Technical Note

Modeling Army enlistment supply for the All-Volunteer Force

DAVID K. HORNE

The success of the All-Volunteer Force depends upon the ability of the U.S. military to meet its manpower requirements. The Army alone intends to maintain a total active duty force of 780,000.[1] This target requires approximately 140,000 new accessions each year. Army recruiting has exceeded overall enlistment goals since 1979, but this trend may soon be reversed in wake of the recent economic expansion. The rising demand for labor is reducing youth unemployment and increasing wages, inducing more youths to enter the civilian labor market. In addition, the population aged 17 to 21 is predicted to fall 6.4 percent between 1985 and 1990.[2] The pool of potential recruits is limited even further by higher enlistment standards mandated by Congress in 1983.

The greatest recruiting challenge facing the Army is to attract a sufficient number of "high-quality males," particularly those who are high school graduates and score above the 50th percentile on the Armed Forces Qualifying Test (category 1–3A), hereafter referred to as graduate-senior males (GSM 1–3A). Evidence suggests that the number of accessions by such individuals is supply constrained, with total manpower goals being met by accepting lower category or nongraduate males, or women, as needed. The first sign of recruiting difficulty, then, may not be a fall in the total number of accessions, but rather a decrease in the percent of accessions among the GSM 1–3A group. Although such a decline may not have a significant immediate effect on total accessions, the emphasis on maintaining the quality of the force requires that the Army be able to compete successfully for "high quality" males.

This report models the peacetime supply of graduate-senior (1–3A) males with no prior military service, with particular interest in the effects of both unemployment and earnings on the Army enlistment rate. The model is then used to generate short-run forecasts. These projections are useful to manpower planners, not only for developing recruitment policies but also for allocating current accessions to military occupational specialties.

Analytical framework

In a simple one-period model, an individual chooses to enlist if the military wage at least equals his or her reservation wage.[3] This reservation wage is a function of the alternative earnings in the civilian sector, the probability of receiving a wage offer in that sector, and the net utility of the nonpecuniary factors such as military lifestyle, travel, loss of personal freedom, and risk. It is clear that both earnings and unemployment rates in the civilian economy should influence enlistment rates.[4] However, much of the recent research, particularly that research using time-series or pooled cross-sectional data, finds no such effects. These and other anomalous results may be due to model misspecification.

When an individual decides to join the Army, he or she signs a contract. The contract may specify immediate entry, or a delay for up to 12 months. Because the enlistment decision is made at the time of contract, total contracts are the appropriate quantity to use as the dependent variable. Accessions at any time are a combination of past and present contracts, and reflect the loss of those individuals who may not actually enlist despite the contract. Some studies have used accessions rather than contracts as the dependent variable, producing ambiguous results.[5]

The recruiting success in the 1981–84 period has been widely attributed to high youth unemployment rates. Yet the relationship between enlistment and unemployment has been difficult to identify empirically. Many studies have found no unemployment effect,[6] or have reported unemployment significant with lags of 1 and 3, but not 2, months.[7] Previous studies use a wide range of unemployment rate measures, such as aggregate unemployment or the jobless rate for 16- to 19-year-old males. Because most male recruits are from 17 to 21 years old, the readily available unemployment rate for males ages 16 to 21 is intuitively a logical choice. This rate also generates the best fit in the regression equations.

Compensation is now a significant inducement for enlistment, particularly for individuals desiring to save for further schooling. Soldiers currently receive $573.60 per

David K. Horne is an economist with the U.S. Army Research Institute, Alexandria, VA.

month in basic pay at entry, rising to $620.40 after advanced individual training (or 4 months). In addition, the Services provide food and housing (or subsistence allowance), a clothing allowance, medical care, social security contributions, retirement benefits after 20 years' service, commissary and exchange benefits, and tax exemption for all allowances. Soldiers may qualify for "special" and incentive pay, and supplemental benefits and allowances. Educational bonuses are also quite substantial. With educational contributions and other related bonuses, a soldier may obtain up to $24,000 in educational benefits for a 4-year tour, and somewhat less for shorter tours. Therefore, the actual compensation package may be quite attractive, particularly for youths just out of high school with little or no work experience.

Not all recruits receive incentive and supplemental pay, nor do all recruits who qualify for enlistment bonuses elect to participate in the program. For simplicity, military compensation is estimated in this analysis as the sum of basic pay, allowances for quarters and subsistence, and the tax advantage derived from the nontaxable status of the allowances. Over time, this series is highly correlated with total compensation. However, the level of military compensation is probably not as important alone as it is relative to civilian earnings. In a one-period model, the opportunity costs might be considered to be youth earnings, although using this series introduces substantial error into the analysis.[8] When military service affects future earnings or when the individual is comparing enlistment with schooling, the rationale for comparing military with civilian youth compensation is less clear. In this analysis, military pay was compared to earnings estimates for production or nonsupervisory workers on private nonagricultural payrolls obtained from the Bureau of Labor Statistics. This series can be interpreted as an average measure of earnings for jobs which are similar in nature to many Army jobs for the enlisted force.

Compensation enters this model with a slightly different twist. Previous analyses simply included a compensation ratio, usually the ratio of military to civilian pay, as an independent variable. Yet the two series are not comparable. The BLS earnings series are essentially moving averages because wages are continually changing throughout the economy over time. Military compensation, however, usually increases just once each year. Therefore, the ratio of military to civilian compensation rises once each year, and then falls for 11 months. Simple econometric models which include the pay ratio yield anomalous results, and the size as well as the sign of the pay effect varies as alternative lags are chosen.[9] In this analysis, military pay is first converted to a moving average, and is then compared to civilian earnings. It appears that the real wage *difference* has a larger impact in the model than the wage *ratio*. Thus, the pay variable of choice is the real difference of the two earnings series expressed as moving averages.

The Army devotes considerable resources to recruiting. In fiscal 1984, the Army spent close to $235 million on recruiting and examining activities alone.[10] Two recruiting factors are easily measured and are statistically significant: (a) the number of recruiters, and (b) the real advertising expenditures on national media.

Finally, the male population ages 16 to 21 is included in the model, albeit indirectly. The dependent variable is number of contracts divided by male population, and recruiters are also expressed as recruiters per eligible male, or recruiter density. The enlistment (contract) forecasts are adjusted by population projections to produce the level of expected contracts.

The model to be estimated takes the form:

$$\text{S/POP} = \text{F}\,(\text{Pay},\ \text{U},\ \text{Recruit/POP},\ \text{Adver})$$

where:

S	= the supply of graduate-senior (1–3A) males;
POP	= population of eligible males;
Pay	= real military compensation relative to civilian earnings;
Recruit	= number of recruiters;
U	= the unemployment rate for 16- to 21-year-olds; and
Adver	= Army advertising expenditures.

Results

Because the model initially exhibited a significant amount of serial correlation, the generalized least squares (GLS) technique was used.[11] Various two-stage GLS specifications of the enlistment model have been estimated using quarterly data covering second-quarter 1977 through second-quarter 1984 and are provided in table 1. The results demonstrate that both the earnings and unemployment variables exert a sizable and statistically significant effect on Army enlistments. In addition, the number of recruiters and national advertising expenditures are also important. The current unemployment rate, although possessing the right sign, is not statistically significant. This is not surprising because individuals would not be expected to respond immediately to an increase in unemployment, wishing to test the civilian job market first before enlisting in the military.

Equation 4 substitutes a pay *ratio* for the pay *difference* used in the other equations. While the ratio term is significant, the higher mean squared error demonstrates an inferior fit. This result is particularly interesting because most other studies use such a ratio as the pay variable. Equations 5 and 6 exhibit two of the Almon polynomial lags fit to the unemployment variable.[12] Neither quadratic distributed lag fits the data very well. The final regression includes only those variables which appear to be significant. Unemployment lagged two quarters is significant at the .10 level; all other variables meet the .05 significance test. The coefficients are quite stable across various specifications.

Table 1. Results of generalized least squares regressions of the determinants of military accessions, second-quarter 1977–second-quarter 1984

Equation	Intercept	Variable							Autoregressive parameter (p)	R^2	Mean squared error
		Unemployment rate			Civilian-military pay difference	Recruiter-to-population ratio	National advertising				
		Current	Lagged one period	Lagged two periods			Current	Lagged one period			
1	−48.4 (0.7)	—	3.11 (2.9)	2.18 (2.0)	−0.023 (3.0)	2.92 (2.8)	0.51 (2.8)	—	.70	.90	24.4
2	—	0.23 (0.23)	2.57 (2.70)	2.24 (2.23)	−0.028 (7.1)	2.09 (2.9)	0.52 (3.3)	0.24 (0.9)	.76	—	20.7
3	—	—	2.66 (3.2)	2.26 (2.3)	−0.028 (7.4)	2.15 (3.5)	0.52 (3.4)	0.23 (0.9)	.79	—	19.5
4	−4.18 (5.3)	—	3.65 (3.2)	2.01 (1.7)	[1]316.11 (2.5)	3.98 (4.0)	0.58 (2.9)	—	.61	.92	29.0
5[2]	—	0.23 (0.2)	2.62 (2.3)	1.99 (1.8)	−.028 (7.6)	2.30 (2.9)	0.47 (2.5)	—	.67	—	26.9
6[2]	—	0.30 (0.3)	2.50 (3.6)	[3]2.28/.35 (3.3/0.3)	−0.028 (7.5)	2.36 (2.8)	0.48 (2.6)	—	.67	—	26.8
7	—	—	2.73 (2.8)	[4]2.03 (1.9)	−0.028 (7.9)	2.33 (3.5)	0.47 (2.7)	—	.71	—	24.8

[1]Pay ratio.
[2]Quadratic Almon distributed lag equation.
[3]Coefficients and statistics for second and third lags.
[4]Significant at .10 level.
NOTE: t statistics in parentheses.

End-point elasticities have been calculated for each of the significant variables from equation 7. Unemployment, with an elasticity of .73 (for both lags combined), has a large impact on the level of contracts. For example, it is estimated that the fall from 17 percent to 16 percent in the unemployment rate for 16- to 21-year-old males would result in a decline of almost 600 GSM 1–3A contracts per quarter. The impact of changes in the unemployment rate is felt after a lag of one to two quarters.

The effect of military compensation is also significant. The pay elasticity based on equation 7 is 2.7, which implies that a military pay increase of approximately $115 will result in an increase of 390 GSM 1–3A contracts per quarter. It is interesting to note that the pay ratio in this study generates an elasticity of 2.1. This is comparable with other enlistment studies which find ratio elasticities of around 2.0.

The recruiter elasticity of .76 implies that 100 additional recruiters will induce 232 "high quality" potential recruits to enlist per quarter, or more than 9 per year per additional recruiter. Additional recruiters will yield more contracts from other recruit categories as well.

Finally, the national advertising elasticity of .044, based on an annual expenditure level of $45.6 million, implies that a $100,000 increase in expenditures per quarter should result in 5.6 additional graduate-senior male recruits per quarter. At this rate, the advertising cost to attract a single additional contract is $17,857. This number appears unduly high, but excludes the associated increase in contracts in other recruit categories.

Enlistment projections

The Army uses enlistment projections to set recruiting goals, allocate recruiting resources, and distribute recruits to various military occupational specialties. The forecasts provided here are generated assuming a constant pay differential and no changes in the number of recruiters per eligible male. Recruiting resources and goals did rise over fiscal 1984, and the projections reflect this recruiting policy change. The forecasts allow the civilian unemployment rate to fall to 6.3 percent by 1988, which is consistent with the August 1984 unemployment projections of the U.S. Congressional Budget Office. The predicted unemployment rate series for 16- to 21-year-old males is derived from forecasts of the total civilian rate, based on the past relationship between the two series. The rate for young males is therefore assumed to fall to 14.5 percent by 1988. Table 2 presents

Table 2. Quarterly Army enlistment contracts and accessions for graduate-senior (1–3A) males, 1984–first-quarter 1987

Calendar year and quarter	Contracts[1]	Accessions[1]
1984:		
I	13,469	13,776
II	12,809	16,116
III	15,920	9,916
IV	13,635	18,619
1985:		
I	13,714	12,891
II	13,666	12,846
III	13,636	12,818
IV	13,587	12,772
1986:		
I	13,530	12,718
II	13,472	12,664
III	13,416	12,611
IV	13,361	12,559
1987:		
I	13,308	12,563

[1]Entries for 1984 are actual numbers of contracts and accessions. All other entries are forecast estimates.

quarterly numbers of contracts and accessions for 1984 and forecasts for first-quarter 1985 through first-quarter 1987.

These results demonstrate the manpower problem facing the Army over the next several years. The forecast contract numbers do not adjust for the delayed entry program loss, which averages approximately 6 percent for graduate-senior males; some persons who sign a contract do not actually enlist when they are due to enter the Army. This effect is illustrated by the forecast accessions in table 2. Given the target of about 60,000 accessions per year for the next few years, the Army alone would be facing a shortfall which increases over time if no counteractive discretionary policies are implemented. Data from the U.S. Army Recruiting Command for fiscal 1984–86 illustrate the problem dramatically:

Fiscal year	*Predicted accessions*	*Accession goals*
1984	58,450	58,370
1985	51,154	57,300
1986	50,397	60,000

The delayed entry program creates a manpower pool which can be reduced when recruiting becomes difficult. Because recruits have some control over the length of the delay, accessions fluctuate relative to contracts from quarter to quarter. The increase in retention rates experienced by the Army in recent years may reduce the number of accessions needed to maintain the desired manpower levels in the future.[13] However, the latest reenlistment rates may indicate a reversal of this trend.

Error analysis. Because the model has been developed to generate forecasts of enlistment contracts, its forecasting properties are considered here. Because the model is estimated over 28 quarters, leaving only 21 degrees of freedom, relatively few back forecasts can be derived. One-quarter-ahead forecasts for five quarters (1983: II–1984: II) were generated, and the mean squared error calculated on the basis of percent changes over time. The error shares are then allocated among the regression, bias, and disturbance proportions.[14] A good forecasting model should have relatively little bias and regression error. If the actual numbers of contracts (A_t) are regressed on predicted values (P_t), the regression can be expressed as:

$$A_t = \alpha + \beta P_t$$

The bias proportion is zero if $\alpha = 0$, and the regression proportion is zero if $\beta = 1$. The disturbance proportion remaining is the random error in the regression. Because the forecast error is expressed in terms of percent changes over time, the root mean squared error provides a measure of error in percent terms. The error allocation is provided above:

Error type	*Proportion of total forecast error*
Regression	.123
Bias	.184
Disturbance	.693
Total	1.000
Root mean squared error	.028

The root mean squared error is 2.8 percent, well within the range of respectable forecast error. The majority of the error is disturbance error, as expected. The bias proportion is quite reasonable, despite the fact that the number of contracts peaked in first-quarter 1983 and began to decline in the next quarter. The bias proportion should fall even further given a longer forecasting horizon. However, the small number of degrees of freedom prevents using an extended forecast test. In any case, the low bias and regression error and the large disturbance proportion indicate that the forecast model is performing well.

These forecasts may perhaps be more accurately described as simulations. It is expected that the Army will, in fact, increase recruiting resources to meet the potential recruiting difficulties ahead. Therefore, the actual shortfall will most likely differ from current estimates. The latest data show that large increases in recruiting resources, in light of the projected shortfall for fiscal 1984, have indeed resulted in more enlistments. The projections in this report provide information on expected enlistment only if everything else (including relative pay and recruiting resources) is held constant, and if the economy continues strong with unemployment declining. While the number of recruiters and national advertising are the only recruiting variables in the model, it is likely that other variables such as the level of resources available to the recruiters, or pressure on recruiters to produce accessions, will influence the level of enlistment as well.

The aggregate time-series models are particularly useful for short-term projections and can be updated and estimated quickly and easily. In the long run, however, aggregation problems become important. Parameter estimates cannot be precise for this level of aggregation and must be used with caution for policy analysis. Our model does not control for competition from the other services, nor for the fact that many recruiting districts met or exceeded recruiting goals.[15] These factors may be significant, although experimentation with limited-information maximum-likelihood estimation incorporating the demand by other services in the time-series model did not yield satisfactory results. The possibility that the contracts are demand constrained is minimized by modeling "high quality" male contracts. Any such constraint would lead to a negative bias in the estimated coefficients. The contract projections become very tenuous when predicting more than several quarters into the future.

Conclusions

The U.S. Army could face serious recruiting problems throughout the remainder of the 1980's. The two primary causes of this shortfall would be economic gains and the continued decline in the population of eligible males. The model demonstrates that unemployment rates are an important determinant of peacetime enlistment, in contrast with many previous studies, and that military compensation relative to civilian earnings is of paramount importance to potential recruits. The recruitment shortfall can be reduced if appropriate manpower management policies are implemented. The number of recruiters is also significant, as are national advertising expenditures.

The model appears to fit the data well over the entire period, while the one-period-ahead forecasts for the four quarters of 1984 differ from actual contracts by between 1.5 and 3.0 percent. Of course, the forecasts are expected to be less accurate as the projections approach 1990, because they depend upon the state of the economy as well as military personnel policy. □

——*FOOTNOTES*——

[1] The characteristics of the Armed Forces are discussed in Carol Boyd Leon, "Working for Uncle Sam: a look at members of the armed forces," *Monthly Labor Review*, July 1984, pp. 3–9.

[2] *Projections of the Population of the United States, by Age, Sex, and Race: 1983 to 2080, Current Population Reports*, Series P–25, No. 952 (U.S. Bureau of the Census, 1984).

[3] A one-period model is described in Anthony C. Fisher, "The Cost of the Draft and the Cost of Ending the Draft," *American Economic Review*, June 1969, pp. 239–54.

[4] In a life-cycle framework the model becomes more complex. The impact of the enlistment decision on future income must be considered. Training and educational opportunities may have little effect on current wages, but are reflected in future income. The life-cycle model thus provides a more realistic approach to the enlistment problem. See David K. Horne, *An Economic Analysis of Army Enlistment Supply*, Technical Report 85–4 (Alexandria, VA, Army Research Institute, 1985).

[5] Examples include Lee D. Olvey, James R. Golden, and Robert C. Kelley, *The Economics of National Security* (Wayne, NJ, Avery Publishing Group, 1984); Richard L. Fernandez, *Forecasting Enlisted Supply: Projections for 1979–1990* (Santa Monica, CA, The Rand Corp., 1979); and Colin Ash, Bernard Udis, and Robert F. McNown, "A Military Personnel Supply Model and Its Forecasts," *American Economic Review*, March 1983, pp. 145–55. For a critique of Ash and others, see Charles Dale and Curtis Gilroy, "Enlistments in the All-Volunteer Force: Note," *American Economic Review*, June 1985.

[6] Insignificant unemployment effects are found in Lawrence Goldberg, *Enlisted Supply: Past, Present, and Future* (Alexandria, VA, Center for Naval Analyses, 1982), as well as in Ash and others, "A Military Personnel Supply Model," and Fernandez, *Forecasting Enlisted Supply*.

[7] See Charles Dale and Curtis L. Gilroy, "The Effects of the Business Cycle on the Size and Composition of the U.S. Army," *Atlantic Economic Journal*, March 1983, pp. 45–53.

[8] Problems with the teen wage series are discussed in Charles Brown, *Military Enlistments: What Can We Learn From Geographic Variation?* Working Paper 1261 (Cambridge, MA, National Bureau of Economic Research, Inc., January 1984). An extract appears in the *American Economic Review*, March 1985, pp. 228–34.

[9] For example, Dale and Gilroy, "The Effects," use a 2-month lead on pay to obtain the correct sign.

[10] The advertising expenditure data, as well as the contract and recruiting data, were provided by the U.S. Army Recruiting Command.

[11] Simultaneity is a potentially serious problem, specifically between the male population statistic in the denominator and independent variables such as civilian earnings and unemployment. However, the time horizon covered in the estimation (7 years) is relatively short, and the variation in the size of the male population during the period is small. This simultaneity is likely to be more of a problem in the long run if the decline in the male population age 16 to 21 begins to exert downward pressure on unemployment and upward pressure on age-specific wages. For short-run prediction and modeling, one would expect the effect of changes in the cohort size to have a small effect on age-specific unemployment and wages. The wage effect is estimated by Hong W. Tan and Michael P. Ward, *Forecasting the Wages of Young Men: The Effects of Cohort Size* (Santa Monica, CA, The Rand Corp., 1984).

[12] The Almon polynomial technique may be briefly described as follows: If the current value of the dependent variable, y_t, depends upon both current and past values of an independent variable x, the distributed-lag regression model can be written:

$$y_t = \beta_0 x_t + \beta_1 x_{t-1} + \cdots + \beta_k x_{t-k} - u_t$$

Least squares estimation of the model loses k degrees of freedom, and the x's exhibit multicollinearity. Some structure can be imposed on the β's, such as a quadratic polynomial where $\beta_l = \alpha_0 + \alpha_l i + \alpha_2 i^2$. Substituting for the β's, the regression model is $y_t = \alpha_0 z_{0t} + \alpha_l z_{lt} + \alpha_2 z_{2t} + u_t$, where $z_{0t} = \Sigma_{i=0}^{k} x_{t-i}$, $z_{lt} = \Sigma_{i=0}^{k} ix_{t-i}$, and $z_{2t} = \Sigma_{i=0}^{k} ix_{t-l}^{2}$. The y_t is regressed on the constructed z variables. The estimated α's are then used to derive the β's. For more information, see G.S. Maddala, *Econometrics* (London, McGraw–Hill International Book Co., 1977), pp. 355–59.

[13] This is suggested by James R. Hosek, Richard L. Fernandez, and David W. Grissmer, *Active Enlisted Supply: Prospects and Policy Options*, mimeo (Santa Monica, CA, The Rand Corp., 1984).

[14] Henri Theil, *Applied Economic Forecasting* (Amsterdam, North Holland Publishing Co., 1966).

[15] The impact of the recruiting of other services is significant in the pooled time-series model in Thomas V. Daula and D. Alton Smith, "Estimating Enlistment Models for the U.S. Army," in Ronald G. Ehrenberg, ed., *Research in Labor Economics*, vol. 7 (Greenwich, CT, JAI Press Inc., forthcoming 1985).

Establishment survey incorporates March 1984 employment benchmarks

JOHN B. FARRELL

With the release of data for May 1985, the Bureau of Labor Statistics introduced its annual revision of national estimates of employment, hours, and earnings from the monthly survey of establishments. These revisions are based on March 1984 benchmark employment counts, the most recent available. As is the usual practice with the introduction of updated benchmarks, the Bureau has also revised the seasonally adjusted series for the previous 5-year period and has introduced new seasonal adjustment factors.

Adjustment procedure. Monthly employment estimates from the establishment survey are based on information provided by a sample of establishments. Each year, the "bench-

John B. Farrell is an economist in the Division of Monthly Industry Employment Statistics, Bureau of Labor Statistics.