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ARMY ENLISTMENTS AND THE ALL-VOLUNTEER FORCE: THE APPLICATION OF AN ECONOMETRIC MODEL

Alan E. Fechter

February 1972

INSTITUTE FOR DEFENSE ANALYSES
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13. ABSTRACT

This paper examines econometric models of Army enlistment behavior in terms of how well they explain the enlistment experience observed between 1958 and 1968, how well they describe the enlistment experience of 1969 and 1970, and how the results can be used by policy analysts. The paper discusses econometric models that were developed to explain the behavior of white Army enlistees in the top three mental categories. The results were then used to (1) compare the forecasting accuracy of the models with other, simpler models, (2) assess the effects on enlistments of the shift to the lottery draft, and (3) project enlistments to 1980.

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FOREWORD

This IDA Paper contains an investigation of econometric models of Army enlistment behavior. The models are examined in terms of how well they explain the enlistment experience observed between 1958 and 1968, how well they describe the enlistment experience of 1969 and 1970, and how the parameters estimated from them can be integrated into policy analysis. The work was originally undertaken as part of IDA's continuous level-of-effort research for OASD(M&RA) under Contract DAHC 15-68C-0342. Interim results of the econometric analysis were used by the President's Commission on an All-Volunteer Armed Force (The Gates Commission).[1]

The paper discusses econometric models that were developed to explain the behavior of white Army enlistees in the top three mental categories. The results of this analysis are then used in three ways: (1) the forecasting accuracy of the models is compared to the accuracy of selected naive models that would be simpler to use in projecting enlistments; (2) the effects on enlistments of the shift to the lottery draft are assessed from the parameters estimated in the econometric analysis; and (3) the estimated parameters are used to generate projections of enlistments to 1980.

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1. A. Fechter, "Impact of Pay and Draft-Policy on Army Enlistment Behavior," in The President's Commission on an All-Volunteer Armed Force (hereafter referred to as the "Gates Commission"), Studies Prepared for the President's Commission on an All-Volunteer Armed Force (hereafter referred to as "Studies"), Volume 1. The results reported in this paper differ somewhat from those presented in the Gates Commission Studies because of revisions in our estimates of some variables made after the Studies had been released.

This continuing research effort has been undertaken with the recognition that solutions to yesterday's questions are not always answers to today's problems. The findings summarized below represent the latest results of our continuing effort. Clearly, further research can generate improvements that will sharpen the focus of the findings and can help to mitigate an occupational syndrome of analysts--a gnawing feeling in the pit of the stomach arising from the knowledge of biases still lurking in the results.

I would like to express my thanks to the following people for their contributions to this product:

Steve Hoenack and Gary Nelson, for stimulation as colleagues and for useful ideas, many of which are found in these pages;

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CONTENTS

TABLES

TABLES (Cont'd)

I

INTRODUCTION

This Paper describes a research effort which, it is hoped, will help policymakers in the Department of Defense in planning military manpower programs: the estimation of the parameters of an Army enlistment model from quarterly time-series data. Substantive findings generated from this study relate to:

- The effectiveness of such policy variables as military pay as a recruiting tool.
- The impact of shifting to the lottery on enlistment behavior.
- The potential effectiveness of the substantial pay increases granted to first-term enlistees in the Military Pay Bill of November 1971.
- The ability of the Army to meet its future recruiting goals in a no-draft environment.

These findings have direct relevance to both short-run and long-run decisionmaking in the formulation of recruiting policy. A sampling of specific findings are listed below:

- A dollar increase in monthly military pay rates produces an additional 95 to 340 Army enlistments each quarter. The best results show a range of from 150 to 260 enlistments per dollar increase in monthly pay.
- The shift to the lottery was accompanied by a 6,000 to 10,000 annual drop in Army enlistments. This loss consisted of draft-motivated enlistments rather than true volunteers.
- The pay increase contained in the November 1971 military pay bill, combined with population growth and an assumed 2.5 percent trend growth in real military and civilian pay, is likely to produce 125,000 to 140,000 annual Army enlistments by calendar year 1974, although it could produce as many as 170,000.

- Population growth can not be counted on to stimulate enlistment beyond 1977, and it may be necessary to devote additional resources to recruiting effort at that time.
- Additional military pay increases will be necessary to meet accession requirements greater than 200,000 men.

The sections following this describe in more detail the methods, procedures, and findings of this research effort. The first three appendices provide a selected review of the existing econometric literature on enlistment behavior and develop the IDA enlistment model that underlies this research effort. The rest of the appendices will satisfy devotees to detail who like statistical tabulations in large doses.

Section II provides an overview of the model and discusses several important events that characterize 1958 through 1970. Section III summarizes and analyzes the research findings generated by the model. Section IV pits the IDA models against several naive models in a test of their forecasting abilities and assesses the impact the transition to a lottery draft has had on enlistments. Section V incorporates the recently-passed military pay increase and generates annual projections of voluntary enlistments. It also develops a method for generating draft-motivated enlistments. Section VI summarizes the findings of this study and relates them to the goal of attaining an all-volunteer Army.

II

AN ECONOMETRIC MODEL OF ENLISTMENT BEHAVIOR

A. AN OVERVIEW OF THE MODEL

Enlistment behavior is represented by an economic model in which the proportion of the eligible population enlisting depends on military pay, civilian incomes and employment rates, the threat of induction ("draft pressure"[1]), as well as a number of noneconomic factors. Past studies[2] have tended to specify enlistment behavior in terms of the ratio of military pay to civilian pay. This assumes that a 10 percent increase in military pay has the same effect as a 10 percent decrease in civilian pay. Enlistment models of this type are called "relative pay" models. Such assumptions are valid if the potential enlistee is limited to the choice between enlistment and civilian employment.

However, the existence of other alternatives could result in an understatement of the effect on enlistments of changes in military pay estimated from the relative pay model.[3] Since the alternatives to enlisting in the Army also include enlisting in some other service and attending school, we believe that the relative pay model of enlistment behavior is inadequate; we have respecified the model so that enlistment behavior is independently related to both military and civilian pay.[4] We call the respecified model the "absolute pay" model.

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1. Draft pressure is loosely defined as the likelihood of being drafted.

2. A detailed review of these studies appears in Appendix A.

3. For a rigorous development of this argument, see Appendix C.

4. This model is described in detail in Appendix B.

One model of enlistment behavior relates enlistments to pecuniary factors, such as military pay; to draft policies, such as the level of draft calls; and to conditions of service, such as whether or not U.S. troops were engaged in combat. Quarterly time-series data covering the period beginning with the second quarter of 1958 (2:58) and ending with the third quarter of 1968 (3:68) were used to generate the enlistment supply schedule. Several events occurred during this period that are worthy of discussion:

(1) The confrontation in late 1961 between the United States and the Union of Soviet Socialist Republics over the construction of the Berlin Wall. The confrontation lasted about six months and involved the recall of 75,000 reservists, an increase in draft calls, and the retention of 85,000 enlisted men beyond the expiration of their terms of enlistment.

(2) The confrontation in late 1962 between the United States and the Union of Soviet Socialist Republics over the construction of missile sites in Cuba.

(3) The shifting of married men to a lower sequence of induction in late 1963 and the subsequent reversal of this policy in August 1965. The effect of this policy was a virtual exemption of married men from the draft from late 1963 until August 1965.

(4) The dramatic force buildup and increase in the number of U.S. troops in combat roles in Southeast Asia in late 1965. This was accomplished by increasing draft calls.[5]

These events could have had significant impacts on enlistment behavior. Thus, they are considered by the IDA time-series analysis as potential enlistment determinants for this period.

B. ECONOMETRIC SPECIFICATION OF THE ENLISTMENT MODEL

Two sets of estimating equations were fit to the data; in one set the ratio of military to civilian pay was an independent variable, and in the second set military and civilian pay were separate independent variables. This was done to estimate the degree of bias

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5. This buildup, which began in August 1965, continued through 1966, when close to one million men entered service.

that arises from estimating the effect on enlistments of military pay changes from the relative pay parameter. The variables included in this analysis are described below:

E - Army enlistment rate,
M - present value of military pay,
C - present value of civilian pay,
DP - probability of being drafted,
EMP - employment conditions of potential enlistees,
VN - index of American combat role in Vietnam,
K - draft status of married men,
CUBA - index of Cuban missile crisis,
BERLIN - index of Berlin crisis,
S2 - seasonal factor, second quarter,
S3 - seasonal factor, third quarter,
S4 - seasonal factor, fourth quarter.

Estimates were made for four models. All the enlistment-supply equations included the following independent variables: S2, S3, S4, CUBA, BERLIN, VN, EMP, and DP. Model 1R contains the pay ratio M/C, while model 1A contains the separate pay measures, M and C.

Models 2R and 2A were identical to models 1R and 1A, except for the inclusion of an additional independent variable E, the enlistment rate for the previous quarter. Models 2R and 2A are ways of specifying an adjustment mechanism in which pay and draft pressure changes produce changes in the enlistment rate that stretch beyond the quarter in which the original change has occurred. In other words, these models assume that some of the enlistment response to a current change in any independent variable occurs in future quarters.[6]

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6. Assume that our enlistment model may be represented by:

$$E_t^* = a_0 + \sum_{i=1}^{n} a_i X_{it}, \qquad (A)$$

where E_t^* = equilibrium enlistment rate in period t, and X_{it} = the value of the i^{th} independent variable in period t. The adjustment process is described by the following equation:

6. (cont'd.)

$$(E_t - E_{t-1}) = b\,(E^*_t - E_{t-1}), \qquad \text{(B)}$$

where E_t = actual enlistment rate in period t and $0 < b < 1$. This equation states that only a fraction of the equilibrating change in enlistments ever occurs over a given time interval. Substituting Eq. B into Eq. A after solving Eq. B for E^*_t produces the following equation:

$$E_t = ba_1 + \sum_{i=1}^{n} ba_i X_i + (1-b)\,E_{t-1}. \qquad \text{(C)}$$

The adjustment process may be described as follows:

Period	Amount of Adjustment
1	b
2	$(1-b)\,b$
3	$(1-b)^2\,b$
.	.
.	.
.	.
n	$(1-b)^{n-1}\,b$

If b were equal to 0.6, then 60 percent of the adjustment would occur in the first period, 24 percent, or 60 percent of the remaining 40 percent, would occur in the second period, 9.6 percent, or 60 percent of the remaining 16 percent, in the third period, etc. Because b is constrained to be less than one, the value of $(1-b)^m\,b$ approaches zero as m approaches infinity. See L. M. Koyck, Distributed Lags and Investment Analysis (Amsterdam: North-Holland Publishing Company, 1955), and M. Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities," Journal of Farm Economics, Vol. 38, No. 2 (1956).

Models 3R and 3A were also similar to models 1R and 1A, except for the inclusion of a variable to reflect changing the draft status of married men during the years of the study. This variable was structured so that the influence of changes in draft status depended on the probability of being drafted. Clearly, if this probability is zero, then changing the draft status of married men should have no influence at all on enlistment behavior.[7]

Models 4R and 4A were the same as the third set, except for the inclusion of a variable to assess the stability of the DP and the VN parameters. It can be argued that the effect on enlistments of changes in DP depends on the existence of combat. Moreover, it can be further argued that the effect on enlistments of changes in combat conditions depends on draft probabilities. The premise of these arguments is that draftees are more likely to be assigned to combat than are enlistees. Thus, the existence of combat conditions provides an additional stimulus to enlist to avoid being drafted. And, by the same token, the existence of the draft, with its greater probability of combat assignment, produces an additional incentive

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7. The method we chose to reflect this relationship was to use DP·K as our independent variable. The estimate of the influence of changing the draft status of married men is then equal to the estimated parameter of DP·K multiplied by DP. If the estimating equation is

$$E_t = a_0 + a_1 \, DP_t \, K_t + \sum_{i=2}^{n} a_i \, X_{it} + a_t,$$

then,

$$\frac{\partial E_t}{\partial K_t} = a_1 \cdot DP_t.$$

Clearly, the influence of K on E is zero when DP is zero and grows stronger with increasing values of DP.

to enlist to avoid combat. This incentive works to offset the negative effect combat would have on enlistments in the absence of a draft, when the burden of combat would fall entirely on enlistees.[8]

C. DEFINITIONS OF THE VARIABLES[9]

The enlistment rate, E, was defined as the number of white, male, nonprior service, Army enlistments in Mental Groups I-III per thousand civilian white males, age 17-20. We confined this analysis to whites to control for possible racial differences in enlistment behavior. Enlistees in Mental Group IV were excluded because of administrative quotas set on their numbers. The population base excludes eligible enlistees who are 21 and over and includes in the population base white male civilians between the ages of 17 and 21 who are physically or mentally ineligible to enlist. These two biases roughly offset each other.[10]

The military pay variable, M, was defined as the present value of annual military earnings expected during the term of the enlistment, which was assumed to be three years. Military earnings include base

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8. The variable included to assess this effect was $VN \cdot DP$. If the estimating equation is

$$E_t = b_0 + b_1 DP_t + b_2 VN_t + b_3 VN_t \cdot DP_t + \sum_{i=4}^{n} b_i X_{it} + V_t,$$

then,

$$\frac{\partial E_t}{\partial DP_t} = b_1 + b_3 VN_t,$$

and

$$\frac{\partial E_t}{\partial VN_t} = b_2 + b_3 DP_t.$$

The analysis described in the text leads one to expect a positive b_3.

9. Detailed descriptions of the data are contained in Appendix D.

10. See Appendix D, pp. 87-88.

pay, quarters and subsistence allowances, and the tax advantage on these allowances. The discount rate used was 30 percent. Annual estimates of these discounted earnings were converted to quarterly estimates by means of linear interpolation.[11]

The civilian income variable, C, was defined as the present value of the annual earnings of white male civilians, age 19-21, who are eligible to enlist. It was estimated from the annual incomes of year-round, full-time workers, age 14-19 and 20-24. These annual incomes were discounted at 30 percent and converted to quarterly estimates by means of linear interpolation. The income figures used to estimate C for white eligible males also included incomes of persons who were ineligible to enlist and incomes of nonwhite eligibles. Their inclusion understates the true civilian earnings by as much as 25 percent.[12]

The measure of draft pressure, DP, was defined as the probability of being inducted and was estimated by the number of inductions per thousand males, age 17-24.[13]

EMP was defined as the employment probability of eligible white male enlistees and was estimated as the employment rate of white male civilians, age 16-19. This estimate also includes the employment rate of persons who were ineligible to enlist and is probably biased downward on that account.

VN was defined as an index of the U.S. combat role in Viet Nam and was estimated by the number of U.S. casualties there. Although other studies have employed a dummy variable for the period of time when there was a heavy U.S. involvement in Viet Nam,[14] we chose the

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11. See Appendix D, Section D2, for a detailed description of this estimating procedure.

12. For details, see Appendix D, Section D3.

13. The actual age range of induction mobility was 19 to 26 for the period of this analysis, with older men being inducted before younger men.

14. A. A. Cook, Jr., "Supply of Air Force Volunteers," in Studies.

more continuous variable because we felt that it is a better measure of the extent of the U.S. involvement.

The variables, CUBA, BERLIN, K, S2, S3, and S4, were represented by dummy variables that assumed the value of one during the period they were supposed to represent and assumed the value of zero for all other periods.

III

REGRESSION RESULTS

Ordinary least-squares multiple regression techniques were used to fit the data to linear enlistment equations. The estimated parameters of these equations are described in Appendix E. Findings may be summarized as follows:

(1) There was a distinct seasonal pattern of enlistments, with peaks in the first and third quarter.

(2) The variables measuring military and civilian pay, draft probability, and draft priority were consistently significant determinants of Army enlistments.

(3) The Berlin crisis was a marginally significant factor influencing enlistment behavior.

(4) The variables measuring employment conditions, the Viet Nam conflict, and the Cuban crisis were consistently insignificant in their influence on enlistment behavior.

The seasonal pattern reflects, in part, institutional policies regarding school enrollment.[1] A substantial number of potential enlistees enter military service soon after the end of the school year, which generally occurs in the first and third quarter of the calendar year. A second reason for the pattern is the reduced level of activity at the Armed Forces Entrance and Examination Stations (AFEES) during the holidays in late December. This is generally offset by increased activity in the first half of January and helps explain the recurring seasonal low of the fourth quarter and seasonal high of the first quarter.

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1. Analysis of monthly enlistment behavior reveals that the months of January, June, July, August, and September are the seasonally high enlistment months.

A. THE IMPACT OF PAY ON ENLISTMENTS

Table 1 summarizes the estimated changes in enlistments resulting from changes in military or civilian pay or changes in the number of inductions. The response to pay is reported in terms of both elasticities and yields. The elasticity is the percent change in the enlistment rate occurring as a result of a 1 percent change in pay. For instance, if the elasticity is 1.25, a 10 percent increase in military pay would increase enlistment rates by 12.5 percent. The yield measures the incremental change in the number of enlistments as the result of a unit change in the variable for which the yield is being estimated. Table 1 expresses the quarterly increase in enlistments resulting from a one-dollar increase in monthly military or civilian pay and the increase in draft-motivated enlistments as a result of the induction of one additional man.

The estimated military pay elasticity derived from the absolute pay model is consistently higher than the one estimated from the relative pay model. Estimates of the military pay elasticity range from 0.8 to 1.5 in the relative pay model, and from 1.8 to 3.2 in the absolute pay model. Military pay yields per quarter range from 95 to 340 enlistees per incremental dollar of monthly military pay and rank perfectly according to the elasticities. Here also the yields are higher in the absolute pay models. These findings support the theoretical contentions discussed in Appendix B which stated that the military pay elasticity would be higher when estimated from an absolute pay model.

The estimated civilian pay elasticity is considerably less sensitive to the specification of the model. Civilian pay elasticities range from -.8 to -1.5 when estimated from the relative pay model, and from -.9 to -2.2 when estimated from the absolute pay model. The point estimate of this elasticity is smaller than the military pay elasticity in three of the four models.[2] Civilian pay yields range

2. It should be noted, however, that the standard errors of the regression coefficients are relatively large and that there is no significant difference in their absolute size.

Table 1

SUMMARY OF ESTIMATED ENLISTMENT YIELDS, PAY ELASTICITIES AND PROPORTIONS DRAFT-MOTIVATED[a]

Model	Relative Pay	Real Military Pay		Real Civilian Pay		Draft-Motivated	
	Elasticity	Yield[b]	Elasticity	Yield[b]	Elasticity	Yield[c]	Proportion
1R	1.39	149		-106		.10	.16
2R	1.48	158		-113		.17	.28
3R	.87	93		- 67		.11	.17
4R	.87	93		- 67		.11	.17
1A		260	2.43	-155	-2.03	.10	.16
2A		195	1.82	-171	-2.25	.17	.28
3A		210	1.96	- 95	-1.25	.11	.17
4A		339	3.17	- 74	- .96	.08	.13

a. The formulas used to estimate the yields, elasticities, and proportions are described in Appendix E.

b. Military and civilian pay yields are based on the quarterly increase (or decrease) in Army enlistments resulting from a one dollar increase in monthly pay. The yields are multiplied by 21.84 to convert the pay estimates from discounted annual values to undiscounted monthly values. The multiple, 12, converts the annual value to a monthly value; and the multiple, 1.82, equivalent to $\frac{1}{1.3} + \frac{1}{1.69} + \frac{1}{2.2}$ is a rough conversion factor that converts the discounted value to an undiscounted value.

c. The draft-motivated enlistment yield represents the number of additional draft-motivated enlistments produced by an additional induction.

from 65 to 175 enlistees per decremental dollar of monthly civilian pay. The yields are substantially lower than the military pay yields in each of the four absolute pay models tested, and they are also lower than the civilian pay yields of the relative pay models.

B. THE IMPACT OF THE DRAFT ON ENLISTMENTS

The enlistment impact of the draft, derived from the estimated parameters in Appendix E, is considerably smaller than that estimated from other data sources. Table 2 compares estimates of the proportion of enlistees who are draft-motivated derived from this analysis, from survey data, and from analysis of enlistments by lottery sequence number. Based on the coefficients estimated in this study, we found that eliminating the draft will reduce white Army enlistments in Mental Groups I-III by anywhere from 13 to 28 percent, a much smaller effect than the 45 percent derived from sample surveys or the 37 to 59 percent derived from analysis of enlistments by lottery sequence number. Possible reasons for the low estimates derived from the time-series analysis are:

(1) The dampened impact of draft pressure on enlistments arising from the "attendance" effect.

(2) The mutual dependence of enlistments and draft probability.

(3) The seasonality of draft probability and its erroneous attribution to the seasonal dummy variables.

(4) Measurement error in the estimate of draft probability.

(5) Misspecification of the relationship between draft probability and enlistment behavior.[3]

In essence, the "attendance" effect is a means of describing how an enlistment determinant operates on an eligible male's decision to remain in school. In the case of draft pressure, it summarizes the greater tendency of eligible males to remain in school to avoid the draft during periods of high draft pressure. This tendency operates to lower the fraction of eligibles who are not enrolled in school. This offsets the positive stimulus to enlist that the draft provides to those who are not enrolled in school and acts to dampen the observed impact of draft pressure on enlistments.[4]

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3. The first four reasons can be applied equally as well to the insignificant coefficient for the variable indexing employment conditions.

4. See Appendix B for an elaboration of this point.

Table 2

COMPARISON OF PROPORTIONS OF DRAFT-MOTIVATED ARMY ENLISTEES, MENTAL GROUPS I-III, DERIVED FROM IDA ECONOMETRIC ANALYSIS, SURVEY DATA, AND LOTTERY-SEQUENCE DATA

IDA Econometric Study[a]	
Absolute Pay	Relative Pay
.16 - .28	.13 - .28
Survey[b]	
.45	
Lottery Sequence[c]	
Method A	Method B
.37	.59

a. Estimates are for white Army enlistees, Mental Groups I-III, calendar year 1970. See Table 1.
b. S. H. Altman, "Earnings, Unemployment, and the Supply of Enlisted Volunteers," Journal of Human Resources, IV, No. 1 (Winter 1969), pp. 38-59.
c. Estimation procedure described in Appendix F. Estimates are for white Army Enlistees, Mental Groups I-III, calendar year 1970.

Mutual dependency of enlistments and draft probability on the draft-probability coefficient can be summarized as follows: when inductions influence enlistments, a positive relationship is expected because the draft stimulates enlistments; when enlistments influence inductions, a negative relationship is expected because a given demand for accessions can be met with fewer inductions when there are more enlistments. Thus, the mutual dependency works in opposing directions and tends to drive the estimated impact of the draft toward zero.

There is some evidence that the seasonal variables may be picking up some of the effects of the draft. In his review of Fisher's work on total enlistments, Klotz finds that omitting the seasonal variables increases the estimate of draft-motivated enlistments from 24 to 41 percent.[5] While this is a striking finding, it must be taken with a grain of salt. If there is a truly seasonal factor involved in the behavior of time-series enlistments, as we believe there is, then the Klotz model is overattributing an enlistment response to draft probability when it omits the seasonal variables.

Errors in estimates of independent variables could drive their estimated parameters toward zero.[6] The draft-probability variable was estimated as the current-quarter probability. However, potential enlistees were subject to being drafted any time between the ages of 19 and 26. Thus, current induction statistics may be a highly inaccurate measure of the longer-run draft conditions that are considered by potential enlistees in making their enlistment decisions. The more volatile the current draft-probability statistic, the larger is the size of the error. Since draft probability tended to fluctuate rather widely and sharply between 1958 and 1968 during the Berlin and Viet Nam buildups, there is probably some downward bias in the estimated draft-probability parameter on this account.

A final possible reason for the low estimate derived from the time series stems from attempting to forecast enlistments well beyond the range of available data. The time-series estimates reflect the relationship between enlistments and inductions at the 1958-1968 levels of these variables (shown in Figure 1, point E_0, I_0). This relationship was assumed to be linear in the range of data from which the draft-probability parameter was derived (line E_1-E_1, Figure 1). The survey and lottery-sequence estimates measure the change in enlistments that would occur if inductions were set to zero. If the

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5. See Appendix A, Table A1.

6. This will happen when these errors are uncorrelated with the error terms of the regression and the true value of the independent variable. J. Johnston, Econometric Methods (McGraw-Hill, 1963), pp. 148-150.

true relationship between enlistments and inductions is nonlinear (E_2-E_2) or discontinuous (E_1-E_2'-E_2), then the linear relationship will understate the enlistment change that will occur when inductions are set equal to zero. It should be noted, however, that the linear relationship may be an adequate representation of the relationship for small changes in inductions within the range of observed variation in inductions. This particular interpretation of the draft-pressure coefficient is relevant to the use of these results in projecting future enlistments, especially draft-motivated enlistments.

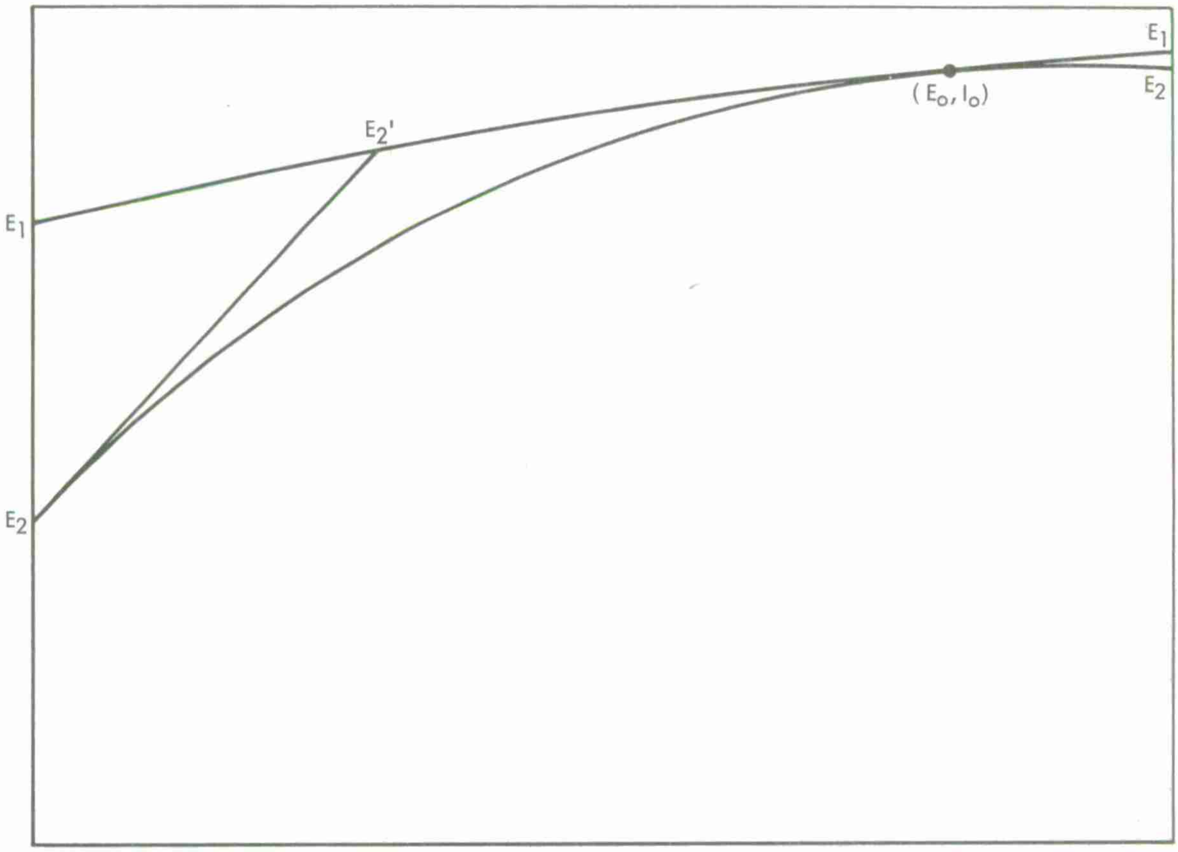

FIGURE I. Alternative Relationships Between Enlistments and Inductions

The effect of lowering the draft-vulnerability of married men by moving them to a lower order of call on enlistments was significantly negative. Such a finding would be consistent with an increase in the proportion of eligible enlistees who were married. Available data do not confirm such a shift.[7] Thus, it is likely that this variable is capturing the effect of some other phenomenon that is associated with this period. Alternatively, these findings are consistent with a feeling on the part of eligible enlistees that the availability of the marital option for escaping the draft was sufficient to deter them from considering enlistment into the Army as a viable alternative option.

C. THE ABSENCE OF AN EMPLOYMENT EFFECT

Possible reasons for the failure to observe a significant relationship between employment conditions and enlistments include the first four reasons offered to explain the relatively low estimate of draft-motivated enlistments derived from the time-series analysis: the attendance effect, mutual dependency between employment conditions and enlistment behavior, seasonality in employment conditions, and measurement error in the estimate of employment conditions.

The greater tendency of eligible males to remain in school during periods of poor employment conditions operates to shift the mix of eligible males between those who are enrolled and those who are not enrolled, lowering the fraction of eligibles who are not enrolled. This operates to counter the positive stimulus to enlist that poor employment conditions provide to those not enrolled in school and thus dampens the observed impact of employment conditions on enlistments.

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7. The percentage of men age 18 to 25 who were married with wives present is given below for the years 1962-64:

Age	18-19	20-24
1962	8.5	44.3
1963	5.4	43.2
1964	6.4	41.8

Source: U.S. Bureau of the Census, Current Population Reports, Series P-20, Population Characteristics, Nos. 122, 135.

The level of enlistments and employment conditions are mutually dependent; this mutual dependency operates to reduce the observed relationship between the two variables. Periods when enlistments are high are often times of force buildups when military expenditures are very high. High military expenditures usually imply low unemployment rates. On the other hand, high unemployment rates tend to make military service relatively more attractive so that voluntary enlistment rates should increase. Since these two forces act in opposite directions, the observed relationship between employment conditions and enlistments may be very small.

The seasonal nature of employment conditions could result in the effects of employment conditions being captured by the seasonal dummy variables. Klotz[8] found that omission of the seasonal variables from the estimating equation employed by Fisher increased the coefficient of the unemployment rate from a statistically insignificant .18 to .62, which was significantly negative.[9] Here again, as in the case of Klotz's finding with respect to draft probability, these findings must be viewed with some reservation. If the seasonal factors are truly legitimate determinants of observed enlistment behavior, then his estimated unemployment-rate coefficient may be capturing more than just the effects of employment conditions when he omits the seasonal variables.

Measurement error in the employment rate variable can exist for two possible reasons: (1) the relevant age range to consider is not 16-19, the range used in this study, but 19-21, the age range assumed relevant in estimating civilian pay for first-term enlistees; and (2) the relevant time horizon over which employment rates should be measured is not just for the current quarter, as is done in this

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8. B. J. Klotz, "The Cost of Ending the Draft: Comment," American Economic Review, LX, No. 5 (December 1970) pp. 970-979.

9. The t-statistic was 1.88.

study, but over the three years of the first-term commitment, if not longer.[10] The second reason is an argument for use of a longer-run measure of employment conditions. Both of these reasons imply that the measure of employment conditions used in this study is more volatile than a more appropriate measure would be, because employment rates tend to be less volatile in their movements for males 20 and above, and because long-run measures of employment conditions usually tend to be more stable than are current measures. As in the case of the draft-probability variable, this greater-than-desired degree of instability in the measure of employment conditions could bias our estimated coefficient toward zero.

D. VIET NAM VARIABLE

Our failure to observe a statistically significant relationship between Viet Nam casualties and enlistment rates runs counter to intuitive notion and existing evidence. In his study of Air Force enlistments, Cook finds that enlistments were significantly lower in the Air Force during the period of U.S. involvement in Viet Nam.[11]

We usually identify increased risk as a factor that would tend to discourage enlistments; i.e., that eligible enlistees are predominantly risk-averters. In the case of Viet Nam, however, choosing not to enlist and risking the chance of being drafted presented a greater threat of becoming a casualty. Evidence that chances of being assigned to combat in Viet Nam were higher for a draftee than for an enlistee is indicated by casualty rates that were higher for draftees than for enlistees in the Army during the Viet Nam period. Thus, strange as it may seem, enlisting in the Army appeared to be a

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10. An argument for considering a longer period can be made based on the draft. Young men were vulnerable to the draft for seven years, from the time they attained the age of 19 until the time they reached 26. Expectations about future employment conditions could affect the timing of an enlistment decision of an eligible enlistee who expected to be drafted.

11. Cook, op. cit.

truly viable way of avoiding combat in Viet Nam. Further weak evidence of this may be inferred by the positive but insignificant sign of the estimated coefficient for draft pressure and Viet Nam in model 3A, indicating that Viet Nam was a stronger incentive for enlisting when draft pressure was high.

By the same token, enlistment in the Navy and the Air Force should also have been helped by the Viet Nam conflict. It is therefore puzzling to note the negative enlistment impact associated with the period of the Viet Nam conflict found in Cook's study.[12]

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12. A possible reason for his finding is that the unpopularity of the war had more of a deterrent effect on enlisting than it did a stimulating effect to avoid becoming a casualty.

IV

AN EVALUATION OF THE EMPIRICAL FINDINGS

The validity of the models tested in this paper depends on how well they are able to forecast actual enlistments. Models that permit accurate forecasts of enlistments are useful for policy planning on such matters as military pay legislation, estimation of draft calls, and overall recruiting policy. An additional consideration is the relative amount of resources necessary to maintain and exercise these models. Other, less sophisticated models, requiring considerably smaller amounts of resources, may be able to explain the real world just as well, even though they do not possess the ability to address as wide a range of policy-planning issues as econometric models.

In this section we examine two aspects of the models tested earlier: (1) how well they describe more recent experience in comparison to some naive models, and (2) how the transition to the lottery as a means of selecting draftees has affected enlistment behavior. Actual enlistment data from the fourth quarter of 1968 through the fourth quarter of 1970 are used in the evaluation.

A. ECONOMETRIC MODELS VS. NAIVE MODELS

The naive models against which the econometric models were tested are as follows:

> Naive Model 1: This quarter's enlistments will be equal to enlistments in the same quarter of last year.[1]

1. This is equivalent to the "most naive," "no-change" model that underlies Theil's "inequality index." See H. Theil, Applied Economic Forecasting (Chicago, 1966), p. 28.

Naive Model 2: This quarter's enlistments will be equal to the average of enlistments in the same quarter of the last three years.

Naive Model 3: This quarter's enlistments will be the same as the average of enlistments in the same quarter of the past five years.

The criterion against which the models were evaluated was the average squared difference between actual enlistments and enlistments predicted by the model (mean square error) for the quarters 4:68-4:70. The smaller the mean square error, the more accurate the model in explaining enlistment behavior.[2]

The results are summarized in Table 3 for the eight alternative specifications of the econometric model tested earlier and the three

Table 3

MEAN SQUARE ERRORS OF ALTERNATIVE SPECIFICATIONS OF ECONOMETRIC MODELS AND NAIVE MODELS, 4:68-4:70

Models	Mean Square Error
Absolute Pay	
1A	212.4
2A	155.8
3A	583.2
4A	698.7
Relative Pay	
1R	194.7
2R	139.8
3R	636.8
4R	241.7
Naive	
1N	358.0
2N	492.1
3N	300.9

Source: Appendix G

2. For an extensive treatment of this criterion, see H. Theil, Optimal Decision Rules for Government and Industry (Amsterdam, 1964).

naive models described above. Absolute pay models 1A and 2A and relative pay models 1R and 2R all perform better than the three naive models. Forecasting errors are discussed in detail in the next subsection; however, the mean square errors of the four econometric models indicate a mean forecasting error of between 10,000 and 15,000 per period during the interval from the fourth quarter of 1968 through the fourth quarter of 1970.

B. THE FORECASTING ACCURACY OF ECONOMETRIC MODELS

The forecasting accuracy of these models may be enhanced by adjusting their parameters according to the linear equation relating the actual and the predicted values of enlistments:

$$A = a + bP + u, \tag{1}$$

where A is the actual enlistments, P is the predicted enlistments generated by one of the models, a and b are the parameters of the linear equation, and u is an error term.[3]

If the model were an accurate description of the real world, then a would be equal to zero and b would be equal to one. If it were a perfect description, u would be equal to zero. If the model consistently overestimated enlistments, then a would be negative. If the model consistently underestimated enlistments, then a would be positive. If the prediction error varied according to the number of enlistments, then b would not be equal to one.

Moreover, this relationship could be used to investigate the impact of structural shifts, such as the lottery, on enlistment behavior. It can be argued that the movement to a lottery draft has reduced the degree of uncertainty with which potential draftees must live. Accordingly, one would expect a decline in enlistments on the part of those who chose to enlist in order to control the time

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3. For a detailed discussion of this, see J. Mincer and V. Zarnowitz, "The Evaluation of Economic Forecasts," in J. Mincer, ed. Economic Forecasts and Expectations: Analyses of Forecasting Behavior and Performance (New York, 1969), pp. 6-12.

at which they do their military service. A statistical method for investigating the validity of this effect is to relate the actual enlistments to the enlistments predicted by the model and to a dummy variable representing the time of the lottery.

$$A = a + bP + cL + v, \qquad (2)$$

where L is a dummy variable which takes on values of one during the period 1:70-4:70, and zero for the period 4:68-4:69. If the argument outlined above is true, then c would be expected to be negative; i.e., for a given level of enlistments predicted by the model, the actual level of enlistments is significantly lower in the period when the lottery draft is in effect. While a significantly negative value of c is consistent with all structural changes that might have occurred since the beginning of 1971, it supports the hypothesis that the lottery discouraged enlistments.

The estimated parameters of Eq. 2 can be used to adjust the coefficients of the enlistment models to produce more accurate projections of future enlistments that take into account the most recent possible experience.[4]

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4. More accurate estimates are produced by adjusting the estimated parameters of the models to reflect actual values of a, b, and c. In the case of the linear estimating equations used in this paper, the adjustment would be as follows:

$$\begin{aligned} A &= a + bP + cL + v \qquad (2) \\ &= a + b(\hat{\alpha}_o + \sum_{i=1}^{n} \hat{\alpha}_i x_i) + cL + v \end{aligned}$$

If $\hat{\alpha} \neq 0$, $\hat{b} \neq 1$ and $\hat{c} < 0$, then the equation used to forecast will be:

$$F = \hat{b}\,\hat{\alpha}_o + \hat{a} + \hat{c}\,L + \hat{b} \sum_{i=1}^{n} \hat{\alpha}_i x_i \qquad (3)$$

It can be shown that the mean square error associated with Eq. 3, the adjusted equation, will be significantly smaller than the mean square error associated with the original equation. See Mincer and Zarnowitz, op. cit.

Table 4 summarizes the coefficients and t-statistics estimated in Eq. 2 using enlistment models 1 and 2. In each of the models analyzed, the prediction derived from the estimated parameters understated the actual enlistment experience by a significant amount. The constant term, a, was significantly positive and corresponded with roughly 15,000 enlistments quarterly. Moreover, there was a tendency to overpredict enlistments at low enlistment levels and to underpredict enlistments at high enlistment levels. The estimate of b was significantly less than one in all the models. Finally, there is evidence that the lottery did affect enlistment behavior. The lottery coefficient, c, was significantly different from zero but had considerably lower t-values than the other coefficients, indicating that its effect can not be measured very precisely. Based on the coefficients estimated from models 1 and 2, there are 6,000 to 10,000 less enlistments per year after the shift to the lottery.

Table 4

COEFFICIENTS (AND T-STATISTICS) OF FORECASTING EQUATIONS GENERATED FROM MODELS 1 AND 2

Model	Coefficient of			R^2
	Constant	P	L	
1A	2.19 (3.9)	.49 (5.7)	-.26 (-1.35)	.87
2A	2.93 (6.5)	.42 (5.5)	-.33 (-1.72)	.87
1R	2.85 (4.9)	.42 (4.4)	-.43 (-1.9)	.81
2R	2.82 (6.3)	.44 (5.8)	-.38 (-2.1)	.88

V

ENLISTMENT PROJECTIONS: AN APPLICATION OF THE FINDINGS

One of the values of econometric models is that they allow one to project nonprior service enlistments under a variety of policy scenarios. Naive models are also useful in projecting enlistments, but they cannot be used to project the implications of policy changes. Moreover, as was demonstrated in Section IV, the naive models do not forecast recent enlistment experience as accurately as some econometric models.

In this section we project Army enlistments based on the parameters estimated from the econometric models. In particular, we incorporate the November 1971 military pay bill into our projection model and generate ten-year forecasts of Army enlistments. These forecasts assume an end to the draft in FY 1973 and further military pay increases designed to keep military pay in line with civilian pay increases. Viet Nam policy is not considered because it did not appear to have any significant net impact on Army enlistment behavior.

The purpose of this projection exercise is to demonstrate a particular application of econometric research. The results are illustrative and should not be considered definitive. There is a wide range in the estimated projections generated by the IDA econometric models. Different econometric models, producing different pay parameters, and alternative projection methods would have produced still different results. Refinements are clearly needed in both the econometric work and the projection techniques to produce more precise forecasts. Because the IDA method of projecting enlistments treats "voluntary" enlistments separately from draft-induced enlistments, this section is divided into two subsections. The first subsection deals with "voluntary" enlistments, and the second subsection treats draft-induced enlistments.

A. VOLUNTARY ENLISTMENTS

The IDA projections of voluntary enlistments are summarized in Table 5.[1] They indicate that the Army can expect to recruit voluntarily anywhere from 125,000 to 175,000 first-term enlistees in the top three mental categories during the years immediately following the elimination of the draft, calendar years 1974 and 1975. They also show that enlistment growth during the five years between 1975 and 1980 will not be very dramatic. Voluntary enlistments in 1980 are expected to range between 140,000 and 185,000, depending on the model and the parameters used in making the projections.

Table 5

PROJECTIONS OF ARMY ENLISTMENTS, MENTAL GROUPS I-III
CALENDAR YEAR 1974, 1975, 1977, 1980
(IN THOUSANDS)

Model Used	1974	1975	1977	1980
Model 1A	170.4	174.4	179.9	186.4
Model 1R	126.2	129.0	133.4	137.3
Model 2A	140.5	142.5	145.4	146.9
Model 2R	130.0	133.0	137.5	141.8

Source: Appendix H.

In addition to the information about how the recent pay bill is expected to impact on voluntary enlistments, the IDA projection model also generated information that appears to be relevant to long-range planning of recruiting activities. The projection model indicates that additional voluntary enlistments stimulated by growth in the eligible population base can only be expected to occur until 1977. Beyond that date, the 17-20 year-old male population is expected to begin to decrease in size. As a result, in spite of the

1. Detailed projections appear in Appendix H.

fact that military pay is assumed to increase at the same rate as civilian pay, enlistments are projected to grow more slowly after 1977. It may therefore be necessary to allocate additional resources to recruiting at that time. Possible options include the further strengthening of the recruiting commands, more intensive advertising, and adoption of a pay policy that allows military pay to increase at a faster rate than civilian pay. Of course, the decision to consider these options rests heavily on the number of accessions that will be required to maintain desired force levels. It becomes relevant to consider these policies when anticipated enlistments fall short of requirements.

The projections of voluntary enlistments generated in this section were benchmarked on 1970. Estimates of voluntary Army enlistments in Mental Groups I-III for 1970 are based on analysis of enlistments classified by the lottery number and lottery group of the enlistee.[2] By benchmarking our projections on the observed enlistments estimated from the lottery data, we limit our projections to changes in enlistments from the benchmark level. This allows us to periodically update the benchmark and introduces a feedback mechanism into the model that enables the analyst to correct future projections to accommodate unanticipated changes in projected conditions or biases in the estimated parameters.

These enlistments are then projected from 1971 to 1980, based on assumed and actual changes in military pay, civilian pay, and eligible population. The parameters used to estimate the effect on enlistments of these changes are derived from models 1A, 1R, 2A, and 2R, all of which demonstrated the greatest forecasting accuracy in the evaluation described in Section IV.

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2. A description of this method of estimating voluntary enlistments appears in Appendix F.

The IDA projection model can be summarized by the following equation:

$$EV_t = EV_o\ (1 + \dot{P}) + \epsilon_m\dot{M} + \epsilon_c\dot{C}\ , \qquad (4)$$

where EV_t = enlisted volunteers, year 1970 + t,

EV_o = enlisted volunteers, year 1970,

$\dot{P}$ = proportional change in male population, 17-20,

$\dot{M}$ = change in military pay,

$\dot{C}$ = change in civilian pay,

ϵ_m = military pay yield,

ϵ_c = civilian pay yield.

Estimates of $EV_o\ (1 + \dot{P})$, $\dot{M}$, $\dot{C}$, $\epsilon_m\dot{M}$, and $\epsilon_c\dot{C}$ are contained in Appendix H.

EV_o was derived from an analysis of 1970 enlistments by lottery number. The method used is similar to the one described in Appendix F, only it is assumed that one-fourth of the enlistees with no lottery number at the time of their enlistment are draft induced.[3] We chose to use the lottery estimate of volunteers over other estimates (e.g. survey, regression) because it is the most recent and most credible estimate available.

$\dot{P}$, the projected male population, age 17-20, was constructed from Census projections of population by single years of age and

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3. This assumption is based on survey responses of enlistees in this group at the time they entered service. These surveys were taken in March-April and September, 1971, and indicated that from 20-30 percent of these enlistees were induced to enlist by the threat of the draft. Appendix I describes the estimating procedure in detail and presents estimates of volunteers for 1970, based on alternative assumptions about the number of enlistees with no lottery number who are draft induced.

sex, (Appendix J).[4] These projections include members of the Armed Forces and are thus inconsistent with the civilian population estimates used in the previous analysis. Since the projections are based on the relative growth of the population rather than on the level of the population, this inconsistency becomes relevant only to the extent that projected changes in the population used in this section do not reflect changes in the relevant civilian population.[5]

$\dot{M}$ consists of two components; one arising from the military pay bill of November 1971, and one expected to keep military pay relatively comparable to civilian pay. The military pay change arising from the recently-passed military pay bill of November 1971 was derived from IDA estimates of the new Regular Military Compensation (RMC)[6] by years of service and pay grade, provided by OASD(M&RA), and from comparable estimates of regular military compensation for 1970, generated by IDA as part of its econometric analysis of the parameters of the enlistment supply equation. Military pay was computed as the present value of the annual military earnings stream received during the enlistees' first three years of service.[7]

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4. U.S. Bureau of the Census, Current Population Reports, Series P-25, Population Estimates and Projections, No. 470. The projections were constructed from the most optimistic projections. The major factor varying between the alternative population projections is the assumption regarding birth rates. Thus, the ten-year projections in the 17-20 year-old group, which are based on observed current populations in younger age-cohorts, should be relatively insensitive to the alternative birth-rate assumptions used by Census.

5. This presents some problem for the years during which the Army is being reduced in size as a consequence of the U.S. disengagement from Viet Nam. For these years, the projected Census series will probably understate civilian population growth somewhat.

6. Regular Military Compensation includes base pay, allowances for quarters and subsistence, and the tax advantage on these allowances. Appendix K describes RMC by pay grade and length of service.

7. The earnings streams were discounted at a rate of 30 percent.

We estimated that first-term RMC in the Army increased by 49 percent.[8] To project these earnings, it was assumed that one-sixth of the pay increase occurred in 1971, and the full increase began to be felt in 1972.

We also assumed an additional change of 2.5 percent per year starting in 1972 to keep pace with the growth in civil service pay.[9]

The change in civilian earnings, $\dot{C}$, was based on an assumed 2.5 percent increase per year, reflecting the recent growth rate in labor productivity. This growth was projected from the 1970 base of $7,334, measured in 1957-1959 dollars.

The military and civilian pay yields were derived from models 1A, 1R, 2A, and 2R described in Section III.[10] These models were chosen for this analysis on the basis of their relatively superior forecasting performance in 1969 and 1970.

B. DRAFT-INDUCED ENLISTMENTS

The effect of the draft on enlistment behavior estimated from alternative sources of data varied widely. The most credible point estimate of the number of draft-induced enlistments was generated from the lottery data for the calendar year 1970. However, for the purpose of projection, we need to know how enlistments will vary with variations in the number of inductions. The estimate of draft-induced enlistments for 1970, while necessary, is not sufficient for projecting future draft-induced enlistments. In this subsection,

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8. Appendix K presents the details and discusses the difference between the IDA estimates of the pay increase and the OASD(M&RA) estimates. In essence, the IDA estimates of the relative pay increase exceed the OASD(M&RA) estimates because IDA discounted the earnings stream, whereas OASD(M&RA) did not.

9. The 2.5 percent figure consists of an assumed 5.5 percent growth in money compensation and an assumed 3.0 percent growth in prices.

10. The quarterly enlistment yields found in Table 1 were multiplied by 4 to produce an annual yield. The method of computing the quarterly yield is described in Appendix E.

we describe a method of generating such projections and illustrate its applicability with an example. It will be shown that draft-induced enlistments and inductions are simultaneously determined, i.e., you can not solve for either separately without solving for both.

The method of estimating draft-induced enlistments is to generate an equation relating enlistments to inductions. This equation has the following properties: (1) It exhibits decreasing enlistment returns to inductions; i.e., the number of additional enlistments generated by a given increment in enlistments decreases as the level of inductions increases. This property defines a world in which the biggest enlistment response to changes in inductions occurs at the lowest possible level of inductions. (2) The number of draft-induced enlistments is zero when induction calls are zero. An equation possessing these properties is:

$$DM = bI + cI^2 \, , \tag{5}$$

where DM is the number of draft-induced enlistments, I is the number of induction calls, and b and c are the parameters of the equation and c is strictly negative. The slope of this equation is:

$$\frac{\Delta DM}{\Delta I} = b + 2cI. \tag{6}$$

These parameters can be estimated from the estimate of draft-induced enlistments for calendar year 1970, when there were 163,500 induction calls, and from the estimate of the enlistment yield from induction calls contained in Table 1. The first piece of information represents a point on the curve described by Eq. 5. The second piece of information can be used to describe the slope of Eq. 5 at I = 163,500.

Using these two pieces of information one can solve simultaneously for the parameters b and c.[11] We find that

$$b = 0.5090$$
$$c = -0.001251.$$

Suppose that required first-term accessions are 200,000 men for 1972. Also suppose that true volunteers plus Mental Group IV enlistments are expected to be 150,000. Inductions plus draft-motivated enlistees, therefore, must equal 50,000 men:

$$I + 0.5090I - 0.00125I^2 = 50.$$

Use of the quadratic formula shows that the minimum (but positive) number of inductions that solve this equation is 33,000. Draft-motivated enlistments at this level of induction are equal to 17,000 men.

Table 6 shows the draft-motivated enlistments and induction resulting under three levels of required accessions and three levels of true volunteer enlistments.

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11. The slope of Eq. 6 is equal to the enlistment yield from Table 1. Thus,

$$b + 2\,(163.5c) = 0.10.$$

Also, at a level of induction of 163,500 we estimate there were 49,800 draft-induced enlistments in Mental Groups I-III. This gives the relationship:

$$163.5b + (163.5)^2c - 49.8.$$

These two independent relationships enable us to determine the parameters b and c.

Table 6

ESTIMATES OF DRAFT-MOTIVATED ENLISTEES (DM) AND INDUCTION-CALLS (I) UNDER ALTERNATIVE VALUES OF REQUIRED ACCESSIONS (R) AND VOLUNTARY ENLISTMENTS (EV)[a]
(IN THOUSANDS)

R \ EV	DM			I		
	100	125	150	100	125	150
175	37.5	13	0	17.5	12	0
200	55	33	13	25	17	7
225	75	53	31	30	22	14

a. Mental Group IV enlistments are assumed to be 20 percent of true volunteers.

VI

SUMMARY AND RELEVANCE TO THE GOAL OF ATTAINING AN ALL-VOLUNTEER ARMY

The results of this research effort can be summarized as follows:

- Military pay, as a recruiting device, produces an additional 95 to 340 quarterly enlistments per incremental dollar of monthly pay. Best estimates show a range of from 150 to 260 additional enlistments.
- Dollar increments in the civilian pay of potential enlistees reduces quarterly enlistments by 65 to 175 enlistments.
- These enlistment productivities are equivalent to pay elasticities ranging from 0.9 to 3.2.
- The enlistment productivity of draft pressure ranges between 8 and 17 per hundred inductions.
- Employment conditions and involvement in Viet Nam had no perceptible net effect on enlistment behavior.
- Changes in the priority of draft eligibles have significant effects on enlistments.
- The shift to the lottery draft has lowered annual enlistments to the Army by 6,000 to 10,000.
- Econometric models were better able to explain 1969-1970 enlistment experience than were naive models.
- The pay increase awarded the military by the military pay bill of November 1971 and anticipated population growth is likely to produce 125,000-140,000 enlistments by calendar year 1974, although it could produce as many as 170,000.
- Population growth can not be counted upon to stimulate enlistments beyond 1977.

The relevance of these conclusions to the goal of attaining an all-volunteer force can only be judged on the basis of the number of enlisted accessions that will be required for maintaining an all-volunteer force. Determination of these requirements is beyond the scope of this research effort. Nevertheless, it would be instructive to point out some policy implications of these findings under a range of reasonable requirements. The range of requirements presented below reflects the commonly anticipated problem that accession requirements will be higher during the transition period when draftees and draft-motivated enlistees are being flushed out of the system. For the Army, this period will extend from FY 1974 through FY 1976. After this time, accession requirements will be at a lower, "Stable state" level. Table 7 describes the gap that will exist between required and voluntary enlistments for alternative sets of requirements and voluntary supply.[1] It also describes the pay increases required to close the gap at a given level of quality and, alternatively, the quality adjustment that would be required if pay were not increased. The value of this table is that it lays out alternative policy choices that must be faced for the set of requirements and supply conditions postulated. From this table it can be deduced that the military pay increases of November 15, 1971 and January 1, 1972 will support an accession requirement of 175,000 men but will not be adequate to support a requirement of 200,000 or more. Additional pay increases, either in the form of increases in regular military compensation or enlistment bonuses, of up to $5,500, or quality deterioration in enlistments that produces up to one-third of the enlistments from Mental Group IV will be necessary to meet enlistment requirements of 225,000.

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1. Calculation of this gap is based on the assumption that enlistments of people from the fourth mental group will be limited administratively to one-sixth of total enlistments. The gap will obviously be smaller if more enlistments are permitted from the fourth mental group.

Table 7

ESTIMATES OF ENLISTMENT "GAP," REQUIRED PAY INCREASES, AND PERCENT OF TOTAL ENLISTMENTS FROM MENTAL GROUP IV IN THE ABSENCE OF A DRAFT

EV[a]	Enlistment Gap	Pay Increase	Percent in Mental Group IV[b]
Requirement: 175,000 men			
150[c]	0	$ 0	18
175[d]	0	0	18
Requirement: 200,000 men			
150	20	$2,500	25
175	10	833	22.5
Requirement: 225,000 men			
150	40	$5,625	31.1
175	15	1,250	22.2

a. Assumes Mental Group IV enlistments are 20 percent of EV.
b. Adds gap to assumed 20 percent enlistments.
c. Assumes an enlistment yield of 7 from model 2R.
d. Assumes an enlistment yield of 12 from model 1A.

Appendix A

A REVIEW OF THE EMPIRICAL LITERATURE ON ENLISTMENT BEHAVIOR

Appendix A

A REVIEW OF THE EMPIRICAL LITERATURE ON ENLISTMENT BEHAVIOR

A large number of enlistment supply studies have been conducted in recent years. Most of these studies were generated as part of two major analyses conducted to estimate the incremental costs to the Department of Defense of moving to an all-volunteer force.[1] The behavioral models developed by these studies typically described enlistments as a function of the number of eligible enlistees, military pay, civilian labor market conditions, the likelihood of being drafted, and a host of other enlistment determinants.[2] The general

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1. The first, initiated by President Johnson, was undertaken by the Department of Defense in 1964. The second, initiated by President Nixon, was undertaken by the President's Commission on an All-Volunteer Armed Force (hereafter referred to as the Gates Commission) in 1969. The findings of these analyses are summarized in: U.S. Congress, House Committee on Armed Service, *Hearings, Review of the Administration and Operation of the Selective Service System* (89th Congress, 2d Session, 1966), pp. 9923-55 (hereafter abbreviated *House Hearings*); U.S. President's Commission on an All-Volunteer Armed Force, *The Report of the President's Commission on an All-Volunteer Armed Force* (Washington: U.S. Government Printing Office, 1970), (hereafter abbreviated *Report*).

2. The literature pertaining to these studies includes: A. C. Fisher, "The Cost of the Draft and the Cost of Ending the Draft," *American Economic Review*, LIX, No. 3 (June 1969), pp. 239-255; S. H. Altman, "Earnings, Unemployment, and the Supply of Enlisted Volunteers," *Journal of Human Resources*, IV, No. 1 (Winter 1969), pp. 38-59; B. J. Klotz, "The Cost of Ending the Draft: Comment," *American Economic Review*, LX, No. 5 (December 1970), pp. 970-979; A. C. Fisher, "The Cost of Ending the Draft: Reply," *loc. cit.*, pp. 979-983; B. C. Gray, "Supply of First-Term Military Enlistees," *Studies Prepared for the President's Commission on an All-Volunteer Armed Force,* Vol. 1 (Washington: U.S. Government Printing Office, 1970), (hereafter abbreviated *Studies*); A. E. Fechter, "Impact of Pay and Draft Policy on Army Enlistment Behavior," *loc. cit.*; A. A. Cook, Jr., "Supply of Air Force Volunteers," *loc. cit.*; A. A. Cook, Jr. and J. P. White, "Estimating the Quality of Airman Recruits," *loc. cit.*, K. H. Kim, S. Farrell, E. Clague, *The All-Volunteer Army: An Analysis of Demand and Supply* (New York: Praeger Publishers, 1971), pp. 79-120.

functional form that was fit to the data was:

$$e = f(R,D,Z), \tag{A1}$$

where e = enlistment rate,

R = ratio of military to civilian pay,

D = draft pressure,

Z = other enlistment determinants.

The behavioral hypotheses were:

$$\frac{\partial e}{\partial R} > 0; \quad \frac{\partial e}{\partial D} > 0. \tag{A2}$$

Military pay was generally defined as the sum, over the period of the enlistment decision, of cash pay plus the value of income received in-kind, all appropriately discounted. Civilian pay generally included the earnings of persons who were comparable to potential enlistees in selected characteristics, such as age, race, or education, discounted over the period of the enlistment decision. A number of variables were included under the rubric of "other" enlistment determinants. Included in the time-series analyses were seasonal variables, variables designed to index actual or potential shooting wars, and changes in draft policies other than the level of inductions. Included in the cross-section studies were variables describing racial or regional characteristics of eligible enlistees. These studies can be conveniently summarized if we classify them by whether they used time-series or cross-section data.

A1. TIME-SERIES STUDIES

Time-series data were used to generate enlistment functions by Fisher,[3] Cook,[4] Cook and White,[5] Klotz,[6] and Kim, Farrell, and Clague.[7] Their findings are summarized in Table A1.

Table A1

SUMMARY OF RELATIVE PAY AND DRAFT-PRESSURE EFFECTS ON ENLISTMENTS ESTIMATED FROM TIME-SERIES STUDIES

Period of Analysis	Equation Estimated	Unit of Aggregation	Relative Pay Elasticity		Proportion Draft-Motivated Enlistments
			With Draft	Without Draft	
III/57-IV/65[a]	semi-log.	All Services	.46	.74	.24
III/57-IV/65[b]	semi-log.		.87	1.44	.41
III/57-IV/65[c]	semi-log.		1.73	2.78	.38
		Army	1.94	2.40	.20
d	logarithmic	Air Force	2.23	N.A.	.23

a. Fisher, op. cit., pp. 248-250.
b. Klotz, op. cit., pp. 972-973.
c. Kim, Farrell and Clague, op. cit., pp. 105, 107.
d. Cook, loc. cit., II-4-17.

Fisher fit quarterly time series data for 1957-1965 to the following semi-logarithmic enlistment function:

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3. Fisher, "The Cost of the Draft and the Cost of Ending the Draft," loc. cit.

4. Cook, op. cit.

5. Cook and White, op. cit.

6. Klotz, op. cit.

7. Kim, Farrell and Clague, op. cit.

$$e = \alpha_0 + \alpha_1 \ln C/M + \alpha_2 \ln (1-U) + \alpha_3 \ln (1-A) + \sum_{i=4}^{6} \alpha_i D_i, \quad (A3)$$

where e = enlistments, Mental Groups I-III,[8] all services, per male civilian, age 17-20,

C/M = estimate ratio of civilian to military pay,[9]

U = unemployment rates, males, age 18-19,[10]

A = total accessions to military service per male civilian, age 17-20, and

D_i = seasonal dummy variable for spring, summer, or autumn.

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8. Mental Groups are categories used by the Department of Defense to establish the ability of the new recruit to absorb military training within a specified period of time. The five mental categories used and the percentage of the population estimated to fall in each category are as follows:

Mental Category	Percentage of Population
I (High)	8
II (Above Average)	28
III (Average)	34
IV (Below Average)	20
V (Low)	10

For a detailed description of the tests used to classify enlistees into these categories, see B. D. Karpinos, "Mental Test Failures," in S. Tax, ed., The Draft: A Handbook of Facts and Alternatives (Chicago: University of Chicago Press, 1967), pp. 35-49.

9. Civilian earnings were estimated from a weighted sum of the median earnings of year-round, full-time workers in the age groups 14-19 and 20-24. Military earnings included basic pay (typically paid in cash), allowances for quarters and subsistence (paid directly to enlistees who live off-post and imputed to enlistees who live on-post as the value of these services received in-kind), and an imputed value for medical services received in-kind. The earnings figures were available annually and Fisher converted them to quarterly estimates by means of linear interpolation. We infer that he used three-year, undiscounted earnings streams to estimate both military and civilian earnings. See Fisher, *op. cit.*, p. 241.

10. Fisher does not explicitly define his labor force base, but we assume it is the civilian labor force.

The semi-logarithmic function has the property that elasticity of its dependent variable with respect to enlistment rates varies inversely with e.[11] It is also consistent with an assumption of log-normality in the distribution of enlistees classified jointly by their civilian pay and tastes for the military.

Fisher lagged the C/M and the (1-U) variables one quarter to minimize possible least squares bias[12] and to take into account possible adjustment lags associated with these variables.[13] The accession rate was used to estimate draft pressure rather than the induction rate in order to avoid the possibility of least squares bias associated with the latter variable.[14]

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11. The formula for computing elasticities is:

$$\epsilon_i = \frac{\alpha_i}{e},$$

where ϵ = elasticity of i^{th} variable with respect to e,

α_i = regression coefficient of i^{th} variable with respect to e.

12. It is clear that enlistment rates affect civilian earnings and unemployment rates as well as being affected by them. A shift in the enlistment supply schedule can be reasonably expected to be accompanied by an opposite shift in the supply schedule in labor markets that constitute close substitutes as alternatives of potential enlistees. The impact of an autonomous shift of the enlistment supply schedule on civilian earnings and unemployment will depend on such factors as the degree of wage rigidity and the demand elasticity in the civilian labor market.

13. He notes that the effect of lagging variables is negligible for the earnings ratio and more pronounced for the unemployment variable.

14. Inductions are affected by and affect enlistments. Given that inductions are the difference between required accessions and enlistments, one expects, ceteris paribus, an increase in enlistments will result in a decline in inductions. Alternatively, an increase in inductions can, ceteris paribus, put pressure on additional potential enlistees to seek enlistment options, and can result in additional enlistments.

Fisher found significant coefficients for α_1, α_3, and the seasonal dummy variables. The results of this study are summarized in Table A1. The relative pay elasticity was considerably less than unity and his estimate of the proportion of enlistees who are draft motivated was .24. The seasonal dummies indicated a pattern in which third quarter enlistments are highest and fourth quarter enlistments are lowest.

Klotz[15] re-estimated Fisher's equation, omitting the seasonal dummy variables. He finds that it increased the unemployment rate and accession rate coefficients, left the relative pay coefficient unchanged, and eliminated serial correlation from the residuals. In the Klotz equation, α_2 and α_3 were significant coefficients, whereas α_1 was not significant. Thus, his empirical findings about effects of relative pay and employment conditions on enlistments stand in direct contrast to Fisher's findings. Moreover, his estimate of the proportion of enlistees who are draft-motivated is substantially higher than the Fisher estimate.

Kim, Farrell, and Clague[16] estimate semi-logarithmic equations for all services and for the Army using the Fisher data base, slightly modified. In place of the number of civilian males, age 17-20 as the deflator of enlistments and accessions, they employ the number of qualified Selected Service registrants, age 18-26.[17] They do not report seasonal dummy coefficients in their all-service enlistment equation, but we believe that they were included in their analysis.

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15. Klotz, op. cit.

16. Kim, Farrell, and Clague, op. cit., loc. cit.

17. Omitted from this number are individuals who were in the following classifications:

- I-Y - qualified in war or national emergency,
- IV-F - not qualified for any military service,
- I-C - in military service,
- IV-A - deferred because of status as a parent or hardship,
- V-A - exempt over current age of liability or have completed military obligation.

The coefficients α_1 and α_3 are significant in the total service regression, and α_1, α_2, and α_3 are significant in the Army regression. The relative pay elasticities for all services, and for the Army, estimated in this study are considerably higher than those estimated by Fisher and Klotz, whereas their estimate of the proportion of total enlistees who are draft motivated is about the same as the Klotz estimate. Their estimate of the proportion of Army enlistees who are draft motivated is substantially below their estimate for all services and is roughly the same as the Fisher estimate for all services. The seasonal dummy coefficients for the Army indicate seasonally high enlistments in the third quarter.

Cook[18] analyzed Air Force enlistments using quarterly time-series data for 1958-1967. He estimated separate logarithmic enlistment functions for each of four mental categories and an enlistment function for all four mental categories combined. He included a "quality" variable to deal with the problem of excess supply of enlistees to the Air Force. His estimating equation was:

$$\ln Y_A = \beta_0 + \beta_1 \ln (V^m/V^c) + \beta_2 \ln D_1 + \beta_3 \ln D_2 + \beta_4 \ln U + \beta_5 \ln Q_A$$

$$+ \beta_6 I_1 + \beta_7 I_2 + \beta_8 I_3 + \sum_{i=9}^{11} \beta_i I_{i-5}, \qquad \text{(A4)}$$

where Y_A = Air Force enlistments for alternative sets of mental groups[19] per male civilian, age 16-20,

18. Cook, op. cit.

19. Cook estimates equations for four groups of enlistees:

Enlistees in Mental Groups I-V,
Enlistees in Mental Groups I-III,
Enlistees in Mental Groups I-II,
Enlistees in Mental Group I.

V^m/V^c = ratio of the present values of military and civilian pay,[20]

D_1 = induction rate,[21]

D_2 = examination rate,[22]

U = unemployment rate, white males, age 16-19, in the civilian labor force,

Q_A = index of mental group composition of total accessions,[23]

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20. Military pay included only base pay. Quarterly estimates were generated from base pay tables and quarterly distributions of Air Force enlistees classified by pay grade and years of service. These data were combined to produce a military earnings profile for airmen over the first four years of service. Expectations of future pay increases were built into this profile on the basis of changes in the earnings stream that occurred in the past year. The resulting earnings stream was discounted at 20 percent. Civilian pay was defined as the foregone earnings of potential airmen over the first four-year term of an Air Force enlistment. This was estimated from the incomes of year-round, full-time male workers, age 14-19 and 20-24, appropriately weighted by the age distribution of Air Force enlistees, to produce annual estimates of four-year income profiles. Expectations of future income increases were built into these profiles in the same manner as they were in the estimation of military pay. These estimates of income streams were discounted at a rate of 20 percent and converted to quarterly estimates by means of linear interpolation. For details, see <u>ibid</u>., Appendix B.

21. The number of men delivered by their draft boards for induction divided by the number of men who were in the 1-A pool and had been examined and found qualified for induction.

22. The number of men delivered by their draft boards for pre-induction examinations divided by the number of men who were in the 1-A pool and had not been examined.

23. Each mental group was assigned the mid-point of the range of AFQT scores constituting that particular mental group. The index was then constructed as a weighted average of those mid-point scores with enlistments in each mental group as the weights.

I_1, I_2, I_3 = dummy variables for the periods of the Berlin crisis, the American involvement in the Viet Nam conflict, and the assignment of married men to a lower order of draft priority,

I_4, I_5, I_6 = seasonal dummy variables representing winter, spring, and summer.

The quality variable was included based on an assumption that Air Force recruiters ration the scarce enlistment openings among potential enlistees by "creaming", i.e., by taking the best qualified (according to mental category) first. Thus, other things equal, the amount of excess supply is indexed by the "quality" variable.

β_1 was significantly positive and ranged between 2.1 and 2.3. The proportion of enlistments that were draft motivated ranged from .12 for Air Force enlistees in Mental Group I to .23 for all Air Force enlistees. The dummy variables representing the lower draft priority of married men and the American involvement in Viet Nam were significantly negative. The seasonal dummy variables indicated a significant seasonal pattern in enlistments, with the third quarter producing significantly higher enlistment rates than other quarters. The quality coefficient was significantly negative in the enlistment equations for the top three and the top four mental categories, indicating an excess supply of enlistees in Mental Groups III and IV.

In a related study, Cook and White[24] used quarterly time-series data for 1959-1967 to estimate the determinants of the quality of Air Force enlistees. They estimated an enlistment function that had elasticities inversely related to the level of quality. The independent variables and the methods by which they were estimated in this analysis were the same as those used in the Cook study, except for the dependent variable, which was Q_A, and the inclusion as independent variables of: (1) the number of airmen recruits, and (2) the eligible male population, age 16-20.

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24. Cook and White, op. cit.

The elasticity of quality with respect to relative pay was 0.5. They estimated that the quality of Air Force enlistees would fall by about three percent if the draft were terminated. The coefficients for the dummy variables for American involvement in Viet Nam, the quarters during which married men were assigned a lower priority, and the airman recruit variable were all significantly positive.

A2. CROSS-SECTION STUDIES

Cross-section data were used to generate enlistment functions by Altman,[25] Oi,[26] Gray[27] and Kim, Farrell, and Clague.[28] The results of these studies are summarized in Table A2.

The Oi and Altman studies both employed the same data base: a cross-section sample of enlistment behavior in 1963 in the nine Census regions.[29] The Altman study presents the details of this particular analysis, so we shall focus on it here. Altman fits logarithmic and log-complement enlistment functions to cross-section enlistment data for the Army and for all services. His estimating equations were:

$$\ln R = \gamma_0 + \gamma_1 \ln Y + \gamma_2 \ln U + \gamma_3 \ln N, \qquad (A5)$$

where R = enlistments in Mental Groups I-III per physically qualified male, age 17-20, who was in the full-time civilian labor force,

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25. Altman, op. cit.

26. W. Y. Oi, "The Costs and Implications of an All-Volunteer Force," in S. Tax, ed., op. cit., pp. 221-251.

27. Gray, op. cit.

28. Kim, Farrell, and Clague, op. cit.

29. These regions were: New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific.

Table A2

SUMMARY OF RELATIVE PAY AND DRAFT-PRESSURE EFFECTS ON ENLISTMENTS ESTIMATED FROM CROSS-SECTION STUDIES

Study	Equation Estimated	Unit of Enlistment	Relative Pay Elasticity		Proportion Draft-Motivated Enlistments
			With Draft	Without Draft	
Altman[a]	logarithmic	All Services	.38	.80	.39
		Army	.54	1.10	.45
	log-complement	All Services	.44	.81	.39
		Army	.62	1.18	.45
Kim[b]	semi-log	All Services	.12	.82	.39
		Army	.46	1.19	.45
Gray[c]	linear	All Services	.84	1.05	
		Army	1.54	1.77	

a. Altman, op. cit., p. 56.
b. Kim, Farrell and Clague, op. cit., p. 105.
c. Gray, op. cit.

Y = relative military earnings,[30]

U = unemployment rates, male nonveterans, age 16-20, not enrolled in school,

N = proportion of the 17-20 year old males who are nonwhite,

and

$$\ell n\, C = \delta_0 + \delta_1 \ell n\, Y + \delta_2 \ell n\, U, \qquad (A6)$$

30. Military income was estimated as average income over the first four years of service. This was assumed to be the same throughout the country. Details of what is included as military income are not provided, although it appears to include base pay, quarters and subsistence. Civilian income was estimated as the average income of male civilian nonveterans, age 16-21 who worked full-time and who were not enrolled in school as full-time students.

where C = 1-Z = complement of the no-draft enlistment rate.[31] The log-complement equation also has the property of elasticities that vary inversely with the enlistment rate.[32] Altman also estimated the logarithmic equation using Z as his independent variable.

The relative pay coefficients are consistently significant. The elasticities derived from these coefficients ranged from .4 with a draft to .8 without a draft for aggregate enlistments, and .6 with a draft to 1.2 without a draft for Army enlistments. The unemployment coefficients are only significant in the Army equations. The racial composition variable was significant in only one equation. Draft pressure was assumed to be uniformly distributed across regions and was estimated from survey data. The proportion of enlistees who were draft motivated was estimated to be .45 for the Army and .38 for all services.

The Kim, Farrell, and Clague study adapted the Fisher equation to the Altman cross-section data.[33] Therefore, it is not surprising to find that their estimated relative pay elasticity is similar to Altman's.

The Gray study estimated separate enlistment functions for each service and an enlistment function for all four services combined, using, alternatively, total and voluntary enlistments. These functions related enlistment rates to the ratio of military to civilian

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31. The no-draft enlistment rate (Z) is calculated from R as follows:

$$Z = R(1-D),$$

where D is the proportion of enlistees who are "draft motivated". This proportion is based on a Department of Defense survey of first-term enlistees taken in 1964. In this survey, they were asked if they would have enlisted if there were no draft and they had no military obligation. Sixty-two percent responded yes.

32. The elasticity formula for the i^{th} independent variable in the log-complement equation is:

$$\epsilon_i = - \delta_i(\frac{1-Z}{Z}).$$

33. Kim, Farrell and Clague, op. cit.

earnings,[34] the unemployment rate, and a dummy variable for Southern observations. Gray experimented with a variety of enlistment equations and found that the results were not sensitive to the explicit functional form fit to the data.[35] His enlistments were adjusted to include only voluntary enlistees (i.e., they exclude enlistees who enlisted because of the threat of being drafted) in a manner similar to that used in the Altman study. Like Altman, Gray also estimated a physically eligible population. However, unlike Altman who used labor force figures as his estimate of eligible enlistees, Gray employed the male civilian population as his estimate of eligible enlistees. In addition, unlike Altman, Gray fit his data to "state" as well as regional data.

Gray reported relative pay elasticities ranging from 1.05 for the enlistment function for all services combined to 1.77 for the Army. The voluntary enlistment equations generally produced higher elasticities and better fits than the total enlistment equations--a finding that was also produced by the Altman study. However, unlike the Altman study, the elasticity estimates derived from the regional analysis were not statistically significant. His analysis using "state" data produce the significant coefficients. The regional dummy variables for the South revealed that Navy enlistment rates were significantly lower in the South than they were in the rest of the country. No significant regional difference appeared in any other service. This also reinforced findings in the Altman study of no observed racial differential in enlistment behavior.

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34. In computing his ratio of military to civilian pay, Gray used the military pay of white enlistees in the top three mental groups, assumed invariant across regions and the full-year equivalent, full-time earnings of white males, age 21-27 over the period 1963-1966, adjusted by a cost-of-living differential. The estimated civilian earnings variable was further adjusted downward for period of unemployment. The estimated military pay was derived from a five percent sample taken in 1965 and included base pay, family separation allowance, quarters and subsistence allowances, the value of post exchanges and commissary privileges and medical benefits, and the tax advantage imputed to the allowances.

35. The forms used were: logarithmic, logit, gompit, and log-complement.

A3. CRITIQUE OF STUDIES

The studies reviewed above have some notable shortcomings. First we will consider the Fisher study and the time-series studies that were derived from it (Klotz, Kim-Farrell-Clague). Klotz arrives at empirical conclusions about the effects of relative pay and unemployment rates that are exactly opposite to Fisher's. The findings of the Kim-Farrell-Clague study are more in accord with the Fisher study, but their relative pay elasticities are considerably higher than those of either Fisher or Klotz, and their estimates of the fraction of enlistees who are draft motivated is substantially higher than Fisher's. An important policy implication of these diverse findings is that they produce widely varying estimates of the cost of moving to an all-volunteer force. Moreover, the debate between Fisher and Klotz over these costs was based on an estimated relative pay coefficient that was not significantly different from zero at the commonly accepted 5 percent of level of significance.[36]

There are additional reservations about the estimating equation used in these studies. The use of an accession rate to isolate the effects of the draft on enlistments can be questioned because of the possible spurious correlation bias it introduces. The studies define accessions as:

$$A \equiv E + I, \tag{A7}$$

where A = accessions,
E = enlistments,
I = inductions.

In relating accessions to enlistments, these studies are relating (E + I) to E. Since E was over 65 percent of (E + I) for most of the period of these analyses, the possibility of spurious correlation between E and (E + I) can not be ignored. An alternative method of

36. The probability that the coefficient is not significantly different from zero was roughly .18.

avoiding these biases would have been to use lagged values of either induction or accession rates. This would also have been consistent with the use of lagged relative pay and unemployment rates to avoid possible identification biases.

Finally, these studies assume that confining the analysis to the top three mental groups eliminates any identification problems associated with an excess supply of enlistment applicants. This is tantamount to assuming either that the services have an excess of enlistment applicants only in the fourth mental category or that, for the top three mental groups, the individual services are perfect substitutes for one another. In the latter case, an applicant from the top three mental groups who was turned away from one service would try other services until he was accepted. Since the Army drafts people, they would presumably always be willing to accept an enlistment applicant from the top three mental groups.

Cook's findings are consistent with an excess supply in Mental Groups III and IV in the Air Force, making the first assumption somewhat implausible. However, the Cook findings are somewhat discredited by other evidence. In a similar, but unpublished, analysis using Army enlistments, Cook's results are also consistent with an excess supply of Army enlistment applicants. Since the Army drafts, this result is difficult to rationalize.

In an examination of the cross-section studies, we found that the relative pay elasticity produced from the Gray study was considerably higher than that produced by either Altman or Kim, Farrell, and Clague. One problem lies in the choice of population deflator used. Gilman[37] points out that Altman's use of persons who are not enrolled in school biases his estimated pay elasticity downward. He suggests that a more appropriate definition would have been the total civilian population, enrolled and not enrolled, which was used by Gray. We agree with Gilman's intuition, and we will show later in

37. H. Gilman, "The Supply of Volunteers to the Military Services," in Studies, Vol. 1.

this paper that consideration of school enrollment as a relevant option for potential enlistees raises further problems in specifying enlistment behavior in terms of relative pay. Another problem was the small sample used in the Altman and Kim studies, and in part of the Gray study.[38] This limitation on sample size was due to the inability to classify enlistees by their place of residence. Data were available only by place of entry into service (Armed Forces Examining and Entrance Stations). Since many of these Stations process enlistees from a number of states, it was difficult to allocate enlistees to their place of residence at a regional level lower than the nine Census regions.[39]

While both the time-series and the cross-section studies were based on theoretical models that generated S-shaped enlistment rate supply schedules, with an inflection point and asymptotes at zero and one, most of the studies used estimating equations that reflected an inverse relationship between the elasticities and the enlistment rate. Other properties of the enlistment supply function were virtually ignored. In particular, little effort was devoted to the theoretical implications of specifying enlistment behavior in terms of relative, rather than absolute, pay. In addition, little attention was given to the problems of estimating the expected values of the independent variables for a long-term enlistment decision.

We will consider first specifying enlistment behavior in terms of relative, rather than absolute, pay. Use of relative military pay, or the ratio of military to civilian pay, as an independent variable in the enlistment function is based on the assumption that equiproportionate changes in military and civilian pay have no effect on enlistments; e.g., a doubling of both military and civilian pay will have exactly offsetting effects. Such a function may be written:

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38. Gray, op. cit., was able to produce estimates of enlistments for 34 states and state-groups and derive statistically significant findings from these estimates.

39. They used nine Census regions as observations and had only five to six degrees of freedom for their findings.

$$\log E = \log \alpha_0 + \alpha_1 \log M + \alpha_2 \log C, \qquad \text{(A8)}$$

where

$$\alpha_1 > 0$$
$$\alpha_2 < 0, \text{ and}$$
$$\alpha_1 = - \alpha_2.$$

The third property has been described as the "symmetry" condition and is analogous to the property of consumer demand functions in which the "own" price elasticity is equal to minus all cross price elasticities of closely related products alternatively, or, in which the own and the cross price elasticities sum to zero.[40] However, this property holds only when all of the relevant elasticities are included, i.e., the price elasticities of all reasonably close substitutes and compliments and, the income elasticity.

If the property of "symmetry" is to be assumed in the enlistment supply function, it should include as arguments the "prices" of all relevant nonenlistment alternatives. Equation A8 assumes that the only relevant alternative to enlisting is working (or looking for work) in the civilian labor market. This assumption seems untenable since one can conceive of a number of other alternatives. A particularly relevant alternative for potential enlistees is remaining in (or attending) school.[41] In the case of a specific-service enlistment model, such as the Cook study, an additional alternative is enlisting in some other service. If these are relevant alternatives,

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40. See P. A. Samuelson, Foundations of Economic Analysis, pp. 104-105.

41. Evidence exists in support of the relevance of this alternative in the form of estimates of enlistment response to differences in college tuition. It shows that, *ceteris paribus*, enlistments tend to be higher when the costs of attending college are high. See S. A. Hoenack, "A Cross-Section Study of the Supply of First-Term Enlistments in the U.S. Armed Forces," Institute for Defense Analyses, February 1970, unpublished manuscript.

then failure to include them in Eq. A8 could make α_1 and α_2 biased estimates of the elasticities of military and civilian pay.[42]

The enlistment decision can span a period of time ranging from two to six years. It is clear that the length of time that a potential enlistee must commit himself will affect his enlistment decision. It is also clear that the independent variables he takes into account in making his decision will be considered for the entire period of the commitment. Practically all of the studies do not explicitly deal with the nature of the expectations function that should be used in estimating the independent variables.[43] This problem is particularly relevant to the time-series studies and to the more volatile of the time-series variables. An approprirate specification of the enlistment model would make long-run enlistment decisions dependent on "permanent" levels of enlistment determinants, i.e., levels of these determinants that are expected to prevail over the period of the enlistment contract. Time-series estimates of draft pressure and unemployment rates have been either current measures or measures that are lagged one quarter. Moreover, the lags are introduced on statistical, rather than theoretical grounds, i.e., to reduce the possibility of simultaneous equations bias. A substantial part of the observed variation in these measures is probably viewed by the potential enlistees as transitory, rather than permanent in nature, and does not influence their long-run enlistment decisions. The permanent-transitory distinction in observed variation in enlistment determinants is one possible explanation for the poor empirical showing for the unemployment rate variable and the relatively low estimate of the proportion of enlistees who were draft motivated, generated from the regression studies.

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42. Necessary conditions for the existence of these biases are developed and described in detail in Appendix C.

43. The Cook and the Cook and White studies are notable exceptions. They build expectations into their pay variables, but they do not take expectations into account in estimating their other variables.

Appendix B

IDA MODEL OF ENLISTMENT BEHAVIOR

Appendix B

IDA MODEL OF ENLISTMENT BEHAVIOR

The analysis of the enlistment literature serves as a basis for a reformulation of the enlistment model that will, hopefully, deal with some of its shortcomings. We assume that a potential enlistee for service i faces four major alternatives that are for the most part mutually exclusive: enlisting in service i; enlisting in any of the other services; working on a civilian job, or attending school.[1] The enlistment rate, e_i, is the ratio of E_i (enlistees to service i) to P (total individuals who are eligible to enlist). This rate can be expressed as the product of three ratios: the ratio S_i of enlistees to service i to total enlistees (E); the ratio e_r of total enlistees (E) to eligibles not attending school (NS); and the ratio of n_a of eligibles not attending school to total eligibles (P). Thus, e_i may be written:

$$e_i = s_i \cdot e_r \cdot n_a = \frac{E_i}{E} \cdot \frac{E}{NS} \cdot \frac{NS}{P} \quad . \qquad \text{(B1)}$$

We call s_i the "service share" ratio; e_r the "restricted enlistment" ratio (to distinguish it from e_i); and n_a the "nonattendance" ratio. Thus, the enlistment rate for any service, i, is affected by the factors which influence the attendance status of eligible enlistees, the enlistment status of those not attending school, and the specific service preference of enlistees.

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1. We recognize that the categories are not actually mutually exclusive. Many individuals both work and attend school, for example. We shall deal with this problem by classifying individuals according to their primary activity.

B1. THE ATTENDANCE EFFECT

The nonattendance ratio, n_a, is the complement of the attendance ratio, a; i.e.,

$$n_a = 1 - a. \qquad (B2)$$

The factors that affect n_a include the pecuniary costs and benefit associated with school attendance, the ability to pay the costs, and governmental policy regarding draft deferment for school attendees. First, the pecuniary costs of school attendance include any direct payments for tuition, books, etc., and the indirect costs of income foregone while attending school. Associated with the latter costs are current wage rates and employment conditions. Second, the pecuniary benefit is the additional future earnings expected from the improvement in productivity produced by attending school. Third, ability to pay is generally associated with the wealth of the school attendee or his family. Fourth, government policy regarding draft deferment for school attendees can influence school-attendance decisions of individuals who seek to avoid involuntary induction by attending school. The number of individuals who choose to attend school in order to avoid involuntary induction will depend on (a) whether school attendance qualifies an individual for a draft deferment, (b) whether the deferment will affect their ultimate likelihood of being drafted, and (c) their current and future likelihood of being drafted if not deferred. It is clear that if school attendance does not qualify an individual for a draft deferment, or if there is no current or future threat of being drafted, then government policy about draft deferment will not influence school attendance.

However, a policy of deferring students and a threat of drafting nonstudents will influence school attendance. If the deferment did not affect the ultimate likelihood of being drafted, then the policy would only affect school attendance decisions if individuals had preferences about the timing of their inductions. Individuals who had a preference for future induction over current induction would consider school attendance as a means of deferring their induction, whereas individuals who had no preference, or who preferred current induction over future induction, would not.

A nonattendance rate function may be written as:

$$n_a = 1 - a = f_n(BA, TA, CA, D, W). \tag{B3}$$

where BA = benefits of school attendance,

TA = direct (tuition) costs of school attendance,

CA = indirect (opportunity) cost of school attendance,

D = draft pressure,

W = ability to pay costs of school attendance,

and,

$$\frac{\partial f_n}{\partial BA} < 0,$$

$$\frac{\partial f_n}{\partial TA} > 0,$$

$$\frac{\partial f_n}{\partial CA} > 0,$$

$$\frac{\partial f_n}{\partial D} < 0,$$

$$\frac{\partial f_n}{\partial W} < 0.$$

CA can be described in more detail:

$$CA = M + C^* \cdot (1-U), \tag{B4}$$

where M = wage rates in military employment,

C^* = wage rates in civilian employment,

1-U = expectation of being employed on a civilian job.

Thus,

$$\frac{\partial f_n}{\partial M} > 0,$$

$$\frac{\partial f_n}{\partial C^*} > 0,$$

$$\frac{\partial f_n}{\partial U} < 0.$$

We assume that there is no uncertainty associated with military employment. A more complex formulation would adjust M and $C^*(1-U)$ for the probability of being rejected for enlistment by the military.

Draft pressure, D, should also be discussed in more detail. We assume that a policy of deferring students reduces the ultimate likelihood of being drafted.[2]

Studies have produced evidence about the effects of many of these variables on school attendance. A comprehensive examination of the economic determinants of teenage school attendance behavior was undertaken by Robert Fearn.[3] He relates school enrollment rates of teenagers, 14-19 years old, classified by single year of age, sex, and race, to a number of potential enrollment determinants, using 1960 Census data for SMSAs. Among the variables in his analysis are several measures of employment conditions, wage rates, and two measures of ability to pay: family income and schooling of the adult

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2. The basis of the assumption is that the school attendee can ultimately attain a draft status that lowers his likelihood of being drafted. Examples of such status are: marriage and/or fatherhood, and age. Note that fatherhood was always sufficient for being granted a lower draft priority, whereas marriage was sufficient only since 1963, and, after 1965 only for those who were married before August, 1965. In addition, note that, until 1970, individuals were generally drafted between the ages of 19-26, starting with the oldest first. Deferments that could be extended beyond the age of 26 became virtual exemptions.

3. Robert M. Fearn, "Labor Force and School Participation of Teenagers" (unpublished Ph.D. dissertation, Department of Economics, University of Chicago, 1968).

population.[4] He reports a significantly positive relationship between enrollment rates and unemployment rates in four of the six cases relevant to this study (17-19 year olds). He also reports a consistent positive relationship between enrollment rates and the schooling of the adult population. These results conform to a priori expectations. He finds, contrary to a priori expectations, that, for whites, there is a significantly positive association between enrollment rates and wage rates: and, for both blacks and whites, there is no significant relationship between enrollment rates and family income.[5]

The association between school attendance and unemployment rates is also observed in time-series data. Duncan[6] reports a tendency for teenagers to remain in school when unemployment rates are high, based on a time-series analysis for 1902-1956. This analysis was constructed from 1960 census data on the age and educational attainment of mature males and from a related examination of annual school enrollment rates and unemployment rates for 1945-1962.

Mincer alludes to the relationship between enrollment rates and draft policies.[7] He finds that, in relating changes in male enrollment rates to changes in female enrollment rates for 18 and 19 year olds, and 20-24 year olds, the male increases for the years 1952 and 1965 are above the average increase that would have been predicted from the female increases. Both years were periods of large military buildups and large draft calls.

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4. He also examines the effects of school attendance laws, population size, marital status, and nativity of the population.

5. Ibid., pp. 35, 37. These relationships do not appear to be stable either among age groups or between blacks and whites.

6. Beverly Duncan, "Dropouts and the Unemployed," Journal of Political Economy, Vol. 73, No. 2 (April 1965), pp. 121-134.

7. Jacob Mincer, "The Short-Run Elasticity of Labor Supply," (unpublished paper for the annual meeting of the Industrial Relations Research Association, December 1966), pp. 10-11.

Hoenack[8] and Campbell and Siegel[9] examine the effects of ability to pay and costs of attendance on college enrollment and find that they have significantly positive and negative effects, respectively.[10] Hoenack also finds a significantly negative relationship between college attendance and earnings foregone.

B2. THE ENLISTMENT EFFECT

The restricted enlistment rate is the relative supply of eligibles not attending school to the military. The factors affecting relative supply can be derived from the traditional theory of occupational choice, with some modification for the institution of the draft. The restricted enlistment rates may be written as:

$$e_r = f_r (M, C^*, T), \qquad \text{(B5)}$$

where e_r, M, and C^* are defined above, and T = net utility of nonpecuniary conditions of military service. The first-order partial derivatives are:

$$\frac{\partial f_r}{\partial M} > 0,$$

$$\frac{\partial f_r}{\partial C^*} < 0, \text{ and}$$

$$\frac{\partial f_r}{\partial T} > 0.$$

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8. Stephen A. Hoenack, "Private Demand for Freshman Attendance at the University of California," IDA Research Paper P-461 (Arlington, Virginia: Institute for Defense Analyses, Program Analysis Division, September 1968).

9. R. Campbell and B. N. Siegel, "Demand for Higher Education in the United States," American Economic Review, LVII (June 1967).

10. Hoenack's cost of attendance variable includes travel costs as well as costs of books, room and board, and fees. Campbell and Siegel's cost variable includes only tuition.

The existence of the draft requires modification of the e_r function to identify its effects on enlistment behavior. In the context of this analysis, a particular consequence of not enlisting is the possibility of being drafted. Thus, the draft affects enlistments through its effects on C and T. If drafted, the potential enlistee will be earning military wages for the period of his induction. These wages until recently have been considerably lower than the wages available to the potential enlistee in civilian employment. Also, the potential enlistee does not expect to be drafted with certainty. Moreover, he can take various actions to affect the likelihood of his being drafted.[11] Thus, the return to not enlisting, C*, is influenced by military pay for inductees, M', the likelihood of being drafted, D, and $C'(1-U')$, civilian wages over the period of induction.

$$C^* = DM' + (1-D)\,C'(1-U'). \tag{B6}$$

If M' is smaller than $C'(1-U')$, then, other things equal, an increase in D will decrease C*, lower the reservation price for enlisting, and, thus, increase enlistments. A similar exercise can be performed using the net utility of the nonpecuniary conditions of military service during induction. If these conditions are considered inferior to civilian employment, then an increase in D will, other things equal, reduce the expected net utility of the nonpecuniary conditions associated with not enlisting, lower the reservation price for enlisting, and thus, increase enlistments. Based on this analysis, the e_r function can be rewritten:

$$e_r = f_r(M, C, T, D), \tag{B7}$$

11. If he is not enrolled in school, the potential enlistee could, until recently, become a father or obtain employment in occupations that carry deferments. Recent changes in draft laws have tended to reduce the availability of deferment options.

where

$$\frac{\partial f_r}{\partial D} > 0.$$

Note that the positive sign of the first-order partial derivative is based on two assumptions: (1) that M' is less than C(1-U), and (2) that the net utility of the nonpecuniary conditions of induction is negative.

Altman[12] estimated the parameters of a restricted enlistment rate function. His elasticities were considerably lower than those reported by Gray, who estimated a more general enlistment function. Consideration of school attendance as a relevant alternative to enlisting provides a partial explanation for the difference. We define the unrestricted enlistment ratio, e, as the product of the restricted enlistment ratio, e_r, and the nonattendance ratio, n_a:

$$e = e_r \, n_a = \frac{E}{NS} \frac{NS}{P} . \qquad \text{(B8)}$$

The first-order partial derivative of e with respect to M is:

$$\frac{\partial e}{\partial M} = n_a \frac{\partial e_r}{\partial M} + e_r \frac{\partial n_a}{\partial M} .$$

The elasticity of e with respect to M is:

$$\frac{\partial e}{\partial M} \frac{M}{e} = \frac{M}{e} \; n_a \; \frac{\partial e_r}{\partial M} + \frac{M}{e} \; e_r \frac{\partial N_a}{\partial M} = \frac{M}{e_r} \frac{\partial e_r}{\partial M} + \frac{M}{n_a} \frac{\partial n_a}{\partial M} . \qquad \text{(B9)}$$

According to this equation, the unrestricted enlistment ratio elasticity will be greater than the restricted enlistment ratio elasticity if the nonattendance elasticity, $\frac{M}{n_a} \cdot \frac{n_a}{\partial M}$, is positive. Estimates of

12. Altman, op. cit.

the nonattendance relative wage elasticity derived from the Gray and Altman coefficients reported in Table A2 are presented below.

	With Draft	Without Draft
Total Service	+.40	+.24
Army	+.92	+.59

B3. THE SERVICE EFFECT

The service share ratio, s_i, is the fraction of total enlistees who choose to enlist in service i. This ratio reflects the pecuniary and nonpecuniary conditions associated with service i, and the same conditions in the other services. The s_i function may be written as:

$$s_i = f_s (M_i, M_o, T_i, T_o), \qquad \text{(B10)}$$

where M_i = military pay in service i,

M_o = military pay, other services,

T_i = net utility of nonpecuniary conditions in service i,

T_o = net utility of nonpecuniary conditions in other services,

and

$$\frac{\partial f_s}{\partial M_i} > 0,$$

$$\frac{\partial f_s}{\partial M_o} < 0,$$

$$\frac{\partial f_s}{\partial T_i} > 0,$$

$$\frac{\partial f_s}{\partial T_o} < 0.$$

There is probably little relative variation in M_i and M_o since the only factor that would produce differences in M_i and M_o among services is differences in promotion rates. On the other hand, significant relative variation in T_i and T_o could arise from changes in world conditions that are expected to result in U.S. combat involvement. The net utility of nonpecuniary conditions in the Air Force and Navy presumably rise when the United States gets involved in combat situations, because the burden of these situations, in terms of fatalities and other casualties, is generally borne most heavily by the Army and the Marine Corps. Thus, for example, the increased casualties arising from the U.S. involvement in Viet Nam should have operated to reduce s_i for the Army and Marine Corps, and to increase s_i for the Navy and Air Force.

No research exists, to our knowledge, that attempts to estimate the parameters of f_s. This gap may be partly attributed to the anticipated lack of relative variation in the independent variables of f_s.

B4. SOME EMPIRICAL IMPLICATIONS

To derive some empirical implications from this analysis, we return to the specification of the enlistment function used in earlier studies.

$$e_i = e_i\,(M, C, D, U), \qquad \text{(B11)}$$

where the subscript i refers to a specific service. The first-order partial derivatives of the function may be written in terms of an attendance effect, an enlistment effect, and a service effect:

$$\frac{\partial ei}{\partial M} = s_i\, e_r \frac{\partial n_a}{\partial M} + s_i\, n_a \frac{\partial e_r}{\partial M} + e_r\, n_a \frac{\partial s_i}{\partial M}\,. \qquad \text{(B12)}$$

In the case of the total service enlistment function, the service effect drops out and the first-order partial derivative becomes:

$$\frac{\partial e}{\partial M} = e_r \frac{\partial n_a}{\partial M} + n_a \frac{\partial e_r}{\partial M} \qquad \text{(B13)}$$

The nature of these effects for each variable is summarized below:

Variable	Attendance	Enlistment
M	+	+
C	+	-
D	-	+
U	-	+

Since ratios, s_i, e_r, and n_a are all positive numbers, the sign of each effect is determined by its first-order partial derivative. The relative importance of each effect is also affected by the magnitude of its ratios.

Several conclusions can be drawn from the tabulation. First, even if changes in military and civilian pay have an equal effect on the restricted enlistment rate $\left(-\frac{\partial e_r}{\partial M} = \frac{\partial e_r}{\partial C}\right)$, changes in M will have a greater effect on the unrestricted enlistment rate, e_i, than changes in C. The reason for this is that the attendance effect reinforces the enlistment effect for M, and offsets it for C. Second, the partial derivative of draft pressure and unemployment will be greater for the restricted enlistment rate than for the normal enlistment rate. This is because the negative attendance effects of D and U tend to offset their positive enlistment effects. Third, a similar effect will exist for civilian pay because its positive attendance effect on e_i tends to offset its negative enlistment effect. Finally, changes in M will have a smaller effect on e_r than on e_i because the positive enlistment and attendance effects tend to reinforce each other.

Appendix C

SPECIFICATION BIASES IN RELATIVE PAY MODELS OF ENLISTMENTS

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The most general specification of an enlistment supply function can be written:

$$E = f(R_1, R_2, \ldots, R_n), \tag{C1}$$

where R_1 is the "own" pecuniary return and $R_2, \ldots, R_n$ represents the pecuniary return to alternative activities, and where $\frac{\partial E}{\partial R_1} > 0$, and $\frac{\partial E}{\partial R_j} < 0$, $j = 2, \ldots, n$. If we assume that this enlistment function is homogeneous of degree zero in R_i, $i = 1, n$, then we can postulate that:

$$\frac{\partial E}{\partial R_1} \cdot R_1 + \frac{\partial E}{\partial R_2} \cdot R_2 + \ldots, + \frac{\partial E}{\partial R_n} \cdot R_n = 0, \tag{C2}$$

or, dividing Eq. C2 by E,

$$\epsilon_1 + \epsilon_2 + \ldots, + \epsilon_n = 0, \tag{C3}$$

where ϵ_i represents the enlistment supply elasticity with respect to the i^{th} return. We can rewrite Eq. C3 as:

$$\epsilon_1 = - \epsilon_2 - \ldots, - \epsilon_n. \tag{C4}$$

This equation appropriately describes the relationship between the "own" elasticity (ϵ_1) and the cross elasticities ($\epsilon_2 \ldots, \epsilon_n$); i.e., that the sum of the relevant cross elasticities equals the own elasticity.[1] Thus, in principle, one would expect ε_1 to be larger for a specific service because its relevant cross elasticities include the cross elasticity of specific-service enlistment supply with respect to returns to enlisting in other services.[2] This cross elasticity is excluded from the calculation of own elasticity in the total-service model.

The homogeneity assumption also allows us to rewrite the enlistment function in which an arbitrarily chosen R_i is used as a numeraire to deflate all other pecuniary returns. Thus, the enlistment function may be written:

$$E = f(R_1', R_2', \ldots, R_m'), \qquad \text{(C5)}$$

where R_j' is the return to the j^{th} activity relative to the return to working (or looking for work) in the civilian labor market and where $\frac{\partial E}{\partial R_1'} > 0$, and $\frac{\partial E}{\partial R_j'} < 0$, $j = 2, m$.

The bias arising from omitting relevant alternatives can be described by comparing the parameters estimated with the parameters that would have been estimated from an equation derived from Eq. C5. Suppose that the correctly specified equation is:

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1. It is possible to conceive of a situation in which the function is not homogeneous of degree zero in all pecuniary returns. This situation arises if changing the level of all returns also changes the marginal rate of substitution between pecuniary and nonpecuniary returns. For example, it is possible that doubling all pecuniary returns will make nonpecuniary returns more valuable in terms of pecuniary returns. This will result in a shift of suppliers toward those occupations in which nonpecuniary returns form a large proportion of total returns. See H. G. Lewis, "Hours of Work and Hours of Leisure," in Proceedings of Industrial Research Association, Vol. 9 (December 1956), pp. 196-206.

2. Similarly, ε_1 should be larger in the specific-service enlistment model than in the specific-service reenlistment model because the option of applying to other services is more readily available to potential enlistees. Offsetting this consideration, however, is the greater capability of potential reenlistees to choose among alternative skill options within the specific service.

$$\log e = \log \alpha_0 + \alpha_1 \log R_1' + \alpha_2 \log R_2' + \log u, \qquad (C6)$$

where e is the total enlistment rate,[3] R_1' is relative military pay, and R_2' is the return to attending school relative to the return to working in the civilian labor market, and u is a random disturbance term. We expect the following properties from this function:

$$\alpha_1 > 0,$$

$$\alpha_2 < 0,$$

$$\alpha_1 = - \alpha_2.$$

If the equation fit to the data is:

$$\log E = \log a_0 + a_1 \log R_1' + v, \qquad (C7)$$

then a_1 may be a biased estimate of α_1. The bias is described by:

$$a_1 = \alpha_1 + \alpha_2 b_{12}, \qquad (C8)$$

where $\alpha_2 B_{12}$ measures the bias. The coefficient b_{12} is the estimated partial regression coefficient of the "auxiliary" regression:

$$R_2' = b_0 + b_{12} R_1' + z, \text{ 4/} \qquad (C9)$$

where z is an error term. The bias thus depends on α_2 and b_{12}. The pay parameters of total enlistment functions estimated in prior studies are biased if both α_2 and b_{12} are nonzero.

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3. It is assumed that the function is homogeneous of degree one in eligible population. This allows us to use the eligible population as a deflator of enlistments in the dependent variable instead of including it on the right-hand side as an additional independent variable and saves us a degree of freedom in the regression analysis.

4. See Z. Griliches, "Specification Bias in Estimates of Production Functions," in Journal of Farm Economics, Vol. 39 (February 1957), pp. 8-20.

The bias in estimates of pay parameters in specific-service enlistments may be estimated from an equation similar to Eq. C8. However, we expect the bias to be larger because of the existence of a wider range of omitted relevant alternatives. In addition to attending school, the specific-service enlistment model has enlisting in another service as a viable option. Thus, we would expect α_2 to be larger in the specific-service enlistment model. In addition, it can be argued that, other things equal, b_{12} will be more positive in the specific-service model because a major component of military pay, base pay, is common to all services.[5]

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5. Any variation in R_1 that is the result of changes in base pay rate will also show up as variation in the component of R_2.

Appendix D

ESTIMATES OF VARIABLES

Appendix D

ESTIMATES OF VARIABLES[1]

D1. ENLISTMENT RATES

Enlistments were estimated as the total number of nonprior service white Army enlistees in Mental Groups I-III. Enlistment contracts typically range from two to six years, with the bulk of the contracts being for three years. We were unable to obtain a breakout of our enlistees by length of enlistment obligation; therefore, we are implicitly assuming that the mix of enlistees by length of obligation has remained relatively stable over the period of this analysis.[2] This estimate also includes a small number of enlistments into the Officer Candidate program. Since we are not able to isolate the race and mental group of specific enlistees to this program and since their numbers were relatively small, we made no explicit adjustment for them.[3]

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1. The estimates described in this Appendix are in A. Fechter, "Impact of Pay and Draft Policy on Army Enlistment Behavior," Studies Prepared for the President's Commission on an All-Volunteer Armed Force, Vol. I. The estimates of military pay, civilian pay, and population have been revised since publication of this paper and the revised estimates appear in Table D1 of this Appendix.

2. Generally, over 80 percent of Army enlistments are three-year contracts. There are indications that the Army began to place heavier reliance on the two-year enlistment contract starting in April 1968. This would only affect two observations in our analysis and would, therefore, have little effect on our finding. It would, however, be a factor to consider if the analysis were extended to later quarters.

3. Their monthly numbers ranged from 200 to 1,600 during the period March 1967-September 1968. They constituted about seven percent of white enlistments in Mental Groups I-III. While there was a discernible upward trend in the numbers during this period (i.e., 1968 was consistently higher than the same month in 1967), the percent remained fairly stable.

We defined our eligible population as all white males in the civilian population between the ages of 17 and 21.[4] This estimate excludes eligible white males who are outside of this age range and includes males in Mental Groups IV and V and males in Mental Groups I-III who are physically or otherwise ineligible to enlist and who are within this age range. We chose to limit our eligible population to the 17-20 year-old age group because it appears to be the relevant market for initial enlistments. Enlistment rates for males over the age of 20 are low and are extremely sensitive to the level of inductions.[5] This sensitivity is not surprising, given that the order of induction priority was oldest first during this period. These rates suggest that most of the enlistees who are over 20 are motivated by the pressure of being drafted. Unfortunately, we were not able to

4. An alternative definition, the civilian population not enrolled in school, has been advocated as a more relevant definition of eligible population. Proponents of this measure argue that individuals who are still enrolled in school either are not really interested in enlisting at any level of R_t or MP_t or are not able to enlist while in school and, therefore, should not be included in the estimates of eligible population. This argument can be rebutted in several ways. First, lack of interest is not a reason for eliminating an individual from the eligible population. Presumably, lack of interest reflects some aspect of voluntary choice that should be accounted for in the analysis. Indeed, one could argue that school enrollment decisions are part of the enlistment-nonenlistment choice that is affected by MP_t. Second, enrollment in school may render an eligible enlistee unable to enlist in the short run, while he is completing his studies, but it does not preclude him from enlisting upon completion of his studies. Indeed, the seasonal pattern of enlistments indicates that eligible enlistees who are enrolled in school tend to enlist upon completion of their school terms.

5. Representative ratios for 1964 and 1966, a low and a high draft-call year, respectively were:

Age	1964	1966
18	.062	.058
20	.032	.100
22	.026	.030
24	.003	.014

break the enlistment data down by age. Therefore, the numerator of the enlistment rate overstates the number of enlistees between the ages of 17 and 21, or alternatively, the rate overstates the enlistment rate of 17 to 25 year-olds. Estimates of the ratios of the number of white males in the civilian population between the ages of 17 and 21 to the number of white males in the civilian population between the ages of 17 and 25, the approximate age span of Army enlistees, were about 55 percent between 1958 and 1968.[6]

Inclusion of eligible enlistees who are in Mental Groups IV and V and males who are in Mental Groups I-III, but who are either physically or otherwise disqualified from enlisting, gives a downward bias to our estimate of enlistment rates. A point estimate of the mental group composition of the male population for 1960 indicates that approximately 22 percent of the white male population between the ages of 19 and 21 were in Mental Groups IV-V.[7] This estimate is likely to vary with changes in the level of school completed by eligible enlistees. Rough estimates of the amount of schooling completed by white males between the ages of 18 and 24 indicate that their years of schooling completed rose about 0.5 years between 1957 and 1968.[8]

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6. U.S. Bureau of Census, Current Population Reports, Series P-20, Population Characteristics, No. 93, p. 8; No. 190, p. 10.

7. B. D. Karpinos, "The Mental Test Qualification of American Youths for Military Service and Its Relationship to Educational Attainment," Proceedings of the American Statistical Association, 1966 Social Statistics Section, p. 105.

8. The number of years of school completed by males for the two years are as follows:

	Age 18-19	Age 20-24
1957	11.7	12.3
1968	12.1	12.8

These figures are for whites and nonwhites and include members of the Armed Forces. See U.S. Bureau of the Census, Current Population Reports, Series P-20, Population Characteristics, No. 77, p. 9; No. 182, p. 9.

This could conceivably result in a downward trend in the ratio of eligible enlistees in Mental Groups IV-V to total eligible enlistees. The approximate rate of disqualification for medical and other causes ranged between 20 and 30 percent during the period of our analysis.[9] If there is no difference between mental groups in the disqualification rate for physical reasons and for reasons other than mental, then we may use the overall disqualification rate as an estimate of the rate of eligible enlistees in Mental Groups I-III. Under these conditions, we estimate that the eligible population is about 40 to 50 percent of the total civilian population. A point estimate for 1958-1960 indicated that about 45 percent of the eligible inductees examined were disqualified for either physical, mental, or administrative reasons.[10]

The combined effects of the exclusion of qualified persons who were over 20 years old and the inclusion of disqualified persons who were in the 17-20 year-old group appear to just about offset each other. If these biases were consistent over the period, we can argue that the errors in measurement arising from these two sources of bias are small and are randomly distributed.

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9. U.S. Department of the Army, Office of the Surgeon General, Health of the Army (December 1968), p. 25. This rate applies only to males who were given a pre-induction physical. There are a number of considerations that could make this rate a biased estimate for the total population and these considerations work in offsetting ways. Those called for pre-induction physicals tended to be nonstudents or persons who had no obvious physical defects that would have resulted in their being screened out by their local draft boards at the time they registered with Selective Service. Nonstudents might tend to have lower disqualification rates than students because of the relative inability of their families to afford the medical expenditures to establish a physical disability. On the other hand, those who were screened out before they were able to take pre-induction exams would probably have higher disqualification rates.

10. B. D. Karpinos, Qualification of American Youths for Military Service (Medical Statistics Division, Office of the Surgeon General, Department of the Army, 1962), p. 80.

D2. MILITARY PAY[11]

Our estimate was defined as follows:

$$MP_{tq} = q \frac{(MP_{t+1} - MP_t)}{4} + MP_t, \qquad (D1)$$

where the subscript t refers to the t^{th} year and q refers to the q^{th} quarter. In essence, this is an interpolation formula that allows one to derive quarterly estimates from annual observations. It expresses expectations in terms of current pay and next year's pay, giving relatively more weight to next year's pay in the later quarters of the year. This produces a relatively smooth quarterly series.

We assumed a three-year enlistment contract governed the time horizon of eligible enlistees. In essence, we assumed that, since eligible enlistees were considering a three-year commitment, only the first three years of military activity were germane to the estimation of military earnings. MP_t is the value of base pay, quarters, and subsistence allowances, and the tax advantages on these allowances, all discounted to the time of entry into service, assumed to be age 19, at a rate of 30 percent.[12] It was computed as a weighted average of the pay of enlistees in all pay grades in a given year of service.[13] Distributions of enlistees by pay grade and years of service were available for the fiscal years 1964-1968. Prior to fiscal year 1964 this distribution was assumed to be the same as the 1964 distribution.

A systematic bias may arise prior to 1964 because the estimate does not account for changes in promotion rates. The bias that would

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11. Revised military pay figures are described in Table D1.

12. The use of a 30 percent discount rate also implies a relatively short time horizon in the decisionmaking process.

13. This computation does not build in any expectation of pay increases beyond the one-year time horizon used in the interpolation formula. Thus, it is assumed that the potential enlistee does not expect any military pay changes beyond the first year of his enlistment. Other time-series studies have built such an expectation into their pay estimates. See, A. A. Cook, Jr. and J. P. White, Estimating the Quality of Air Force Volunteers, Rand, RM-6360-PR (September 1970), pp. 29-34 and A. A. Cook, Jr., The Supply of Air Force Volunteers, Rand, RM-6361-PR (September 1970), pp. 18-23.

have existed after 1964 had we not accounted for promotion change would have been only seven percent for 1968; i.e., MP_t was about seven percent higher in 1968 when the faster promotion rates were included in our estimate. A minor bias may arise because of the imputation of quarters and subsistence allowances to first-termers who are receiving them in-kind. These allowances are imputed on the basis of budget averages for persons who actually receive them. Our estimates will be biased if the value of the quarters and food actually received by the first-termer differs from the imputed values. In addition, the value of such fringe benefits as PX and Commissary privileges and medical benefits received by first-termers has been excluded from our estimates.[14]

D3. CIVILIAN PAY

We assume that the monetary return to not enlisting in the Army is equal to the monetary return to civilian employment.[15] Our estimate of civilian pay was:

$$CP_{tq} = q \frac{(CP_{t+1} - CP_t)}{4} + CP_t. \qquad \text{(D2)}$$

Again, this is an interpolation formula that states that expected pay is based on actual current pay and the pay expected in the next year,

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14. Benchmark estimates of PX and Commissary privileges and benefits indicate that they would increase our estimate of military pay by approximately $126 in 1965. While other studies have reported adding medical benefits to their estimates of military earnings, these estimates are not reported. See, Department of Defense, Modernizing Military Pay, Report of the First Quadrennial Review of Military Compensation, Vol. I, Active Duty Compensation (November 1967), pp. 102 and 108, for estimates of PX and Commissary benefits. See J. C. Hause and A. C. Fisher, The Supply of First-Term Enlisted Manpower in the Absence of a Draft, Institute for Defense Analyses, Program Analysis Division, IDA Study S-293 (Arlington, Virginia, April 1968), p. 64, for a discussion of medical benefits.

15. This is tantamount to assuming that potential Army enlistees either enlist in the Army or they do not enlist at all. The consequences of this assumption are discussed above in Appendix C.

with next year's pay taking on relatively more weight in the later quarters of the year. It assumes that next year's pay is anticipated accurately; i.e., that the eligible enlistee is able to make a perfect forecast, and like MP, it produces a relatively smooth quarterly series. A three-year time horizon was also assumed and the eligible enlistee was assumed to be 19 years old at the time of his enlistment decision. Civilian pay was defined as the income of persons who were employed year-round, full-time and who were in the 19-21 year-old age group.[16] This estimate, an annual series, was interpolated to produce quarterly data. It was then discounted to age 19 at 30 percent to produce an estimate of the present value of the three-year income stream of eligible enlistees who enter the civilian labor force. This estimate of the three-year income stream includes the incomes of white persons who are in Mental Groups IV and V, of white persons who are in Mental Groups I-III who are ineligible to enlist, and of nonwhite persons. Inclusion of the incomes of persons from all of these groups tends to bias our estimate of CP downward. This bias is a function of the income differential between eligible white males and males in the groups that have erroneously been included; it can be as large as 25 percent.[17]

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16. The pay of 19 year-olds was estimated from the incomes of 14-19 year-olds, and the pay of 20 and 21 year-olds was estimated from the incomes of 20-24 year-olds. The former estimate is biased downward and the latter two estimates are biased upward. An alternative procedure would have assumed the incomes of 14-19 year-olds to be centered on 17 and the incomes of 20-24 year-olds to be centered on 22. Estimates of earnings of 19-21 year-olds by single year of age could then have been interpolated from these two points by assuming that the income profile was linear between them. Since the biases were offsetting in nature, it was not deemed necessary to employ the alternative procedure.

17. The bias may be expressed algebraically as follows:

$$B = \hat{C} - C = (1 - \alpha)(C' - C),$$

where $\hat{C}$ = the estimated income stream of eligible enlistees, C = the correctly measured income stream of eligible enlistees, α = proportion of income recipients who are eligible enlistees, and C' = income stream of persons other than eligible enlistees. It can readily be seen that there is no bias when $\alpha = 1$ or $C' = C$, and that the bias is small when α is close to 1 or when $(C' - C)$ is small.

Benchmark estimates indicate that the bias in annual earnings arising from including white males from Mental Groups IV-V ranges between -$180 and -$240. The earnings differential, $(C' - C)$, is between $600 and $800, and α is approximately .70. Estimates of $(C' - C)$ were derived from unpublished tabulations of PROJECT TALENT tapes furnished by the American Institutes for Research. The estimates were based on the 1963 earnings experience of white males who were in 10th grade in 1960. The estimate of α is for the entire population of white males, not just male wage earners, between the ages of 19 and 21, and was made for 1960. See, B. D . Karpinos, "The Mental Qualification of American Youths for Military Service and Its Relationship to Educational Attainment," Proceedings of the American Statistical Association, 1966 Social Statistics Section, Table 5.

The bias in annual income arising from including nonwhites may be inferred from estimates of the 1968 incomes of year-round, full-time male workers between the ages of 20 and 24. Based on these data, we estimate that the bias was approximately -$600. The income differential between whites and negroes was approximately $1,200, and roughly half of the income recipients were white. See, U. S. Bureau of the Census, Current Population Reports, Series P-60, Consumer Income, No. 66, pp. 90-91. These two independent sources of bias combine to reduce our estimate of C by approximately $1,500, assuming these estimates of income differentials and α apply to each of the three years included in our income stream. This is approximately 24 percent of the average value of our estimated C for the 1958-1968 period.

Table D1

REVISED QUARTERLY ESTIMATES OF MILITARY PAY,
CIVILIAN PAY, AND POPULATION, AGE 17-20 AND 17-24

Military Pay				
Year \ Quarter	1	2	3	4
1958	4613	4613	4613	4613
1959	4613	4613	4613	4613
1960	4613	4613	4613	4613
1961	4613	4613	4613	4613
1962	4613	4613	4613	4613
1963	4613	4613	4613	4823
1964	4823	4823	4818	4809
1965	4805	4801	4958	5272
1966	5305	5336	5560	5625
1967	5679	5726	5749	6174
1968	6181	6186	6485	6477

Civilian Pay				
Year \ Quarter	1	2	3	4
1958	5017	5026	5049	5099
1959	5148	5198	5264	5396
1960	5456	5552	5625	5651
1961	5678	5705	5747	5818
1962	5889	5961	6019	6050
1963	6081	6112	6152	6208
1964	6264	6321	6436	6668
1965	6901	7133	7276	7237
1966	7199	7161	7178	7306
1967	7434	7562	7682	7789
1968	7895	8002	8140	8341

Table D1 (Cont'd)

White Male Civilian Non-Institutional Population, Age 17-20				
Year \ Quarter	1	2	3	4
1958	3495	3520	3544	3577
1959	3627	3676	3725	3777
1960	3836	3894	3953	4005
1961	4046	4086	4127	4160
1962	4180	4199	4219	4253
1963	4316	4379	4442	4503
1964	4562	4620	4679	4756
1965	4871	4986	5101	5187
1966	5215	5242	5270	5276
1967	5242	5207	5173	5171
1968	5232	5294	5356	5402

White Male Civilian Non-Institutional Population, Age 17-24				
Year \ Quarter	1	2	3	4
1958	6436	6495	6554	6620
1959	6703	6785	6867	6949
1960	7031	7112	7194	7274
1961	7353	7431	7510	7575
1962	7616	7656	7697	7761
1963	7870	7980	8090	8200
1964	8313	8425	8537	8658
1965	8795	8933	9070	9175
1966	9214	9252	9291	9324
1967	9346	9368	9390	9427
1968	9495	9562	9630	9706

Appendix E

ESTIMATES OF ENLISTMENT BEHAVIOR

Appendix E

p. 8 for Defn of VBLES

ESTIMATES OF ENLISTMENT BEHAVIOR

Table E1

SUMMARY OF REGRESSION STATISTICS

Variables	Model			
	IR		2R	
	Coefficient	t-Value	Coefficient	t-Value
Constant	-6.488	- .85	- .777	- .11
S2	-1.146	-3.74	-1.495	-5.07
S3	.122	.28	.441	1.11
S4	-1.514	-3.86	-1.884	-5.12
M/C	8.737	4.64	5.750	2.98
DP	.180	3.40	.199	4.19
VN[a]	.695	.47	- .090	- .07
Cuba	.294	.77	.299	.88
Berlin	.437	2.05	.239	1.20
EMP	5.799	.68	- .513	- .07
E_{t-1}			.381	3.09
R^2	.67		.74	
Durbin Watson Statistic	1.47		2.17	

Variables	Model			
	1A		2A	
	Coefficient	t-Value	Coefficient	t-Value
Constant	-1.577	- .21	3.467	.49
S2	-1.129	-3.75	-1.466	-4.91
S3	.153	.36	.406	1.02
S4	-1.568	-4.04	-1.882	-5.11
M[b]	.208	1.97	.100	.96
C[b]	.124	-4.08	- .0880	-2.99
DP	.184	3.49	.204	4.23
VN[a]	- .402	- .17	- .039	.02
Cuba	.333	.85	.288	.81
Berlin	.431	2.02	.233	1.12
EMP	5.526	.62	.584	.07
E_{t-1}			.359	2.77
R^2	.68		.74	
Durbin Watson Statistic	1.48		2.16	

a. per 10,000 casualties.
b. per $100.

Table E1 (Cont'd)

Variables	Model			
	3R		4R	
	Coefficient	t-Value	Coefficient	t-Value
Constant	1.972	.25	1.607	.20
S2	-1.168	-4.13	-1.167	-4.06
S3	.387	.94	.378	.90
S4	-1.292	-3.47	-1.292	-3.42
M/C	5.491	2.55	5.482	2.51
DP	.198	4.01	.193	3.25
VN[a]	.398	.29	- .0659	- .02
Cuba	.163	.46	.150	.41
Berlin	.296	1.45	.300	1.44
EMP	-1.025	- .12	- .560	- .06
DP·K	- .0693	-2.56	- .0690	-2.51
DP·VN[a]			.0538	.18
R^2	.72		.71	
Durbin Watson Statistic	1.80		1.80	

Variables	Model			
	3A		4A	
	Coefficient	t-Value	Coefficient	t-Value
Constant	3.720	.50	-2.181	- .23
S2	-1.154	-4.11	-1.143	-4.07
S3	.379	.92	.357	.87
S4	-1.356	-3.64	-1.391	-3.72
M[b]	.168	1.68	.271	1.87
C[b]	- .0762	-2.27	- .0588	-1.55
DP	.199	4.02	.145	1.98
VN[a]	- .897	- .41	-6.648	-1.06
Cuba	.234	.64	.234	.64
Berlin	.321	1.56	.401	1.82
EMP	-1.730	- .20	-1.087	- .12
DP·K	- .0647	-2.37	- .0644	-2.36
DP·VN[a]			.438	.98
R^2	.73		.73	
Durbin Watson Statistic	1.86		1.88	

a. per 10,000 casualties.
b. per $100.

FORMULAE USED TO ESTIMATE ENLISTMENT YIELDS, PAY ELASTICITIES, AND PROPORTION DRAFT-MOTIVATED

Let the following symbols represent 1970 values of variables:

E = enlistments, whites, Mental Group I-III, Army, in thousands.

P1 = white male civilian non-institutional population, 17-20, in thousands.

e = E/P1

M = military pay

C = civilian pay

I = induction calls

P2 = white male civilian non-institutional population, 17-24, in thousands.

DP = I/P2

β_X = regression coefficient variable X.

ϵ_X = elasticity of enlistments with respect to variable X.

$\partial E/\partial X$ = enlistment yield per unit of X.

The formulae for quarterly enlistment yields can be expressed as follows:

Military Pay:

Relative pay model

$$\frac{\partial E}{\partial M} = \frac{\partial e}{\partial M/C} \cdot \frac{\partial E}{\partial e} \cdot \frac{\partial M/C}{\partial M} = \beta_{M/C} \cdot P1 \cdot \frac{1}{C} = \beta_{M/C} \cdot \frac{5723}{7334}$$

Absolute pay model

$$\frac{\partial E}{\partial M} = \frac{\partial C}{\partial M} \cdot \frac{\partial E}{\partial C} = \beta_M \cdot P1 = \beta_M \cdot 5723$$

Civilian pay:

Relative pay model

$$\frac{\partial E}{\partial C} = \frac{\partial e}{\partial M/C} \cdot \frac{\partial E}{\partial e} \cdot \frac{\partial M/C}{\partial C} = \beta_{M/C} \cdot P1 \cdot \frac{M}{C} = \beta_{M/C} \cdot 5723 \cdot \frac{5226}{(7334)}$$

Absolute pay model

$$\frac{\partial E}{\partial C} = \frac{\partial e}{\partial C} \cdot \frac{\partial E}{\partial C} = \beta_C \cdot P1 = \beta_C \cdot 5723$$

Draft pressure:

$$\frac{\partial E}{\partial I} = \frac{\partial C}{\partial DP} \cdot \frac{\partial E}{\partial e} \cdot \frac{\partial DP}{\partial I} = \beta_{DP} \cdot P1 \cdot \frac{1}{P2} = \beta_{DP} \cdot \frac{5723}{10728}$$

The formulae for elasticities are:

$$\epsilon_{M/C} = \beta_{M/C} \cdot \frac{M/C}{e} = \beta_{M/C} \cdot \frac{7126}{4.473}$$

$$\epsilon_{M} = \beta_{M} \cdot \frac{M}{e} = \beta_{M} \cdot \frac{5226}{4.473}$$

$$\epsilon_{C} = \beta_{C} \cdot \frac{C}{e} = \beta_{C} \cdot \frac{7334}{4.473}$$

The formula for proportion draft-motivated (DM) is:

$$DM = \frac{\partial E}{\partial I} \cdot \frac{I}{E} = \beta_{DP} \cdot \frac{P1}{P2} \cdot \frac{I}{E} = \beta_{DP} \cdot \frac{5723}{10728} \cdot \frac{163.5}{100.6}$$

Appendix F

PROCEDURE FOR ESTIMATING VOLUNTEERS FROM LOTTERY DATA

Appendix F

PROCEDURE FOR ESTIMATING VOLUNTEERS FROM LOTTERY DATA

In estimating the number of voluntary enlistments, we assumed that all enlistees with lottery numbers above some arbitrary number, n, are true volunteers.[1] The total number of true volunteers, V, was:

$$V = \left[\frac{365}{365-n}\right] \sum_{i=n}^{365} V_i,$$

where V_i represents the number of enlistments in the i^{th} lottery number class. This procedure was utilized for individuals who knew their lottery numbers before they enlisted.[2] We assumed that individuals who enlisted before they knew their lottery number were volunteers since they could have waited to see whether or not their lottery numbers were high enough to exempt them from the draft.

Since 42 percent of the 1970 Army accessions came from this group, this assumption becomes a highly crucial determinant of the ultimate findings. Two methods were used to estimate voluntary enlistments from this group. Method A assumes that all individuals in this

---

1. There are three lottery groups: (1) enlistees who were born in 1944-1950 and were assigned lottery numbers for 1970, (2) enlistees who were born in 1951 and were assigned lottery numbers for 1971 before they enlisted in 1970, and (3) enlistees who were not assigned lottery numbers before they enlisted in 1970.

The lottery sequences are classes of enlistees ranked by their lottery numbers. For those who have numbers, they are classified into six classes: (1) enlistees with lottery numbers 1-60, (2) enlistees with lottery numbers 61-120.....(6) enlistees with lottery numbers 301-365.

2. This also assumes that enlistees who were in the second group expected draft-calls to reach no higher than n, the arbitrary lottery number chosen for the analysis. The procedure also assumes that there is no systematic difference in the number of voluntary enlistments between lottery number classes above and below n.

group are volunteers. This represents an upper bound on volunteers. Method B assumes that the proportion of volunteers for this group is equal to the volunteer-proportion of those who have lottery numbers. This represents an upper bound.

Appendix G

PREDICTED AND ACTUAL VALUES FOR ALTERNATIVE MODELS

Appendix G

PREDICTED AND ACTUAL VALUES FOR ALTERNATIVE MODELS

Table G1

PREDICTED AND ACTUAL VALUES, ALTERNATIVE MODELS
(April 1968 - April 1970)

Model / Quarter	1A	2A	3A	4A	1R	2R	3R	4R	1N	2N	3N	Actual
	Predicted											
68.4	30.4	26.7	28.8	28.9	26.4	27.1	30.6	26.6	29.9	32.2	27.7	27.6
69.1	40.6	37.3	41.4	40.2	39.1	37.4	42.8	39.0	38.2	37.9	33.0	30.4
69.2	32.6	29.0	39.4	31.7	31.4	29.1	35.4	31.5	37.8	31.5	27.5	26.5
69.3	41.8	38.4	43.1	45.4	39.1	38.8	44.1	40.1	40.6	40.8	36.4	34.4
69.4	28.1	22.3	26.8	30.5	24.1	22.9	28.7	24.7	28.1	32.0	29.1	25.4
70.1	35.0	31.1	36.1	39.7	33.3	31.8	37.8	33.9	31.1	33.2	33.5	27.3
70.2	27.2	22.6	35.4	31.4	25.9	23.6	30.9	27.1	27.4	31.6	29.0	23.3
70.3	32.4	29.9	35.7	39.9	31.3	31.4	38.2	34.3	35.9	39.7	38.7	27.2
70.4	22.8	16.9	24.6	30.0	20.0	18.5	27.4	23.8	26.6	29.3	31.8	23.2

Table G2

DIFFERENCES BETWEEN PREDICTED AND ACTUAL VALUES AND MEAN SQUARE ERRORS, ALTERNATIVE MODELS (April 1968 - April 1970)

Model / Quarter	1A	2A	3A	4A	1R	2R	3R	4R	1N	2N	3N
	Predicted minus Actual										
68.4	+ 2.8	- .9	+ 1.2	+ 1.3	- 1.2	- .5	+ 3.0	- 1.0	+ 2.3	+ 5.4	+ .1
69.1	+10.2	+ 6.9	+11.0	+ 9.8	+ 8.7	+ 7.0	+12.4	+ 8.6	+ 7.8	+ 7.5	+ 2.6
69.2	+ 6.1	+ 2.5	+12.9	+ 5.2	+ 4.9	+ 2.6	+ 7.9	+ 5.0	+11.3	+ 5.0	+ 1.0
69.3	+ 7.4	+ 4.0	+ 8.7	+11.0	+ 4.7	+ 4.4	+ 9.7	+ 5.7	+ 6.2	+ 6.4	+ 2.0
69.4	+ 3.3	- 3.1	+ 1.4	+ 5.1	- 1.3	- 2.5	+ 3.3	- .7	+ 2.7	+ 6.6	+ 3.7
70.1	+ 7.7	+ 3.8	+ 8.8	+12.4	+ 6.0	+ 4.5	+10.5	+ 6.6	+ 3.8	+ 5.9	+ 6.2
70.2	+ 3.9	- .7	+ 8.1	+ 8.1	+ 2.6	+ .3	+ 7.6	+ 3.8	+ 4.1	+ 8.3	+ 5.7
70.3	+ 5.2	+ 2.7	+ 8.5	+12.7	+ 4.1	+ 4.2	+11.0	+ 7.1	+ 8.7	+12.5	+11.5
70.4	- .4	- 7.3	+ 1.2	+ 6.8	- 3.2	- 4.5	+ 4.2	+ .6	+ 3.4	+ 6.1	+ 8.5
Mean Square Error	212.40	155.79	583.24	698.68	194.73	139.85	636.80	241.71	358.05	492.09	300.89

Appendix H

ALTERNATIVE PROJECTIONS OF VOLUNTARY ARMY ENLISTMENTS

Appendix H

ALTERNATIVE PROJECTIONS OF VOLUNTARY ARMY ENLISTMENTS

Table H1

ALTERNATIVE PROJECTIONS OF VOLUNTARY ARMY ENLISTMENTS, MENTAL CATEGORIES I-III, ALL RACES, 1971-1980

Enlistments (in thousands)

Year	Model			
	1A	1R	2A	2R
1971	62.1	61.6	60.9	61.7
1972	163.3	120.5	136.3	124.2
1973	166.9	123.4	138.4	127.2
1974	170.4	126.2	140.5	130.0
1975	174.4	129.0	142.6	133.0
1976	177.3	131.5	144.4	135.6
1977	179.9	133.4	145.4	137.5
1978	182.1	134.7	145.9	138.9
1979	184.4	136.1	146.6	140.4
1980	186.4	137.3	146.9	141.8

Table H 2

DETAILED COMPONENTS OF ENLISTMENT CHANGES[a]

Year	Predicted Changes			Model 1A - Absolute			Model 2A		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	EV. (1+P)	$\dot{M}$	$\dot{C}$	$\epsilon_m \dot{M}$	$\epsilon_c \dot{C}$	Projected	$\epsilon_m \dot{M}$	$\epsilon_c \dot{C}$	Projected
1971	60.6	+ 169	+ 183	+ 8.0	- 6.5	62.1	+ 6.0	- 5.7	60.9
1972	62.1	2404	371	114.4	-13.2	163.3	85.8	-11.6	136.3
1973	63.5	2595	564	123.5	-20.1	166.9	92.6	-17.7	138.4
1974	64.8	2790	761	132.8	-27.2	170.4	99.6	-23.9	140.5
1975	66.1	2990	963	142.3	-34.4	174.4	106.7	-30.2	142.6
1976	67.0	3195	1170	152.1	-41.8	177.3	114.1	-36.7	144.4
1977	67.2	3406	1383	162.1	-49.4	179.9	121.6	-43.4	145.4
1978	66.9	3622	1601	172.4	-57.2	182.1	129.3	-50.3	145.9
1979	66.6	3843	1824	182.9	-65.1	184.4	137.2	-57.2	146.6
1980	66.1	4069	2055	193.7	-73.4	186.4	145.3	-64.5	146.9
Year	Predicted Changes			Model 1R			Model 2R		
1971	60.6	+ 169	+ 183	+ 4.6	- 3.6	61.6	+ 4.9	- 3.8	61.7
1972	62.1	2404	371	65.6	- 7.2	120.5	69.7	- 7.6	124.2
1973	63.5	2595	564	70.8	-10.9	123.4	75.3	-11.6	127.2
1974	64.8	2790	761	76.2	-14.8	126.2	80.9	-15.7	130.0
1975	66.1	2990	963	81.6	-18.7	129.0	86.7	-19.8	133.0
1976	67.0	3195	1170	87.2	-22.7	131.5	92.7	-24.1	135.6
1977	67.2	3406	1383	93.0	-26.8	133.4	98.8	-28.5	137.5
1978	66.9	3622	1601	98.9	-31.1	134.7	105.0	-33.0	138.9
1979	66.6	3843	1824	104.9	-35.4	136.1	111.4	-37.6	140.4
1980	66.1	4069	2055	111.1	-39.9	137.3	118.0	-42.3	141.8

a. Annual marginal enlistment returns per dollar increment are as follows:

	1A	2A	1R	2R
ϵ_m:	47.6	35.7	27.3	29.0
ϵ_c:	28.4	31.4	19.4	20.6

Appendix I

ESTIMATION OF VOLUNTARY ENLISTMENTS TO THE ARMY IN CALENDAR YEAR 1970, THE METHOD AND THE RESULTS

Appendix I

ESTIMATION OF VOLUNTARY ENLISTMENTS TO THE ARMY IN CALENDAR YEAR 1970, THE METHOD AND THE RESULTS

Estimates of EV_o, voluntary enlistments for 1970, were derived from an analysis of enlistments classified by lottery sequence and lottery category. The following equation summarizes the procedure:

$$EV_o = 2.92\ (EV_1 + EV_2) + .75\ EV_3,$$

where EV_1 = enlistments from the first lottery group[1] with lottery sequence numbers greater than or equal to 240,

EV_2 = enlistments from the second lottery group[2] with lottery sequence numbers greater than or equal to 240,

EV_3 = enlistments of persons who had no lottery number at the time they signed their enlistment contract.[3]

The term for EV_3 assumes that one-fourth of the enlistees in that group are draft-motivated. This assumption is based on survey responses of enlistees in this group at the time they entered service.[4] The first term of the equation assumes that the number of voluntary enlistments is independent of the lottery sequence number.[5]

---

1. Persons with birth years of 1944-50.

2. Persons with birth years of 1951. Since the lottery sequence numbers of this group were determined on June 30, 1970 in the middle of the year for which these numbers apply, this group excludes persons who were born in 1951 but did not know their lottery sequence number at the time they entered service, i.e., persons who were enlisted before June 30.

3. This group also includes persons who were born in 1951 who did not know their lottery number at the time they entered service.

4. These surveys were taken in March-April and September 1971 and showed from 20 to 30 percent of these enlistees to be draft-motivated.

5. The lottery sequence number is based on birth date.

Table I-1 summarizes the estimates for each lottery group and each assumption regarding draft-induced enlistments for the third lottery group.

Table I-1

ALTERNATIVE ESTIMATES OF VOLUNTARY ENLISTMENTS TO THE ARMY BY MENTAL GROUP, CALENDAR YEAR 1970

Mental Group	Method		
	A[a]	B[b]	C[c]
I	3.2	3.0	2.6
II	22.6	19.6	15.2
III	43.5	36.4	28.1

a. Assumes all enlistees in EV_3 are volunteers.

b. Assumes 75 percent of EV_3 are volunteers.

c. Assumes proportion of EV_3 who are volunteers is equal to proportion of EV_1 and EV_2 (combined) who are volunteers.

Appendix J

PROJECTIONS OF THE TOTAL MALE POPULATION, AGE 17-20

Appendix J

PROJECTIONS OF THE TOTAL MALE POPULATION, AGE 17-20

Table J1

PROJECTIONS OF THE TOTAL MALE POPULATION, AGE 17-20,
(in thousands),
1970-1980

Year	Number	Percent Change
1970	5653	-
1971	5804	+ 2.67
1972	5946	+ 5.18
1973	6080	+ 7.56
1974	6211	+ 9.87
1975	6334	+12.05
1976	6418	+13.53
1977	6434	+13.82
1978	6412	+13.43
1979	6381	+12.88
1980	6330	+11.98

Source: U.S. Bureau of the Census, *Current Population Reports*, Series P-25, *Population Projections*, No. 470, Table 2, Series B.

Appendix K

ESTIMATION OF THE MILITARY PAY CHANGE RESULTING FROM THE MILITARY PAY BILL OF NOVEMBER 1971

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Military pay was estimated so that it would be comparable with the estimate used in the econometric analysis. It was defined as the discounted value of the annual earnings stream received by an enlistee during his first three years of service. Table K1 describes the regular military compensation received by enlistees in pay grades E-1 and E-5 both before and after the passage of the November 1971 pay bill. These pay rates were weighted by the number of enlistees in these pay grades as of 30 June 1970 (Table K2) to produce average military pay for each year of first-term service in the Army, present values of these pay streams, and the proportional change that is attributable to the November 1971 pay bill (in Table K3). Table K3 also contains estimates of these pay streams and present values derived by OASD(M&RA). The major difference between the IDA and the M&RA estimates can be attributed to two factors: (1) the IDA present values are discounted, while the M&RA estimates are not;[1] and (2) different weights were used to collapse the RMC estimates by pay grade and length of service into annual estimates of military pay.[2] The M&RA weights are summarized in Table K4.

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1. The smaller percentage change in present values produced by M&RA appear to be largely due to the larger present values they derived by not discounting. The absolute difference in the present value estimated by IDA was only $3,000 compared to $4,000 estimated by M&RA. Yet, the percent change estimated by M&RA was smaller.

2. These differences serve to explain the observed differences in military pay by years of service.

Table K1

REGULAR MILITARY COMPENSATION[a] BY PAY GRADE AND YEARS OF SERVICE

H. R. 6531, passed 14 Nov. 1971			
Pay Grade	Years of Service		
	Under 2	2-3	3-4
E-1	4872	4872	4872
E-2	5311	5311	5311
E-3	5603	5814	5972
E-4	5951	6168	6401
E-5	6463	6824	7037
1 Jan. 1971			
E-1 under 4 months - 3107			
E-1	3239	3843	3843
E-2	3306	4067	4067
E-3	3715	4619	4834
E-4	4865	5459	5680
E-5	5545	6403	6615

a. Includes base pay, quarters and subsistence allowances, and the tax advantage on the allowances.

Table K2

WEIGHTS[b] USED TO COMPUTE AVERAGE RMC BY YEARS OF SERVICE

Pay Grade	Years of Service		
	0-1	1-2	2-3
E-1	125	9	3
E-2	85	23	5
E-3	87	62	11
E-4	40	204	71
E-5	7	54	83

b. Number of enlisted men as of 30 June 1970 in thousands.

Table K3

MILITARY INCOME STREAMS BY YEARS OF SERVICE AND PRESENT VALUES, IDA AND OASD(M&RA) ESTIMATES

Army	Years of Service			Present Value[a]	Percent Change
	0-1	1-2	2-3		
IDA Estimates					
New bill	5323	5899	6413	10501	+49.0
Jan. 1, 1971	3219	3927	4946	7048	
OASD(M&RA)[b]					
New bill	5171	5625	6157	16953	+31.1
Jan. 1, 1971	3334	4025	5577	12936	

a. The IDA estimates are discounted at a rate of 30 percent per annum. OASD(M&RA) estimates are undiscounted.
b. Source: OASD(M&RA), unpublished memorandum for the record, 22 September 1971.

Table K4

WEIGHTS USED BY OASD(M&RA) IN ESTIMATING MILITARY PAY

Pay Grade	Years of Service		
	0-1	1-2	2-3
E-1	.30		
E-2	.50		
E-3	.20	.64	
E-4		.36	.72
E-5			.28

Source: OASD(M&RA), unpublished memorandum for the record, 22 September 1971.