The Effect of Employer-Sponsored Education on Job Mobility: Evidence from the U.S. Navy

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We examined the impact of employer-sponsored part-time college education on job mobility, using the case of the Tuition Assistance (TA) program of the U.S. Navy. We used two modeling approaches—a bivariate probit model of job mobility and TA usage that accounts for the endogeneity of TA usage, and a propensity score model. The results from both models showed that TA usage significantly decreases the probability of staying in the Navy.

Introduction

Educational assistance is a common employment benefit. Over 40 percent of full-time employees in the private industry are offered job-related educational assistance (Bureau of Labor Statistics 2003). Estimates of the prevalence of assistance for general education vary. A survey by the Bureau of Labor Statistics (2003) reports that 11 percent of full-time employees are offered assistance for general education. However, several surveys involving large employers found 80 percent or more of employers offering assistance for general education (Society for Human Resource Management 2002; Bureau of National Affairs 1992; International Foundation of Employee Benefit Plans 2000).

From the worker's perspective, employer-sponsored education has several potential benefits, including better promotion and earnings opportunities within the firm, and a higher probability of finding a better job in another firm. In support of this, several studies of young adults have shown substantial economic returns to college attendance even if that attendance is on

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a part-time basis at a community college (Kane and Rouse 1995; Leigh and Gill 1997).[1]

From the firm's perspective, the incentive to provide employer-sponsored education is not as clear, especially if the education is general. While educational opportunities may increase worker productivity and morale, these opportunities may also increase the possibility that workers leave the firm for better jobs. *A priori*, the effect of employer-sponsored education on job mobility is ambiguous, and must be empirically determined. However, there is virtually no research examining the impact of employer-sponsored general education on job mobility among civilians. We know of only one study that examines the relationship between employers offering a tuition assistance plan and employee turnover. This study found that tuition assistance reduces employee turnover. However, this study was conducted at the firm level and measured employer offers of education assistance rather than actual use of assistance by employees (Cappelli 2002). In this paper, we examine the impact of employer-sponsored part-time college education on job mobility, using the case of the Tuition Assistance (TA) program in the U.S. Navy.

Background

The TA program offers active-duty military members the opportunity to enroll in college courses at a subsidized cost. TA courses reflect a broad range of academic disciplines and are not a part of direct military job training. In 2000, active-duty military members enrolled in nearly 646,000 college classes under the TA program. TA courses are provided through a network of accredited colleges that agree to offer courses on individual military bases. Military members enroll in a standard university curriculum, and the service branches reimburse the member for 75 percent of their tuition expenses, or up to \$187.50 per semester hour. Annual assistance is capped at \$3500 per member per year.[2] Beginning in October 2002, the TA program covered 100 percent of tuition expenses. The total cost of TA in 2000 was \$157.3 million.

TA course offerings span a broad range of academic disciplines and are not intended to substitute for direct military job training. TA is intended to provide off-duty opportunities for service members to enhance their general

[1] For a review of the theoretical and empirical on-the-job training literature, see Barron, Berger, and Black (1997).

[2] In special circumstances, the TA program increases aid to 100 percent of tuition costs. The Navy covers all course costs for sailors on ships at sea as part of the Program for Afloat College Education (PACE). The services also pay all costs when members are serving in contingency areas like Bosnia, Kosovo, and Afghanistan.

academic skills. College-level instruction may broaden a member's skills and contribute to their success in the military. Indeed, members receive credits towards future promotions for completing college courses.

The military services have provided some form of tuition reimbursement for off-duty education since 1948 (Anderson 1991). In early Congressional testimony, a Department of Defense official explained that the education program was designed so service members could "(1) improve their value to the service; (2) have an opportunity to continue civilian education while in the service; and (3) make profitable use of their spare time" (Anderson 1991).

Providing TA is likely to enhance the ability of the services to attract high quality recruits (Acemoglu and Pischke 1998; Autor 2001; Cappelli 2002). Service advertising campaigns herald education opportunities available through the military that include vocational training, college courses while in the service (tuition assistance), and educational benefits to cover post-military educational expenses. In the 1999 Active Duty Survey, about 62 percent of military members claim that education benefits and opportunities were a primary reason they joined the military. The survey data does not distinguish between the importance of in-service and post-service education opportunities, but the results do show the strong educational interest of incoming members.

Employers' incentive to provide assistance for general education also depends on the organization of work and the perceived costs and benefits of education for different types of workers within the institution. Olson (2003) found higher levels of training for skilled, mid-career workers, probably because these workers are likely to have the highest productivity gains from training. However, the institutional structure in the military may increase incentives to offer general education to young workers relative to civilian employers. Since the military only hires workers at the start of their careers, and does not have any system of lateral entry for experienced workers, the military may have a higher incentive to invest in early-career workers. Furthermore, the greater weight on team production and morale in the military may also increase incentives to provide general education (MacDuffie and Kochan 1995; Olson 2003).

Conceptual Issues

The effect of TA usage on retention in the Navy is theoretically ambiguous. TA usage may increase members' civilian opportunities or spur their interest in leaving the military to become a full-time students. Since TA courses comprise of general education, human capital theory suggests that the return from this education should accrue to the individuals who possess the education rather than to the Navy (Becker 1993). If the Navy chooses not to pay service-members a higher wage equivalent to the increase in their marginal product after taking TA courses, service-members may choose to leave the Navy and seek civilian employment at a competitive wage. Because the military wage structure is possibly more rigid than competing civilian wages (Department of Defense 1996), the military may not match the civilian competitive wage. Under the signaling model of education, individuals with high ability take courses to signal their ability level to civilian employers, and therefore may be able to obtain good jobs outside the military that would cause them to leave the Navy.

On the other hand, human capital theory suggests that TA usage may improve service members' job performance within the Navy, and therefore increase promotion opportunities and job satisfaction. The signaling theory of education suggests that TA courses may be a way for service members to signal high ability with the military. In fact, college courses are a requirement for some promotions in the Navy, and therefore taking courses is also likely to increase wages within the military. Individual college courses obtained through Navy-sponsored general education may not be easily interpreted by other employers (Katz and Ziderman 1990), especially if the service member has not completed a degree program. The Navy may be more aware of the content of TA courses and therefore, may be in a better position to interpret the value of TA courses. Furthermore, if there is an interaction between the content of general education and firm specific knowledge, the human capital productivity effect from general education may be higher for the Navy than for other employers (Olson 2003). Therefore, both the human capital and the signaling theories of education suggest that the effect of TA on mobility is ambiguous. It is unclear if the productivity gain or the signaling value of TA is greater in the Navy or in the civilian world, and therefore must be determined empirically.[3]

Another issue is that the GI Bill provides benefits to cover college expenses after military service. Therefore, service-members do not need to stay in the military to avail themselves of in-service educational assistance—they can leave the military and attend school (either full- or part-time) using their GI Bill benefits. Despite the availability of GI Bill benefits, TA benefits are still valuable since they allow service members to acquire education while still in the Navy, and therefore minimize possible transitions after

[3] While there is a large literature that estimates the effect of college education on civilian earnings, there is no work that provides similar estimates for the military. Kilburn and Goldman (2001) have conducted the only study of the determinants of military compensation. They note that while there are military pay tables that determine compensation at various levels of experience in the military, these tables do not show how compensation varies holding other factors constant.

leaving the Navy. However, it is possible that the availability of GI Bill benefits may reduce service members' propensity to take TA courses if they decide to wait until they leave the Navy to obtain further education.

Estimating the effect of TA usage on job mobility is complicated by the potential endogeneity of TA usage. TA users may be inherently predisposed to stay or leave their jobs irrespective of their participation in the program. Therefore, the underlying effect of TA usage on job mobility can only be disentangled by jointly modeling both TA usage and mobility.

Earlier work has found that the TA program significantly reduces the probability of leaving the military (Boesel and Johnson 1988; Garcia and Joy 1998; Garcia, Arkes, and Trost 2002). However, estimates from these studies are biased because they did not adequately control for the unequal length of time that stayers and leavers were eligible to use TA. Leavers are in the military for substantially less time and inherently less likely to use TA than were similar stayers, because they are eligible for fewer months. The authors incorrectly infer that TA users are more likely to stay than nonusers, but the data are simply showing that leavers have more opportunity to use TA. We reestimated these models and showed that TA users were consistently less likely to remain in the military than nonusers, when both groups were eligible for TA for equal periods of time (Buddin and Kapur 2002).

In addition, Boesel and Johnson (1988) do not account for the endogeneity of TA usage. If high ability service members were more likely to take TA and to stay in the military, we would expect a positive bias in the effect of TA usage on retention. While Garcia and Joy (1998) and Garcia, Arkes, and Trost (2002) do attempt to account for endogeneity, their identification strategy is problematic.[4]

This study improves on the previous literature by using two models for the analysis. One is a bivariate probit model of TA usage and the propensity to quit. This model directly accounts for the endogeneity of TA use. The second model uses the "propensity score" approach to compare the job mobility for those who use TA with a similar group of service personnel who did not use the program. The two models complement each other and make the overall results more robust. The results from this study are of clear relevance to the military, as it plans to expand its existing TA program. In addition, this study also provides a unique opportunity to understand the likely impact of employer-sponsored education in the broader civilian context.

[4] Garcia and Joy (1998) and Garcia, Arkes, and Trost (2002) used an instrumental variable approach to address the endogeneity of TA usage. In both studies, the instrument used was an indicator variable for whether the sailor participated in academic counseling on a ship. Most likely, this instrument is itself endogenous, biasing any estimates obtained using this strategy.

Empirical Methodology

Ideally, the effect of TA usage on job mobility could be measured in a controlled experiment where members were randomly assigned eligibility for TA. This approach would isolate program effects, but an experiment is not feasible in this case where the Navy has an ongoing TA program. We developed two models that allowed us to estimate the effect of TA on job mobility—the bivariate probit model and the propensity score model.

The bivariate probit model and the propensity score model are based on different assumptions. The bivariate probit model relies on assumptions about the distribution of the data and the validity of instrumental variables. The propensity score approach depends less on distributional assumptions, but rather conditions on observable factors. A limitation of the propensity score approach is that it does not account for unobservable factors in the decision to use TA (Rosenbaum 2002). Using both the propensity score and the bivariate probit method verifies the robustness of our results to the assumptions implicit in the two models.

The analysis focused on Navy enlistees who have successfully completed their initial contracted term, which lasts 4 years, and are deciding whether to stay or leave the Navy. We refer to this decision as the decision to "quit" or "stay" in the Navy. Members were excluded from our analysis if they were involuntarily separated from the Navy without completing their contracted commitment. The decision to stay in the Navy at the end of the term is modeled as a function of TA usage over the full enlistment period prior to the quit decision point (the end of the initial enlistment) as well as various demographic and military characteristics. This approach avoids the problems in previous research where the period of eligibility for TA usage differed across individuals in the analysis.

In this analysis, we measured TA usage with an indicator variable for whether or not a service member took any courses. An alternative measure for TA usage is the number of TA credits earned during enlistment. We found that the TA usage indicator variable was sufficient for the analysis, because few members accumulated many credits.[5] Among TA users, the median number of credits earned was 6 semester hours.[6]

[5] Signaling models of education place a greater emphasis on the value of a degree ("sheepskin" effect) than human capital models that do not incorporate discontinuities in the value of education. Given the relatively low course taking in the TA program, the human capital theory may be more applicable than the signaling model for the TA program, however it is not possible to use our empirical framework to test between these models.

[6] An alternative model where TA was measured by the number of credits also yielded a negative and statistically significant effect of TA on retention. The magnitude of this effect was consistent with the magnitude of the reported effect for taking any TA courses.

Bivariate Probit Model

We used a bivariate probit model to jointly estimate the factors that influence both TA usage and job mobility in a two-equation framework. This framework accounts for the endogeneity of TA usage. This bivariate probit model is an extension of the "instrumental variable" approach to the case where both outcome variables (job mobility and tuition assistance participation) are dichotomous variables.[7] The two-equation model is estimated jointly and simultaneously using maximum likelihood. Assuming the instrumental variables used in the TA equation are truly exogenous shifters of TA usage, the bivariate probit model will provide an estimate of the effect of TA on retention in the Navy that is uncontaminated by self-selection effects or unobserved ability bias. The model consists of a TA usage equation and a "stay" equation. The probability of TA usage is:

$$TA_i^* = \beta_1 X_i + \delta Z_i + \varepsilon_{1i} \tag{1}$$

where the individual's tendency to take a tuition assistance course (denoted by TA_i^*) is modeled as a function of a (column) vector of observed variables, X_i, a (row) vector of unobserved parameters β_1, a set of instrumental variables, Z_i and their corresponding parameters δ, and an unobserved random error ε_{1i}. The explanatory variables in X_i include the service member's demographic characteristics such as age, sex, race, marital status, education, and Armed Force Qualification Test (AFQT) score categories.[8] X_i also includes variables on the service members' occupation and months deployed during the year. Demographic factors measure the expected benefits and costs from college attendance, and therefore, may affect TA usage. For example, human capital theory would suggest that younger service members might have relatively more to gain by investing in education. Married service members are likely to have family commitments that increase the costs of attending college. Service members with higher scores in AFQT and in skilled occupations have higher ability, and therefore may gain relatively

[7] An alternative to the bivariate probit model is a two-stage approach where predictions from a TA usage probit equation are used as the independent variable in the retention equation. This approach provides very similar estimates to the bivariate probit model. However, the bivariate probit model provides more efficient estimates by jointly modeling TA and retention. Another alternative to the bivariate probit model is a two-stage least squares model that models both TA usage and staying in the Navy as linear probability models. Since the linear probability model is particularly likely to be biased and inconsistent when the frequency of the dependent variable is low, as is the case with the proportion of TA usage, the bivariate probit model is more suitable to our estimation than the two stage least squares approach (Horrace and Oaxaca 2003).

[8] AFQT is scored on a percentile scale based on a nationally representative sample of American youth. AFQT categories are based on ranges of the AFQT percentile score.

more from education and may find it less burdensome. Deployment and assignment to a ship is likely to reduce TA usage because of the lack of opportunities to take TA courses. Z_i denotes the instrumental variables that are excluded from the mobility equation, since these variables have no direct effect on job mobility and affect mobility only indirectly through their effect on TA usage. The subscript i denotes an individual. The latent variable, TA_i^* is a continuous measure of the tendency to take tuition assistance courses, but we observe only whether a course is taken, so the observed variable, TA_i, is truncated as a zero-one variable:

$$TA_i = \begin{cases} 1 & \text{if } TA_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

The probability of staying in the Navy is modeled as a function of the same set of X variables and TA usage. The probability of staying is a latent (i.e., not directly observed) random variable. The individual's probability of staying denoted by S_i^*, is modeled as a function of a (column) vector of observed variables, X_i, a (row) vector of unobserved parameters β_2, an indicator variable that denotes whether or not the individual took a tuition assistance course, TA_i and its corresponding parameter γ, and an unobserved random error ε_{2i}.

$$S_i^* = \beta_2 X_i + \gamma TA_i + \varepsilon_{2i} \tag{3}$$

The variable S_i^* is a latent variable that measures the probability of staying. However, we only observe the action of staying, so the observed variable, S_i, is truncated as a zero-one variable:

$$S_i = \begin{cases} 1 & \text{if } S_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

The instrumental variables, Z, in this model include several factors that affect TA usage and have no direct effect on job mobility. In our model, we rely on two sets of instrumental variables.

The first instrumental variable is access to college before enlistment. We expect that some members have a stronger interest in college education than others. The literature on college attendance suggests that individuals growing up near a 4-year college are more likely to attend college than those who live far from a college (Card 1993; Rouse 1994; Kane and Rouse 1999). Individuals who grew up near a college may have a stronger interest or expectation in attending college (on average) than other individuals. They may also be more informed about the benefits of a college education. On the other hand, service-members who grew up next to a college, yet decided to join the military rather than go to college may be a subgroup that has demonstrated a low interest in college education. Alternatively, these individuals may have a preference for college, but may be financially constrained. While the effect is theoretically ambiguous, on net, we expect that military members who grew up near a college may have a stronger interest or expectation in attending college (on average) than other members. The TA usage equation includes a measure of the distance between the members' home when they joined the military and the nearest 4-year college to capture the effect of these possible differences in "tastes" for college education.

The second instrumental variable is educational opportunities at their military base. Military members have little choice about their base assignment and are probably unfamiliar with college course availability until they arrive at their assignment. If course availability is greater, we expected that members would be more likely to enroll and use TA. There is no corresponding reason to expect course availability to have a direct effect on mobility. The TA usage equation included a measure of the number of college course offerings at each member's base. We also included the interaction of base size and the number of courses offerings at the base as an instrumental variable. We included base size as a control variable in both the TA and the quit equation. The interaction of base size and course offerings captures service-members' potential peer group at TA classes. Following the existing literature on the effect of peer groups on educational attainment (Feinstein and Symons 1999; Hoxby 2000; Robertson and Symons 2003), we expected a larger peer group to increase the incentive to take TA courses.[9] However, we do not expect this interaction to have a direct effect on retention in the Navy.

The empirical validity of the instruments rests on the instruments being significant determinants of decision to take TA courses but not of the decision to stay in the Navy. Several studies in the literature have implemented bivariate probit models to account for endogeneity when the dependent variable and the endogenous variable in the model are binary. For example, Evans and Schwab (1995) and Neal (1997) both estimated the effect of Catholic schooling on educational performance using bivariate probit models. We have followed the tests used in these papers to verify that our instruments are valid. First, a joint test of significance of the three instruments in a probit model of the decision to take tuition assistance is $\chi^2(3) = 13$ with $P = 0.005$ [$\chi^2(3) = 19$ with $P = 0.0003$ without a clustering correction by base for the standard errors] confirming that the instruments

[9] An alternative instrumental variable that measures the number of Navy service-members taking courses at each base provides similar results—a marginal effect of −14% for the effect of TA on retention. We did not use this instrument in our main analysis because of the possible biases involved in using an aggregate measure of the dependent variable as an instrument (Manski 1993).

are good predictors of the tuition assistance. Even though one of the instruments, number of courses, is not individually statistically significant, the interaction of number of courses with the size of the base is statistically significant ($P = 0.03$) in the probit model for tuition assistance. Second, a test for the joint significance of the instruments in a linear probability model for tuition assistance also confirmed that the instruments are good predictors of tuition assistance (F-statistic = 11, $P = 0.003$ with the clustering correction by base; F-statistic = 18, $P = 0.0005$ without the clustering correction by base). Third, an informal test for the exclusion of the instruments from the "stay in the Navy" equation is based on including the instruments in the probit model for staying in the Navy that includes TA usage. In this model, valid instruments should be jointly insignificant. We conducted this test, and confirmed that the three instruments were jointly and individually statistically insignificant in this model with $\chi^2(3) = 1.7$ and $P = 0.64$. The three instruments were also individually insignificant in this specification. They were also insignificant when included individually in the probit stay model (P values = 0.37, 0.26, and 0.35 for each instrument individually). Fourth, we conducted over-identification tests for the instruments and found that we could not reject any of the three instruments based on these tests. Estimates from alternative versions of the bivariate probit model that included only the base-specific instruments or the individual specific instruments gave very similar estimates of the effect of TA. These tests confirmed that the instrumental variables used in the bivariate probit model were valid.

The vector of explanatory variables, X_i, included the same variables as those in the TA equation. We expected older service-members to be more likely to be committed to a Navy career. Married service-members with children may have less time to search for civilian jobs. Furthermore, the military provides higher compensation for married service-member, suggesting they should be more likely to stay in the military. Service-members with high ability (measured by AFQT score, education, and occupation) would be more likely to leave the military if the civilian return for their skills is higher than the return in the military.

We made a number of stochastic assumptions in order to estimate the bivariate probit model. In particular, we assume that ε_1 and ε_2 are jointly bivariate normal with zero means and variance covariance matrix:

$$\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{bmatrix} \tag{5}$$

that is, $V(\varepsilon_1) = \sigma_{11} = 1$, $V(\varepsilon_2) = \sigma_{22} = 1$, and $\mathrm{cov}(\varepsilon_1, \varepsilon_2) = \sigma_{12} = \rho$. Notice that the variance of ε_1 and ε_2 are normalized to one since the scale of S_i and TA_i are not observed. As a result, $\sigma_{12} = \rho$.

We can estimate the two-equation system under these stochastic assumptions using a bivariate probit maximum likelihood model. The likelihood function is given by:

$$L = \sum_{i=1}^{n} \ln \Phi_2(q_{1i}\xi_{1i}, q_{2i}\xi_{2i}, \rho_i^*) \tag{6}$$

where

$$q_{1i} = 2S_i - 1, \tag{7}$$

therefore, for a stayer $q_{1i} = 1$, and for a separator $q_{1i} = -1$,

$$q_{2i} = 2TA_i - 1, \tag{8}$$

and similarly for a course taker, $q_{2i} = 1$, and for a nontaker $q_{2i} = -1$, and

$$\xi_{1i} = \beta_2 X_i + \gamma TA_i, \tag{9}$$

from the "stay" equation,

$$\xi_{2i} = \beta_1 X_i + \delta Z_i, \tag{10}$$

from the TA equation, and

$$\rho_i^* = q_{1i} q_{2i} \rho \tag{11}$$

Note that Φ_2 is used to denote the cumulative density function of the bivariate normal density.

The model can be summarized by four regimes depending on whether the individual takes a TA course or not and whether the individual stays or not, as shown in Table 1.

Maximization of this bivariate probit maximum likelihood function yields consistent, asymptotically efficient estimates of the model coefficients and the covariance matrix. The correlation between the errors in the two equations, ρ, can be interpreted as the interdependence of the unobserved components in the tuition assistance and the mobility equations.

Because of the nonlinear nature of the bivariate probit maximum likelihood model, interpretation of the coefficients is not as straightforward as with linear models. For the continuous variables such as age and months deployed, we report partial derivatives to aid interpretation. The partial derivatives can be interpreted as the effect of a one-unit increase in the X variable on the outcome variable being considered. For binary variables, such as TA in the stay equation, we used the model coefficients to predict the average rate of staying in the sample after TA is set to one for the full sample. Next, we predicted the average rate of staying in the sample when TA is set to zero for the full sample. The difference

TABLE 1

Summary of Model Regimes

Regime	Event in terms of ε_1 and ε_2	Probability
Stay and TA	$\varepsilon_{1i} < \xi_{1i}$, $\varepsilon_{2i} < \xi_{2i}$	$\Phi_2(\xi_{1i}, \xi_{2i}, \rho)$
Quit and TA	$\varepsilon_{1i} < -\xi_{1i}$, $\varepsilon_{2i} < \xi_{2i}$	$\Phi_2(-\xi_{1i}, \xi_{2i}, -\rho)$
Stay and no TA	$\varepsilon_{1i} < \xi_{1i}$, $\varepsilon_{2i} < -\xi_{2i}$	$\Phi_2(\xi_{1i}, -\xi_{2i}, -\rho)$
Quit and no TA	$\varepsilon_{1i} < -\xi_{1i}$, $\varepsilon_{2i} < -\xi_{2i}$	$\Phi_2(-\xi_{1i}, -\xi_{2i}, \rho)$

Notation:

ε_1 and ε_2 are jointly bivariate normal errors from the TA and the TA equation with zero means $\text{cov}(\varepsilon_1, \varepsilon_2) = \rho$.

Φ_2 denotes the cumulative density function of the bivariate normal density.

From the "stay" equation: $\xi_{1i} = \beta_2 X_i + \gamma TA_i$, and from the "stay" equation: $\xi_{2i} = \beta_1 X_i + \delta Z_i$ where independent variables are X_i and instrumental variables are Z_i.

between these two rates of staying was interpreted as the effect of TA on mobility.

Propensity Score Model

We used a propensity score model as an alternative estimation strategy to measure the effect of TA usage on mobility. This statistical methodology compares the mobility behavior for a TA user with that for a matched nonuser (Rosenbaum and Rubin 1985; Angrist 1997; Heckman, Hichimura, and Todd 1997; Angrist 1999; Dehejia and Wahba 1999; Hirano, Imbens, and Ridder 2000; Ichimura and Taber 2001). The propensity score approach attempts to replicate an experimental design by comparing mobility for otherwise very similar individuals. Individuals are aligned based on their predicted probability of using TA and each user is matched with a nonuser with a similar probability of using TA. This matching of users and nonusers balances the two groups on the observed factors that affect TA. Only about 10 percent of members use TA during their first term, and we may expect that many nonusers are unlikely to take a college class (e.g., they have long deployments or low levels of education). These expected differences in TA users and nonusers suggest that the full set of TA nonusers is an inappropriate comparison group for TA users. The propensity score matching approach addresses this issue by linking observations with similar probabilities of using TA.

The model is estimated in two steps. The first step estimates the probability of TA usage as a function of demographic characteristics, military environment, proximity to a 4-year college at accession, and number of college course offerings at the member's base. This is the same as the first equation in our bivariate probit model. From this equation, we predict the probability of TA usage based on each individual's X and Z variables. This prediction is called the propensity score. For each TA user, we find the nearest available nonuser in terms of the propensity score. Finally, using the matched sample, we estimate the probability of staying as a function of the X variables and TA usage. The estimated effect of TA usage on staying is the coefficient of the TA variable in this stay equation.

The propensity score approach has two advantages over the bivariate probit model. First, the propensity score approach does not require valid instrumental variables.[10] Second, this approach does not make functional form restrictions on the error term correlation in the TA usage and stay equations. The disadvantage of the propensity score method is that it conditions only on observed differences between TA users and nonusers. If these groups differ systematically in some unmeasured factors that affect job mobility, then the propensity score method might be misleading. The bivariate probit model is better suited to handing correlations in unobserved factors between the two equations. By using two different methodologies, the propensity score approach and the bivariate probit joint model, we are able to evaluate whether our estimates of the effect of TA usage on job mobility are robust to the estimation approach.

Data

Our analysis is based on the first-term job mobility decisions of enlisted personnel in the Navy during FY 1997 and the first half of FY 1998. We focused on mobility at completion of the first-term for several reasons. First, we expected the pattern of TA usage may differ during the first-term from that later in the career. Second, we believed that TA usage is likely to have the largest effect on mobility for first-term members who may be in the process of choosing long-term careers. Therefore, we restricted our analysis to individuals who had successfully completed their first term and were considering staying for a second term.

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[10] We have also implemented an alternative estimation strategy proposed by Altonji, Elder, and Taber (2002) to test for the role of endogeneity in a bivariate probit model when there are no plausible instruments. This paper proposes an informal way to bound the extent of selection bias by estimating the bivariate probit model under the assumption that the selection in the observable variables is equal to selection in unobservable variables. Using this methodology, we find that the effect of tuition assistance on staying in the Navy continues to be negative and statistically significant, and in fact, increases in magnitude relative to the estimates reported in the paper.

The analysis file consisted of two main components: personnel records for Navy enlistees, and course records for each course enrollment of a sailor. We merged this information and some information from other sources to build our analysis file.

The personnel data file is maintained by the Defense Manpower Data Center (DMDC) and provides a month-by-month record of members during their enlistment term. The file contains information on service members' demographics, occupation, service history, and overseas deployment. The data also include information on the number of months remaining in the service-member's enlistment term, and whether or not the service member quits. We constructed annual measures of hostile and nonhostile deployment based on pay information (Hosek and Totten 1998). The deployment information is especially pertinent to our analysis, since work responsibilities make it difficult for members to take college courses during deployments.

The second data source used in our analysis is the course enrollment and completion data from the Navy Campus Management Information System (NCMIS). Using the enlisted service-members' social security number, we merged the DMDC and the NCMIS data to create the analysis database.

We added several other variables to the database. First, we merged information on the number of courses offered at the service members' current base. Second, using the service members' zip code before enlistment, we merged information on the service members' proximity to a 4-year college before enlistment in the Navy.

Our sample means show that about 33 percent of Navy enlistees stay after the end of their first enlistment term. Overall TA usage rate is 10 percent in the Navy. Comparing average probabilities of staying in the Navy between TA users and nonusers (without adjusting for control variables), TA users are 2 percentage points less likely to stay than nonusers.

Results

Table 2 presents the results from the bivariate probit model for the Navy.

Effect of TA Usage on Job Mobility. The results showed that TA users are less likely to stay than similar nonusers. Specifically, the probability of staying in the Navy at the end of the first term is 16.5-percentage points lower for sailors participating in TA than for other sailors. While TA may be an important recruiting incentive, our result suggests that TA users are prone to leave the Navy for civilian employment or schooling opportunities.

TABLE 2

BIVARIATE PROBIT MODEL RESULTS FOR TUITION ASSISTANCE USAGE AND THE PROBABILITY OF STAYING IN THE NAVY

	Tuition assistance usage		First-term retention		
Characteristic	dF/dX	Standard error	dF/dX	Standard error	Mean
Tuition assistance usage			−0.1653*	0.0408	0.0996
Age	0.0014	0.0007	0.0092*	0.0012	23.8702
Female	0.0703*	0.0082	0.0264	0.0146	0.1433
Black	−0.0042	0.0037	0.1961*	0.0094	0.1860
Hispanic	0.0236*	0.0051	0.0653*	0.0101	0.1044
Asian/Pacific islander	0.0295*	0.0083	0.1939*	0.0151	0.0380
AFQT 93–99 percentile	0.0609*	0.0106	0.0557*	0.0157	0.0253
AFQT 65–92 percentile	0.0369*	0.0047	0.0089	0.0059	0.3294
AFQT 50–64 percentile	0.0165*	0.0037	0.0031	0.0055	0.2537
Non-High school graduate	−0.0183	0.0101	0.0521*	0.0234	0.0122
GED	−0.0271*	0.0093	0.0069	0.0188	0.0153
Alternative education credential	−0.0084	0.0084	0.0249	0.0228	0.0252
Some college	−0.0176*	0.0071	−0.0541*	0.0196	0.0176
Single parent	−0.0358*	0.0042	0.0953*	0.0166	0.0599
Married parent	−0.0450*	0.0033	0.1335*	0.0209	0.1186
Married nonparent	−0.0220*	0.0039	0.0958*	0.0151	0.2673
Joint military couple	0.0054	0.0086	0.0528*	0.0176	0.0279
Skilled technical	0.0409*	0.0053	0.1824*	0.0118	0.2469
Support and administration	0.0684*	0.0059	0.1911*	0.0104	0.1244
Electrical/mechanical	−0.0054	0.0036	0.0708*	0.0128	0.3169
Craftsmen, service, and supply handlers	−0.0025	0.0076	0.1007*	0.0121	0.0981
Number of deployments in the past 2 years	−0.0142*	0.0038	0.0190*	0.0065	1.4431
Months deployed in the past 2 years	−0.0001	0.0008	−0.0036	0.0021	5.5604
Lives in off-base housing	0.0238*	0.0045	0.0049	0.0105	0.3390
Retention decision in FY97	−0.0022	0.0030	−0.0001	0.0060	0.7585
Stationed overseas	0.0577*	0.0145	0.1084*	0.0324	0.0273
Assigned to a ship	−0.0600*	0.0121	−0.0465*	0.0199	0.7223
Size of base (logarithm of enlisted/10,000)	−0.0162*	0.0038	−0.0144*	0.0041	0.2141
Distance from pre-Navy home to a 4-year college	−0.0002*	0.0001			21.2623
Number of courses at base	−0.0002	0.0005			9.1319
Number of courses at base*size of base	0.0006*	0.0003			4.4678
Proportion staying at end of first term					0.3273
Correlation (ρ)			0.1666*	0.0825	
Sample size					32,712

NOTES: The estimated effects (dF/dX) correspond to changes in the probability relative to the excluded reference category for discrete variables and the derivative of the probability for continuous variables. Entries with asterisks are associated with coefficients that are significant at the $\alpha = 0.05$ confidence level.

The reference categories for demographic variables in the model are male, white non-Hispanics, test category below 50th percentile, high school diploma graduate, and single with no children. The reference groups for military characteristics are combat arms occupation, on-base housing, retention decision in FY98, stationed at U.S. base, not on assigned to a ship, and not using tuition assistance.

We explored the sensitivity of the model to the identifying variables in the model (distance to a 4-year college at accession and the number of courses available at the member's base). We found that the results were stable for alternative specifications that relied on either variable individually for identification. We found an effect of –16.39 percent using the course offerings on the base and the interaction of the course offerings with base size as the instruments and a –16.07 percent effect using distance to nearest college as the instrument.

The error term correlation between the TA and stay equation is 0.17 and this correlation is statistically significant—substantiating the importance of jointly modeling TA and retention. By adjusting for this correlation in the model, we allowed for the possibility that unobserved factors affecting TA usage might also affect mobility and bias the estimated parameters. The bivariate probit model also improved the efficiency of the model estimates. We found that the model predicts average TA usage and average retention well—the difference between actual and predicted TA usage is 0.0001. The difference between predicted and actual retention is 0.001.

Tuition Assistance Usage. While this paper focuses on identifying the effect of TA on mobility, the estimates from the TA equation also revealed several notable findings.

TA usage varied by demographic group. In particular, TA usage for Hispanic and Pacific islander sailors was over 2 percentage points higher than for other sailors. Women were much more likely to use TA than men: A woman is 7 percent more likely to take college classes than a man with similar demographic and military (i.e., this effect is after adjusting for ship assignment and deployment status) characteristics.

Aptitude and education levels related positively to TA usage. For instance, TA usage was 6 percentage points higher for sailors in the highest AFQT category compared to sailors in the lowest AFQT category. Sailors with a GED had TA usage rates about 3 percentage points below those of high school diploma graduates. The results showed that members with some college experience before enlisting were no more likely to take college classes in the Navy than sailors with no college experience.

Family responsibilities were a deterrent to college enrollment. Parents (single or married) were less likely to take classes than nonparents, but the difference in usage rate is only about 4 percentage points. Similarly, married sailors with no children were 2 percentage points less likely to take college classes than are single nonparents.

The results suggest that heightened work pace during deployments may make it difficult to schedule college classes. The results show that TA usage falls by about 1.4 percentage points per deployment. Similarly, assignment on a ship reduces TA usage, since TA courses are not available at sea. However, being stationed overseas increases TA usage by almost 6 percentage points, possibly because of less competition for leisure time from family and community activities.

A surprising result is that TA usage for members in off-base housing is 2 percentage points higher than for members living on base. We had expected lower usage rates, since sailors in off-base housing might be reluctant to return to the base for college classes. The result is puzzling, since it suggests that proximity is inversely related to enrollment in college classes. One possible explanation is that most Navy-owned housing is located in the community and not on the base itself (Buddin et al. 1999). As a result, sailors in Navy housing (so-called on-base housing) may actually be no closer to education centers than sailors living in private housing.

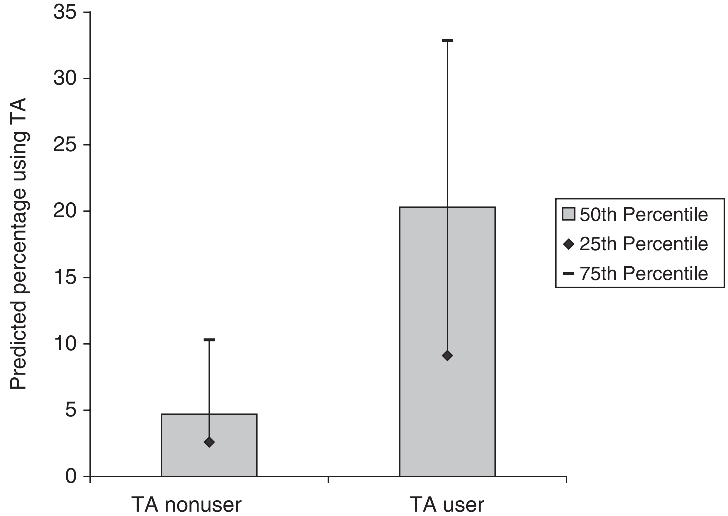
As expected, the instrumental variable, sailor access to college before accession, is related to TA usage in the Navy. Members who grew up near a 4-year college were more likely to enroll in a college course while on active duty than are members who did not live near a college. These sailors appear to have greater interest in college and pursue their education while in the Navy. The second instrumental variable, the number of courses at the Navy base did not have a statistically significant effect on TA usage. However, the interaction of the number of courses at the base and base size is positively related to TA, suggesting that peer effects in TA are important.

Probability of Staying. Results from the model estimates of the probability of staying in the Navy reveal some interesting findings. The probability of staying varies substantially across demographic groups. Older sailors were more likely to stay than others: each year increment in age is associated with a 1-percent increase in staying. Other things being equal, white non-Hispanics are much less likely to stay than other ethnic groups. The stay rates for blacks, Hispanics, and Asian/Pacific islanders are estimated as 20, 7, and 19 percentage points higher than for otherwise comparable white non-Hispanics. Single sailors were less likely to stay than either married members or parents. Single parents and married nonparents were about 10 percentage points more likely to stay in the Navy than are single nonparents. Married parents have stay rates 13 percentage points higher than those of singles without dependents.

Mobility decisions are sensitive to sailors' assignment patterns during the first term. Other things being equal, ship assignments reduced the probability of staying by 4 percentage points relative to shore assignments. Contrary to public opinion, service-members appear to enjoy the opportunity to utilize

FIGURE 1

PREDICTED PROBABILITY OF USING TA FOR USERS AND NONUSERS



their training during a deployment—the probability of staying rises 2 percentage points per deployment.

Propensity Score Model. The first step in estimating the propensity score model for the Navy is to estimate a probit equation for TA usage. TA usage is modeled as a function of sailor characteristics and military experiences as reported in the TA equation of the bivariate probit model. Figure 1 shows the broad range of predicted TA usage based on this probit regression. The median predicted TA rate is four times greater for TA users (20 percent) than for nonusers (5 percent). The variance in the predicted rate for users is also much larger than for nonusers. These differences mean that a direct comparison of job mobility rates for TA users and nonuser may be confounded by the set of factors that affect TA usage.

TA users are quite different from nonusers in terms of most of the demographic and military variables in the model. Table 3 shows that the prematching means and proportions differ substantially for nearly all variables in the model.

The matching process pairs each TA user with a similar nonuser, so the differences in means for the covariates diminish substantially. Column 3 shows that there were virtually no significant differences in covariate means for the matched data set.

The results from the propensity score model showed that the probability of a TA user staying in the Navy at the end of the first term is 7.5 percentage

TABLE 3

P value from Two-tailed *T*-test of Covariate Means (TA Users minus Nonusers) before and after matching

Characteristic	Before matching	After matching
Age	0.009	0.078
Female	<0.001	0.142
Black	0.017	0.699
Hispanic	0.019	0.700
Asian/Pacific islander	0.006	0.995
AFQT 93–99 percentile	<0.001	0.300
AFQT 65–92 percentile	<0.001	0.705
AFQT 50–64 percentile	0.706	0.719
Non-High school graduate	0.004	0.878
GED	0.001	0.671
Alternative education credential	0.011	0.914
Some college	<0.001	0.946
Single parent	0.152	0.429
Married parent	<0.001	0.553
Married nonparent	<0.001	0.103
Joint military couple	<0.001	0.508
Skilled technical	<0.001	0.409
Support and administration	<0.001	0.046
Electrical/mechanical	<0.001	0.395
Craftsmen, service, and supply handlers	<0.001	0.499
Number of deployments in the past 2 years	<0.001	0.896
Months deployed in the past 2 years	<0.001	0.519
Lives in off-base housing	<0.001	0.533
Retention decision in FY97	0.156	0.995
Stationed overseas	<0.001	0.906
Assigned to a ship	<0.001	0.787
Size of base (in logarithms)	<0.001	0.217
Distance from pre-Navy home to a 4-year college	0.009	0.078
Number of courses at base	<0.001	0.142
Number of courses at base*size of base	0.017	0.699

points lower than for a comparable sailor who did not participate in TA (see Table 4).[11] This estimated effect is much smaller in magnitude compared to the results from the bivariate probit model. However, both methods showed that the direct effect of TA usage on the probability of staying in the Navy is statistically significantly negative. It is possible that the difference in results from the two models stemmed from the significant estimated correlation

[11] The effects of the other explanatory variables were generally similar to those in the bivariate probit model. However, there are some exceptions—several AFQT and education categories are no longer statistically significant. Since the propensity score model uses a matched sample, rather than the full sample, the effect of control variables in model may differ from the bivariate probit model.

TABLE 4

Propensity Score Results for the Probability of Staying in the Navy

Characteristic	dF/dX	Standard Error	Mean
Tuition assistance usage	−0.0753*	0.0144	0.5002
Age	0.0098*	0.0031	24.1103
Female	0.0187	0.0184	0.3810
Black	0.1628*	0.0228	0.1643
Hispanic	0.0148	0.0203	0.1180
Asian/Pacific islander	0.1898*	0.0310	0.0486
AFQT above 93 percentile	0.0443	0.0358	0.0385
AFQT 65–92 percentile	−0.0049	0.0195	0.4316
AFQT 50–64 percentile	0.0056	0.0191	0.2489
Non-High school graduate	−0.0620	0.0597	0.0078
GED	0.0187	0.0684	0.0098
Alternative education credential	0.0110	0.0383	0.0186
Some college	−0.1048*	0.0410	0.0275
Single parent	0.0743*	0.0276	0.0560
Married parent	0.1076*	0.0338	0.0709
Married nonparent	0.0483*	0.0179	0.3213
Joint military couple	0.0725*	0.0301	0.0609
Skilled technical	0.1736*	0.0246	0.4029
Support and administration	0.1689*	0.0277	0.2169
Electrical/mechanical	0.0730*	0.0280	0.1771
Craftsmen, service, and supply handlers	0.1337*	0.0429	0.0540
Number of deployments in the past 2 years	0.0236	0.0133	0.6994
Months deployed in the past 2 years	−0.0020	0.0030	2.7871
Lives in off-base housing	0.0035	0.0158	0.4575
Retention decision in FY97	−0.0038	0.0161	0.7482
Stationed overseas	0.1160*	0.0356	0.1103
Assigned to a ship	−0.0245	0.0287	0.3543
Size of base (logarithm of enlisted/10,000)	−0.0139*	0.0060	−0.5407
Proportion staying at end of first term			0.3527
Sample size			0.6501

Notes: The estimated effects (dF/dX) correspond to changes in the probability relative to the excluded reference category for discrete variables and the derivative of the probability for continuous variables. Entries with asterisks are associated with coefficients that are significant at the $\alpha = 0.05$ confidence level.

The reference categories for demographic variables in the model are male, white non-Hispanics; test category: below the 50th percentile, high school diploma graduate, and single with no children. The reference groups for military characteristics are combat arms occupation, on-base housing, retention decision in FY 1998, stationed at U.S. base, not on assigned to a ship, and not using tuition assistance.

in the unobserved error terms between the TA and retention equations. While the bivariate probit model accounts for this correlation, the propensity score method is based solely on matching observable variables. However, the difference in the estimates may also be because of estimation error given that the propensity score estimate is within the 99 percent confidence interval of the bivariate probit estimate.

Conclusions

In this study, we examined the effect of employer-sponsored general education on job mobility. Using the case of the Navy TA program, we found that TA significantly reduces the probability of staying in the Navy. We used two different modeling strategies, a bivariate probit model and a propensity score model, and found that while both models yield a negative effect, the magnitude of the effect from the bivariate probit model is much larger than from the propensity score model. Possibly, the importance of unobserved factors account for the difference in the results from the two models. Alternatively, estimation error may be responsible for the variation in the estimates from the two models. Ultimately, the difference in the estimates from the two models underlines the importance of not relying on a single model.

Our results are at odds with those of previous studies (Boesel and Johnson 1988; Garcia and Joy 1998; Garcia, Arkes, and Trost 2002) that show TA users are more likely to stay in the military than are nonusers. However, these studies had methodological problems that would lead to biased estimates of TA.

The results from our models suggest that service-members are using the TA program to prepare for post-service education or jobs. Our results suggest that increases in the size or generosity of the TA program are likely to increase service members' propensity to leave the military. Since this result is based on the range of available data and the existing institutional structure, we are hesitant to use these estimates to predict outcomes in extreme cases, such as the elimination of the TA program. While our results may seem to suggest that the TA program is not cost-effective for the Navy, it is important to note that TA may have important recruiting benefits that help recoup the cost of the program. In addition, TA may increase productivity while in the Navy.

Several factors apply to the case of the Navy that do not affect civilian employers. First, the GI Bill provides benefits to cover college expenses after military service. Even though most civilians have access to low cost community college courses, GI Bill benefits are probably more valuable. While the availability of the GI Bill is likely to reduce service-members' propensity to take tuition assistance while in the military, it should not change the effect of interest—the impact of TA on the probability of staying in the military under either the human capital or the signaling theory. Second, deployments and work conflicts make it difficult for members to accumulate college credits and progress towards a degree. Members anxious to earn a degree may see little reason to pursue their studies as a full-time sailor. Rather, they can leave the military and attend school (either full- or part-time) under their GI Bill benefits.

The results from this study also shed light on the potential effect of civilian employer-sponsored general education on job mobility—an area where there is virtually no research. Majority of employers do not offer general education benefits, possibly because of the effect of these benefits on employee retention. Although part-time education has been found to increase earnings, employers' incentives to provide these benefits are questionable. This suggests that public policy to encourage part-time college attendance is likely to be beneficial.

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