In this chapter, we describe our simulation approach and the assumptions we make to implement it. We use this approach to address questions about the relative generosity of FERS compared with that of CSRS, about the retirement and separation incentives embedded in each system, and the incentives to switch to FERS by those covered by CSRS.

The typical approach for comparing the relative generosity of benefits under different retirement systems is to compare their replacement rates at different retirement ages—the fraction of final pay that is covered by the retirement plan’s annuity (see, for example, GAO, 1997). A problem with this approach is that the replacement rate does not easily account for differences in contribution rates between retirement systems. For example, the annuity under one system may be more generous, but if employees contribute more of their earnings to the system, their expected lifetime wealth may not be greater.

Replacement rates also do not account for differences in cost-of-living-adjustment (COLA) provisions between systems. For example, an annuity may be larger under one system and yield a higher replacement rate, but if it is not inflation protected, the overall value of the benefit could be lower. The replacement rate approach also does not account for what the individual could earn in alternative employment. A retirement system may be more generous in terms of its replacement rate, but so may the replacement rate in alternative employment, so the individual may not be better off. Other problems with the replacement rate approach are that it does not account for mortality risk or for the fact that the replacement rate may be higher at older retirement ages but the payout period shorter, resulting in potentially lower lifetime benefits.

Because of these flaws, we do not use replacement rates to compare benefits under FERS with those under CSRS. Instead we use a measure that accounts for such factors as mortality risk, contribution rates, payout length, COLA provisions, and the value of the alternative. Before developing our approach, we note that labor economists have developed several alternative models for analyzing retirement and separation decisions and for comparing the incentives embedded in alternative retirement systems. One class of models is based on stochastic dynamic programming (Gotz and McCall, 1980; Rust, 1989; and Daula and Moffitt, 1995). In stochastic dynamic programming models, the incentive to remain with an employer rather than
separating or retiring may be shown to be a weighted average of the incentive to re-
main one more period and then leave, two more periods and then leave, and so forth.
Weights are based on the individual’s probability of remaining to each future point
and then separating. These probabilities depend, in turn, upon the individual’s pref-
erences and upon random shocks to the stay-leave decision at each point in time.
Asch and Warner (1994) employ a version of the Gotz-McCall stochastic dynamic
programming model to analyze the military compensation and personnel systems.

A simpler model is based upon deriving a future time horizon that is the focal point
of current-period decisionmaking. This model has come to be known as the Annual-
ized Cost of Leaving (ACOL) and is developed in detail in Warner and Goldberg
applied the model to the separation decisions of an entry cohort of DoD employees
tracked for their first 10 years of employment. Lazear and Moore (1983) and Stock
and Wise (1990) developed similar models of retirement decisions of workers in large
firms.

ACOL is defined as the expected DPV of a person’s lifetime earnings, net of his or her
wealth accumulation in an alternative job, annuitized over the length of the em-
ployment period. ACOL includes differences in future retirement pay and Social Se-
curity accumulations. The rest of the report will often refer to ACOL as the expected
net lifetime earnings and retirement wealth of the individual. Since ACOL is annu-
itized DPV, it becomes the average annual pay differential between employment in
the current job and the alternative.

In the economics literature, ACOL is also called the option value of staying in a given
job. There has been much discussion about the relative strengths of the ACOL or
option value approach and the stochastic dynamic programming approach (see the
discussion in Stock and Wise, 1990; Lumsdaine, Stock, and Wise, 1992; and the ex-
change between Gotz, 1990, and Black, Moffitt, and Warner, 1990a and 1990b). Be-
cause we seek to describe only the retirement and separation incentives embedded
in the two systems and do not attempt to estimate a structural model from actual
data, we eschew the stochastic dynamic programming approach in favor of the sim-
pler ACOL approach. This approach is well-suited for our purposes.

In both classes of models, nonmonetary factors also influence retirement and sepa-
rating decisions. Models typically recognize two sources of nonmonetary distur-
bances. One source is “permanent preference factors.” Some jobs offer better
working conditions and better amenities than do other jobs. Below, we let the sym-
bol \( \tau \) represent the value an individual places upon the nonpecuniary aspects of
federal versus nonfederal employment. The other source arises from unexpected, or
purely random, “shocks” to the retirement or separation decision. Poor health or an
unexpectedly good job offer elsewhere are random factors that can cause even a per-
son with strong preferences for the current employer (i.e., a high \( \tau \)) to retire or sepa-
rate.

In the remainder of this chapter, we describe more formally how the ACOL variable is
defined, and we discuss how we infer retirement and separation incentives from the
ACOL variables we compute. We then discuss the assumptions we make to com-
puter simulate the ACOL values for a “representative” individual. These computer simulations allow us to analyze the retirement and separation incentives embedded in FERS compared with those in CSRS.\(^1\)

**DEFINING THE ACOL VARIABLE**

To compute the ACOL, we subtract from the DPV of the employee's future earnings from staying the DPV of his or her future earnings (i.e., earnings wealth) if he or she leaves the civil service immediately. The net earnings and retirement wealth if the employee leaves includes the DPV of pay in the alternative sector, the DPV of the civil service retirement benefit he or she would be eligible for upon leaving immediately as of the current period, and the DPV of the Social Security benefits that the employee would be eligible for at retirement.\(^2\) To account for differences in the length of time over which discounting is done when the career horizon changes, the net wealth measure is annuitized to create the ACOL variable. All dollars are discounted to the entry age.

Formally, we denote the cost of leaving today, at time \(t\), compared with that of staying until a future time period \(N\) as \(\text{COL}(N,t)\). If \(S_N\) is the value of staying until period \(N\), and \(L_t\) is the value of leaving today at time \(t\), then \(\text{COL}(N,t)\) equals

\[
\text{COL}(N,t) = S_N - L_t.
\]

The value of leaving today, \(L_t\), is given by

\[
L_t = W_tA + R_tC + SS_t,
\]

where

\[
W_tA = \text{DPV of alternative pay (net of Social Security contributions) from } t \text{ until the person exits the labor force.}
\]

\[
R_tC = \text{DPV of civil service retirement benefits for which he or she would be eligible upon leaving at } t.
\]

\[
SS_t = \text{DPV of any Social Security benefits for which he or she would be eligible upon leaving at } t.
\]

The value of staying until a future period \(N\) is given by

\(^1\)Our simulations focus on the provisions for immediate and deferred retirement under FERS and CSRS. They ignore the provisions for “early” retirement. The early retirement benefit is available in certain involuntary separation cases and in cases of voluntary separations during a reduction-in-force. Since our focus is on normal voluntary separation incentives, we ignore this part of FERS and CSRS.

\(^2\)It should be noted that in computing the discounted present value of future retirement annuities we account for mortality risk in our calculations using a life table that gives the probability that an individual will survive to each age.
\[ S_N = W_{NC} + W_{NA} + R_{NC} + SS_N, \quad (2.2) \]

where

\[
W_{NC} = \text{DPV of civil service net pay (net of Social Security and retirement contributions) from } t \text{ until period } N. \\
W_{NA} = \text{DPV of alternative pay from } N \text{ until the person exits the labor force at period } T. \\
R_{NC} = \text{DPV of civil service retirement benefits for which he or she would be eligible upon leaving at } N. \\
SS_N = \text{DPV of Social Security benefits for which he or she would be eligible upon leaving at } N. \\
\]

Given these definitions, the \( \text{COL}(N,t) \) can be written as follows:

\[
\text{COL}(N,t) = S_N - L_t = (W_{NC} + W_{NA} - W_{tA}) + (R_{NC} - R_{tC}) + (SS_N - SS_t). \quad (2.3)
\]

The first right-side term in Eq. (2.3) is the difference between the DPV of earnings from a career path that includes staying \( N \) more years in the federal sector and then working \( T - N \) more years before withdrawal from the labor force \( (W_{NC} + W_{NA}) \) and the DPV of a \( T - t \) year career within alternative employment \( (W_{tA}) \). The second term in Eq. (2.3) measures the increase in the DPV of retirement pay if the individual stays \( N - t \) more years rather than leaving immediately. Similarly, the third term measures the net change in the DPV of Social Security benefits as a result of \( N - t \) more years of employment in the federal sector.

Let \( \beta = 1/(1 + \rho) \) where \( \rho \) is the individual’s personal discount rate. Then, the annualized cost of leaving now rather than remaining \( N - t \) more periods is

\[
ACOL(N,t) = \frac{\text{COL}(N,t)}{\sum_{j=t+1}^{N} \beta^{j-t}}. \quad (2.4)
\]

Since \( ACOL(N,t) \) is the annuity equivalent of \( \text{COL}(N,t) \), \( ACOL(N,t) \) measures the average annual earnings differential between employment in the federal and nonfederal sectors, including not just pay differences while employed but also differences in expected future retirement benefits between sectors as well as differences due to Social Security accumulations.

**DECISION RULE FOR DETERMINING OPTIMAL RETIREMENT AGE**

Notice that there are \( T - t \) values of \( ACOL \) for a given individual: \( ACOL(t + 1,t), ACOL(t + 2,t), \ldots, ACOL(T,t) \) or \( N - t \) values from \( ACOL(t + 1,t) \) through \( ACOL(N,t) \). To determine the optimal retirement age, we assume that the individual stands at the entry age (i.e., \( t \) is assumed to equal 1) and looks at every possible future career hori-
zon N, calculates ACOL(N,1), and chooses the N or age where his or her expected ACOL(N,1) is maximized (denoted ACOL*(N,1)). At this point, the person will maximize his or her expected net earnings and retirement wealth over his or her lifetime relative to the entry age.

As will be discussed in the context of separation incentives, individuals may leave before the optimum career length once nonmonetary and random factors are considered. For example, if the individual receives an unexpectedly good outside opportunity that exceeds this maximum or if he or she finds that the disamenities of the civil service outweigh this maximum, then he or she will leave prior to the age when the ACOL is maximized. That is, the ACOL indicates the financial net gain to staying (or the financial cost of leaving) over the time horizon that maximizes wealth, but other factors can also influence the decision to leave.

As an example, Figure 2.1 graphs ACOL(N,1) for alternative N and shows the N at which we find ACOL*(N,1). For someone who enters at age 40, the maximized ACOL(N,1) is ACOL*(20,1), i.e., the ACOL is maximized at 20 YOS and age 60.

To compare retirement age incentives under FERS with those under CSRS, we simulate ACOL(N,1) for a representative individual under FERS and under CSRS, holding entry age constant. We then find the N where ACOL*(N,1) occurs for each system. If the maximized ACOL(N,1) occurs at the same N, we conclude that FERS and CSRS embed the same retirement age incentives, given our assumptions.

![Age at which ACOL is maximized](Image)

*Figure 2.1—Annualized Cost of Leaving by Leaving Age*
DECISION RULE FOR WHETHER TO SEPARATE AT A GIVEN AGE

Although the time horizon over which ACOL is maximized, ACOL*(N,1), indicates the optimal retirement point, it does not, by itself, indicate whether a person will remain until that point or separate. As noted above, preferences and such random factors as sudden ill health or an unexpectedly strong or weak economy will also affect the separation decision in period t.

To examine separation incentives at each t, we no longer set t equal to 1 as we do in our examination of retirement incentives. Instead, we let t vary, and we find ACOL*(N,t) for every t, given entry age. We then compare ACOL*(N,t) to the value of nonmonetary and random factors. Formally, if τ is an individual’s net preference for federal employment and εt denote random shocks to the current-period separation decision, an individual remains in federal employment at time t if ACOL*(N,t) + τ + εt > 0 or ACOL*(N,t) > –(τ + εt). In other words, the individual stays in period t if the maximum expected future annualized pay differential (or expected net lifetime wealth) exceeds his or her net preference for nonfederal employment plus the (negative of the) value of new shocks to the decision.

As the individual progresses through his or her career, he or she is assumed to compare ACOL*(N,t) with τ + εt when deciding whether to separate at time t. As it turns out in our simulation analysis of FERS and CSRS, we find that the age or the N at which ACOL(N,t) is maximized does not generally vary with t. In other words, ACOL*(N,t) maximizes at the same N, for all t, holding entry age constant. For example, for someone who enters the civil service at age 20, ACOL(N,t) is maximized at age 55 when the individual would have 35 YOS (i.e., N equals 35 at the maximum). We find that, if it was optimal to stay until age 55 at the beginning of the individual’s career, it is usually optimal for him or her to stay until 55 as the career progresses and the individual ages.

Although the N at which ACOL*(N,t) occurs does not vary with t, ACOL*(N,t) does vary with t. For example, for someone who enters the civil service at age 20, ACOL*(35,1) may equal $4,000 for someone contemplating leaving after the entry age. If the leaving decision is contemplated at age 30, ACOL*(35,10) may equal $7,000. If it is contemplated at age 40, ACOL*(35,20) may equal $13,000. Figure 2.2 illustrates this example. The age or N at which ACOL*(35,1), ACOL*(35,10), and ACOL*(35,20) occurs is 55. Nonetheless, ACOL*(35,t) varies with t when t equals 1, 10, or 20. Since ACOL*(N,t) varies with t, there may be some t’s at which ACOL*(N,t) < –(τ + εt) and therefore at which it is optimal for the individual to leave the civil service.

Since all dollars in our calculations are discounted to the entry age, the differences in ACOL*(N,t) as t varies (or the differences in $4,000 and $7,000 and $13,000 in the example illustrated in Figure 2.2) are not due to discounting nor to the fact that one value is calculated for someone who is at the beginning of his or her career and the others are calculated for someone who is older. Rather, the differences are due to variations in the value of civil service retirement benefits and Social Security benefits in the alternative sector for someone thinking of leaving at age 30 or age 40 compared with someone thinking of leaving at age 20.
In Figure 2.3, we plot the ACOL*(N,t) for the different t’s that are shown in Figure 2.2. For example, Figure 2.3 shows that for an individual at age 30, ACOL*(35,10) equals $7,000. The individual is assumed to choose to remain in federal service in period t if ACOL*(N,t) exceeds the value of nonmonetary factors, including preferences and random factors. For illustrative purposes, we assume that the value of nonmonetary factors is shaped like the gray curve in the example shown in Figure 2.3. In this example, the individual will stay until age 45 because ACOL*(N,t) exceeds the nonmonetary factors until that age. Beyond age 45, the value of nonmonetary and random factors exceeds the maximized net wealth that can be expected by the individual in the civil service.

To compare separation incentives under FERS with those under CSRS, we compare ACOL*(N,t) for all t, given entry age, under both systems. In other words, we simulate the values illustrated in Figure 2.3 for a representative individual under FERS compared with one under CSRS. If ACOL*(N,t) under FERS is greater than ACOL*(N,t) under CSRS for a given t, then the cost of leaving and the gain to staying is greater under FERS at that decision age. In this case, we would conclude that FERS embeds weaker separation incentives or stronger stay incentives at that decision age.

### SIMULATION ASSUMPTIONS

To implement the ACOL approach discussed above, we need to make several assumptions that allow us to computer simulate the expected ACOL values under CSRS compared with those under FERS. These assumptions allow us to hypothesize a
“representative individual” working in the civil service under “representative” conditions. Specifically, we need to make assumptions about the individual’s personal discount rate, the inflation rate over the individual’s lifetime, the rate at which the individual’s TSP fund will grow, the individual’s entry salary level and growth rate over his or her career, the fraction of salary that the individual will contribute to the TSP over his or her career, and the minimum retirement age that the individual will face under FERS. The assumptions that we make are listed in Table 2.1. We call this set of assumptions the base case. At the end of Chapter Three, we discuss how our results vary when we vary these assumptions.

We assume an annual inflation rate of 3 percent. We also assume that the individual’s personal discount rate is 5 percent. As discussed in Appendix A, the minimum retirement age (MRA) at which an individual can retire under FERS Basic Plan varies with birth year. We assume that the MRA is 55. We also assume that the Thrift Savings Plan grows at a real annual rate of 6 percent over the course of the individual’s

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Base Case Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation rate</td>
<td>3 percent</td>
</tr>
<tr>
<td>Real Thrift Savings Plan growth rate</td>
<td>6 percent</td>
</tr>
<tr>
<td>Personal discount rate</td>
<td>5 percent</td>
</tr>
<tr>
<td>Minimum retirement age (FERS)</td>
<td>Age 55</td>
</tr>
<tr>
<td>Employee contribution rates</td>
<td>Vary with age&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>See Thrift Savings Plan Board, 1997.
career. This assumed rate is far short of the actual real growth in the stock market portion of the TSP in recent years. Nonetheless, for someone forecasting what average growth in the TSP will be over his or her entire career, a 6 percent rate seems reasonable. We also assume that the individual’s contribution rate to the TSP varies with age. We used average TSP contribution rates by age, which were obtained from the Thrift Savings Plan Board. Finally, we assume the real pay profile illustrated in Figure 2.4. The pay profile is based on the average grade of DoD civil service personnel by age and years of service. These averages were computed using data on DoD civil service personnel in 1996, obtained from the Defense Manpower Data Center (DMDC). We applied these averages to the fiscal year (FY) 1997 civil service pay table to compute average earnings by age and YOS. In real FY97 dollars, the person starts out at $25,000 and ends at around $56,000. Finally, we assume that the individual will exit the labor force at age 65. In other words, if an individual retires at, say, age 55, he or she is assumed to find a job for 10 years in the alternative sector.

Figure 2.4—Assumed Real Pay Profile

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3See Chapter Five for a more detailed data description.

4Ideally we should use the representative employee’s expected earnings profile, which will most likely differ from the mean profile observed in the FY96 DMDC data because of selectivity biases. For example, if retirement and separation rates vary positively with earnings and YOS, then average earnings of those with more YOS in our cross-sectional data will be biased downward. As noted in the text, we conduct sensitivity analysis using alternative pay profiles to determine how our main results regarding the relative incentives embedded in FERS compared with those in CSRS are affected. As discussed in Chapter Three, our qualitative results are unchanged when a different pay profile is assumed. Therefore, we do not believe our main results are affected by using cross-sectional data to develop the assumed pay profile.