CROSS SECTION ANALYSIS OF FIRST TERM REENLISTMENT
IN THE AIR FORCE

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The purpose of this study is to gain a better understanding of
the impact of changes in military pay and a reduction in the presence
of draft-induced enlistees upon the airmen reenlistment decision making
process. The work on this study was initially undertaken for the Air
Force and then modified for the President's Commission on an All
Volunteer Armed Force. The estimates presented here were used as inputs
even in the calculation of the budgetary cost of the Commission's proposals.
Additional estimates based on time series data are currently being made.

Development of the Model

The phenomenon of a voluntary choice between military and civilian
employment is merely a special case of the more general decision between
any two employment alternatives. Let us assume that an individual is
faced with such a decision and knows the salary levels of the two
alternatives as well as the non-pecuniary aspects of one job relative
to the other. The individual can summarize this information by applying
his discount rate to the expected salary levels over time in each job.
He compares the present value of his expected earnings from each
alternative, and his decision is based upon evaluating these income
streams relative to the perceived advantages of each source of employment.¹

¹Alfred Marshall Principles of Economics, Ninth Ed., ed. G.W. Guillebaud,
If Job B requires frequent moves and family separations, an individual's strong aversion to family separation may cause him to choose Job A even though the present value of the income stream in Job B is much larger. In the same way, if the individual is indifferent to the non-pecuniary aspects of Jobs A and B, he will choose the job with the larger income stream. Although one cannot necessarily quantify, or even directly observe, an individual's pattern of non-pecuniary preferences, it is possible to observe the income streams of the job alternatives from which he chooses.

When an individual is already employed in a particular job, he evaluates the opportunity to change employment in a similar manner, taking into account the costs of the transition. Thus, the individual's non-pecuniary preferences determine the alternative income level that will make him indifferent between the contemplated job and his current one. This income level is called the critical value. Likewise, each serviceman facing the reenlistment decision has a critical value based on his opportunity income and his relative taste for military life. For an individual, we do not observe this critical value; we can only observe his choice and the income streams offered him. By observing a large number of individual decisions we can observe variations in the proportion reenlisting as the income streams vary. In this manner, we will attempt to estimate the distribution of critical values for the population of potential reenlistees.
The shape of this distribution depends upon tastes, that is, the perceived non-pecuniary aspects of the two alternatives. Figure 1 presents a hypothetical plot of these critical values for a group of potential enlistees with the same alternative civilian income. Figure 1 assumes that these critical values are unimodal and symmetrically distributed.

\[ Z(Y_C, Y_M) \]

\[ Y_{M1} \quad Y_{M2} \quad Y_M \]

Figure 1: Assumed Response to Military Income

The proportion of the population reenlisting at \( Y_{M1} \) is \( \int_{Y_{M1}}^{Y_M} Z(Y_C, Y_{M1}) dY_M \).

An increase in pay \( (Y_{M2} - Y_{M1}) \) would yield \( \int_{Y_{M1}}^{Y_{M2}} Z(Y_C, Y_M) dY_M \) additional reenlistees.

If the non-pecuniary advantages of service life would suddenly become greater, this distribution of critical values would move to the left since a greater proportion of servicemen would then choose a service career at each military income level. If we choose a population in which the individuals place similar values on the non-pecuniary aspects of service life and their civilian alternatives, the distribution of critical values becomes more peaked as is illustrated in Figure 2.
For example, we would anticipate that a movement to a force composed of all true volunteers would shift the current distribution to the left. This is based on the assumption that draft induced enlistses have a lower reenlistment rate than do true volunteers. If distribution I in Figure 2 represents the current mixed force of draft-induced enlistses and true volunteers, we might expect that the removal of the draft induced enlistses from the population would shift the distribution to the left (II) and also increase its peakedness (III) since the variance in tastes would probably be reduced. An increase in pay from \( Y_{M1} \) to \( Y_{M2} \) would yield a much larger increase in reenlistses for such an assumed population (distribution III).

The assumption of a unimodal, symmetrical distribution of critical values of military and civilian income implies a supply curve (cumulative distribution) that has a general S shape. The following equation is a useful form that has this property.\(^2\)

\[ P_1 = \frac{e^{\beta_0 + \beta_1 Y_{M1} + \beta_2 Y_{C1}}}{1 + e^{\beta_0 + \beta_1 Y_{M1} + \beta_2 Y_{C1}}} \]

where \( P_1 \) = probability of reenlisting

\[ Y_{M1} \] = present value of the expected military income stream

\[ Y_{C1} \] = present value of the expected civilian alternative income stream

This equational form is desirable because it can easily be put into a linear form for estimation purposes. Also, \( P_1 \) asymptotically approaches 0 and 1 for extreme values of civilian or military income. These values, of course, are the natural limits of the reenlistment probability. The linear form of this equation is shown below.

\[ \log \left( \frac{P_1}{1-P_1} \right) = \beta_0 + \beta_1 Y_{M1} + \beta_2 Y_{C1} \]

Assuming that the individual is a rational man and treats sunk costs as such, the appropriate incomes for comparison are the future military and civilian alternative incomes. Given an individual's discount rate, we can compute the present value of these streams.

The model can be formulated either in terms of separate income measures (as in equations 1 and 2) or in terms of the income ratio.

\[ \log \left( \frac{P_1}{1-P_1} \right) = \beta_0 + \beta_1 \frac{Y_{M1}}{Y_{C1}} \]

Equation 3 assumes that individuals react to proportional changes in income. Equal proportional changes in both military and civilian alternative income result in the same reenlistment probability. This assumption
implies a symmetrical response to civilian and military income, that is, individuals react the same way to increases in military income as to decreases in civilian income.³

One hypothesis that is contrary to this assumed relationship is that the preference for military service is such that only those people with limited civilian opportunities would enter the service. As civilian opportunities increase, a proportionately-larger premium would have to be offered to enlist or to reenlist the desired number.

Even if in the long run individuals reacted the same to increases in military as to proportionate decreases in alternative civilian income, information lags could cause a divergence in their elasticities in the short run. For these reasons, both formulations of the logit model will be estimated and the results compared.

In order to calculate the actual military income stream that the individual faces it would be necessary to observe the individual's earnings over a long period of time. Using the individual's discount rate, we can compute the present value of these earnings. However, it would be difficult and expensive to obtain this type of information. In addition, this computation assumes that the individual has perfect knowledge of future promotion policies and pay increases. An alternative assumption which simplifies data acquisition is that an individual bases his expected income stream on the earnings of persons with similar characteristics but with more years of service. For example an individual

³ From equation (3): \( \epsilon_Y = \frac{Y_M}{P} \cdot \frac{dP}{dY_M} = \frac{\beta_1 Y_M}{Y_C} (1-P) = \epsilon_Y \)

The elasticities derived from equation (2) will be equal only if \( \beta_1 = \frac{Y_M}{Y_C} \)
with four years of service would expect to receive future income that
corresponds to that received by servicemen who are in their fifth, sixth,
etc., years of service. This method will be used in this study.

Since the transition to the civilian labor market can be made at
any point in time, the appropriate measure of expected military earnings
should include the probability of attrition and the probability of
accepting each successive enlistment term. The problem can be made
more manageable if we assume that the differences between civilian and
military income streams are highly correlated with the differences during
the fifth through eighth years. This is true at least through the
twentieth year of service when military early retirements become effective.
However, differences at this point in time, when discounted back sixteen
years are quite small. Given these assumptions, we can use the measure
of the expected four year income stream which covers the period of the
reenlistment contract.

The same time period and procedure was followed in calculating the
expected civilian income stream. Potential reenlistees were assumed to
value their alternative future income in relation to that of civilians
with similar characteristics but with more years of experience in the
civilian labor market.

In addition to measures for civilian and military income, variables
will be added to explicitly control for shifts in the distribution of
critical values. These will include such characteristics as race,
education and age. In addition, the impact of the presence of draft
induced enlistees on the reenlistment rate will be estimated.
Data Collection and Variable Specification

In order to estimate this model, data on Air Force reenlistment experience was obtained at both a point in time (Fiscal Year 1968) and over time (January 1960-December 1966). The two data bases were obtained from different personnel files and consequently contain somewhat different information. This paper is based on the cross section estimates. Additional estimates based on the time series data are currently being made. Preliminary results are presented in Appendix C.

The cross section data was obtained from three primary sources: Air Force personnel files, Current Population Survey files, and a 1964 Department of Defense Survey of military personnel. The Air Force personnel files contained a forty percent sample of all enlisted men who were on active duty during FY 1968. This file contained socio-economic characteristics of the individuals as well as the reenlistments and separations from the Air Force.

The March Current Population Surveys were obtained from the Bureau of the Census for the years 1963 through 1966. In order to obtain samples of sufficient size for analysis, all four years of data were used. The full time earnings were adjusted by unemployment to obtain the expected civilian income for each observation.

4 I am indebted to Miss Sheila Rafferty of the Center for Naval Analysis of the University of Rochester for the programming support she provided both in putting this data into useable form and in performing statistical analysis.

5 This file was originally created by Captain John Maybee, Analysis Division, Directorate of Personnel Plans, Hqtrs. USAF.

6 J. Huston McCulloch, Center for Naval Analysis, was responsible for obtaining and analyzing this data. Mr. McCulloch provided all the CPS income distributions used in this study.
The Department of Defense survey was used to obtain the responses to the question of whether the individual would have enlisted in the absence of the draft. The respondents who entered the Air Force in FY 1964 were used since these are the airmen who faced the reenlistment decision in FY 1968.

From these three sources the following variables were created.

**Probability of Reenlisting (P1).**

For any individual, the distribution of his probability of reenlistment is \( P^x(1-P)^{1-x} \) where \( x \) is 1 for reenlistment and 0 for nonreenlistment. In order to estimate the true probability of reenlistment we must observe the proportion of each group, \( P_k \), that reenlists.

\[
P_k = \frac{\sum_{i=1}^{N_k} X_i}{N_k}; \quad \text{where } X_i = 0 \text{ or } 1
\]

In defining these \( K \) groups we wish to achieve homogeneity within the groups with respect to the variable whose impact we are attempting to measure. Since we are primarily concerned with determining income elasticities, we grouped by race, education, DOD occupational groupings, mental test score and dependency status. These are the variables that have been found to determine most consistently military or civilian pay. Defining groups in this manner then will tend to minimize the income variance within groups and maximize it between groups.
In defining these groups, two racial categories were used, white and nonwhite. Approximately 8.4 percent of the airmen in their fourth year of service in FY 1968 were nonwhite. On the basis of education the sample was divided into four categories: less than a high school education, high school graduate, one to three years of college, and four or more years of college. This latter category was so small that it was eliminated from the sample. The bulk of the airmen (92 percent) were in the high school graduate category. Approximately 3.6 percent of the sample did not graduate from high school and about 4.4 percent had between one and three years of college. The nine standard Department of Defense occupational groupings (0 through 8) were used. 7 DOD group 0 was eliminated due to its small size. Four mental groupings based on the Armed Forces Qualifying Test (AFQT) were used. Ten percent of the sample were in mental group one (percentile score 93 to 100), forty-three percent in group two (65-92), forty-three percent in group three (31-64) and four percent in group four (10-30). The few airmen with scores below the group four level were eliminated from the sample. The sample was further divided according to the number of dependents (0, 1, 2 or more dependents). Sixty-three percent were single, twenty-two percent had one dependent and fifteen percent had two or more.

The sample of airmen in their fourth year of service was allocated into these cells and the proportion of each cell reenlisting was

7The nine occupational groups are described in Appendix B.
calculated. Airmen who reenlisted prior to their fourth year of service as well as airmen who extended for at least 24 months were added to normal reenlistments to form the numerator of the reenlistment rate. The denominator included these transactions plus the voluntary losses of fourth year airmen. Involuntary losses and extensions for less than two years were not included. The overall reenlistment rate for this sample of airmen calculated in this manner was 18.4 percent. This compares with an official unadjusted rate of 18.1 percent.

Expected Military Income ($_{m}$);

As discussed previously, the military income variable represents the expected pay and allowances over the period of the reenlistment contract which is four years. Military compensation consists of a large component of income-in-kind. Since the level of in-kind income varies among observations, it is important to include this component. It varies across dependency status categories and to some extent across occupational groupings. Consequently, an attempt was made to impute a value for in-kind income.

Total military compensation is defined here to include basic pay, proficiency pay, reenlistment bonuses, incentive pays, and the imputed value of housing or the allowance given, the imputed value of food or the

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8 Many of the 576 possible cells were empty. Others were eliminated when enough information was not available to calculate expected military income of the cell. The final sample consisted of 209 observations.

9 The elimination of observations due to insufficient information did not change the overall reenlistment rate which remained 18.4 percent.
allowance given, value of BX and commissary privileges, clothing allowances, and the tax advantage due to the fact that certain allowances and payments in-kind are not taxable. Basic pay, proficiency pay and reenlistment bonuses could be measured directly. For each group defined above, the average pay grade or rank was found for airmen in the fifth, sixth, seventh and eighth year. Applying the pay tables to these grades the expected income for years of service five through eight was calculated for each cell. Discounting at an annual rate of ten percent, the present value of base pay was computed. The same methodology was used to include the expected amount of proficiency pay. The regular reenlistment bonus is simply four times an airman's basic pay and is paid at the time of reenlistment. A variable reenlistment bonus (VRB) is also offered to certain airmen. Eligibility for this payment depends upon an airman's occupational specialty. Selected specialties are paid between one and four times the normal reenlistment bonus in addition to the regular bonus. The VRB payment can either be given in a lump sum or paid in four yearly installments. In the past, the Air Force has been very reluctant to authorize lump sum payments. In FY 1968, six percent received lump sum payments. Since the distribution of lump sum payments across cells was not known, it was assumed that all airmen received the VRB in annual payments. The average

10 Proficiency pay is paid to career airmen in certain technical skills at one of two rates, $30 or $60 per month.

11 In FY 1966 and FY 1967, there were almost no exceptions to this rule. In FY 1970, approximately 16 percent have been authorized lump sum payments.
discounted value of basic pay, proficiency pay and the bonuses was found to be $13,477. Incentive and special pays had to be calculated from an earlier (FY 1965) sample. The 1965 sample was taken for the First Quadrennial Pay Study (Hubbel Report) and contained a five percent sample of the compensation records of all active duty personnel. The incentive pays account for a relatively insignificant amount. This sample also included data on the percent of airmen receiving housing and food in-kind by three cross classifications: years of service, dependency status and military occupation. For those airmen not receiving these payments in-kind, the authorized cash allowance was added to the total military compensation.

The fact that a queue of married personnel can be observed for military housing indicates that this housing is valued more highly than the alternative cash allowance. The value of provided housing was estimated based on the number of bedrooms provided and the market cost of additional bedrooms. The value of the dormitory type housing provided single enlisted men was arbitrarily assumed to be $30 per month. The value of food in-kind was assumed to be $2.57 per day. This is the amount authorized enlisted persons when rations in-kind are not available. This is almost twice the allowance given when government facilities are available but permission to mess separately is granted. The value of medical benefits was assumed to vary only by the number of dependents.

The value was based on the cost data for Kaiser Permanente and HIP.

12 These estimates were made by Harry Grubert and Rodney Weiler of the Center for Naval Analysis of the University of Rochester. The estimates are based on Navy facilities.
(New York) as reported by Anne Somers. Commissary and Base Exchange privileges were valued at the same rate as used in the Hubbell Report. The savings enjoyed as a result of these facilities is based on the income level and number of dependents. Finally, a cash value of the income tax savings was added.

The average discounted value of total military compensation during years five through eight was found to be $21,875 or 61.9 percent greater than the total of direct cash payments.

Expected Civilian Income ($) :

Expected civilian earnings are based on the Current Population Survey (CPS) file. The CPS file was stratified by age, race, and education. The average age of each observation was calculated and then used with race and education to compute the expected civilian income over four years. Civilian income was assumed to increase each year by an amount equal to the income difference between single years of age.

In addition, it is desirable to obtain an estimate of the effect of military occupation and mental group on expected civilian earnings. A survey was taken by the Office of Assistant Secretary of Defense for Manpower and Reserve Affairs in the Spring of 1969 to determine the weekly income of previous enlistees ten months after separation from the service. The data has not yet been compiled for the Air Force. However, the survey results were available for the Navy and the Army. The Navy data revealed only a small education effect, insignificant occupational differences and

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about an eleven percent income differential between mental groups one and four. An attempt was made to use this Navy data to control for possible differences among similar Air Force occupations and mental groups. The results using this data were inferior to those using CPS data. Therefore CPS income estimates will be used. Dummy variables denoting mental group and occupational group will be entered in the equation to control for any significant effects on civilian income.

Draft Pressure (1-Dp):

This variable is constructed from the responses to a question pertaining to the extent of draft induced enlistments in 1964 DON Survey of "Military Service Plans, Experience, and Attitudes. There were five possible answers to the question of whether a person would have enlisted in the absence of the draft: Yes definitely, Yes probably, No definitely, No probably, Not sure. The uncertain category was eliminated and the percent answering yes definitely or yes probably was calculated for each of 209 groups that have the same characteristics as the 1966 observations. Since this variable is the percent not draft motivated, it is referred to as 1-Dp. Approximately fifty-seven percent of the sample airmen can be classified true volunteers by this definition.

Other Independent Variables:

It is desirable to control for possible shifts in the reenlistment supply function due to differences in tastes for military life. As

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14 The analysis of this data was performed by Harry Grubert of the Center for Naval Analyses.

15 The wording of the survey question was "If there had been no draft and if you had no military obligation, do you think you would have volunteered for active military service?"
mentioned above, occupational variables will be used to control for
differences in civilian opportunities due to job training and experience.
In addition to adjusting civilian income, the occupation variables also
may be controlling for differences in conditions of service among occu-
pational specialties. Likewise, the variables denoting mental groups
will control for differences in tastes as well as neglected income
differentials. Since the data has been grouped by Department of Defense
occupational groupings and by mental groupings, these variables will have
a value of 0 or 1 for each observation.

Variables will also be added to control for independent differences
by race, age and education. Age is entered as the mean of each grouped
observation. Dummy variables will be used for the various race and
education categories.

Cross Section Estimates

The logit model was applied to the Air Force cross section data on
enlisted men at the end of their first term of service. For the ith
observation, the model states:

$$\log \left( \frac{p_i}{1-p_i} \right) = \beta_j X_j + u_i$$

where $p_i$ is the observed reenlistment rate for the ith group of airmen.
$X_j$ are the independent variables (income streams, draft pressure, etc.).
$u_i$ is a random variable for the ith group, uncorrelated with the independent
variables and has a mean of zero. However, since $p_i$ is binomially
distributed, the expected value of the variance of the error term is not
a constant as required for a least squares estimate. Consequently, it
was necessary to construct weights to meet the assumption of homos-
scedasticity. After weighting the observations, the logit model was
estimated first using the ratio of total military compensation to civilian
income as the income measure. Estimates are then presented using separate
military and civilian measures.

Pay Ratio

The initial estimation presented below includes only the income ratio
and the percent of the airmen who indicated that they were true volunteers.

\[
\log\left(\frac{1}{P_{1-p}}\right) = 4.831 + 2.947 \frac{Y}{M} + 0.803 (1-D_p) \\
(0.013)^2 (0.273)^p
\]

\[R^2 = .73\]

Both variables have the expected sign. An increase in military pay
relative to civilian alternative income is associated with an increase
in the reenlistment probability. The variable, 1-D_p, represents the
percent of a given group of airmen who indicated that their enlistments
in the Air Force were not made with the primary purpose of avoiding the
draft. Consequently, we would expect to find higher reenlistment probabilities
associated with larger values of 1-D_p. Both coefficients are statistically
significant and together they explain a large portion of the total variance.

The magnitudes of the coefficients are within the expected range. An
expected range of values can be calculated for the coefficient of the
draft variable based upon the observed reenlistment rate. The

16 See Appendix A.
overall rate \( r_t = 0.184 \) is a weighted average of the rate for draft-
induced enlistees \( r_D \) and the rate for true volunteers \( r_v \). If there
is no difference between \( r_D \) and \( r_v \), the coefficient of the draft-pressure
variable would be close to zero and insignificant. The upper bound of
the coefficient can be calculated by assuming that \( r_D = 0 \).

\[
0.57 \, r_v + 0.43 \, r_D = r_t = 0.184
\]

\[\text{If } r_D = 0, \quad r_v = 0.323\]

Thus, if we assume that no draft induced airmen reenlisted, the rate for
the true volunteers would have been 32.3 percent. Using the above
reasoning, we can calculate the limits of the coefficient \((0 \leq \beta \leq 2.15)\)\(^{17}\)

The point elasticity of the income ratio is estimated to be 2.36.
That is, for small changes around the mean income ratio \(( \bar{Y} / \bar{Y}_C = 0.980)\),
we expect the percentage increase in the reenlistment rate to be 2.36
times the percentage increase in the income ratio.\(^{19}\) The point elasticity
for the draft pressure variable is 0.374.

\[^{17}\text{The upper limit is calculated in the following manner.}\]

Since \( \frac{dP}{P} < \frac{0.323 - 0.134}{0.184} \) and \( \frac{d(1-Dp)}{1-Dp} < \frac{1.00 - 0.57}{0.57} \)

\[
\therefore \quad \frac{dp}{d(1-Dp)} \quad \frac{(1-Dp)}{P} < 1
\]

\[\beta(1-P) (1-Dp) \leq 1\]

\[0.465 \leq 1 \text{ or } \beta \leq 2.15\]

\[^{18}\text{The equation for the elasticity measure is } e = \frac{dp}{d \left( Y_m / Y_c \right)} \cdot \frac{Y_m / Y_c}{P} \text{ or}\]

\[e = \beta(Y_m / Y_r) (1-P)\]
As mentioned above, some asymmetry occurred when we observed the income ratio. While military pay was measured across mental groups and occupational groupings, data was not available to permit measurement of differences in alternative income due to these variables. Consequently, dummy variables were entered for each mental and occupational group. In addition, binary variables were entered to control for possible taste differences between races, among educational classes and between married and single airmen. A variable was also entered to control for possible differences in reenlistment probabilities that can be attributed to age. The results are presented in Table 1. The coefficient of the income ratio is very stable. The draft pressure coefficient increased to 1.390; the point elasticity increased to .652.

Mental Group 1 (MG 1) airmen have reenlistment probabilities significantly lower than other mental groups. Since we did not control for differences in civilian alternative income due to mental group, this relationship could be explained by the greater opportunity income of these airmen. It could also be due to differences in tastes apart from income.

The occupation variables are more difficult to interpret. The groups cannot easily be ordered according to degree of technicality, civilian opportunities or general conditions of service. Two of the occupational groups have significant coefficients: DOD 5 and DOD 7. Both have reenlistment probabilities significantly higher than the other groups. DOD 5 is composed of administrative specialists and clerks and DOD 7 is primarily
TABLE 1
REGRESSION RESULTS FOR TOTAL AIR FORCE LOGIT MODEL

\[
\frac{\ln(P)}{(1-P)} = C + \sum \text{variable} \times \text{coefficient} + \epsilon
\]

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</table>

\[ R^2 = .899 \]

* Significant at .05 level
** Significant at .01 level
craftsmen. Both of these areas encompass little general training. However, DOD 7 involves considerable specific training. A more complete analysis of the impact of military training and job experience on Air Force reenlistment can be accomplished when the above mentioned survey of the civilian incomes of Air Force separates is available from the Department of Defense.

The age variable has a positive and significant coefficient. The expected influence of an airmen's age on his reenlistment decision is uncertain. Since age and draft pressure are positively related, age for could be a surrogate/draft pressure and exert a negative influence. If we have already sufficiently controlled for draft pressure, the age variable could be adding a further refinement to the income measure or it could be indicative of a change in the taste distribution. If an individual is younger at the time when he chooses between reenlistment and separation, both his expected civilian and military income streams are larger. If discount rates are smaller for older airmen, we would expect these airmen to reenlist at higher rates since retirement benefits would be valued more. In addition, if an individual is older when he faces the reenlistment decision, it probably means that he has had previous experience in the civilian labor market. This is true only if we have adequately controlled for education and draft inducement. The positive coefficient of the age variable then might indicate that those airmen who had previous civilian labor market experience which culminated in an

19 See Appendix B for a description of the occupational groupings.
original enlistment are more likely to choose the military as a career.

Perhaps the most interesting result of this estimation is the lack of significance of the race and education variables. While significant differences exist in the reenlistment rates of whites and nonwhites (29.0 versus 17.4 percent), the variation in income accounts for this difference. Although not statistically significant, the negative sign on this variable is interesting. This could be attributed to a different taste distribution or to consistent overstatement of the pay ratio.

There is reason to believe that the pay ratio is over-stated for nonwhites. The nonwhite population in the Air Force is a select group of the total nonwhite population in regards to mental and physical standards. This is shown by the higher rates of nonwhite rejections on these grounds. By using the civilian population to obtain a measure for nonwhite service-men, their civilian opportunity income is consistently understated.

This would explain the negative relationship. The relationship between reenlistment probability and race will be examined in more detail later when separate models are estimated for both whites and nonwhites.

The negative sign on the less than high school graduates can likewise be explained as an adjustment to the income ratio. When this group of airmen enlisted in FY 1964, the Air Force enjoyed an excess supply of enlistees. From this supply, they tended to choose the most qualified first on the basis of education and mental test scores. Less than

---

A historical quantitative analysis of this process has been done by Alvin A. Cook, Jr. and John P. White, The Rand Corporation, Santa Monica, California
four percent of these airmen had less than a high school education when they faced the reenlistment decision in FY 1968. These airmen without a high school diploma probably have greater civilian opportunities than the average non-high school graduate.

Separate Income Measures:

In the above estimations, we have assumed that individuals react in the same manner to an increase in one employment alternative as they do to decreases in the other alternative. Also, this formulation assumes that the individual has perfect knowledge about both alternatives and that we have captured the individual's income expectations equally well for both alternatives.

The military income is the easiest to measure. However a large proportion of this value is imputed and measured imprecisely. Military income is measured across occupational groups, mental groups and dependency categories whereas civilian income is not. In addition, national averages are used which tend to understate those who were selected and completed four years of military service. Consequently, estimations will be presented entering military pay and civilian pay separately.

It is usually more difficult to enter pay variables separately due to high correlation across cells between alternative incomes. However, in this case the simple correlation is .238. It becomes more difficult to enter additional variables. If we look at the regression where only Yc and Ym are permitted to enter the equation, we get the following result.
\[ \frac{\ln (P)}{1-P} = -1.176 + 0.135 \text{Ym} - 0.152 \text{Yc} \]

\[ R^2 = 0.72 \]

The elasticity for military income is 2.40 as compared to -2.78 for
in civilian income. Both coefficients have the expected sign and are
statistically significant. The coefficients are very close considering
the measurement biases.

The mental and occupational groups were entered in addition to the
draft variable. The results are presented in Table 2. The draft variable
is highly correlated with civilian income \((r = 0.91)\). Its entry into the
equation reduced the magnitude of the civilian income measure. The
elasticity of the military income variable varies across mental and
occupational groupings. The size of this coefficient is increased when
these variables enter the equation. The elasticity is now 2.81. The
other coefficients are not unlike those found earlier. The elasticity
of the variable for proportion of true volunteers is 0.520.

The evidence is such that we cannot reject the hypothesis that airmen
respond to proportional changes in income. Both variables have the
expected sign, are significant and are approximately equal in value,
particularly given the crude definitions. Unless there is evidence to
the contrary, it is desirable to use the ratio for ease of estimation.
The separate income measures are highly correlated with other independent
measures. It is impossible to enter the race, age and education variables
when the income variables are entered separately. In the rest of this
study only the ratio will be used.
**TABLE 2**

REGRESSION RESULTS FOR TOTAL AIR FORCE LOGIT MODEL
USING SEPARATE INCOME MEASURES

\[
\frac{\ln \left( \frac{P}{1-P} \right)}{\ln \left( \frac{1-P}{P} \right)} =
\]

<table>
<thead>
<tr>
<th></th>
<th>COEFFICIENT</th>
<th>STD. ERROR</th>
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<tbody>
<tr>
<td>Constant</td>
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<td>.500</td>
</tr>
<tr>
<td>Yn</td>
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<tr>
<td>Yc</td>
<td>.108**</td>
<td>.015</td>
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<tr>
<td>1-Dp</td>
<td>1.120**</td>
<td>.342</td>
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<tr>
<td>MG1</td>
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<td>.122</td>
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<tr>
<td>MG2</td>
<td>-.058</td>
<td>.108</td>
</tr>
<tr>
<td>MG3</td>
<td>-.086</td>
<td>.103</td>
</tr>
<tr>
<td>MG4</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>DOD1</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>DOD2</td>
<td>.207**</td>
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<td>DOD3</td>
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<td>DOD7</td>
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<td>.077</td>
</tr>
<tr>
<td>DOD8</td>
<td>.124**</td>
<td>.052</td>
</tr>
</tbody>
</table>

\[ R^2 = .898 \]

**Significant at the .01 level.**
White and Nonwhite Comparisons:

The previous regression results suggested that the difference in reenlistment rates between whites and nonwhites (29.0 and 17.4 percent respectively) can be explained by the difference between their military to civilian income ratios. This hypothesis can be further investigated by dividing the sample into two parts and estimating separate regressions for whites and nonwhites.\footnote{There are 151 white observations and 50 nonwhite observations.}

Whites:

\[
\frac{\ln (P)}{(1-P)} = -5.008 + 2.973 \frac{Ym}{Yc} + 0.052 \quad (1-Dp) \quad R^2 = .721
\]

Nonwhites:

\[
\frac{\ln (P)}{(1-P)} = 4.2356 + 2.551 \frac{Ym}{Yc} + 0.419 \quad (1-Dp) \quad R^2 = .560
\]

The elasticity for whites is 2.365 which is almost the same as for all airmen. All the results for white airmen will closely parallel previous results since only 8.4 percent of the airmen are nonwhite. The elasticity for nonwhites is slightly less, 1.795.

In Figures 3, the reenlistment probability function is plotted for both whites and nonwhites. A plot of the slopes and elasticities are also presented. The mean values of the income ratio are indicated for whites and nonwhites. The plot of the slope is a density function denoting the distribution of critical values. The number of white airmen just indifferent between separating from the Air Force and reenlisting...
WHITE VERSUS NONWHITE ESTIMATES

[Graph showing data points for Whites and Nonwhites]
reaches a maximum when \( \frac{Ym}{Yc} = 1.52 \). This occurs for nonwhites when \( \frac{Ym}{Yc} = 1.32 \). The pay ratio elasticities are also shown in Figure 3.

The pay elasticity of whites is greater than nonwhites throughout the relevant range. If the ratio is increased from .96 to 1.20, the elasticity for white airmen increases slightly from 2.36 to 2.59. The elasticity for white airmen remains within a small range for about a forty percent increase in income before it begins to decrease. The nonwhite elasticity is near its maximum with the mean ratio of 1.16. When the ratio increases to 1.40, the elasticity declines from 1.79 to 1.62.

Thus, the distribution of critical values for nonwhites appears to peak at a lower income ratio. The reenlistment probability is consistently larger for nonwhites, but their elasticity is less in the relevant range.

Functional Form:

The estimations used previously have been based on the logit form of the equation. This form was derived from the assumption of a unimodal, symmetrical distribution of critical values of the military to civilian income ratio. This formulation assumes that there is an area of increasing as well as decreasing elasticity. Rather than accept this assumption, two additional assumptions will be tested. These forms are presented below

\[
(1) \quad P = a_0 \left( \frac{Ym}{Yc} \right)^{a_1} e^{a_2(1-Dp)}
\]

\[
(2) \quad P = a_0 + a_1 \left( \frac{Ym}{Yc} \right) + a_2 (1-Dp)
\]
The first has a constant pay ratio elasticity. The second has a pay ratio elasticity equal to
\[ a \frac{P}{Ym/Yc}. \]

These equations will be estimated to compare with the logit results. In calculating the expected response for large movements from the mean, the general form of the assumed distribution becomes increasingly important. In this section we are concerned about determining which equation is the best least squares estimate of the data, what is the importance of choosing the best one of these three forms over the observed range of data, and how sensitive the expected response to large movements from the mean is to functional form.

The results of estimating the three forms are presented below. P is plotted against Ym/Yc for each of these formulations in Figure 2.4

1. \( \ln P = -2.0499 + 2.3016 \ln (Ym/Yc) + .5524 (1-\Delta p) \)
   \( (1.1508) \quad (2.2592) \quad R^2 = .64 \)

2. \( P = -.2376 + .4524 (Ym/Yc) + .1195 (1-\Delta p) \)
   \( (.0271) \quad (.0470) \quad R^2 = .59 \)

3. \( \ln \left( \frac{P}{1-P} \right) = -4.831 + 2.947 (Ym/Yc) + .803 (1-\Delta p) \)
   \( (.013) \quad (.273) \quad R^2 = .73 \)

In all three estimates the coefficients of the pay ratio are significant at the .001 level. The t statistic is the greatest for the logit model for both the income ratio and draft pressure variables. The \( R^2 \) is also greatest for the logit formulation. However, this can be a misleading indicator since it represents the ratio of the explained to total variance from the regression line. A more desirable goodness of fit test for comparative purposes would
FIGURE 4
COMPARISON OF FUNCTIONAL FORMS
base this ratio on the variance from $P$ rather than from the logarithmic transformations. This test shows little difference in the fit of the three functional forms ($R^2 = .59 - .64$).

A comparison of the regression results obtained when the control variables are entered gives some indication of the stability of the income ratio and draft pressure coefficients in the three functional forms. These results are presented in Table 3. The coefficient of the income ratio is the least stable in the linear estimation. It increases from .452 to .626 when the control variables are added; the elasticity increases from 2.41 to 3.34. The pay coefficient in the log estimation, which is also the elasticity, remains very stable. It increases slightly from 2.30 to 2.43. This coefficient in the logit estimation is virtually unchanged.

The measured draft pressure effect is much less stable. In all three cases, the elasticity increased significantly when the control variables were entered. However, the range of elasticities was similar for the three estimates: .314-.695 for the log, .370-.808 for the linear, and .374-.652 for the logit estimation.

The control variables for race and education tend to be more significant for the log and linear estimations than for the logit. Since the variables denoting nonwhites, less than a high school education and more than a high school education are the ones associated with the largest deviations from the mean income ratio, the logit equation seems to be better at predicting observations furthest from the mean.

The logit formulation seems to be the most desirable of the three assumed relationships. Although all three fit the data quite well, the
TABLE 3
REGRESSION RESULTS USING LOG, LINEAR
AND LOGIT FORMS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Log, Linear</th>
<th>Logit</th>
<th>Logit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-2.286***</td>
<td>-.594**</td>
<td>-5.164**</td>
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<tr>
<td>Ln (Ym/Yc), Ym/Yc</td>
<td>2.434**</td>
<td>.626**</td>
<td>2.952**</td>
</tr>
<tr>
<td>1-Dp</td>
<td>1.176*.</td>
<td>.261**</td>
<td>1.390**</td>
</tr>
<tr>
<td>MG1</td>
<td>-.132</td>
<td>...</td>
<td>-.167**</td>
</tr>
<tr>
<td>MG2</td>
<td>...</td>
<td>.007</td>
<td>...</td>
</tr>
<tr>
<td>MG3</td>
<td>-.027</td>
<td>...</td>
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</tr>
<tr>
<td>MG4</td>
<td>.094</td>
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<td>.191</td>
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<td>.329*</td>
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<td>.022</td>
<td>-.055</td>
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<td>-.119**</td>
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<tr>
<td>HS</td>
<td>1.374</td>
<td>.060**</td>
<td>-.090</td>
</tr>
<tr>
<td>Nonwhite</td>
<td>-1.875**</td>
<td>-.072**</td>
<td>-.186</td>
</tr>
<tr>
<td>Single</td>
<td>-.085</td>
<td>.017</td>
<td>-.104</td>
</tr>
</tbody>
</table>

** Significant at the .01 level
*

Significant at the .05 level

| R²              | .718        | .774    | .899      |
logit model seems to fit somewhat better and has a more stable income ratio coefficient. To gain an understanding of the error introduced by incorrectly specifying the relationship in this case, a plot of the elasticities is presented in Figure 4. This plot is based on the estimations where the control variables are entered. If we assume a forty percent increase in relative pay, the elasticity based on the logit equation would remain almost constant at about the same level as the log elasticity. Only for increases of greater than forty percent is there a significant difference between these two curves. The linear estimate, however, has a much higher elasticity at the mean and decreases rapidly. For a forty percent increase in relative pay, the pay elasticity decreases from 3.3 to 2.0. For increases of less that twenty percent, the linear estimate has a larger pay ratio elasticity.

RESULTS AND CONCLUSIONS

The reenlistment decision was found to be very sensitive to an increase in expected military income relative to civilian opportunities. Using a sample of airmen who faced the reenlistment decision in FY 1968, the expected response to changes in the ratio of military to civilian income was measured. The best estimate of the expected reenlistment response is that a one percent increase in the income ratio would yield a 2.36 percent increase in the reenlistment rate. The following table presents the expected response from alternative pay increases.
TABLE 6

EXPECTED REENLISTMENT RATES FOR VARIOUS PAY ALTERNATIVES

<table>
<thead>
<tr>
<th>Percentage Increase in Military Income</th>
<th>Expected Reenlistment Rates 23</th>
<th>Percentage Increase in Cash Payments 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0</td>
<td>23.2</td>
<td>16.2</td>
</tr>
<tr>
<td>15.0</td>
<td>25.9</td>
<td>24.3</td>
</tr>
<tr>
<td>20.0</td>
<td>28.8</td>
<td>32.4</td>
</tr>
<tr>
<td>25.0</td>
<td>31.8</td>
<td>40.5</td>
</tr>
</tbody>
</table>

The model used to estimate these rates was based on the expected value of total military compensation during the four years of the reenlistment contract. This compensation can be easily divided into two components: direct cash payments (base pay, proficiency pay and reenlistment bonuses) and benefits and allowances (medical, food, housing, etc.). Direct cash payments are responsible for approximately 62 percent of the total compensation. Since the measured response is to total compensation, the expected response to increases in direct cash payments must be adjusted accordingly. In Table 6, the comparable increase in direct cash payments associated with the total compensation increase and expected reenlistments response is presented.

23 This calculation assumes that other factors affecting the reenlistment rate are constant.

24 This assumes that the military income increase is entirely in base pay, proficiency pay or bonuses.
Thus, if the plan for moving to an all-volunteer force incorporates an increase in military compensation for career airmen, we can anticipate significant increases in first term retention as outlined in Table 6. There is an additional reason to be optimistic about the tenure of airmen in an all-volunteer force. Based on the results of a survey on FY 1964 entrants and their observed reenlistment behavior, it was possible to estimate the influence of being draft-induced upon the reenlistment decision. Although survey responses might not present an accurate reflection of their true enlistment motivation, this was the best available measure. Other things being equal, the higher the proportion of true volunteers, the higher the expected reenlistment rate. This variable was consistently a significant predictor of reenlistment probability, but the measured response from increasing the proportion of true volunteers did vary. This was due to the relationship between this draft pressure measure and the race, education and mental group control variables. The best estimate of the draft pressure effect was obtained when we controlled for these influences. A .652 percentage increase in the reenlistment rate was found to be associated with a one percent increase in the proportion who are true volunteers. Using the methodology discussed previously the implied reenlistment rates for true volunteers and draft-induced enlees can be calculated. The implied rate for true volunteers is 27.4 percent and 6.4 for draft induced volunteers. If we assume that the true volunteers who replace the draft induced enlees behave in the same manner as the true volunteers currently in the force, other things being equal, we would expect an all-volunteer force reenlistment rate around 27 percent. However, this is a strong
assumption to make since the replacements for the draft induced volunteers will require additional incentives to induce them into the service. For equal quality levels, the new volunteers probably have less taste for military life than the airmen who volunteered under the previous incentive system. Thus, the 27 percent reenlistment rate is probably somewhat overestimated. However, the magnitude and significance of the coefficient of the variable denoting the proportion of true volunteers indicate that the reenlistment rate of an all-volunteer force will be substantially higher than current experience.

Although this study was primarily concerned with measuring the sensitivity of the reenlistment decision to income and draft pressured enlistments, other conclusions were made from the analysis. It does not appear that nonwhites' reenlistment behavior is substantially different than that of whites. Although they reenlist currently at much higher rates than do whites, this is primarily attributable to their better income opportunities in the military as compared with their civilian opportunities. Additional increases in military income have a greater than proportional impact on the white reenlistment rate. A one percent increase in white military income is associated with a 2.36 percent increase in the white reenlistment probability. Such an increase in nonwhite income yields a 1.79 percent increase in the nonwhite rate.

Apart from differences attributable to civilian and military income differentials, the airmen's observed reenlistment behavior does not vary significantly with mental group and educational level. The large apparent
differences in reenlistment rates can be explained by the differences in their respective income opportunities.

Age tends to be a consistent and significant positive predictor of the reenlistment probability. After controlling for education and draft pressure, age probably indicates prior exposure to the civilian labor market. Age could also be a surrogate for differences in discount rates. Either explanation would account for the positive relationship between age and reenlistments.

The airman's occupation also seemed to exert a significant influence on his reenlistment probability. Since civilian income differences were not available by military occupation, the variables denoting occupational groupings could be controlling for these differences. They also could be measuring differences in the conditions of service. In either case, further analysis would be required to make any positive statements about the importance of military occupational experience or training on reenlistments.

In general the model used in this study was capable of explaining a large proportion of the total variance in reenlistment decisions. The income and draft pressure variables and the expected sign and the magnitudes are within the expected range. The reenlistment decision was found to be very sensitive to both changes in relative income and to substitution of true volunteers for draft induced enlistees.
Appendix A

To use regression theory to estimate the model for all i groups of airmen, it is required that:

\[ E(U_i U_j) = 0 \quad i \neq j \]
\[ E(U_i U_i) = \sigma_u^2 \quad i = j, \]

That is, the variance of the error term is required to be constant and its covariance is required to be equal to zero.

In the econometric model under investigation, \( P_i \) is the true proportion of the individuals in i who reenlist.

The observed proportion who reenlist (\( \hat{P}_i \)) is equal to the true probability plus some random error \( V_i \)

\[ \hat{P}_i = P_i + V_i \]

\( \hat{P}_i \) is the observed proportion of the ith group who reenlist. \( V_i \) is a binomially distributed random variable with variance \( \text{Var}(V_i) = P_i(1-P_i)/N_i \).

Thus,

\[ \frac{\hat{P}_i}{1-\hat{P}_i} = \frac{P_i + V_i}{1-P_i - V_i} = \frac{P_i}{1-P_i} \left[ 1 + \frac{V_i}{P_i} \right] \]

\[ \log \left( \frac{\hat{P}_i}{1-\hat{P}_i} \right) = \log \left( \frac{P_i}{1-P_i} \right) + \log \left( 1 + \frac{V_i}{P_i} \right) - \log \left( 1 - \frac{V_i}{1-P_i} \right) \]
But
\[ \log \left( 1 + \frac{\frac{V_1}{P_1}}{1 - \frac{V_1}{P_1}} \right) = \frac{V_1}{P_1} - \frac{1}{2} \left( \frac{V_1}{P_1} \right)^2 + \ldots \]

And
\[ \log \left( 1 - \frac{\frac{V_1}{1 - P_1}}{1 - P_1} \right) = \frac{-V_1}{1 - P_1} - \frac{1}{2} \frac{V_1}{1 - P_1}^2 + \ldots \]

Since \( V_1 \) is small, the higher order terms can be ignored; thus,

\[ \log \left( \frac{P_1}{1 - P_1} \right) = \log \left( \frac{P_1}{1 - P_1} \right) + \frac{V_1}{P_1 (1 - P_1)} \]

Substitution into equation 1 yields
\[ U_1 = \frac{V_1}{P_1 (1 - P_1)} \]

and thus

\[ \text{Var} \left( U_1 \right) = \frac{\text{Var} \left( V_1 \right)}{\left[ P_1 (1 - P_1) \right]^2} = \frac{1}{N_1 P_1 (1 - P_1)} \]

Since \( N_1 \) and \( P_1 \) vary for each observation, the variance-covariance matrix of error does not satisfy the stated requirements.

However, if weights, \( W_1 = \left[ N_1 P_1 (1 - P_1) \right]^{\frac{1}{2}} \) are constructed for each observation, and the model:

\[ W \log \left( \frac{P_1}{1 - P_1} \right) = W_{1a} a_0 + W_{1a} Y_{m1} + W_{a2} Y_{C1} + W_{1 U_1} \]
is estimated using conventional least squares regression analysis, the
weighted error term $W_i u_j$ will be distributed so that

$$E(W_i u_i W_j u_j) = 0 \quad i \neq j$$

$$E(W_i u_i W_j u_j) = \sigma_{W_j}^2 \quad i = j$$

We do not have data on $P_i$, but we do have observations on $P_i$, an unbiased
estimate of the true probability. We can thus construct weights

$$W_i^* = \left[ N_i P_i (1 - P_i) \right]^{1/2}$$

which approximate the true weights. The model can
then be estimated using these weights for each observation. This implies
that the supply function can be estimated accurately from the grouped data
by weighting each observation by the approximate $W_i$. 
The eight occupational groups, used in this study, referred to as DOD 1 through DOD 8, are described below. A listing of the particular Air Force specialities included in each group can be obtained from the DOD Occupational Conversion Table. 26

DOD 1: Electronic Equipment Repairmen

This group includes the maintenance and repair of radio, radar and electronic navigational, countermeasures, missile guidance, missile checkout and test, computers, torpedoes, nuclear weapons control, equipment and related or allied equipment maintenance.

DOD 2: Communications and Intelligence Specialists

This includes the operation and monitoring of radio, radio teletype, radar, sonar, and allied communications and intelligence consoles. It also includes the interpretation of photographic, electronic, and documentary intelligence.

DOD 3: Medical and Dental Specialists

This occupation includes patient care and treatment, technical and related medical and dental services.

DOD 4: Other Technical and Allied Specialists

DOD 4 includes technical and professional skills which are not classified elsewhere, such as surveying, drafting, photography, cartography, meteorology, scientific aids, physical laboratory analysis, ordnance disposal and music.

26 Department of Defense Occupational Conversion Table: Enlisted; Office of the Assistant Secretary of Defense, Manpower, March 1968.
DOD 5: Administrative Specialists and Clerks.

DOD 5 includes personnel and administrative supply and transportation administration, accounting, communications center operation, and related activities.

DOD 6: Electrical/Mechanical Equipment Repairmen

These are occupations charged with the maintenance and repair of electrical, mechanical, hydraulic, and Pneumatic equipment.

DOD 7: Craftsmen

Craftsmen are involved in forming, fabricating and installing structures and components; in utilities installation and maintenance; and in the operation of construction equipment and power tools and related crafts and trades.

DOD 8: Service and Supply Handlers

Included in this group are protective and personal services, non clerical personnel involved in warehousing, food handling and motor transportation.
Appendix C

Time Series Estimates

An alternative data base was obtained to estimate this reenlistment model. It consists of 224 groups of airmen who faced the reenlistment decision during the period from January 1960 through December 1966. These groups are based on the 28 quarter year intervals, two racial categories (white and nonwhite) and four educational groupings (less than high school, high school graduate, some college, college graduates).

Various measures of income and draft pressure were used. The model presented below uses the ratio of expected total military compensation to expected civilian income (CPS estimates). Draft pressure is measured by the ratio of inductions to the l-A pool. In addition, unemployment and percent of the Air Force stationed in Vietnam were entered. Two estimations are presented below, in the second a dummy variable for race and a variable denoting years of education are also entered. After controlling for these essentially cross sectional differences, the expected income ratio becomes insignificant.

<table>
<thead>
<tr>
<th>Variable</th>
<th>First Estimation</th>
<th>Second Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC/CPS</td>
<td>2.723**</td>
<td>.106</td>
</tr>
<tr>
<td>I/l-A Pool</td>
<td>-.533**</td>
<td>-.365**</td>
</tr>
<tr>
<td>Unemployment</td>
<td>.246**</td>
<td>.096**</td>
</tr>
<tr>
<td>AF/VN</td>
<td>.488</td>
<td>-5.265*</td>
</tr>
<tr>
<td>RACE</td>
<td></td>
<td>.960**</td>
</tr>
<tr>
<td>Yrs. of Education</td>
<td></td>
<td>- .249**</td>
</tr>
</tbody>
</table>

Significant at the .01 level
Significant at the .05 level
The income elasticity based on this data (1.93) compares favorably with that estimated using purely cross sectional data (2.36). However, when we control for cross sectional differences, we are not measuring an income effect due to the variance in the income ratio over time.