AMERICAN SOCIOLOGICAL ASSOCIATION

American Sociological Review
78(6) 1009–1032

DOI: 10.1177/0003122413505198
http://asr.sagepub.com

SAGE

The Mechanics of Social Capital and Academic Performance in an Indian College

Sharique Hasan[a] and Surendrakumar Bagde[b]

Abstract

In this article we examine how social capital affects the creation of human capital. Specifically, we study how college students' peers affect academic performance. Building on existing research, we consider the different types of peers in the academic context and the various mechanisms through which peers affect performance. We test our model using data from an engineering college in India. Our data include information about the performance of individual students as well as their randomly assigned roommates, chosen friends, and chosen study-partners. We find that students with able roommates perform better, and the magnitude of this roommate effect increases when the roommate's skills match the student's academic goals. We also find that students benefit equally from same- and different-caste roommates, suggesting that social similarity does not strengthen peer effects. Finally, although we do not find strong evidence for independent friendship or study-partner effects, our results suggest that roommates become study-partners, and in so doing, affect performance. Taken together, our findings demonstrate that peer effects are a consequential determinant of academic achievement.

Keywords

social capital, peer effects, social networks, learning, India

The metaphor of *social capital* has been an indispensable lens for scholars studying a diverse range of social and economic phenomena. The social capital approach argues that individuals are embedded in a network of interpersonal relations (Coleman 1988)—friends, co-workers, and school peers—who possess valuable skills, information, and other assets that individuals can use to get ahead. Voluminous literature shows that social capital improves labor market outcomes (Granovetter 1973; Lin 1999), innovation (Burt 2004), chances of promotion within organizations (Podolny and Baron 1997), and academic achievement (Morgan and Sorensen 1999; Sacerdote 2001; Zimmerman 2003).

Indeed, social capital may have its greatest impact in the accumulation of *human capital*—the skills and knowledge that allow individuals to perform economically valuable labor (Becker 1962; Coleman 1988). Understanding how social capital leads to human capital is essential. Education, especially a college education, is a primary vehicle through which people acquire human capital and achieve

[a]Stanford University
[b]Indian Administrative Service

Corresponding Author:
Sharique Hasan, 655 Knight Way, Stanford, CA 94305
E-mail: sharique@stanford.edu

upward mobility (Blau and Duncan 1967; Brand and Xie 2010). Within the educational context, scholars suggest that students' peers (e.g., roommates, classmates, and friends) constitute their most important relationships. These peers can affect performance in school (Coleman 1988; Sacerdote 2001) and structure behaviors outside of it (Haynie and Osgood 2005). Despite the volume of research on peers and academic achievement, considerable uncertainty remains about the specific mechanisms through which these effects operate (Sacerdote 2011).

In recent years, four issues have animated the study of peer effects in educational settings. The first concern, which has generated much of the recent discourse, is whether peer effects actually exist or merely reflect a student's capabilities (Epple and Romano 2011; Mouw 2006). This identification problem is primarily methodological, but it has raised theoretical questions about *how* peers matter, *which* peers are most important, and *how long* peer effects last. Some scholars posit that peers matter because students actively learn from them; others argue that peers serve as role models who affect a student's aspirations (Buchmann and Dalton 2002; Legewie and DiPrete 2011). Some scholars have also begun to problematize the conceptualization of the peer relation (DiMaggio and Garip 2012; Lomi et al. 2011). If some peers are more consequential than others, research should focus on determining which peers matter more (Lomi et al. 2011). Finally, uncertainty remains concerning how long peer effects last. Do peers have only short-term effects, or do they produce long-term divergences in achievement?

Resolving these puzzles about how peers matter in the accumulation of human capital is critical because we know that different social groups have differential access to high-quality peers; this fact may help to perpetuate social and economic inequalities (DiMaggio and Garip 2012; Lin 2000). Indeed, scholars and policymakers have suggested that interventions providing underprivileged students access to more capable peer groups can reduce inequality in educational achievement, thus reducing inequality in income and wealth (Hanushek, Kain, and Rivkin 2009). Moreover, a better understanding of the mechanisms through which social capital operates matters beyond secondary and postsecondary education. Greater insight into mechanisms will improve our understanding of when and why social capital affects individuals' outcomes in the labor market (Fernandez and Fernandez-Mateo 2006; Mouw 2003), the workplace (Podolny and Baron 1997), and other contexts where the resources people access through social relationships have the potential to produce divergent outcomes (Lin 1999).

We use a unique dataset from an engineering college in India that combines information about students' randomly assigned roommates with data about their friends and study-partners. We use these data to examine five questions about how peers affect academic performance. First, we examine whether roommates affect students' academic performance. Second, we study whether roommate effects are stronger when their skills match the focal student's academic goals—allowing us to test for direct and indirect peer effects. Third, we examine whether socially similar roommates—that is, from similar caste backgrounds—have a greater effect on performance than do different caste roommates. Fourth, we study whether students' friends and study-partners affect their performance. Finally, we examine the durability of peer effects beyond the first academic year. Our analyses provide greater nuance to the important debates in the peer effects and social capital literatures. Moreover, our Indian context allows us to demonstrate the broader applicability of social capital theory in an important international setting, one where education has become the primary pathway through which all segments of society achieve economic mobility (Desai and Dubey 2011; Desai and Kulkarni 2008).

THEORY AND HYPOTHESES: PEERS AND ACADEMIC ACHIEVEMENT

One domain where scholars have engaged with the concept of social capital, and specifically peer effects, is the context of college education. College is often a useful setting to study peer effects because students, many for the first time in their lives, are removed from their familiar social networks: school, friends, and family. New peers in college, particularly roommates, constitute an important source of academic and nonacademic influence. These peers possess an assortment of characteristics and resources—family backgrounds, values and orientations, and academic abilities—that could affect students' achievement. Of these, scholars believe that peers' prior academic performance captures their most relevant traits. For instance, peers' achievement can capture their higher stock of general and subject-specific knowledge, better study habits, and higher aspirations. Conversely, poor academic performance can reflect lower levels of knowledge and weaker motivation or signal participation in distracting nonacademic activities.

Because peers' academic achievement captures so many important traits, numerous studies have attempted to relate students' performance to that of their peers (Angrist and Lang 2004; Arcidiacono and Nicholson 2005; Carrell, Fullerton, and West 2009; Hanushek et al. 2003; McEwan and Soderberg 2006; Sacerdote 2001; Stinebrickner and Stinebrickner 2006; Zimmerman 2003). Despite the volume of studies, cumulative findings are mixed, as are the implications for theory (for a recent review, see Sacerdote 2011). Some studies, particularly those that analyze classroom or cohort effects, have found compelling evidence of peer effects on academic achievement (Carrell et al. 2009; Rumberger and Palardy 2005). Such compositional effects, however, may exist for several reasons: a classroom's composition may affect the level at which a teacher instructs (Duflo, Dupas, and Kremer 2011), the number of disruptions (Lazear 2001), or the environment's learning orientation (Legewie and DiPrete 2011). On the other hand, research looking at roommate effects has found only inconsistent results. Many of these roommate studies find no effects (McEwan and Soderberg 2006), small effects, or effects that exist for only a limited segment of students (Stinebrickner and Stinebrickner 2006; Zimmerman 2003). Broadly speaking, these mixed results have raised several important theoretical questions. First, scholars have become more motivated in trying to understand the channels through which these effects operate. Progress in this regard will help make sense of inconsistent results across contexts. Second, scholars have begun to think more carefully about the types of peers a student has in college and which peers matter more. Finally, questions remain about how long the peer effect on academic performance lasts. Indeed, different assumptions imply different durations of peer effects. We build on extant theory and hypothesize about *how* peers may affect academic performance, *which* peers have the greatest effect, and *how long* such a peer effect may last.

How Peers Matter: Indirect and Direct Mechanisms of Peer Influence

Scholars have generally theorized that peer effects operate through two primary channels—one *indirect* and the other *direct*. Arguments relying on the indirect channel view the mechanisms linking peer characteristics to students' performance as operating through how peers affect students' preferences, aspirations, and beliefs (Davies and Kandel 1981; Hallinan and Williams 1990; Kandel and Lesser 1969). Peers may serve as crucial role models, socializing students into having a positive and constructive outlook on academic achievement (Buchmann and Dalton 2002; Cohen 1983). A diligent peer, even one with whom the student does not frequently interact, may help a student set expectations about how many hours one should spend studying, whether one should regularly attend classes, and the satisfaction one should derive from achieving good grades (Duncan, Haller, and Portes 1968; Stinebrickner and

Stinebrickner 2006). On the other hand, academically disengaged peers may legitimize behaviors and attitudes detrimental to academic achievement. For example, peers who believe education is unimportant, or believe high levels of academic achievement do not constitute type-appropriate behavior, may make a student less interested in working hard at school or attending classes (Fryer and Torelli 2010; Legewie and DiPrete 2011). Similarly, a less academically engaged peer may—aside from reducing a student's academic motivation—push a student to engage in activities such as drinking (Kremer and Levy 2008) or drug use (Bauman and Ennett 1996; Duncan et al. 2005).

Scholars have also suggested that relationships between students and their peers may be more interactive. A peer who has previously done well in school is more academically capable. If a student is working on an assignment that he finds challenging, his peer may be a valuable resource who can clarify what the teacher is asking, help the student work through a difficult problem, or suggest additional study materials. All these activities will help the student do better academically. This direct channel, however, assumes that peer resources are tangible and specific. Furthermore, it also assumes that the relationship between students and peers is highly interactive. While students may learn the appropriate norms of being a good student through only minimal contact with peers, learning concrete analytic procedures, skills, and facts necessitates greater interaction between the two parties. This heightened interaction between a student and her peers can take several forms. First, students and peers can study together. Second, a student, even one who does not regularly study with her peers, may consult them when it is necessary. The direct channel implies that more able peers will be more useful for a student when she is attempting to learn.

Both the direct and indirect channels imply a positive relationship between students' own performance and that of their peers. Thus, we hypothesize the following:

Hypothesis 1: Students with more academically able roommates will achieve greater academic performance.

Matching Peer Resources and Student Goals

Given that both direct and indirect accounts are consistent with Hypothesis 1, it is useful to consider when evidence for one account can be distinguished from the other. One important consideration is that students in most educational settings do not desire just to do well overall, but to do well in a specific academic subject. Given the specificity of students' academic goals, the indirect and direct arguments imply different effects depending on peers' different resources and knowledge. If peers do affect performance indirectly—by shaping a student's motivation to study—then the actual content of a peer's knowledge base should matter less than the motivation gleaned from that peer's high academic performance. For example, a highly motivated peer who is skilled in math, but not in English, should affect a student's performance in both math *and* English. On the other hand, if peers are more actively involved in a student's learning process, then the peer effect may depend on the match between a student's academic goals and the resources—the specific skills or knowledge—possessed by her peers. Consider a student taking an algebra course whose roommate is highly skilled in algebra. This roommate can be exceptionally useful: she can explain a concept or work through a problem with the student. On the other hand, if the roommate is skilled in French but not mathematics, then regardless of how helpful or involved the roommate is, the student will derive less benefit than if the roommate had the relevant mathematical skills. If the direct channel is stronger, we thus arrive at the following hypothesis:

Hypothesis 2: The academic achievement of a student's peers will have a greater effect on the student's academic performance when there is a match between peers' resources and the focal student's goals.

Which Peers Matter? The Importance of Social Similarity, Friendships, and Study Relations

The indirect and direct channels provide clues about *how* peers matter, but there remains significant debate about *which* peers matter (DiMaggio and Garip 2012; Lomi et al. 2011). A persistent concern about the peer effects literature is its inability to differentiate between different types of social relations: copresence is often assumed to imply meaningful interaction. This assumption is often problematic. A student may have richer and more frequent interactions with only a subset of her peers. Given the potential for heterogeneous effects across types of peers, it is worthwhile to think about whether certain peers may be of greater consequence than others.

The extent to which a pair of individuals shares some social or demographic characteristic is an important dimension in determining interaction. A large and diverse body of literature has found that homophily, individuals' tendency to form social relations with similar others, has a significant effect on social interaction (McPherson, Smith-Lovin, and Cook 2001). People tend to interact and form social ties at a higher rate with others similar to them in age, ethnicity, education, and a host of other important characteristics (McPherson et al. 2001; Wimmer and Lewis 2010). Many reasons exist for why individuals desire greater interaction with socially similar others: they may have similar upbringings, have similar outlooks on important issues, and participate in similar activities. The more relevant the social characteristic, the more it will cause homophilous sorting (Mehra, Kilduff, and Brass 1998) and result in stronger ties between socially similar individuals (Reagans 2011). Consequently, similar individuals may have more frequent interactions; these interactions may be more intense and more intimate; and the relationship may be characterized by greater motivation, trust, and patience—characteristics required for transmitting complex and multifaceted information (Aral and Van Alstyne 2011).

The Social Significance of Caste

Given that the setting of this study is India, it is useful to describe an important social characteristic in this context: *caste* (Desai and Dubey 2011; Ghurye 2008; Srinivas 1957). Caste remains important for gauging social similarity, and thus for understanding interaction patterns, for several reasons. Historically, one of the primary functions of the caste system was to regulate interpersonal interaction in both secular and religious realms. The caste system did this by first dividing society into five hierarchically ordered and closed hereditary groups and then specifying the permissible interactions between groups (Beteille 1991; Ghurye 2008; Srinivas 1957). Atop this hierarchy were three groups: Brahmins (the priests), Kshatriyas (the warriors and administrators), and Vaisyas (the traders) (Shah 2006). These three castes enjoyed the greatest freedom and economic well-being, although significant restrictions on social interaction and marriage existed among these groups, too (Dumont 1980). Today, the Indian government classifies these three caste groups as "forward castes" or the "open category." The next set of castes is the Shudra, the peasants and laborers who served the first three castes. Individuals descended from Shudra origins are now called the "backward castes."[1] Although no officially recognized caste group exists after the Shudra in religious terms, a set of castes known as the "untouchables" constituted the lowest rung of the system—so low that they had *no* caste. These formerly "untouchable" castes are known today as Dalits—the oppressed—and are classified by the Indian government as "scheduled castes." Historically, the scheduled castes faced the most discrimination. They were considered so polluting that merely touching them was prohibited (Shah 2006). Finally, a set of communities collectively known as the Adivasis or "scheduled tribes" were members of indigenous tribes who lived in remote areas and thus had a distinct identity outside of traditional Hindu society. Social interactions among individuals from

different castes were governed by rules restricting intermarriage, the sharing of food, and even touch (Dumont 1980; Ghurye 2008; Shah 1985; Srinivas 1957). Consequently, caste boundaries continue to result in low levels of inter-caste interaction.

Aside from the religious rules that restricted inter-caste interaction, the caste system created significant economic and geographic divides in Indian society. The caste system placed important restrictions on the lower castes' access to education and valuable occupations. Such restrictions resulted in the forward castes becoming the most economically well-off, followed by the backward castes, scheduled castes (Desai and Dubey 2011; Shah 2006), and then scheduled tribes (Xaxa 2001). In recent years, government mandated quotas have increased lower castes' access to higher education and more economically valuable occupations (Chitnis 1972; Cunningham and Menron 1998; Narasimhan 2002). Some commentators argue that due to such policies, caste no longer reflects deep economic divides. Some even contend that the beneficiaries of the quota systems are merely lower-caste students from higher socioeconomic backgrounds; however, empirical research generally does not support these claims (Bertrand, Hanna, and Mullainathan 2010; Desai and Kulkarni 2008). Although caste-based economic disparities have declined, caste remains a significant correlate of economic inequality (Desai and Dubey 2011). Similarly, the caste system has long been associated with geographic and organizational segregation—lower castes were often forced to live at the boundaries of villages and were prevented from entering educational institutions, temples, and town squares (Shah 2006). However, because the Indian constitution outlaws discrimination based on caste, and the quota system has brought individuals from all parts of the caste hierarchy together into close proximity, reductions in physical boundaries may make caste boundaries less pronounced (Pettigrew and Tropp 2006; Srinivas 1957). Generally, although physical and geographic boundaries have declined, evidence suggests that caste-based homophily strongly influences outcomes such as the choice of a spouse (95 percent of Indian women marry within their caste) and the choice to participate in caste-specific civic, educational, and religious organizations (Desai and Dubey 2011). Moreover, recent evidence suggests that caste-based segregation into neighborhoods is greater than socioeconomic segregation in major Indian cities (Vithayathil and Singh 2012).

Extant theory therefore suggests that economic disparities between castes and their segregation on several dimensions will reinforce and make more salient the social boundaries between members of different castes (Blau and Schwartz 1984; Reagans 2011). We thus hypothesize that identification and interaction will be greater with same-caste peers than with different-caste peers:

> *Hypothesis 3:* The academic achievement of students' same-caste peers will have a greater effect on students' academic performance than will the achievement of their different-caste peers.

The Effect of Chosen Friends and Study-Partners

Students are likely more affected by peers whom they consider their friends and with whom they study, compared to peers with whom they rarely interact. Lomi and colleagues (2011:1058) argue that "it stands to reason that it should matter greatly who" the influential peers are. They suggest that although it may be analytically expedient to define a student's peer group as her roommates, a student may interact with only a subset of these peers. This subset—namely, peers whom a student considers friends—may have the most influence on a student's actions and behaviors.

Students' chosen friends and study-partners will have a greater effect on their academic performance, through both indirect and direct channels. With respect to the indirect channel,

students' friends and study-partners are the peers they observe most frequently and most intimately. Students will know more about their friends' and study-partners' habits, attitudes, and orientations toward learning than about peers with whom they do not frequently interact. Furthermore, students may care more about what their friends think about them; thus, students will more readily adopt behaviors that conform to friends' expectations. Regarding the direct channel, friends and study-partners are usually the peers with whom a student frequently studies. They also have more motivation to help the student when she has a problem or concern. Even among a student's friends and study-partners, some may have greater motivation to help than others. Social networks literature suggests that strong relations, often characterized by agreement about the nature and content of a relation (e.g., both individuals consider each other friends), may result in more frequent and deeper interactions between students than will weak relations (Krackhardt 1992). Consequently, strong ties may be more willing to help, more available, and better able to understand a student's needs than would weaker ties (Aral and Van Alstyne 2011). We thus hypothesize the following:

Hypothesis 4a: The academic achievement of students' friends and study-partners will mediate the roommate effect on students' academic performance.

Hypothesis 4b: The academic achievement of students' strong friends and study-partners will have a greater effect than that of weak friends and study-partners on students' academic performance.

How Long Do Peer Effects Last?

The final question in the peer effects literature concerns whether students' peers have an enduring impact on academic outcomes (Epple and Romano 2011; Zimmerman 2003). The direct and indirect channels imply different predictions about the durability of peer effects. Regarding the indirect channel, if a student internalizes her roommate's norms, she should continue to experience higher levels of performance even if she no longer has frequent interactions with her peer. If, however, peers' effect on aspirations is fleeting—mattering more when students regularly observe their peers—then peer effects on academic performance should decline over time. Similarly, if peer effects operate through the direct channel, then peer effects should decline if a student and her peer are no longer in frequent contact. If the primary channel through which peer effects operate is *indirect*—changing a student's motivations and causing her to internalize her peers' norms—then we would predict the following:

Hypothesis 5: The academic achievement of a student's first-year roommates will continue to affect that student's second-year academic performance.

DATA AND METHODS

Assessing the relative merits of each hypothesis requires data with several important properties. Of primary importance is that the data include the academic performance of all students, including their pre-college and college performance across multiple years. Performance should ideally be measured across students in a comparable manner to minimize measurement error. Second, to test our resource-matching hypothesis, we will need disaggregated performance data on several academic subjects. Third, to minimize problems of self-selection into peer groups introducing bias into estimates of peer effects, a student's peers should be randomly assigned (further discussed below). Fourth, to examine the differential impact of socially similar and dissimilar peers in the Indian context, data should contain information about all students' caste background. Finally, to examine whether friends or study-partners affect academic performance, data should include information on these relations, too.

Our analysis uses a dataset that possesses these properties. We use data on 2,122 students

studying in an engineering college in a southern state of India. These students were members of the college's first admitted cohort; they represent 98 percent of all enrolled students that year. Students admitted to the college came primarily from within the state and were generally within the top 10 percent of high school students. Based on incoming students' test scores, the university is similar to a good U.S. state school, rather than an elite private university. We have detailed data on the five dimensions described in the previous paragraph. The following subsections describe the important features of our setting and the construction of our variables of interest.

Admissions

The baseline admissions procedure for a government recognized college in India is the caste-based quota system (Cunningham and Menron 1998; Desai and Kulkarni 2008; Narasimhan 2002). The government requires colleges to reserve a specified proportion of total seats for scheduled caste (SC), scheduled tribe (ST), and backward caste (BC) students (Chalam 1990). Our college has the following baseline quota requirements: 15 percent of seats are reserved for SC students, 6 percent for ST, and 25 percent for BC. Many states divide the BC castes into subcategories, with a proportion of the total BC quota reserved for each. In the state where this engineering college is located, the subcategory division is as follows: 7 percent for BC-A, 10 percent for BC-B, 1 percent for BC-C, and 7 percent for BC-D. The college classifies the remaining 54 percent of seats as "open category." Because quota eligible students who score well on the entrance exam can elect admission via the open category, more students from the disadvantaged castes are sometimes admitted into the college than the minimum quota amount. At this university, SC students represent 18 percent of the enrolled population, ST 8 percent, and BC students from the four BC categories comprise 57.4 percent; the remaining students are open category students. The university admitted approximately 18.3 percent of the SC students, 31.8 percent of ST students, and 56 percent of BC students through the open category quota; the remaining quota-eligible students were admitted through the reserved seats for each category. Students admitted through the quota system usually have lower entrance examination scores than do nonquota students; the quota system thus leads to increased variation in the overall population of students (Fryer, Loury, and Yuret 2008).[2]

Entrance and Roommate Assignment

The students in our dataset are the first cohort admitted to this engineering college. During their first year, they were the only students living on campus. Although this situation is unique, it is valuable for cleanly identifying the social-capital effect of peers for two reasons: (1) the data include nearly the entire population of potential peers, and (2) the engineering college requires all students to live on campus and in university housing. The university's standard policy of randomly assigning all students to dormitory rooms before arriving on campus is useful for identifying causal peer effects. One exception to pure random assignment is that male and female students live in different dormitories. An administrator used Microsoft Excel to assign students to rooms in the following manner: he divided dormitory rooms into those for men and those for women and then assigned students to rooms until all students had a room. To our knowledge, and the knowledge of administrators we spoke with at the university, neither students nor parents requested changes in room assignment. At the end of the assignment procedure, each of the 92 dormitory rooms contained 20 to 25 students of the same sex. In the second academic year, the college randomly re-assigned students to new roommates in different buildings.

During the first year, each room was a rectangular physical space with no dividing walls. Beds were organized such that students were spread uniformly across the room; no bunk beds were used.[3] The average size of a

student's peer group is the set of 23 other randomly assigned students who shared the same room. Along with being sleeping quarters, students used the rooms for studying and socializing. In this setting, students interacted individually with some roommates and collectively with others when studying together.

Data about Friends and Study-Partners

During the third week of the first academic year, students were surveyed about their social networks at the university. At this point, students were already living in their dormitory rooms and had begun taking classes. Examinations, however, had not been held. A survey was distributed to all enrolled students asking them to list up to 12 individuals they considered friends ("list the first name, last name, hostel and district of the students at [the college] who you consider your close friends"). The survey also asked students to separately list their study-partners ("list the first name, last name, hostel and district of the students with whom you study").[4] Students were provided space to list up to 12 individuals for each category, but they were told they could list as few or as many as they would like. Students were asked to return the completed survey by the end of the day. We matched 83 percent (N = 1,755) of our survey responses to the academic data. To examine whether any differences between respondents and nonrespondents existed, we estimated logistic regressions. We did not find any consistent relationships between student characteristics such as pretreatment academic performance, gender, caste, and survey response.

Dependent Variables: Measures of Academic Performance

Our data include a comparable set of pre- and post-treatment measures of academic performance. All students offered admission to this university took the same multi-day, government-administered board exam in the same academic year. This board examination consisted of subtests in various subjects ranging from mathematics to the social sciences. For our pretreatment measures, we used each student's performance on this board exam to construct three variables: *own score*—a student's aggregate score on the board examination across all subjects; *own math score*—a student's score on the mathematics sub-examination; and *own socsci score*—a student's score on the social science sub-examination. Our dependent variables, students' post-treatment academic performance (i.e., college performance), were measured at three points in time: the end of the second, third, and fourth semesters.[5] At this college, students take the same classes[6] in the same subjects in their first and second years. At the end of the second, third, and fourth semesters, all students in our sample took extensive paper-and-pencil examinations that lasted several days and reflected the content they had learned during the semester. Subjects covered in these examinations included chemistry, physics, mathematics, and English. We used the total score a student received on her semester two, three, and four examinations to construct three dependent variables: *second-semester total score (self),* *third-semester total score (self),* and *fourth-semester total score (self)*. To test for resource matching, we constructed three additional subject-specific measures of post-treatment academic performance: *second-semester physics/chem.* *second-semester math,* and *second-semester English*.

To ease the comparison of effect sizes across the years, we normalized academic performance variables so they have a mean of zero and a standard deviation of one. Distributions of the standardized pre- and post-treatment academic performance are presented in Figures S1, S2, and S3 in the online supplement.

Independent Variables: Roommate, Friend, and Study-Partner Effects

The first independent variable of interest in our study is the average pretreatment academic achievement of the focal student's

roommates—called *roommates' score*. For roommates' score to have a causal interpretation, two concerns—the *reflection* and *selection* problems—must be addressed (Manski 1993, 1999). The *reflection* problem occurs when a focal student's academic performance is measured at the same time as her peers' performance. When a student's own performance and that of her peers are measured simultaneously, it is difficult to tell whether the focal student affected her roommates or vice versa. Furthermore, this problem leaves open the possibility that common shocks, such as noisy neighbors, poor facilities, or other contemporaneous features of the environment, induced the correlation. Resolving the reflection problem requires lagged measures of peer performance. The second problem is often called the *selection* problem. This occurs when people choose their social relations and researchers cannot observe all the bases of selection. Such selection on unobserved characteristics can bias the estimate of a peer effect, causing researchers to infer a peer effect when none exists. The ideal way to address selection effects is to randomly assign peers to a student. Random assignment breaks the correlation between observed and unobserved characteristics of a focal student's peers, thus making a causal interpretation possible.

The construction of our roommate variables addresses both the reflection and selection problems. Randomized roommate assignment resolves the selection problem. And because roommates' scores are measured before students enter college, and before roommates are assigned, the reflection problem is resolved. We computed the roommate score variable as the mean performance of a focal student's roommates on the high-school board exam. We calculated the roommates variable using the aggregate score (*roommates [score]*) and disaggregated scores in mathematics (*roommates [math]*) and social science (*roommates [social science]*). These variables exclude the focal student's achievement. Statistical tests evaluating the effectiveness of the random assignment of roommates can be found in Table S1 in the online supplement.

Same- and Different-Caste Roommate Effects

We computed two additional roommate performance variables: *roommates (same caste)* and *roommates (different caste)*. The first—*roommates (same caste)*—is the average pretreatment performance of a student's same-caste roommates. A concern about this variable is that a category such as SC constitutes multiple castes. Although this fact may introduce some level of error in our estimate, two castes make up over 90 percent of all scheduled castes in the state where our engineering college is located. Similarly, one tribe constitutes 41.4 percent of all scheduled tribes in our state, with three other tribes making up another 29.2 percent. In our dataset, we can separately identify students from the four subcategories of the larger BC category, namely BC-A, BC-B, BC-C, and BC-D. Our data also include an indicator variable denoting that a student is from the Muslim community.[7] Thus, same-caste roommates share with the focal student one of the following eight classifications: SC, ST, BC-A, BC-B, BC-C, BC-D, Muslim, or OC.[8] The second variable, *roommates (different caste),* is the mean pretreatment performance of a focal student's different-caste roommates. For example, *roommates (different caste)* for an SC student is the average pretreatment achievement of her non-SC roommates. To interpret these two variables in a causal manner, we control for a student's own caste category. Including own caste variables causes the correlation between students' own pretreatment performance and that of their same-caste roommates to approach zero.

Friend and Study-Partner Effects

In addition to the roommate variables, we created variables that capture the performance of a student's friends and study-partners. As mentioned earlier, students completed a survey in which they listed up to 12 names of individuals (at the university) whom they considered friends and study-partners. On average, students listed 6.78 friends and 5.45

study-partners. Using this information, we created two levels of tie-strength for each relation. We considered a weak friendship or study-partner relation to exist between two students if *at least* one student in the dyad considered the other a friend or study partner, respectively. Similarly, we considered a strong friendship or study-partner relation to exist between two students if both students considered the other a friend or study partner, respectively. The strong friendship variables are thus a subset of the weak friendship variables. Using these four relations, we created four variables: *friend (weak), friend (strong), study-partner (weak),* and *study-partner (strong)*. These variables measure the average pretreatment scores of a focal student's strong and weak friends and study-partners.

Control Variables

A key strength of our study is that roommates were randomly assigned. However, we also include a substantial set of control variables in our analysis to ensure the exogeneity of our main independent variables (Imai, King, and Stuart 2008). Our estimations include a variable indicating whether a student is male or female; approximately 44.3 percent of students are female. Our dataset also includes information about students' caste category. In our models, the caste variable indicates students' actual caste category and not the category through which students were admitted. That is, a BC-A student admitted through an open category seat is classified as BC-A, not OC. Approximately 63 percent of students attended local government high schools, which often have fewer resources than private schools. We include an indicator variable for *government school* to capture any differences in student performance arising from this fact.

Finally, students enrolled at this university come from 23 districts across the state, although 88 percent of students hail from just nine districts. Our models include fixed effects for each district. Finally, we cluster standard errors at the dormitory-room level to account for multiple observations within a room. Table 1 summarizes the relevant variables.

RESULTS

Are There Roommate Effects?

We begin our analysis by examining whether students' roommates affected their academic performance in the first year (Hypothesis 1). We regress a student's performance in semester two on the *roommates' score* variable. Table 2 presents the first set of estimation results. All models, except Model 1, include the control variables. All models cluster correct standard errors at the room level.

Column 1 reports estimates of the regression of a student's performance in semester two on that of her roommates. This model does not include the control variables. The coefficient is positive and statistically significant. In column 2, we re-estimate this model; this time the control variables are included in our estimation. The coefficient on the roommate variable remains positive and statistically significant ($t = 3.27$). The magnitude indicates that a one-standard-deviation increase in the average pretreatment score of a focal student's roommates is equivalent to a .095 standard deviation increase in her examination scores in the second semester. In column 3, we include the focal student's pretreatment score into our model. Including this variable does not significantly change the coefficient or the level of statistical significance of the roommate effect. We test the equality of the two roommate score coefficients across Models 2 and 3 and find that the difference is not significantly different from zero (diff = –.007, $p = .571$). Because the coefficients on *roommates' score* and *own score* quantify the magnitude of change in second-semester examination scores corresponding to a one-standard-deviation change in these variables, dividing the coefficient on *roommates' score* by that of *own score* indicates that the relative magnitude of the roommate effect equals a .17 standard deviation increase in one's own performance.[9]

We argue that this test provides causal evidence for a roommate effect. First, the reflection problem does not bias our estimate because the academic performance of a student's roommates is measured before students enter the college (Manski 1993, 1999). It is

Table 1. Summary Statistics of Key Variables Used in Analyses

	Observations	Mean	SD	Min.	Max.
Roommate Effects					
Roommates' score	2,122	.000	1.000	–3.152	2.537
Roommates (same caste)	1,968	–.000	1.000	–4.924	2.774
Roommates (different caste)	2,122	–.000	1.000	–2.872	3.446
Roommates (top 20)	2,122	.200	.400	.000	1.000
Roommates (bottom 20)	2,122	.200	.400	.000	1.000
Roommates (math)	2,122	–.000	1.000	–3.120	2.333
Roommates (social science)	2,122	.000	1.000	–2.911	2.379
Relational Effects					
Friends (strong)	2,121	.000	1.000	–5.533	2.917
Friends (weak)	2,121	.000	1.000	–6.110	2.758
Study-partners (strong)	2,121	.000	1.000	–9.451	3.369
Study-partners (weak)	2,121	.000	1.000	–4.975	2.706
Pretreatment Performance					
Own score	2,122	–.000	1.000	–5.723	2.168
Own math score	2,122	–.000	1.000	–5.318	1.193
Own social science score	2,122	.000	1.000	–5.701	1.670
Dependent Variables					
Sem. 2 total score (self)	2,122	.000	1.000	–2.402	2.929
Sem. 3 total score (self)	2,116	.000	1.000	–3.007	2.940
Sem. 4 total score (self)	2,114	.000	1.000	–7.828	2.127
Sem. 2 physics/chem. (self)	2,122	–.000	1.000	–2.887	3.085
Sem. 2 math (self)	2,122	.000	1.000	–2.507	1.980
Sem. 2 English (self)	2,122	.000	1.000	–1.871	3.523
Control Variables					
Female	2,122	.443	.497	.000	1.000
SC	2,122	.186	.389	.000	1.000
ST	2,122	.080	.272	.000	1.000
BC-A	2,122	.134	.341	.000	1.000
BC-B	2,122	.252	.434	.000	1.000
BC-C	2,122	.011	.106	.000	1.000
BC-D	2,122	.176	.381	.000	1.000
Muslim	2,122	.040	.196	.000	1.000
Open category	2,122	.120	.325	.000	1.000
Government school	2,122	.635	.482	.000	1.000
Observations	2,122				

therefore unlikely that shared shocks, such as noisy neighbors, poor facilities, or other contemporaneous features of the environment or context, are the cause of the observed correlation. Second, because roommates are randomly assigned, selection of peer groups on unobservable characteristics is not an issue. Thus, our results strongly support Hypothesis 1. Qualitatively, these results also suggest that social capital, in the form of roommates, is critical in producing (or limiting the production of) human capital. Students with roommates who previously performed well achieve higher performance; conversely, those with roommates who have not previously done well perform worse.

Table 2. Are There Roommate Effects? Second-Semester Academic Performance Regressed On Roommates' Pretreatment Academic Performance

	Second-Semester Total Score			
	(1)	(2)	(3)	(4)
Roommates' Score	.122**	.095**	.088**	.088**
	(.032)	(.029)	(.023)	(.023)
Own Score			.509**	.509**
			(.022)	(.022)
Roommates' x Own Score				.010
				(.020)
Female	−.585**	−.659**	−.627**	−.627**
	(.059)	(.057)	(.053)	(.053)
SC		−.745**	−.302**	−.302**
		(.081)	(.071)	(.071)
ST		−.801**	−.414**	−.414**
		(.100)	(.087)	(.087)
BC-A		−.476**	−.259**	−.259**
		(.085)	(.071)	(.071)
BC-B		−.230**	−.146*	−.146*
		(.081)	(.066)	(.066)
BC-C		−.026	.156	.155
		(.231)	(.210)	(.210)
BC-D		−.341**	−.227**	−.227**
		(.081)	(.071)	(.071)
Muslim		−.624**	−.229	−.230
		(.131)	(.129)	(.129)
Government School		−.479**	−.191**	−.191**
		(.044)	(.036)	(.036)
Control Variables	No	Yes	Yes	Yes
District FE	No	Yes	Yes	Yes
Observations	2,122	2,122	2,122	2,122
Adjusted R^2		.224	.416	.415

Note: Coefficients on one's own and peer academic performance are standardized. Standard errors clustered at the room level in all models. All models included fixed effects for individual background variables and home district.
*$p < .05$; **$p < .01$ (two-tailed tests).

Some prior literature suggests that one's own achievement conditions how much peers affect academic achievement. For instance, Zimmerman (2003) finds that students with average levels of achievement are more susceptible to roommate effects compared to students at the upper and lower tails. We test this intuition in column 4 by interacting a student's own pretreatment score with her roommates' scores. Coefficients for the two key variables remain unchanged and the interaction term is not significant in our model ($t = .41$). We do not find evidence that roommate effects vary with a student's own level of achievement. We conducted similar tests using discretized versions of *own score* and interacted them with *roommates' score* and found similar results. This suggests that roommate effects are consequential for students across the entire range of achievement, thus providing strong support for Hypothesis 1. In addition, we estimated several nonparametric models examining whether roommate effects on second-semester achievement were

Table 3. Are Social Capital Effects Stronger within Disciplinary Subjects? Second-Semester Academic Performance in Chemistry/Physics, Mathematics, and English, Regressed on Roommates' Pretreatment Academic Performance in Mathematics and Social Science

	Sem. 2 Chem./ Physics	Sem. 2 Chem./ Physics	Sem. 2 Math	Sem. 2 Math	Sem. 2 English	Sem. 2 English
	(1)	(2)	(3)	(4)	(5)	(6)
Own Math Score	.323**	.324**	.426**	.428**	.271**	.272**
	(.024)	(.024)	(.027)	(.027)	(.023)	(.024)
Own SocSci Score	.112**	.110**	.052*	.052*	.125**	.125**
	(.020)	(.020)	(.021)	(.021)	(.021)	(.021)
Roommates (Math)	.084**		.074**		.032	
	(.027)		(.028)		(.030)	
Roommates (SocSci)		.0601*		.008		.006
		(.026)		(.029)		(.025)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,122	2,122	2,122	2,122	2,122	2,122
Adjusted R^2	.314	.310	.326	.321	.244	.243

Note: Coefficients on one's own and peer academic performance are standardized. Standard errors clustered at the room level in all models. All models included fixed effects for individual background variables and home district.
*$p < .05$; **$p < .01$ (two-tailed tests).

nonlinear; our results suggest the roommate effect is appropriately specified as a linear term.

Finally, we note that even in the models that control for one's own prior performance, gender, high school type, and district of origin, students from scheduled castes, scheduled tribes, and BC-A, BC-B, and BC-D castes still have lower average levels of performance than do forward caste students. There may be several reasons for this residual gap, including caste differences in help-seeking behavior, differences in faculty attention by caste, and other peers not reflected in the set of randomly assigned roommates—factors we cannot capture in our models.

Resource Matching: Are Social Capital Effects Stronger within Subjects?

Next, we examine whether peer effects are stronger when a match exists between roommates' resources and a student's academic goals (Hypothesis 2). As previously mentioned, we computed students pre- and post-treatment aggregate scores from specific subjects. Regarding pretreatment scores, we have data on how students performed in mathematics and social science. With respect to post-treatment scores, we have disaggregated data on how students performed in physics/chemistry, mathematics, and English. We should note that within-student scores in various subjects are correlated. Students who did well in mathematics also did well in the social sciences. However, a student's performance across subjects is not perfectly correlated. We thus ask whether having roommates skilled in social science, for instance, helps a focal student improve her score in mathematics. Similarly, we ask whether roommates skilled in mathematics (because they have good study habits) will affect a focal student's performance in English. Table 3 provides some evidence that roommate effects depend on whether a match exists between roommates' skills and the subject a focal student is studying. The table presents estimates that examine how focal students perform in chemistry/physics, mathematics, and English as a function of their roommates' performance

Table 4. Do Roommates from Same and Different Castes Have Differential Effects? Second-Semester Academic Performance Regressed on Same- and Different-Caste Roommates' Pretreatment Academic Performance

	Second-Semester Total Score			
	(1)	(2)	(3)	(4)
Own Score	.498**	.511**	.497**	.497**
	(.022)	(.022)	(.022)	(.022)
Roommates (Same Caste)	.066**		.063**	.062**
	(.019)		(.018)	(.018)
Roommates (Different Caste)		.069**	.066**	.072**
		(.023)	(.022)	(.024)
Number of Other-Caste Peers				.009
				(.009)
Control Variables	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Observations	1,968	2,122	1,968	1,968
Adjusted R^2	.417	.412	.421	.420

Note: Coefficients on one's own and peer academic performance are standardized. Standard errors clustered at the room level in all models. All models included fixed effects for individual background variables and home district.
*$p < .05$; **$p < .01$ (two-tailed tests).

in mathematics and social science. All models include the control variables, and standard errors are cluster corrected at the room level.

Based on the skill and knowledge requirements of each subject, we would expect that roommates skilled in mathematics are more beneficial to a focal student studying for math or science, rather than English. On the other hand, we would predict that having roommates skilled in social science should not affect the focal student's performance in math or science. Our results do indicate a relationship between the skills of a focal student's roommates and the focal student's subsequent performance in specific fields of study. Focal students who have mathematically skilled roommates do better in mathematics and science but not English. Similarly, roommates skilled in social science have little effect on the focal student's performance in mathematics or English. Finally, we do observe a correlation between roommates' social science score and the focal student's subsequent score in science. If we include mathematics performance in our model, the social science variable is no longer significant ($p = .751$), but the math score remains significant ($p < .05$). Our results thus provide modest support for Hypothesis 2.

Do Roommates from Same and Different Castes Have Differential Effects?

Table 4 reports tests of Hypothesis 3 that examine whether same-caste roommates have a greater effect than different-caste roommates on students' academic performance. In column 1, we include the *roommates (same caste)* variable, which measures the mean performance of students' same-caste roommates on their academic performance. The effect is positive and significant, suggesting that students' randomly assigned same-caste roommates affect their subsequent academic performance. In column 2, the variable *roommates (different caste),* measuring the mean performance of different-caste roommates, is also positive and significant. The magnitude is similar to that of the same-caste variable. In column 3, we include both variables together. We again find that both variables are positive and significant and have similar magnitudes.

As a further test of Hypothesis 3, we examine whether the magnitudes of these two variables are equal to each other. An F-test finds no significant difference between the effect of a focal student's same- and different-caste peers ($F[1,91] = .01$, $p = .904$). Our tests therefore do not support Hypothesis 3: same- and different-caste roommates appear to have equivalent effects on how well a student performs.

One concern is that the number of same- and different-caste roommates for a given student may vary; thus, we need to control for the number of different-caste peers that constitute a student's social context. In column 4 of Table 4, we include a variable counting the number of other-caste roommates for each student. This variable is not significant, but the other two variables remain positive and significant. A test of the equality of the main coefficients in column 4 also indicates that same- and different-caste peers have effects of similar magnitude ($F[1,91] = .14$, $p = .710$). Thus, we cannot reject the null hypothesis that same- and different-caste roommates equally affect students. To further test the robustness of this result, we interacted the variable measuring the performance of a focal student's roommates of the same caste and the indicator for a focal student's own caste to examine whether this effect varies by caste. The interactions were not significant in any of the models. Why do same- and different-caste roommates have similar effects? We believe one explanation is that propinquity may reduce the effects of homophily based on social similarity. Students from different castes, because they are living together in the same room, interact more frequently in the college context than outside it. Furthermore, college students from different castes admitted to good universities are similar in another respect: they have similar levels of merit, which equalizes them in an important respect. Outside the college context, individuals from different castes often live in different parts of town, their parents are often employed in occupations with different status, and they may attend different schools; inter-caste interaction is thus significantly higher in college where these structural barriers are lower.

Are Roommate Effects Actually Friendship or Study-Partner Effects?

Thus far, our results have demonstrated that students' roommates affect their academic performance. However, students also create their own social networks at college. These networks consist of peers with whom students study and consider to be friends. In the analysis below, we examine the extent to which friendship and study-partner effects can be distinguished from roommate effects. We begin this analysis by first relating students' own pretreatment performance to that of their friends and study-partners. Whereas we found no correlation between a student's pretreatment performance and that of her randomly assigned roommates, we find that a student's weak friends ($p < .01$), strong friends ($p < .05$), weak study-partners ($p < .01$), and strong study-partners ($p < .01$) all have similar levels of pretreatment achievement to her own. This suggests that students select friends and study-partners similar to themselves, in academic ability at the very least.

Noting this potential for self-selection on unobservable characteristics, we begin by analyzing the effect of weak and strong friends on a student's performance in the second semester. Table 5 presents these results. After controlling for a student's own pretreatment performance, friends (both weak and strong) do not seem to have a large and independent effect on academic performance. This is not to say that friends have no effect, but rather that a friendship effect may be mediated through the selection of friends with similar characteristics. Nevertheless, the roommate effect remains and is still 14 percent the size of one's own prior performance.

In Table 6, we assess whether study-partners affect a student's academic performance. These results are similar to those we find for friendships. We find no statistically significant effect of weak study-partners on academic performance with or without the control variables. However, we find a moderately sized effect of strong study-partners, but this declines in magnitude as we include controls for a student's own performance and the performance

Table 5. Are Roommate Effects Actually Friendship Effects? Second-Semester Academic Performance Regressed on Friends' Performance

	Second-Semester Total Score					
	(1)	(2)	(3)	(4)	(5)	(6)
Friends (Strong)	.044	.019	.006			
	(.024)	(.020)	(.019)			
Friends (Weak)				.062**	.024	.006
				(.021)	(.019)	(.019)
Own Score		.501**	.500**		.500**	.500**
		(.024)	(.024)		(.024)	(.024)
Roommates' Score			.071**			.071**
			(.023)			(.024)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,755	1,755	1,755	1,755	1,755	1,755
Adjusted R^2	.213	.405	.409	.215	.405	.409

Note: Coefficients on one's own and peer academic performance are standardized. Standard errors clustered at the room level in all models. All models included fixed effects for individual background variables and home district.
*$p < .05$; **$p < .01$ (two-tailed tests).

Table 6. Are Roommate Effects Actually Study-Partner Effects? Second-Semester Academic Performance Regressed on Study-Partners' Performance

	Second-Semester Total Score					
	(1)	(2)	(3)	(4)	(5)	(6)
Study-Partners (Strong)	.086**	.051**	.042*			
	(.020)	(.018)	(.017)			
Study-Partners (Weak)				.044	.015	−.005
				(.026)	(.022)	(.021)
Own Score		.497**	.496**		.501**	.501**
		(.024)	(.023)		(.024)	(.024)
Roommates' Score			.065**			.074**
			(.023)			(.023)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,755	1,755	1,755	1,755	1,755	1,755
Adjusted R^2	.220	.408	.411	.213	.405	.409

Note: Coefficients on one's own and peer academic performance are standardized. Standard errors clustered at the room level in all models. All models included fixed effects for individual background variables and home district.
*$p < .05$; **$p < .01$ (two-tailed tests).

Table 7. How Long Do Roommate Effects Last? Third- and Fourth-Semester Academic Performance Regressed on First-Year Roommates' Pretreatment Academic Performance

	Sem. 3 Total Score	Sem. 3 Total Score	Sem. 4 Total Score	Sem. 4 Total Score
	(1)	(2)	(3)	(4)
Own Score	.506**	.511**	.533**	.533**
	(.022)	(.022)	(.021)	(.020)
Roommates' Score	.050		.037	
	(.026)		(.023)	
Roommates in Top 20 Percent		.201**		.066
		(.053)		(.053)
Roommates in Bottom 20 Percent		.055		–.044
		(.067)		(.057)
Control Variables	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Observations	2,116	2,116	2,114	2,114
Adjusted R^2	.420	.423	.402	.402

Note: Coefficients on one's own and peer academic performance are standardized. Standard errors clustered at the room level in all models. All models included fixed effects for individual background variables and home district.
*$p < .05$; **$p < .01$ (two-tailed tests).

of her randomly assigned roommates. The moderate but declining effect of strong study-partners ($p < .05$), and the persistent and positive effect of roommates, suggest several possible mechanisms for how peers affect academic performance. First, when *own score* is included in the model, the significance of the study-partner effect declines, which means students likely chose study-partners with similar ability levels. Second, when roommates' scores are included in the model, the study-partner effect also declines, which means students' chosen study-partners are often their roommates. Because roommate assignment occurs before college enrollment, roommates subsequently become study-partners; as study-partners, they affect a student's academic performance. As for the persistence of roommate effects, we think one explanation may be that although a focal student might not consider a given roommate a study-partner, that student might still interact with this roommate on a regular, although relatively less frequent, basis. When a student has a question or concern that her chosen study-partners cannot answer, she might ask a skilled roommate, who may be willing to help. A second possible reason for persistent roommate effects is that our study-partner measure may exclude roommates who became the focal student's study-partner only later in the semester. The roommate effect variable may reflect study-partner relations not captured in the third week of the academic year when the network survey was conducted.

How Long Do Roommate Effects Last?

Prior studies have found that social capital effects, if they exist at all, are usually small in magnitude and short-lived (Angrist and Lang 2004; Sacerdote 2001). Using longitudinal data on student performance, we test whether randomly assigned first-year roommates have a lasting effect on student performance. To do this, we regress the focal student's third- and fourth-semester performance on the pretreatment performance of their first-year roommates. Table 7 presents these results. In column 1, we find that roommates have a

positive, although not statistically significant, linear effect on performance in the third semester. Because students are assigned to new dormitory rooms in the second year, they may continue to interact with only a subset of their first-year roommates. For example, a student may continue to interact more with a high-performing first-year roommate than a low-performing one. If this were the case, we would predict that high-performing roommates may continue to have an effect on performance, but low-performing roommates may decline in significance. In column 2, we test this intuition, and examine whether the effect is perhaps nonlinear, by entering indicator variables for whether the student has roommates in the top or bottom 20 percent of roommates in our setting. Here we find that focal students with roommates in the top 20 percent have a higher level of performance in their third semester. This suggests that less prepared roommates have no longitudinal effect on academic performance, whereas better-prepared roommates do. In column 3, we find a positive but not significant relationship between roommates' pretreatment performance and the focal student's fourth-semester performance. While the evidence for an independent fourth-semester effect is weak, we may not have the statistical power to detect an effect of this size.

Our results provide limited support for Hypothesis 5, which predicts the existence of durable peer effects. We find that peer effects decline over time and are primarily limited to high-performing peers. We can imagine a couple possible reasons for why we may see this pattern. First, a student's interactions with her first-year roommates may decline as she meets new people and forms new friendships. College students form social ties with others they meet during class, in after-school activities, and outside the university. Students may dissolve ties with their roommates as they create these new relations. Second, as time progresses, students may become embedded in more homogenous networks, which may have no relationship to their achievement, except through the selection of peers with similar levels of academic ability.

DISCUSSION

Peer effects on students' academic achievement is a notable illustration of the role that social capital plays in the creation of human capital (Coleman 1988). The analysis presented in this article provides evidence of such an effect. We find that students' randomly assigned roommates have a significant effect on their first-year performance. Our estimates indicate that roommates have an effect equaling nearly 17 percent the magnitude of a student's own prior performance. Stated differently, a one-standard-deviation increase in roommates' performance increases a student's class rank by 56 positions; a two-standard-deviation increase in roommates' performance improves a student's class rank by nearly 112 positions. Clearly, the magnitude of this effect is meaningful.

However, this effect is consistent with multiple theoretical explanations. Although we cannot precisely identify the channel through which this peer effect is produced, our analysis does provide greater evidence for some channels than for others. Our results suggest that the specific resources—that is, the tangible skills and knowledge—possessed by a student's peers are a critical determinant of peers' usefulness. In analyses of whether peer effects are greater when a match exists between roommates' skills and the subject a student is studying, we find that a resource-match does matter. A peer skilled in mathematics affects a student's performance in science and math, but not English. We think this pattern of results is more consistent with a direct channel than an indirect one. However, the resource-matching argument deserves more attention. Future research should examine instances where greater heterogeneity exists in focal students' academic goals as well as peers' goals and resources.

Our results also shed light on the role of different kinds of peers in the academic context. We expected that a student's same-caste peers would have a greater effect on performance than would different-caste peers. However, we found that same- and different-caste peers equally affected a student's academic

performance. This suggests that although caste may result in increased interaction and stronger ties in many contexts, the college dormitory setting reduces the salience of caste due to propinquity as well as students' similar ages, academic merits, and goals (Pettigrew et al. 2011). In this context, a student may have similar rates of interaction with her same- and different-caste roommates. Furthermore, we only analyze academic outcomes. Future research should examine whether socially similar peers have greater influence on non-academic outcomes such as participation in extracurricular activities or the development of political views. Furthermore, we analyzed additional peer relations such as friendships and study-partners. As expected, we found that the pretreatment academic performance of a student's chosen friends and study-partners is correlated to her own. When we controlled for a student's own prior performance and that of her roommates, friend and study-partner effects declined in magnitude or disappeared. This empirical pattern suggests that students befriended and studied with their roommates, but also learned from roommates whom they did not consider friends or study-partners.

Finally, we find peers have modest but declining longitudinal effects. On this dimension, our results are consistent with prior work. We show that roommates have a contemporaneous effect on academic performance, but this effect all but disappears by the end of the second year. Moreover, it appears that students' high-ability peers have a greater longitudinal effect than do low-ability peers. This is perhaps because students more readily maintain relations with high-quality peers and dissolve relations with low-ability ones. Furthermore, if peers do self-select into more homogenous networks over time, such sorting will make first-year roommates less relevant.

CONCLUSIONS

This study holds several implications for social capital theory. First, our analyses provide some of the strongest evidence for the existence of social capital effects in the college setting. We find that the mere act of placing students into contexts where they can interact with high-ability peers can have a meaningful effect on academic performance. However, our study also suggests that scholars should pay more attention to other factors that can influence the magnitude of these effects. Second, future work should be attentive to students' diverse academic goals and peers' sundry resources. We see several important directions for further thinking about student goals and peer resources. The simplest is by considering other types of academic and nonacademic resources that peers possess. These additional resources include peers' family backgrounds, values, cultural tastes, and social connections. Research should try to understand how peers affect students' more discrete goals, such as choice of a major, academic persistence, graduate school attendance, and career choice. These outcomes are all important for long-term economic well-being. Third, future research will benefit by further delineating the nature and content of various kinds of peer relations and their differential impact on outcomes. Our results suggest that caste-based social similarity does not affect the magnitude of academic peer effects, but socially similar peers may be consequential for other, more discrete choices. Finally, the long-term effects of social capital require rigorous attention. Students' social relations are dynamic: some peer relations persist, others cease to exist, and new ones form (Hasan 2012). Future research needs to address the dynamic nature of social capital by capturing changing peer groups and their changing effects.

Our results also have implications beyond the educational context, including job searches in the labor market. Scholars have been studying networks and labor markets for nearly four decades, yet there remains uncertainty about whether contacts matter in job searches (Mouw 2003), why they matter (Fernandez and Fernandez-Mateo 2006), and which contacts are most useful (Smith 2005). Aside from labor markets, we think greater attention to resources and types of relations may be useful in enriching theories of social capital and innovation

(Burt 2004; Tortoriello and Krackhardt 2010), health (Christakis and Fowler 2007), and entrepreneurship (Nanda and Sorensen 2010). Furthermore, although we focus on how peers affect individual performance, our results have implications for the study of social capital and group-level inequality. Changes to peer composition affect achievement. Improving disadvantaged groups' access to higher quality peers can help reduce some of the achievement gap, but this effect may be conditioned by whether the context facilitates meaningful inter-group interaction.

To our knowledge, this is the first study of peer effects at an Indian university and one of the few to examine social capital using a quasi-experimental research design. Our results provide strong evidence that social capital is a useful concept for understanding educational attainment in India. Scholars of economic inequality in India should be attentive to other settings, schools, and neighborhoods where differential access to high-quality peers can create divergences in the accumulation of human capital. Although all students appear to benefit from high-quality peers, students from the more disadvantaged castes may have the most limited access to such peers and thus may benefit more from changes in peer quality. Moreover, the absence of greater caste-specific peer effects is telling, and suggests meaningful inter-caste interaction is occurring. Finally, although our results are limited to the higher educational context, they do indicate that social capital may matter more broadly in India. Future research will need to better understand where else and why social capital matters.

In conclusion, we note some limitations of our study. Our findings are based on data from a single engineering college in India and may not be broadly generalizable. Several features of our context, including quota-based admissions, common semester or yearly board exams in college, and multiple and randomly assigned roommates, provided a rich context for studying peer effects. However, future research needs to examine which of these features matters more in producing these effects. Nevertheless, these constraints are common in the Indian setting. At the very least, we think our results apply to a large number of colleges in India. In the United States, our results can be considered upper-bound estimates. First, the effect size should decline because roommates differ in their majors and courses and the variability in incoming student quality also decreases. Second, dormitory rooms in our setting are larger compared to those in the U.S. context, and such large rooms may encourage stronger enforcement of collective norms and behaviors, resulting in stronger peer effects. Future research will need to examine whether room size matters in this regard. Furthermore, our study, like others, focuses on the effect of first-year roommates. Future work should more carefully study the dynamics of social relations over longer periods of time and examine how such network dynamics affect academic achievement (Lomi et al. 2011).

Acknowledgments

The authors would like to thank David Krackhardt and Mark Wessel; members of the macro organizational behavior group at Stanford; seminar participants at the NUS Business School; and the director and staff of the engineering college we study for their assistance, comments, and suggestions.

Notes

1. The official category of "backward caste" is a broad category with inter-state heterogeneity. Some Shudra castes may be classified as backward in one state but not another. Within a state, however, classification of a specific caste into the backward caste category is consistent. In some instances, members of a Shudra caste, depending on occupation, may be classified as "scheduled caste."
2. For the mean performance of students by caste category, see Table S2 in the online supplement (http://asr.sagepub.com/supplemental).
3. Unfortunately, our data do not include the arrangement of individuals' assignments to specific beds in the room.
4. These questions were developed after consulting university students in India from both the state where the college is located and several other states.
5. Students took the same classes in the first semester, but no examinations were held then.
6. Classroom assignments, unlike dormitory room assignments, are co-educational and have an approximately equal proportion of men and women. Students are not necessarily assigned to the same classrooms as their roommates.

7. It is important to note that Muslims are a religious category and not a caste category. In a general sense, Muslims cannot be considered a caste, because caste is a characteristic of the Hindu religion.
8. In our dataset, 156 students were the only members from their caste category in their dorm rooms; *roommates (same caste)* is thus undefined for them.
9. We also conducted a nonparametric LOWESS estimation examining a focal student's performance as a function of her roommates' performance. We found that the linear specification for the peer effect is justified for the second-semester performance models.

References

Angrist, Joshua D. and Kevin Lang. 2004. "Does School Integration Generate Peer Effects? Evidence from Boston's Metco Program." *American Economic Review* 94:1613–34.

Aral, Sinan and Marshall Van Alstyne. 2011. "The Diversity-Bandwidth Trade-Off." *American Journal of Sociology* 117:90–171.

Arcidiacono, Peter and Sean Nicholson. 2005. "Peer Effects in Medical School." *Journal of Public Economics* 89:327–50.

Bauman, Karl E. and Susan T. Ennett. 1996. "On the Importance of Peer Influence for Adolescent Drug Use: Commonly Neglected Considerations." *Addiction* 91:185–98.

Becker, Gary S. 1962. "Investment in Human Capital: A Theoretical Analysis." *Journal of Political Economy* 70:9–49.

Bertrand, Marianne, Rema Hanna, and Sendhil Mullainathan. 2010. "Affirmative Action in Education: Evidence from Engineering College Admissions in India." *Journal of Public Economics* 94:16–29.

Beteille, Andre. 1991. "The Reproduction of Inequality: Occupation, Caste and Family." *Contributions to Indian Sociology* 25:3–28.

Blau, Peter Michael and Otis Dudley Duncan. 1967. *The American Occupational Structure*. New York: Wiley.

Blau, Peter Michael and Joseph E. Schwartz. 1984. *Crosscutting Social Circles: Testing a Macrostructural Theory of Intergroup Relations*. Orlando, FL: Academic Press.

Brand, Jennie E. and Yu Xie. 2010. "Who Benefits Most from College? Evidence for Negative Selection in Heterogeneous Economic Returns to Higher Education." *American Sociological Review* 75:273–302.

Buchmann, Claudia and Ben Dalton. 2002. "Interpersonal Influences and Educational Aspirations in 12 Countries: The Importance of Institutional Context." *Sociology of Education* 75:99–122.

Burt, Ronald S. 2004. "Structural Holes and Good Ideas." *American Journal of Sociology* 110:349–99.

Carrell, Scott E., Richard L. Fullerton, and James E. West. 2009. "Does Your Cohort Matter? Measuring Peer Effects in College Achievement." *Journal of Labor Economics* 27:439–64.

Chalam, K. S. 1990. "Caste Reservations and Equality of Opportunity in Education." *Economic and Political Weekly* 25:2333–39.

Chitnis, Suma. 1972. "Education for Equality: Case of Scheduled Castes in Higher Education." *Economic and Political Weekly* 7:1675–81.

Christakis, Nicholas A. and James H. Fowler. 2007. "The Spread of Obesity in a Large Social Network over 32 Years." *New England Journal of Medicine* 357:370–79.

Cohen, Jere. 1983. "Peer Influence on College Aspirations with Initial Aspirations Controlled." *American Sociological Review* 48:728–34.

Coleman, James S. 1988. "Social Capital in the Creation of Human Capital." *American Journal of Sociology* 94:S95–S120.

Cunningham, Clark D. and N. R. Madhava Menron. 1998. "Race, Class, Caste . . . ? Rethinking Affirmative Action." *Michigan Law Review* 97:1296–1310.

Davies, Mark and Denise B. Kandel. 1981. "Parental and Peer Influences on Adolescents' Educational Plans: Some Further Evidence." *American Journal of Sociology* 87:363–87.

Desai, Sonalde and Amaresh Dubey. 2011. "Caste in 21st Century India: Competing Narratives." *Economic & Political Weekly* 46:41–49.

Desai, Sonalde and Veena Kulkarni. 2008. "Changing Educational Inequalities in India in the Context of Affirmative Action." *Demography* 45:245–70.

DiMaggio, Paul and Filiz Garip. 2012. "Network Effects and Social Inequality." *Annual Review of Sociology* 38:93–118.

Duflo, Esther, Pascaline Dupas, and Michael Kremer. 2011. "Peer Effects, Teacher Incentives, and the Impact of Tracking: Evidence from a Randomized Evaluation in Kenya." *American Economic Review* 101:1739–74.

Dumont, Louis. 1980. *Homo Hierarchicus: The Caste System and its Implications*. Chicago: University of Chicago Press.

Duncan, Greg J., Johanne Boisjoly, Michael Kremer, Dan M. Levy, and Jacque Eccles. 2005. "Peer Effects in Drug Use and Sex among College Students." *Journal of Abnormal Child Psychology* 33:375–85.

Duncan, Otis D., Archibald O. Haller, and Alejandro Portes. 1968. "Peer Influences on Aspirations: A Reinterpretation." *American Journal of Sociology* 74:119–37.

Epple, Dennis and R. E. Romano. 2011. "Peer Effects in Education: Survey of the Theory and Evidence." *Handbook of Social Economics* 1:1053–1163.

Fernandez, Roberto M. and Isabel Fernandez-Mateo. 2006. "Networks, Race, and Hiring." *American Sociological Review* 71:42–71.

Fryer, Roland G., Glenn C. Loury, and Tolga Yuret. 2008. "An Economic Analysis of Color-Blind Affirmative Action." *Journal of Law, Economics, and Organization* 24:319–55.

Fryer, Roland G. and Paul Torelli. 2010. "An Empirical Analysis of 'Acting White.'" *Journal of Public Economics* 94:380–96.

Ghurye, Govind S. 2008. *Caste and Race in India*. Mubai: Popular Prakashan.

Granovetter, Mark. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78:1360–80.

Hallinan, Maureen T. and Richard A. Williams. 1990. "Students' Characteristics and the Peer-Influence Process." *Sociology of Education* 63:122–32.

Hanushek, Eric A., John F. Kain, Jacob M. Markman, and Steven G. Rivkin. 2003. "Does Peer Ability Affect Student Achievement?" *Journal of Applied Econometrics* 18:527–44.

Hanushek, Eric A., John F. Kain, and Steven G. Rivkin. 2009. "New Evidence about Brown v. Board of Education: The Complex Effects of School Racial Composition on Achievement." *Journal of Labor Economics* 27:349–83.

Hasan, Sharique. 2012. "Group Based Trajectories of Network Formation and Dynamics." *Social Networks* 34:506–514.

Haynie, Dana L. and D. Wayne Osgood. 2005. "Reconsidering Peers and Delinquency: How Do Peers Matter?" *Social Forces* 84:1109–30.

Imai, Kosuke, Gary King, and Elizabeth A. Stuart. 2008. "Misunderstandings between Experimentalists and Observationalists about Causal Inference." *Journal of the Royal Statistical Society Series A-Statistics in Society* 171:481–502.

Kandel, Denise B. and Gerald S. Lesser. 1969. "Parental and Peer Influences on Educational Plans of Adolescents." *American Sociological Review* 34:213–23.

Krackhardt, David. 1992. "The Strength of Strong Ties: The Importance of *Philos* in Organizations." Pp. 216–36 in *Networks and Organizations: Structure, Form, and Action,* edited by N. Nohria and R. Eccles. Boston: Harvard Business School Press.

Kremer, Michael and Dan Levy. 2008. "Peer Effects and Alcohol Use among College Students." *Journal of Economic Perspectives* 22:189–206.

Lazear, Edward P. 2001. "Educational Production." *Quarterly Journal of Economics* 116:777–803.

Legewie, Joscha and Thomas A. DiPrete. 2011. "School Context and the Gender Gap in Educational Achievement." *American Sociological Review* 77:463–85.

Lin, Nan. 1999. "Social Networks and Status Attainment." *Annual Review of Sociology* 25:467–87.

Lin, Nan. 2000. "Inequality in Social Capital." *Contemporary Sociology: A Journal of Reviews* 29:785–95.

Lomi, Alessandro, Tom A. B. Snijders, Christian E. G. Steglich, and Vanina Jasmine Torló. 2011. "Why Are Some More Peer Than Others? Evidence from a Longitudinal Study of Social Networks and Individual Academic Performance." *Social Science Research* 40:1506–20.

Manski, Charles F. 1993. "Identification of Endogenous Social Effects: The Reflection Problem." *Review of Economic Studies* 60:531–42.

Manski, Charles F. 1999. *Identification Problems in the Social Sciences*. Cambridge, MA: Harvard University Press.

McEwan, Patrick J. and Kristen A. Soderberg. 2006. "Roommate Effects on Grades: Evidence from First-Year Housing Assignments." *Research in Higher Education* 47:347–70.

McPherson, Miller, Lynn Smith-Lovin, and James M. Cook. 2001. "Birds of a Feather: Homophily in Social Networks." *Annual Review of Sociology* 27:415–44.

Mehra, Ajay, Martin Kilduff, and Daniel J. Brass. 1998. "At the Margins: A Distinctiveness Approach to the Social Identity and Social Networks of Underrepresented Groups." *Academy of Management Journal* 41:441–52.

Morgan, Stephen L. and Aage B. Sorensen. 1999. "Parental Networks, Social Closure, and Mathematics Learning: A Test of Coleman's Social Capital Explanation of School Effects." *American Sociological Review* 64:661–81.

Mouw, Ted. 2003. "Social Capital and Finding a Job: Do Contacts Matter?" *American Sociological Review* 68:868–98.

Mouw, Ted. 2006. "Estimating the Causal Effect of Social Capital: A Review of Recent Research." *Annual Review of Sociology* 32:79–102.

Nanda, Ramana and Jesper B. Sorensen. 2010. "Workplace Peers and Entrepreneurship." *Management Science* 56:1116–26.

Narasimhan, Sakuntala. 2002. "Gender, Class, and Caste Schisms in Affirmative Action Policies: The Curious Case of India's Women's Reservation Bill." *Feminist Economics* 8:183–90.

Pettigrew, Thomas F. and Linda R. Tropp. 2006. "A Meta-analytic Test of Intergroup Contact Theory." *Journal of Personality and Social Psychology* 90:751–83.

Pettigrew, Thomas F., Linda R. Tropp, Ulrich Wagner, and Oliver Christ. 2011. "Recent Advances in Intergroup Contact Theory." *International Journal of Intercultural Relations* 35:271–80.

Podolny, Joel M. and James N. Baron. 1997. "Resources and Relationships: Social Networks and Mobility in the Workplace." *American Sociological Review* 62:673–93.

Reagans, Ray. 2011. "Close Encounters: Analyzing How Social Similarity and Propinquity Contribute to Strong Network Connections." *Organization Science* 22:835–49.

Rumberger, Russell W. and Gregory J. Palardy. 2005. "Test Scores, Dropout Rates, and Transfer Rates as Alternative Indicators of High School Performance." *American Educational Research Journal* 42:3–42.

Sacerdote, Bruce. 2001. "Peer Effects with Random Assignment: Results for Dartmouth Roommates." *Quarterly Journal of Economics* 116:681–704.

Sacerdote, Bruce. 2011. "Peer Effects in Education: How Might They Work, How Big Are They and How Much Do We Know Thus Far?" *Handbook of the Economics of Education* 3:249–77.

Shah, Ghanshyam. 1985. "Caste, Class and Reservation." *Economic and Political Weekly* 20:132–36.

Shah, Ghanshyam. 2006. *Untouchability in Rural India*. New Delhi: Sage Publications.

Smith, Sandra S. 2005. "'Don't Put My Name On It': Social Capital Activation and Job-Finding Assistance

among the Black Urban Poor." *American Journal of Sociology* 111:1–57.
Srinivas, Mysore Narasimhachar. 1957. "Caste in Modern India." *Journal of Asian Studies* 16:529–48.
Stinebrickner, Ralph and Todd R. Stinebrickner. 2006. "What Can be Learned about Peer Effects Using College Roommates? Evidence from New Survey Data and Students from Disadvantaged Backgrounds." *Journal of Public Economics* 90:1435–54.
Tortoriello, Marco and David Krackhardt. 2010. "Activating Cross-Boundary Knowledge: The Role of Simmelian Ties in the Generation of Innovations." *Academy of Management Journal* 53:167–81.
Vithayathil, Trina and Gayatri Singh. 2012. "Spaces of Discrimination: Residential Segregation in Indian Cities." *Economic & Political Weekly* 47:60–66.
Wimmer, Andreas and Kevin Lewis. 2010. "Beyond and Below Racial Homophily: ERG Models of a Friendship Network Documented on Facebook." *American Journal of Sociology* 116:583–642.
Xaxa, Virginius. 2001. "Protective Discrimination: Why Scheduled Tribes Lag behind Scheduled Castes." *Economic and Political Weekly* 36:2765–72.
Zimmerman, David J. 2003. "Peer Effects in Academic Outcomes: Evidence from a Natural Experiment." *Review of Economics and Statistics* 85:9–23.

Sharique Hasan is an Assistant Professor of Organizational Behavior at the Stanford Graduate School of Business. His research focuses on social networks, careers, and education. He earned his PhD from Carnegie Mellon University.

Surendrakumar Bagde is an officer in the Indian Administrative Service. He is currently Private Secretary to the Home Minister in the Ministry of Home Affairs, Government of India. His research focuses on economic development and education. He earned his PhD from Carnegie Mellon University.