

Accounting for the Difference in PhD Creation Rates Across Liberal Arts Colleges

Robert J. Lemke¹
Department of Economics
Lake Forest College
555 N. Sheridan Road
Lake Forest, IL 60045
lemke@lakeforest.edu
847-735-5143

September 15, 2006

Introduction

Liberal arts colleges are an important source of PhD students. Although they award only eleven percent of all undergraduate degrees in the United States, liberal arts colleges account for seventeen percent of all PhDs awarded to American students. The most recent data suggest about 5.3 percent of all graduates from the best liberal arts colleges eventually earn a PhD, while only 2.2 percent of all graduates from the best universities do. Graduates of the best liberal arts colleges also go on to earn a PhD at a rate that is about three times as great as graduates from lower ranked colleges.

How is it that some liberal arts colleges are consistently more successful than others at producing graduates who go on to earn a PhD? The answer(s) to this question are inherently complex and difficult to isolate. This chapter is a first attempt to unravel parts of the story.

The social benefits provided by institutions of higher education in the form of having a highly educated citizenry are well understood. Society benefits from scientific discoveries, creative works of art, and informative policy analyses as well as from having a more

¹ Financial assistance was provided by the Richter Apprentice Scholars Program at Lake Forest College. Max Falaleyev, Mariyana Zapryanova, and James Zender provided research assistance. I thank Ron Ehrenberg, Kristina Lybecker, Bob McCaughey, Isaac Rischall, and Jeff Sundberg for their valuable suggestions. All remaining errors are my own.

knowledgeable electorate. Institutions of higher education, however, vary greatly in their approach toward education. At liberal arts colleges, where graduate degrees are seldom awarded, the primary mission is focused on educating undergraduates. Even though creating students who will eventually earn a PhD is not the sole objective (and maybe not even a primary objective) of liberal arts colleges, the graduate school success of their students is important to liberal arts colleges. As socially conscious institutions, colleges value education and the benefits that a graduate education offers. Many faculty members at liberal arts colleges measure their contribution to society in part by the students they produce, including future PhDs who go on to undertake meaningful research of their own. More locally, the rate at which an institution's students pursue graduate study indicates how successful the institution is in general at fostering growth in students to enjoy learning and a desire to pursue their own path toward understanding and discovery after college. Liberal arts colleges also have a preference, at least marginally, for hiring faculty with a liberal arts background. This suggests there is some consensus, at least among college Deans, that liberal arts college graduates may have a greater appreciation, if not a greater affinity, for teaching because of their liberal arts background (Astin, 1999; Warch, 2001). And more selfishly, post-college education of alumni affect college rankings, and granting agencies like the National Science Foundation and the accreditation process consider the graduate school success of alumni when evaluating institutions of higher education.

This chapter also provides insight into the effect faculty scholarship has on graduate school choices of students at liberal arts colleges. Whether faculty scholarship should be required, encouraged, fostered, or tolerated at liberal arts colleges has long been debated. Through the 1950s, faculty at liberal arts colleges were not expected to be engaged in research. Over the last forty years, however, scholarship expectations have changed. Presently, the most

elite colleges require their faculty to be deeply engaged in research. Many if not most lower-ranked liberal arts colleges also consider scholarship in tenure decisions, though the quantity and quality of the scholarship requirements are less than at the top institutions and vary considerably across institutions (McCaughey, 1994).

On one hand, some argue that imposing unnecessary research expectations on faculty detracts from high quality teaching (the foremost stated mission of most liberal arts colleges) as research competes for scarce funds and faculty time.² In terms of PhD creation, faculty who spend more of their time engaged in research will have less time to devote to teaching and advising, persuading fewer students to pursue a PhD. In contrast, others maintain that engagement in scholarship, at least at the very best liberal arts colleges, helps faculty become better teachers (McCaughey, 1994). In terms of PhD creation, faculty research engages students, sometimes even includes them directly, and fosters excellent teaching. As a result, students are more likely to pursue a PhD.³ The results presented later suggest that both effects exist, with the positive effects of faculty scholarship when measured in terms of encouraging students to pursue a PhD being strongest at the best colleges.

PhD Creation

In order to study the differences in PhD creation rates across institutions, data from two surveys are used: the National Center of Education's Higher Education General Information Survey (HEGIS) and Integrated Postsecondary Education Data System (IPEDS) *Completions*

² Boyer (1987, 1990) argued that the traditional definition of scholarship is too limiting, especially in a liberal arts setting, and should be thought of as any activity that strengthens and contributes to one's teaching.

³ Ehrenberg (2005) suggests such interaction as a means to encourage undergraduates at research universities to consider pursuing a PhD.

Survey and the National Science Foundation's *Survey of Earned Doctorates*.⁴ Both surveys report information at the institutional level. The *Completions Survey* includes the number of undergraduate degrees awarded each year, while the *Survey of Earned Doctorates* reports the number of PhDs earned each year by alumni of each institution.

Although the surveys contain information on thousands of institutions of higher education, attention will be focused on a few particular groups by using the 1994 Carnegie Classification system: liberal arts colleges are taken to be those institutions designated BA I or II, and universities are those institutions designated Research I or II, Doctoral I or II, or Masters I or II. According to these definitions, there are 604 colleges and 732 universities. Much attention, however, will be restricted to the “top” institutions in each group. There are 165 colleges designated as BA I and 87 universities designated as Research I.⁵ For colleges and universities alike, the “top” institutions account for about one-third of all undergraduate degrees awarded.

For purposes here, **PhD creation** refers to the **undergraduate** institution of the student who received a PhD **in the United States**. Every year since 1970, American universities and liberal arts colleges have created between 20,000 and 24,000 and between 3,600 and 4,900 PhD's respectively.⁶ The top universities consistently account for just under half of all PhD's created by universities, while the top colleges account for two-thirds or more of all PhDs created by liberal arts colleges.

Using data on PhDs created (*Survey of Earned Doctorates*) and undergraduate degrees awarded (*Completions Survey*), PhD creation rates can be calculated for each institution or for

⁴ The data for both surveys can be found on-line at www.webcaspar.org.

⁵ McCaughey (1994) discusses the differences across BA I colleges as well as various definitions for liberal arts colleges, including “elite,” “selective,” and “research colleges.”

⁶ While PhD creation has risen and fallen modestly for American universities and liberal arts colleges, foreign institutions witnessed a remarkable increase in PhD creation since 1980 (Ehrenberg, 1991). Total PhD creation in the United States increased from 30,000 per year in 1985 to 40,000 per year by 1995. Of this 10,000 increase, seventy percent was attributable to foreign institutions. In 1985, about 5,000 PhD's were awarded in the United States to graduates of foreign undergraduate institutions. By 1995, this had increased to over 12,000.

each type of institution. Two issues, however, are worth mentioning. First, the *Survey of Earned Degrees* does not report when the PhD recipient received his or her undergraduate degree. Thus, a five-year rolling window between undergraduate and graduate degrees is used.⁷ Second, to smooth the data year-to-year, the PhD creation rate for any particular year is calculated as all PhDs awarded within two years as a fraction of all undergraduate degrees awarded within two years. For example, the 1975 PhD creation rate for liberal arts colleges is calculated as all PhDs received from 1973 through 1977 by graduates of liberal arts colleges measured as a fraction of all undergraduate degrees awarded by liberal arts colleges from 1968 through 1972.

Figure 1 shows yearly PhD creation rates for the top liberal arts colleges vs. the top universities (diamond lines: dark solid vs. light dashed) and for all liberal arts colleges vs. all universities (smooth lines: dark solid vs. light dashed). PhD creation rates fell following the Vietnam War for all types of institutions. Since 1985, however, only top liberal arts colleges have been experiencing an increase in creation rates, from just under 4.7 in 1987 to over 5 percent by 1992 and in excess of 5.3 percent since 2000. Comparatively, the PhD creation rate for top universities fell below 2.5 percent by 1980, and has hovered between 2.2 and 2.5 percent since. A similarly persistent, though not quite as large of a gap, exists between all colleges and all universities. Whereas the PhD creation rate for all colleges fell fairly steadily from just over 3 percent in 1980 to around 1.8 percent in 2000, the PhD creation rate for all universities fell from just under 1.8 percent in 1980 to under 1.5 percent in 2000.⁸

These differences in PhD creation rates are substantial. Throughout the 1990s, for example, whereas liberal arts colleges graduated one person for almost every eight university

⁷ Fuller (1986) also allows for a five-year rolling window.

⁸ The differences persist across academic division as well. In the 1990s, about 1.25, 1.40, and 1.79 percent of graduates from the top liberal arts colleges earned a PhD in the humanities, social sciences, and natural sciences respectively. In contrast, only 0.35, 0.56, and 0.84 percent of graduates from the top research universities did so.

graduates, liberal arts graduates earned one PhD for every five earned by university graduates. The ratios are even more striking for the top institutions. Figure 2 shows the ratio of PhD creation rates over time. The top (solid) line depicts the ratio of PhD creation at the top colleges to the top universities. From 1985 to 1995, the top liberal arts colleges were consistently producing PhDs at twice the rate of the top universities. By 2000, however, as they had in the mid 1970s, the top liberal arts colleges were producing PhDs at a rate two and a half times greater than the top universities. The bottom (dashed) line of Figure 2 shows that the ratio of PhD creation rates between all colleges and all universities has hovered around 1.6 since 1975.

Choosing to Pursue a PhD

There are many possible explanations for why liberal arts colleges create PhDs at a greater rate than their university counterparts. Liberal arts colleges might attract the type of student, not only with greater ability but also with other intangible qualities such as curiosity and self-motivation, who will later be drawn to a PhD. Students at liberal arts colleges also interact frequently with their professors, and typically at a deeper level than do students at universities. This closer relationship may lend itself to faculty members encouraging students to go on to graduate school more often (or that graduate school advice is more frequently followed). Apart from that of their parents, it may be that the occupation students at liberal arts colleges are most familiar with is that of professor, and this familiarity leads students to graduate school.⁹

⁹ With particular emphasis on the role forming expectations play in the decision, Ehrenberg (1991) discusses factors that likely influence one's decision to pursue a PhD, including the pecuniary and non-pecuniary benefits, time to complete the degree, cost of graduate school, etc. Given the close relationship between students and professors at liberal arts colleges, these students arguably can form fairly good expectations of the non-pecuniary benefits of being a college professor at such an institution. Of course, even though many faculty at liberal arts institutions may not be able to fathom it, it is not clear whether students are actually drawn to the occupation when they observe faculty working long hours on teaching and research while foregoing higher wages outside of academia.

Others argue that it is not so much advice given and received but rather that the experiences afforded by liberal arts colleges naturally foster a desire to learn more and to study more, which in turn leads to greater participation in graduate school. Warch (2001), for example, argues that the one-on-one undergraduate research experiences offered to students at liberal arts colleges are not only transforming, but such opportunities are rare to non-existent at universities where graduate students have first claim to laboratories, equipment, and the professor's time. Astin (1999), Bourque (1999), Warch (2001) and others claim that it is only natural that one-on-one research experiences are likely to have a transformative effect on students and that liberal arts faculty are particularly suited to lead such experiences. Quantitative evidence to this point, however, is lacking.

To try to begin to fill this void, a survey was sent to 850 current full-time faculty members at liberal arts colleges asking when they knew they wanted to go to graduate school and what factor was most responsible for that decision. Surveys were returned by 358 faculty members for a response rate of 42 percent.¹⁰ Of those returned, 152 were from faculty who attended a liberal arts college, while 206 attended a research university. The tabulation of responses is given in Table 1.

The question of timing is addressed in panel A. Roughly fifty percent decided on graduate school during their last two years of college regardless of type of undergraduate institution. Graduates from universities are more likely to make the decision to go to graduate school before college or early in college than graduates from colleges, while the reverse is true

¹⁰ Responses from people who attended a foreign undergraduate institution were omitted. To what extent the selection issues affect the results are unclear. In particular, only PhDs who are currently at liberal arts colleges were surveyed. One's choice of undergraduate institution, reasons for going to graduate school, reasons for accepting a job at a liberal arts college, and decision to respond to this survey may not be unrelated.

for making the decision after working for some time. None of the differences in Table 1, however, are statistically significant at the five percent level.

The question of who or what most influenced the decision to go to graduate school is reported in panel B. The responses are grouped broadly into four categories – family, undergraduate institution (including a professor, classmates, a research experience, or a particular class), employment goals (including frustration with one’s job, needing a PhD to do interesting research, or wanting to teach at the collegiate level), and self-motivation. Although much more research should be done on the motives underlying the decision to go to graduate school, this simple survey provides some evidence that liberal arts colleges connect with their students in a way that universities do not.¹¹ Whereas 48 percent of graduates of universities attribute the primary factor to their pursuit of a PhD to something concerning their undergraduate institution, 58 percent of graduates from liberal arts colleges do. (The difference is statistically significant with a p -value of 0.032.)

The other statistically significant difference in Table 1 concerns self-motivation. Whereas ten percent of graduates from universities attribute their pursuit of a PhD to self-motivation, only three percent of graduates from a liberal arts college do (with a p -value of 0.005). This difference might be attributable to the difference in how students and professors interact on university campuses or simply to the number of students on university campuses. For a student to be an academic standout on a university campus, he or she must rise above thousands, not hundreds. To do this undoubtedly requires an inner desire for academic success. Whereas this desire no doubt exists in the standouts at liberal arts colleges, it may be more necessary on university campuses, and thus is more frequently noted by such graduates.

¹¹ Graduates of liberal arts colleges are more likely at least to attribute their pursuit of a PhD to something concerning their undergraduate experience – a professor, research experience, a particular class, etc. – than are graduates of universities.

Cautious of the small sample sizes and rudimentary survey method, it appears that liberal arts colleges deliver on their promise to interact closely with students and to possibly “change lives” where graduate school is concerned. More research in this area, however, would be well worthwhile. In particular, how engaging students in undergraduate research projects likely affects future decisions concerning PhD pursuits remains largely unknown. If liberal arts colleges have an advantage in this particular area, then calls for further funding, such as from NSF grants (Warch, 2001), to expand such opportunities should be explored.

Quantitative Analysis

Attention now turns from comparing liberal arts colleges to universities to that of exploring empirically why some colleges have higher PhD creation rates than others. In order to carry out the analysis, attention was restricted to the BA I colleges as defined by the Carnegie Classification in 1994. The *Completions Survey* was used to determine the number of graduates from each college from 1989 through 1998. The *Survey of Earned Doctorates* was then used to determine the number of doctorates awarded between 1994 and 2003 in the humanities, social sciences, and natural sciences to alumni of each college. Each college’s overall PhD creation rate as well as its creation rate in the humanities, social sciences, and natural sciences was then calculated. The average college saw about 4.2 percent of its graduates go on to earn a PhD, with division-specific PhD creation rates of 1.0 percent in the humanities, 1.3 percent in the social sciences, and 1.9 percent in the natural sciences.¹²

To carry out a statistical analysis of PhD creation, additional data was collected from two sources. The 1994 edition of U.S. News and World Reports’ *America’s Best Colleges* lists, in

¹² Notice that the division-specific creation rates were calculated as a percent of all college graduates. They are not measured as a percent of college graduates from within the division as the *Completions Survey* does not allow for accurate calculation of this sort.

four tiers,¹³ 161 top liberal arts colleges and provides data on the 75th percentile SAT score of incoming freshmen (average of 1235)¹⁴ and per student expenditures. Expenditures per student ranged from a low of \$4,510 to a high of \$23,715, with the average college spending \$13,420 per student. Barron's 1995 *Profiles of American Colleges* reports enrollment, percent of students who are female, student-faculty ratio, and the percent of incoming students who scored above a 700 on the verbal/ math sections of the SAT.¹⁵

Lastly, the Web of Science citation database was used to determine the number of articles attributed to each college in the Arts and Humanities Citation Index (A&HIS), the Social Science Citation Index (SSCI), and the Science Citation Index Expanded (SCI-EXPANDED) for the years 1989 through 1998. Using each college's enrollment and student-faculty ratio, the number of articles per college was transformed into the number of articles per faculty member over the ten-year period. The average school had 0.3, 0.4, and 0.6 articles in A&HIS, SSCI, and SCI-EXPANDED respectively per faculty member for the entire ten years. These low rates reflect the fact that they are calculated per faculty member and not per faculty member in a particular division. Combining the three citation indexes, the average college had almost 2.5 entries of any kind, not just journal articles, per faculty member over the ten years; put differently, each faculty member contributed an entry to the index on average once every four years. Whereas the least prolific college had almost no entries, the most prolific college averaged almost 8 citations per faculty member over the ten years (or just under one publication per faculty member per year).

¹³ The tiers are defined as follows: tier one contains colleges ranked 1 to 40, tier two 41 to 82, tier three 83 to 122, and tier four 123 to 161. Also, U.S. News classified Reed College as tier four, because Reed refused to fill out part of the survey. For the purposes of this study, Reed is classified as a tier two college to better reflect its reputation.

¹⁴ When U.S. News reports percentiles for the ACT instead of the SAT, the scores were converted to the SAT scale using the College Board's conversion table at www.collegeboard.com.

¹⁵ To limit the number of colleges with missing data, the data for some colleges was obtained from other sources.

When attention is restricted to only BA I colleges with an enrollment of at least 500 and at most 3,500 students for which there is no missing data, there are 148 colleges in the sample. Table 2 lists all of the colleges used in the analysis, along with their overall PhD creation rate of students who graduated between 1989 and 1998.

Explaining Overall PhD Rates

Using these data, the relationship certain factors have with PhD creation can be estimated. To do this, two models were estimated using ordinary least squares regression – one for the 81 colleges in the top two tiers and one for the 67 colleges in the third and fourth tiers. The dependent variable is each college’s overall PhD creation rate as reported in Table 2. The explanatory variables included are the college’s 75 percentile SAT score, log of enrollment, percent of students who are female (measured 0 to 100), per student expenditures (measured in \$1,000), whether the college offered a business degree in the 1990s, whether the college is located in the northeast,¹⁶ and the number of WebScience citations per faculty member from 1989 – 1998. Offering a business degree was included for two reasons. First, offering a business degree might indicate that the college attracts students who are more inclined to pursue professional degrees or to have more immediate job expectations after graduation. Second, offering a business major may compete with the more traditional liberal arts majors, which in turn may limit student options for a PhD after graduation. Location has also been included

¹⁶ To be considered as offering a business degree, it was required that the college had awarded at least 100 degrees in the area of business between 1989 and 1998 according to the IPEDS/HEGIS data. Colleges located in CT, MA, ME, NH, NJ, NY, RI, or VT are considered to be in the northeast.

because of the historical presence of many elite colleges, and clusters of elite colleges (e.g., the sister colleges), in the northeast. Kaufman and Woglom (2005) also account for location.¹⁷

The results from both models are reported in Table 3. The percent of students scoring in the top quartile of the SAT is positively related to PhD creation for both groups of colleges, though the magnitude of the effect is much greater for tier 1 and 2 colleges than for tier 3 and 4 colleges. While neither enrollment nor the percent of students who are female are statistically significant in either regression, the most important take-away point from Table 3 is how different PhD creation is for the colleges in the top two tiers than it is for the colleges in the next two tiers. There are meaningful differences between the creation of PhDs and college expenditures, offering a business degree, college location, and faculty scholarship. Each of these is discussed in turn below.

While expenditures per student are not statistically significant in the creation of PhDs at tier 1 or 2 colleges, they are statistically significant at the 5 percent level at tier 3 and 4 colleges. The magnitude of the effect, however, is very small. A \$1,000 increase in per student spending is associated less than a 0.15 percentage point increase in PhD creation. For the typical college, this suggest that increasing the annual budget by over \$1 million annually would be associated with one additional graduate every two years going on to eventually earn a PhD.

Among colleges in the top two tiers, those that offer a business degree create PhDs at a rate that is almost 2 percentage points less than those that do not offer a business degree.

Offering a business degree by colleges in the bottom two tiers, however, is not statistically

¹⁷ Other variables such as acceptance and retention rates, 25th percentile SAT score, percent international and percent minority students were also included in previous specifications, but none were consistently statistically significant and therefore have been omitted from the final specification given the small sample sizes. A dummy variable for tier 2 colleges is insignificant in the first model; a dummy variable for tier 4 colleges is statistically significant at the 10 percent level in the second model. The coefficient estimates, however, are fairly insensitive to the inclusion or exclusion of these dummy variables so they too has been omitted from the final specification. The results are qualitatively unchanged if one includes per student expenditures (as is done here) or the log of per student expenditures as Kaufman and Woglom (2005) do.

associated with PhD creation. One interpretation of this finding is that not only are good students at the best colleges attracted to non traditional liberal arts majors like business, but also that students who choose these majors develop less interest in graduate school or find it more difficult to pursue a graduate degree.

Tier 1 and 2 colleges located in the northeast are predicted to create PhDs at a rate that is 3 percentage points less than comparable colleges not located in the northeast. In contrast, tier 3 and 4 colleges located in the northeast are predicted to create PhDs at a rate that is almost 1 percentage point higher than comparable colleges not located in the northeast. The location of Wall Street and the U.S. financial/banking industry could explain this pattern if the financial sector of the U.S., which is located predominantly in the Northeast, has a preference for hiring the best students from the best regional colleges.

Finally, the relationship between PhD creation and faculty scholarship also varies by tier. Among tier 1 and 2 colleges, faculty scholarship is positively related to PhD creation, while faculty scholarship is unrelated to PhD creation at tier 3 and 4 colleges. This suggests that both arguments made in the introduction – that increased faculty scholarship might detract from a professors time to advise and teach or it might add to faculty interactions with students – hold, but that they are realized to varying degrees at different colleges. Faculty at the best colleges who are engaged in scholarship may affect their students positively toward graduate school. At lower ranked colleges, however, faculty scholarship does not appear to be a catalyst for encouraging students to pursue a PhD.¹⁸

¹⁸ Although there is a measurable difference in average student ability between the colleges in the top two tiers and the bottom two tiers, there is also likely to be a difference in the research abilities of the professors across the colleges. To what extent these findings on faculty scholarship and PhD creation are due to the students or to the faculty remains unknown, and would be worthwhile future research.

Explaining PhD Rates Across Disciplines

Using the same data as above, the relationship certain factors have with PhD creation within each division can be estimated. To do this, each of the previous models was re-estimated using seemingly unrelated regression.¹⁹ Each model estimates three equations with the dependent variables being each college's PhD creation rates (measured 0 to 100) in the humanities, social sciences, and natural sciences.²⁰ The explanatory variables are identical as in Table 3 except that each equation includes faculty citations within each division.

The regression results strongly suggest that PhD creation rates are correlated across academic divisions. The correlations of the error terms are greater than one-half and are positively correlated at the one percent level. Moreover, if the errors were randomly distributed, one would expect roughly one in every eight colleges to have a positive (negative) error in all three equations. Instead, 21 (28) of the 81 tier one and tier two colleges have positive (negative) errors in all three equations. Similarly, 14 (22) of the 67 tier three and tier four colleges have positive (negative) errors in all three equations.

The results are reported in Table 4. Looking across the three equations for both models, the estimated relationships between PhD creation and enrollment, per student expenditures, offering a business degree, being located in the northeast, and faculty scholarship largely support the results from Table 3.

A notable difference between the specifications of Table 3 and Table 4, however, concern the percent of female students. Although the percent of a college's student body that is female

¹⁹ Seemingly unrelated regression allows for consistent and efficient estimation of parameters when error terms may be correlated across equations.

²⁰ The humanities include art, art history, communications/librarianship, English, foreign and modern languages, history, philosophy, and religion; the social sciences include anthropology, economics, government, political science, psychology, and sociology; the natural sciences include biology, bio-chemistry, chemistry, mathematics, physics, and all engineering programs. Omitted from the analysis are doctorates awarded in education programs, social service professions, vocation studies, and home economics.

was unrelated to overall PhD creation rates, the results in Table 4 suggest there is a deeper relationship according to academic divisions. Having a greater percentage of female students on campus is associated with greater PhD creation rates in the humanities and social sciences compared to the natural sciences.

The results concerning test scores are roughly the same in Table 4 as they were in Table 3. A college's 75th percentile SAT score is positively associated with PhD creation rates for both groups of colleges, but a 100 point increase is associated with between a 0.6 and 0.9 percentage point increase, depending on discipline, for the top two tiers while a 100 point increase is associated with only a 0.1 percentage point increase for the bottom two tiers. The model can be expanded by replacing the 75th percentile SAT score with the percent of students who scored above a 700 on each subject test of the SAT.²¹ Almost twenty percent of the colleges, however, fail to report these variables. Consequently, many estimated coefficients are statistically insignificant as they are associated with large standard errors given the smaller sample sizes. That said, the results suggest that student abilities matter in their choices of major and graduate study. The percent of students who score above a 700 on the verbal portion is positively associated with PhD creation in the humanities and social sciences but is unassociated with PhD creation in the natural sciences. Conversely, the percent of students who score above a 700 on the math portion is positively associated with PhD creation in the natural sciences but is unassociated with PhD creation in the humanities or social sciences.

Lastly, a final test of robustness should be mentioned. The *Completions Survey* data are not disaggregated enough to calculate the number of graduates in each academic division for each college. When a student double majors, for example, only one of his or her majors is recorded in the data. Accurate division-specific PhD creation rates can be calculated, therefore,

²¹ The results are available from the author upon request.

only if every double major always double majored in the same division or if by chance double majors that spanned division were spread across the divisions and recorded for the survey randomly (e.g., not alphabetically or by size of major). Making the heroic assumption that the *Completions Survey* data accurately reflects the distribution of undergraduate degrees, division-specific PhD creation rates were calculated along with division-specific shares of undergraduate degrees. The model was re-estimated, once using the division-specific creation rates as dependent variables and once including each division's share of undergraduate degrees as an explanatory variable in that division's equation. Both sets of results qualitatively match the results found in Table 4, but estimates are much less stable across equations and models, and standard errors are larger.

Discussion

The creation of PhDs from elite liberal arts colleges remains a mysterious process, but this chapter has begun to shine some light on the differences across colleges. First, within colleges, PhD creation rates are highly correlated across academic divisions. Second, college characteristics and student traits matter. Most important is student ability (as measured by test scores) when they enter the college, but location, the percent of students who are female (positively related to PhD creation in the humanities and social sciences; negatively related in the natural sciences), and curriculum (colleges that offer a business major are associated with lower rates of PhD creation) also matter. Third, faculty research plays an important but selective role: PhD creation is positively related to faculty scholarship, especially in the social and natural sciences, but only among the top 80 or so colleges.

Although the above mentioned factors are important, they do not tell the entire story. The regressions only explain about 50 percent of the variation in PhD creation rates among the top two tiers of colleges, and even less in the next two tiers. To try to understand more of the PhD creation process, the regression results were used to identify 21 colleges that consistently over- produce PhDs in all three academic divisions and 26 colleges that consistently under-produce PhDs.²² Using these two groups of colleges, a search was undertaken regarding each college's Career Center webpage and the services offered pertaining to graduate school. Under the assumption that colleges with career centers in the 1990s that focused attention on student applications to graduate school would continue to do so, a present-day comparison between the over-producing and under-producing colleges' career centers could be fruitful. Although quantitatively comparing webpages across colleges is difficult, the overall assessment showed that career centers at colleges that over-produce PhDs are about twice as likely to offer a large amount of information and provide access to multiple resources on the web to students who are interested in graduate school than are the career centers at colleges that under-produce PhDs.

The directors of the career centers of the over-producing colleges were also asked their opinion concerning how their center meets student needs. The over-riding theme told by the career center directors is that they do not focus on funneling students toward graduate school; rather, when students come to them for advice, the approach is to present the student with many options – job, graduate school, professional school, volunteering. Although graduate school is not the focus, it is discussed and presented as a viable option. All of the centers also had resources available to students to help with the process of applying to graduate school – from providing practice GRE tests to offering a list of alumni to talk to at various graduate programs to helping write a personal statement. Of course, it is unclear if the mission of career centers and

²² The details of classifying colleges as over- or under-producing PhDs is available from the author upon request.

the services provided result in greater interest in graduate school or if the students at colleges that create many PhD's require the career center to serve their needs.

In addition to career centers, the set of over- and under-producing colleges can also be used with the previously discussed faculty survey. Of the 358 responses to the faculty survey, 31 attended one of the over-producing colleges and 17 attended one of the under-producing colleges. Although the sample size is very small, some interesting patterns emerge. Compared to students from the under-producing colleges, students from the over-producing colleges were more likely to make the decision to go to graduate school in their last two years of college (61 vs. 47 percent) and were less likely to make the decision early in college or even before college (16 vs. 35 percent). There are also notable differences to what the respondents most attributed their decision to go to graduate school. Compared to students from the under-producing colleges, students from the over-producing colleges were more likely to attribute the decision to a professor (36 vs. 24 percent) and less likely to attribute the decision to a particular class (7 vs. 18 percent) or not enjoying work (3 vs. 18 percent). Response rates were more equal in attributing the decision to an undergraduate research project (7 vs. 6 percent) or not wanting to stop with schooling or having a love of learning (7 vs. 12 percent).

Finally, it is interesting to hear from the colleges directly as to what they think the source of their college's success is. The Dean of Faculty (or equivalent) at each of the over-producing colleges was asked: "Please describe why you think it is that your college is successful at having its students go on to earn PhDs." The common theme from all Deans concerned curriculum. Two examples stand out: Kalamazoo College and Scripps College.

Kalamazoo College has long been successful at producing future PhD's. Its creation rate was 9.2 percent in the 1970s, 10.6 percent in the 1980s, and 12.2 percent in the 1990s. It is also

at or near the top in per capita volunteers with the Peace Corps. In the 1960s, Kalamazoo undertook a substantial curriculum change, called the K-Plan, that frames each student's entire four years of college.²³ All students participate in a Freshmen Seminar and an off-campus internship in the second year. Study abroad is strongly encouraged in the third year, with over 80 percent of students participating. And all students are required to complete an individual research project during their senior year, many of which are year-long endeavors.

Scripps College is the only all-women's college in the consortium of Claremont Colleges. Scripps has long offered a humanities focus to its students, but it intentionally widened its curriculum and recruited students to match in the 1980s. The required humanities curriculum was developed into the Core Program. The Core Program, in which all faculty are expected to teach regularly, is a three-course sequence with the shared theme of "Culture, Knowledge and Representation."²⁴ In addition to a more interdisciplinary curriculum, a new science building opened in 1990 and the number of science faculty was substantially increased. The number of science majors increased from just a handful each year in the 1970s to presently graduating between 30 and 40 science majors each year. These developments, however, have helped to vastly increase Scripps' PhD creation rate across all academic fields not just in the sciences. Scripps' PhD creation rate was 2.4 percent in the 1970s and 4.2 percent in the 1980s. It has since increased even more to 5.7 percent in the 1990s.

Although the abilities and talents of incoming freshmen matter in terms of which colleges are most likely to produce future PhDs, the academic experiences of students while at college also play a role. Providing a serious curriculum, encouraging students to take on challenges, and developing a campus environment that respects intellectual curiosity all contribute to the

²³ For more information regarding the K-Plan, see www.kzoo.edu/about_kplan.htm.

²⁴ For more information regarding the Core Program, see www.scrippscollege.edu/dept/core/about/index.html.

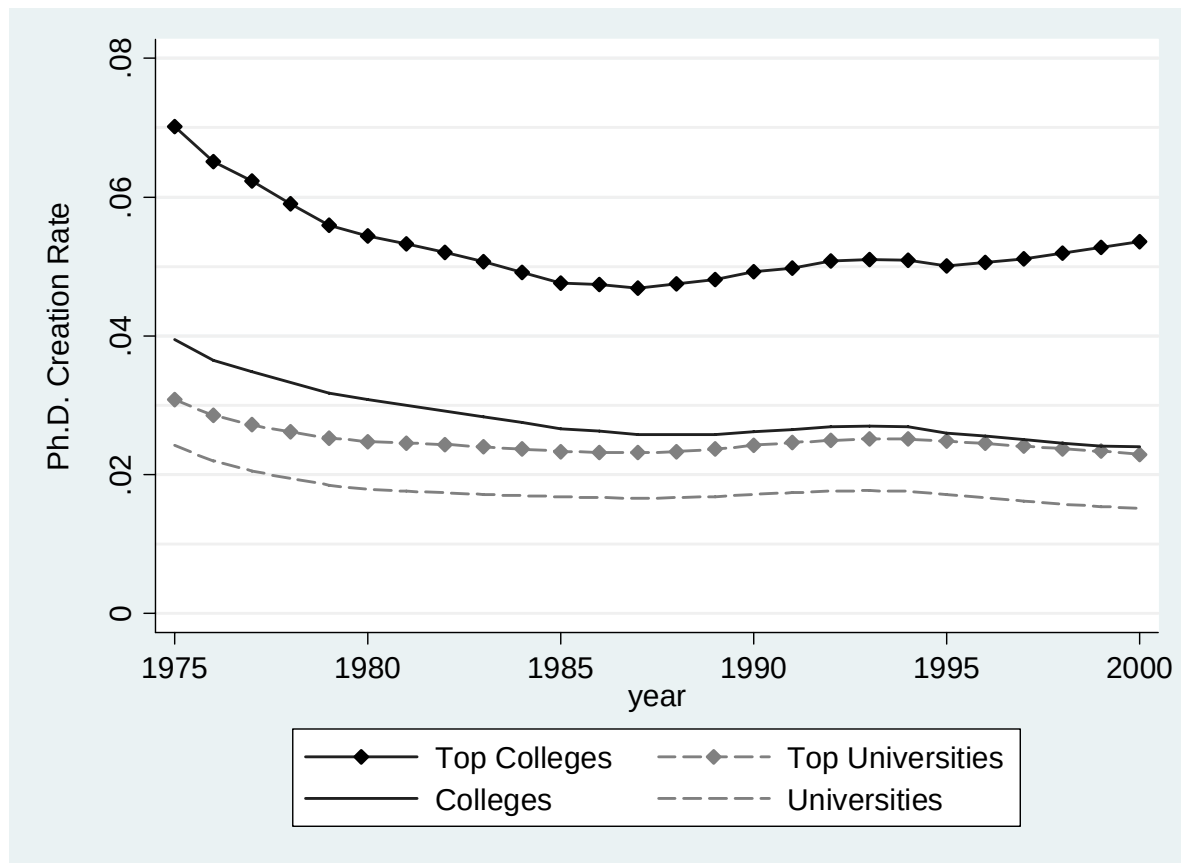
development of students. The idea of a campus culture in which graduate school is well-thought of was articulated by many Deans.

This chapter has begun to explore why some colleges are better than others at producing future PhDs. Much more research is needed. In particular, a careful analysis of why individuals choose to go to graduate school would be fruitful. Do undergraduate research experiences push students toward graduate school? And if so, are these experiences different at colleges than at universities? Is the academic lifestyle so appealing at liberal arts colleges that this explains why graduates of liberal arts colleges pursue PhDs at about twice the rate of graduates from large universities? The answer to these and many other questions would help us better understand the connections between an individual's undergraduate experience and his or her decision to go on to graduate school, and possibly help colleges better target this outcome.

References

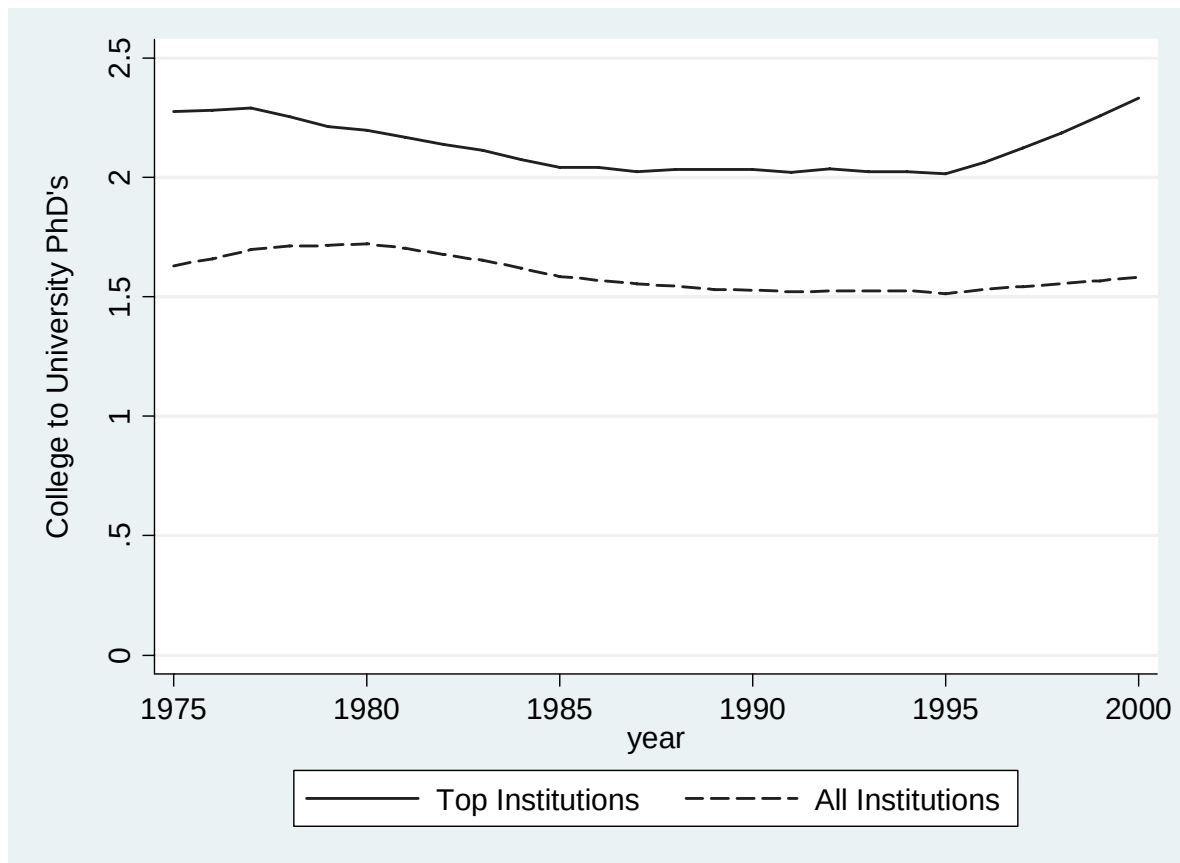
- American Association of University Professors (AAUP), "Status of the Profession Report," *Academe*, March-April, 1994.
- Astin, Alexander W., "How the Liberal Arts College Affects Students," *Daedalus*, Vol. 128(1), Winter, pp. 77 – 100, 1999.
- Astin, Alexander W. and Mitchell J. Chang, "Colleges that Emphasize Research and Teaching," *Change*, Vol. 27(5), September/October, pp. 45 – 49, 1995.
- Barron's, *Profiles of American Colleges, 20th Edition*, Barron's Educational Series, Inc., New York, 1994.
- Bourque, Susan C., "Reassessing Research: Liberal Arts Colleges and the Social Sciences," *Daedalus*, Vol. 128(1), Winter, pp. 265 – 272, 1999.
- Boyer, Ernest L. *College: The Undergraduate Experience in America*, Harper & Row, New York, 1987.
- Boyer, Ernest L. *Scholarship Reconsidered: Priorities of the Professoriate*, Carnegie Foundation for the Advancement of Teaching, Princeton, 1990.
- College Board, *SAT Program Handbook 1993-94*, Princeton, New Jersey, 1994.
- Ehrenberg, Ronald G. "Academic Labor Supply," in Charles Clotfelter, Ronald Ehrenberg, Malcolm Getz, John Siegfried, eds., *Economic Challenges in Higher Education*, Chicago University Press, Chicago, 1991.
- Ehrenberg, Ronald G., "Involving Undergraduates in Research to Encourage Them to Undertake Ph.D. Study in Economics," *American Economic Review*, Vol. 95(2), May, pp. 184 – 188, 2005.
- Fuller, Carol. "PhD Recipients: Where Did They Go To College?" *Change*, November, pp. 42-52, 1986.
- Kaufman, Roger T. and Geoffrey Woglom, "Financial Changes and Measures of Success Among the Second Tier of Top Liberal Arts Colleges 1996-2001," mimeo, March, 2005.
- Lemke, Robert J., Todor L. Barzev, Detelina N. Filipova, and Veska I. Suleva, "The Role Faculty Scholarship Plays in Producing Economics PhD's from Liberal Arts Colleges" mimeo, Lake Forest College, January 2006. (A previous version was published under the title, "Economics BA's and Ph.D.'s from Liberal Arts Colleges: Do Degree Requirements or Faculty Scholarship Matter?" ERN Educator Working Paper Series, Social Science Research Network, <http://ssrn.com/abstract=654241>.)
- McCaughey, Robert A., *Scholars and Teachers: The Faculties of Select Liberal Arts Colleges and Their Place in American Higher Learning*, Conceptual Litho Reproductions, Inc., New York, 1994.
- U.S. News and World Report, "Best National Liberal Arts Colleges," September 18, 1995.
- Warch, Richard, "Liberal Arts Colleges Lead the Way in Changing How We Teach and Learn Science," *Chicago Sun-Times*, April 21, 2001.

Figure 1. PhD Creation Rates by Type of Institution



Source: Author's calculations using the NSF's Survey of Earned Doctorates and HEGIS/IPEDS Completion Survey. Colleges are all BA I and II Carnegie classified institutions in 1994. Universities are all Research I and II, Doctoral I and II, and Masters I and II Carnegie classified institutions in 1994. Top colleges are the BA I institutions, while top universities are the Research I institutions.

Figure 2. Ratio of PhD Creation Rates: Liberal Arts Colleges to Universities



Source: Author's calculations using the NSF's Survey of Earned Doctorates and HEGIS/IPEDS Completion Survey. Displayed is the five-year PhD creation rate of colleges to universities.

Table 1. The Timing and Motivation of Graduate School by Undergraduate Institution

Type of Undergraduate Institution	Liberal Arts College (N=152)			Research University (N=206)	
<i>A. When did you know you were going to go to graduate school?</i>					
Before College	14	9%		30	15%
Fresh/Soph Year of College	14	9%		30	15%
Junior/Senior Year of College	83	55%		102	49%
After College	41	27%		44	21%
<i>B. To what factor would you most attribute your decision to go to graduate school?</i>					
Family	16	11%		15	7%
Undergraduate Institution	89	58%		97	47%
Employment Goals	43	28%		73	36%
Self Motivation	4	3%		21	10%

Source: Author's survey. In the summer of 2006, the author sent the survey to 850 randomly chosen faculty members of elite liberal arts colleges, of which 358 were returned for a response rate of 42 percent.

Table 2. List of Colleges and 1989-98 PhD Creation Rates

Rate	College	Rate	College	Rate	College
4.8	Agnes Scott College	2.3	Guilford College	18.4	Reed College
2.8	Albion College	2.9	Gustavus Adolphus Col	5.9	Rhodes College
3.2	Albright College	4.5	Hamilton College	5.1	Ripon College
5.9	Allegheny College	1.5	Hamline University	1.0	Salem College
3.1	Alma College	1.9	Hampden-Sydney Col	3.3	Sarah Lawrence College
9.3	Amherst College	6.6	Hampshire College	4.7	Scripps College
1.8	Antioch University	3.3	Hanover College	0.6	Shepherd College
3.2	Augustana College (IL)	2.1	Hartwick College	1.1	Siena College (NY)
3.1	Austin College	2.9	Hastings College	2.2	Skidmore College
4.1	Bard College	12.1	Haverford College	5.3	Smith College
7.4	Barnard College	6.4	Hendrix College	2.8	Southwestern University
5.4	Bates College	3.7	Hiram College	2.6	Spelman College
7.5	Beloit College	3.2	Hobart & William Smith	2.5	St. Andrews Presbyterian
2.1	Bethany College (WV)	1.8	Hollins College	4.0	St. John's University (MN)
2.5	Birmingham Southern Col	4.7	Hope College	3.3	St. Lawrence University
6.5	Bowdoin College	3.5	Houghton College	1.4	St. Mary's College of MD
7.5	Bryn Mawr College	1.9	Huntingdon College	7.1	St. Olaf College
4.1	Bucknell University	1.2	Illinois College	18.0	Swarthmore College
14.6	Carleton College	3.5	Illinois Wesleyan Univ	1.9	Sweet Briar College
2.6	Central College (IA)	5.1	Juniata College	2.5	Transylvania University
4.5	Centre College	11.2	Kalamazoo College	3.8	Trinity College (CT)
3.4	Chatham College	5.1	Kenyon College	3.4	Union College (NY)
2.2	Claremont McKenna Col	7.5	Knox College	1.6	University of Dallas
2.7	Coe College	4.1	Lafayette College	1.3	UNC at Asheville
4.5	Colby College	2.6	Lake Forest College	1.7	University of Puget Sound
4.3	Colgate University	7.7	Lawrence University	4.5	University of the South
1.7	Col of St. Benedict (MN)	1.6	Lewis and Clark College	2.4	Ursinus College
7.7	College of Wooster	3.4	Luther College	6.8	Vassar College
3.6	College of the Holy Cross	7.3	Macalester College	2.0	Virginia Military Institute
5.0	Colorado College	1.8	Manhattanville College	1.1	Virginia Wesleyan College
2.3	Concordia College (MN)	1.5	McDaniel College	7.9	Wabash College
3.5	Connecticut College	4.3	Middlebury College	2.2	Wartburg College
3.2	Cornell College	2.1	Mills College	1.8	Washington College
7.0	Davidson College	2.7	Millsaps College	2.2	Washington & Jefferson Col
3.4	DePauw University	2.7	Monmouth College	2.0	Washington and Lee Univ
3.5	Denison University	1.9	Moravian College	8.2	Wellesley College
3.5	Dickinson College	1.2	Morehouse College	6.9	Wesleyan University
2.6	Drew University	7.4	Mount Holyoke College	2.4	Westminster College (MO)
8.3	Earlham College	3.6	Muhlenberg College	1.7	Westminster College (PA)
2.5	Eckerd College	2.6	Nebraska Wesleyan U.	2.5	Westmont College
2.0	Erskine College	13.4	Oberlin College	2.4	Wheaton College (MA)
1.0	Franklin College Indiana	7.0	Occidental College	5.1	Wheaton College (IL)
5.7	Franklin and Marshall Col	1.2	Oglethorpe University	6.3	Whitman College
4.3	Furman University	3.8	Ohio Wesleyan Univ	1.4	Whittier College
1.3	Georgetown College	3.9	Pitzer College	1.5	Willamette University
3.0	Gettysburg College	11.4	Pomona College	1.7	William Jewell College
3.5	Gordon College (MA)	1.6	Presbyterian College	8.2	Williams College
4.6	Goshen College	2.3	Randolph-Macon College	3.5	Wittenberg University
4.4	Goucher College	4.0	Randolph-Macon Wom's	2.5	Wofford College
11.1	Grinnell College				

Table 3. OLS Regression Results

	Tier 1 & 2 Colleges	Tier 3 & 4 College
SAT 75 th percentile score.	0.0203*** 0.0049	0.0037** 0.0017
Ln(enrollment).	0.3578 0.8361	-0.0782 0.3464
Percent students who are female (0 to 100).	0.0048 0.0172	-0.0069 0.0066
Per student expenditures in \$1,000.	0.0721 0.1271	0.1484** 0.0673
College offers a business degree (0/1).	-1.9485*** 0.6893	0.2123 0.3922
College is located in the northeast (0/1).	-3.0178*** 0.6677	0.8110* 0.4451
Citations per faculty member 1989-98	0.4497** 0.2289	-0.0161 0.1856
Constant	-24.3854 8.6792	-2.8280 3.6664
Number of Observations	81	67
R-squared	0.5615	0.2482
Adjusted R-squared	0.5195	0.1590

Note: The dependent variable is each college's overall PhD creation rate measured 0 to 100 and is calculated as the number of PhDs earned by alumni of the college from 1994 – 2003 measured as a percent of the college's graduates from 1989 – 1998.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 4. Seemingly Unrelated Regression Results

Dependent variables are the division-specific PhD creation rates for each college (0 to 100).	Model 1: Tier One and Two Colleges			Model 2: Tier Three and Four Colleges		
	<u>Humanities</u>	<u>Social Sci.</u>	<u>Natural Sci.</u>	<u>Humanities</u>	<u>Social Sci.</u>	<u>Natural Sci.</u>
SAT 75 th percentile score.	0.0062*** 0.0011	0.0065*** 0.0013	0.0088*** 0.0027	0.0013*** 0.0005	0.0010* 0.0005	0.0011 0.0010
Ln(enrollment).	0.3407* 0.1883	0.0129 0.2306	-0.0135 0.4900	-0.0241 0.0995	0.0648 0.1017	-0.1480 0.2067
Percent students who are female (0 to 100).	0.0111*** 0.0041	0.0103** 0.0049	-0.0142 0.0100	0.0020 0.0019	0.0010 0.0019	-0.0096** 0.0043
Per student expenditures in \$1,000.	0.0595** 0.0271	0.0219 0.0348	0.0102 0.0682	0.0158 0.0178	0.0538*** 0.0182	0.0618*** 0.0363
College offers a business degree (0/1).	-0.4926*** 0.1627	-0.5236*** 0.1973	-0.8771** 0.4012	-0.0540 0.1157	-0.0090 0.1128	0.3210 0.2388
College is located in the northeast (0/1).	-0.7861*** 0.1602	-0.6563*** 0.1875	-1.4151*** 0.3823	0.3572*** 0.1301	0.2875** 0.1308	0.1624 0.2701
Citations per faculty member 1989-98:						
Humanities	0.4175 0.2921			0.3351 0.3193		
Social Sciences		0.6775*** 0.2338			0.2631 0.2081	
Natural Sciences			0.6749*** 0.2888			0.0117 0.2911
Constant	-10.3447 1.8538	-7.6458 2.2395	-7.9049 4.7710	-1.1768 1.0294	-1.5525 1.0781	0.4878 2.1234
Root Mean Squared Error	0.5601	0.6766	1.3724	0.2981	0.2999	0.6169
R-squared	0.6361	0.5349	0.4224	0.2780	0.3363	0.1574
Chi-squared	142.14	104.12	59.72	26.41	35.73	12.54

Note: There are 81 observations for model 1, and 67 observations for model 2.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.