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The Effects of Selective Reenlistment Bonuses, Part I: Background and Theoretical Issues

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THE EFFECTS OF SELECTIVE REENLISTMENT BONUSES, PART I: BACKGROUND AND THEORETICAL ISSUES

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In order to manage its Selective Reenlistment Bonus (SRB) program effectively, the U.S. Army needs reliable information about the effects of SRBs on reenlistment rates at the Military Occupational Specialty (MOS) level. Until recently, research had not addressed important methodological and empirical issues concerning structural economic modeling of the reenlistment decision, bias due to population heterogeneity, and interaction between compensation policy and retention. This research examines these fundamental issues and suggests techniques for their application at the MOS level. It highlights the importance of (1) understanding institutional details of compensation policy, including the role of SRBs; (2) defining random error terms in the empirical analyses; and (3) using longitudinal research data.

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THE EFFECTS OF SELECTIVE REENLISTMENT BONUSES, PART I: BACKGROUND AND THEORETICAL ISSUES

INTRODUCTION

Historical Development of Reenlistment Bonus Programs

The purpose of Selective Reenlistment Bonuses (SRBs) is to "provide a monetary incentive to encourage enlisted uniformed services personnel in critical skill specialties with high training costs to reenlist."[1] Reenlistment bonuses for the Army were first authorized by the Act of March 3, 1791, which established a lump sum bonus of $6 for a reenlistment. Of course, there have been many changes in reenlistment bonus programs since that time. One characteristic has remained unaltered, however. In order to qualify for the bonus, enlisted personnel must serve "continuously" by reenlisting "immediately."

Among the changes that have occurred are the uniformed services covered, eligibility requirements, methods of payment (e.g. lump sum vs. installment), and length of service obligation. Reenlistment bonuses were first authorized for Marines in 1854 and Navy personnel in 1855. Lump sum bonuses were also replaced by annual installment payments in 1854. In an effort to establish a consistent approach to reenlistment bonuses, Congress passed the Joint Services Pay Act of 1922. This law mandated a service-wide reenlistment bonus of $50 by the number of years served in the term of service from which the member was last discharged. Additional pay could be received based on total rather than continuous length of service. In effect, the financial incentive to reenlist recognized the value of experience.

The Career Compensation Act of 1949 substantially altered reenlistment bonus programs. First, the Act required that years of future obligated service, rather than past service, be used to compute bonus amounts. Second, bonuses increased with length of obligated service to encourage longer reenlistments. Third, career limits were placed on (1) the number of times and length of obligated service during which bonuses could be received and (2) the cumulative amount of bonuses. Congress modified bonuses further by authorizing regular reenlistment bonuses (RRB) in the Act of July 16, 1954. This program directed relatively more of the budget for reenlistment bonuses to first term reenlistments, reduced the career total obligated service during which bonuses could be received (from 30 to 20), and increased the career dollar limit.

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[1] The historical context of reenlistment bonuses and the development of the SRB program are described in the third edition of Military Compensation Background Papers, Department Of Defense(1987).

The services subsequently experienced shortages of first term personnel in technical, high training-cost skills. The variable reenlistment bonus (VRB) program was authorized by the Act of August 23, 1965 to address these shortages. Under the VRB program, bonuses were computed as multiples of RRBs. The maximum VRB payment was not to exceed four times the RRB amount. This limited VRBs to a maximum of $8000 because the maximum RRB was $2000. Four VRB multiplier levels were determined on the basis of first term training costs and shortages in critical skills.

RRBs were paid to all members of the military whether or not they were in critical shortage skill categories. Consequently, bonuses were paid to personnel in skill categories that did not have retention problems and could have been maintained at adequate levels without them. The Department of Defense (DOD) estimated that $43 million was spent unnecessarily for this reason in fiscal years 1972 and 1973. During this period, a problem with the VRB program also became apparent. VRBs could only be paid for first term reenlistments and could not be used to address retention problems in critical skills at the second and third term reenlistments. The Selective Reenlistment Bonus program was authorized by the Armed Forces Personnel Bonus Revision Act of 1974 to correct these problems.

Initially, the Act provided payment of SRBs not to exceed $15000 to members who: (1) had completed at least 21 months but not more than ten years of active service, (2) had a skill designated as critical, and (3) reenlisted or extended an existing enlistment for at least three years. Obligated service beyond twelve years could not be used in computing SRB payments. The Department of Defense Authorization Act of 1981 expanded coverage of the original SRB authorization to include members with up to fourteen years of active service. With this change, obligated service that could be used in computing SRB payments was limited to sixteen years. This regulation is still in effect. The maximum bonus amount was also increased to $20000 for members with nuclear skills and $16000 for everyone else. The maximum was further increased to $30000 in 1987.

The method of payment of SRBs has also undergone major changes since they were first authorized. Initially, bonuses were paid in equal annual installments over the period of obligated service. In 1979, Congress added a lump sum option which allowed payment of the entire amount of bonus at the beginning of a new reenlistment or extension of an existing enlistment. In 1982, this was changed so that fifty percent of the bonus could be paid as a lump sum and the remainder in equal annual installments. Members could still elect to be paid in equal annual installments. The DOD Authorization Act of 1986 changed the percentage for lump sum amounts from fifty to at least seventy five percent. However, this change has yet to be implemented.

Other important aspects of the SRB program are regulations developed by the Secretary of Defense to implement SRB authorization. Three eligibility zones have been established corresponding to first, second, and third term reenlistments. Zone A is for reenlistments between 21 months and six years of service, Zone B reenlistments are between six and ten years, and Zone C reenlistments are between ten and fourteen years. A member completing between 21 months continuous and six years total active duty can qualify for a Zone A SRB. A member who completes between six and ten years of continuous active duty can qualify for a Zone B SRB whether or not he/she received a Zone A SRB. Similarly, members completing between ten and fourteen years of continuous active duty can qualify for a Zone C SRB, regardless of whether a Zone A or Zone B SRB was received.

Members are limited to one SRB in each zone, must possess a "critical" skill, be in pay grade E-3 or higher, and reenlist or extend an enlistment at least three years to qualify for an SRB in any zone. In addition, a reenlistment or extension when combined with a member's completed active service time must total at least six years of service for Zone A, ten years for Zone B, and fourteen years for Zone C. Those members eligible to reenlist may do so (or extend an existing enlistment) up to eight months prior to his/her expiration-of-term of service (ETS) date.[2] Finally, six levels of skill "criticality" have been authorized for the military services for computation of SRB payments.

The computation of SRBs is straight forward. A member's bonus is the product of the skill criticality factor, or multiplier, designated for his/her military occupational speciality, (MOS) monthly basic pay, and number of years of active obligated service (not to extend beyond sixteen years). For example, the SRB multiplier for the Army's Imagery Analyst MOS 96D was 5.0 in FY 1985. That year, the basic pay of soldiers in pay grade E-4 with three years of service was $10,292, or $858 per month. The SRB payment to soldiers in this pay grade who reenlisted for three more years in 96D would therefore have been $12,865 (= 3x5.0x$858/mo.).

Cost-Effectiveness of the SRB Program

With the change from the draft to the All Volunteer Force (AVF) in 1973, the focus of military personnel policy shifted to meeting career military manpower requirements through the retention of highly trained qualified personnel. In this setting, SRBs became an important element in a system of financial and non-financial incentives designed to make active military service an attractive alternative to civilian occupations. Since 1974, SRB program expenditures for all

[2] Regulations governing reenlistment in the Army are in Army Regulation 635-200, Department of the Army (1988).

uniformed services increased from $126 million in 1974 to a high of $487 million in 1985, an increase of almost four fold.[3] In proportional terms, SRB expenditures increased from .1 percent of total military compensation to 2.3 percent during this period.

SRB expenditures by the Army followed a similar pattern. Actual SRB payments rose from $44.5 to $140.5 million between fiscal years 1975 and 1986, and then declined to $88.4 million in fiscal 1991.[4] These fluctuations reflect changes in the size of the enlisted force and compensation policy. SRB payments by all uniformed services doubled in the 1980's compared to the 1970s as the number of enlisted personnel increased and military pay rose. Similarly, the Army's SRB expenditures reached a high of $145 million in 1981 and, with one exception, remained above $100 million until fiscal year 1989, when the Army began to downsize the enlisted force.

SRB payments are a small proportion of the Army's personnel costs (as well as the other uniformed services) because they are a supplement to basic pay and are selective. They may be allocated to prevent manpower shortages in occupations critical to the readiness capability of the force. For the SRB program to accomplish this mission effectively and efficiently, information is needed about (1) critically important MOS (2) retention rates and "desired" force levels in critically important MOS, (3) the effects of bonus payments on retention in these MOS and (4) the costs of the SRB program. Understanding the relationship between bonus payments and SRB multipliers is also important because the Army determines bonuses by selecting SRB multiplier levels.

Historically, the Army has used a subjective process to select MOS that qualify for SRBs and define multiplier levels for those MOS.[5] Factors considered in this process include authorization levels for MOS, retention rates, per cent "fill" in MOS (i.e., difference between retention rate and authorization), training costs, pay grade, and SRB zones. These factors along

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[3] Dept. of Defense (1987).

[4] The SRB expenditure data for the Army were obtained from the Force Alignment Division of the U.S. Personnel Command (PERSCOM), now Total Army Personnel Command.

[5] The discussion in the text is an overview of a complex process used to manage the SRB program by personnel in the Force Alignment Division of PERSCOM and the Office of the Deputy Chief of Staff for Personnel (ODSCPER), U.S. Army. This is summarized in "Selective Reenlistment Bonus Decision Support System (SRB.DSS) Study Directive", ODCSPER, 28 Aug 86, p. 3. See also Action Memorandum "Development of a Selective Reenlistment Bonus (SRB) Database and SRB Modules Within the Headquarters, Department of the Army.

with others are used as criteria in the selection of multiplier levels.

Estimates of the effects of multipliers on reenlistment rates for ten broad skill groupings are used to estimate the costs of the SRB program and provide a check of the cost-effectiveness of multipliers selected for the SRB program. These estimates are not however applied in the current process of setting SRB multipliers and are inadequate for this purpose. First, they are results of a research completed in 1983 and therefore based on data that are out of date. Secondly, the estimates attempt to measure the effects of multipliers rather than bonus payments themselves. In addition, they include the effects of other factors correlated with bonus multipliers that have an impact on reenlistments. These factors include unobserved differences in preference for Army life, other forms of compensation, and the interaction between compensation policy and retention. Finally, the skill groupings are not MOS specific and do not correspond to the current Career Management Field (CMF) definition of skill categories.

In this context, the U.S. Army Research Institute (ARI) undertook economic research to evaluate the effects of SRB payments on retention at the MOS level. The information objectives of the research are spelled out by the Office of the Deputy Chief of Staff for Personnel (ODCSPER), U.S. Army as follows:[6]

> "Further, it is impossible to subjectively determine the appropriate multiplier level for a MOS in a cost-effective manner without modeling the expected reenlistment response to the SRB by the soldiers in the MOS. A methodology is needed to improve the selection of multiplier levels so that the Army may better meet the needs of MOS given a constrained budget environment." (1986, p.3).

Economic theory and military manpower research are reviewed in this report to identify relevant methodological issues and alternative techniques. Results of early research are summarized in the section on methodological issues. The focus of the discussion is on fundamental research issues that need to be addressed in reenlistment research. A structural economic model of the reenlistment decision is described next, beginning with a summary of the economic theory of occupational choice. Reenlistment research since the late 1970s is reviewed in the section on research based on the Annualized Cost of Leaving (ACOL) model. The effectiveness of models developed during this period in forecasting the impact of personnel policy options is examined in this section. Conclusions demonstrate: (1) the importance of accounting for unobserved differences between

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[6] Information needs for the SRB program are defined in the two SRB.DSS memorandum from ODSCPER referred to above.

soldiers in their preferences for Army life, and (2) the need to use longitudinal data on soldiers' careers for this purpose.

METHODOLOGICAL ISSUES IN REENLISTMENT RESEARCH

Research Through the Mid-1970s

Most early reenlistment research examined the budgetary costs of increasing retention for an all volunteer force. The research objective was to evaluate the effect of alternative compensation policies on reenlistments in the military or in the service branches of the military. Nelson (1970) estimated the percent increase in the reenlistment rate (i.e. the elasticity of reenlistments) of first term Army personnel per 1 percent increase in total military pay to be 2.0.[7] Grubert and Weiher (1970) found an elasticity of 2.2 for first term Navy enlisted personnel. Wilburn (1970) obtained a similar estimate of 2.4 for enlisted Air Force personnel at their first reenlistment decision point.

In an early study of the effects of bonuses, Kleinman and Shugart (1974) estimated elasticities of reenlistments with respect to variable reenlistment bonuses (VRBs) for Navy personnel at their first reenlistment decision. Estimates ranging from 2.2 to 4.2 were derived for three time periods, FY 1965-67, FY 1968-1969 and FY 1971-1972. Enns (1977) estimated VRB elasticities separately for the Army, Navy and Air Force. His estimate for the Army was 2.0, indicating that a one percent increase in expected military pay due to higher VRB payments would result in a two percent increase in reenlistments in the Army.

There are several problems with this early work.[8] First, the empirical econometric models used in the research are examples of reduced form rather than structural models of the reenlistment decision because they were not derived explicitly from the economic theory of occupational choice (Black, Hogan, & Sylwester, 1987).[9] This has implications for forecast accuracy of costs and benefits of compensation policy options, and they are examined in the next section.

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[7] The studies discussed in this section are representative of earlier retention research. See Enns (1977) for a survey of research during the period 1966-1974.

[8] Black et al. (1987) discuss a list of problems with early retention research.

[9] Kleinman and Shugart (1974) developed a model of the reenlistment decision based on the theory of occupational choice. However, their empirical specification was not rigorously derived from this model.

Second, the lack of structural modeling meant that functional forms of reenlistment supply functions (e.g. linear probability models, logistic functions) were chosen for ease of interpretation and empirical estimation rather than theoretical reasons. Thus, as Nelson indicates, "The choice of a specific functional form for the supply of reenlistments is somewhat arbitrary." (1970, p II-6-3). He estimated a log normal equation that related reenlistment rates to expected military pay and civilian earnings, respectively, and variables indicating dependency status, service in Vietnam, enlistment motivation, and combat status. Enns (1977) used the logistic probability model to relate a transformation of reenlistment rates to dollar amounts of VRBs, base pay, race, education, mental aptitude, age at entry and presence of dependents.[10] The logistic model is easy to estimate and was applied in most of the early research on reenlistments. Hausman and Wise (1978) have shown, however, that this model is inconsistent with the assumption of utility maximization underlying the theory of occupational choice. A model that is consistent with this theory and related research is examined in the methodological issues section.

Third, the presence of unobserved population heterogeneity and selection bias were relatively unknown in econometric research at the time early reenlistment studies were conducted. Consequently, retention research during this period did not address the issue of unobserved heterogeneity and its effects on estimates of policy effectiveness.[11]

Fourth, important details of the services respective personnel systems were often incorrectly specified in reenlistment models. For example, all of the early studies assumed arbitrary planning horizons, usually three or four

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[10] Nelson (1970) used average values computed from data for individual soldiers grouped according to race, education, mental group and Army MOS. Enns (1977) also used average values calculated from enlisted personnel data grouped by service, occupation (e.g.MOS), pre-service education, AFQT percentile, dependents status, race and age at entry. The use of averages in these two studies is typical of early retention research. Much of the variation in the data is due to differences between rather than within military occupations. Consequently, the effects of reenlistment bonuses could not be estimated for specific MOS.

[11] Kleinman and Shugart (1974) recognized that Navy personnel reaching their second reenlistment decision differed from the first-term population. They attempted to control for this by including changes in VRBs in second term reenlistment equations.

years.[12] However, length of service is an outcome of the reenlistment decision because: (1) enlisted personnel in each branch of service must choose a length of time for their reenlistment, and (2) there are multiple reenlistment decision points.

A fifth issue stems from the fact that personnel policy provides incentives to reenlist in specific MOS. This can create an interaction between policy variables and reenlistments that results in the econometric problem of simultaneous equation bias. Research through the mid-1970s did not address this problem.

Key Questions and Models for Reenlistment Research

The problems described above raise important questions for analysts of military compensation policy. What does economic theory imply about the reenlistment decision process and the effects of reenlistment bonuses on that decision? What econometric techniques are available to address estimation problems posed by the presence of unobserved heterogeneity among soldiers? What is the nature of the econometric issue of simultaneous equation bias and how can it be resolved? What kinds of data are needed to address these issues? Answers to these questions involve basic principles of economic research strategy and policy evaluation.

The first question concerns specification of economic models for the evaluation of policy alternatives. Marschak (1953) described a process for deriving structural economic models wherein economists interpret economic behavior as the outcome of decisions made by economic agents (e.g., consumers, firms, and government) in institutional and technological environments. Structural models describe the interaction between behavioral relationships, institutional factors such as government policy, and the technological environment. The form of behavioral relationships is determined by psychological and social factors, or "preferences". Structural models also incorporate interdependence between variables that measure the outcome of economic decisions. Reduced form models are transformations of structural models that simplify the relationship between the dependent variables (i.e., outcome) and factors that influence them. Unlike structural models, reduced forms do not directly reflect the interdependence of decision variables.

Structural models. These include endogenous and exogenous variables. Endogenous variables measure the outcome of behavioral decisions. Exogenous variables measure factors that affect endogenous variables and are determined outside of the

[12] For example, Nelson (1970) assumed a three year planning horizon. Enns (1977) and Kleinman and Shugart (1974) used four year horizons.

model (e.g., policy variables). The behavioral relationships of a structural model describe how each endogenous variable is determined by exogenous variables and other endogenous variables. After accounting for the effects of observed variables, however, an unexplained residual would remain for each outcome (i.e., endogenous) variable. These residuals are disturbances that represent the joint effect of random shocks, measurement errors, and unobserved factors. Shocks, errors and unobserved influences can be considered random variables with a joint probability distribution. This distribution may be regarded as another characteristic of a given economic structure.

In this framework, changes in government policy affect exogenous variables, behavioral relationships, and/or the stochastic nature of a structural model. Knowledge of economic structure and the effects of changes in policy on that structure is, therefore, necessary to predict the effects of alternative policies (Marschak, 1953).

<u>Reduced form models</u>. A reduced form is derived by solving the equations of a structural model. A reduced form model defines each endogenous variable as a function of the exogenous variables and population parameters of a given structure.[13] Reduced forms are a class of models often used in policy evaluation. They are generally easier to formulate, understand, estimate, and apply than their structural counterparts. The empirical models of earlier reenlistment research are examples of reduced form models.

<u>Structural vs. reduced form models in policy evaluation</u>. Reduced form models can predict behavior as long as policies that existed in the past <u>are not expected to change in the future</u> (Marschak, 1953). Policy evaluation, however, involves predicting the effects of changes in policy. Marschak and Lucas (1976) demonstrated that changes in policy cause shifts in the parameters of reduced form models. Consequently, predictions based on reduced forms with fixed parameter estimates (i.e., ignoring shifts due to policy change) result in errors in forecasts of policy effects (Lucas, 1976; Taylor, 1986).

An effective research strategy, therefore, is to define and estimate structural rather than reduced form economic models (Marschak, 1953). Structural models are capable of accurately forecasting the effects of a wide range of policy options. This is especially important because policy changes are difficult to predict in advance.

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[13] The relationship between structural and reduced form models can be found in any econometrics text that discusses simultaneous equation estimation. See, for example, Goldberger (1964).

An example of structure vs. reduced form in reenlistment research. The concepts of economic structure and reduced form are illustrated by Hosek and Peterson (1985) in a study of reenlistment bonuses and retention in military occupations.[14] Their research is based on a structural model with two endogenous variables, the reenlistment rate and the level of reenlistment bonuses, for a given military occupation. These variables are determined according to the equations

$$r_{it} = \beta_1 B_{it} + \beta_2 X_{it} + \delta_i + \omega_{it} \quad (1)$$

$$B_{it} = \alpha_0 + \alpha_1 (r_{it}^{*} - r_{it}^{o}) + \alpha_2 Z_{it} + \eta_{it}. \quad (2)$$

Military occupation is indicated by the index i and year by t. In these two equations, r_{it} is the reenlistment rate and B_{it} the dollar value of bonus payments for an occupation in a given year (i.e., the endogenous variables). The variable r_{it}^{o} is the reenlistment rate in equation (1) without a bonus and is therefore endogenous. In equation (1), X_{it} is a vector of exogenous variables that affect the reenlistment decision, including measures of military compensation policy, civilian earnings opportunities, the unemployment rate and demographic characteristics (e.g. gender, race, and education). The exogenous variables in equation (2) are represented by the vector Z_{it} and include the cost of additional personnel and "criticality" of a given occupation.

The parameter δ_i in equation (1) is an occupation intercept and captures the effects of occupation-specific unobserved factors that are "permanent", or stable over time, such as unchanging aspects of promotion and rotation policy, career development opportunities, reenlistment eligibility criteria and work conditions. These permanent factors also include unchanging characteristics of civilian job opportunities (e.g. wages, hours of work, and fringe benefits).

The variable ω_{it} in (1) is a random error term that consists of two components: (1) an occupation-specific component correlated over time (i.e., auto-regressive) that accounts for changes in the unobserved factors noted above; and (2) a time-varying component that is uniform across occupations. The equation defining the error is

$$\omega_{it} = \nu_{it} + \epsilon_t, \text{ where } \nu_{it} = \rho_i \nu_{it-1} + \xi_{it}.$$

Here, ξ_{it} accounts for randomness in reenlistment rates and is uncorrelated with the other components of error, and ϵ captures the effects of factors such as transitory changes in national security posture that affect all occupations similarly.

[14] Hosek and Peterson's research is reviewed in detail in the ACOL MODEL RESEARCH section below.

In equation (2), r_{it}^* is the reenlistment rate needed to meet manning requirements for occupation i in period t, and η_{it} is a random error. Finally, the reenlistment rate without a bonus in (2) is the forecast for period t derived by setting B_{it} equal to zero equation in (1) which yields

$$r_{it}^{\circ} = \beta_2 X_{it} + \delta_i + \rho_i \mu_{it-1} \qquad (3)$$

The term μ_{it-1} in equation (3) is defined as the residual between the actual and predicted reenlistment rates for a given period (t-1 in this case).

Compensation policy determines occupation-specific reenlistment rates and the level of bonus payments in this model (i.e., the endogenous variables of the structure) in several ways. First, compensation and other personnel costs affect the magnitudes of the exogenous variables X_{it} and Z_{it} directly. Defining skill "criticality" factors for occupations also affects the latter. Second, the selection of critically important MOS and the definition of their manning requirements r_{it}^* are the result of military personnel policy decisions. Finally, the random error term in (1) is influenced by policy changes because it accounts for unobserved policy effects on reenlistment rates.

If data are available to measure the variables and policy parameters defined for equations (1) and (2), the structural reenlistment equation (i.e., (1)) can be estimated and used to forecast the impact of changes in SRB policy. An alternative is to estimate the reduced form of (1) and apply the results to evaluate changes in SRB policy. This approach is less complicated than structural estimation because: (a) the detailed formulation of a structural model may be avoided, and (2) reduced forms depend only on exogenous variables and are therefore easier to estimate.

In general, the reduced form of a structural equation can be formulated and estimated without knowledge of structure. A reduced form equation can therefore be determined without knowing how changes in policy affect the structure of economic decision making. Under this circumstance, the effects of policy changes on the parameters of a reduced form will also be unknown. The example below demonstrates that application of a reduced form model in this context can result in erroneous forecasts of policy effects.

The reduced form of the reenlistment equation (1) is derived as follows: (1) substitute equation (3) for r_{it}° in (2) and solve for B_{it} as a function of the exogenous variables X_{it} and Z_{it}, and (2) insert the result in (1). The reduced form of (1) is

$$r_{it} = (\alpha_o + \alpha_1 r_{it}^*)\beta_1 + (1 - \alpha_1\beta_1)\beta_2 X_{it} + \alpha_2\beta_1 Z_{it} \qquad (4)$$

$$+ \beta_1 \eta_{it} - \beta_1 \alpha_1 \rho_i \mu_{it-1} + \omega_{it}.$$

Equation (4) can be estimated by fitting reenlistment rates for given MOS to data measuring the exogenous variables X_{it} and Z_{it}, a constant term and an appropriately specified random error term. Forecasts of reenlistment rates can be derived for particular MOS provided SRB policy remains unchanged. Suppose however the Army reduces the required manning level r_{it}^* for a given occupation as part of a broader manpower policy objective of downsizing the enlisted force. This change in policy causes a shift in the constant term, $(\alpha_0 + \alpha_1 r_{it}^*)\beta_1$, in (4). Forecasts of reenlistment rates based on the "old" reduced form are therefore subject to forecast error.

Another important research question concerns potential sources of bias. Self selection occurs if soldiers who reenlist differ from soldiers who separate, and these differences are unobserved and constant over time.[15] Failure to account for such differences may result in estimates of the effects of military compensation that are inaccurate.

The interaction between reenlistment bonuses and the reenlistment decision may also result in biased estimates of the effects of bonuses on reenlistment rates. Higher SRBs are expected to increase reenlistment rates. At the same time, selective reenlistment bonus policy targets increased bonus payments to critical shortage MOS. Estimation of the effects of SRB payments proceeds by comparing different levels of bonus payments with corresponding reenlistment rates. Unless the use of reenlistment bonus policy is accounted for in the analysis, estimates of SRB effects may be too low (i.e., biased downward) compared to their actual impact.

The Dynamic Retention Model (DRM), the Annualized Cost of Leaving Model (ACOL) and the ACOL-2 model, a recent extension of the ACOL model, are structural models that depart from the approach of previous research.[16] However, the development of these models from the economic theory of occupational choice is not thoroughly discussed in the literature. Such a discussion is

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[15] Lee (1976) and Heckman (1976) independently undertook econometric analyses of self-selection. Maddala (1983) surveys econometric research on selection bias. Recent developments include the application of duration models in analyses of longitudinal data. See for example Heckman and Singer (1986).

[16] The DRM preceded the ACOL model. The latter was in fact, derived from the former. See Warner (1979) for the first description and application of the ACOL model, and a discussion of its origins. Research involving the development and application of the DRM and ACOL models has focused on the institutional aspects of compensation policy. ACOL-2 research shifts attention to the importance of structure and the resolution of structural issues.

needed and is important for two reasons. First, it provides information that can be used by policy makers/analysts and other researchers to asses the effectiveness of alternative models available for analyses of reenlistment policy. Second, it identifies areas of research that may improve the forecasting accuracy of models of the reenlistment decision.

The next section describes a structural model of the reenlistment decision beginning with the economic theory of occupational choice. This is followed by a summary of the ACOL model and a review of research based on this model and an alternative methodology. The section on the ACOL-2 model examines the second generation ACOL model. Finally, the implications of this review for estimation of SRB effects for selected MOS are discussed in the last section.

THE ECONOMIC THEORY OF OCCUPATIONAL CHOICE

Willis and Rosen (1979) summarized the economic theory of occupational choice in the context of educational investments.[17] The theory predicts that an individual will select that occupation providing the largest expected lifetime utility, or satisfaction. This criterion is expressed in terms of the present value of monetary benefits of each alternative. Non-pecuniary differences between occupations are also incorporated in the analysis to account for the effects of observed and unobserved individual tastes and family circumstances on the selection of an occupation.

For example, suppose an individual must select an occupation from n alternatives. Each occupation provides earnings during the time he/she is employed. The time dimension of earnings is ignored initially to simplify the discussion. Let Y be potential lifetime earnings for a given individual, indicated by the index i, if occupation j is selected, where

$$Y_{ij} = y_j\ (X_i,\ \tau_i) \tag{5}$$

Here X_i includes observed ability indicators and socioeconomic factors (e.g., race, gender, education, experience) that affect the individual's lifetime earnings, and τ_i represents unobserved components of ability.

The value of choosing occupation j is the value now, or present value, of expected future earnings and non-pecuniary benefits in that occupation. Present value is defined according to

$$V_{ij} = g(Y_{ij},\ z_i,\ \mu_i) \tag{6}$$

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[17] The general theory of human capital is developed by Becker (1975) and Mincer (1974).

where z_i represents observed individual taste and family background factors, and μ_i captures unobserved taste and family background effects. Equation (6) translates expected future earnings into present value and is conditioned on taste and family background effects.

In this model, a given individual selects that occupation with the highest present value, V_i^*, where

$$V_i^* = \max (V_{i1}, V_{i2}, \ldots, V_{in}) \tag{7}$$

The model also incorporates the assumption that unobserved individual and family effects, τ_i and μ_i, are distributed among individuals according to the distribution function

$$F(\tau_i, \mu_i) \tag{8}$$

A structural model of the decision to reenlist in the Army is derived from equations (5) - (8) as follows. The value of staying in the Army, V_{Ai}, is the present value of: (1) military compensation, (2) civilian earnings after separation or retirement from the army, and (3) the value of non-pecuniary benefits. From equation (6), this present value is defined according to

$$V_{Ai} = g(Y_{Ai}, z_i, \mu_i) \tag{9}$$

where y_{Ai} is expected earnings over time if a soldier reenlists. Similarly, V_{Ci}, the present value of civilian occupations that are alternatives to the Army, is defined as

$$V_{Ci} = g(Y_{Ci}, z_i, \mu_i) \tag{10}$$

where Y_{Ci} is expected lifetime earnings if a soldier leaves the Army and enters a civilian occupation instead.

Equation (7) implies that an individual will reenlist in the Army if and only if $V_{Ai} > V_{Ci}$. Otherwise he/she will separate immediately and enter a civilian occupation (i.e., if $V_{Ci} > V_{Ai}$). The selection criteria in this model are defined in terms of probabilities (Pr)

$$\Pr(\text{reenlist in the Army}) = \Pr(V_{Ai} > V_{Ci}) \tag{11}$$

$$\Pr(\text{separate from the Army}) = \Pr(V_{Ai} \leq V_{Ci}) \tag{12}$$

Stochastic assumptions (i.e., regarding random or non-parametric errors) and key features of military compensation need to be added to the model represented by equations (5)-(8) to complete the specification of a structural reenlistment model. Both issues are addressed by translating equations (9) and (10) into empirical definitions of the present value of the income streams for staying in and leaving the Army, respectively. In general, the present value of the earnings stream of an occupation is the discounted value of expected dollar earnings over the working life of an individual

$$V_{it} = \sum_{j=t}^{t+s} Y_{ik} / (1+r_i)^{k-t+i} \tag{13}$$

In (13), Y_{ik} is expected earnings of a given individual in year j, r_i is his/her rate of time discount, s is length of working life, and V_{it} the value of the earnings stream Y_{ij} discounted at the rate r_i.[18]

Most empirical economic research on earnings is concerned with estimating rates of return to human capital investments (e.g., schooling, on-the-job training) and analyses of the distribution of earnings in the working population. For this purpose, a log earnings specification of the earnings model is consistent with the theory of investment in human capital (Mincer, 1974). The log earnings model replaces the level of earnings in each time period with its natural logarithm.

However, the structural model of the reenlistment decision for this research employs the level of earnings rather than log earnings. There are several considerations underlying this definition. First, dollar profiles of earnings are also consistent with human capital theory (Mincer, 1974).[19] For analyses of retention, including SRB effects, it is important to know the contribution of schooling and work experience to the <u>dollar</u> value of earnings over the life cycle of soldiers, rather than percentage rates of return. This is accomplished by including school completion categories and years of work

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[18] Present value formulas can be discrete or continuous functions, and reflect a finite working life or an infinite planning horizon. Mincer (1974) applied present value equations that are continuous over a finite working life. Willis and Rosen (1974) assumed continuous functions for the infinite planning horizon case. Becker (1975) used present value formulas that are discrete and represent both finite and infinite horizons. Continuous formulations with infinite horizons are convenient for both analytical and empirical reasons. However, discreet formulations with finite planning horizons have traditionally been applied in military manpower research. This issue is examined in the following section.

[19] Mincer (1974) defined two forms of dollar earnings-experience functions consistent with the underlying theory of investment in human capital (pp. 86-7). In both formulations, the returns to investments in schooling are estimated by using categorical (i.e., dummy) variables for different levels of school completion.

experience variables in a model of dollar earnings profiles. Second, when log earnings profiles are used to estimate present values, simplifying assumptions are made that imply length of stay in an occupation is not an endogenous variable in a model of occupational selection (Willis & Rosen, 1979). As demonstrated later in this section, length of stay is a key decision variable of the reenlistment process.

Given the specification thus far, dollar earnings profiles are a function of observed ability variables (e.g., education and experience), an unobserved component of ability, and random events. This relationship is expressed by

$$Y_{it} = X_{it}\beta+\epsilon_{it} \tag{14}$$

where Y_{it} is earnings in year t for a given individual, X_{it} is a vector of observed variables affecting earnings with accompanying weights β. The random error, ϵ_{it} in (14), accounts for the effects of (1) unobserved, individual-specific ability factors represented by u_i, and (2) random shocks v_t that change over time and are the same between individuals

$$\epsilon_{it} = u_i + v_t \text{ .}^{20} \tag{15}$$

The error terms u_i and v_t are normally distributed with zero means, constant variances $\acute{o}_u^2$ and $\acute{o}_v^2$ respectively, and zero covariance.

Substituting (14) and (15) into (13), the present value at time t of earnings in an occupation can be rewritten as

$$V_{it} = \sum_{j=t}^{t+s} d_{j-t} X_{ij}\beta + \alpha u_i + \sum_{j=t}^{t+s} \alpha_{j-t} v_{j-t} \tag{16}$$

where

$$d_{j-t} = 1/(1+r)^{j-t}$$

and

$$\alpha = \sum_{j=t}^{t+s} \alpha_{j-t}$$

The first term on the right side of (16) is the present value of annual earnings explained by observed ability indicators. The next two terms account for the effects of

[20] Equation (14) is a simple error components model. A more complicated model of earnings and references to research in this area are found in Lillard & Willis (1977).

unobserved components of ability and random shocks. To simplify notation, let $V_{it}*$ be the present value of earnings attributable to measurable characteristics. Define the error term $\epsilon_{it}*$ as

$$\epsilon_{it}^{*} = \alpha u_i + \Sigma\, \alpha_{j-t}\, v_t$$

Equation (16) can be written as

$$V_{it} = V_{it}^{*} + \epsilon_{it}^{*} \tag{17}$$

The random error ϵ_{it}^{*} is normally distributed with a mean of zero and variance $\acute{o}_e^{*2}$. Because u_i and v_t are normal random variables, V_{it} is also a normally distributed random variable.

From (17), the present values of reenlisting in the Army or entering civilian occupations are, respectively,

$$V_{Ai} = V_{Ai}* + \epsilon_{Ai}*$$

$$V_{Ci} = V_{Ci}* + \epsilon_{Ci}*$$

Substituting these expressions in (11), the supply function of reenlistments becomes

$$\Pr(V_{Ai} - V_{Ci} > 0) = \Pr(V_{Ai}^{*} - V_{Ci}^{*} > -(\epsilon_{Ai}* - \epsilon_{Ci}*)) \tag{18}$$

$$= F(\epsilon_{Ai}^{*} - \epsilon_{Ci*})$$

where F is the cumulative normal distribution function. The second line of (18) follows from the fact that the normal distribution is symmetric. Equation (18) is a probit probability model that can be applied to estimate the probability that soldiers with given characteristics will reenlist in the Army.[21]

The length of working life in an occupation, taken as given thus far, is an important outcome of the reenlistment decision. First, there are three reenlistment points, or expiration of term of service (ETS), that span up to 14 years after enlistment. The

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21 The value of non-pecuniary benefits are not explicitly included in the derivation of equation (18). This simplifies the discussion and does not alter the results of the analyses in this section. Non-pecuniary factors are accounted for by: (1) adding observed taste and family background variables to the equations defining the present values V_{Ai} and V_{Ci} (i.e. (17)) and (2) including the unobserved components of these two sets of factors in the definition of the error terms in the respective equations. See Smith, Sylwester, and Villa (in press) for the specification of taste effects in a reenlistment supply equation similar to (18). Taste effects are treated in a similar manner in the ACOL model of retention. See the discussion in the section on ACOL model research below.

first ETS date occurs between 2 and 6 years of service. The second and third ETS dates take place in the intervals 6-10 and 11-14, respectively. When soldiers reenlist, they select a length of service obligation within the relevant ETS interval. Retirement is a second feature of the Army's personnel system that makes length of service an important decision variable. A soldier must stay in the Army at least 20 years to receive retirement benefits. The value of expected retirement pay depends on the personal discount rate r_i. If this rate is relatively low (e.g., less than 10 percent), retirement benefits will be given greater value than if r_i is relatively high.Soldiers with lower discount rates are therefore more likely to reenlist and make the Army a career than those with higher discount rates.

An early attempt to formulate a structural model of the military reenlistment decision was the ACOL model. It is examined below and compared to the model described in this section. Research that has applied the ACOL model to estimate supply elasticities for military occupations is summarized next. Other evaluations of the effects of SRBs are included in this discussion. The ACOL-2 model, a recent extension and improvement of the ACOL model, is described in the following section. The implications of this review for analyses of the impact of SRB's are discussed in the final section.

ACOL MODEL RESEARCH

The ACOL Model

The ACOL model evaluates the Cost of leaving the military for addtitonal years of active duty service. Warner (1979) developed the initial specification of the ACOL model in analyses of the military retirement system. Recently, several versions of the model have been applied across the services to a variety of compensation policy issues. The essential elements of the model are described as follows.[22] A given soldier eligible to reenlist according to Army standards can either stay for an additional period of time or leave and enter a civilian occupation. Let RS (s) be the present value of the expected income stream at time t if the soldier stays in the Army s more years (V_{Ai} in (9)). Similarly, let RL be the present value of income expected over time if the soldier leaves the Army at time t (V_{Ci} in (10)). The returns to staying, RS(s), are the sum of (1) the present value (at time t) of expected active duty pay for s more periods (2) the present value of retirement benefits (if any) that would begin in period t+s, and (3) the present value of expected civilian earnings after s additional years in the Army. The returns to leaving at t are: (1) the present value of

[22] The notation and variable definitions in this section are in Black et al. (1987), Appendix A.

civilian earnings that begin at time t plus (2) the present value of any retirement income that may be received in the future if the soldier leaves immediately.

The monetary value to the individual of non-pecuniary factors in each alternative also enters the calculations of the ACOL model. Suppose ϵ_{Ai} and ϵ_{Ci} represent preferences, or taste, the individual has for staying in or leaving the Army, respectively. The present value of staying s more periods is the present value of monetary returns plus the present value of the monetary equivalent of the taste component

$$RS(s) + \sum_{j=t}^{t+s} d^{j-t} \epsilon_{Ai} \tag{19}$$

$$d = 1/(1+r_i)$$

Similarly, the returns to leaving are the sum of RL and the value of the individual's taste component for a civilian career

$$RL + \sum_{j=t}^{t+s} d^{j-t} \epsilon_{Ci} \tag{20}$$

Ignoring random shocks, equation (18) above implies a given individual will stay in the Army s more periods only if the present value of staying exceeds the present value of leaving for a civilian job (i.e., if the cost of leaving now is positive). This is the case if

$$RS(s) - RL + \sum_{j=t}^{t+s} d^{j-t} \epsilon_i > 0 \tag{21}$$

where ϵ_i represents the "net" value of the taste component for the Army relative to civilian alternatives (i.e., $\epsilon_i = \epsilon_{Ai} - \epsilon_{Ci}$).

The difference between the present values in (21) is the financial cost of leaving now rather than staying s more years,

$$COL(s) = RS(s) - RL$$

The annualized cost of leaving (ACOL) now rather than staying s more years is defined as the ratio

$$A_s = COL(s) / \Sigma d^{j-t}$$

Given these definitions, the selection rule (21) is stay in the Army s more years if and only if

$$COL(s) > - \sum_{j=t}^{t+s} d^{j-t} \epsilon_i \tag{22}$$

Equation (22) can be expressed in terms of the annualized cost of leaving A_s (because ϵ_i is constant over time)

$$A_s = COL(s) / \Sigma d^{j-t} > - \epsilon_i \tag{23}$$

There are a finite number of periods of future service available to a soldier at the time a reenlistment decision is made. At time t, the number of such periods is s = 1, ..., 30 - t, since 30 years is the maximum length of service possible. The present value of future income from alternative occupations is maximized when a given soldier selects the largest value of the ACOL variable and length of service, A_s, provided it exceeds the net value of taste for a civilian career. According to the ACOL model, a soldier will therefore reenlist in the Army s more years if and only if

$$A^*_s = \max \{A_s; s=1, \ldots, 30-t\} > - \epsilon_i \tag{24}$$

The ACOL model represented by equations (19)-(24) is applied in a straight forward way to the selection of a particular military occupational speciality (MOS) in the Army. Rather than the two alternatives described above, stay or leave, a soldier would need to select one of n - 1 MOS or a civilian job. In terms of the structural model in previous section, civilian jobs and MOS are the alternative occupations. The selection rule of that model, equation (18), implies that a decision to stay in the Army is made simultaneously with choice of an MOS. In the context of the ACOL model, an ACOL variable such as A^*_s would be calculated for each MOS according to equations (19)-(24). A soldier then selects that military occupation with the largest A^*_s, provided it exceeds $-\epsilon_i$ in (20).

In the next section, attention is focused on research based on the ACOL model to answer the question central to this project. Do supply responses to financial incentives differ between MOS in the Army?

<u>Review of ACOL Literature and Related Research</u>

Warner and Simon (1979) first used the ACOL model to examine reenlistment bonus effects for Navy occupations. They estimated the effects of bonuses at first- and second- term reenlistments separately for selected Navy ratings and groups of ratings (i.e., occupational specialties in the Navy) during the period FY 1974-78. The data for the study consisted of longitudinal records of all personnel who made a first- and/or second- term reenlistment decision during the period FY 1974-78.

A probit model was estimated that included alternative measures of the ACOL variable, fiscal year dummy variables (i.e., variables with a value of 1 or 0), marital status, and in some cases, education and race variables. In an effort to account for a changing distribution of taste for Navy life, the first-term reenlistment bonus was included as a variable in second-term reenlistment equations. The estimated effect of a one unit increase in the bonus multiplier at first-term reenlistment ranged from 1.7 to 5.1 additional reenlistments per 100 eligible Navy personnel. The estimated effect of a one unit change in the bonus multiplier on second-term reenlistment rates were similar. The effect of first-term bonuses on second-term reenlistment rates was consistently negative as expected.

Goldberg & Warner (1982) applied another version of the ACOL model to assess the impact of reenlistment bonuses and regular military compensation on reenlistments and extensions across Navy ratings during FY 1974-80. Using data grouped by fiscal year, Navy rating and length of service, they estimated multinomial logit models of reenlistments and extensions for first- and second-term reenlistments separately. They found that the effect of a one level increase in SRB multipliers increased reenlistments at the first term point from 1.7 to 3.3 persons per hundred eligible to reenlist and 1.9 to 6.0 persons at the second term.

A measure of the incidence of shore duty was included in the first term and second term equations to determine whether reenlistment rates were relatively lower for ratings that required more time at sea. The results for this variable were mixed, although the majority of the estimates were negative and statistically significant. Following Warner and Simon (1979), Goldberg and Warner (1982) also included actual (average) SRB payments received at first-term reenlistment as a variable in the second term equations. The results for this variable were inconclusive.

Neither version of the ACOL model described above explains why pay elasticities, including SRB effects, are expected to differ between occupations. In a subsequent study, Warner and Goldberg (1984) developed an ACOL model where differential pay effects are a consequence of the role of non-pecuniary factors in the reenlistment decision process. In their model, the taste parameters for civilian and military occupations, respectively, are assumed to be normally distributed, unobserved random variables. The effects of non-pecuniary factors on reenlistment supply elasticities are captured by the variances of these underlying taste distributions. The principle implications concerning supply elasticities are:

1. Reenlistment supply will be more elastic with respect to pay if there is no correlation between taste for military and civilian occupations, and the dispersion of taste factors in the population is small.

2. The greater the correlation in taste between occupations in military and civilian jobs, the more easily occupations in the two sectors can be substituted for one another. This means that small changes in military compensation will lead to relatively large increases in reenlistment rates. Conversely, small changes in civilian earnings will induce relatively large reductions inreenlistment rates.

3. The primary non-pecuniary factor present among Navy ratings is the incidence of sea duty, measured by the proportion of time spent at sea. Warner and Goldberg (1984) demonstrated that reenlistment supply was more inelastic with respect to pay the greater this ratio. In terms of the Army, comparable non-pecuniary factors would include degree of risk (e.g., combat arms) and location of duty station (CONUS vs OCONUS). For example, combat arms MOS (11B - 19E) and MOS that involve overseas duty stations are expected to be less responsive (i.e., less elastic) to reenlistment bonuses and other forms of military compensation relative to other MOS.

In their empirical analyses, Warner and Goldberg (1984) focused on Navy personnel who made a first-term reenlistment decision during the period FY 1974-78. Approximately 80 enlisted occupations were reclassified into 16 occupational categories. The proportion of enlisted personnel assigned to sea duty varied between occupational groups from a low of 6.3% to 69.8%. Separate probit models of reenlistment were estimated for each of the 16 occupational groups. The estimated increase in reenlistment rates from a 1 unit increase in SRB multipliers ranged from 1.8 to 5.5 persons per hundred eligible to reenlist. The results also support the hypothesis that a higher incidence of sea duty is associated with lower supply elasticities. The correlation between the percentage of personnel assigned sea duty and estimated pay effects, -.49, was statistically significant at the 5% level.

None of the research reported above accounted for the effect of simultaneous equation bias discussed earlier. This issue arises because there is interaction between reenlistment rates and selective reenlistment bonuses. When selective reenlistment bonuses increase in an MOS, the returns to staying relative to other MOS and civilian jobs increase, causing the annualized cost of leaving to rise. Soldiers in an MOS (and possibly other MOS as well) on the margin of reenlisting who would have left the Army in the absence of the SRB, will stay. For these soldiers, higher values of ACOL exceed the value they place on taste for civilian employment. On the other hand, the Army systematically allocates reenlistment bonuses to increase reenlistments in critically important MOS that are below target force levels. Consequently, estimates of the effects of SRBs on reenlistment rates will be based on data that include low reenlistment rates associated with high SRB's. As noted earlier, this tends to bias the estimate of the average SRB effect downward.

Hosek and Peterson (1985) address the simultaneous equation bias issue in a study that compares the effects of annualized vs. lump sum reenlistment bonuses. They do this by controlling for the effects of unobserved factors on reenlistments. First, each military occupation (i.e., Army MOS) has its own intercept term in their model. The intercept accounts for the effects of unobserved factors that are fixed over time. These factors include the unchanging aspects of work conditions in the MOS, promotion policy, reenlistment eligibility criteria, rotation policy and career development opportunities. The effects of unchanging aspects of civilian jobs that are alternatives for personnel in the MOS, such as wages, hours of work, etc., are also accounted for by the intercept. Secondly, the error term in Hosek and Peterson's model has two components. The first component is an occupation-specific first order autoregressive error. It represents the effects of the unobserved factors described above that do change over time. The second component allows for the effect of transitory changes that affect all MOS equally. Examples of the latter are an unexpected threat to national security and changes in military compensation that would affect all services and military occupations alike.

Other variables include a military/civilian wage index (rather than an ACOL variable), an indicator of the presence of a bonus in a MOS, bonus amount, national unemployment rate, percent of males without a high school diploma and percent black. The bonus presence and amount variables are multiplied by a factor defined as one if the time period was after April 1, 1979 to compare the effects of lump sum vs. annual installments on reenlistments. Logit models were estimated for reenlistments, extensions and retention. Retention was defined as the occurrence of either a reenlistment or an extension. The models were estimated using data consisting of cell means for all military occupational specialties in the Army, Navy, and Air Force during the period FY 76-81.

An important implication of Hosek and Peterson's (1985) model is that if reenlistment bonuses are targeted so that they are higher for "critical shortage" MOS, the inclusion of occupation intercepts and removal of intertemporal correlation from the error term controls for simultaneous equation bias. Therefore it would be reasonable to expect estimates of reenlistment bonus effects based on this specification to exceed estimates derived from a model that excludes an occupation intercept and/or fails to remove auto-correlation from the error term. The results of the study confirm this hypothesis. The estimated effect of reenlistment bonuses for first-term reenlistments was .0173 when simultaneity was ignored. This estimate increased significantly to .0759, however, when occupation intercepts were added to control for permanent fixed effects. The addition of the auto-correlated error disturbances to account for the influence of time varying unobserved factors had little effect on the estimates.

THE SECOND GENERATION ACOL (ACOL-2) MODEL

The preceding discussion of ACOL research raises important issues about the specification of the ACOL model as a structural economic model. First, the stochastic assumptions of the ACOL model do not provide adequate control for the influence of unobserved population heterogeneity. Consequently, estimates of effects of policy variables may be biased. Furthermore, the ACOL model incorporates incomplete knowledge about the effects of changes in defense policy and Army personnel policy on the structure of the reenlistment decision. These specification problems may reduce the forecasting accuracy of the ACOL model and its usefulness as a policy evaluation tool.

Unobserved heterogeneity is included in the ACOL model as the source of random error in the earnings and cost of leaving equations. The selection rule of the model, equation (24), implies that a soldier will reenlist if the net cost of leaving (the value of expected military compensation less the value of expected civilian income) exceeds the monetary equivalent value to him/her of net (unobserved) taste for civilian life. The cost of leaving measures the pecuniary or financial cost of leaving to an individual. The value of net taste for civilian life on the other hand is the monetary value of non-pecuniary benefits of civilian relative to Army life. Given the financial cost of leaving, the smaller the non-pecuniary benefits of civilian relative to Army life, the more likely it is that a soldier will stay in the Army. Alternatively, given the cost of leaving (ACOL) the greater the preference for Army life, the higher is the probability soldiers will reenlist. Thus, the presence of unobserved heterogeneity means that for an enlistment cohort, soldiers eligible to reenlist who decide to stay at their first reenlistment decision point are those with greater preferences for Army life than soldiers who leave.

As length of service increases the value of the ACOL variable tends to rise because of retirement pay. The distribution of unobserved preferences for Army life also changes over time. In particular, at the 2nd ETS, the average value of unobserved taste factors will increase for soldiers who reenlist a second time. Differences in taste also become smaller (i.e., the variance of the taste distribution declines) as soldiers become more homogeneous in terms of their preferences. The distributional changes outlined here combined with rising ACOL values imply that the probability of reenlistments will increase over time. Thus, the probability of reenlistment at the second ETS is expected to be higher than at the first ETS. A similar conclusion follows comparing the second and third reenlistments.

The specification of the random error term in the ACOL model does not capture the notion of a changing taste distribution as described here. One consequence is that the model does not accurately predict reenlistment rates after the first ETS. A second issue is that estimates of the effect of the ACOL variable derived from the model are biased upward. Consider first, the selection rule, equation (24). By assumption, the error term ϵ_i is constant over time. Furthermore, as indicated above, the value of ACOL tends to rise with length of service. Consequently, the value of A_s^* at the second reenlistment decision print, call it A_2^*, will be greater than ACOL at the first reenlistment, A_1^*. The ACOL model, therefore, predicts (i.e., see equation (24)) that all soldiers who reenlisted that their first ETS will also reenlist at their second ETS. That is, it predicts a reenlistment rate of one.

Observed reenlistment rates after the first ETS, though high, are significantly less than one. The source of this specification problem is that the error term in (24) consists of only a permanent fixed component. Thus, soldiers do not revise their assessments of the value of non-pecuniary factors over time according to the ACOL model.[23] This problem can be corrected by including a random shock, or transitory, error component that fluctuates randomly over time. Such a component represents changes in non-pecuniary factors and other unobserved variables that may influence reenlistments. This issue is examined in detail in the discussion of the ACOL-2 model below.

Warner (1979), Warner and Simon (1979), and Goldberg and Warner (1982) acknowledged the potential for bias attributable to unobserved differences and included the value of first term reenlistment bonuses as a variable in second term reenlistment equations. This approach did <u>not</u> however adequately address the heterogeneity issue. Estimation of reenlistment supply functions based only on data for soldiers at a specific ETS (e.g., Warner and Simon) ignores selectivity by implicitly assuming that the error term is normally distributed with a mean of zero and a constant variance for that ETS decision point.

Another issue raised by the specification of the ACOL model concerns how policy changes are incorporated in a structural model of reenlistments. For example, consider the effects of a general increase in selective reenlistment bonuses. As the value of the ACOL variable increases, soldiers with relatively less taste for Army life will reenlist rather than leave. If first term bonuses are not maintained for the second reenlistment decision, however, ACOL values will decline (relative to their values at the first ETS) and second term reenlistment rates fall as soldiers with relatively less taste for Army life leave. In general, changes in compensation policy affect reenlistment rates by changing the relative benefits of the Army as an occupation, and changing the distribution of unobserved taste for Army life.

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[23] See Smith, Sylwester, and Villa (in press) for an analysis of this issue. The specification of the error term in the ACOL model does not allow standard methods of estimation to be applied to the multiple decision process of reenlistment.

Therefore, for policy evaluation purposes a structural economic model of the reenlistment decision must address the issue of heterogeneity in a multiple stay-leave environment. The preceding discussion demonstrates that the ACOL model does not do this.

A fourth issue is the selection of probability models used to estimate the probability of reenlistments. Much of the ACOL research (as well as other military manpower research) has relied on the logit probability model for reasons of computational convenience and cost. However, empirical research on dollar earnings and log earnings profiles has traditionally hypothesized normally distributed error terms. The earlier discussion indicates that under this circumstance, the probit probability model is the appropriate model for analyses of the reenlistment decision.[24]

Recent research has extended the ACOL framework to address the problem of unobserved heterogeneity. Black, Hogan and Sylwester (1987) developed the ACOL-2 model for analysis of reenlistment in the Navy. This model is an error components probit model that predicts the probability of reenlistment based on estimates derived from longitudinal data. Self selection is controlled by specifying an error term with two components. One component represents the effect of heterogeneity of taste for military service. The second component reflects the impact of transitory changes on the value of non-pecuniary factors for the Army and civilian occupations. Data for the study were obtained from annual enlisted master files for first-term ETS cohorts in FY 75, FY 77, FY 79 and FY 81. These annual files were linked to construct longitudinal records that traced each individual's career in the Navy through 30 June 1985.

As the objective of the research was to evaluate the information gains of the ACOL-2 model relative to the ACOL model, a conventional ACOL model was also estimated using the longitudinal database. Each model included an ACOL variable, Armed Forces Qualifying Test (AFQT) score, date of entry into the Navy, Navy occupational group (groups of Navy ratings), gender, race, education and number of dependents. Variables for 2nd and 3rd ETS and years of service (YOS) entered some models as

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[24] The method for computing the ACOL variable in research based on the ACOL and more recent ACOL-2 and other methodologies raises a specification issue. Earnings profiles are calculated by transforming the log of earnings. Because log earnings are normally distributed in this research, dollar earnings do not follow a normal distribution. Section three demonstrates, however, that the probit probability model follows from the hypothesis that dollar earnings are normally distributed. The empirical implications of this specification issue are unclear.

regressors to assess the effects of military experience on reenlistments.

The estimated impact of the ACOL variable ignoring heterogeneity indicated that for each $1000 increase in military pay, the 1st term reenlistment rate increased by 1.7 percent. The estimate of ACOL in the ACOL-2 model which does control for unobserved heterogeneity, was .9 percent, approximately half as large as the conventional estimate. This difference clearly suggests that the estimated impact of military pay in the ACOL model includes the impact of self selection, and thus overstates the effect of military pay.

An ad hoc procedure for controlling selection bias was evaluated by including term of service and YOS variables in the ACOL model. When these two sets of military experience variables were entered separately and together as regressors, the estimates of the effects of the ACOL variable were about .9, the same as the ACOL-2 model. It appears that "YOS and ETS serve as proxies for the censoring of the taste distribution over successive reenlistment decisions." (Black et al., 1987, p. 5-10). This finding appears to suggest that including experience-related variables in the conventional ACOL model may provide adequate statistical control for the effects of unobserved heterogeneity.

However, the ACOL model does not capture the effects of policy changes on the structure of the reenlistment decision process as noted previously. To illustrate this, Black et al. (1987) simulate policy alternatives by assuming reenlistment bonuses increase at the 1st ETS in such a way that ACOL values rise by 50 percent. The ACOL-2 model predicts an increase of 2.4% in reenlistments at the 1st ETS and a decrease of 1.3% and .5% at the 2nd and 3rd ETS. The ACOL model predicts a 2.1% increase at the 1st ETS and no change for subsequent ETS.

IMPLICATIONS

The purpose of this research is to examine key issues that must be addressed to reliably estimate the effects of SRBs on reenlistment rates in critical shortage MOS. First, evidence from recent economic research indicates that unobserved heterogeneity is an important factor affecting reenlistments and can result in overestimates of the impact of financial incentives, including SRBs, on reenlistment rates. Second, there is also evidence that reenlistments and reenlistment bonuses are interrelated within specific military occupations. Unless corrected, this interaction may impart a downward bias in estimated bonus effects. Third, what characteristics of soldiers are important in estimating SRB effects (e.g. race/ethnicity, sex, mental category), and what is the most appropriate way to obtain these estimates at the MOS level?

The ACOL-2 model combined with longitudinal data controls for biased compensation effects due to population heterogeneity.

The simultaneous equation bias problem is also addressed by appropriate specification of the model's random error term. In addition, the ACOL-2 model provides a flexible approach for evaluating SRB effects for subgroups of soldiers in selected MOS.

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