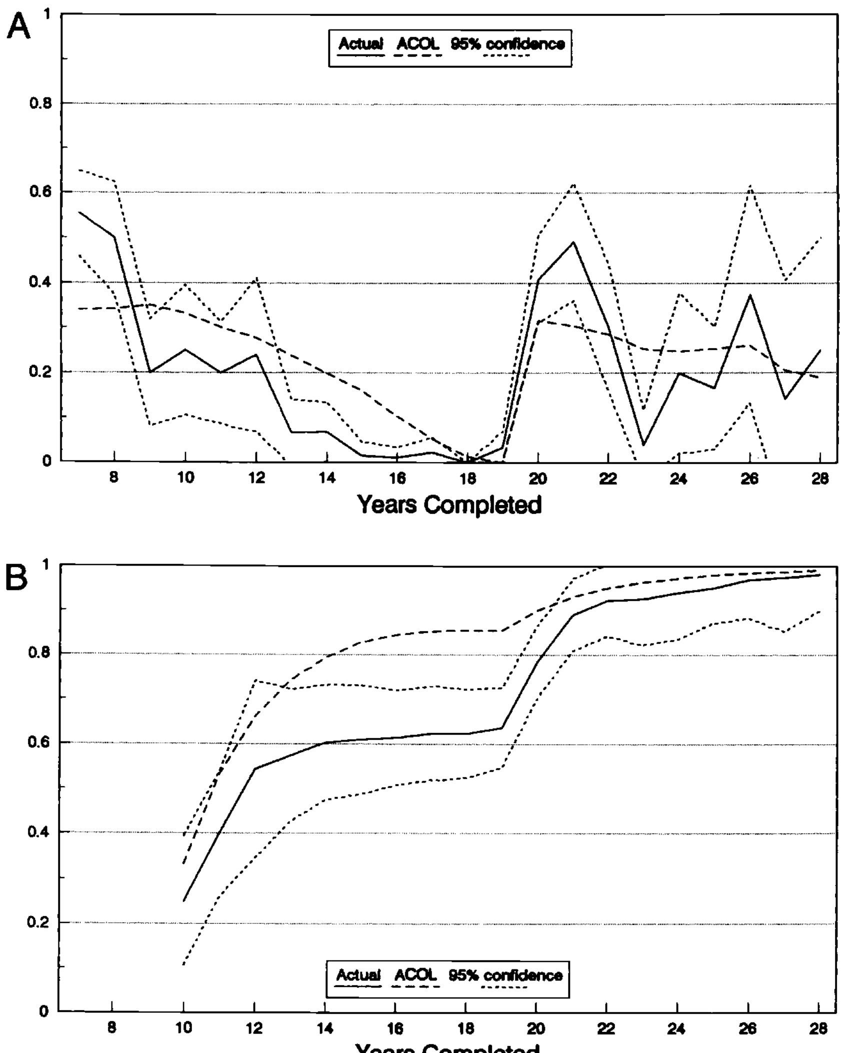


Fig. 3.3 Actual and predicted 1988 voluntary loss rates, ACOL model

in departure rates as a result of the bonus payments than does either the option value or the dynamic programming model.[5]

5. The introduction of ACP did not produce the desired reduction in pilot losses. The Air Force view is that those who accepted the bonus were planning to remain in the service anyway. However, the bonus is not viewed as a failure. Those who accept the bonus incur a service commitment, and so Air Force personnel planners know which pilots will not be able to leave the military in future years.

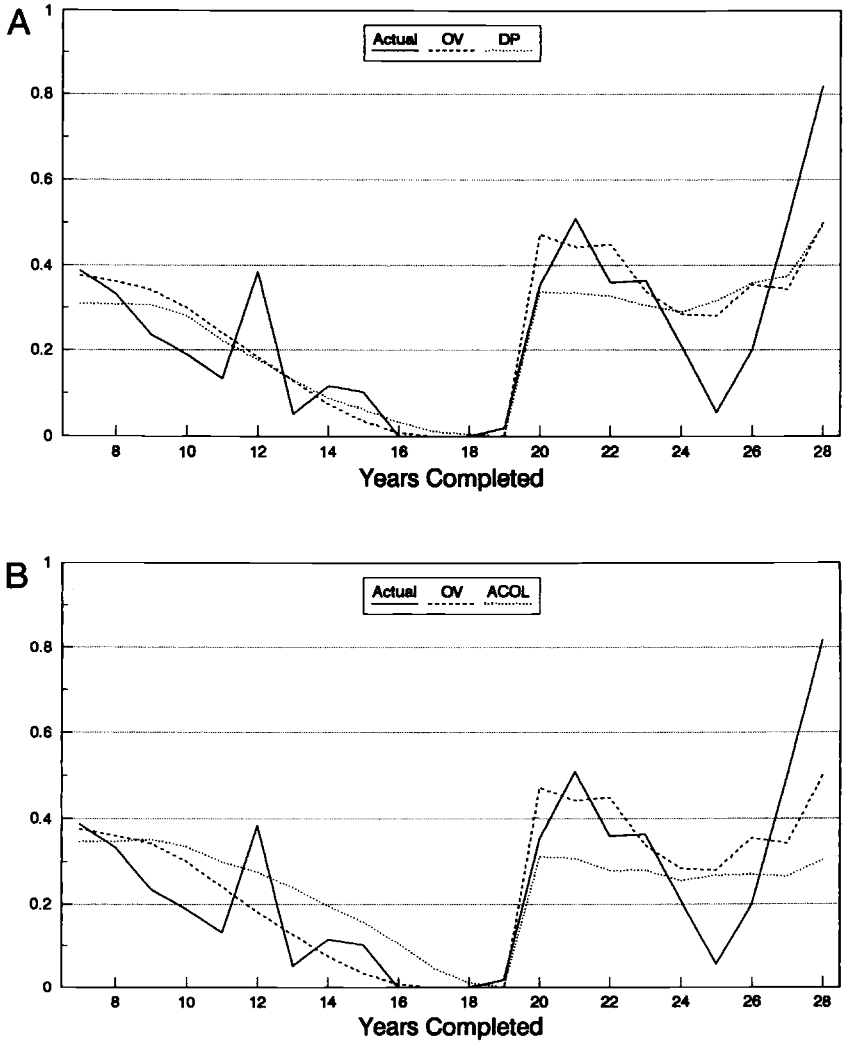


Fig. 3.4 TAC voluntary loss rate comparisons: *a,* option value and dynamic programming models; *b,* option value and ACOL models

The importance of the improved predictive capability of the option value model from a policy perspective is apparent in figure 3.7. The figure compares the potential effects of the 1986 change in the military pension predicted by the option value model to those predicted by the ACOL model.[6] Numbers be-

6. This was done by assuming that the relative changes in departure patterns caused by the pension change in the sample are representative of the changes that would be observed in the

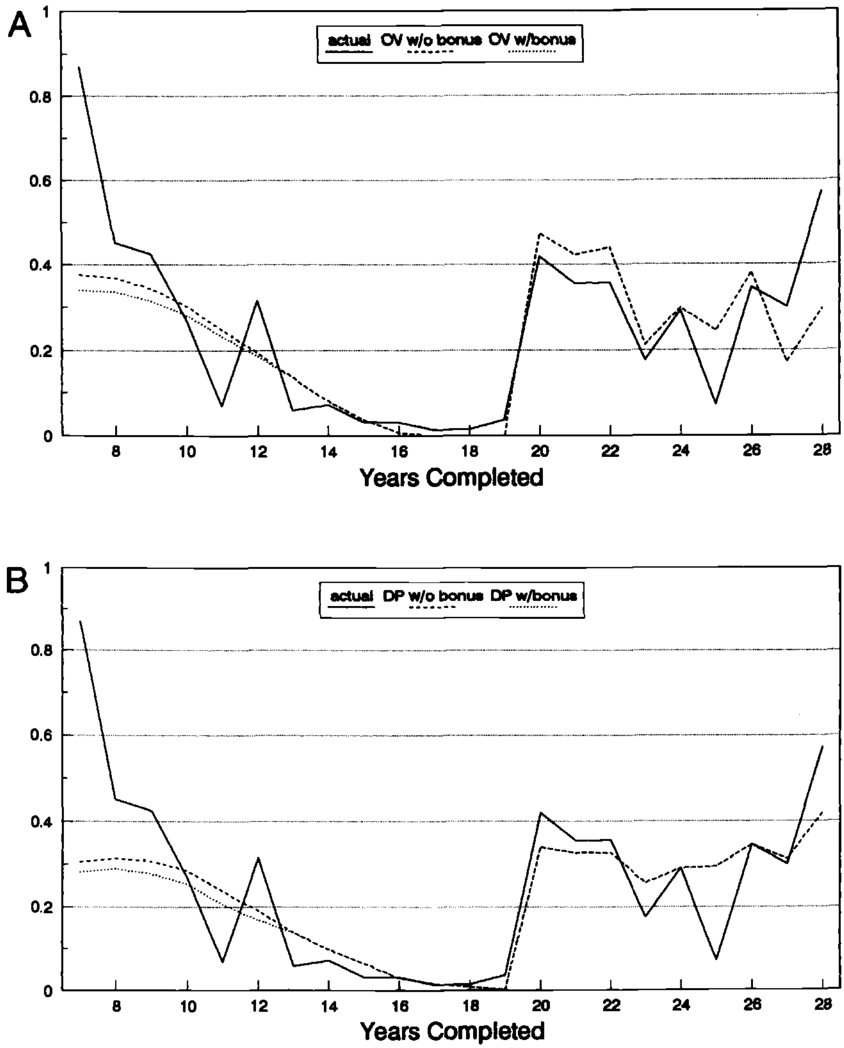
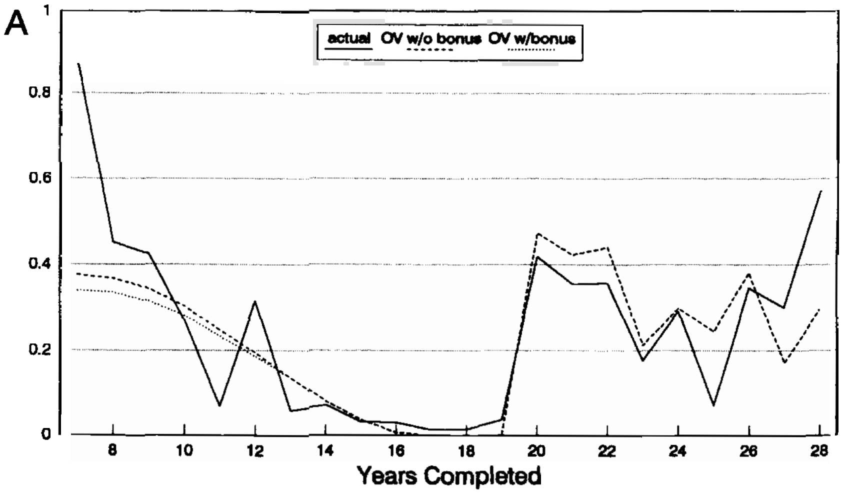


Fig. 3.5 Predicted 1989 departures with 1988 parameters, with and without the pilot bonus: *a*, option value model; *b*, dynamic programming model

low the zero reference line mean that pilots will leave because of the change; numbers above it mean that more will stay. For example, at twelve years of service, the option value model predicts that almost one hundred pilots will

entire pilot population. The simulation assumes that pilots present in 1987 are suddenly faced with the prospect of being subject to the new pension plan.



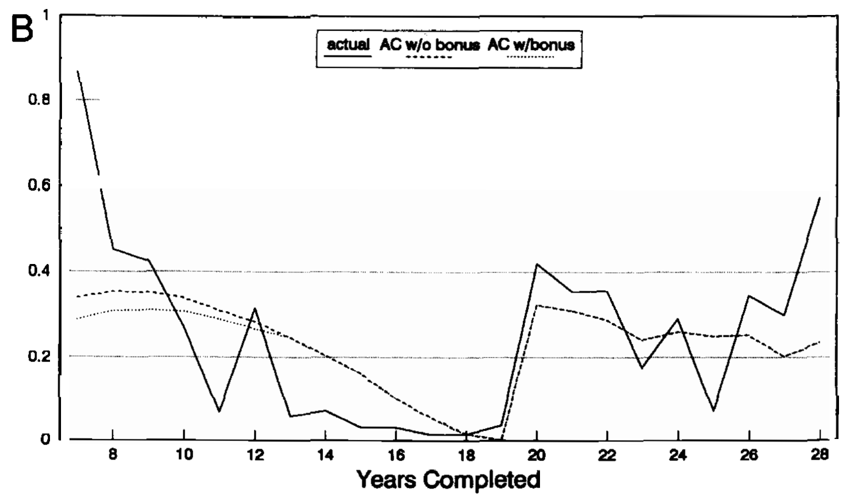


Fig. 3.6 Predicted 1989 departures with 1988 parameters, with and without the pilot bonus: *a,* option value model; *b,* ACOL model

leave because of the new pension plan, while the ACOL model predicts that only ten will leave. What is most important here is that the changes in pension benefits may affect officers at an earlier stage in their career than previously expected. The ACOL model shows very little effect until after twelve years of service; the option value model shows large effects as early as seven years of service. Using 1987 pilot populations, the option value model shows the Air Force losing 714 pilots in the seven-to-nineteen-years-of-service cohorts under

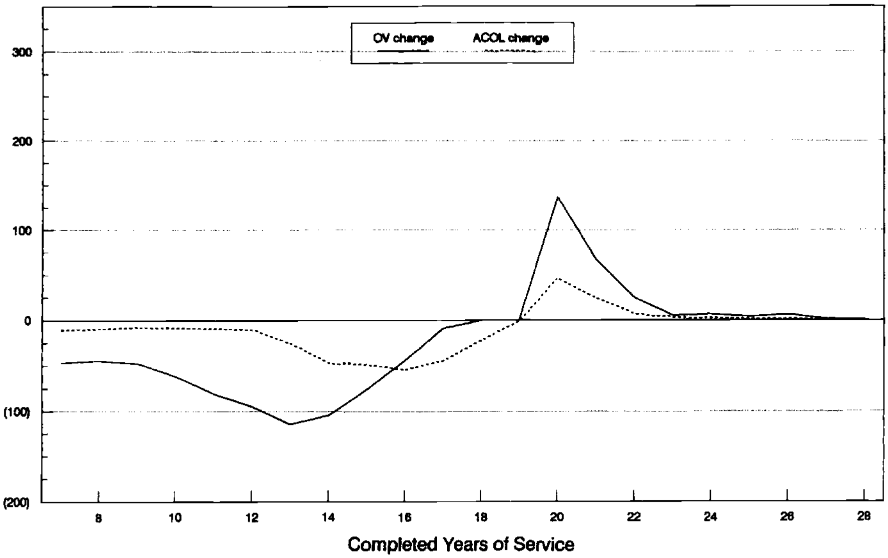


Fig. 3.7 Potential effect of pension change, using total 1987 pilot population

the new system, while the ACOL model shows a loss of only 229. The possibility of the pension change having larger effects on younger military members was raised by Argüden (1987), using the Gotz-McCall dynamic programming model with the Air Force enlisted population.

3.3.2 Potential Changes in Pilot Distribution

Using factors such as the expected number of aircraft available in future years and the number of crews required to fill them, the DoD and the Air Force develop an "objective force" as part of the five-year defense plan to show the desired distribution of pilots by years of service. Decisions concerning changes in the management of the pilot force are made with the objective force structure in mind.

Figure 3.8 shows the 1994 objective force (taken from the *Department of Defense Aviator Retention Study*), the actual distribution of pilots by years of service in 1990, and the distribution of pilots if the departure rates of 1990 continued for the next four years. The figure assumes that sixteen hundred pilots complete pilot training each year. Compared to the objective force, current pilot levels are low in all years except five, six, seven, and the years after fifteen. With the 1990 departure rates, the shortages will increase in all years from six through nineteen, and, of course, this is the problem that the pilot bonus was meant to solve.

We noted in section 3.3.1 that the implementation of ACP did not have the desired effect on pilot retention rates. We have attempted to devise a bonus

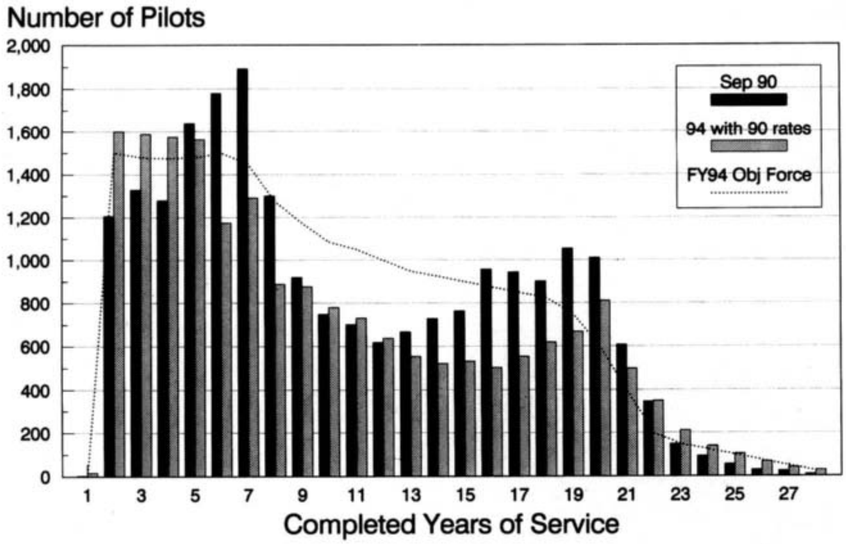


Fig. 3.8 Population in 1990 and 1994, assuming 1990 departure rates

that would induce the departure rates necessary to maintain the 1994 objective force.

We do this by noting the percentage decrease in 1990 departure rates necessary to reach the 1994 steady-state rates and determining the bonus necessary to achieve this decrease of departure rates in the 1988 sample of MAC and SAC pilots.[7]

The result of this exercise is shown in figure 3.9. The best fit using a new bonus amount requires that current bonuses be increased sixfold—that is, for a pilot who has completed six years of service, the annual bonus for the next eight years needs to be $72,000 instead of $12,000! The population changes over the five-year period from 1990 to 1994 lead to the distribution in the figure. The pilot shortages from seven years of service to twelve years of service are largely reduced (overcome more than we want in nine, ten, and eleven), but shortages continue from thirteen years on. This would obviously be an extremely expensive program.

If we assume that the pension plan change that affects military members who entered the service after August 1986 were suddenly applicable to pilots present in 1990, the long-term effects of the decrease in pension compensation result in the distribution of figure 3.10. Pilot shortages increase from eight years of service through nineteen years of service, then surpluses exist through twenty-seven years of service.

7. We assume that the new bonuses are a constant multiple k of the current bonuses available. The k that produces the best fit (in a least squares sense) to the desired departure rates gives us the new bonuses.

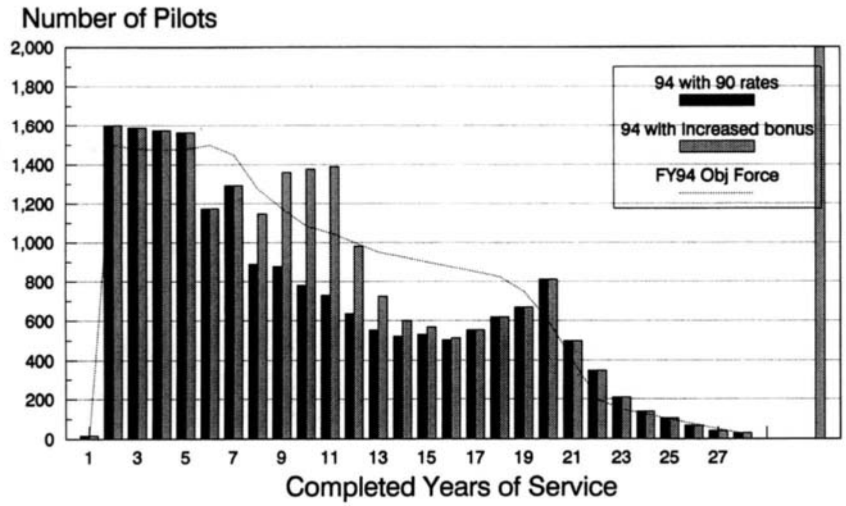


Fig. 3.9 Population in 1990 and 1994: 1990 departures versus increased bonus. Base total = 18, 911; new total = 21,552.

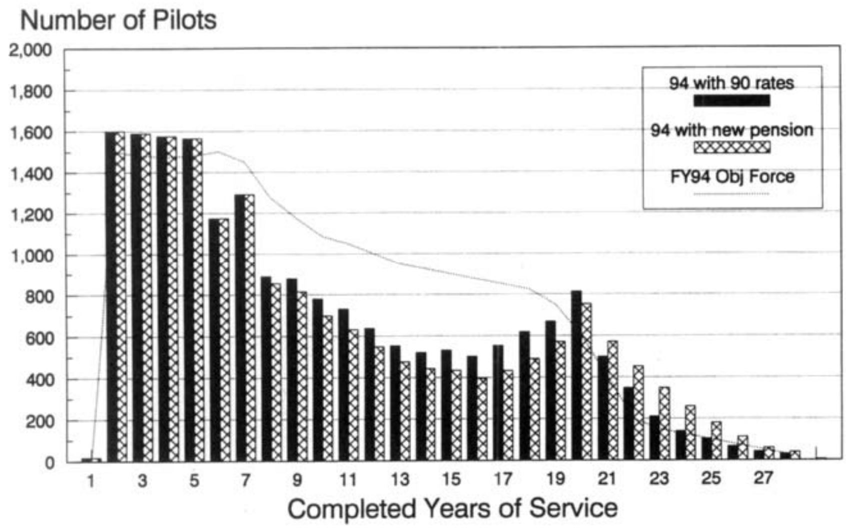


Fig. 3.10 Population in 1990 and 1994: 1990 departures versus new pension rates

3.4 Conclusions

The option value model captures Air Force pilot departure behavior much better than the ACOL model that has been used by the military, and substantially better than a more complex stochastic dynamic programming specification. The superiority of the option value model to the dynamic programming formulation raises the possibility that individual decision making may not always be best modeled with a model that is intended to approximate "correct" economic financial calculations. This is consistent with the results of Lumsdaine, Stock, and Wise (1992).

Predictions of the effects of changes in compensation using the option value model indicate that individuals at early stages in their careers are more sensitive to losses of future benefits than indicated by previous models. The effects of temporary annual bonuses such as ACP are small—and bonus amounts must be extremely large to induce departure rates that come close to achieving the 1994 objective force.

The extraordinary changes in the world's political and military climate since the summer of 1991 will lead to adjustments in the defense structure of the United States. Already, decreases in the defense budget have led to a drop in the planned number of Air Force tactical fighter wings and a 25% decrease in the number of cockpits available for pilots. Entries into undergraduate pilot training will be reduced by 270 pilots per year starting in 1992, and the total number of pilots in the Air Force is expected to be down from over 21,000 in 1990 to 16,500 in 1997.[8]

Overall Air Force strength is projected to decrease markedly in the next few years—from 545,000 personnel in 1990 to approximately 415,000 by 1995. To encourage people to leave the service, the Air Force instituted two incentive programs in 1992. The first, called the Voluntary Separation Incentive (VSI), provides an annual payment to an individual (payment based on base pay and number of years of service) that will last for twice the number of years the individual has been in the service. For example, a major with sixteen years of service could leave the Air Force and receive an annual payment of $17,466 for thirty-two years (a present value of $236,343, according to the Air Force).

The second, called the Special Separation Benefit (SSB), is a lump-sum payment that is 15% of an individual's base pay multiplied by the number of years served. The major mentioned above would receive a one time SSB payment of $104,795.

Both programs were introduced with little econometric modeling of their potential effects, and fewer officers than expected applied to accept either program.

As the Air Force and the other services struggle to reduce in size, other

8. These figures for pilot reductions were reported in the 15 July 1991 *Air Force Times*.

separation incentives will be proposed and studied. The procedure discussed here may be useful in predicting their effects.

3.5 Postscript: VSI/SSB Results

The present value of the SSB is significantly less than the present value of the VSI. Nonetheless, initial applications to leave the Air Force under either program showed a large preference for the lump-sum payment. By June 1992, of the 4,870 officers who accepted one of the programs, a small majority chose the annuity (2,366 accepted the lump sum); of 24,807 enlisted personnel who accepted one of the programs, the vast majority—22,140—chose the lump-sum payment.

Acceptance rates varied with age and rank. All enlisted ranks preferred the lump-sum payment. On the officer side, first lieutenants preferred the VSI to the SSB by a slight margin (51.7% to 48.3%), captains preferred the SSB by a slight margin (51% to 49%), and majors preferred the VSI 68.6% to 31.4%.[9] In an exit survey conducted by the AFMPC, reasons given for selecting the lump sum over the annuity included "quick money" and "investment." Reasons for preferring the annuity included "greater value" and "long-term income." On a more sour note, 95 of 900 written comments received in the survey addressed lack of trust in the government to follow through on the annuity payments as a reason to accept the lump sum instead.[10]

The unexpected pattern of benefit acceptance raises questions about how individuals treat lump-sum payments as opposed to annuities. It is no surprise that the option value model shows that the pilot population should prefer the VSI program to the SSB because of the former's higher present value; however, one experiment with the option value model showed an interesting result.

In figure 3.11, the "Base, few hires" line shows hazard rates predicted by the option value model if the probability of being hired by an airline gradually decreases as an individual gets older and neither VSI nor SSB is offered. The VSI6 line in the figure (which we could call the predictions for the "pessimistic" pilots) shows the predicted hazard rates for pilots who believe that airline hiring will decline and would treat VSI as a retirement benefit; that is, the benefit is multiplied by the k parameter in the model.

On the other hand, if we assume that the probability of being hired by an airline after leaving the Air Force remains certain and also assume that an SSB lump-sum payment is treated as ordinary income (that is, it is not multiplied by the k parameter in the model), the predicted hazard rates are as shown by the SSB8 line (the "optimistic" pilots).

9. These figures come from information provided by Major Jerry Ludke, of the AFMPC/DPYO at Randolph Air Force Base.

10. The survey was conducted by the Analysis Division, Directorate of Personnel Operations, AFMPC, Randolph Air Force Base, Texas.

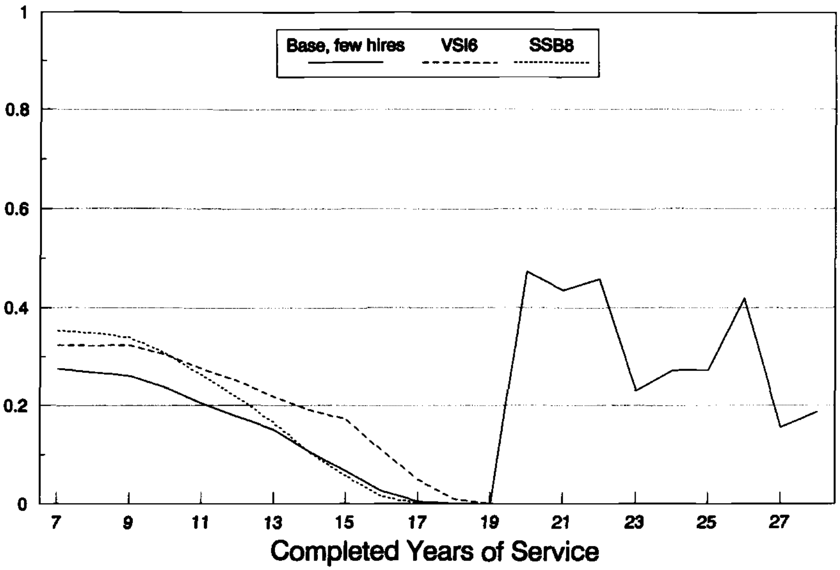


Fig. 3.11 Postscript simulations

The lines cross at about ten years of service. A very loose interpretation of this result could be that before ten years of service pilots are optimistic about getting an airline position and prefer the SSB income; after ten years of service pilots are less optimistic about an airline job and treat the VSI as an early pension.

In actuality, the pilot population did prefer the SSB to the VSI before about ten years of service, and the VSI afterward. However, the population involved is very small (482 pilots were eligible for either program, only 370 applied, and 313 of these were in the eleven-to-sixteen-year cohorts), and it is premature to read too much into the result of this experiment. Nonetheless, it is intriguing that the model hints at what should be obvious: individuals consider a variety of issues besides the present value of a benefit when making a decision about leaving employment.

Appendix

Stochastic Dynamic-Programming Model

In year t, the individual makes the decision to stay or leave based on the value function W_t given by

$$W_t = \max\Big[E_t(Y_t^\gamma + \Gamma + \varepsilon_{1t} + \beta W_{t+1}), \tag{A1}$$

$$E_t(\sum_{s=t}^{T}\beta^{s-t}(C_s(t) + kB_s(t))^\gamma + \varepsilon_{2t})\Bigg],$$

where β is the discount factor and T is the time of death. The first expected value in the brackets is that of remaining in the service one more year and then making the best decision in year $t + 1$; the second term is the expected value of leaving now.

Since the disturbances are independently and identically distributed, $E_t\varepsilon_{i,t+s} = 0$ for $s > 0$. With this fact, and again taking into account the probability of surviving to year s given a person is alive in year t, we can write

$$\text{(A2)} \qquad W_t = \max[W^*_{1t} + \varepsilon_{1t}, W^*_{2t} + \varepsilon_{2t}],$$

where

$$\text{(A3)} \qquad W^*_{1t} = Y^\gamma_t + \Gamma + \beta\pi(t + 1 \mid t)E_tW_{t+1}$$

and

$$\text{(A4)} \qquad W^*_{2t} = \sum_{s=t}^{T}\beta^{s-t}\pi(s \mid t)(C_s(t) + kB_s(t))^\gamma.$$

An individual will decide to leave the military if

$$\text{(A5)} \qquad W^*_{1t} + \varepsilon_{1t} < W^*_{2t} + \varepsilon_{2t},$$

and so the probability of leaving in year t is

$$\text{(A6)} \qquad Pr[W^*_{1t} + \varepsilon_{1t} < W^*_{2t} + \varepsilon_{2t}] = Pr[\varepsilon_{1t} - \varepsilon_{2t} < W^*_{2t} - W^*_{1t}].$$

If we assume that the ε_{it} are independent draws from a normal distribution with zero mean and variance σ^2, the variance of $(\varepsilon_{1t} - \varepsilon_{2t})$ is $2\sigma^2$, and we can write equation A6 as

$$\text{(A7)} \qquad Pr[R = t] = Pr\left[\frac{(\varepsilon_{1t} - \varepsilon_{2t})}{\sqrt{2}\sigma} < \frac{(W^*_{2t} - W^*_{1t})}{\sqrt{2}\sigma}\right] = \Phi(a_t),$$

where Φ is the cumulative normal distribution function and $a_t = (W^*_{2t} - W^*_{1t})/\sqrt{2}\sigma$.

To find this probability, we need to get an expression for the recursive part of the function W_t, that is, $E_{t-1}W_t$. This can be shown to be

$$\text{(A8)} \qquad E_{t-1}\left(\frac{W_t}{\sigma}\right) = \frac{W^*_{1t}}{\sigma}(1 - \Phi(a_t)) + \frac{W^*_{2t}}{\sigma}\Phi(a_t) + \sqrt{2}\phi(a_t),$$

where ϕ is the standard normal density function.

In equation A8, $\Phi(a_t)$ represents the probability that the individual leaves the military and receives utility W^*_{2t}, and $(1 - \Phi(a_t))$ represents the probability that the decision is made to remain and receive utility W^*_{1t}. The remaining term comes from the expectation of the disturbances. In sum, we use equation A8 to recursively calculate the values of W^*_{1t} and W^*_{2t}, and then use equation A7 to calculate the probability of retirement.[11]

The error structures of the option value and dynamic programming approaches are similar, but arise from different assumptions. In both cases, future errors are normally distributed with nonzero covariance. This is the result of the Markov assumption for the generation of the errors in the option value model, but comes from a "components of variance structure, with an individual specific effect" (Lumsdaine, Stock and Wise 1992, 14) in the dynamic programming model.

References

Argüden, Yilmaz R. 1987. *Unintended Effects of the New Military Retirement System.* RAND Note N-2604-AF. Santa Monica, CA: RAND Corporation.

Ausink, John A. 1991. The Effect of Changes in Compensation on a Pilot's Decision to Leave the Air Force. Ph.D. dissertation, Harvard University.

Baldwin, Robert H., and Thomas V. Daula. 1985. Modeling the Retention Behavior of First Term Military Personnel: Methodological Issues and a Proposed Specification. *Research in Labor Economics* 7: 339–63.

Bartholomew, Herbert A. 1982. *Military Compensation Background Papers: Compensation Elements and Related Manpower Cost Items, Their Purposes, and Legislative Backgrounds.* 2d ed. Washington, DC: Department of Defense, Office of the Secretary of Defense.

Bowman, Charlie T. 1990. Aviator Continuation Pay Memorandum. HQ AFMPC/DPMATM, Randolph Air Force Base, TX, 3 October.

Congressional Budget Office. 1989. *Alternative Compensation Plans for Improving Retention of Air Force Pilots: A Special Study.* Washington, DC: Government Printing Office.

Daula, Thomas V., and Robert A. Moffitt. 1989. A Dynamic Model of Enlisted Retention Behavior in the Army. April. Manuscript.

Department of Defense. 1984. *Fifth Quadrennial Review of Military Compensation.* 6 vols. Washington, DC: Government Printing Office.

———. 1988. *Department of Defense Aviator Retention Study, 1988.* Washington, DC: Government Printing Office.

———. 1989a. *Department of Defense Annual Report, 1989.* Washington, DC: Government Printing Office.

———. 1989b. *Report of the Secretary of Defense.* Washington, DC: Government Printing Office.

Gotz, Glenn A., and John J. McCall. 1984. *A Dynamic Retention Model for Air Force Officers.* RAND Corporation Report R-3028-AF. Santa Monica, CA: RAND Corporation.

Lumsdaine, Robin L., James H. Stock, and David A. Wise. 1992. Three Models of Retirement: Computational Complexity versus Predictive Validity. In *Topics in the*

11. When no taste factor is used, this is all that is needed in the estimation. When the taste factor is allowed, it is also necessary to integrate over the taste distribution. This integration substantially increases the computation time for the dynamic programming model.

Economics of Aging, ed. David A. Wise, 19–57. Chicago: University of Chicago Press.
Norris, James M. 1987. *The DPAC Compensation Model: An Introductory Handbook.* Maxwell Air Force Base, AL: Air Command and Staff College.
Stock, James H., and David A. Wise. 1990. Pensions, the Option Value of Work, and Retirement. *Econometrica* 58 (5): 1151–80.
Warner, John T. 1979. *Alternative Military Retirement Systems: Their Effects on Enlisted Retention.* Alexandria, VA: Center for Naval Analyses.
Wise, David A., ed. 1985. *Pensions, Labor, and Individual Choice.* Chicago: University of Chicago Press.

Comment on Chapters 2 and 3

Robert J. Willis

The two papers that I am to discuss represent significant new applications of theories of optimal retirement, including dynamic programming models and the option value model developed by Stock and Wise (1990), to real world problems. The application by Ausink and Wise (AW) to decisions by pilots to leave the Air Force appears to be a nearly unqualified success, while the paper by Lumsdaine, Stock, and Wise (LSW) attempts, without success, to eliminate a small but interesting blemish on their otherwise excellent track record in predicting retirement behavior using forward-looking optimal models.

Since it is difficult to quarrel with success, I will postpone that task and turn first to a discussion of the LSW paper, which attempts to explain the spike in the retirement hazard at age 65. The paper's title describes its focus on an interesting empirical puzzle that was noted but remained unexplained in Lumsdaine, Stock, and Wise (1992), a previous paper in this conference series. As a discussant, it is heartening to note that at least one idea from comments on their paper concerning the effect of continuation of employer health benefits after retirement (Schieber 1992) received serious attention in this year's paper. But it is both surprising and chastening to discover that this good suggestion has no merit: the current LSW paper shows that the presence or absence of such benefits has absolutely no effect on retirement decisions at any age. I was also surprised that marital status had so little effect and that retirement patterns for men and women are so similar.

After finding that other possible explanations, at best, go only partway toward explaining the age-65 spike, the tentative explanation advanced by the authors is that retirement at age 65 is a norm that remains normative because, according to their calculations, adherence to the norm has a low opportunity cost (for most people) relative to the optimal age calculated from a dynamic program. Given that the continual reoptimization needed to calculate optimal

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retirement is difficult and, perhaps, anxiety-inducing, the authors argue that adoption of a simple rule of thumb to retire at age 65 is understandable.

Before discussing my reactions to the theoretical issues embedded in this explanation, I first wish to express a little skepticism about the claim that the spike in the retirement hazard at age 65 represents a norm, at least in the sense that the term "norm" can be equated with the term "normal age of retirement." First, to complement the figures presented in the paper that plot the retirement hazards for data from three firms, in figure 3C.1 I plot the hazards for males from the three national samples that are reported in the final three columns of table 2.2 in LSW. These hazards are nearly identical to one another and are similar in shape to the empirical hazard functions for individual firms, which are displayed in figures 2.1–2.3 of LSW. In particular, they each show a spike at age 65. However, the spike at age 65 is followed by quite elevated hazards at ages after 65, possibly suggesting that it is retirement at age 65 or over that is normative.[1]

I also used the data in table 2.2 to calculate cumulative hazard functions for all six samples, which are plotted in figure 3C.2. The functions from the NMES data and from the two SIPP samples lie between the plot for Firm 2, which shows a pattern of relatively delayed retirement, and the plots for Firms 1 and 3, in which retirement is relatively accelerated. I note in passing that it is slightly misleading for LSW to emphasize the similarities in the shapes of the hazard functions in the three firms without pointing out how different Firm 2 is in the pattern of cumulative retirement. Focusing on the national samples, we see that about 50% of retirements occur before age 65, with 20% occurring before age 62 and 30% between ages 62 and 64. Moreover, almost one-third of the retirements occurring at age 65 or later take place after age 65. Put simply, my skepticism about viewing retirement at age 65 as a norm is based on evidence that only a small minority of retirements take place at age 65.

To be persuasive, I believe that the empirical argument presented in the paper in favor of viewing the choice of retirement at age 65 as a rule of thumb needs to be generalized to consider the opportunity cost of an arbitrary decision to retire at any given age before or after age 65 relative to the benefits of choosing an "optimal age." Apart from windows and special early retirement features, I would guess that the data for another age such as 64 or 66 would look much like the data presented in table 2.7. If so, the argument for regarding the peak at age 65 as a norm does not seem compelling. A rule of thumb that selected another age would be just as attractive. The argument that age 65 is special seems to appeal to an idea of what was typical behavior two or three decades ago but which is now quite atypical.

1. A possible caveat, however, is that the hazard rates at older ages may be biased upward because the samples are restricted to persons of at least age 70 who declared themselves to be retired at the time of interview. Unless the samples are concentrated at the lower end of this age limit, this bias seems unlikely to be very large.

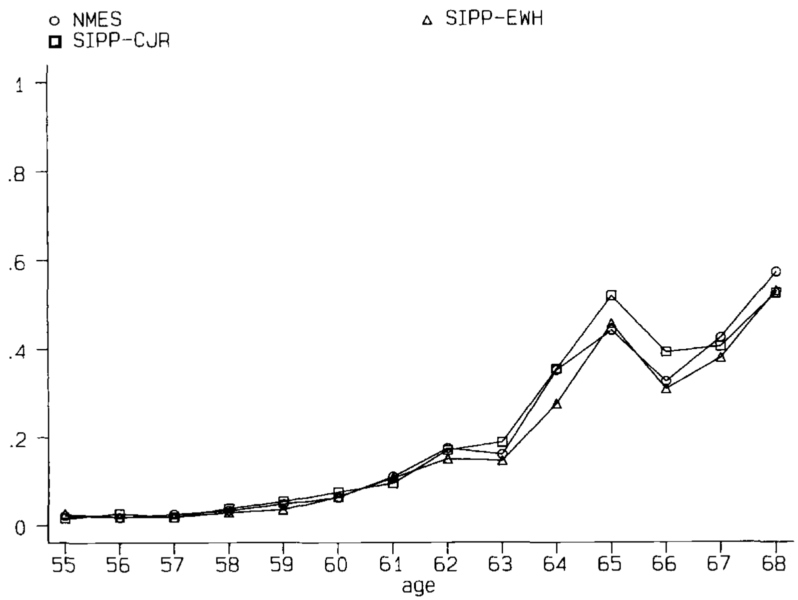

Fig. 3C.1 Retirement hazard rates, National Medical Expenditure Survey and Survey of Income and Program Participation

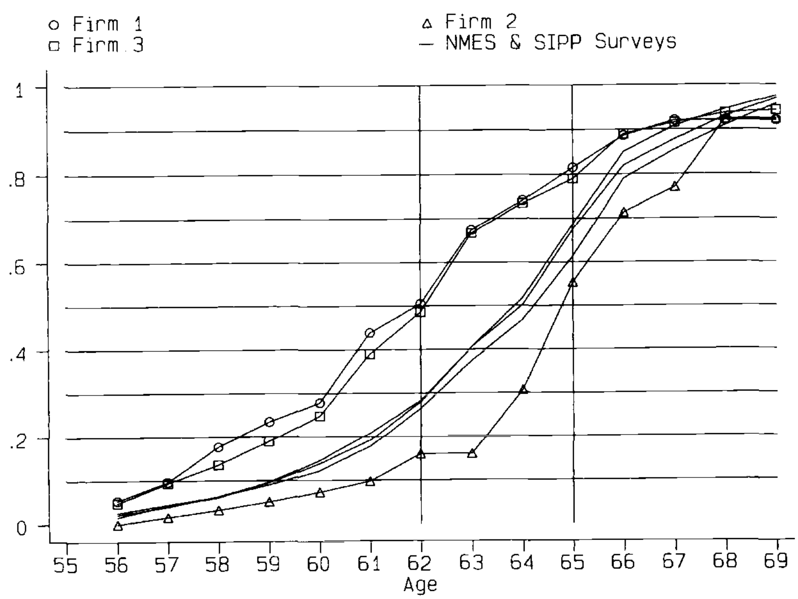

Fig. 3C.2 Cumulative proportion retired

Even if it is not a fully satisfactory way of explaining the age-65 peak, the rule-of-thumb argument may still be useful. As I understand it, LSW argue that those components of an individual's retirement resources that are outside the control of a firm's personnel policies (e.g., Social Security wealth, defined-contribution pensions, personal assets) do not provide strong incentives to retire at a particular age. Given this lack of incentive, workers may enjoy the luxury of choosing an age to retire with certainty and without complex calculation, thereby improving their capacity to make unmodeled decisions, such as the purchase of a retirement home in Sun City. On the other hand, if firms attempt to manipulate pension provisions in an attempt to keep or get rid of workers of a given age, we may infer from the predictive success of the option value and dynamic programming models that workers are capable of rational decision making of at least moderate complexity. To the extent that the opportunity costs of varying the age of employment are small, at least in the vicinity of age 65, it may be possible for employers to generate considerable alterations in behavior at quite modest cost. I hope that this possibility is kept from my employer, which has responded to the elimination of mandatory retirement for professors as of 1 January 1994 with a plan to pay a bonus of twice their academic salary to professors who agree to retire at age 65. Unfortunately, choices made by my senior colleagues may reveal the secret before I am eligible to collect my windfall.

Let me now turn to the AW paper on Air Force pilots. This is a wonderful application of the option value/dynamic programming methodology to a very important problem that acquired vastly greater importance with the end of the Cold War. The predictive success of these models is extremely impressive, and the demonstration of their superiority over the DoD's existing ACOL model is persuasive, although I would like to see some added discussion of what features of the option value and dynamic programming (OV/DP) models are responsible for this superiority. I suspect that the success of these models will lead to the replacement of the ACOL model with OV/DP models to design and evaluate military manpower policies for dealing with the dynamics of downsizing the military. Pictures such as those in figure 3.9 of the paper are, therefore, of more than academic interest.

My only serious reservation about the paper, and about the application of these models to policy, concerns the use of data on civilian opportunities. After pointing out that military pilots almost always leave to become pilots in civilian airlines, the paper is completely silent about what assumptions are made about employment conditions in the civilian sector. The reader should be told more about the data and/or assumptions about the civilian sector that underlie the estimates presented in the paper. More important, it seems likely that the current negative trends in the market for civilian airline pilots may have a very substantial effect on decisions by pilots to leave the Air Force and that predictions of rates of departure based on the booming market for pilots during the 1980s may be far off the mark in designing policies for the 1990s. It would be useful to add some discussion and, if possible, develop some quantitative measures of the sensitivity of model predictions to variations in civilian labor market conditions. Given the high cost of training pilots and the correspondingly high value of making good decisions about manpower decisions in this area, I would think that the Air Force might consider investing in the acquisition of some postretirement data on its pilots, at least by using their Social Security earnings histories.

My final comments concern issues of interpretation of these forward-looking models of retirement behavior and suggestions for directions for further research. Ostensibly, estimates of these models tell us about behavioral parameters that measure the value of leisure, the degree of risk aversion, and the rate of time discount. These parameters are of very general interest and importance in explaining many decisions in addition to retirement, such as consumption and savings, insurance purchases, housing choices, and so forth. Moreover, the values of these parameters have crucial implications for evaluating both the positive and normative aspects of policy toward the elderly.

My question is how seriously (or literally) we should take estimates of these parameters? For example, should I take estimates of $\gamma = 1.8$ for Air Force pilots as confirmation of my prior beliefs about this risk-loving bunch whom I should expect to see patronizing Las Vegas in large numbers? Should I take estimates of $\gamma = 1.0$ among the retirees of Firm 3 as evidence that they are risk neutral? Or, alternatively, should I regard this as evidence that these employees do not suffer diminishing marginal utility from concentrations of income in a given period because they are able to smooth their incomes through transactions in financial markets? What should I make of large differences in extra value of pension dollars to pilots, depending on whether their decisions are modeled with the option value or dynamic programming framework? Do men in Firm 3 value their leisure more than do women? A much more cautious view is that k, β, and γ are to be regarded as no more than parameters that provide enough flexibility of functional form to enable the model to fit the data. Stock and Wise (1990) discussed such questions in their initial presentation of the option value model and tended, at that time, to come down toward the cautious end of the interpretational spectrum. Now that they and their collaborators have had more experience in estimating these models with different data sets and in both dynamic programming and option value specifications, I would like to see them revisit these questions of whether the variations in incentives provided by pension programs provide natural experiments that can reveal underlying general behavioral parameters.

In a similar vein, I would like to see the authors discuss the potential of applying these models to general data sets such as the new Health and Retirement Survey that contain data on individuals who face a wide variety of pension plans, including no plans at all. Although I do not know this literature well, it appears that much of the excellent track record of the forward-looking models has been earned by predicting behavior of individuals who are all employees of a given firm. This is certainly true of both papers under discussion today, albeit the Air Force is a very large firm. When applied to one firm at a time, the models can be very useful management tools. For most questions of broad policy, however, one would like to have estimates of the impact on the retirement behavior of broad population groups. I know from the record of previous conferences in this series that the ambitious efforts of John Rust to apply dynamic programming methods to the RHS data have been frustrated by computational difficulties. What I am wondering is whether the simpler and more approximate, but computationally feasible, methods pioneered by the authors of these two papers can make a useful contribution when applied to broader populations.

References

Lumsdaine, R. L., J. H. Stock, and D. A. Wise. 1992. Three Models of Retirement: Computational Complexity versus Predictive Validity. In *Topics in the Economics of Aging,* ed. David A. Wise, 19–57. Chicago: University of Chicago Press.

Schieber, Sylvester J. 1992. Comment on Three Models of Retirement, by R. L. Lumsdaine, J. H. Stock, and D. A. Wise. In *Topics in the Economics of Aging,* ed. David A. Wise. Chicago: University of Chicago Press.

Stock, James H., and David A. Wise. 1990. Pensions, the Option Value of Work, and Retirement. *Econometrica* 58 (5): 1151–80.