

RATIONAL EXPECTATIONS CRITICISM IN A MICROECONOMIC SETTING:
THE CASE OF MILITARY PERSONNEL RETENTION MODELS

R. Yılmaz Argüden

August 1987

P-7340

The RAND Corporation

Papers are issued by The RAND Corporation as a service to its professional staff. Their purpose is to facilitate the exchange of ideas among those who share the author's research interests; Papers are not reports prepared in fulfillment of RAND's contracts or grants. Views expressed in a Paper are the author's own and are not necessarily shared by RAND or its research sponsors.

The RAND Corporation, 1700 Main Street, P.O. Box 2138, Santa Monica, CA 90406-2138

PREFACE

This paper develops a simulation methodology to evaluate the practical importance of rational expectations criticism in a microeconomic setting. It applies this methodology to a particular policy problem to show that the Annualized Cost of Leaving (ACOL) model, the most commonly used retention model, suffers considerable biases in analyzing the new military retirement policy.

The paper develops a methodology to evaluate the practical importance of the theoretical limitations of simpler models. It should, therefore, be of interest to policy analysts, economists, and statisticians who are faced with policy situations where the structures of simple models are likely to change with the policy interventions that need to be analyzed and where more complex models are difficult to implement empirically. It should also be of interest to personnel planners in all three military services and to policy analysts in the DOD and the Congress who have been using the ACOL model to analyze the effects of the new retirement policy, because it documents the limitations of the ACOL methodology.

This research was conducted under the Enlisted Force Management Project (EFMP), a joint RAND/Air Force project to develop a new, integrated, computer-based decision support system for the management of enlisted personnel. RAND's work on the EFMP falls within the Resource Management Program of Project AIR FORCE. The EFMP is part of a larger body of work in that program that is concerned with the effective utilization of human resources in the Air Force.

SUMMARY

The rational expectations approach has been one of the most important developments in economic theory in the past decade. Lucas's (1976) criticism has been central to this development. According to Lucas's criticism, if a policy intervention changes the structure of a model that was estimated when past policies were in effect, the model cannot be used for analyzing the policy intervention. Although this criticism has been taken seriously, especially in macroeconomic modeling, it has been difficult to quantify its practical importance in analyzing specific policies.

This paper shows how simulation can be used to evaluate the practical importance of Lucas's criticism in a microeconomic setting. This methodology is applied to the analysis of the new military retirement system. Most of the analyses that were conducted in formulating the new retirement policy and in analyzing the personnel retention effects of the new policy were based on the Annualized Cost of Leaving (ACOL) model. The simulation is used to show that the ACOL model suffers considerable biases and that the potential retention effects of the new policy are likely to be much larger than what the ACOL model predicts.

The theoretical problems of the ACOL model are identified as (1) an inability to trace the self-selection effects in a sequential decision environment (tastes); (2) an inability to differentiate among variance components (e.g., temporal random shocks versus fixed tastes); and (3) being a maximum regret model (ignoring all the options except the best one).

A similar simulation approach can be used in other microeconomic and macroeconomic settings to identify the limitations of other simple models, to quantify their practical importance, and to devise improvements to the simple models.

ACKNOWLEDGMENTS

I wish to express my appreciation to Glenn A. Gotz, not only for his helpful review but also for his critical guidance at earlier stages of this research. I am grateful to Frank A. Camm for his thoughtful suggestions and Michael P. Murray for his encouragement and critical reviews of an early draft. I also wish to thank Major Harvey R. Greenberg (AF/DPPOF) for his assistance and cooperation in this research. Finally, special thanks are due to Warren E. Walker, the project leader for the Enlisted Force Management Project (EFMP), for his support and useful suggestions.

CONTENTS

PREFACE	iii
SUMMARY	v
ACKNOWLEDGMENTS	vii
FIGURES	xi
TABLES	xiii
Section	
I. INTRODUCTION	1
II. THEORY AND METHODOLOGY	3
Modeling Considerations	4
The Annualized Cost-Of-Leaving Model (ACOL)	6
Dynamic Retention Model (DRM)	9
The Simulation Methodology	11
III. AN APPLICATION OF THE SIMULATION METHODOLOGY	13
Aggregate Effects of the New Retirement Policy	14
Disaggregate Effects of the New Retirement Policy	18
IV. CONCLUSIONS	21
APPENDIX A LIMITATIONS OF THE ACOL METHODOLOGY	23
Tastes	23
Random Shocks	25
Maximum Regret	31
Future Research	32
Appendix B DIFFERENT ACOL MODELS PRODUCE SIMILAR RESULTS	33
Air Force Enlisted Inventory Projection Model	34
Predictions by Different Models	36
REFERENCES	39

FIGURES

1.	Lifetime Annuity for a 40-Year-Old Retiree with 20 Years of Service	15
2.	Lifetime Annuity for a 50-Year-Old Retiree with 30 Years of Service	15
3.	USAF Enlisted Force Experience Profile	16
4.	DRM Predicts Greater Losses than ACOL under the New Retirement Policy	16
5.	Effects of the New Retirement Policy on Airman Retention as a Percentage of Baseline Population	17
6.	Additional Losses Will Be Greater among Personnel with Higher Civilian Opportunities	20
A.1.	The Effect of Random Shocks on the First Term Retention Rate	29
B.1.	Personnel changes as a percentage of base population predicted by three ACOL models	37

TABLES

A.1.	Parameter Estimates of ACOL (QRMC V) from Simulated Data'...	26
A.2.	Comparison of Simulated Retention Rates with ACOL (QRMC V) Predictions	27
A.3.	Comparison of the Actual Standard Deviation of Tastes with ACOL (QRMC V) Estimates	30

I. INTRODUCTION¹

Rational expectations doctrine was first introduced into economics by Muth in 1961. With Lucas's (1976) criticism of conventional procedures for econometric policy evaluation, rational expectations doctrine gained momentum and has become one of the most important developments in economic theory in the past decade. Conventional economic forecasting models are based on past behavior, and the basic assumption of policy analysis is that the parameters of the econometric models are invariant to changes in policy. Lucas pointed out that if a policy intervention changes the structure of the econometric models that were estimated when past policies were in effect, then those models cannot be used for analyzing the policy intervention. This argument cast serious doubt on the validity of many macroeconomic models in analyzing economic policies.

One of the reasons that parameters of econometric models are not invariant to policy changes is that they incorporate people's expectations. The implication of Lucas's criticism is that instead of estimating parameters of response functions, what should be estimated are the parameters of economic agents' objective functions and of the stochastic processes they faced historically. In the past ten years, analysts have tried to deal with Lucas's criticism by incorporating the expectations of economic agents into econometric equations. However, the requirement to identify the parameters of the stochastic processes the agents face jointly with the parameters of their objective functions adds to the difficulty of estimation.

This paper shows that similar arguments apply to an important model used in a microeconomic setting. In particular, the most commonly used military personnel retention model, the Annualized Cost of Leaving

¹The basic research for this paper was conducted as a part of a doctoral dissertation in policy analysis at The RAND Graduate School. For more comprehensive treatment of the subject see R. Yilmaz Argüden, *Personnel Management in the Military: Effects of Retirement Policies on the Retention of Personnel*, The RAND Corporation, R-3342-AF, January 1986.

(ACOL) model, is shown to be vulnerable to Lucas's criticism. However, this vulnerability varies with the policies that need to be analyzed. To assess the practical importance of the ACOL model's theoretical limitations with respect to specific policies, a simulation methodology is developed. A similar strategy could be used to evaluate the practical importance of the rational expectations criticism for macroeconomic models in analyzing specific policies.

Section II describes two approaches to modeling personnel retention behavior. It also explains the simulation methodology that is used in evaluating the deficiencies of the ACOL models. Section III shows an application of this methodology to evaluate the practical importance of the ACOL model's limitations in analyzing the new military retirement policy. Section III also reports the differential effects of the new retirement system on personnel with different skill levels (a measure of the impact on personnel quality). Section IV summarizes the paper and comments on the policy relevance of this research.

II. THEORY AND METHODOLOGY

Evaluation of cost changes of any military personnel policy change requires the distribution of the manpower available to the various services by years of service (YOS) and grade, because military pay (active and retirement) is primarily dependent upon these factors. Changes in military manpower influence military readiness. Managers assessing the future readiness of the force would also profit from having information on the potential effects of the new retirement system on occupational composition, quality,¹ and experience of available personnel. Therefore, retention models that can provide predictions of detailed force profile consequences of retirement policy changes are central to the evaluation of cost and readiness effects of retirement policies.

In June 1986, the Congress passed the Military Retirement Reform Act. Most of the analyses of alternative retirement policies leading to the new retirement policy were primarily based on the most commonly used retention model, the Annualized Cost of Leaving (ACOL) model. However, the structure of the estimated ACOL model is likely to change by the policy interventions, (the alternative retirement policies), that were being analyzed. Therefore, the predictions of the retention effects obtained from the ACOL model may be biased. Another model, the Dynamic Retention Model (DRM), was developed at RAND to analyze a broad range of compensation policies including those without a historical analogue. This section describes the theory behind the ACOL and DRM models.²

¹See Ward and Tan (1985) for an operationalization of the concept of quality.

²For a more complete description of these models, see Gotz and McCall (1984) and Argüden (1986).

MODELING CONSIDERATIONS

Behavioral models of retention incorporate four factors with varying degrees of success: military income opportunities, civilian income opportunities, persistent differences among individuals that influence their valuation of nonpecuniary benefits of military and civilian life (tastes), and random events--such as sickness in the family--that may influence individuals' retention decisions ("random shocks").

Financial Incentives

The models used in retirement policy analysis assume that retention decisions are influenced not only by current military and civilian compensation levels, but also by life-cycle income opportunities offered in these two sectors. The models calculate a cost-of-leaving (COL) measure, which is the monetary gain or loss from staying in the military for at least one more term relative to leaving the military at the current decision point. The COL is then related to observed retention rates to estimate the sensitivity of military personnel to compensation levels. Most military personnel who leave usually do not come back. Therefore, the value of leaving is straightforward to calculate. But the value of staying is difficult to calculate, because it depends on how long an individual stays with the military. One of the major differences among retention models originates from the way they weigh the values of staying based on each possible length of stay.

Of the four factors that are incorporated in these models, military and civilian income opportunities are directly observable (despite the difficulties of doing so), but tastes and random shocks are not. The most important differences among the retention models are caused by the approaches they take in modeling tastes and random shocks.

Tastes

If retention decisions were not affected by tastes or random shocks, then each member of the cohort who faces the same military and civilian income opportunities would make the same stay/leave decision. But individuals differ in their tastes toward military service³.

Therefore, at the first decision point those with higher tastes toward military are more likely to stay. The voluntary retention decisions act to sort out those who have high tastes for the military from those who do not. As the cohort ages, the concentration of individuals with higher tastes for the military increases. Under similar economic conditions, retention rates increase with years of service because the individuals with higher taste for the military are more likely to stay in military service. Note that this increase in retention rates is distinct and separate from any increase in the financial incentive to stay with years of service. That is, if we compare the responses of a cohort with the same cost of leaving at the first decision point and at a later decision point, we will see that the retention rate is higher at the later decision point.

Inadequate modeling of tastes can lead to three problems. First, if the effect of increasing average tastes of a cohort on the increasing retention rates with years of service is not captured, then all of the increase in retention rates will be attributed to increasing financial incentives of military service with years of service due to approaching retirement eligibility. Hence, the effects of compensation changes would tend to be overpredicted.

Second, tastes provide a link between past compensation policies and current retention rates. This cannot be captured without modeling tastes. An example helps to clarify this point. Suppose that at the first decision point a very large bonus is paid to increase the retention rate. This will increase the returns to staying with the military for one more term, so many individuals who would otherwise leave will change their minds and stay. However, those who would have stayed even without the incentive of this large bonus will have a higher taste for the military than those who were induced to stay with the bonus. Hence, the *average* tastes for those who stay will be lower when more people are induced to stay by providing a large bonus. At the next decision point the additional people who stayed with the military due to the large bonus will be more likely to leave than those who would have

³This may be due to personal differences in the valuation of the nonpecuniary elements of military and civilian life or it may capture other unmeasured persistent personal peculiarities among individuals.

stayed without the bonus. Therefore, past compensation policies (in this case a large bonus in the previous term) will have an effect on current retention. Inadequate modeling of this leads to predictions that miss the effects of long-term behavioral responses of agents to policy interventions.

Third, higher-taste people are less sensitive to changes in military pay than lower-taste people, because a smaller part of their satisfaction is due to military income. Failure to estimate separate COL effects on the retention behavior of people with different tastes will cause underprediction of the effects of military pay changes in earlier years of service and overprediction in later years of service, because average tastes increase with years of service.

Random Shocks

If there were no random shocks, then each member of a cohort who has the same taste for military life and who faces the same military and civilian income opportunities would make the same stay/leave decision. Typically, after the first decision point, cost of leaving increases until the 20th YOS due to the retirement system. Since an individual's taste for military life is unlikely to change and his financial incentives to stay are increasing, those who stay at the first decision point will have no reason to leave until YOS 20, unless there are random shocks. But there are losses after the first decision point. Retention models vary in how they incorporate random shocks into the models. Most of them treat random shocks in the error term of a regression equation. This implicitly assumes that although the random shocks affect individual decisions at each decision point, the individuals persist in behaving as if there would be no more random shocks in the future. This cannot be considered a rational way of forming expectations.

THE ANNUALIZED COST-OF-LEAVING MODEL (ACOL)⁴

The ACOL model tries to incorporate four factors into the model: military income opportunities, civilian income opportunities, tastes

⁴For a formal exposition of the model see Warner (1979, 1981), and Smoker (1984).

toward military life, and random shocks. The first step in calculating the cost-of-leaving measure for the ACOL model is to obtain a separate COL for staying until the person reaches each of the future decision points. This is done by subtracting the present value of the income stream that would be obtained by leaving at the current decision point from the present value of staying until the relevant future decision point and then leaving. Then the annuity equivalence of the present value of COL is computed over the horizon between the current decision point and the relevant future decision point. This value is called the annualized cost of leaving, hence the name ACOL. It is the net amount forgone in pay for each year between the current year and the relevant future decision point if the individual leaves military service rather than staying until the future decision point. The problem of determining the appropriate time horizon for staying is resolved by choosing the future decision point that gives the maximum annualized COL value. If this value plus the annual monetary value of his tastes is positive, then it means that the military is offering him more money than his valuation of civilian income and civilian employment. If that sum equals zero, then the individual is just on the margin between staying and leaving. If it is less than zero then the civilian sector is more attractive and the model assumes that the individual would leave.

This formulation of cost of leaving makes the measure of financial incentives directly comparable to the annual monetary value of tastes. Unfortunately, tastes cannot be observed directly. Yet, the higher the value of annualized COL, the higher will be the retention rates. If the tastes in a cohort are distributed according to a particular probability distribution, then the calculated annualized COL values can be related to observed retention rates to estimate the effects of compensation changes on retention rates. Usually, tastes are assumed to be distributed logistically and the parameters of the model are estimated by using the following equation:

$$r_i = 1 / (1 + \text{EXP} (-(B_0 + B_1 * \text{ACOL}_i)))$$

where r_i is the retention rate at the decision point i , and ACOL_i is the annualized cost of leaving at the decision point i , B_0 and B_1 are the parameters to be estimated.

The ACOL model suffers three important limitations. First, it cannot predict the censoring of tastes over time due to self-selection.⁵ The model is estimated by pooling data across different YOS (to have sufficient variation in annualized COL values), but it does not explicitly capture the effect of past policies on average tastes at different YOS. Therefore, its estimated parameters are dependent on the compensation and personnel policies that were faced by the current personnel. Any significant policy change will affect not only the annualized COL values, but also the parameters of the ACOL model. Because the average value of tastes, the annualized COL measure, and the retention rates increase with YOS, the retention effects of pay will be overstated.

Second, the ACOL model does not explicitly model the effects of random shocks on retention decisions, but treats them as the error term of a regression equation. This leads the ACOL model's estimate of the standard deviation of the taste distribution to be higher than the actual standard deviation. Since the coefficient of the annualized COL variable is inversely proportional to the standard deviation of tastes, the sensitivity of the retention rates to pay will be understated.

Third, the ACOL model is a maximum regret model. Because, in deciding the time horizon for staying, it focuses only on the future decision point that maximizes the annualized COL, it rejects the possibility that policy changes affecting compensation in certain YOS ranges may change the retention rates in earlier years. Furthermore, when a policy changes the time horizon that maximizes the annualized COL, abrupt retention effects may be predicted. Fortunately, most retirement policies do not change the time horizon in which annualized COL is maximized and do not affect the second best time horizon differentially from the best time horizon.

The first two limitations are more important than the last in most applications. The biases caused by them work in opposite directions and the net effect is to understate the effects of retirement policy changes

⁵As individuals make voluntary stay/leave decisions over time, those who stay are more likely to have greater tastes for military life than those who leave.

The first two limitations are more important than the last in most applications. The biases caused by them work in opposite directions and the net effect is to understate the effects of retirement policy changes on retention rates, particularly in the earlier YOS where more individuals are affected. Appendix A provides a more detailed analysis and quantification of the limitations of the ACOL methodology.

DYNAMIC RETENTION MODEL (DRM)⁶

In an all-voluntary force environment, military personnel commit themselves to military service for limited time periods (usually four years for enlisted members). Therefore, they face multiple stay/leave decisions during their careers. Compared to ACOL, the DRM is the more theoretically sound model because it incorporates the sequential nature of the retention decisions explicitly in the model and estimates the parameters of economic agents' objective functions and of the stochastic processes they faced historically rather than estimating parameters of a response function. This ensures that the structure of the model is not affected by the policies that are analyzed.

The DRM recognizes that each individual's probability of remaining in the military depends not only on civilian and military income streams but also on the possibility of random shocks and on his taste value. The DRM recognizes that individuals differ persistently in their tastes toward military life and incorporates the monetary value of their tastes in the model's cost-of-leaving calculations. Because the taste values of individuals cannot be observed explicitly, calculations of the cost of leaving require inferences about the distribution of tastes among the members of a cohort.

The DRM also assumes that individuals recognize that random shocks may change their future behavior. Therefore, they cannot know when they will leave military service with certainty. Hence, in calculating returns to staying, the DRM does not focus on a single future decision point, but uses a weighted average of the present values of staying

⁶For a formal exposition of the model see Gotz and McCall (1984) and, for the nontechnical reader, Fernandez, Gotz, and Bell (1985).

until each future decision point. The weights are an individual's probability of remaining in the military until the relevant future decision points. In the DRM, individuals are assumed to know the monetary value of their tastes and the probability distribution of random shocks. For example, the model recognizes that individuals are more likely to stay today if they know that they can avoid receiving large negative random shocks, say undesirable assignments, by leaving the military in the future. The random shocks are an integral part of the model. The parameters of the stochastic process (random shocks) are estimated jointly with parameters of the economic agents' objective function (tastes), and these parameters are independent of the policies that need to be analyzed. Therefore, DRM deals with Lucas's criticism effectively.

The versatility of the model and its consistent treatment of the self-selection effects exact a cost in increased difficulty of estimation. This is because, in the DRM, the cost-of-leaving measure cannot be evaluated independently from the estimation of the model's parameters. The DRM specifies distributional forms for the random shocks and the tastes among the members of a cohort at the time of their entry to the military. It also assumes that these distributions are the same across cohorts and that individuals know their taste values, the value of the random shock they receive in the current period, and the probability distribution of future random shocks. The parameters of the model can be estimated by maximum likelihood methods, where the likelihood measure is the probability that the model attaches to the observed set of sequential stay/leave decisions for a given set of parameters.

Estimation of the DRM requires longitudinal data that are more difficult to collect and use than cross-sectional data. Estimation of the model for different subgroups of personnel with different taste or random shock distributions would add to the difficulty of its data requirements. Although theoretically possible, incorporating additional variables that may influence retention decisions is very difficult because additional variables further complicate the already cumbersome estimation process.

Despite its estimation difficulties, predictions from the DRM are fairly easy to obtain once the parameters of the model are known. A simulation model is required to obtain estimates of retention rates because the DRM's parameter estimates are not average responses of military personnel to different compensation policies, but describe the dynamic environment and preferences of military personnel.

THE SIMULATION METHODOLOGY

Lack of variance in the deferred compensation component of the military compensation package makes estimation of the potential effects of changes in retirement policies and validation of the retention models difficult. Therefore, the evaluation of the adequacy of ACOL models for retirement policy analysis was based on a simulation methodology.⁷ This methodology used a theoretically sound model, the Dynamic Retention Model (DRM), to generate pseudo-data under different policy settings. Then, an ACOL model⁸ was estimated using the simulated data under the old retirement system, and its predictions were evaluated against simulated retention behavior under different retirement policies.

Because of the estimation difficulties of the DRM and the limited availability of data, we did not formally estimate it. Instead, the DRM was "calibrated" by using retention rates⁹ of airmen from 1971-1981 and the parameters obtained from the calibration¹⁰ were used as inputs to

⁷A similar approach has been used in statistics in evaluating the properties of different estimators. It has also been applied in a policy setting to evaluate the adequacy of simpler models by Ignall, Kolesar, and Walker (1978).

⁸There are many ACOL models. They differ mainly in the proxy used for censoring of tastes. Most applications use a function of YOS as the proxy. The ACOL model used here is the version employed by the Fifth Quadrennial Review of Military Compensation (QRMC V), which has a single dummy variable indicating YOS less than or equal to five as the proxy for censoring of tastes.

⁹Retention rate is defined as the proportion of airmen who decide to stay with the Air Force at a particular YOS.

¹⁰For a detailed description of the calibration procedure, which is akin to maximum likelihood estimation, and the data used see Argüden (1986).

the simulation model. In the remaining part of this paper, we assume that the simulation is an adequate representation of reality. Four arguments support this assumption. First, simulated retention rates under the current retirement policy mimic actual retention rates. Second, elasticities of retention rates to a uniform increase in the military pay schedule is in accord with previous studies. Third, the simulation model gives logically consistent results for changes in the retirement system. Fourth, another version of the ACOL model¹¹ that was estimated from independent, current,¹² real data gave very similar predictions to those of the QRMV ACOL model that was estimated from the simulated data. The last point not only improves our confidence in the ability of the simulations to replicate the real world, but also shows that the major theoretical limitations of the ACOL methodology have a major impact on predictions by different ACOL models regardless of the minor implementation differences among them. For a more detailed discussion of this point, see Appendix B.

ACOL models try to incorporate the same factors as the DRM, but take some short cuts to avoid estimation difficulties. The simulation methodology is a way of evaluating the effects of these short cuts. Of course the simulated responses of airmen to different retirement systems should not be accepted as absolute truth. However, they can be used to demonstrate the size and importance of biases in ACOL models.¹³

¹¹Used by the Air Force Personnel Analysis Center (AF/DPAC) in analyzing proposals for the new retirement system.

¹²Actual retention rates of Air Force enlisted personnel from 1978-1984.

¹³The simulation methodology can also be used to devise improvements to simpler models. See Appendix A and Argüden (1986) for suggestions to improve the ACOL models.

III. AN APPLICATION OF THE SIMULATION METHODOLOGY

In June 1986, the new Military Retirement Reform Act was signed into law with the intention of saving \$2.9 billion in the 1986 accrual funding of the military retirement budget. This section applies the methodology explained in the previous section to show that the ACOL model underestimates the retention effects of this policy change.¹

The old retirement system provides an immediate, lifetime annuity to personnel who retire after 20 or more years of service. The annuity is equal to 2.5 percentage points of average of highest three years' basic pay² multiplied by the number of years of service, plus a cost-of-living adjustment (COLA). Basic pay is about 70 percent of total military compensation, so an individual who retires after 20 years of service receives about 35 percent of his final total military compensation as retirement pay. Chief master sergeants who serve the maximum 30 years in the military get 75 percent of their basic pay (about 55 percent of their final pay) as retirement pay. An average retiree is a master sergeant with 23 years of service. Under the 1987 military pay schedule, his annual retirement pay would be \$12,000. Typically, he receives retirement pay for an average of 35 years starting about age 40.

Under the new policy, the benefits will continue to be based on the highest three years of basic pay. In addition, the cost-of-living adjustments will be held to one percentage point under the inflation rate. At age 62, there will be a one-time restoral of COLA to bring the pay to the level it would have been if full COLA had been received all along. After this recomputation, COLA will again be our percentage point below inflation. Therefore, the decline in real purchasing power of the annuity will be a function of the prevailing inflation rate.

¹For a detailed policy analysis of the new retirement policy see Argüden (1987).

²All retirees whose date of entrance into military service is prior to September 7, 1980, have their retirement benefits calculated on the basis of their final basic pay.

Under the new policy, until age 62, the annuity will be 40 percent of the highest three years of basic pay for those who retire at 20 YOS and will increase by 3.5 percentage points per year for those who stay longer with the military. Therefore, the multiplier for those who retire at 30 YOS will be 75 percent, the same maximum as the old retirement system. At age 62, the annuity will be increased to reflect the multipliers available to pre-August 1986 retirees. Figures 1 and 2 show lifetime annuities, in constant dollars, for a typical 20 YOS retiree and 30 YOS retiree, respectively.

AGGREGATE EFFECTS OF THE NEW RETIREMENT POLICY

Figure 3 shows a force experience profile of Air Force enlistees, using the average retention rates during the period 1971-1981 and assuming new accessions to be 80,000. A majority of the airmen have fewer than 5 years of service. The expected years of service per accession is about 6.9 years. The retirement system ensures a stable supply of mid-length careerists between 10 and 20 Years of Service.

The new retirement system reduces the retirement income of persons in the military, making the military less desirable as a career. Therefore fewer airmen will stay with the military. Figure 4 shows the additional losses from the force profile shown in Figure 3 as predicted by ACOL and DRM. According to DRM, the largest effect of the new retirement system will be observed between YOS 8 and 20. It is interesting to note that the number of airmen staying for more than 24 YOS will increase, reflecting the higher opportunity cost of leaving prior to 30 YOS.

As explained in the previous section, the most important limitations of the ACOL methodology are due to inadequate modeling of the censoring of tastes and random shocks. The effect of these two limitations on ACOL predictions work in opposite directions. According to our simulations, the net effect is to underpredict the changes in retention rates. For example, while the DRM predicts that under the new retirement system there will be about 2500-3000 fewer airmen in each YOS group between YOS 10 and 20, the ACOL model predicts only about 500 fewer airmen. As a percentage of the number of airmen currently serving in the mid-career YOS groups (YOS 8 to 20), the DRM predicts a 22

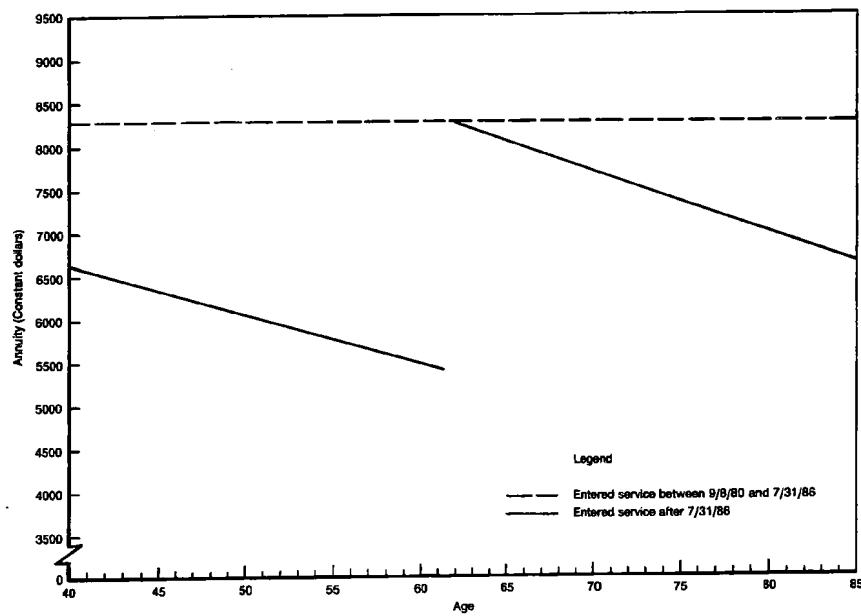


Fig. 1 -- Lifetime annuity for a 40-year-old retiree with 20 years of service

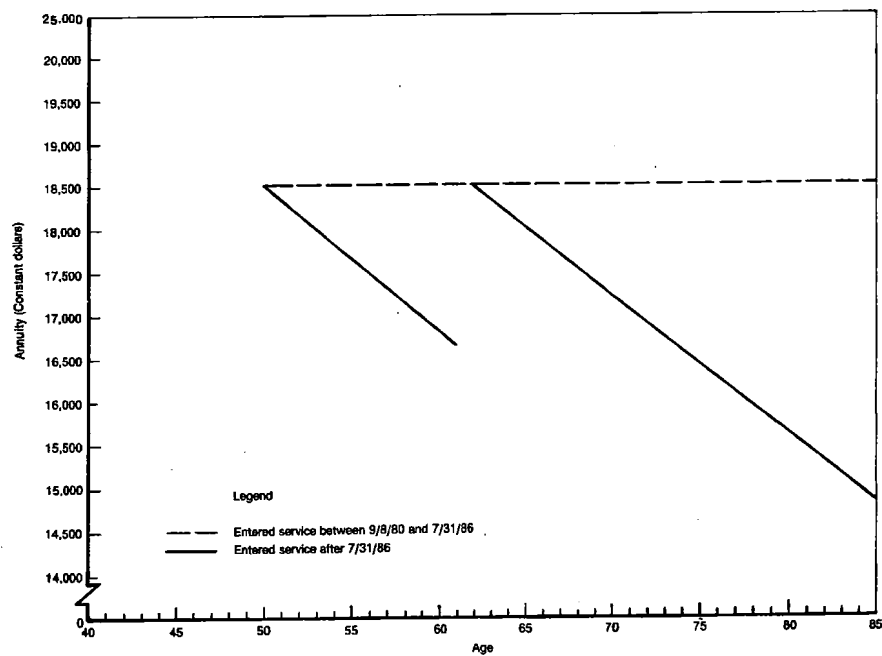


Fig. 2 -- Lifetime annuity for a 50-year-old retiree with 30 years of service

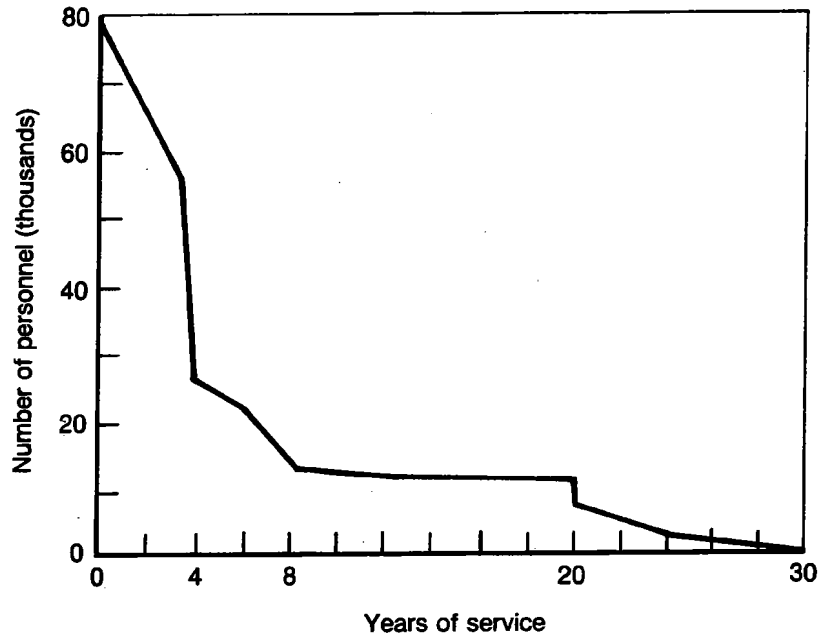


Fig. 3 -- USAF enlisted force experience profile

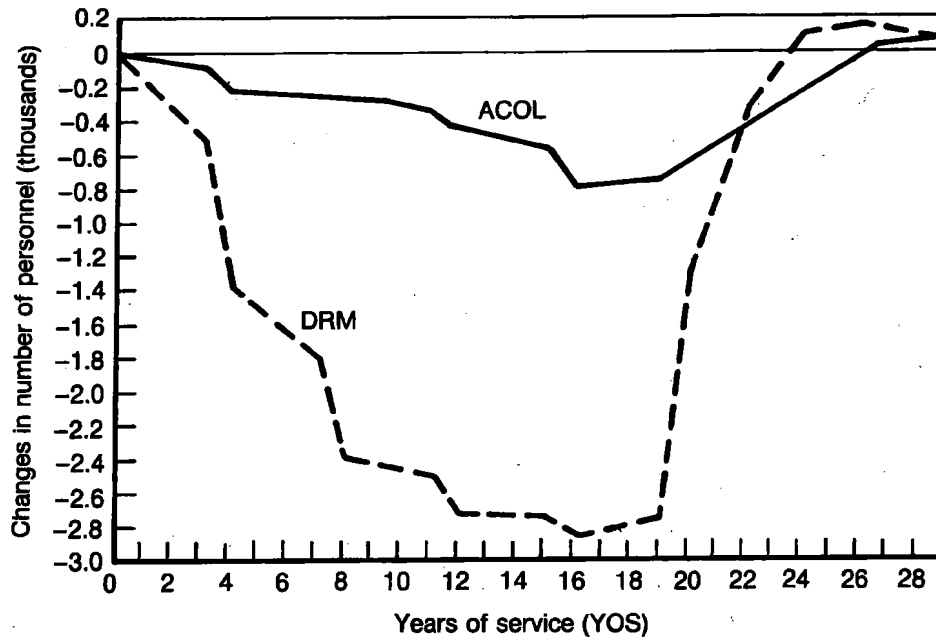


Fig. 4 -- DRM predicts greater losses than ACOL under the new retirement policy

percent reduction and the ACOL predicts only a 4.5 percent reduction (Figure 5). Clearly, the structure of the ACOL model does *not* remain stable under the policy intervention. Therefore, it provides misleading predictions about the retention effects of the new retirement policy. A theoretically more rigorous model whose structure is unaffected by the policy intervention (the DRM) predicts that the expected years of service per accession will be reduced by about 0.5 years to 6.4 (about 7.5 percent reduction), while the ACOL model can only capture a quarter of that change.

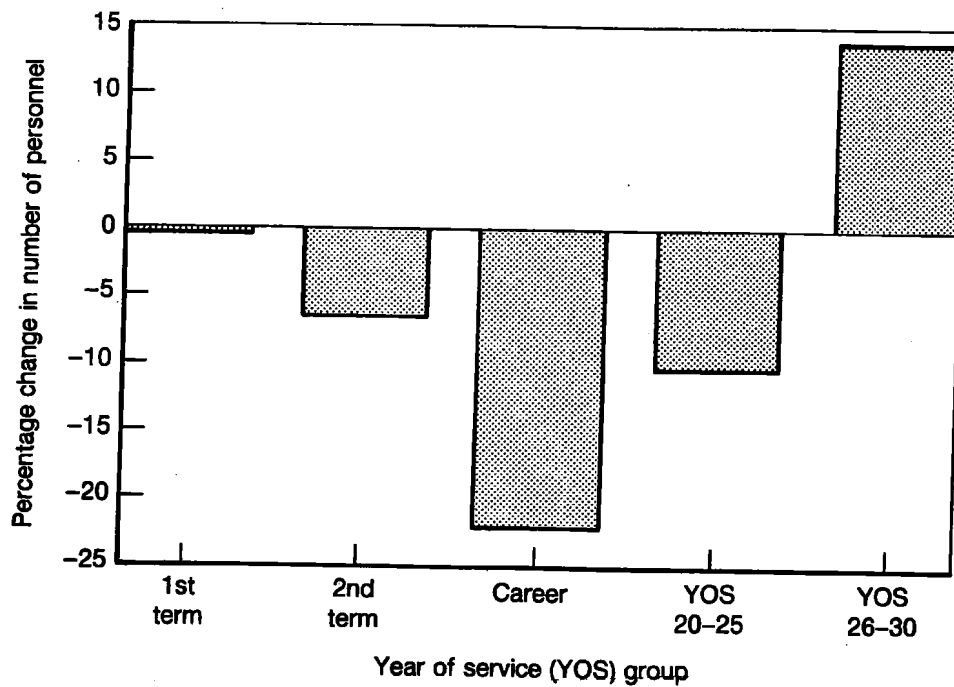


Fig. 5 -- Effects of the new retirement policy on airman retention as a percentage of baseline population

DISAGGREGATE EFFECTS OF THE NEW RETIREMENT POLICY

The simulation methodology not only enables quantification of the importance of the theoretical limitations of simpler models, but also provides an environment in which controlled experiments can be conducted.

The previous subsection examined the retention effects of different retirement policies by concentrating on retention rates by years of service. Further disaggregation of the retention effects by grade, occupational group, and quality levels would be useful for accurate assessment of cost and military readiness effects. In particular, personnel in different occupations with different quality and experience levels³ are likely to have different productivity levels in terms of military readiness. Concentrating on only the aggregate retention effects of alternative policies may disguise large gains in one group with large losses in another. Because of the differences in the productivities of these groups, important military readiness effects may go unnoticed unless disaggregate analysis is conducted.

In reality it may be difficult to identify subgroups of airmen with different characteristics like "quality" levels. However, in the simulation environment we can test to see how individuals with different characteristics will behave under the new retirement system.

In our simulations we differentiated among three groups of airmen: those facing civilian income opportunities that are 10 percent higher than the average, those facing average civilian income opportunities, and those facing civilian income opportunities that are 10 percent lower than the average.⁴ If we assume that skills may be transferred between military and civilian occupations and that those with better skills would receive higher civilian income than others, the differential effects of alternative retirement systems on personnel with different

³See Ward and Tan (1985) for operationalizing the concept of quality.

⁴We also differentiated among airmen with different promotion probabilities and bonus opportunities. For differential retention effects of retirement policies with respect to these dimensions see Argüden (1986).

"quality" levels can be inferred by observing the changes in the retention rates of these three groups.

Two factors drive the differences in the effects of a policy change across groups of airmen with different characteristics. First, if the retention rate at a *particular* decision point is *very high or very low*, then the effect of a compensation policy change is likely to be *small*, *ceteris paribus*.⁵ A very high retention rate means that the financial incentives offered are already much more than enough for many individuals and only those with very low tastes for the military leave.⁶ In that case, a change in the compensation is likely to leave the financial incentives high enough for many individuals, so they will not change their stay decision. Similarly, if the retention rate is very low, the financial incentives are already too low for many individuals and only those with very high tastes stay in the military. Therefore, a change in the retirement system is unlikely to influence the decisions of many individuals. However, if the retention rate is closer to the mode of the taste distribution, more individuals are making close calls between staying and leaving. In this case, a change in the retirement system is likely to influence more individuals' decisions.

Second, if the retention rates at the *earlier* decision points were already *low*, the effect of a policy change is likely to be *smaller* than otherwise, *ceteris paribus*. Low retention rates at the earlier decision points mean that those who stayed did so despite low financial incentives. Many others who faced similar financial incentives left. Therefore, those who stayed are likely to have very high tastes for military life and their decisions are less likely to be swayed by changes in the compensation system. For individuals who persistently face financial incentives different from those of the rest of their

⁵This argument assumes unimodality of the taste distribution. It also assumes that the probability density function of tastes increases monotonically with tastes until the mode of the distribution is reached and decreases monotonically with tastes thereafter (that is, the probability of an individual having very high or very low tastes toward military life is less than the probability of having a taste value closer to the one most commonly observed).

⁶Random shocks may also influence decisions, but for simplifying the argument we ignore this consideration.

cohort, the first and the second factors will be working in opposite directions during career years.

Figure 6 shows that between YOS 8 and 20, the retention rate for high quality airmen (those with high civilian opportunities) under the new retirement system will be lower than the retention rate for others. Therefore, not only would there be fewer airmen serving in the YOS 8 to 20 groups but those who leave are likely to be the more productive ones.

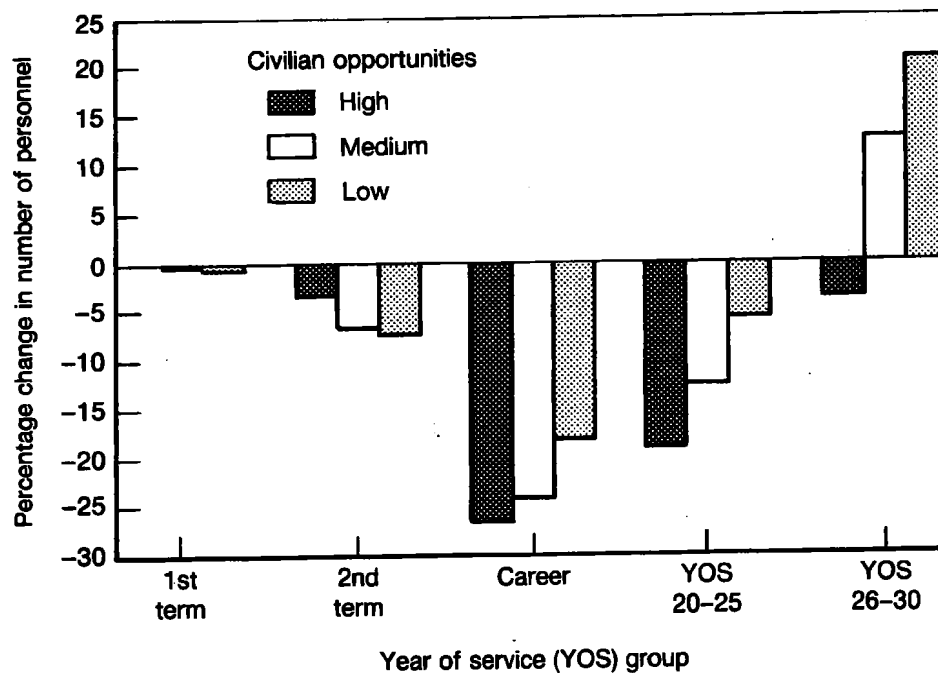


Fig. 6 -- Additional losses will be greater among personnel with higher civilian opportunities

IV. CONCLUSIONS

We have shown that the rational expectations criticism should be taken seriously not only for macroeconomic models but also for microeconomic models. Especially in analyzing policies that are structurally different from past policies (such as the military retirement policy), more emphasis has to be placed on using models whose structures will remain stable.

In practice, empirical implementation of theoretically more rigorous models may be difficult. Nevertheless, such models might be able to be used in a simulation mode to evaluate the practical importance of the limitations of simpler models and to devise improvements to the simpler models.

Most of the analyses that were conducted in formulating the new retirement policy for U.S. military personnel and in analyzing the retention effects of the new policy were based on the Annualized Cost of Leaving (ACOL) model. This paper used the Dynamic Retention Model (DRM) in a simulation mode, to show that the ACOL methodology suffers considerable biases and that the potential retention effects of the new policy are likely to be much larger than what the ACOL models predict.

Appendix A

LIMITATIONS OF THE ACOL METHODOLOGY

This appendix elaborates on the three important limitations of the ACOL methodology: inadequate modeling of tastes, inadequate modeling of random shocks, and being a maximum regret model. Although there are other papers¹ comparing the DRM with ACOL models, none of them is as comprehensive as Argüden (1986) in its treatment of the limitations of the ACOL methodology. This appendix summarizes that discussion.

TASTES

The first limitation of the ACOL model is that it cannot predict the censoring of tastes over time due to self-selection. By pooling data across different YOS without explicitly modeling the change in the distribution of tastes, the statistical methodology to estimate the parameters of the model implicitly assumes that an individual's tastes change at each decision point.² This assumption breaks the link between compensation policies in one period and the retention rates in the next. When tastes are assumed to be logistically distributed, B_0 is proportional to the mean of the taste distribution and B_1 is inversely proportional to the standard deviation of the tastes in a cohort. After the first decision point, if people with low tastes leave, then the mean of the truncated distribution will be higher and the standard deviation will be smaller (i.e., the remaining people will be more homogeneous in their tastes toward military life and their tastes will be higher than the average tastes for the entering cohort). Therefore, the parameters of the model will not be constant over time due to self-selection effects. Furthermore, the shifts in the parameters will be a function

¹See Warner (1981), Gotz and McCall (1984), and Fernandez, Gotz, and Bell (1985).

²The calculation of the ACOL values assumes that tastes persist over time. Therefore, there is an internal inconsistency in the model as it has been applied. This point has been identified by Gotz and McCall (1984).

of the past compensation policies that influenced the self-selection effects in the past. In estimation, if the parameters are assumed to be constant across years of service, then the ACOL model will have different biases in different years of service. In particular, the decrease in the standard deviation of the taste distribution with years of service is likely to increase the coefficient, B_1 . But, if a single B_1 is estimated across years of service then the retention effects of compensation changes at the earlier years of service are likely to be overpredicted and the retention effects at the higher years of service are likely to be underpredicted.

Realizing this problem, users of the ACOL model make ad hoc adjustments by using a proxy variable to capture the censoring of tastes as the cohort ages. Most applications use a function of years of service (YOS) as the proxy for censoring of tastes. These functions include a dummy variable at each decision point (the natural logarithm of years of service) and estimating different coefficients for the ACOL variable for different YOS groups. QRMC V used only one dummy variable-- YOS less than or equal to five. However, the estimate of the coefficient of the YOS variable will reflect the particular censoring pattern that gave rise to the data that were used in estimating the model. Therefore, when major shifts in the retention patterns are analyzed with this model, the predictions will not be sensitive to the new censoring patterns of the tastes. Although this adjustment may be adequate in analyzing retention effects of minor changes in compensation, it is less likely to be adequate when major changes in the retirement system are being analyzed with this model.

Different versions of the ACOL model have different biases. This study uses QRMC V's version as the base case ACOL model in evaluating the limitations of the ACOL methodology. To evaluate the impact of these limitations, the QRMC V ACOL model was estimated using three sets of simulated data corresponding to three different discount rates.³ The estimated coefficients for the three cases are presented in Table A-1.

³The simulation model was calibrated against retention data from the period 1971-1981 by using three different discount rate assumptions and then, using the calibrated parameters, retention decisions of military personnel under the current compensation system were simulated. These data were then used to estimate the QRMC V ACOL model.

They are similar to each other, but the coefficient of the ACOL variable is larger for a 10 percent discount rate than for a 5 percent rate or a tapered rate from 20 to 2 percent.⁴ The differences in the ACOL coefficients are consistent with previous findings. When the dispersion in tastes is greater, the coefficient of the ACOL variable is greater. Gotz and McCall (1984) estimated the ACOL model for Air Force officers using the same data as used in their estimates of the DRM and found the same phenomenon. This is simply due to ignoring the persistence of tastes. Since the average value of tastes, the annualized cost-of-leaving measure, and retention rates increase with YOS, the retention effects of pay in the ACOL model will be overstated. Furthermore, we would expect the ACOL model's predicted retention rates to be larger than the actual retention rates in earlier YOS and smaller in later YOS. Table A.2 compares simulated retention rates with those predicted by the ACOL model. The large significant negative coefficient for the YOS=4 dummy variable in Table A.1 and the differences between predicted and actual (simulated) retention rates in Table A.2 confirm that the censoring of tastes is not fully captured in the QRMC V ACOL.

RANDOM SHOCKS

The inability of the ACOL model to capture the self-selection effect has been identified in previous studies,⁵ but ACOL has another limitation that introduces biases in the opposite direction: It does not explicitly model the effects of random shocks on retention decisions but treats them as statistical error terms in a regression. ACOL focuses only on those who are on the margin of staying and leaving when their tastes and financial incentives are considered. But, as discussed earlier, uncertain events, such as especially good or bad assignments, may influence retention decisions as well. Therefore, some individuals with very high tastes may leave due to a large negative random shock and some individuals with very low tastes for the military may decide to

⁴Tapering assumes that the individual's discount rate decreases exponentially with YOS, falling more rapidly at the early YOS from 20 percent at YOS 4 to 2 percent at YOS 30.

⁵See for example, Warner (1981), Gotz and McCall (1984), and Fernandez, Gotz, and Bell (1985).

Table A.1
PARAMETER ESTIMATES OF ACOL (QRMC V)^a
FROM SIMULATED DATA^b

Variable	Estimate (Asymptotic Standard Error)		
	Discount Rate		
	10% ^c	5% ^d	20-2% ^e
Intercept	1.095 (0.0061)	0.916 (0.0062)	0.966 (0.0067)
ACOL ^f	0.101 (0.0017)	0.085 (0.0010)	0.076 (0.0008)
YOS = 4	-1.376 (0.0090)	-1.063 (0.0097)	-1.257 (0.0093)

^aAlthough tastes are distributed according to a normal distribution, the ACOL model was estimated with logistic regression to be consistent with previous work (Warner, 1979, and Enns, Nelson, and Warner, 1984). But logistic and normal probability distributions do not differ materially.

^bData based on simulated decisions of 100,000 airmen, each belonging to one of 28 groups defined by a different civilian and military earnings potential.

^cAirmen differ in their tastes toward military life according to $N(0, 5001^2)$.

^dAirmen differ in their tastes toward military life according to $N(500, 2001^2)$.

^eDiscount rate is tapered from 20 percent to 2 percent. Airmen differ in their tastes toward military life according to $N(1000, 2001^2)$.

^fAnnualized cost of leaving is expressed in thousands of dollars.

Table A.2
COMPARISON OF SIMULATED RETENTION RATES WITH
ACOL (QRMV) PREDICTIONS

	Years of Service							
	4	8	12	16	20	23	26	29
<i>Discount rate = 10%</i>								
Simulated Ret. Rate	.326	.539	.808	.950	.726	.531	.353	.190
ACOL Prediction	.326	.723	.740	.820	.664	.376	.288	.180
<i>Discount rate = 5%</i>								
Simulated Ret. Rate	.325	.535	.853	.971	.705	.474	.297	.140
ACOL Prediction	.325	.667	.731	.863	.660	.373	.280	.149
<i>Discount rate = 20%-2%</i>								
Simulated Ret. Rate	.338	.542	.940	.998	.725	.607	.340	.146
ACOL Prediction	.338	.719	.770	.897	.734	.456	.320	.171

stay due to a very large positive random shock. Hence, everybody is on the margin of a stay/leave decision, not only those whose tastes are equal to the negative of the cost of leaving.⁶

Describing the estimation of the parameters of an ACOL model will clarify the biases caused by ignoring random shocks. Assume that the mean of the taste distribution is known and one is trying to estimate the standard deviation of the taste distribution by focusing on the first decision point. Given an observed retention rate at the end of the first term of enlistment, estimation of ACOL is equivalent to (1) assuming a functional form for the taste distribution, (2) calculating the cost of leaving from financial incentives, and (3) asking what value of the standard deviation of the taste distribution makes the proportion of airmen with taste values greater than the negative of annualized cost

⁶Each person has a probability of leaving that is greater than zero. Those with higher tastes for military life are likely to have lower probabilities of leaving than those with low tastes.

of leaving (-ACOL) equal the observed retention rate? If there were no random shocks (and if the functional form and the mean of the taste distribution were known) this procedure would estimate the standard deviation of the taste distribution correctly.

Assume that the parameters of the taste distribution are known and observe what happens to the retention rate if random shocks are introduced. The retention probabilities at the first decision point are usually less than 0.5, so adding the influence of random shocks will increase the proportion of airmen that are staying. Some individuals with tastes lower than -ACOL will stay and some individuals with tastes higher than -ACOL will leave, but more individuals who would have left without the random shocks will stay than the other way around. Since random shocks could change the decisions of individuals who are the same distance away from -ACOL with equal probabilities, and there are more individuals who have taste values that are less than -ACOL than individuals with greater taste values than -ACOL, the random shocks will increase the retention rate at the first decision point (see Figure A.1).

In the estimation of the standard deviation of the taste distribution in an ACOL model, the higher the retention rate the higher will be the estimate of the standard deviation. If the distributional form and the mean of the taste distribution are known to have a higher probability in the righthand tail of the distribution (i.e., probability of tastes being greater than a specified level (-ACOL)), the standard deviation of the distribution should be higher, too. Therefore, if random shocks actually influence retention decisions, the ACOL model's estimate of the standard deviation of the taste distribution will be higher than the actual standard deviation. Since the coefficient of the ACOL variable is inversely proportional to the standard deviation of tastes, the sensitivity of the retention rates to ACOL will be underpredicted. When a retirement policy change that reduces the ACOL values is considered, the potential reduction in the retention rates will be predicted to be smaller than the actual changes.⁷

⁷This effect has been explained here only at the first decision point and with the assumption of known mean for the taste distribution. Obviously, the mean of the taste distribution has to be estimated, too. Therefore, ignoring random shocks will bias that parameter's estimation

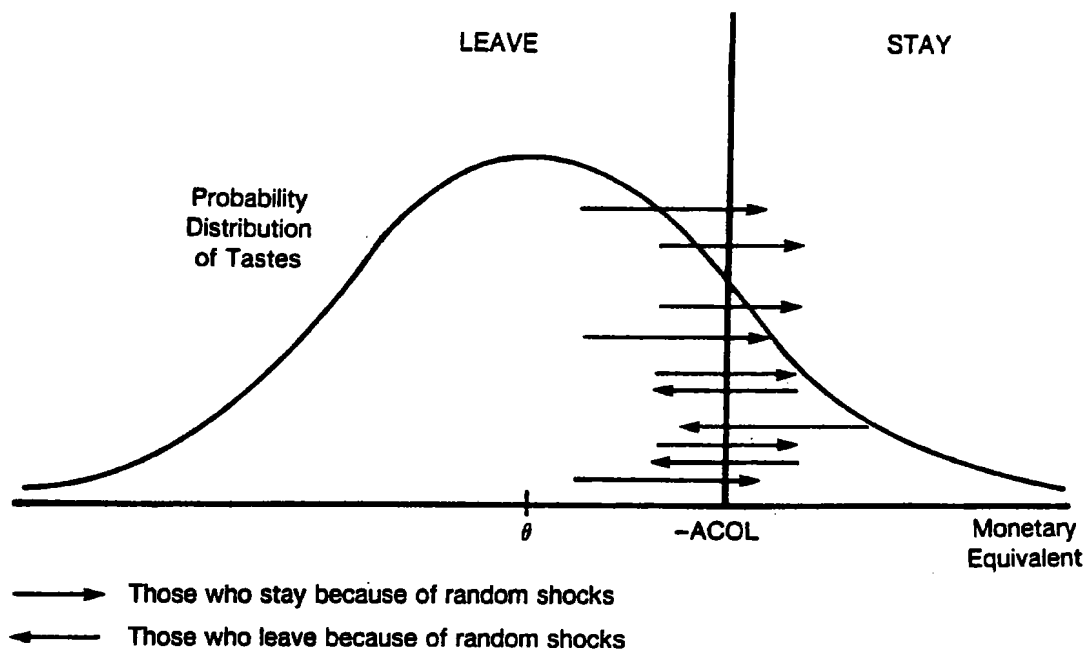


Fig. A.1 -- The effect of random shocks on the first-term retention rate^a

^aBecause the probability distribution of tastes is a symmetric, unimodal probability distribution around its mean θ , and the retention rate without random shocks is less than 0.5 (i.e., $-ACOL > \theta$), the introduction of random shocks increases the retention rate.

Fig. A.1 -- The Effect of Random Shocks on the First Term Retention Rate

Ignoring the existence of random shocks leads the ACOL model to assume that two income streams whose annuity equivalences are the same will have the same retention effects regardless of the differences in length of time required to realize the benefits in each stream. But the longer an individual has to wait to realize the benefits of an income stream, the higher will be the probability of receiving a large random shock that may induce him to leave and not be able to receive those benefits.

as well. Furthermore, the argument becomes more difficult through years of service (it becomes conditional on ACOL values at previous decision points).

In previous work, the evaluation of the limitations of ACOL methodology was limited to showing that, when the dispersion in tastes is greater (i.e., when individuals are less sensitive to pay), the coefficient of the ACOL variable is greater (Gotz and McCall, 1984). Our findings in Tables A.1 and A.2 are in agreement with earlier work. However, unlike previous research, in the simulation world we actually know the standard deviation of the taste distribution. Therefore, we can compare ACOL's estimate of the standard deviation of the taste distribution with the actual standard deviation. ACOL's estimate for the standard deviation of tastes is the inverse of the coefficient of the ACOL variable. Table A.3 compares ACOL estimates with the actual taste distribution standard deviations. Two observations can be made from Table A.3. First, the higher the actual standard deviation of tastes, the lower is ACOL's estimate. Second, the ACOL model's estimates of the standard deviation of tastes are much larger than the actual standard deviations. This is due to ignoring the existence of random shocks. Basically, ACOL's estimate of the variance of tastes

Table A.3
COMPARISON OF THE ACTUAL STANDARD DEVIATION OF TASTES
WITH ACOL (QRM C V) ESTIMATES

Discount Rate in Simulation	Actual Standard Deviation of Tastes	ACOL Estimate
10% ^a	5001	9900
5% ^b	2001	11700
20%-2% ^c	2001	13200

^aTastes are distributed according to $N(0, 5001^2)$;
random shocks are distributed according to $N(0, 30000^2)$.

^bTastes are distributed according to $N(500, 2001^2)$;
random shocks are distributed according to $N(0, 40000^2)$.

^cTastes are distributed according to $N(1000, 2001^2)$;
random shocks are distributed according to $N(0, 26000^2)$.

incorporates some of the variance of the random shocks. The implication of this bias is that ACOL will underpredict the effects of changes in the retirement system on retention rates.

MAXIMUM REGRET

The third limitation of the ACOL model is that it is a maximum regret model. Therefore, it does not predict any retention effects for pay changes that do not affect maximum ACOL value and the time horizon over which ACOL values are maximized. For example, the ACOL model predicts no effect on retention rates in the first 20 YOS for such a drastic change in the retirement system as having a flat 50 percent multiplier for all YOS between 20 and 30. This is because the annualized COL values for those at the earlier YOS are maximized at YOS 20, and any policy change that does not change the value of the retirement benefits at YOS 20 will not change this maximum value. However, in an uncertain world, changes in the values of staying until the second or third best years are also likely to affect retention behavior.

Furthermore, when the time horizon changes, abrupt retention effects may be predicted. For example, the ACOL model will predict a major reduction in the retention rates at YOS 16 for even for a hypothetical retirement policy change that increases the eligibility from 20 YOS to 24 YOS, even if the discounted benefits under this policy are kept equal to the discounted benefits under the current policy. If the discount rate is zero, the ACOL measure will be halved⁸ implying a major reduction in the retention rate at YOS 16. This policy change will indeed reduce the retention rates, but probably not as much as the ACOL model will predict. So far, most retirement policies being considered have not changed the time horizon in which annualized COL is maximized and do not affect the second best time horizon differentially from the best time horizon. Therefore, this limitation is not as important as the others.

⁸Under the new policy the same cost of leaving will be annualized over 8 years rather than 4. Discount rates other than 0 percent would not change the argument materially.

FUTURE RESEARCH

One way to deal with the *first* limitation of the ACOL model is to include a proxy variable to measure the effect of censoring tastes. A function of the proportion of an entering cohort still in the military to make a stay/leave decision at a particular decision point was used as a proxy variable in Arguden (1986) and it improved ACOL's predictive capability. A promising avenue for future research to deal with the *second* limitation would be to estimate a variance components model with a taste proxy and the ACOL measure as the independent variables. The *third* limitation may be dealt with by using weighted average of ACOL values for leaving at each future decision point rather than focusing on the best one. However, the third limitation is more difficult to deal with because proper weighting of future decision points requires incorporation of the effects of tastes and random shocks into the weights, which complicates the estimation process.

The simulation methodology explained in the main body of the paper could be utilized to evaluate the effectiveness of the proposed modifications to the ACOL model.⁹

⁹See Arguden (1986) for examples and further details.

Appendix B

DIFFERENT ACOL MODELS PRODUCE SIMILAR RESULTS

This appendix presents estimates of the retention effects of an alternative retirement system that were produced by three different models: the simulation model, which was based on DRM and calibrated with retention rate data from the 1971-1981 period; the QRMC V ACOL model, which was estimated by using the simulated data under the old retirement system; and the Air Force's ACOL model, which was estimated by using retention rate data from 1978 to 1984.¹

The retirement policy being analyzed is slightly different from the new retirement policy. It is one of the alternative retirement policies that was proposed prior to adoption of the new retirement system. We use it as an illustration here due to the availability of predictions of impacts from all three models for this policy. We show that the predictions from the two ACOL models suffer similar biases in analyzing retirement policies. In particular, the Air Force's ACOL model, which was estimated from independent, current,² real data, gives similar predictions to those from the QRMC V ACOL model, which was estimated from simulated data. This not only improves our confidence in the ability of the simulations to reflect the real world, but also shows that the theoretical limitations of the ACOL methodology, which are described in Appendix A, are likely to have a major impact on predictions from any ACOL model, regardless of the implementation differences among them.

The retirement policy analyzed here changes the retirement base from a high three-year average to a high five-year average. It also changes the multiplier from two and a half percent (50 percent at 20 YOS to 75 percent at 30 YOS) to a more complex function resulting in 43 percent at 20 YOS with an increase of 3.2 percent per year up to 75

¹This is the model that the Air Force Personnel Analysis Center (AF/DPAC) used to analyze proposals for the new retirement system.

²Actual retention rates of Air Force enlisted personnel from 1978-1984.

percent at 30 YOS. This increase in the slope of the multiplier is likely to induce more people to stay longer past 20 YOS. Full cost-of-living adjustment (COLA) is provided under this policy.

AIR FORCE ENLISTED INVENTORY PROJECTION MODEL³

The policy analysis tool currently being used by the Air Force for analyzing the impact of alternative enlisted force policies is the EPOM aggregate model. EPOM is an inventory projection model (IPM) written in the SAS programming language that econometrically adjusts loss rates using ACOL input. This section describes the ACOL calculations, the EPOM model fit, the EPOM database, and the actual inventory projection mechanism.

To compute annualized COLs for fitting and using EPOM, a FORTRAN program referred to as the Compensation Model is used. The Compensation Model reads a database consisting of pay and allowances, grade distribution, life expectancies, and civilian earnings. The program asks the user to supply assumptions for the annualized COLs, including projected pay raises, inflation, selective reenlistment bonuses, and (of particular interest to retirement analysis) year of retirement eligibility and retirement annuity base. The computer program then produces an annualized COL for each YOS using a process that is described in the literature. (See, for example, Warner, 1979.)

Before using annualized COLs to adjust loss rates in the inventory projection model, it is first necessary to establish the relationship between annualized COL and losses. In formulating appropriate linear regression models, the Air Force gathers historical data on losses over several years and runs the Compensation Model to calculate the annualized COLs that people might have implicitly calculated when they decided to stay or leave. It is assumed that, for nonretirement-eligible enlisted people, only airmen whose dates of separation (DOS) fall within a fiscal year are decisionmakers in that year. All other losses are assumed to be unrelated to economic conditions. Retirement-eligible people are assumed to be economic decisionmakers each year.

³I wish to thank Major Harvey R. Greenberg, who provided this description of the ACOL model used by the Air Force Personnel Analysis Center (AF/DPAC) to analyze proposals for the new retirement system.

The historical database has records on individual decisions with the following variables:

Category of Enlistment (CATENL) (1 = first term, 2 = second term,
4 = career)
Term of Enlistment (TOE) (4 or 6 years)
Fiscal year (FY)
Loss (1 = loss, 0 = reenlist or extend)

These individual records (approximately 400,000 for FY 78-84) are grouped into cells (several hundred), with individual loss variables averaged into rates. Associated with each cell are the ACOLs (a function of YOS and FY, and including an average bonus multiple) and the civilian unemployment rate lagged three quarters (a function of FY only).

The cells are transformed logistically by the formula:

$$\text{LOGRR} = \text{LOG} [\text{RR}/(1 - \text{RR})],$$

where RR is the retention rate and LOGRR is the logistically transformed retention rate. The result is assumed to be a linear function,

$$\text{LOGRR} = A + B1 * \text{ACOL} + B2 * \text{URL3},$$

with URL3 being the three quarter lag of unemployment. The correct heteroscedasticity--weighted linear regression is used with weights of the form $W = \text{SQRT} [N * \text{RR} * (1 - \text{RR})]$, where $N = \text{cellsize}$.

Because the responses of airmen to COL has been observed to be different for different YOS groups,⁴ the fit has been decomposed into five submodels as follows:

1. First termers (CATENL = 1)
2. Second termers (CATENL = 2)

⁴This is due to the inability of ACOL models to capture censoring of tastes (see Appendix A).

- 3 Early career (CATENL = 4, YOS \leq 14)
4. Preretirement (15 \leq YOS \leq 19)
5. Retirement eligible (YOS \geq 20)

The coefficients B1 and B2 are retained from each of the submodels (a total of 10 coefficients) and incorporated into the inventory projection model. It is not necessary to retain the constant terms because, rather than predicting an absolute loss rate, the inventory projection model adjusts an existing rate by applying the changes in ACOLs and unemployment rates to the Bs.

The inventory projection begins with a starting inventory drawn from the latest Uniform Airman Record (UAR) extract summarized into the IPM cells (YOS, grade, DOS, CATENL), and the associated rates are constructed by comparing two consecutive UARs.

The IPM itself is a relatively detailed model of enlisted force flows. Given an inventory and a set of annualized COLs and unemployment changes, loss rates are adjusted and losses by cell are computed. The survivors are aged and either extended or reenlisted for various terms according to historical rates. Then they are promoted based on a grade authorization table and historical distributions of promotions by year of service. High year of tenure losses are applied, nonprior service accessions are brought into YOS 0, and prior service accessions join various YOSs. The resulting YOS/grade profiles over the number of years of the inventory projection are sought to be as close to reality as is practical.

PREDICTIONS BY DIFFERENT MODELS

Figure B.1 shows the estimates of the changes in manpower availability by YOS as predicted by the three models. Although the ACOL model estimated from the simulated data (QRMC V) is not exactly the same as the AF/DPAC's ACOL model, they both share the same theoretical weaknesses. They differ mainly in the taste proxies used. AF/DPAC's model also incorporates a larger number of variables, such as unemployment rate. Since the unemployment rate is not modeled in the simulations, I was unable to estimate the exact form of AF/DPAC's model

by using the simulated data. Nevertheless, the predictions of both ACOL models are of similar magnitudes (Figure B.1), particularly between YOS 4 and 20, where the largest number of airmen are affected by the policy change. The similarity of the predictions from the two ACOL models, particularly for second termers and career airmen, is important in two respects. First it improves the confidence in the ability of the simulations to replicate the real world, since an ACOL model estimated from the simulated data gives similar predictions to an ACOL model estimated from independent real data. Second, it indicates that the major theoretical limitations of the ACOL methodology have a major impact on predictions by different ACOL models regardless of the implementation differences among them.

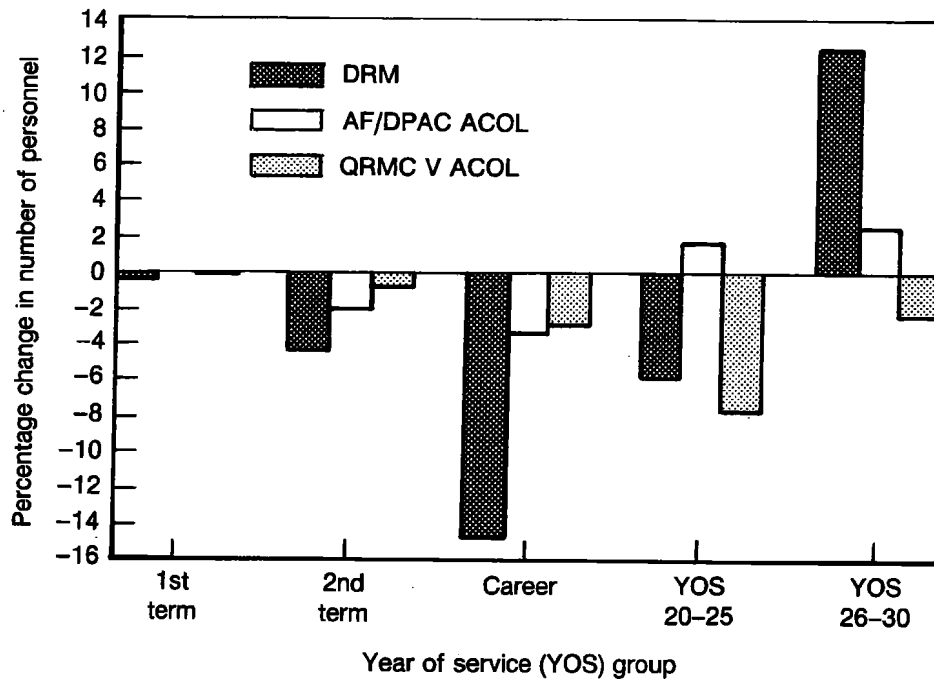


Fig. B.1 -- Personnel changes as a percentage of base population predicted by three ACOL models

It is interesting to note that the biases of the AF/DPAC ACOL model (as measured by deviations from the simulation model) are slightly less than the biases of the QRMC V ACOL model. This is likely to be a reflection of the less restrictive form of the AF/DPAC's ACOL model. In AF/DPAC's version, a separate model was estimated for those who are in different YOS groups. In the QRMC V model, a single ACOL coefficient was estimated for all personnel.

REFERENCES

- Argüden, R. Yilmaz, *Unintended Effects of the New Military Retirement System*, The RAND Corporation, N-2604-AF, May 1987.
- Argüden, R. Yilmaz, *Personnel Management in the Military: Effects of Retirement Policy on the Retention of Personnel*, The RAND Corporation, R-3342-AF, January 1986.
- Enns, John H., Gary R. Nelson, and John T. Warner, "The Economics of Retention and Retirement: The Case of the U.S. Military," *Policy Sciences*, Vol. 17, 1984. pp. 101-121.
- Fernandez, Richard L., Glenn A. Gotz, and Robert M. Bell, *The Dynamic Retention Model*, The RAND Corporation, N-2141-MIL, April 1985.
- Fifth Quadrennial Review of Military Compensation* (QRMC V), Vols. I, I-A, I-B, I-C, January 1984.
- Gotz, Glenn A., and John J. McCall, *A Dynamic Retention Model for Air Force Officers: Theory and Estimates*, The RAND Corporation, R-3028-AF, December 1984.
- Gotz, Glenn A., and John J. McCall, "A Sequential Analysis of the Stay/Leave Decision: U.S. Air Force Officer," *Management Science*, Vol. 29, No. 3, March 1983, pp. 335-351.
- Ignall, Edward J., Peter Kolesar, and Warren E. Walker, "Using Simulation to Develop and Validate Analytic Models: Some Case Studies," *Operations Research*, Vol. 26, No. 2, March-April 1978, pp. 237-253.
- Lucas, R. E., Jr., "Econometric Policy Evaluation: A Critique", in K. Brunner and A. H. Meltzer (eds.), *The Phillips Curve and Labour Markets*, "Carnegie-Rochester Conferences on Public Policy 1" (North-Holland, Amsterdam) Supplement to the *Journal of Monetary Economics*, No. 2, 1976.
- Muth, J., "Rational Expectations and the Theory of Price Movements," *Econometrica*, July 1961.
- Smoker, Roy E., Major, USAF, "Annualized Cost of Leaving Model," *Fifth Quadrennial Review of Military Compensation*, Vol. IB, Appendix I, January 1984.
- Ward, Michael P., and Hong W. Tan, *The Retention of High Quality Personnel in the U.S. Armed Forces*, The RAND Corporation, R-3117-MIL, February 1985.

RAND/P-7340

RATIONAL EXPECTATIONS CRITICISM IN A MICROECONOMIC SETTING:
THE CASE OF MILITARY PERSONNEL RETENTION MODELS

R. Yilmaz Argüden