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Peer Effects and Alcohol Use among College Students

Michael Kremer and Dan Levy

Peer effects are central to debates over a variety of issues, including substance abuse, education policy, urban policy, and technology adoption. Peers could potentially affect others' endowments or choice sets, for example through disruption in classrooms (Lazear, 2001), disease exposure (Miguel and Kremer, 2004), or the spread of information (Foster and Rosenzweig, 1995; Munshi and Myaux, 2006; Duflo and Saez, 2002). Peers could also affect others' preferences. For example, seeing friends consume an addictive substance could act as a cue and stimulate desire for that substance (Laibson, 2001). Moreover, current peers may not only affect current behavior but also choice of future peers, creating even larger effects in the future (Akerlof, 1997). Yet peer effects are notoriously difficult to estimate econometrically because in most contexts, people *choose* with whom they associate. Hence, while similarities in behavior among members of a group may be due to peer effects, it is difficult to rule out the possibility that group members may be similar to each other along unobserved dimensions or may have come together with the intention of achieving similar outcomes.

This paper estimates peer effects in the context of a large state university that uses a lottery system to assign roommates. The university's use of a lottery to assign roommates randomly makes it possible to isolate the effect of peers. Our results suggest that males who were assigned roommates who drank alcohol prior to

■ *Michael Kremer is Gates Professor of Developing Societies, Department of Economics, Harvard University, Cambridge, Massachusetts. He is also Senior Fellow, Brookings Institution, Washington, D.C., and Research Associate, National Bureau of Economic Research, Cambridge, Massachusetts. Dan Levy is Lecturer in Public Policy and Faculty Chair of the Master's in Public Administration Programs, Kennedy School of Government, Harvard University, Cambridge, Massachusetts. He is also a Senior Researcher at Mathematica Policy Research. Their e-mail addresses are* ⟨*mkremer@fas.harvard.edu*⟩ *and* ⟨*dan_levy@harvard.edu*⟩.

college obtained on average a lower grade point average than those assigned to nondrinking roommates. In contrast, we found no effect of roommates' academic or socioeconomic background on grade point averages.

Our findings have implications for understanding alcohol use and abuse. About 40 percent of university students reported binge drinking at least once within the past two weeks (Wechsler, Lee, Kuo, and Lee, 2000), and student alcohol use is widely seen as influenced by peers. For the U.S. population as a whole, alcohol abuse causes an estimated 85,000 deaths per year (Mokdad, Marks, Stroup, and Gerberding, 2004). More broadly, our findings seem more consistent with theories in which peer effects operate by influencing preferences than with those in which peers change narrowly interpreted endowments—for example by providing help with homework or by disrupting study.

Background

A number of studies, beginning with Sacerdote (2001), examine peer effects in the context of universities. Such studies ideally satisfy three criteria. First, at least a subset of students is assigned to roommates randomly, conditional on a set of observable variables, such as housing preferences and gender. Comparing students who had the same observable characteristics influencing roommate assignment, but who were randomly assigned different types of roommates, isolates the impact of roommates.[1]

Second, unless assignment is totally random, researchers should have access to the student housing application data used in the process of assigning roommates. If regressions of student outcomes on roommate characteristics are to be informative, they should control for the variables used by housing offices in assigning roommates.

Third, student outcomes should be regressed not on contemporaneous roommate outcomes, but rather on roommate characteristics that were determined prior to college entry. This calculation makes it possible to isolate the impact of peer effects from the potential confounding effect of common shocks—such as having the same residential advisor, living in a room exposed to a lot of noise, or taking the same section of a popular course—which could also lead to correlation in roommate outcomes.

Table 1 summarizes the results of some studies that look at the effect of predetermined roommate academic characteristics on student academic outcomes. Typically, the only available data on roommate characteristics prior to entering college is on variables that enter the college admissions, financial aid, and housing

[1] In selecting a university for this study, we found that housing officers often initially claimed that roommate assignment was random, but later revealed that it was done manually or in the order that housing applications were received. Ideally randomization should be done by computer algorithm or some other clearly random process.

Table 1

Effect of Pre-College Roommate Characteristics on Student Outcomes

Panel A: Impact of Pre-College Roommate Academic Characteristics

Authors	*Explanatory peer characteristic*	*Nature of random assignment*	*Uninteracted linear peer effects*	*Other effects*
Foster (2006)	High school grade point average, SAT scores	Not reported; based on responses in housing questionnaire and date questionnaire returned to university	None reported	Male students who have floormates (excluding roommates) with higher high school GPAs, though they did not continue to live with same floormates, have higher college GPAs. Male students with floormates (including roommates) or neighbors (students living in rooms adjacent or across from theirs) with higher high school GPAs have a higher college GPA.
Han and Tao (forthcoming)	Chinese College Entrance Test (CET)	Student ID numbers manually mapped to rooms after sorting by gender, major, home province	None reported	Female students whose roommates have a higher CET are found to have higher college GPAs. The effect is stronger for students with low CET.
Sacerdote (2001)	Pre-college academic index	Housing slips grouped by living habits (smoking, sleep schedule, neatness and noise tolerance during studying) and then hand shuffled	No overall effect of the roommate's academic index on GPA is found.	Students whose roommates are in the top 25% of the academic index have higher first-year college GPAs. Looking at subgroups, the effect is only found for students with an index in the bottom 25% or top 25%.
Siegfried and Gleason (2006)	High school AP courses, SAT scores	Not reported; incoming students allowed to request particular dormitories, roommates or living conditions	Students whose roommates took a high number of AP courses in high-school have higher first-year college GPAs.	Students in the top quartile of the SAT score distribution, whose roommates are also in the top quartile of the SAT distribution, have higher college GPAs.
Stinebrickner and Stinebrickner (2000)	ACT scores	Computerized algorithm[a]	None reported. In all gender and income subcategories, roommate ACT score has no effect on either first-semester grades or retention rates.	

Table 1—Continued

Authors	*Explanatory peer characteristic*	*Nature of random assignment*	*Uninteracted linear peer effects*	*Other effects*
Zimmerman (2003)	Math, verbal, and combined SAT scores	Housing applications grouped by gender and living habits (smoking, noise tolerance, sociability, neatness, and sleep schedule)	Students whose roommates had higher verbal SAT scores have higher first-semester and cumulative GPAs. There is no overall effect from the roommate's combined math/verbal SAT score.	Students in the middle 70% of the SAT distribution whose roommates had a low verbal SAT score have lower GPAs. Female students in the bottom 15% and middle (15–85%) of the SAT distribution with a roommate who had a high math SAT score have lower GPAs. Students with low overall SAT scores who live in a part of the dorm with a low average verbal SAT score have lower GPAs.

Note: GPA means grade point average; AP is advanced placement; CET is Chinese College Entrance Test.
[a] "As evidence of the school's intention to randomly assign rooms, in at least one year, roommates were determined by a random room assignment program on the campus computer system."

Panel B: Effect of Pre-College Roommate Nonacademic Characteristics

Authors	*Explanatory peer characteristic*	*Nature of random assignment*	*Uninteracted linear peer effects*	*Other effects*
Boisjoly, Duncan, Kremer, Levy, and Eccles (2006)	Race	Computerized randomization algorithm based on responses to housing questionnaire	None reported: by design, this paper looks at subgroups by analyzing the impacts of having a black roommate on white students' attitudes.	White students with African American roommates are more likely to endorse affirmative action and interact with members of other ethnic groups than other white students.
Sacerdote (2001)	Beer consumption in high school	Housing slips grouped by living habits (smoking, sleep schedule, neatness, and noise tolerance during studying) and then hand shuffled	Students whose dormmates report high beer consumption during high school are more likely to join a fraternity or sorority, though high school alcohol consumption of direct roommates is not found to have a significant effect on joining a fraternity or sorority.[b]	None reported

Table 1—continued

Authors	*Explanatory peer characteristic*	*Nature of random assignment*	*Uninteracted linear peer effects*	*Other effects*
Stinebrickner and Stinebrickner (2000)	Family income	Computerized algorithm[c]	None reported	For female students, first-semester grades and retention rates improve with increasing family income of roommate. Within subgroups, the effects persist only for female students from low-income backgrounds (defined as standard deviation below mean).
Zimmerman, Rosenblum, and Hillman (2004)	Political attitudes and emphasis on intellectual versus career values	Not reported[d]	None reported	Students with college roommates who identified themselves as politically far left prior to entering college are more likely to identify as being economically or socially conservative six years later relative to students who had a roommate who identified themselves as liberal or middle of the road before entering college. No effect is found of the roommate's political attitudes on the probability that the student will identify as liberal later in life. With regards to the stated emphasis on intellectual versus career values when entering college, neither the student's own values nor the roommate's values have an effect on personal values reported six years later.

[b] Sacerdote also finds a positive contemporaneous correlation of the probability of a student joining a fraternity or sorority with the dorm average membership and with roommate membership in such groups.
[c] "As evidence of the school's intention to randomly assign rooms, in at least one year roommates were determined by a random room assignment program on the campus computer system."
[d] "The assignment mechanism of students to housing units (as indicated by their housing descriptions on the World Wide Web and conversations with their housing offices) seems roughly random."

databases—such as high school grades, standardized test scores, and parental socioeconomic status.

Panel A reviews the literature on the effect of predetermined academic characteristics of roommates. Most studies do not find effects of these predetermined characteristics on the whole sample of students. Some find effects for certain

subgroups, but the very different pattern of effects on different subgroups found in different settings, and the absence of a consistent story linking all these effects does not suggest major effects of roommate academic characteristics on academic outcomes. Summarizing the literature, including a working paper version of this study, Foster (2006) writes that "compared with the effects of own observables, conventional peer effects on academic achievement . . . are not estimated to be particularly important. Indeed, stronger and more significant effects from peers have been found by researchers modeling social outcomes."

Panel B of Table 1 reviews the more limited literature examining the effect of roommate nonacademic characteristics on student outcomes. While data on roommate nonacademic characteristics prior to entering college are scarce, it is worth noting that Sacerdote (2001) finds intriguing evidence that students whose dormmates report high beer consumption during high school are more likely to join a fraternity or sorority as well as evidence of contemporaneous correlations in roommate social outcomes.

This study takes advantage of the Cooperative Institutional Research Program's (CIRP's) Entering Student Survey, which contains data on a rich set of student characteristics prior to college entrance, to examine further the impact of peers' nonacademic characteristics—alcohol consumption in particular. The study was conducted using data from a large Midwestern state university (whose name remains confidential because of an agreement we made to gain access to the data). The university is academically strong, with entering students in our sample having an average high school grade point average (GPA) of 3.56 and scoring around the 90^{th} percentile of the national distribution of standardized college admission tests. It is slightly above average in student precollege consumption of beer, wine, and liquor. Students at this university typically live in residence halls for their first year at the university, but by their sophomore years about two-thirds move off campus, either to apartments shared with other students or to fraternities. Fraternities are associated with heavy drinking: 73 percent of students who joined a fraternity report drinking more than once a week over the past year, compared to 37 percent of students who never joined a fraternity. A rush process, which involves a sequence of fraternity parties, takes place during students' first year, but students do not actually move into the fraternity until their second year.

First-year students are assigned roommates through the housing lottery if they submit housing applications on time, do not request a specific roommate who also wishes to room with them, and do not request specialized housing. When entering the lottery, housing preferences can be stated in four categories: 1) environment (substance-free housing; nonsmoking roommate; do not mind smoking roommate; and smoker); 2) room type (single, double, or triple occupancy, and other); 3) geographic area of campus; and 4) gender composition of hall and corridor (for details, see Kremer and Levy, 2003). Of the approximately 7,500 first-year students from the 1997 and 1998 entering classes for whom we have data, 1,357 students were randomly assigned. The main reason that the rest of the students were not randomly assigned is that they missed the lottery deadline. Students who partici-

pated in the lottery and those who were not randomly assigned have fairly similar observable characteristics. To check that housing assignment was in fact random, conditional on gender and housing assignment, we tested for correlations between roommate background variables within cells defined by roommate characteristics and found no more correlation than would be expected by chance.[2]

The key outcome we examine in this paper is cumulative grade point average at the end of the summer of 1999, which corresponds to the end of the second year for the 1997 cohort and the end of the first year for the 1998 cohort.[3] Grade point average can be seen as a proxy for student learning. In principle, we cannot rule out that changes in grade point average may come from a change in the choice of classes, or a decreased focus on exams together with an increased focus on nonexam-relevant learning. But given the data available to us, GPA is the only measure of academic performance that we can use.

Our explanatory variables of interest are the ones related to roommate drinking. These were obtained from the Entering Student Survey of the Cooperative Institutional Research Program (which was administered to all admitted students during their orientation week in the summer prior to starting classes and had a response rate of 89 percent). This survey contains a section in which respondents are presented with a list of activities and asked whether they undertook the activities frequently, occasionally, or not at all during the last year. The list of activities includes "Drank beer" and "Drank wine or liquor."

We classified as "frequent drinkers" the 15 percent of the sample who answered "frequently" to at least one of the two drinking-related questions. We classified as "occasional drinkers" the 53 percent of the sample who were not "frequent drinkers," but answered "occasionally" to at least one of the two drinking-related questions. Students who reported not drinking beer, wine, or liquor in the last year were classified as "nondrinkers." There are only small differences in self-reported high school drinking behavior between males and females; however, male and female students may have different interpretations of "frequent" and "occasional" drinking.

To account for the fact that roommates were assigned randomly conditional on gender and four basic housing preferences, we created a dummy variable for each of the possible combinations of gender and housing preferences. In all our regressions, we include these dummies as control variables. Controlling for these dummies ensures that we examine differences in outcomes among students who expressed identical housing preferences, but were assigned roommates with different backgrounds.

[2] An Appendix available with the on-line version of this paper at ⟨http:/www.e-jep.org⟩ provides additional background and detail. Appendix Table A1 compares observable characteristics of those who participated and did not participate in the lottery. For more discussion on this point, and also for tests to ensure that assignment was in fact random, see Kremer and Levy (2003).

[3] Throughout the paper we use this as our outcome except for Table 5.

Results

Consistent with the general pattern of the previous literature, we find no evidence that roommates' academic background variables, measured by high school grade point average and admissions test score, and family background, measured by parental income and education, are either individually or jointly significant in affecting students' college grade point average across a range of specifications.[4]

By taking advantage of the survey data, however, we are able to go beyond this to examine peer effects from behavior, and from alcohol use in particular. As shown in Table 2, when data on males and females are combined together, point estimates of the impact of roommate drinking on grade point average are substantially negative, but they are only statistically significant at the 10 percent level when comparing occasional drinkers and nondrinkers (column 1). However, this overall average treatment effect conceals an effect that is highly concentrated among males. Males' GPAs are reduced by 0.28 points by having a roommate who drank frequently in the year prior to college and by 0.26 points by having a roommate who drank occasionally (column 3).[5] Both of these effects are very large and statistically significant at the 5 percent level. For comparison, the effect of roommate drinking on college grade point average is slightly larger than the effect of a half-point reduction in a student's own high school grade point average, and is equivalent to the effect of a reduction of 50 SAT points or 1.2 ACT points in the students' own aptitude test.

Given that the coefficients on our two drinking variables—"frequent drinking roommate" and "occasional drinking roommate"—were similar, we also ran our regressions grouping the two drinking variables into one. In this regression, the new drinking variable had a very similar coefficient (−0.27) and a very high level of statistical significance.

One possible reason for the difference in results between male and female students could be that college-age males are more susceptible to peer influences than college-age females. However, institution-specific factors might matter as well. Because drinking is reportedly more likely to take place in male than female rooms, a male student with a drinking roommate is more likely to be exposed to drinking than a female student. Moreover, considerable drinking takes place in fraternities, and many first-year students attend a series of parties at fraternities to determine

[4] In our main specification, the coefficient on roommate's high school grade point average is 0.017 with a standard error of 0.090 (that is, if the roommate's GPA is increased by 1, the student's GPA is estimated to increase by 0.017), while that on a standardized test score (measured in units of standardized test scores within the sample), is 0.025 with a standard error of 0.040. See Kremer and Levy (2003) for more details.

[5] Dropouts are rare in the data, so these results are not likely to be subject to substantial bias from lack of follow up. Point estimates suggest dropouts are more common among students who drink, although the difference is not significant, so it is unlikely that correcting any bias from missing GPA data on these students would reduce the estimated effect. See Appendix Table A2, available with the online version of this paper at ⟨http://www.e-jep.org⟩, for more details.

Table 2

Effect of Roommates' Background Characteristics and Own Characteristics on Student's Cumulative Grade Point Average

	Whole lottery sample	*Subsample*	
		Females	*Males*
Roommates' high school drinking			
Frequent	−0.104	0.118	−0.282**
	(0.093)	(0.126)	(0.128)
Occasional	−0.132*	−0.008	−0.263***
	(0.073)	(0.103)	(0.101)
Student's high school drinking			
Frequent	−0.070	−0.032	−0.109
	(0.096)	(0.124)	(0.150)
Occasional	−0.046	−0.029	−0.028
	(0.076)	(0.093)	(0.119)
Observations	1011	555	456
R^2	0.642	0.706	0.595
Adjusted R^2	0.218	0.272	0.173

Note: Robust standard errors in parentheses. Huber–White standard errors were calculated using roommate clusters. All regressions include controls for student's and roommate's academic background (high school GPA and admissions test scores), student's and roommate's parental background (father's education, mother's education, parental income), and type of admission tests, as well as dummy variables for cells.

* significant at 10 percent level, ** significant at 5 percent level, *** significant at 1 percent level.

which one they want to join. Male students may be likely to attend fraternity parties together with their first-year roommates.

Effects on Distribution of Grade Point Average

Roommates' drinking does not seem to cause a uniform downward shift in males' grade point average, but rather to reduce greatly the lower tail of GPA, to decrease somewhat median GPA, and to have a smaller impact on the upper tail of GPA, as shown in the results from quantile regressions in Table 3. (Quantile regressions estimate how specific quantiles of the GPA distribution are affected by roommate alcohol consumption, in a similar way as ordinary least squares regressions estimate the effects of roommate alcohol consumption on the mean of the GPA distribution.) For example, we find that the 90th percentile of grade point average does not differ significantly between male students whose roommate drank occasionally and those with nondrinking roommates. However, the 10th percentile of grade point average is 0.53 points lower among those who had roommates who drank occasionally prior to college.

Why does having a drinking roommate particularly reduce the lower tail of the distribution of grade point average? There is no evidence that students with low predicted grades based on their own academic background variables or other observable characteristics in our data (other than own drinking) are particularly

Table 3
Effect of Roommate Drinking on Distribution of Grade Point Average for Males

	Quantiles				
Quantile	*10%*	*25%*	*50%*	*75%*	*90%*
Frequent drinking roommate	−0.50***	−0.37**	−0.33**	−0.30**	−0.24
	(0.15)	(0.17)	(0.15)	(0.12)	(0.15)
Occasional drinking roommate	−0.53***	−0.35**	−0.13	−0.09	−0.05
	(0.20)	(0.14)	(0.12)	(0.11)	(0.14)
GPA associated with quantile (for students with nondrinking roommates)	2.54	2.90	3.19	3.49	3.78

Note: Table reports results from quantile regressions. Bootstrapped standard errors in parentheses. All regressions include controls for student's and roommate's academic background (high school GPA and admissions test scores), student's and roommate's parental background (father's education, mother's education, parental income), and type of admission tests, as well as dummy variables for cells.
* significant at 10 percent level, ** significant at 5 percent level, *** significant at 1 percent level.

susceptible to drinking roommates.[6] Rather, the large effect at the bottom of the distribution of grade point average is consistent with the hypothesis that the negative effect of roommate drinking is concentrated, so some students have no effect or a mild effect, while others have a large effect, as might be the case if some students are more vulnerable to addiction than others, for genetic or other reasons.

Interaction Between Own and Roommates' Pre-College Drinking

For male students who drank frequently in high school, having a roommate who also drank frequently is associated with a particularly sharp decline in grade point average. The last column of Table 4, which reports results from a regression run only on males who drank frequently, suggests that having a roommate who also drank frequently is associated with a 0.99 point lower grade point average. An analysis using the whole lottery sample to estimate interactions between own and roommate drinking also suggests that frequent drinkers are significantly more strongly influenced by frequent-drinking roommates than occasional drinkers, but the implied effect of a frequent-drinking roommate on a frequent-drinking student's GPA is not quite as large (around 0.67).

Dynamics and Persistence of Effects

Male students whose roommates were frequent drinkers in high school have a grade point average that is 0.18 points lower in their first year and 0.43 points lower in their second year, as shown in Table 5. This finding suggests that peer effects may persist, and possibly even grow from the first to the second year, although it is worth

[6] For example, there is no evidence that religious or nonreligious students were more subject to influence by roommate drinking or that the degree of similarity of roommates, as reflected in the number of similar responses to the CIRP questionnaire, affected the strength of peer effects. However, our inability to find these effects may be due to our small sample size.

Table 4

Effect of Roommates' High School Drinking on Cumulative Grade Point Average at the End of Second Year, by Own High School Drinking, for Males

		Subsample of males		
	Males only	*Did not drink in high school*	*Drank occasionally in high school*	*Drank frequently in high school*
Roommates' high school drinking				
Frequent	−0.282**	−0.273	−0.119	−0.992*
	(0.128)	(0.348)	(0.178)	(0.517)
Occasional	−0.263***	−0.447**	−0.279*	−0.487
	(0.101)	(0.199)	(0.167)	(0.428)
Student's high school drinking				
Frequent	−0.109	—	—	—
	(0.150)	—	—	—
Occasional	−0.028	—	—	—
	(0.119)	—	—	—
Observations	456	147	232	75
R^2	0.595	0.883	0.603	0.899
Adjusted R^2	0.173	0.536	−0.042	0.320

Note: Robust standard errors in parentheses. Huber–White standard errors were calculated using roommate clusters. All regressions include controls for student's and roommate's academic background (high school GPA and admissions test scores), student's and roommate's parental background (father's education, mother's education, parental income), and type of admission tests, as well as dummy variables for cells.

* significant at 10 percent level, ** significant at 5 percent level, *** significant at 1 percent level.

bearing in mind that the difference between the two coefficients is not statistically significant. This result is particularly striking, since only 17 percent of students still room with their initially assigned roommate during their sophomore year.

Mechanisms

One could imagine several possible mechanisms through which having a drinking roommate might reduce a student's grade point average. In some stories, roommate drinking operates to restrict students' choice sets. For example, roommates who drink might create noise, reducing opportunities for study. In other stories, roommate drinking affects preferences. For example, seeing beer around could induce a desire for alcohol.

While randomization makes it possible to establish the causal impact of peers, it cannot definitively establish the mechanisms behind the impact. Although the survey data from the Cooperative Institutional Research Program provides rich information on students' background, attitudes, and behavior, and the impact of roommate drinking seems robust to controlling for other roommate characteristics, such as frequency of television watching or degree of socializing, it is impossible to rule out the possibility that students are influenced by some unmeasured

Table 5
Peer Effect Dynamics

	Outcome	
	End of first-year GPA	*End of second year GPA*
Roommates' high school drinking		
Frequent	−0.183	−0.428**
	(0.117)	(0.181)
Occasional	−0.151	−0.297**
	(0.102)	(0.143)
Student's high school drinking		
Frequent	−0.137	−0.250
	(0.145)	(0.193)
Occasional	0.021	−0.043
	(0.103)	(0.133)
Observations	342	332
R^2	.538	.507
Adjusted R^2	.171	.109

Note: End of second year GPA is for the second year *only*. Robust standard errors in parentheses. Huber–White standard errors were calculated using roommate clusters. All regressions include controls for student's and roommate's academic background (high school GPA and admissions test scores), student's and roommate's parental background (father's education, mother's education, parental income), and type of admission tests, as well as dummy variables for cells. Sample restricted to males from the 1997 lottery sample cohort.
* significant at 10 percent level, ** significant at 5 percent level, *** significant at 1 percent level.

variable correlated with roommate drinking rather than by roommate drinking itself. For example, we might be measuring the effect of having a boisterous roommate, rather than a roommate who drinks.

However, taken as a whole, our results seem more consistent with the hypothesis that roommates influence each other's preferences than with the hypothesis that roommates who drink are disruptive, altering students' choice sets.[7] Several observations point in that direction. First, the roommate effect is concentrated in the bottom quantiles of the grade point average distribution. Arguably, under the disruption hypothesis, students who would otherwise have spent time studying and would be in the upper grade ranges should be more vulnerable to drinking roommates, but this does not appear to hold true.

Second, students who themselves drank frequently in high school are particularly susceptible to roommates who drank. This finding is consistent with the idea that those who have some predisposition to alcohol use are most vulnerable to the cues and social acceptability provided by a drinking roommate, while those who do not want to use alcohol anyway are less affected.

[7] One other possibility is that there are scale economies in alcohol consumption, because one roommate with a fake ID or a cooperative older friend can procure alcohol on behalf of the other. Our impression is that purchasing alcohol during the relevant period was easy enough that this was not a major factor, and this story would not explain the persistence of the effects.

Third, the effects of initial roommate assignment persist during the second year, even though only 17 percent of students lived with their first-year roommate after the first year. Under a simple disruption model, the initial roommate assignment will only matter during the second year for the 17 percent of students who remain with their initial roommate. As we formally modeled in Kremer and Levy (2003), under a preferences model, having a drinking roommate as a first-year student could lead to more drinking as a first-year student, which could lead to stronger taste for drinking as a second-year student, which in turn could affect academic performance as a second-year student.[8] The medical and psychological literature suggests that misuse of alcohol has a strong genetic component, but also responds strongly to environmental influences and that previous alcohol use can induce strong desires for future use (Gardner and Lowinson, 1993; Beatty, Tivis, Stott, Nixon, and Parsons, 2000; National Institute of Alcohol Abuse and Alcoholism, 2001).

It is interesting to note that for the subsample of males who did not drink heavily in high school, there is a stronger adverse effect on GPA from roommates who are occasional, rather than heavy drinkers (see Table 4, columns 2 and 3). It is not clear what to make of this finding, given the confidence intervals around the point estimates, but it is not necessarily what we would have expected. One possibility is that occasional drinkers or nondrinkers may be more tempted to join the drinking activities of a moderately drinking roommate, while a roommate who drinks heavily may be sufficiently different that he has a smaller impact. This pattern may also be some evidence against the hypothesis that the effect of a drinking roommate on GPA stems from noise and distraction, rather than from peer effects in behaviors.

In our main sample, we do not have data on students' subsequent drinking or on any outcome data other than registrar data. However, further evidence for the preference hypothesis comes from work we did jointly with Johanne Boisjoly, Greg J. Duncan, and Jacque Eccles (2006), in which several cohorts of students were surveyed. Students assigned to roommates who reported drinking in the year prior to entering college are more likely to drink after the first year of college. Pairing up students with binge drinking histories sharply increases the amount of college binge drinking. Furthermore, the peer effect from first-year roommates appeared just as strong in the senior year as it did in the first year, despite the fact that the vast majority of first-year roommates did not room together after their first year.

Another model that could potentially contribute to the persistence of peer effects in preferences over time is the cumulative peer selection model of identity along the lines of Akerlof (1997). Suppose that once one starts associating with a particular person, one becomes more similar to that person. One then chooses

[8] Another possible hypothesis for the persistent effect of a drinking roommate would be cumulative learning. However, the effect of initial assignment to a drinking roommate on second-year grades in classes for which there is a prerequisite is actually insignificantly positive, while that in subjects without prerequisites is strongly negative. We also find no evidence that the extent of drinking by the initially assigned roommate affects whether people take classes with prerequisites.

other peers who are similar to the original peer and the process repeats itself and intensifies. For example, a student who is assigned a first-year roommate who drinks may also interact with other students in the same residence hall who do not drink much, and hence may drink only moderately during the first year of college. But the roommate may move into a fraternity where heavy drinking is common during his sophomore year, and if the student follows, the student's peers in the sophomore year may drink even more than in the freshman year. We have data on whether students joined fraternities, but not which fraternity they joined. About 21 percent of male students who were assigned roommates who drank frequently in high school joined fraternities, compared to 16 percent of those who were assigned roommates who did not drink in high school. However, this difference was not statistically significant.

An alternative mechanism might be that the effect of a drinking roommate operates not through drinking directly, but from activities that are correlated with drinking, such as partying and staying out late or spending more time socializing with friends and therefore studying less. The normative implications of such an interpretation may be different. Since this study does not have data on the actual drinking behavior of the students during college, it cannot definitively distinguish whether the channel through which grade point average is affected is really college drinking or activities such as partying and staying out late that are correlated with drinking behavior. However, the evidence of Boisjoly, Duncan, Kremer, Levy, and Eccles (2006), discussed above, which finds that being assigned a roommate who drinks leads to increased drinking, points in the direction that the effect may stem from the drinking itself.

Finally, it is worth noting that our finding of no evidence that roommates' academic background (high school GPA and admissions test score) or family background (parental income and education) affects students' college GPA is consistent with the idea that endowments of resources for studying is not the chief channel of roommate effects on grades in this setting.

Selection in the Roommate Request Sample

A common assumption when discussing peer effects is that when peers choose each other, their effects on each other may appear much larger than when peers are randomly assigned, because peers who choose each other are more likely to be similar on characteristics that are unobserved by the econometrician. However, our evidence suggests that biases in inference in settings where peers choose each other may be quite complicated, rather than simply exaggerating the peer effects found in random assignment studies.

We compared our results based on random assignment to those from a sample of students who selected their own roommates—henceforth called the "roommate request sample." Although males in the random lottery sample have a lower grade point average if their roommate drank in high school, this same pattern does not

hold in the roommate request sample.[9] This may be because when students choose their own roommates, any negative effects of drinking peers may already have occurred prior to university admission and may thus be reflected in high school grades, standardized test scores, and the admissions decisions of the university. In this case, one would not expect roommate characteristics to affect student outcomes in a regression controlling for the students' own high school grades and test scores (and limited to a sample of students who were admitted into this particular university).

Students' own drinking prior to college is not a stronger predictor of college grade point average in either the lottery or the roommate request sample. This may also be because the effect of students' high school drinking is already picked up in their high-school grades and in the admissions decision.

Taken together, these results suggest that selection may bias nonexperimental estimates in more subtle ways than commonly recognized and can lead to downward as well as upward biases in estimates of peer effects.

Conclusions and Policy Implications

Peer effects appear in a number of theoretical models and policy discussions, but they are difficult to estimate empirically. A number of recent studies in which peers are randomly or pseudo-randomly assigned find that peer effects are very real, but often take forms different than suggested either by simple models common in the literature or by empirical literature that seeks to estimate such models from nonexperimental data while imposing structural assumptions based on these models (Katz, Kling, and Liebman, 2000; Hoxby and Weingarth, 2005; Duflo, Dupas, Kremer, 2007).

In the context of education, many theoretical models assume that students' academic outcomes are a linear function of the academic or socioeconomic background of their peers (Epple and Romano, 1998; Hsieh and Urquiola, 2006). Empirically, with respect to roommates' academic backgrounds, this study, as well as other studies, suggests that in the context of universities, such linear effects are very small. However, roommates' preferences or habits may well have stronger effects. By taking advantage of the rich data on precollege behavior available in the Cooperative Institutional Research Program's Entering Student Survey, this study suggests that males' grade point average in the Midwestern state university we study is reduced by more than one-quarter of a percentage point by having a roommate who drank prior to college. The roommate drinking effects are most pronounced at the lowest quantiles of the college grade distribution. Roommate effects are stronger for students who reported drinking frequently in high school. They persist, and perhaps even strengthen during the second year of college, even

[9] See Appendix Table A3, available with this paper at ⟨http://www.e-jep.org⟩, for details.

though only 17 percent of students still live with their initially assigned roommate during their second year of college.

This evidence raises the possibility that interventions aimed at directly reducing problem drinking may generate multiplier effects. A policy that directly reduces drinking by some students may indirectly reduce drinking by others, leading to a greater cumulative effect over time than would be identified simply by looking at the impact on the individuals exposed to the program. The peer effects among roommates found in this study are likely to capture only part of the peer effects going on in a campus. Not all roommates may be spending time together, so peer effects among friends or other types of peers may be even larger.

A number of policies are predicated on the notion that peer effects play an important role in substance abuse. For example, many universities have launched campaigns to convince students that their peers drink less than they think (Wechsler, Lee, Kuo, and Lee, 2000). One alcohol-related policy some universities have adopted is removing students with problem behavior from the environment, by introducing so-called "substance-free" housing. Substance-free housing may affect grade point average through a variety of channels. For example, students in substance-free housing may feel more pressure not to drink, which could improve their college grades. But students who do not choose substance-free housing will be more concentrated together in "regular" residence halls. For the university as a whole, the academic costs of concentrating drinkers together may be higher than the benefits of moving the nondrinking students together. Based on the estimated coefficients for roommates' high school drinking listed in Table 4, matching two frequent drinkers together and two nondrinkers together yields an average overall GPA 0.36 points lower than matching frequent drinkers with nondrinkers.[10] This analysis also suggests that programs that allow students to self-select roommates may similarly have the side effect of lowering average grade point average to the extent that they lead frequent drinkers to match together. At the same time, while policies that lead to drinkers rooming with nondrinkers may be beneficial for the university as a whole, they may have detrimental effects on those nondrinkers who room with drinkers.

We believe it would be worthwhile to conduct similar studies in other settings to see if the results generalize to other contexts. The state university we examine is academically strong. We did not find evidence of strong interaction effects between roommate drinking and student academic characteristics, so we have no particular reason to think effects would be weaker in a less selective institution, but this would be worth checking. Moreover, it would be worthwhile to explore (as Greg Duncan and Guang Guo are planning to do) whether those with genetic predispositions towards alcoholism are particularly susceptible to peer influences regarding

[10] Consider that there are four students, two frequent drinkers and two nondrinkers. Matching same types, the two frequent drinkers are affected –.99 grade points each, while the two never drinkers lose 0 grade points each. (–.99 + –.99 + 0 +0) / 4 = –.495 grade points. Mixing types, the grades of the frequent drinkers are not effected while the grades of the never drinkers are .27 grade points lower than otherwise. (0 + 0 + –.27 + – .27) / 4 = –.135. So the difference between the two cases is .36.

alcohol. To the extent this is the case, those individuals might undertake special measures to reduce exposure to environmental cues stimulating alcohol use.

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Appendix Table A1
Descriptive Statistics for the Various Samples

	Lottery sample	*Whole sample*	*Roommate request sample*
Academic background			
Admissions test score (normalized)	−0.03	0.00	**−0.11**
	(0.86)	(1.00)	(0.97)
High school GPA	3.61	**3.56**	3.60
	(0.40)	(0.44)	(0.42)
Parental background			
Father's years of schooling	16.30	16.23	**16.06**
	(2.10)	(2.21)	(2.25)
Mother's years of schooling	15.68	15.68	15.57
	(2.20)	(2.22)	(2.17)
Parental income (in thousands of $)	120.01	119.05	118.25
	(74.75)	(79.37)	(76.19)
Drinking background			
Drank frequently in high school (all)	0.15	0.15	0.18
Drank frequently in high school (males)	0.16	0.17	0.20
Drank occasionally in high school (all)	0.53	0.51	**0.49**
Drank occasionally in high school (males)	0.51	0.48	**0.44**
Demographics			
Females	0.55	**0.51**	**0.45**
Blacks	0.03	**0.07**	**0.10**
Academic Outcomes			
Cumulative GPA, 1999	3.10	**2.94**	**3.01**
	(0.56)	(0.87)	(0.73)
Cumulative credits, 1999	46.57	**40.32**	**36.27**
	(14.73)	(17.32)	(14.37)
Housing preferences (% requesting)			
Substance-free hall	0.32	0.34	0.3
Smoker	0.06	0.06	**0.09**
Single room	0.02	**0.09**	**0.02**
Double room	0.86	**0.80**	0.88
Triple room + economy	0.12	0.11	0.1
Enrichment living center	0	**0.25**	**0.22**
Number of observations	1357	7541	1052

Note: Means in bold are significantly different from the lottery sample means at 5 percent significance level. Standard deviations for nondummy variables reported in parentheses. The number of observations in the lottery and roommate request samples do not add up to the number of observations in the whole sample because many students did not meet the lottery deadline (and hence were assigned nonrandomly) and did not choose a particular roommate.

Appendix Table A2

Effect of Roommates' and Own Drinking on Probability of Non-Enrollment *(probit regressions using the lottery sample)*

	Dummy for non-enrollment	
	Males and females	*Males only*
Roommates' high school drinking		
Frequent	−0.039	−0.123
	(0.315)	(.442)
	[−0.001]	[−.001]
Occasional	0.288	0.418
	(0.231)	(.298)
	[0.010]	[.012]
Student's high school drinking		
Frequent	0.094	0.017
	(0.270)	(.359)
	[0.004]	[.003]
Occasional	−0.045	−0.094
	(0.207)	(.305)
	[−0.002]	[−.001]
Observations	1013	458
χ^2	40.08	61.93
Prob > χ^2	0.001	0.000

Note: Robust standard errors are reported in parentheses. Marginal effects are reported in brackets. Huber–White standard errors were calculated using roommate clusters. The mean of the non-enrollment dummy is 0.0278.

All regressions include controls for student's and roommate's academic background (high school GPA and admissions test scores), student's and roommate's parental background (father's education, mother's education, parental income), and type of admission tests, as well as dummy variables for cells.

* significant at the 10 percent level, ** significant at 5 percent level, *** significant at the 1 percent level.

Appendix Table A3

Determinants of Cumulative GPA, Lottery Sample vs. Roommate Request Sample (Males Only)

	Lottery sample	*Roommate request sample*
Roommates' high school drinking		
Frequent	−0.282**	0.018
	(0.128)	(0.155)
Occasional	−0.263***	−0.082
	(0.101)	(0.114)
Roommates' parental background		
Roommates' avg. father's education	0.017	−0.047
	(0.032)	(0.033)
Roommates' avg. mother's education	0.003	−0.025
	(0.023)	(0.034)
Roommates' avg. parental income	0.318	0.953
	(0.629)	(0.801)
Roommates' academic background		
Roommates' admission test score	0.077	0.016
	(0.059)	(0.062)
Roommates' avg. high school GPA	−0.158	0.075
	(0.154)	(0.150)
Student's high school drinking		
Frequent	−0.109	0.033
	(0.150)	(0.158)
Occasional	−0.028	−0.133
	(0.119)	(0.123)
Observations	456	452
R^2	0.595	0.629
Adjusted R^2	0.173	0.283

Note: Robust standard errors in parentheses. Parental income is measured in millions of dollars. Huber–White standard errors were calculated using roommate clusters. Regressions include controls for student's academic background (high school GPA and admissions test scores), parental background (father's education, mother's education, parental income), and type of admission tests, as well as dummy variables for cells.

* significant at 10 percent level, ** significant at 5 percent level, *** significant at 1 percent level.

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