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ESTIMATING AND INTERPRETING PEER AND ROLE MODEL EFFECTS FROM RANDOMLY ASSIGNED SOCIAL GROUPS AT WEST POINT

David S. Lyle*

Abstract—The random assignment of cadets to social groups at West Point provides a rare opportunity to highlight potentially misleading estimates of social group effects found in many studies. Estimates of contemporaneous group effects in human capital production are typically positive and significant; however, evidence in this study suggests that occurrences common to a group may account for much of this correlation. Models that address these biases provide little evidence of group effects in academic performance, although there is evidence of group influences in choice outcomes such as the selection of academic major and the decision to remain in the Army.

I. Introduction

RESEARCHERS from a variety of disciplines have long been interested in how social groups affect individual behavior. Some examples include how peers affect educational attainment within schools (Coleman, 1966; Sacerdote, 2001), how peers affect pregnancy and dropout behavior among teenagers (Evans, Oats, & Schwab, 1992), and how peers affect criminal activity within neighborhoods and families (Case & Katz, 1991). Standard models that regress individual outcomes on social group characteristics often find statistically significant and qualitatively important effects. Researchers continue to debate, however, the extent to which unobserved aspects of social groups—from their formation to the experiences of the group as a whole—confound the interpretation of estimates reported in the literature.

One such bias, commonly referred to as "selection bias," occurs when an individual selects into (or is selected into) a social group based on characteristics that are correlated with the outcomes of the group. For example, a family may choose a neighborhood by the quality of its surrounding schools, a parent may request that his or her child be assigned to a teacher with a positive reputation, a student may choose peers with similar attributes, or a school may assign students to classrooms by measures of demonstrated ability. In each of these cases, the formation of the social group was based on important independent factors in educational achievement. Most recent studies of social effects attempt to correct for selection bias.

Few studies, however, account for the bias that results from a common occurrence that influences the outcomes of everyone in the social group. I refer to this as a "common shock." Examples of common shocks in an educational setting may include the quality of the teacher, the sequence of daily instruction, the location of the classroom, or the seating configurations in the classroom. Again, each of these common shocks may also be important factors that impact educational achievement.

Still other biases stem from the inherent nature of social interactions. First, there are numerous possible influential constituents of a social group; they could be members of a student's homeroom class, fellow companions on an athletic team, neighborhood acquaintances, or any number of other possibilities. Second, there are countless past and contemporaneous social interactions in an individual's life that can affect his or her current behavior. For contemporaneous interactions, there is also the possibility for what Manski (1993) calls "endogenous effects": individuals can impact their social group at the same time that their social group impacts them.

Therefore, determining how social groups affect individual behavior is difficult because many of these potential biases are unobserved. Sacerdote (2001) provides one clever way to deal with many of these biases by exploiting a natural experiment at Dartmouth College, where freshmen are randomly assigned a roommate. Sacerdote reports strong correlations between outcomes of freshmen and their roommates with regard to academic achievement and the decision to join a fraternity. Although Sacerdote addresses many of the aforementioned biases, data restrictions preclude an adequate assessment of the degree to which common shocks may bias his estimates of social effects at Dartmouth College.

The first part of this study investigates the extent to which common shocks may confound estimates of group effects at the U.S. Military Academy. Similar to the Sacerdote study, I exploit the random assignment of individuals to social groups and find large positive correlations between the outcomes of an individual and his or her peer group. However, I also find that common shocks, those affecting the peer group as a whole, appear to account for a large part of the estimated social group effect.

The second part of this study avoids potential biases from common shocks by studying how preexisting behavior and attitudes of social groups affect an individual's contemporaneous behavior. Using Manski's (1993) terminology, I refer to these as exogenous social group effects. I study two performance and two choice outcomes at West Point. The two performance outcomes are academic grade point average (GPA) and math grades, both of which are measured at the end of the freshman year. The two choice outcomes are the selection of academic major and the decision to remain in the Army longer than five years. I find little statistical

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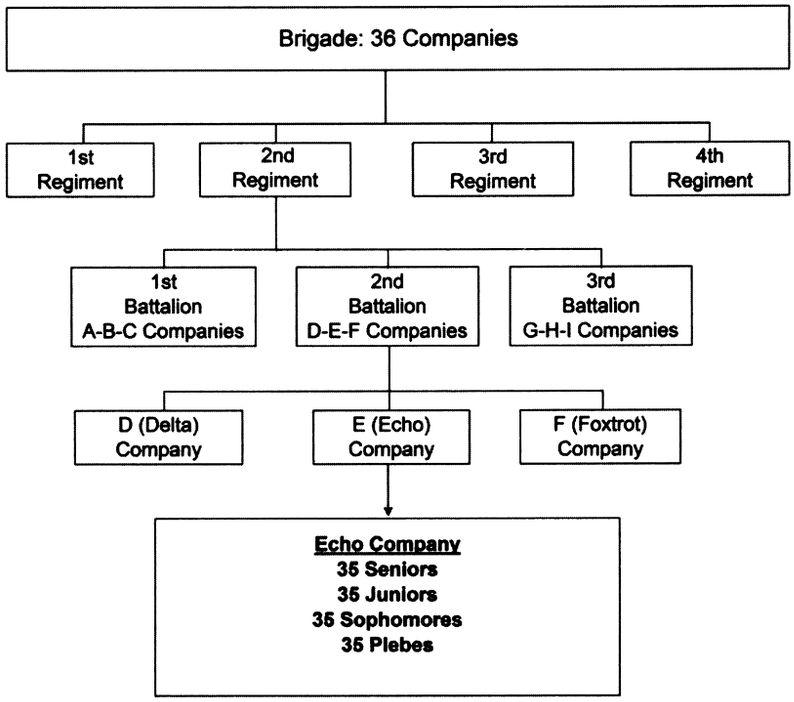
FIGURE 1.—ORGANIZATION OF THE CORPS OF CADETS



Term	Description
Company	Made up of all four classes: approximately 35 cadets in each class
Cadet	General term referring to an individual from any of the four classes
Plebe	Freshmen or 4th classmen

evidence of social group effects in academic performance outcomes when I use preexisting measures of academic ability. However, I find that preexisting attitudes of members of a social group toward academic majors and military service influence an individual's choice of academic major and the decision to remain in the Army.

In the next section, I provide background information on the U.S. Military Academy. Section III describes the data and section IV explains the random assignment of cadets to companies. In section V, I present the empirical framework and formally discuss the identification assumptions and interpretations. Section VI contains the main results for common-shock bias and section VII contains the main results for exogenous social group effects. Section VIII concludes.

II. The United States Military Academy

The purpose of the U.S. Military Academy is to "provide the Nation with leaders of character who serve the common defense" (*USMA, Bugle Notes,* 1994). Graduates receive a Bachelor of Science degree; in return, they must fulfill a five-year service obligation as an officer in the U.S. Army.

Each year West Point randomly assigns new cadets to one of 36 companies, after controlling for several observable characteristics such as gender, race, recruited athlete, and measures of prior performance and behavior.[1] Freshmen cadets are the focus of this study, so I use West Point terminology and refer to them as "plebes." I refer to all other upperclassmen using the standard convention of sophomores, juniors, and seniors. The company serves as the primary social group in this study. I use the term "peer effect" to describe how other plebes in a company affect an individual plebe. The organizational structure at West Point also provides a rare opportunity to evaluate how role models impact human capital production. Thus, I use the term "role model effect" to describe how sophomores in a company impact a plebe. As shown in figure 1, each of the 36 companies has approximately 140 cadets, 35 from each of the four classes.

Plebes arrive at West Point six weeks prior to the beginning of the academic year to take part in cadet basic training. During this training period, plebes eat, sleep, attend mandatory social activities, and conduct military training together as a company. By design, there is little interaction with other plebes outside of the company. Upon completion of cadet basic training, plebes join the upperclassmen in their company to begin the academic year.

[1] West Point attempts to equalize companies across these characteristics. I provide a detailed explanation of the assignment process in the next section.

TABLE 1.—COMPANY-LEVEL SUMMARY STATISTICS

	A. Outcome Variables				
	Companies	Mean	Std. Dev.	Minimum	Maximum
Academic GPA during plebe year	252	2.66	0.11	2.31	2.93
Math grade during plebe year	252	2.69	0.23	2.10	3.18
Choose engineer major	252	0.407	0.101	0.120	0.643
Choose social science major	252	0.136	0.075	0.000	0.375
Choose natural science major	252	0.094	0.060	0.000	0.290
Choose all other majors	252	0.363	0.093	0.080	0.542
Continue in Army past 6 years of service	180	0.505	0.108	0.231	0.864
Left academy during cadet basic training	252	0.073	0.046	0.000	0.257
Left the academy during plebe year	252	0.050	0.037	0.000	0.194
	B. Pretreatment Characteristics				
	Companies	Mean	Std. Dev.	Minimum	Maximum
Total SAT score (math + verbal)	252	1,189.2	16.8	1,149.1	1,237.3
Math SAT score	252	636.7	10.6	599.0	661.8
Leadership potential score	252	603.8	7.6	578.4	621.2
Intend to study engineering major	216	0.444	0.098	0.100	0.667
Intend to study social science major	216	0.172	0.083	0.000	0.471
Intend to study natural science major	216	0.114	0.063	0.000	0.350
Intend to study all other majors	216	0.269	0.082	0.000	0.538
Anticipate an Army career	216	0.360	0.096	0.115	0.630
	C. Random Scrambling Controls				
	Companies	Mean	Std. Dev.	Minimum	Maximum
Female	252	0.118	0.025	0.032	0.212
Black	252	0.065	0.030	0.000	0.167
Hispanic	252	0.043	0.026	0.000	0.143
Recruited football players	252	0.075	0.032	0.000	0.184
Other recruited athletes	252	0.141	0.043	0.000	0.314
Attended the West Point Prep School	252	0.140	0.030	0.054	0.219
College entrance exam rank (CEER)	252	607.3	5.0	586.3	623.7
Whole candidate score (WCS)	252	6,032.3	31.8	5,952.2	6,167.1

The data are from the Office of Economic and Manpower Analysis, West Point, NY. Data include personnel files, admissions files, performance records, and extracurricular records for the graduating classes of 1992–1998. There are 36 companies across seven years. Background information from the Survey of Incoming Freshmen is available for graduating classes of 1992, and 1994–1998. Active duty Army personnel data are available only for the classes of 1992–1996. The LPS is an aggregated score of high school leadership activities. The CEER score is a weighted average of SAT, ACT, and high school rank. WCS is an aggregated score of high school activities and performance. SAT scores are comparable across years because they were all taken prior to the 1995 renormalization.

During the academic year, cadets from all four classes live together as a company in a designated section of the barracks. The hierarchical structure of a company at West Point is similar to a company in an active duty Army unit and is designed to develop the leadership skills of the upperclassmen and to foster teamwork among the plebes: seniors serve as officers, juniors serve as noncommissioned officers (NCOs), sophomores serve as small-unit leaders, and plebes serve as privates.

As small-unit leaders, sophomores supervise plebes in the performance of routine duties. These duties include maintaining the physical appearance of the company area and delivering newspapers, mail, and laundry. In an effort to promote teamwork and achievement, sophomores frequently attribute failures and successes of one plebe to other plebes within the company. This spills into the academic realm as sophomores routinely hearten plebes within the company to assist each other on homework assignments and exam preparations.

All cadets take the same courses during their first two years at West Point. During plebe year, academic scores in calculus, English, history, computer science, psychology, and chemistry constitute a plebe's academic GPA. By the end of the second year, cadets declare their academic major from one of thirteen different academic departments ranging from history and social sciences to engineering and physics. An additional feature of the academic program at West Point is that plebes do not usually take academic classes with other plebes from their company. However, all plebes complete the same program of instruction, do the same homework assignments, and take the same exams.

III. Data Description

The data for this study are from the Office of Economic and Manpower Analysis (OEMA) at West Point, New York. I combine data from several sources for the graduating classes of 1992 through 1998 to include admissions files, the Survey of Incoming Freshmen, cadet personnel records, and officer personnel records. Table 1 contains company-level summary statistics and is divided into three categories: academic performance and choice outcomes, pretreatment characteristics obtained prior to entering West Point, and randomization controls. In most cases, data are available for plebes in 252 companies—that is 36 companies over seven years.

All grades in panel A range from 0.0 to 4.3 points: a 4.3 equates to an A+, a 4.0 equates to an A, and a 3.7 equates to an A−. The average plebe academic GPA is 2.66 points (C+) and the average plebe math grade is 2.69 (C+) points. The choice of academic major ranges from 9% in the natural sciences to approximately 41% in engineering. Roughly half of all graduates remained in the U.S. Army at least one year past their initial obligation of five years.[2] Finally, about 7% of each class drops out of West Point during cadet basic training and an additional 5% drops out during plebe year.[3]

In panel B, I present summary statistics for the pretreatment data. All cadets have an SAT score.[4] The average total SAT score is approximately 1,200 points, with the average math SAT score being about 640 points. The leadership potential score (LPS) is a measure of leadership experience prior to entering West Point. For example, being the captain of a varsity high school basketball team may contribute 75 points to the LPS, and being a member of a high school student council may account for 50 more points. The LPS ranges from 0 to 800 points and has a mean of 600 points. The remaining background data are from the Survey of Incoming Freshmen, which a plebe completes during his or her first week at West Point.[5] The survey captures pretreatment intentions including the preferred academic major of study, which ranges from 11% in the natural sciences to more than 44% in engineering, and plans to make the military a career, which 36% of incoming cadets state as their intention.

Panel C contains summary statistics for the randomization controls. Females constitute almost 12% of each class, and blacks and Hispanics combine to account for about 10% of each class. A little more than 21% of incoming cadets are recruited for one of the athletic programs at West Point. Also, 14% attended the U.S. Military Academy Prep School the year before entering West Point. The college entrance exam rank (CEER) is a weighted average between the high school graduation ranking of the cadet and the SAT score. The range of this admissions score is 0–800 points, with a mean of approximately 600 points. The whole candidate score (WCS) is similar to the LPS in that it aggregates assigned values to various activities and performance outcomes from high school. The WCS ranges from 0 to 8,000 points and has a mean of about 6,000 points.

IV. Social Groups and Random Assignment

In general, it is difficult to assign an individual to a well-defined social group. It is even more difficult to view that assignment as untainted by selection bias. However, the conditional random assignment of cadets to companies at the U.S. Military Academy obviates both concerns. Not only does "Uncle Sam" issue a uniform and a "tight haircut," but he also issues peers and role models.

The critical identification assumption for this experiment is that the assignment of cadets to companies at West Point is random, after conditioning on the eight individual-level controls listed in panel C of Table 1. West Point uses a computer program to assign a random number to each incoming plebe in a process known at the Academy as "scrambling" (USMA, 1998). Incoming plebes are assigned to a company based on their random number; then the computer program shuffles plebes between companies in an attempt to equalize the means of the eight characteristics with the aim of producing comparable companies. All subsequent rearrangements of plebes between companies are a function of the eight characteristics and the random number.

Estimates in table 2 support this description of the assignment process. I regress average pretreatment characteristics of social groups on corresponding individual-level characteristics to determine if a cadet's background predicts the background of his social group. I test peer assignments in panel A. The peer average is the average pretreatment characteristics of the plebes in a company minus the individual plebe. Estimates in column 1 are from a bivariate regression of average total SAT score of the peer group or company on the total SAT score of the individual. The small and negative correlation is expected given the equalizing nature of the scrambling process described above.[6] The specification in column 2 adds the eight individual-level scrambling controls. The point estimate is smaller in absolute value and no longer significant. I conduct a similar exercise for each of the other pretreatment measures in this study, as seen in table 2. In general, estimates from specifications without the scrambling controls have a small and negative correlation, while estimates from specifications with the scrambling controls have no significant correlation. Panel B contains estimates from identical regressions using the averages of role models or the sophomores in the same company as the plebe. In this case, regardless of whether I include the scrambling controls, the background characteristics of the role models do not predict the background characteristics of a plebe.

[2] These data are only available for plebes in 180 companies because many cadets in year groups 1997 and 1998 were unable to leave the military at the conclusion of their five-year obligation because of the requirements associated with the Global War on Terror.

[3] Nearly 18% of an entering cohort drop out of West Point prior to graduation. Regression estimates reveal no significant correlation between drop out behavior and the characteristic variables in table 1.

[4] About 10% of cadets have only an ACT score. West Point converts ACT to SAT scores using a standard conversion formula from Schneider and Dorans (1999). Since the conversion factor produces a total SAT score and not math and verbal components, some observations have only a total SAT. All SAT scores were taken prior to the 1995 renormalization, so they are directly comparable.

[5] The American Council on Education and the University of California at Los Angeles conduct this survey each year. These data are available for plebes in only 216 companies because members of the graduating class of 1993 did not participate in the survey.

[6] Equalizing group means through the scrambling process generates a negative correlation between the peer average SAT and the individual SAT because the peer group measure omits an individual's SAT from the group mean SAT score.

TABLE 2.—RANDOMLY ASSIGNED PEER AND ROLE MODEL GROUPS
OUTCOME VARIABLE: SOCIAL GROUP MEAN SCORE (AS LISTED IN COLUMN HEADINGS)

	A. Peer Pretreatment Characteristic Correlations									
	Total SAT		Math SAT		Intend to Major in Engineering		Leadership Potential Score (LPS)		Anticipates an Army Career	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Total SAT	−0.011	0.003								
	(0.002)	(0.003)								
Math SAT			−0.010	0.004						
			(0.002)	(0.004)						
Intend to major in engineering					0.000	0.001				
					(0.004)	(0.004)				
Leadership potential score (LPS)							−0.015	0.000		
							(0.002)	(0.003)		
Anticipates an Army career									−0.002	−0.001
									(0.003)	(0.004)
R^2	0.07	0.08	0.06	0.06	0.01	0.01	0.21	0.22	0.11	0.11
Observations	8,508	8,508	7,733	7,733	5,791	5,791	8,555	8,555	6,049	6,049
Scrambling controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
	B. Role Model Pretreatment Characteristic Correlations									
	Total SAT		Math SAT		Intend to Major in Engineering		Leadership Potential Score (LPS)		Anticipates an Army Career	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Total SAT	0.000	0.000								
	(0.001)	(0.003)								
Math SAT			0.000	0.001						
			(0.002)	(0.003)						
Intend to major in engineering					0.003	0.002				
					(0.004)	(0.004)				
Leadership potential score (LPS)							−0.001	0.001		
							(0.001)	(0.003)		
Anticipates an Army career									−0.001	−0.001
									(0.004)	(0.004)
R^2	0.08	0.08	0.05	0.05	0.00	0.00	0.10	0.10	0.06	0.06
Observations	7,220	7,220	6,584	6,584	3,524	3,524	7,265	7,265	3,638	3,638
Scrambling controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Standard errors in parentheses account for clustering at the company and year level. OLS estimates reflect regressions of peer means on individual-level characteristics. All specifications include year dummies and a constant. The random scrambling controls gender, race, recruited athlete, prep school, CEER, and WCS are included as indicated. Changes in sample size reflect available data for the given characteristic. See table 1 notes for sample description.

V. Empirical Framework

Manski (1993) identifies three primary sources of measured social group effects: exogenous effects, endogenous effects, and correlated effects. In the context of this study, the exogenous effects are the behavior and experiences of the peers or role models in the company prior to arriving at West Point. In the data section above, I refer to the exogenous effects as pretreatment effects. Endogenous effects exist when an individual's contemporaneous behavior varies with the contemporaneous behavior of his or her peers. Correlated effects include the selection and common-shock effects that I described in the introduction.

Following Sacerdote (2001), I consider a model that includes each of these potential sources of measured social effects in the context of West Point:

$$Y_{ict} = \alpha + \theta_t + \lambda \cdot Z_{ict-1} + \gamma \cdot \bar{Z}_{gt-1} + \delta \cdot \bar{Y}_{gt} + \beta \cdot X_{ict-1} + \varepsilon_{ict}. \quad (1)$$

The left-hand-side variable, Y_{ict}, is the outcome of interest (such as academic GPA) for cadet i, in company c, in year t (plebe-year). On the right-hand side, α is a constant term and θ_t is a vector of year dummies for 1992 to 1998. The coefficient λ represents the effect of own pretreatment $(t-1)$ measures (such as SAT) and γ represents the effect of average pretreatment measures (such as average SAT) of the social group, g ($g = c - i$). The parameter δ is the effect of contemporaneous average behavior (average GPA) of the social group and β denotes the individual-level scrambling controls contained in X_{ict-1}. Finally, ε_{ict} corresponds to other potential determinants of individual-level outcomes, where $\varepsilon_{ict} = \sigma_{ict} + \omega_{ct} + \eta_{ict}$. Here σ_{ict} represents unobserved selection effects, ω_{ct} represents unobserved common-shock effects, and η_{ict} represents a standard stochastic error term.

In most settings, estimates of γ and δ would be subject to selection bias due to correlations between pretreatment group characteristics ($\bar{Z}_{gt-1}$) and selection characteristics (σ_{ict}), and between contemporaneous group characteristics

($\bar{Y}_{gt}$) and selection characteristics (σ_{ict}). However, the conditional random assignment of cadets to companies mitigates such bias.

With regard to the common-shock bias, the effect depends on the timing of the shock and the variable of interest. For example, estimates of γ are not subject to common-shock bias because common shocks (ω_{ct}) occurring in time period t are not likely to be correlated with pretreatment characteristics ($\bar{Z}_{gt-1}$) from the previous time period. However, estimates of δ are subject to common-shock bias because common shocks (ω_{ct}) in period t are likely to be correlated with contemporaneous group outcomes ($\bar{Y}_{gt}$), which also occur in time period t.

If all common shocks were accounted for such that $E[\bar{Y}_{gt}\ \omega_{ct}] = 0$, statistically significant estimates of δ would suggest the presence of a social group effect. However, the social group effect is still not likely to have a causal interpretation because cadet i and his or her peers may simultaneously influence each other while earning their GPAs. The endogeneity between Y_{ict} and $\bar{Y}_{gt}$ can be viewed in the context of a simultaneous-equations model where equation (1) and equation (2) form a system of equations linked through Y_{ict} and $\bar{Y}_{gt}$.

$$\bar{Y}_{gt} = \tilde{\alpha} + \tilde{\theta}_t + \tilde{\lambda} \cdot Z_{ict-1} + \tilde{\gamma} \cdot \bar{Z}_{gt-1} + \tilde{\delta} \cdot Y_{ict} + \tilde{\beta} \cdot \bar{X}_{gt-1} + \tilde{\varepsilon}_{gt} \tag{2}$$

Having contemporaneous outcomes in the model is the source of the problem for both common shocks and endogeneity. Zimmerman (2003), which studies peer effects using the random assignment of roommates at Williams College, circumvents this problem by estimating models that contain only pretreatment or exogenous characteristics. This is equivalent to estimating the reduced form of the simultaneous system characterized by equations (1) and (2).

$$Y_{ict} = \pi_{10} + \pi_{11} \cdot Z_{ict-1} + \pi_{12} \cdot \bar{Z}_{gt-1} + \pi_{13} \cdot X_{ict-1} + \mu_{ict} \tag{3}$$

Here the coefficient of interest is π_{12}, where $\pi_{12} = \gamma/(1 - \delta \cdot \bar{\delta})$. With random assignment, estimates of π_{12} are free of selection, common shock, and endogeneity problems, and therefore can provide causal estimates of peer effects. The reduced-form estimate of π_{12} accounts for multiple channels through which a social group's average SAT score may impact an individual's GPA. If equations (1) and (2) represent the correct structural model, then π_{12} contains a direct component of the social group's average SAT effect and an indirect component of the social group's average SAT effect that works through the average GPA. Untangling the two effects is not possible without additional restrictions, but the reduced-form specification in equation (3) does allow for a causal interpretation of the net effect of average group SAT scores on individual GPA.

VI. Common Shocks

I begin by estimating a Sacerdote-like model, as in equation (1), to demonstrate how common shocks potentially confound interpretations of contemporaneous social effects. Given the design of this experiment, a nonzero estimate of δ suggests either a social effect or the presence of common shocks. Since the key right-hand-side variables vary by social group and time period, all standard errors are corrected for clustering at the company-year level with Huber-White robust standard errors.

Table 3 contains estimates using the plebe-year GPA as the outcome and the total SAT score as a measure of pretreatment academic ability. In column 1, I regress individual GPA on own SAT score and the scrambling controls. Own SAT score is a positive predictor of own plebe GPA: a 100 point increase in own SAT score implies a 0.04 point increase in academic GPA or 4% of a letter grade.[7] In column 2, I add the average SAT score for the cadet's peer group. The own SAT effect remains identical to that in column 1, and the peer SAT effect is insignificant. In column 3, I include the average GPA for the cadet's peer group as a measure of contemporaneous academic ability. The effect of the peer GPA is large, positive, and statistically significant.

Column 4 contains the full specification in equation (1). The own SAT effect remains stable, there is no statistically significant peer SAT effect, and a one standard deviation increase in peer GPA translates to a 0.024 point increase in own GPA, or 2.4% of a letter grade. The magnitude of the correlation between own GPA and peer GPA is comparable to the findings in Sacerdote (2001).[8] Despite the potential for common-shock bias, Sacerdote's interpretation of this finding as providing evidence for contemporaneous peer effects is not entirely unreasonable because common shocks would have to play a significant role to account for such a sizable correlation. So, how important are common shocks?

Hanushek et al. (2003) provide some evidence that common shocks could play a substantial role in contemporaneous peer-effect estimates. Using panel data for children in the Texas public school system, they find sizable differences in the estimated coefficients on $\bar{Y}_{gt-2}$ when fixed effects are included at varying levels of group organization. Sacerdote (2001) attempts to deal with the common-shock problem by including dorm-level fixed effects, and finds

[7] Since the CEER score is partially determined by SAT score, this point estimate may be low given its positive correlation with CEER. An identical regression without the CEER control reveals a point estimate of 0.10 with a standard error of 0.006 on the own SAT effect. This gives an idea of the actual magnitude of the own effect for comparison to the magnitude of the peer effects.

[8] The micro-level standard deviations in the SAT scores and the plebe year GPAs are comparable to those in Sacerdote (2001); the math SAT s.d. = 67 is the same for both studies. However, the standard deviations of the mean peer group characteristics are three to four times smaller than the micro-level standard deviations.

TABLE 3.—CONTEMPORANEOUS PEER EFFECTS WITH POTENTIAL COMMON SHOCKS
OUTCOME VARIABLE: INDIVIDUAL-LEVEL PLEBE ACADEMIC GPA

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Own total SAT/100	0.042	0.042	0.042	0.042	0.042	0.037	0.037
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.008)	(0.009)
Average peer total SAT/100		−0.002		−0.024	−0.018	−0.013	−0.011
		(0.035)		(0.027)	(0.030)	(0.033)	(0.038)
Average peer academic GPA			0.234	0.241	0.206	0.256	0.140
			(0.056)	(0.057)	(0.061)	(0.076)	(0.092)
CEER/100	0.398	0.398	0.399	0.398	0.397	0.352	0.352
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.030)	(0.030)
WCS/1,000	0.203	0.203	0.206	0.206	0.205	0.283	0.281
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.039)	(0.039)
Female	−0.071	−0.071	−0.071	−0.071	−0.071	−0.064	−0.065
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.023)	(0.023)
Black	−0.141	−0.141	−0.142	−0.141	−0.141	−0.115	−0.114
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.025)	(0.026)
Hispanic	−0.046	−0.046	−0.047	−0.047	−0.047	−0.048	−0.048
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.033)	(0.032)
Recruited football player	−0.031	−0.031	−0.032	−0.032	−0.033	−0.014	−0.013
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.030)	(0.030)
Other recruited athlete	−0.009	−0.009	−0.010	−0.010	−0.010	0.013	0.015
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.020)	(0.020)
Attended the West Point Prep School	−0.036	−0.036	−0.038	−0.038	−0.037	−0.037	−0.035
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.019)	(0.019)
R^2	0.43	0.43	0.43	0.43	0.43	0.40	0.41
Observations	7,527	7,527	7,527	7,527	7,527	4,048	4,048
Battalion and regiment controls	No	No	No	No	Yes	No	No
Average upperclassmen controls (shocks)	No	No	No	No	No	No	Yes

Standard errors in parentheses account for clustering at the company and year level. OLS estimates reflect regressions of individual-level academic GPA on individual and peer average SAT and peer average GPA. All specifications include year dummies and a constant. Sample size changes in columns 6 and 7 are the result of unavailable data for the company commander and upperclassmen for year-groups 1992–1994. See table 1 notes for sample description.

that the correlation between roommate and own GPA remains positive and significant. I conduct a similar exercise in column 5 by including fixed effects for battalions and regiments, the next two levels above a company, and also find little evidence of common shocks in the data. Nevertheless, if common shocks are room specific in Sacerdote's study or company specific in this study, then including fixed effects at higher levels of organization will not account for them.

The unique environment at West Point provides an opportunity to investigate the common-shock problem further. Within a cadet company, the attitudes and behavior of upperclassmen can easily affect plebes. For example, the sophomore class is directly responsible for supervising all plebes in a company, juniors and seniors establish the living environment, and the cadet company commander is responsible for leading the company and has influence over policies that affect plebes. Therefore, I represent potential common shocks with a vector of academic, military, and physical attributes of the upperclassmen and the cadet company commander in each company.[9]

I do not have data on upperclassmen and company commanders for plebes in the earlier year-groups, so column 6 contains the same specification as column 4 for data from year-groups 1995 through 1998. The change in sample causes only slight changes in the point estimates. Column 7 contains the specification with the vector of common shocks included. Comparing column 6 with column 7 reveals that common shocks attributed to the characteristics of the company's upperclassmen reduce the contemporaneous peer effect by almost half, while not affecting the point estimate of either the peer SAT effect or the own SAT effect. Undoubtedly, there are other unobservable common shocks that could further impact the estimate of peer GPA. Consequently, common shocks may account for most or even all of the measured correlation between own and peer GPA.

The contrast between the peer SAT and the peer GPA effects provide further suggestive evidence that common shocks may be substantial in this study. Given that own SAT is a positive predictor of own GPA, it seems likely that peer SAT is a positive predictor of peer GPA. A regression of peer GPA on peer SAT and the full set of controls reveals a positive correlation with a point estimate of 0.093 and a standard error of 0.037. The random assignment process is apt to negate any common shocks between peer SAT and peer GPA. Thus, the correlation found between peer SAT and peer GPA is likely attributable to a measure of academic ability, which is arguably a component of both SAT and GPA. The lack of a peer SAT effect suggests that the academic ability component of the peer GPA is not responsible for the positive

[9] This vector of characteristics contains the average academic GPA, military GPA, and physical GPA of sophomores, juniors, and seniors in the plebe's company as well as those of the cadet who serves as the company commander.

TABLE 4.—REDUCED-FORM ESTIMATES OF PEER AND ROLE MODEL EFFECTS ON ACADEMIC OUTCOMES
OUTCOME VARIABLE: INDIVIDUAL-LEVEL SCORE (AS LISTED IN PANEL HEADINGS)

	A. Plebe Academic GPA				
	(1)	(2)	(3)	(4)	(5)
Own	0.042	0.042	0.036	0.036	0.036
total SAT/100	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
Average peer		−0.002	−0.002		−0.002
total SAT/100		(0.035)	(0.041)		(0.041)
Average role model				−0.023	−0.023
total SAT/100				(0.036)	(0.036)
R^2	0.43	0.43	0.41	0.41	0.41
Observations	7,527	7,527	6,417	6,417	6,417
	B. Plebe Math Grade				
	(1)	(2)	(3)	(4)	(5)
Own	0.191	0.191	0.167	0.167	0.167
math SAT/100	(0.019)	(0.019)	(0.020)	(0.020)	(0.020)
Average peer		−0.029	−0.019		−0.019
math SAT/100		(0.088)	(0.098)		(0.098)
Average role model				−0.071	−0.070
math SAT/100				(0.081)	(0.082)
R^2	0.29	0.29	0.28	0.28	0.28
Observations	6,309	6,309	5,447	5,447	5,447

Standard errors in parentheses account for clustering at the company and year level. OLS estimates reflect regressions of individual-level academic outcomes on individual and social group average SAT scores. Sophomores in a company serve as the role models and the other plebes within a company serve as peers. All specifications include year dummies, a constant, and random scrambling controls: gender, race, recruited athlete, prep school, CEER, and WCS. The sample is restricted to 1993–1998 in columns 3–5 because role model measures are not available for year-group 1992. See table 1 notes for sample description.

average peer GPA effect found in table 3. Instead, some other component of the average peer GPA is probably responsible for this sizable correlation, and common shocks are a leading candidate.

On balance, the results from table 3 suggest that common shocks confound estimates of contemporaneous peer effects at West Point. Given the design of this experiment and the potentially sizable common shocks, the reduced-form specification in equation (3) provides the most credible method of estimating social group effects. Thus, for the remainder of this study, I use this reduced-form specification to test for evidence of social group effects from peer and role model relationships.

VII. Exogenous Social Effects

Specifications in table 4 test for exogenous social group effects, or how pretreatment measures of a social group's average academic ability affect an individual cadet's academic performance at West Point. Estimates for plebe-year academic GPA and plebe-year math grade are found in panels A and B, respectively. I use total SAT score as a pretreatment measure for GPA and math SAT score as a pretreatment measure for math grades.

Estimates in column 2 reveal no statistically significant peer effects for GPA or plebe math grades. Moreover, the economic magnitude of the effect is negligible; a one-standard-deviation increase in the average math SAT scores of the peer group affects an individual's math grade by 0.003 points. The specification in column 3 is identical to the specification in column 2, except the sample does not contain data for the year-group 1992. I include this specification as a baseline for the role model specifications because data on role models are not available for 1992. In column 4, I replace the peer group measure of average ability with the role model measure of average ability. In both panels, there is no statistically significant role model effect. Column 5 reveals almost no change in the estimates when both peer and role model effects are included in the same regression.

The results in table 4 provide little evidence for exogenous peer or role model effects in academic performance using pretreatment measures of academic ability. It is possible that the scrambling process reduces the variation in average pretreatment ability measures to the extent that no effect is identifiable.[10] However, this result is consistent with findings in similar studies. Sacerdote (2001) reports no significant peer effects from pretreatment measures of academic ability, and Zimmerman (2003) finds small effects for only one of the three pretreatment measures of academic ability in his study between roommates at Williams College. The evidence to date suggests that any social effects arising from pretreatment measures of academic ability are apt to be modest, if they exist at all.

[10] The nature of the scrambling process discussed in section IV creates a mechanically driven negative correlation between the peer SAT score and the individual's GPA when the own SAT effect is included in the model. Specifications in appendix table A1 test the extent to which this negative covariance potentially affects the estimates in table 4. I include specifications that contain the own SAT effect (column 1), the peer SAT effect minus the own effect (column 2), and the peer SAT effect including the own effect (column 3). The estimates in columns 2 and 3 of panel A are small, positive, and insignificant. Even though they are negative in columns 4 and 5 when the own effect is included, they remain small and insignificant. Regardless of the specification, the magnitude of the effect is qualitatively negligible.

TABLE 5.—REDUCED-FORM ESTIMATES OF PEER AND ROLE MODEL EFFECTS ON ACADEMIC MAJOR AND MILITARY SERVICE CHOICES
OUTCOME VARIABLE: INDIVIDUAL-LEVEL CHOICE (AS LISTED IN COLUMN HEADINGS)

	A. Sophomores as Role Models for Plebes and Plebe Peer Effects					
	Engineering Major (1)	Social Sciences (2)	Natural Sciences (3)	All Other Majors (4)	In Army after 6 years (5)	In Army after 6 years (6)
Own effect	0.382	0.213	0.279	0.173	0.091	0.113
	(0.016)	(0.020)	(0.026)	(0.023)	(0.032)	(0.028)
Average peer effect	−0.064	−0.012	0.048	0.062	0.034	0.246
	(0.080)	(0.065)	(0.078)	(0.098)	(0.122)	(0.136)
Average role model effect	0.148	0.060	0.048	−0.085	0.156	0.021
	(0.073)	(0.058)	(0.079)	(0.094)	(0.098)	(0.135)
R^2	0.17	0.07	0.12	0.08	0.02	0.04
Observations	3,068	3,068	3,068	3,068	3,912	1,286
Pretreatment characteristics	Intend to major in engineering	Intend to major in soc. sciences	Intend to major in nat. sciences	Intend to major in all other majors	Leadership potential score/100	Anticipates an Army career
	B. Falsification: Plebes as Role Models for Sophomores and Sophomore Peer Effects					
	Engineering Major (1)	Social Sciences (2)	Natural Sciences (3)	All Other Majors (4)	In Army after 6 years (5)	In Army after 6 years (6)
Own effect	0.403	0.211	0.317	0.186	0.110	0.091
	(0.015)	(0.020)	(0.025)	(0.021)	(0.029)	(0.021)
Average peer effect	−0.080	−0.058	0.015	−0.142	0.045	0.113
	(0.084)	(0.060)	(0.079)	(0.092)	(0.083)	(0.114)
Average role model effect	−0.027	−0.078	−0.094	−0.024	−0.091	−0.113
	(0.068)	(0.062)	(0.070)	(0.086)	(0.107)	(0.104)
R^2	0.18	0.07	0.15	0.09	0.02	0.04
Observations	3,161	3,161	3,161	3,161	4,845	2,252
Pretreatment characteristics	Intend to major in engineering	Intend to major in soc. sciences	Intend to major in nat. sciences	Intend to major in all other majors	Leadership potential score/100	Anticipates an Army career

Standard errors in parentheses account for clustering at the company and year level. OLS estimates reflect linear probability regressions of individual choice as indicated in column heading (choice = 1) on corresponding peer and role model average characteristics (listed at the bottom of each column). All specifications include year dummies, a constant, and random scrambling controls: gender, race, recruited athlete, prep school, CEER, and WCS. Sample restricted to year-groups 1995–1998 for all specifications because role model measures are not available for year-groups 1992 and 1994 and proposed major data is not available for year-group 1993 for specifications in columns 1–4. Samples for specifications in column 5 are restricted to year-groups 1992–1996 because Global War on Terror requirements have precluded some officers from leaving the military. Samples for specifications in column 6 are restricted to year-groups 1995 and 1996 for a combination of aforementioned reasons. In panel B, specifications are identical to panel A, except plebes and role models are reversed. Nearly identical marginal estimates using a probit specification are found in appendix table A2. See table 1 notes for sample description.

Nonetheless, it may also be the case that choices, and not performance, are more susceptible to social influences. Therefore, I test how social groups affect two significant choices facing cadets: the choice of academic major and the decision to remain in the military past an initial five-year obligation. Undergraduate academic majors provide skills in specific disciplines, which affect job market prospects, income, and graduate school opportunities. Likewise, the decision to remain in the military past the initial period of obligation influences future job prospects, lifetime income, and the development of valuable leadership skills.

Columns 1 through 4 of table 5 contain estimates from a linear probability model for the choice of several academic majors. The left-hand-side variable is dichotomous, where a one denotes the choice of major as listed in the column headings.[11] The pretreatment characteristics are the proposed academic major of study as indicated on the Survey of Incoming Freshmen. Estimates in column 1 of panel A reveal that cadets who intended to study engineering upon their arrival at West Point are 38% more likely to select engineering than cadets who did not intend to be engineering majors. While there is no significant peer effect, the role model effect is positive and significant. A 10-percentage-point increase in the fraction of role models who intend to study engineering leads to a 1.5-percentage-point increase in the probability that a plebe will choose engineering as a major. There are no statistically significant social effects for the academic majors tested in columns 2 through 4.

A possible explanation for the presence of role model effects, but no peer effects, is that cadets must choose their academic major by the end of their sophomore year. Thus, a common topic during professional development sessions between sophomores and plebes is the choice of academic major. The effect found in engineering but not in the other majors is possibly due to West Point's strength in engineering. Table 1 shows that 44% of all incoming cadets intended to study engineering. Cadets who chose to come to West Point specifically to study engineering may have strong prior attitudes about this program, thereby exerting a greater influence on plebes.

The final two columns in table 5 address the decision to remain in the Army one year past an initial obligation period

[11] Nearly identical marginal effects from corresponding probit specifications are in appendix table A2.

of five years. Here, the left-hand-side variable equals one if the individual is still in the Army six years after graduation and zero otherwise. The first pretreatment measure of interest is the leadership potential score (LPS). As described in the data section, the Admissions Office assigns the LPS based on participation in leadership-related activities prior to entering West Point. Since the Army develops and promotes the leadership skills of officers, the LPS is likely to be correlated with an officer's decision to remain in the Army.

Estimates in column 5 show that a 100-point increase in a cadet's LPS results in a 9-percentage-point increase in the probability of remaining in the military past six years. While there is no statistically significant peer effect, there is a marginally significant role model effect. A 100-point increase in the average LPS of role models results in a 15-percentage-point-higher chance of remaining on active duty six years past graduation. Again, the presence of a role model effect seems reasonable because of the implicit leadership dimensions that accompany a role model relationship in this setting. Plebes who experience better leadership from the sophomore class may choose to spend more time in the Army when they become an officer for a couple of reasons. They may decide to stay in the Army to improve their own leadership skills, if they valued the positive leadership that they experienced during their plebe-year. They may also choose to remain in a profession where they have a comparative skill advantage, if they are a better leader because of the good leadership that they experienced during their plebe year.

The second pretreatment measure of interest is the expressed intent of a cadet to make the military a career as indicated on the Survey of Incoming Freshmen. Estimates in column 6 reveal that cadets who anticipated making the military a profession prior to entering West Point are 11 percentage points more likely to remain in the military one year past their initial obligation period than cadets who did not anticipate a military career. In this case, there is a significant peer effect, but no significant role model effect. A 10-percentage-point increase in the fraction of peers who anticipated a military career increases the chance of remaining in the military at least six years after graduation by 2.5 percentage points. This suggests that the attitudes of peers toward military service may be quite influential in shaping a cadet's own attitude toward military service, particularly during plebe year.

A falsification exercise for the role model estimates is presented in panel B. Here I reverse roles and test if plebes as a group affect the decision that a sophomore makes. For all outcomes, the own intention effects are similar in magnitude to those in panel A. However, plebes do not appear to serve as role models for sophomores.

VIII. Conclusions

Multiple sources of potential bias make identifying social group effects particularly challenging. The current literature has focused primarily on selection bias and has given less attention to bias that can result from common shocks. I present evidence suggesting that common shocks may play a significant role in the correlations found in many social effect studies. This study addresses the main identification concerns by exploiting the random assignment of plebes into companies at the U.S. Military Academy, thus relying on military institutions to define social groups and estimating the effects using reduced-form specifications.

I find little evidence of social effects in academic performance using pretreatment measures of academic ability. However, social groups at West Point do appear to impact at least two choice outcomes: role models have a positive effect on a plebe's decision to study engineering, and role models and peers have positive effects on a cadet's eventual decision to remain in the Army.

This study highlights two important areas for subsequent research on social group effects. First, future analysis should consider the potential bias associated with common shocks to the group. Second, research on social relationships other than peers and on measures of outcomes other than academic performance may provide valuable insights into other key components of the human capital production process.

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TABLE A1.—EFFECT OF MECHANICAL CORRELATION ON REDUCED-FORM ESTIMATES OF PEER AND ROLE MODEL EFFECTS
OUTCOME VARIABLE: INDIVIDUAL-LEVEL ACADEMIC SCORE (LISTED IN PANEL HEADINGS)

	A. Plebe Academic GPA				
	(1)	(2)	(3)	(4)	(5)
Own total SAT/100	0.042 (0.006)			0.042 (0.006)	0.042 (0.006)
Average peer − i total SAT/100		0.001 (0.035)		−0.002 (0.035)	
Average peer + i total SAT/100			0.033 (0.035)		−0.005 (0.036)
R^2	0.43	0.43	0.43	0.43	0.43
Observations	7,527	7,527	7,527	7,527	7,527
	B. Plebe Math Grade				
	(3)	(2)	(3)	(4)	(5)
Own math SAT/100	0.191 (0.019)			0.191 (0.019)	0.192 (0.020)
Average peer − i math SAT/100		−0.014 (0.089)		−0.029 (0.088)	
Average peer + i math SAT/100			0.066 (0.085)		−0.029 (0.092)
R^2	0.29	0.29	0.29	0.29	0.29
Observations	6,309	6,309	6,309	6,309	6,309

Standard errors in parentheses account for clustering at the company and year level. OLS estimates reflect regressions of individual-level academic outcomes as indicated in panel headings on individual and social group average SAT scores. Average peer − i is the average score of the peers in an individual cadet's company not inlcuding the individual cadet's score. Average peer + i is the average score of the peers in an individual cadet's company including the individual cadet. All specifications include year dummies, a constant, and random scrambling controls: gender, race, recruited athlete, prep school, CEER, and WCS. Sample restricted to 1993–1998 in columns 3–5 because role model measures are not available for year-group 1992. See table 1 notes for sample description.

TABLE A2.—REDUCED-FORM PROBIT ESTIMATES OF PEER AND ROLE MODEL EFFECTS ON ACADEMIC MAJOR AND MILITARY SERVICE CHOICES
OUTCOME VARIABLE: INDIVIDUAL-LEVEL CHOICE (AS LISTED IN COLUMN HEADINGS)

	A. Sophomores as Role Models for Plebes and Plebe Peer Effects					
	Engineering Major (1)	Social Sciences (2)	Natural Sciences (3)	All Other Majors (4)	In Army after 6 years (5)	In Army after 6 years (6)
Own effect	0.386 (0.016)	0.215 (0.020)	0.275 (0.026)	0.176 (0.024)	0.092 (0.033)	0.115 (0.029)
Average peer effect	−0.070 (0.094)	−0.016 (0.068)	0.034 (0.069)	0.066 (0.103)	0.034 (0.124)	0.254 (0.141)
Average role model effect	0.165 (0.084)	0.061 (0.061)	0.053 (0.072)	−0.098 (0.099)	0.156 (0.100)	0.023 (0.139)
Observations	3,068	3,068	3,068	3,068	3,912	1,286
Pretreatment characteristics	Intend to major in engineering	Intend to major in soc. sciences	Intend to major in nat. sciences	Intend to major in all other majors	Leadership potential score/100	Anticipates an Army career
	B. Falsification: Plebes as Role Models for Sophomores and Sophomore Peer Effects					
	Engineering Major (1)	Social Sciences (2)	Natural Sciences (3)	All Other Majors (4)	In Army after 6 years (5)	In Army after 6 years (6)
Own effect	0.407 (0.015)	0.210 (0.019)	0.308 (0.025)	0.189 (0.022)	0.112 (0.029)	0.093 (0.021)
Average peer effect	−0.091 (0.098)	−0.068 (0.062)	0.001 (0.073)	−0.149 (0.098)	0.046 (0.085)	0.117 (0.118)
Average role model effect	−0.035 (0.081)	−0.076 (0.063)	−0.085 (0.067)	−0.024 (0.094)	−0.091 (0.108)	−0.116 (0.107)
Observations	3,161	3,161	3,161	3,161	4,845	2,252
Pretreatment characteristics	Intend to major in engineering	Intend to major in soc. sciences	Intend to major in nat. sciences	Intend to major in all other majors	Leadership potential score/100	Anticipates an Army career

Standard errors in parentheses account for clustering at the company and year level. All estimates from these probit specifications are reported for the partial changes and are comparable to table 5. See table 5 notes for specification description and table 1 notes for sample description.