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ABSTRACT

The paper examines the effect of military training and experience on the civilian earnings and employment of persons who have served one term of military service. Since training effects are specific to individuals and to civilian occupations, empirical problems in precisely defining the meaning of training effects arise. Additional problems in understanding and estimating training effects result from selectivity bias. Preliminary assessments of the effects of military training on civilian earnings indicate that when civilian occupational choice is ignored, military training does not seem to significantly affect civilian earnings. However, within occupations, military training does sometimes have such an effect. Having discussed these theoretical pitfalls and preliminary findings of the project, the paper develops a model of choice from which it is possible to derive empirically estimable relationships to calculate military training effects and to impute the total returns to training in a military specialty from the occupational choices actually made by enlisted personnel. Finally, the paper discusses four problems which need to be solved before the model can be applied (treatment of unemployment, choice of critical sample sizes, survey nonresponse, and selection of civilian alternative categories), and outlines a plan for proceeding with the analysis of military training premiums. (JR)

THE ESTIMATION OF TRAINING PREMIUMS FOR U.S. MILITARY PERSONNEL

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Adele P. Massell and Gary R. Nelson[1]

I. INTRODUCTION

Over six million persons have entered the U.S. military during the past 10 years as either enlistees or inductees.[2] Historically low reenlistment rates for first-term personnel indicate that approximately 85 percent of those persons will have left military service after four or fewer years. These rates imply that over 30 percent of the male U.S. population between ages 19 and 30 has entered military service, a figure comparable to the percentage of all members of the same age cohort who have received training in institutions of higher education in the U.S.[3] The questions posed by this paper relate to the possible effect that military training and experience have on the civilian earnings and employment of persons who have served one term of military service.

In terms of either the number of persons trained or the billions of dollars spent each year on training, the DoD is one of the largest educational institutions in the world. Approximately 90 percent of enlisted accessions are currently receiving formal training in specific occupational areas. Formal training in the various areas ranges from the high-density Army occupations (such as infantry and armor) in which training is essentially an extension of basic training, to courses in electronics which are conducted

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[1]This paper was presented at the June 1974 Meetings of the Western Economics Association in Las Vegas, Nevada. The authors wish to acknowledge the advice and criticism of Charles Robert Roll, Jr., Richard V.L. Cooper, and E. M. Norrblom.

[2]Military manpower data are published in *Selected Manpower Statistics*, Office of the Comptroller, Department of Defense, Washington, D.C., April 1973.

[3]Enlistments and inductions for FY1964-1973 are 35.7 percent of the total male population aged 15-24 in the 1970 Census. The proportion of the total population with one or more years of college was 38.3 percent in 1970 for persons aged 20-21, 36.2 percent for ages 22-24, and 32.0 percent for ages 25-29. Source: *Educational Attainment*, 1970 *Census of Population*.

primarily in classrooms and laboratories. The average length of formal specialized training in the DoD is 12.2 weeks[1] but in some areas is as long as 48 weeks or more. Moreover, training on the job is another important aspect of skill acquisition in the DoD,[2] even for men attending technical school.

A distribution of enlisted personnel by occupational areas (see Table 1) indicates the diversity of military specialties and the extent of comparability between military and civilian occupations. If there was ever a time when the U.S. military consisted of men whose principal skills were in the combat arms, it is certainly no longer true. Combat personnel (Occ. Code 0) comprise less than 15 percent of total first-term personnel and are outnumbered by administrative and clerical personnel and by electrical/ mechanical repairmen. For the large majority of specialties outside the combat arms there is some degree of comparability with civilian occupations.

Given the extent to which military personnel are trained in occupational areas with civilian analogs, the question arises as to whether there are societal benefits to military training and experience. This is one of the issues to which the estimation of the returns to military training and experience is relevant.

Two other contexts in which the measurement of training effects on civilian opportunities arises are retention and accession analysis and analysis of veterans' programs. In the context of accession and retention policy, training effects represent one aspect of the benefits accruing to enlistment, as well as one aspect of the opportunity cost of reenlistment. The DoD now has the option of awarding enlistment and reenlistment bonuses selectively among military specialties; if empirical estimates of training can be obtained, the military services could structure these awards to provide, for instance, bonuses to encourage enlistments in specialties where no training premium is received and reenlistment bonuses to compete for personnel who have received benefits from military training.

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[1] DoD Training Requirements Report, p. 20.

[2] Robert M. Gay, "On-the-Job Training Costs and Their Determinants in Military Occupations," Ph.D. thesis, U.C.L.A., 1973 (also R-1351, The Rand Corporation, 1974).

Table 1

DISTRIBUTION OF FIRST-TERM ENLISTED PERSONNEL BY MILITARY SERVICE ACROSS OCCUPATIONAL AREAS, JUNE 30, 1973
(percent)

Code	DoD Occupational Area	Army	Navy	Marines	Air Force	Total
0	Infantry, Gun Crews, and Seamanship	24.0	2.8	34.0	0.0	14.5
1	Electronics Repair	12.8	16.1	6.8	13.1	12.7
2	Communications, Intelligence	3.3	13.2	9.6	8.1	7.3
3	Medical and Dental	6.8	10.6	--	6.1	6.4
4	Other Technical	2.2	1.8	1.1	1.6	1.8
5	Administrative and Clerical	22.0	11.9	19.1	19.9	19.2
6	Electrical/Mechanical Repair	13.0	33.5	12.9	23.5	19.8
7	Craftsmen	2.7	6.6	1.7	9.8	5.3
8	Service and Supply	13.2	3.5	14.8	17.8	13.0
	TOTAL	100.0	100.0	100.0	100.0	100.0

Source: Office of the Assistant Secretary of Defense (Manpower and Reserve Affairs).

In the context of veterans' programs, an analysis of the effects of military service on the labor market experience of former military personnel gives direct evidence of the problems and benefits experienced by veterans. Such evidence would seem to have a logical bearing on policies of the Federal Government to provide aid to veterans through such programs as educational support.

The approach this study takes to the problem of estimating the benefits to military training and experience is to focus on differences in civilian opportunities among veterans who have served in different military occupational areas. This approach has been determined by our principal source of data, consisting of a survey of personnel approximately one year after completing military service. To determine specific training effects, civilian opportunities of veterans trained in specific military occupations can be compared with those of personnel who served in the infantry, a large specialty with no civilian analog. Although the approach can be extended to estimate the general effects of military training, to do so would require extensive data on nonveterans; this extension is not considered here.

The initial problem faced in this study is to define precisely what is meant by training effects. Although this creates no real conceptual problems, the fact that training effects are specific to individuals and to civilian occupations creates some empirical problems, as does the existence of such complexities as lifetime earnings streams, non-pecuniary returns, and unemployment. A key factor in both understanding and estimating training effects is the selectivity bias problem, which has been treated in another context by Gronau.[1] All of these conceptual and empirical issues are introduced in Section II.

A conventional analysis of the earnings of former military personnel show the importance of the considerations introduced in Section II. In the preliminary results reported in Section III, military specialty is shown to have little effect on overall earnings, but evidence is presented to suggest that to examine the interactions between earnings and military specialty,

[1]Reuben Gronau, "The Intrafamily Allocation of Time: The Value of the Housewives' Time," *American Economic Review*, Vol. 63, No. 4, September 1973, especially pp. 641-650.

it may be necessary to control for civilian occupation. Also, the distribution of personnel across civilian occupations is shown to vary by military specialty. As a result of this direct, and admittedly superficial, empirical analysis, it becomes obvious that some of the choice-theoretic aspects of decisions made by enlisted personnel need to be examined more carefully.

In Section IV a model of choice is presented from which it is possible to derive empirically estimable relationships to calculate military training effects. Using this procedure, one can impute the total returns to training in a military specialty from the occupational choices actually made by enlisted personnel. These returns represent non-pecuniary as well as the pecuniary aspects of the returns to training. The procedure is general enough to incorporate two troublesome but important aspects of the problem: the fact that some men choose to remain in the military and the fact that a large proportion of military separations choose further education in preference to participation in the labor force. Therefore, whereas past studies have attempted to estimate the civilian alternatives to military personnel and to use these estimates in models of retention behavior, the present methodology provides a way to integrate what are truly inseparable aspects of the same problem.

Finally, it must be conceded by the authors before more words are produced that this paper really ends with the introduction of this methodology and a discussion of some of the empirical problems. No answers are given here to the questions posed in this introduction. Instead this is a report on work in progress designed to solicit responses to a new and somewhat unusual approach to what appears to be an important problem.

II. THE NATURE OF MILITARY TRAINING EFFECTS

The civilian employment opportunities available to an enlisted man are job offers made by employers. Among the attributes of the veteran a civilian employer may take into account in determining the offer to be made are age, race, education, preservice experience, dependency status, and military training and experience. The employer may be particularly interested in the combination of a veteran's characteristics, so that the sum of incremental effects on the offer due to each characteristic may be less than the total effect of a particular combination. Moreover, the employer will be interested only in those worker characteristics likely to have a bearing on productivity in the job vacancy in question and may not make a better offer to a veteran with additional education or training if the additional human capital is irrelevant to the job vacancy to be filled.

Given the combination of factors determining offers, there are a variety of ways to measure the effects of training. For example, one might wish to measure the differences in average offers made to otherwise identical men in different military training groups. One might also wish to measure the effect of military training and experience for various categories of enlisted personnel relative to their civilian offers at the time of initial enlistment. Alternatively, one can measure the effects relative to the offers that would now be available if the individual had not entered military service in the first place. In this paper, we focus on the effects of training on civilian offers for various groups of men relative to the offers for otherwise identical groups receiving military training not transferable to the civilian sector. These *relative* training effects, which will differ according to the attributes of the serviceman, may not include some important general effects which all personnel derive from military service.

Because of the differential transferability of military training, relative training effects may vary among civilian occupations. The effects that can be measured using the methodology of this paper are specific to the occupation. For example, we distinguish the effect of electronics training on offers in a civilian electronics occupation from the effect of the same training on offers in other fields. An additional reason for differentiating among civilian occupations is that the benefits of military training may be taken in the form of non-pecuniary job benefits, such as the working environment, risk of unemployment, and expectations of future job opportunities. These non-pecuniary job aspects, together with present earnings and prospects for future earnings growth constitute the offer presented to a serviceman. Since non-pecuniary job aspects and prospective growth rates of earnings tend to vary among occupations, these may not be properly accounted for if occupations are ignored in the analysis.

In measuring training effects, we wish to include both pecuniary and non-pecuniary aspects of improvement in offers. We assume that each serviceman, in effect, assigns a hypothetical scalar value to the set of aspects embodied in a specific offer; it is the effect of training on this scalar value, or *return*, that is of interest. We define the difference in occupational returns due to training as the training *premium*; therefore, the methodology presented here is designed to estimate relative training premiums in various civilian occupations for various types of individuals.

III. PRELIMINARY ATTEMPTS AT ESTIMATING TRAINING PREMIUMS

This paper focuses on military training effects for men who have served one term of military service. Data are available from a survey of veterans conducted by the Office of the Assistant Secretary of Defense (Manpower & Reserve Affairs) since 1969.[1] (The data considered in the present study are from FY1971.) Approximately one year after leaving military service, each survey respondent reports his labor force participation, weekly earnings and occupation (if employed), and enrollment in education or training programs. The survey data are matched against service records in order to obtain information on race, education, military service test scores, age, military specialty, and other attributes of each veteran.

DATA LIMITATIONS AND SELECTIVITY BIAS

Previous studies of civilian alternatives for military personnel have focused on the earnings information from the postservice survey--a procedure subject to certain shortcomings. The earnings variable may bear little relationship to lifetime earnings. The data do not take account of future growth paths of earnings; even as measures of initial productivity, earnings may be depressed because on-the-job training may be taking place.[2] Also, use of earnings data implies omitting the unemployed--persons new to the civilian labor force and likely to be engaged in job search, where a number of complex factors, such as costs of search and earnings expectations, play an important role. Use of the earnings variable for those veterans who are employed may imply attributing differences in reservation wages or some other factor affecting the job search behavior of individuals to differences in productivity.

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[1] These survey data (for 1969) have been utilized previously by Eric A. Hanushek, *Review of Economics and Statistics*, February 1973. An analysis of non-response bias has been conducted by Gary Bridge, R-1501-ARPA, The Rand Corporation (forthcoming).

[2] See Gary S. Becker, *Human Capital*, New York: Columbia University Press, 1964.

Beyond these limitations in the use of earnings data--and perhaps even more important--is the extent to which the earnings we observe are the result of choices made by individuals. We observe full-time earnings for individuals who have chosen:

(1) To leave military service. (Overall reenlistment rates are low, only 13.5 percent in FY1970, but may vary widely among groups.)
(2) Not to enroll full-time in school nor in a training program not run by the employer. (The proportion of separations enrolled in a school or training program vary from 20 to 50 percent, depending on the branch of the service under consideration.)
(3) To look for and to accept an offer of full-time employment.

This raises the specter of selectivity bias. The theory of occupational choice and the theory of labor supply predict that returns to persons choosing an occupation, *ceteris paribus*, would be greater than the returns available in that occupation to persons choosing another occupation or choosing to remain unemployed. Hence, the selectivity bias due to observing earnings for less than the full population would be an overstatement of the actual earnings offered to veterans.

The issue of selectivity bias has appeared in the literature previously in the analysis of earnings by women where labor force participation rates are low. The model proposed by Gronau[1] can provide a rough framework for our analysis here, although an analysis of earnings by veterans is inherently more complicated due to our interest in the possibly incomplete transferability of military training to various civilian occupations. In fact, as the empirical results of this section will show, it is necessary to consider the occupations chosen to identify the full extent of military training premiums. Due to the greater complexity of this model, relative training premiums are imputed from the actual choices of military personnel rather than from earnings *per se*. For this reason it is useful to discuss in the remainder of this section the empirical evidence on military training premiums which can be derived from a straightforward examination of actual earnings of persons leaving military service and the distribution of the

[1] *Op. cit.*

civilian occupations chosen by these personnel. As noted previously, evidence is limited to a comparison of civilian work experience of veterans trained in different military occupations.

RESULTS OF PRELIMINARY ANALYSIS

This subsection describes the results of three different statistical analyses of the post-service survey data: (1) Regression of earnings on individual attributes, employing separate intercept terms to attempt to identify the effects of military training; (2) Regression analysis of veterans' earnings in two civilian occupation categories, comparing wages of military electronics personnel with those of other personnel; (3) A partial tabulation of civilian occupational distributions for personnel serving in different military specialties. The results tend to confirm the need for a different methodological approach to the problem of estimating training premiums.

Regression of Earnings on Attributes and Military Specialty

Under ideal conditions we might hope to estimate relative military training premiums directly from observed earnings. Table 2 presents the results of a regression of the logarithm of hourly earnings on year of birth, AFQT score, months of military service, and a dummy variable designating each military specialty. Regressions were run for each military service on a sample of white high school graduates (no college), employed between 38 and 42 hours per week and with between 33 and 60 months of military service.

Table 2 compares the results of regressions including variables for each military specialty with regressions omitting these variables. In the Army and the Navy we can reject the hypothesis that these variables as a group contribute significantly to earnings after military service. But as the F-test score in the table indicates, the 62 variables for military specialties do show a statistically significant improvement in the explanatory power of earnings of former Air Force personnel. However, with the increase in adjusted R^2 from .004 to .086, the observed effect of age on earnings changes from positive, which should be expected, to a negative value. As a result it is difficult to evaluate the Air Force results which include specialty variables. As a further point only a small fraction of

Table 2

CIVILIAN EARNINGS OF MILITARY SPECIALISTS WITH AND WITHOUT VARIABLES FOR MILITARY SPECIALTY
(Regression Coefficients and t-Scores)

Service	Version	Constant	Year of Birth	AFQT	Months of Service	$\bar{R}^2$	F-Test	Military Total	Specialties Significant at 5 Percent
Army (1391 Observations)	Specialty Variables	2.326†	-.0259** (3.54)	.0016** (3.96)	-.0006 (.27)	.050**	1.24	68	4
	Constant Term	2.5290 (6.69)	-.0320** (4.42)	.0020** (5.45)	.0001 (.57)	.038**			
Navy (803 Observations)	Specialty Variables	2.561†	-.0329** (3.34)	.0001 (.16)	.0004 (1.13)	-.011	0.08	22	2
	Constant Term	2.6868 (5.20)	-.0331** (3.41)	.0004 (.66)	.0010 (.30)	-.014			
Air Force (1367 Observations)	Specialty Variables	.205†	.0105** (2.77)	.0004 (.97)	.0107** (2.94)	.086**	3.07**	62	3
	Constant Term	2.0300 (4.88)	-.0169** (2.39)	.0005 (1.45)	-.0009 (.20)	.004			

†Constant is a weighted average of intercept terms for each military specialty.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

the individual military specialty variables differ from the sample mean value of the specialty coefficients in a statistically significant way. Only four out of 68 in the Army, two out of 22 in the Navy, and three of the 62 specialties in the Air Force satisfy this criterion.

Other aspects of this regression are worth noting aside from the low R^2 and the insignificance of military specialty as a determinant of earnings: AFQT has a varying but generally weak effect as a determinant of earnings and length of military service likewise has little impact on post-service earnings.

A More Detailed Look at Electronics Specialists

A variety of factors, in addition to the problems already identified may make it difficult to observe training premiums from earnings data taken across civilian occupations. There may be occupational wage differentials which "compensate" for unfavorable non-pecuniary job attributes, such as hard physical labor, unpleasant working conditions, considerable travel or other negative factors. These differentials may also occur where there is seasonality in earnings, such as in the construction trades, or where there is a considerable risk of unemployment, such as employment in the aerospace industry. Moreover, the degree of unionization in an occupational field can affect both the level of earnings and the observed differentials[1] in earnings within the field. Finally, individuals may receive varying amounts of training on the job. Not only will this depress current earnings but it will have the effect of raising unobserved future earnings. The problems caused by all of these factors will be reduced if earnings are examined on an occupational basis.

Table 3 contains the results of regression analysis of veterans' earnings within two civilian occupational groups: (1) electrical and electronics, DOT occupational codes 720-729 and 820-829 and (2) a subfield of professional and technical workers, DOT 000-029. A regression of log earnings on education, AFQT scores, number of dependents, and year of birth is presented for military personnel trained in electronics and trained in other areas.

[1]Including differences between union and non-union workers with similar characteristics and lack of difference among union workers who differ in attributes.

Table 3

EARNINGS OF MILITARY ELECTRONICS AND NON-ELECTRONICS SPECIALISTS IN SELECTED CIVILIAN OCCUPATIONS[a]
Regressions for Army, Navy, Air Force Combined
(with t scores)

Sample	Constant	AFQT	Year of Birth	Dependents	Education	Electronics Training	$\bar{R}^2$	F-Test of Homogeneity
Electrical and Electronics, Bench and Structural, DOT 720-9, 820-9								
Electronics (DOD Code 1) (396 observations)	5.086 (9.44)	.0005 (.70)	-.0332** (-3.60)	.0256* (2.33)	-.0034 (-.24)	--	.05**	--
Non-Electronics (308 observations)	4.808 (6.31)	.0012 (1.61)	-.0310* (-2.30)	.0225 (1.53)	.0061 (.31)	--	.04**	--
Combined (704 observations)	4.96 (11.26)	.0010* (2.16)	-.0326** (-4.28)	.0244** (2.76)	.0012 (.10)	--	.06**	.32
Combined, with Intercept for Electronics	4.920 (11.13)	.0009 (1.80)	-0318** (-4.14)	.0243** (2.75)	.0010 (.08)	.0168 (.86)	.06**	.22
Professional and Technical Subfields, DOT 000-029								
Electronics (DoD Code 1) (169 observations)	2.997 (4.18)	.0011 (.90)	-.0014 (-.11)	.0105 (.57)	.0428* (2.58)	--	.05**	--
Non-Electronics (12? observations)	3.431 (2.986)	.0019 (1.76)	-.0149 (-.76)	.0282 (1.19)	.0452 (1.94)	--	.15**	--
Combined (291 observations)	2.908 (4.89)	.0030** (4.37)	-.0041 (-.40)	.0191 (1.35)	.0441** (3.43)	--	.15**	2.51*
Combined, with Intercept for Electronics	2.729 (4.63)	.0022** (2.89)	-.0016 (-.16)	.0210 (1.50)	.0501** (3.90)	.0891** (3.02)	.17**	5.20**

[a]Earnings are wage rates for white personnel, employed 38-42 hours per week.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 3 also presents results from regressions using a combined sample of military personnel with and without a dummy variable for electronics training.

Some explanation of the results in Table 3 may be helpful. The coefficients and the R^2 for the professional and technical regressions may be larger than in the electrical and electronics regressions because of the greater heterogeneity among the jobs in the occupational class. The fact that year of birth, but not education, is significant in the electrical and electronics equation but the reverse is true in the professional equation may be due to the degree of correlation between age and education. Older individuals tend to have completed more years of schooling than younger individuals.

The professional and technical equations show higher earnings for men with military training in electronics, but this does not appear to hold for the electrical and electronics equations. In both cases, however, we can reject the hypothesis that electronics and nonelectronics personnel can be combined without adding a variable for electronics training. On the other hand, one can reject the hypothesis that the coefficients of the remaining variables are significantly different between electronics and nonelectronics personnel in both occupational groups, implying that the effect of military training does not interact with the effects of the other variables.

Although these regression equations only look at two groups of civilian occupations and only distinguish between electronics and nonelectronics personnel, this procedure does show some of the gains from examining military training benefits on an occupation-by-occupation basis. In particular, the equations generally explain a larger percentage of a smaller-variance earnings variable than was true in the regressions described in the preceding subsection. The effects of electronics training observed in professional and technical occupations may have been caused by selectivity bias or some of the other problems raised above, or they may in fact be a good estimate of the relative military training premium for electronics technicians. It will require a different estimating procedure to be sure.

Civilian Occupational Choices of Military Personnel

An analysis of the distribution of personnel by civilian occupation shows the effects of military specialty training more strongly than does an analysis of earnings. Table 4 shows the civilian occupational distributions of employed veterans from selected Army specialties. The figures enclosed in boxes indicate the civilian occupations most comparable to the respective military specialty. These data have not been controlled for test score differences, so the degree of matching may be overstated. In no case, however, have more than about 25 percent of employed veterans gone into similar civilian fields. Considering the proportion remaining in the military, enrolling in school, or being unemployed, the proportion of all veterans entering similar civilian fields is even smaller.

SUMMARY

The admittedly limited empirical analyses presented in this section nevertheless are consistent with conclusions reached on theoretical grounds alone. When civilian occupational choice is ignored, military training rarely is revealed to have a significant effect on civilian earnings. However, within occupations military training is sometimes observed to have an effect and the existence of the effect may well differ among occupations. Moreover, there do appear to be substantial differences across training groups in the civilian occupations selected by men who have high school diplomas and have accepted full-time civilian employment.

These results do not, of course, address the questions of whether reenlistment behavior itself introduces selectivity bias in earnings estimation, nor whether nonearnings returns to civilian employment significantly influence choices or reflect additional gains to training. The methodology presented in the next section addresses these issues.

Table 4

OCCUPATIONAL DISTRIBUTIONS BY SPECIALTY: PERCENT OF SEPARATEES[a]

	91B Medical Special-ists	010 Infantry	63H Engine and Powertrain Repair	63B Wheel Vehicle Mechanic	800 Food General	121 Missile Guidance and Control
__Professional__						
00-05 Sciences, Professional		1.4		1.2	2.4	8.3
07, Medicine, Health	5.4	.1				.9
09, Education	.7					
10-19, Art, Library, Enter-tainment, etc.	3.8	2.0	1.1	3.6	4.9	6.4
__Clerical and Sales__						
20-29	18.1	13.4	11.2	9.7	7.3	
__Service Occupation__						
30-38 (i.e., food preparation ser-vices, police and firemen, etc.)	21.5	6.6	2.2	5.5	19.9	5.5
__Farming, Fishery, etc.__						
40-46		.9	2.2	3.4	1.8	
__Processing__						
50-59	8.8	5.7	5.5	4.5	8.5	6.4
__Machine Trades__						
60-69, (i.e., Mechanics, etc.)	8.2	11.9	25.9	24.1	10.3	13.6
__Bench Work__						
70-79, (i.e., electronics repair)	3.7	6.3	7.9	5.5	6.1	6.4
__Structural Work__						
80-89, (i.e., construction)	10.7	25.6	18.9	16.2	13.0	18.6

Table 4, continued

	91B Medical Special-ists	010 Infantry	63H Engine and Powertrain Repair	63B Wheel Vehicle Mechanic	800 Food General	121 Missile Guidance and Control
Miscellaneous						
90-97, (i.e., Bus and Truck drivers, graphic art, etc.)	16.1	21.1	21.3	22.1	24.3	16.7
Sample Size	128	414	88	137	160	106

[a]High school graduates, not in education program, working full time.

IV. A CHOICE-THEORETIC APPROACH TO THE IMPUTATION OF MILITARY TRAINING PREMIUMS

There are essentially two key ideas underlying the approach to estimating military training premiums proposed in this section. First, training premiums cannot be properly identified unless the process of choice is explicitly taken into consideration. This is necessary because the process of choosing among alternatives creates a discrepancy between the average of accepted returns and the average available returns on which decisions are based. Second, the process of choice itself makes it possible to impute values to the various alternatives. Hence, from observing choices made by personnel at the end of military service, it is possible to estimate the returns perceived in those alternatives by the individuals making the choices.

A MODEL OF BINARY OCCUPATIONAL CHOICE

The economics and mathematics of choice between two alternatives in a one-period model is well understood. Associated with the two activities m and c are pecuniary returns, or wages, w_m and w_c as well as the monetized value of non-pecuniary returns, n_m and n_c. The individual chooses alternative m if w_m is greater than the total of w_c and the "taste differential" $t = n_c - n_m$. If the wage w_m, say the military wage, is given and if $u = w_c + t$ is distributed in the population according to the probability density function f(u), then the proportion choosing occupation m can be written

$$P = \int_{-\infty}^{w_m} f(u)du \quad . \tag{1}$$

P is simply the probability that an individual chosen at random from the population will prefer w_m to $w_c + t$.

Selectivity bias arises in the following way: Suppose we can observe all of the values u for individuals choosing alternative c. This means either that we can observe the composite value $w_c + t$ or that we can observe

w_c and the taste differential is uniformly 0 throughout the population. Our estimate of the mean μ would be biased because we can only observe values of u for which $u = w_c + t > w_m$. In fact, following Gronau,[1] it can be shown that the expected value of the sample mean is

$$E(\hat{\mu}) = \mu + \sigma \int g(u)du \ , \qquad (2)$$

where $\int g(u)du$ is a positive integral related to the conditional probability of observing $w_m > u$. Hence $E(\hat{\mu})$ is biased upwards.

Nor does selectivity bias disappear in the case at hand, where we observe the outcome of choices made by personnel in different specialty areas. The relative military training premium can be defined as a shift in the mean of earnings in activity c relative to another occupation, assuming no change takes place in the variance σ^2. The training premium in occupation j relative to occupation 0 can be written $\hat{\mu}_j - \hat{\mu}_0$ but the estimate $\Delta\hat{\mu}_j = \hat{\mu}_j - \hat{\mu}_0$ is biased because

$$E(\Delta\hat{\mu}_j) = \Delta\mu_j + \sigma_j(\Delta \int g(u)du). \qquad (3)$$

Selectivity bias arises in the estimation of relative training premiums.

<u>A MULTI-CHOICE MODEL</u>

To show how to develop estimates of the relative training premiums which correct for occupational choice, it is necessary to adopt a somewhat different version of the preceding model, in which each alternative is represented by a random variable R_i representing total returns as the sum of pecuniary and non-pecuniary returns

$$R_i = w_i + n_i \qquad (4)$$

and there exists a joint probability density function

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[1] *Op. cit.*, p. 643.

$$f(R_1, \ldots, R_n) \qquad (5)$$

of returns in all n occupational alternatives. Moreover, the multi-choice case is appropriate for the problem at hand because the individual must choose among continued military service, enrollment in school or other training programs, employment in the civilian labor force, and nonemployment. Within the employment alternative we will want to consider also a variety of occupational alternatives, because of the problems cited above, such as compensating differentials, unionization and other factors.

If we could observe the full range of all the marginal distributions for personnel in each military specialty j,

$$f_{1j}(R_{1j}), \ldots, f_{nj}(R_{nj}) \;, \qquad (6)$$

we could calculate unbiased estimates of $\hat{\mu}_{1j}$ to $\hat{\mu}_{nj}$ and determine the relative military training premium for j from the values

$$\hat{\mu}_{1j} - \hat{\mu}_{10}, \ldots, \hat{\mu}_{nj} - \hat{\mu}_{n0} \;, \qquad (7)$$

where specialty 0 is the control group. Instead we observe a set of choices which may be used to infer the parameters of the offer distributions.

The probability that an individual will be observed in the jth alternative is the probability that the jth alternative will offer the highest value of R, that is, the probability $R_j > R_k$, $k \neq j$. Suppose that returns in each alternative are normally distributed, having a frequency function of the form:

$$f(R_j) = \frac{1}{\sigma_j\sqrt{2\pi}} e^{-1/2\left(\frac{R_j - \mu_j}{\sigma_j}\right)^2} \;. \qquad (8)$$

Then, if the individual randomly samples offers in two alternative, j and k, the probability that $R_j > R_k$ is given by:

$$P\{R_j > R_k\} = \int_{-\infty}^{\infty} \int_{-\infty}^{R_j} \frac{1}{2\pi\sigma_j\sigma_k} \exp\left[\left(\frac{R_j - \mu_j}{\sigma_j}\right)^2 + \left(\frac{R_k - \mu_k}{\sigma_k}\right)^2\right] dR_k dR_j , \tag{9}$$

where the covariance of R_j and R_k is assumed zero (i.e., R_j and R_k are independent).

More generally, the probability that an individual will choose occupation j is:

$$P_j = \int_{-\infty}^{\infty} \frac{1}{\sigma_j\sqrt{2\pi}} e^{-1/2\left(\frac{R_j - \mu_j}{\sigma_j}\right)^2} \left[\prod_{\substack{k=1 \\ k \neq j}}^{n} \int_{-\infty}^{R_j} \frac{1}{\sigma_k 2\pi} e^{-1/2\left(\frac{R_k - \mu_k}{\sigma_k}\right)^2} dR_k\right] dR_j , \tag{10}$$

where it is again assumed that the returns $R_1, \ldots, R_n$ are distributed independently. This probability is, therefore, a function of the means and variances of R in all alternatives. For example, P_j increases with increases in the mean of R_j and with decreases in the means of the R_k, $k \neq j$.

To estimate relative military training premiums requires the assumption that any effect of military training on the population variances

$$\sigma_1^2, \ldots, \sigma_n^2 \tag{11}$$

can be ignored. Thus, we can limit our attention to the effect of military service on mean wage offers. Suppose that, as Table 4 indicated, the distribution of personnel across civilian occupations differs according to the military specialty. Let us define the distribution of personnel across civilian occupations as the choice probability set. Our method of proceeding is derived from the observation that changes in the probability sets are dictated by changes in the mean offers (assuming the variances of offers is fixed). Thus, we are interested in the change in P_j owing to a change in human capital--specifically, military training.

To derive the result of the analysis, we begin by considering a general two-alternative case, where P_1 is the probability of choosing the first alternative. P_1 can be written

$$P_1 = \int_{-\infty}^{\infty} \int_{-\infty}^{R_1} \frac{1}{2\pi\sigma_1\sigma_2} e^{-1/2\left(\frac{R_1 - \mu_1}{\sigma_2}\right)^2 + \left(\frac{R_2 - \mu_2}{\sigma_2}\right)^2} dR_2 dR_1 \qquad (12)$$

using the same notation as above. Our estimate of the relative military training premium can be approximated from the total differential:

$$dP_1 = \frac{\partial P_1}{\partial \mu_1} d\mu_1 + \frac{\partial P_2}{\partial \mu_2} d\mu_2 \ . \qquad (13)$$

In evaluating this expression, the differentials $d\mu_1$ and $d\mu_2$ are replaced by the relative training premiums $\Delta\mu_1$ and $\Delta\mu_2$. As the appendix demonstrates, the resulting expression is

$$P_1 = \frac{e^{-1/2\frac{(\mu_1 - \mu_2)^2}{\sigma_1^2 + \sigma_2^2}}}{\sqrt{2\pi(\sigma_1^2 + \sigma_2^2)}} (\Delta\mu_1 - \Delta\mu_2) \ . \qquad (14)$$

Or, solving for the change in μ_1:

$$\Delta\mu_1 = \frac{\Delta P_1}{F} + \Delta\mu_2 \ , \qquad (15)$$

where F is the factor outside parentheses in Equation (14), and, under our assumptions, is constant.

This result suggests a methodology for comparing the effects of training among different alternatives, and for determining the value of training premiums. The first step is to select a particular training group as a base, such as the Army infantry (DoD code 010). The two occupations under consideration are, say, reenlistment and a single civilian alternative. Let P_1, μ_1, and σ_1 apply to the civilian alternative. For the military occupation as a whole, we observe σ_2 and μ_2; the value of μ_2 is the mean pecuniary return to reenlistment and σ_2 is, say, the average within-specialty variance in returns for reenlistment. Let us suppose we also observe μ_1 and σ_1 for the infantrymen who separate and defer for the moment how estimates of these values can be obtained. Finally, we observe any other training group, such as electronics specialists, and use the differences in mean returns to reenlistment and the proportion of separatees as estimates of $\Delta\mu_2$ and ΔP_1, respectively. Entering these values in Equation (15) enables us to compute an estimate of $\Delta\mu_1$: the effect of noninfantry training on civilian returns relative to returns for infantrymen.

Returning to the issue of obtaining estimates of μ_1 and σ_1 for the infantry group, we note that this group is proposed for use as the comparison group because it is unlikely that combat training is transferable to the civilian sector. For this reason, we can initially use the mean and variances of the present value of career earnings streams for civilian males with the relevant nonmilitary characteristics as estimates of μ_1 and σ_1 for the infantry group. Although these estimates do not include nonearnings civilian returns, we presume that within a civilian occupation (at least when the multi-alternative version of the model is used), there are not major differences among training groups in these non-pecuniary returns. Therefore, the differences in the probability of selecting a given alternative across training groups will largely reflect career earnings differences. Thus, the model picks up differences in non-pecuniary returns across occupations rather than within them.

If there are three or more alternatives, the analysis is complicated by the larger number of terms in the probability expression (Equation (10)). In the case of n alternatives, the probability relation can be written:

$$P_j = \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}\sigma_j} e^{-1/2\left(\frac{R_j - \mu_j}{\sigma_j}\right)^2} \left[\prod_{\substack{k=1 \\ k\neq j}}^{n} x_{jk}\right] dR_j \tag{16}$$

where:

$$x_{jk} = \int_{-\infty}^{R_j} \frac{1}{2\pi\sigma_k} e^{-1/2\left(\frac{R_k - \mu_k}{\sigma_k}\right)^2} dR_k \quad . \tag{17}$$

Then the following discrete approximation to the total differential holds:

$$\Delta P_j = \frac{\partial P_j}{\partial \mu_1} \Delta\mu_1 + \ldots + \frac{\partial P_j}{\partial \mu_k} \Delta\mu_k + \ldots + \frac{\partial P_j}{\partial \mu_n} \Delta\mu_n \quad . \tag{18}$$

There are (n-1) independent equations which must be solved simultaneously in order to obtain estimated relative values of the $\Delta\mu_j$ as functions of the ΔP_j and the constant term involving μ_j and σ_j. Beyond this mathematical manipulation, the analytical approach is the same as in the two-variable case.

The multi-alternative problem is simplified, of course, if some values of $\Delta\mu_j$ can be assumed to be zero, such as for civilian alternatives clearly unrelated to skills acquired in the military specialty under investigation. Moreover, if values of $\Delta P_j/P_j$ are equal within some subset of civilian alternatives, then this subset can be treated as a single alternative, thereby reducing the number of cases under consideration. The greatest degree of simplification results where only one civilian alternative is affected by military training. In this case the problem is identical to the two-alternative problem presented above. Also, some degree of simplification can result from an examination of military training premiums for pairs of civilian alternatives whose returns have identical means and variances. It can be shown that differences in training premiums for this pair of occupations is independent of whatever training premiums occur in other civilian occupations.

V. ISSUES IN APPLYING THE METHODOLOGY

Several specific issues arise in applying the methodology outlined in Section IV. This concluding Section discusses four relatively important problems which must be solved before the methodology can be applied. These include: (1) the treatment of the unemployed; (2) the choice of critical sample sizes; (3) the problem of survey nonresponse; and (4) the selection of civilian alternative categories. At the conclusion, we outline a plan for proceeding with the analysis of military training premiums.

TREATMENT OF THE UNEMPLOYED

Among separatees surveyed shortly after separation, there are three identifiable groups with no occupation: (a) those unemployed and looking for employment; (b) those unemployed and not in school but not looking for work; and (c) those in a full-time civilian training program and unemployed. The question is: How do we evaluate civilian opportunities for groups of men with identical characteristics except for military training?

Men who elect to engage in civilian training programs, such as school enrollment or other programs not combined with employment, can be treated in our framework as individuals who selected an alternative that did not involve immediate labor force activity. The methodology we have proposed deals with this choice more adequately than would the analysis of earnings data, which requires omitting these men. In principle it is possible to estimate differential returns to schooling among military occupations from observing the proportion choosing this alternative.

Those not employed and not in school create something more of a problem. For some proportion of the unemployed, both those looking for work and those not looking, unemployment can be treated as a choice alternative.[1]

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[1]Economic theory suggests that there are three possible kinds of unemployment. One is transitory: As people change jobs we may observe them passing through a period of unemployment during which job search is occurring. The duration of unemployment is determined by the cost of search and the target offer which the worker is hoping to achieve. This category includes the standard causes of unemployment--frictional, structural, and

An increased rate of unemployment for one of two training groups can be interpreted to mean that the returns to unemployment are higher for this group or, more reasonably, that the group has suffered a loss in civilian opportunities from the military training.

Of men who are facing identical wage-offer distributions, those unemployed tend to have either unusually low costs of search or unusually high expectations of the returns to search, or both. We can control for differences in the costs of search due to such observable characteristics as the number of dependents to be supported. Beyond this, we assume that differences in the proportion of men in search across training groups reflect differences in expected offers. A null hypothesis we propose to test is that the probability that the expected (or target) offer differs from the mean offer by a given increment is independent of training group.

CRITICAL SAMPLE SIZES

Although, in principle, we would like to confine the analysis to homogeneous samples of individuals and to consider a large number of different civilian occupations and other alternatives, sample size poses a severe practical constraint. For a single fiscal year, the total survey sample of separatees is large--roughly 200,000 for FY1970. However, if we were to stratify by the two categories of draft status in the Army, three military services, two categories of race, four categories of AFQT score, four educational attainment categories, two categories of age and two categories of dependency status, and if men were uniformly distributed with respect to all these categories, the average sample size of a stratum would be under 800 persons. Even ignoring the set of civilian alternatives defined by occupations it is clear that division into even 50 military specialties would reduce the individual samples to extremely low numbers.

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inadequate demand. A second cause of unemployment is the possible existence of unearned income; the individual who is independently wealthy or content to live on government subsidy, for example, may never enter the labor market. The third possibility is that the unemployed individual is investing in training for later entrance into the market.

A method of increasing sample sizes is to combine strata while attempting to control for the effects that different individual characteristics have on mean returns and the choice of occupations. There are two procedures for estimating P_j, the proportion of homogeneous individuals choosing occupation j. Both involve the use of either conditional logit analysis or discriminant analysis because individuals are choosing among more than two alternatives. One procedure is to relate the observed proportions choosing each occupation to the observed attributes of individuals in each military training group. From these relationships one can generate predicted choices $\hat{P}_j$ and $\Delta\hat{P}_j$ for homogeneous groups of individuals which can be used in the methodology outlined in Section IV. Since many military training groups are quite small, another procedure might be to employ discriminant analysis or conditional logit analysis only on the large control groups, e.g., Army infantry. If the effects of individual attributes on mean returns $\mu_1, \ldots, \mu_j$ and the proportions $P_1, \ldots, P_j$ are assumed to be the same in each military training group, then corrections can be made in the proportions observed in the other training groups to control for differences in mean individual attributes between military training groups. This latter procedure embodies some strong assumptions, such that effects of attributes on mean returns are equal across specialties and that there is little interaction between military training premiums and attributes like education and AFQT score. The second assumption, however, can be tested through experimentation with different methods of combining strata.

SURVEY NONRESPONSE

One of the criticisms that has been raised concerning the use of average earnings of separatees as estimates of civilian returns is that survey nonresponse may bias these estimates.[1] In very simple terms, it may be argued that men who do not respond to the survey tend to have characteristics that are also associated with low earning potential (e.g., less education, frequent change of address, etc.); if so, omitting the earnings of these men from analysis would produce an upward bias in the estimates.

[1] See R. Gary Bridge, "Nonresponse Bias in Mail Surveys," The Rand Corporation (forthcoming, 1974).

The existence of survey nonresponse will not cause a bias in estimates derived from the proposed methodology provided either that these men do not have different probabilities of being in the various civilian alternatives than do other men with the same characteristics who are observed or that, *compared with other men with the same characteristics,* the nonresponders are equally likely to be assigned to each military specialty. The latter condition is acceptable since the methodology requires comparison of behavior across specialties rather than estimation of behavior for individual specialties. Fortunately, since the military records of nonresponders are available, we can test the hypothesis that these men are randomly distributed among specialties, given their characteristics.

SELECTION OF CIVILIAN ALTERNATIVE CATEGORIES

The selection of the set of civilian alternatives to be analyzed is a matter of logistics as well as of analytical judgment. The number of occupations can be broken down in considerable detail; the three-digit occupation codes used in the Post-service File permits as many as 1,000 alternatives. These can be further broken down into part-time, full-time, and over-full-time categories. Clearly, even the sample size advantages of combining strata of men will be nullified if the number of alternatives under consideration is allowed to proliferate.

The civilian occupation codes used in our data file represent a partial hierarchy of job categories. The first digit represents one of ten general categories, such as professional or technical. Within a one digit category, the second digit further describes subcategories, such as educators or artisans and, of course, the third digit indicates still further disaggregated groupings. The principle on which we wish to create the set of job categories for analysis is that within a category mean returns in various occupations should be as nearly identical as possible. Our approach will be to treat one- and two-digit categories as hierarchies within which nonpecuniary job characteristics are relatively similar. Therefore, we should not attempt to combine three-digit codes across one- or two-digit categories. Within a two-digit category, however, we can combine three-digit groupings which have similar wage and hours characteristics, the latter as observed in the hours data for men in that category in the Post-service File; the wage data require domestic sources because of the possible existence of training premiums.

AN ANALYSIS PLAN

The following is an outline of the steps to be taken in applying the proposed methodology using currently available data sources:

(1) Select alternatives for analysis. Initially, we propose to consider (a) two-digit categories of civilian occupation; (b) nonschool unemployment categories (labor force participants and nonparticipants); (c) two schooling categories (technical and formal); and (d) reenlistment. Further aggregation of the civilian occupational categories may be feasible, allowing improved sample sizes.

(2) Calculate proportions of men in each training group choosing each alternative, stratifying by educational attainment, qualifying test score categories, dependency status and race.

(3) Use discriminant analysis on a large training group (e.g., the Army Infantry) to determine the effect of such variables as education, length of service, age, etc., on the proportion of men selecting each alternative. Use these results to compute the variation in proportions across training groups due only to training.

(4) Compute occupational variances in earnings, using data on the civilian labor force and variances in lifetime military compensation for reenlistment.

(5) Insert the values obtained in the three previous steps into Equation (18) to calculate the estimates of military training premiums.

(6) Examine the unemployment probabilities to determine if job search returns apparently vary by military training group.