THE ROLE FACULTY SCHOLARSHIP PLAYS IN PRODUCING ECONOMICS PH.D.S FROM LIBERAL ARTS COLLEGES

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Abstract:

This paper investigates how faculty scholarship by economics professors at elite liberal arts colleges in the United States is related to the rate at which college graduates eventually earn a Ph.D. in economics. On the surface it appears that faculty scholarship is strongly and positively correlated with producing Ph.D. students. Using a multi-variable regression model that includes several college characteristics, however, what really drives the production of Ph.D. students is enrolling high ability students.

Keywords: Faculty Scholarship, Ph.D. Creation, Liberal Arts Colleges, Economics Education

JEL Classifications: A2, I2

1. Introduction

One of the steadiest and most ubiquitous developments facing faculty at liberal arts colleges over the last forty years has been an increased focus on research (Baughman and Goldman, 1999; McCaughey, 1994). Research at these institutions was a distant after-thought in the 1950s. Beginning primarily at the more elite liberal arts colleges, research expectations were placed on faculty in the 1960s. These expectations grew with time, and research output eventually became an important factor when evaluating a faculty member's application for tenure or promotion. Research expectations spread to all liberal arts colleges (though the definition of research output varies across colleges), and the most elite liberal arts colleges are presently conducted more as miniature research universities with high research expectations and lower teaching loads than as institutions rooted in the liberal arts that excel at teaching.

Why this fundamental shift has occurred and, more importantly, whether an emphasis on faculty research benefits students remains open for debate. Early contributions to the debate include Centra (1983), Faja (1976), Hoyt and Sprangler (1976), and Michalak and Friedrich (1981). While Feldman (1987) provides a review of this early literature, more recent contributions include Dyl (1991), Lemke (2009), Manakyan and Tanner (1991), Noser et al. (1996), and Volkwein and Carbone (1994).

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This paper asks a question that is important to two different ideas of thought. The first is found in the literature cited above that discusses the relationship between research and teaching effectiveness. The second pertains to thinking about why some undergraduates choose to pursue graduate degrees, and specifically Ph.D.s, and why others do not. A recent edited volume by Ronald Ehrenberg and Charlotte Kuh (2009) raises many questions (and offer some answers) regarding the Ph.D. pursuits of undergraduate students, especially in terms of the current behavior of students, the status of undergraduate training, and graduate program expectations and requirements.

There are three important contributions of this paper. First, the empirical analysis is conducted for 109 elite liberal arts colleges in the United States. Most research in this area focuses on just a select few colleges or on research universities that house the best researchers. Liberal arts colleges in the United States, however, award almost twenty percent of all undergraduate degrees, and over five percent of all graduates of elite liberal arts colleges ultimately earn a Ph.D. whereas barely two percent of undergraduates from research institutions go on to earn a Ph.D. (Lemke, 2009). Second, the measure of faculty scholarship used in this paper is taken from Hartley and Robinson (1997) who constructed the variable by searching an economics journal database (*Econ Lit*). Thus, the measure of faculty scholarship is not self-reported, as it frequently is in studies of this kind. Third, the question being asked is different from the traditional "teacher effectiveness" question. Teaching effectiveness is difficult enough to measure in the best of circumstances. In the past, most studies have used self-reported data on teaching effectiveness (e.g., Noser, et al., 1996) or have used the actual teacher evaluation instrument at a small number of schools (e.g., Michalak and Friedrich, 1981; Volkwein and Carbone, 1994). Although teaching is of great importance at liberal arts colleges, what really matters are student outcomes and not necessarily student perceptions of teaching effectiveness. That is, what is important is whether teaching transforms lives. It is interesting, therefore, to consider the relationship between faculty research and particular student outcomes, such at earning a Ph.D., as is done here.

Without empirical evidence, it remains unclear how or even if increased faculty scholarship leads to more students pursuing graduate degrees. While it may be the case that research-active faculty are better teachers and more able to make economics interesting to undergraduates, it is also possible that research-active faculty have little time to improve their teaching or to mentor or advise students. That said, it is unclear if students need convincing or can be convinced to attend graduate school as some high school students have graduate school plans even before starting college while others may not be interested in research and are unwilling to consider graduate school regardless of their professors' pursuits.

It is important to note that the empirical analysis here specifically concerns economics. Thus, while the concluding section of the paper provides some discussion about disciplines other than economics, the empirical task at hand is to identify the relationship between research activity of faculty in the economics departments at the best liberal arts colleges and the rate at which graduates of these institutions eventually earn a Ph.D. in economics. At first glance it appears that faculty scholarship is strongly and positively correlated with producing Ph.D. students. Using a multi-variable regression model that includes several college characteristics, however, it is shown that what really drives the production of Ph.D. students is enrolling high ability students.

2. Data

The original set of colleges considered here are the top 123 liberal arts colleges as ranked in U.S. News and World Report's 1998 *America's Best Colleges*. Each of these colleges is also listed as a Baccalaureate I institution under the Carnegie classification. Of these 123 colleges, fourteen are omitted for various data reasons,[1] leaving a sample of 109 elite liberal arts colleges. All 109 colleges are listed in Appendix Table A1 along with three other key variables in the analysis: 1992 college tier, a measure of research output among the college's economics faculty, and a measure of undergraduates who eventually earn a Ph.D. in economics.

The Dependent Variable

The Earned Degrees Survey (EDS), collected by the National Center for Education Statistics, reports the total number of degrees awarded by each college from 1988 through 1997. EDS also reports the number of degrees awarded by discipline, but this data is somewhat unreliable as some colleges associate each student, regardless of his or her number of majors, with a single discipline. In addition to EDS, the National Center for Education Statistics also provides access to the Baccalaureate Institution Counts Survey which reports the number of Ph.D.s awarded in economics between 1993 and 2002 to the alumni of each elite liberal arts college in the sample.

The dependent variable of interest is constructed as the number of alumni from a college who received a Ph.D. in economics between 1993 and 2002 per 1000 graduates of the college from 1988 through 1997. For example, Lake Forest College awarded degrees to 2,468 individuals between 1988 and 1998, and 3 of its graduates completed a Ph.D. in economics between 1993 and 2002. The ***economics Ph.D. creation rate per 1,000 graduates*** for Lake Forest College, therefore, is calculated as $1000 \times (3 \div 2468) = 1.216$. Thus, out of every 1000 graduates of Lake Forest College, 1.2 are expected to eventually earn a Ph.D. in economics during the sample period. Note that the ***Ph.D. creation rate***, as it will be referred to throughout the paper, is per 1,000 graduates not per 100 graduates. Of the 109 colleges being considered, ten failed to produce a single economics Ph.D. during the required time span so the economics Ph.D. creation rate for each of these colleges is set to zero. Swarthmore College's creation rate of 15.570 is the largest of all colleges over the time period (58 alumni complete economics Ph.D.s while 3,725 undergraduate degrees were awarded). The only other colleges with a creation rate above 5 per 1,000 graduates during the sample period are Grinnell College (7.145), Carleton College (7.605), and Williams College (6.965). The average creation rate for the entire sample of 109 colleges is 1.502 per 1,000 graduates with a median of 1.010.

The economics Ph.D. creation rate as defined above incorporates two important assumptions. First, it implicitly assumes five years of graduate study to complete a Ph.D. which is reasonable in economics during this time period although the results are qualitatively unchanged if a six- or seven-year duration is used. Second, the definition

[1] Ten colleges have partner colleges for which data is hard to separate and/or do not offer conventional economics degrees (Antioch, Bennington, College of Saint Benedict's, Erskine, Hampshire, Sarah Lawrence, St. Thomas Aquinas, St. John's College in Maryland, St. John's College in New Mexico, and St. John's University). Four had missing data (Bard, Coe, Millsaps, and Oglethorpe).

appears to assume that students attend graduate school immediately after completing their undergraduate work which is certainly not the case for some if not most students. This feature of the definition of the creation rate will not bias the results, however, as long as college enrollment is relatively stable over time and as long as the rate of delaying graduate school and the time of delay is the same before, during, and after the sample period of 1988 to 1997.

Independent Variables

Many liberal arts colleges started awarding business degrees during the last 30 years. Certainly many factors enter the decision to start a business program. At the time it is made, therefore, offering a business degree is an endogenous choice. Once the decision has been made, however, whether a college offers a business degree is an exogenous factor that likely influences other college characteristics and student profiles/outcomes, especially in terms of graduate school pursuits. Thus, it seems appropriate to treat a college's business offerings when explaining its economics Ph.D. creation rate as exogenous. Specifically, a college is labeled as offering a business degree if it granted at least 100 business degrees (or degrees in a related field such as accounting, finance or management) from 1988 to 1997 according to the EDS data. Of the 109 colleges in the sample, 48 consistently awarded business degrees over this time period.

Table 1 reports the descriptive statistics for the entire sample of 109 college, including separately for non-business- (n = 61) and business-degree-granting (n = 48) institutions. The first line of Table 1 shows the average economics Ph.D. creation rate is 1.5 per 1,000 graduates across all colleges but that the average creation rate at non-business-degree-granting colleges is 2.1 while it is under 0.75 at business-degree-granting colleges. (The two-sided p-value associated with the difference is less than 0.01). To quantify this difference more sharply, the average business-degree-granting college requires 16.7 years of graduates to expect to eventually produce 20 economics Ph.D.s while the average non-business-degree-granting college requires only 6.3 years of graduates to expect to eventually produce 20 economics Ph.D.s. As will be shown shortly, however, this extreme difference can be attributed mostly to the quality of entering student and not directly to offering a business degree.

The independent variable of primary interest regards faculty scholarship. Hartley and Robinson (1997) report the number of journal publications per faculty member as catalogued by *Econ Lit* for 161 liberal colleges from 1989 to 1994.[2] Overall, the average number of publications over the six-year time period per economics department was 1.3 publications per faculty member, but as also shown in Table 1 there is a substantial difference in publication rates at non-business- and business-degree-granting institutions. In particular, the economics faculty at the average non-business-degree-granting college published 1.6 articles per faculty member over the six-year time period, while the economics faculty at the average business-degree-granting college published 0.9 articles per faculty member over the same six-year span. (The two-sided p-value associated with the difference is less than 0.01).

[2] Many papers report rankings of departments or individual faculty, but these tend to focus only on, at most, the top 50 liberal arts colleges. See, for example, Bodenhorn (1997, 2003) and Kasper (1991). Others, such as Conroy et al. (1995) and Thursby (2000), focus on research institutions rather than liberal arts colleges.

In addition to Hartley and Robinson's measure of faculty research productivity, several college characteristics were also collected. U.S. News and World Report's 1992 *America's Best Colleges* provides 1990 (academic year 1989-90) values for undergraduate fulltime enrollment, the percent of freshmen from the top ten percent of their high school class, the percent of undergraduates from in-state, the percent of female students, and the tier of the college. The descriptive statistics for each of these variables are also reported in Table 1.

Table 1. Descriptive Statistics: Elite U.S. Liberal Arts Colleges

	All colleges				No business degree offered	Business degree offered
	Mean	St Dev	Min	Max	Mean	Mean
Econ Ph.D.s 1993-02 per 1,000 graduates 1988-97	1.502	1.971	0.000	15.570	2.099	0.743
College consistently offered a business degree: 1988-97	0.440	0.499	0	1	0.000	1.000
Publications in *Econ Lit* per Faculty Member: 1989-94	1.307	1.205	0.000	5.000	1.612	0.920
Undergraduate fulltime enrollment: 1990	1561	625	450	3551	1518	1616
Percent of students from top 10% of high school class: 1990	49.164	44.385	13	88	49.164	38.313
Percent of students from in-state: 1990	42.817	22.134	5	93	35.016	52.729
Percent female enrollment: 1990	55.349	18.797	0	100	58.344	51.542
Percent of degrees awarded in math 1988-97	2.356	1.225	0.582	9.138	2.657	1.973
1992 Tier 1 College	0.303	0.462	0	1	0.459	0.104
1992 Tier 2 College	0.266	0.444	0	1	0.344	0.167
1992 Tier 3 College	0.266	0.444	0	1	0.164	0.396
1992 Tier 4 College	0.165	0.373	0	1	0.033	0.333

Notes. There are 109 colleges in total, with 61 not offering a business degree and 48 offering a business degree. A college is designated as offering an undergraduate business degree if it awarded 100 or more degrees in business or a related field such as accounting, finance, or management from 1988 through 1997. Sources. The data on degrees come from the Earned Degrees Survey collected by the National Center for Education Statistics. Hartley and Robinson (1997) provides the faculty scholarship variable. College tier and 1990 characteristics come from U.S. News and World Report's *1992 America's Best Colleges*.

Because the analysis looks at Ph.D.s earned in economics and because economics Ph.D. programs require a high level of mathematical preparation, it may be useful to designate some colleges as having a strong math presence on campus. This will help capture math majors who go on to graduate school in economics, but more importantly a strong math program may simply encourage economics students to take more math classes during their undergraduate years. Subsequently, students may find themselves in a better position to consider pursuing a Ph.D. in economics when they graduate college.

Using the EDS data on the number of degrees awarded in mathematics, each college's percent of graduates from 1988 through 1997 who majored in math is calculated. About 2.65 percent of all graduates at non-business-degree-granting colleges majored in math, while 1.97 percent of all graduates at business-degree-granting colleges majored in math.

Each tier of the ratings in 1992 included 40 colleges. Because of the data issues noted earlier, the 109 colleges used here encompass 33 tier one (the best) colleges, 29 tier two colleges, 29 tier three colleges, and 18 tier four colleges. Table 1 shows that college tier (or ranking) is highly correlated with the presence of a business program. Of the 61 colleges that do not offer a business degree, 28 are in the top tier while only 2 are in the bottom tier. Conversely, only 5 of the 48 colleges that offer a business degree are in the top tier while 35 are in the bottom two tiers.

Sample Size Restrictions

The empirical analysis in the next section is an important contribution to the literature in part because it looks exclusively at the best liberal arts colleges which has been a population largely ignored in the literature. However, by restricting attention to just these elite colleges, two sample size problems arise. First, regression analysis is constrained by the number of independent variables that can be included while maintaining an acceptable number of degrees of freedom. Second, the empirical results can be strongly influenced by one or two outliers.

As there are no other elite liberal arts colleges that can be added to the sample, there are only two options–use the small sample or increase the sample by collecting data on lower ranked colleges. The latter option, however, is not worth pursuing. The general question of the paper concerns the relationship between faculty research (measured in publications) and the rate at which alumni pursue a Ph.D. in economics. Among the eighteen tier four colleges in the current sample, the average (maximum) number of *Econ Lit* publications per economics faculty member over a six-year period was just 0.344 (1.00) and the average (maximum) economics Ph.D. creation rate was 0.65 (2.31) per 1,000 graduates. Adding lower quality colleges to the sample, therefore, would almost exclusively be adding colleges with very few publications and economics Ph.D.s. For these reasons, the analysis goes forth with 109 colleges, while remaining aware of the potential small sample problems.

3. Faculty Scholarship and Producing Economics Ph.D.s

The primary empirical objective of this paper is to characterize the relationship between faculty scholarship and the graduate school pursuits in economics of undergraduates at the best liberal arts colleges in the United States. Table 2 presents a first look at this relationship. The first line of Table 2 reports the average Hartley and Robinson (1997) measure of faculty scholarship by academic tier. For example, tier one colleges averaged almost 2.2 publications catalogued by *Econ Lit* from 1989 to 1994 per economics faculty member, while these averages were 1.3, 0.9, and 0.34 at tier two, tier three, and tier four colleges respectively. The implication is clear and probably as expected–the faculty at more highly ranked academic institutions, on average, produce more measurable research.

Table 2 further demonstrates two relationships. First, the general pattern of increased research output with academic quality holds for colleges that do not offer a

business degree as well as for colleges that offer a business degree. Second, the amount of research being carried out in economics departments at colleges that offer a business degree is comparable to that being carried out at colleges that do not offer a business degree *once academic tier is taken into account*. Small sample sizes prevent meaningful statistical analysis across the cells of Table 2, but nonetheless the numbers (2.17 vs. 2.30; 1.17 vs. 1.69; 1.15 vs. 0.75; 0.69 vs. 0.30) fail to demonstrate that the level of research is substantially different across the two types of institutions within the same academic tier. On this measure, therefore, the presence of a business degree does not necessarily indicate a difference in the focus or goals of a liberal arts college but rather that business degree opportunities for students are simply more prevalent at lower ranked institutions.

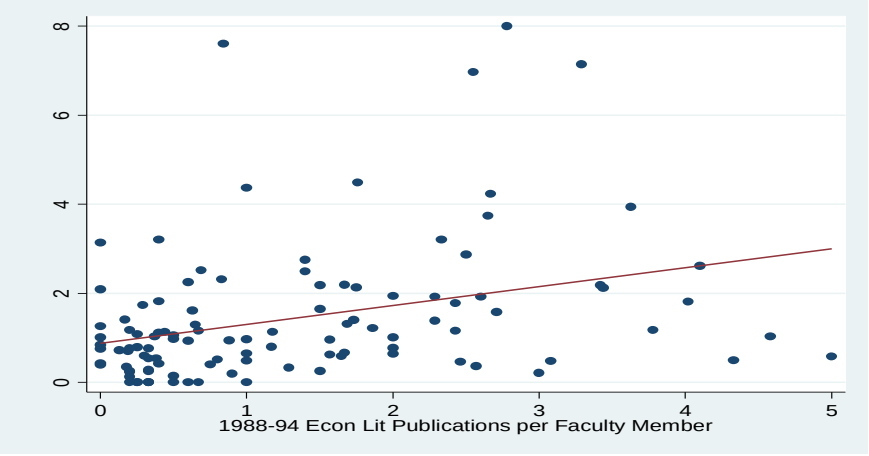
Table 2. Average Faculty Scholarship by 1992 Academic Tier and Business Offerings.

	1992 Academic Tier (1 = Highest)			
	1	2	3	4
All Colleges (total *n* = 109)	2.19 (33)	1.31 (29)	0.89 (29)	0.34 (18)
Colleges that did not offer a business degree in 1992. (total *n* = 61)	2.17 (28)	1.17 (21)	1.15 (10)	0.69 (2)
Colleges that offered a business degree in 1992. (total *n* = 48)	2.30 (5)	1.69 (8)	0.75 (19)	0.30 (16)

Notes: Faculty scholarship is measured by each economics department's average number of publications appearing in *Econ Lit* from 1989 to 1994. The number of colleges in each cell is reported in parentheses. See the notes to Table 1 for variable definitions and data sources.

To complement Table 2, Figure 1 plots the data points and the best fit line of faculty scholarship and economics Ph.D. creation rates per 1,000 graduates for the 109 colleges in the sample.

Figure 1. Faculty scholarship and the economics Ph.D. creation rate.



Notes: See the notes to Table 1 for variable definitions and data sources. Included on the graph is the fitted line from regressing the rate of Ph.D. creation on faculty scholarship. The economics Ph.D. rate per 1,000 graduates for Swarthmore College has been recoded from 15.57 to 8 in order to remove the visual effect of the outlier.

Swarthmore College's creation rate of 15.57 per 1,000 graduates is a significant outlier in the sample. In Figure 1 (and in all of the subsequent empirical analysis), therefore, Swarthmore's creation rate has been recoded to 8. Because Swarthmore is an extreme outlier and because of the small sample, how the outlier is treated potentially affects the results. By recoding its creation rate to being just above the next highest college, Swarthmore's overall affect on the relationship is mitigated but not eliminated.[3]

Figure 1 demonstrates a couple of empirical results. First, the data values for both faculty publications and Ph.D. creation rates are fairly spread out. Second, the best fit line is significantly upward sloping–each additional publication per faculty member is associated with a higher creation rate by 0.44 (p-value < 0.01). To put this in context, an average sized college with an economics faculty that produces one publication per faculty member over six years is expected to take over ten years to graduate twenty future economics Ph.D.s compared to under five years if its economics faculty produced four publications per faculty member over six years.

Figure 1, however, fails to allow for other effects to influence Ph.D. creation. In particular, one might expect more highly ranked colleges to enroll students who are more likely to attend graduate school regardless of faculty scholarship. Other college characteristics could also affect this process. The next section discusses the regression results when college characteristics are taken into account.

4. OLS Regression Results

The measure of faculty scholarship–journal articles per faculty member over six years–comes from Hartley and Robinson (1997). Hartley and Robinson estimate a regression in which the number of economics Ph.D.s awarded from 1989 to 1994 to alumni of liberal arts colleges is regressed on the total number of department publications over the same time period, the number of faculty in the department, and the college's national rank. The estimated coefficient on each variable is statistically significant and of the expected sign–publications, department size, and a more favorable rank are all associated with the production of more Ph.D.s.

The analysis here is similar but with several key changes. Although liberal arts colleges tend to be small compared to research institutions, there is considerable variation in their size and the size of departments. The 90th percentile college in the sample, for example, enrolls almost three times the number of students as the 10th percentile college (2,423 vs. 850 students) and the 90th percentile economics department graduates on average 64 economics majors per year while the 10th percentile department graduates 7. Thus, instead of explaining the total number of economics Ph.D.s eventually created, this paper explains the *rate* (per 1,000 graduates) at which graduates earn Ph.D.s. For similar reasons, Hartley and Robinson's data on publications *per faculty member* rather than the total number of publications is used to measure research output. As a further improvement, the faculty research variable is measured from 1988-1994 while economics Ph.D.s are counted from 1993 to 2002 in order to better capture the lag in time from

[3] If Swarthmore College is dropped from the analysis, the results do not change much from what are presented in the next section. If the data observation on Swarthmore College is left unchanged, the results in the next sections would reflect to an even greater extent that faculty research and Ph.D. creation are strongly correlated up to the threshold of three publications over six years per faculty member.

undergraduate to graduate work. Finally, the regression model is expanded to include other college characteristics, and college enrollment is used as a regression weight to control for the heteroskedasticity that exists whenever the dependent variable is measured as a rate.

Table 3. Regression Results.

Dependent Variable: Economics Ph.D. Creation Rate (1993-2002 Ph.D.s per 1,000 graduates 1988-97).

	(1)	(2)	(3)	(4)
Sample	Full	Full	Full	Full
Avg per faculty publications 1988-94 (APFP).	0.4443[a]	1.1018[a]		
	0.1175	0.3646		
APFP Squared		-0.1714[b]		
		0.0901		
At least 1 APFP but not 2.			0.3706	-0.4983
			0.3555	0.3961
At least 2 APFP but not 3.			1.4832[a]	0.4679
			0.4040	0.4541
At least 3 APFP but not 4.			1.6214[a]	0.1857
			0.5583	0.6223
At least 4 APFP but not more than 5.			0.4916	-0.2130
			0.7011	0.6807
Academic Tier = 2 in 1992.				-1.2268[a]
				0.3859
Academic Tier = 3 in 1992.				-1.6459[a]
				0.4274
Academic Tier = 4 in 1992				-1.7618[a]
				0.5012
Constant	0.8040[a]	0.4620	0.9822[a]	2.4179[a]
	0.2173	0.2800	0.1952	0.3853
R-squared	0.1178	0.1469	0.1540	0.2828
Adjusted R-squared.	0.1095	0.1308	0.1215	0.2331
Number of Observations	109	109	109	109

Notes: Standard errors are reported beneath the estimated coefficients. [a,b] denote statistical significance at the 5% and 10% level respectively. See the notes to Table 1 for variable definitions and data sources. All regressions are weighted by college enrollment to control for the heteroskedasticity in the dependent variable.

The upward-sloping best fit line in Figure 1 suggests there is an important relationship between faculty research and future Ph.D. creation in economics. The OLS regression equation that forms this best fit line is presented in model (1) of Table 3. Not only is the slope of the line statistically significant but, as demonstrated earlier, it is empirically large as well.

Models (2) and (3) of Table 3 estimate the relationship between faculty scholarship and Ph.D. creation in slightly different ways while still not allowing for influences from other college characteristics. Model (2) includes a squared term on scholarship to allow for decreasing or increasing returns to scholarship. The point estimates of model (2) suggest that Ph.D. creation is increasing up to 3.2 published articles per economics faculty member over six years, but the return to further

publications declines past that point. Both terms are statistically significant, and they are jointly significant with a *p*-value less than 0.01.

Table 3. Regression Results Continued.

Dependent Variable: Economics Ph.D. Creation Rate (1993-2002 Ph.D.s per 1,000 graduates 1988-97).

	(5)	(6)	(7)	(8)
Sample	Full	Full	Full	Restrict
Avg per faculty publications 1988-94 (APFP).	0.1670	0.2037		
	0.1135	0.3717		
APFP Squared		-0.0089		
		0.0858		
At least 1 APFP but not 2.			-0.1858	0.1406
			0.3292	0.2301
At least 2 APFP but not 3.			0.6040	0.3904
			0.3871	0.2768
At least 3 APFP but not 4.			0.1783	0.3415
			0.5434	0.3991
At least 4 APFP but not more than 5.			0.3874	0.5548
			0.6071	0.4190
Ln(college enrollment)	-0.5036	-0.5093	-0.5073	-0.1478
	0.3318	0.3380	0.3366	0.2366
Percent stud's in top 10% of high school class.	0.0409[a]	0.0408[a]	0.0409[a]	0.0236[a]
	0.0089	0.0091	0.0093	0.0067
Percent students from in-state.	-0.0117[b]	-0.0116	-0.0138[b]	-0.0049
	0.0070	0.0072	0.0071	0.0050
Percent female students.	0.0086	-0.0087	-0.0079	-0.0028
	0.0072	0.0072	0.0074	0.0051
Percent of grads who majored in math 88-97.	0.1474	0.1475	0.1517	0.0436
	0.1009	0.1013	0.1014	0.0714
College offered a business degree 1988-97.	-0.2931	-0.2901	-0.2705	-0.3765[b]
	0.3080	0.3109	0.3130	0.2173
Constant	3.7810	3.8047	3.9865	1.5266
	2.5800	2.6027	2.6159	1.8308
R-squared	0.4064	0.4065	0.4193	0.3511
Adjusted R-squared.	0.3653	0.3590	0.3600	0.2821
Number of Observations	109	109	109	105

Notes: Standard errors are reported beneath the estimated coefficients. [a,b] denote statistical significance at the 5% and 10% level respectively. See the notes to Table 1 for variable definitions and data sources. All regressions are weighted by college enrollment to control for the heteroskedasticity in the dependent variable.

In place of a squared term, model (3) incorporates four dummy variables– colleges with economics faculty that average at least one but less than two, at least two but less than three, at least three but less than four, and at least four publications every six years. The omitted comparison group is colleges with economics faculty that average less than one publication every six years. Compared to the least research-active departments, the return to Ph.D. creation increases with publications (by 0.37 to 1.48 to 1.62) until the last group, which is associated with an estimated effect of 0.49 relative to the comparison group. Compared to the omitted group, the estimated coefficients are

statistically different from zero only for colleges that produce two to three or produce three to four publications per faculty member over the six-year span. The results from this very simple model could be interpreted, therefore, as implying that faculty research positively relates to future Ph.D. creation but only in an intermediate range–too little research (less than two articles per faculty member every six years) or too much research (more than four articles per faculty member every six years) is not related to Ph.D. creation. This conclusion, however, is premature as college characteristics likely contribute to Ph.D. creation.

Model (4) in Table 3 provides the simplest empirical model that incorporates academic reputation along with faculty scholarship. Along with the previously defined dummy variables for faculty research, college tier is included as dummy variables with the variable for tier one colleges (the best colleges) being omitted. The results from model (4) are striking. Faculty scholarship at any level is no longer statistically significant. (The *p*-value of the faculty scholarship variables being jointly significant is over 0.17.) Conversely, academic tier is very significant and with the expected pattern that the rate of Ph.D. creation decreases with academic reputation.[4]

The next three models reported in Table 3 (models 5 – 7) extend models (1) – (3) by including a variety of college characteristics. In each case, the coefficient estimates on faculty publications are reduced greatly in magnitude and lose all statistical significance compared to the previous models that excluded college characteristics. For example, the estimated coefficient on having between two and three publications per economics faculty member over a six-year span decreased from 1.48 with a *p*-value under 0.01 in model (3) to only 0.60 with a *p*-value over 0.10 in model (7).

The only two college characteristics consistently related to future Ph.D. creation are the percent of freshmen students who graduated in the top ten percent of their high school class (strongly positively related to Ph.D. creation) and the percent of students who are in-state students (strongly negatively related to Ph.D. creation). The most important result here seems to be that entering student quality matters much more when discussing the production of future economics Ph.D.s than does the scholarship activity of economics faculty.[5]

Model (8) in Table 3 presents the estimated coefficients from estimating the identical empirical specification as that in model (7) except that a data restriction is imposed. It was argued earlier that Swarthmore College was the only extreme outlier in the data. Looking at Figure 1 again, the argument could be made that each of the four colleges with Ph.D. creation rates over five are outliers. Three of these four colleges are associated with between 2.5 and 3.5 publications per faculty member every six years, while the fourth is associated with less than one publication per faculty member every six

[4] Because of the large standard errors for each of the academic tier estimates (likely because of the small sample size), there is no statistical difference between the estimated coefficients on tier two, tier three, and tier four colleges in model (4) of Table 3. Regardless, the point estimates are monotonically decreasing, and they are economically large. The difference between a tier two and a tier four college, for example, is over 0.5, which is greater than the slope of the best fit line in Figure 1.

[5] Noser et al. (1996) reach a similar conclusion regarding the quality of incoming students in the context of faculty research and teaching effectiveness.

years. Model (8) provides the estimated coefficients when these four colleges are omitted from the analysis. On the whole, the results from model (8) closely match the results of model (7).

Lastly, two sets of results that are not presented in tables are worth discussing. First, the EDS data is somewhat suspect when looking at the number of students who majored in a particular discipline, because many colleges assign each student to a single particular major even if the student double or triple majored. For this reason, the analysis in this paper has focused exclusively on the economics Ph.D. creation rate per 1,000 graduates regardless of major (i.e., regardless of field of study). Despite potentially flawed data, the analysis can be repeated by using a dependent variable that measures future economics Ph.D.s as a rate of the EDS counts of undergraduate economics majors. This has been done for all eight models of Table 3, and the results unanimously indicate that faculty scholarship is unrelated to Ph.D. creation. None of the point estimates on the faculty research variables, even in models (1) – (3), when using this new dependent variable are statistically significant.

Second, the general conclusion from models (4) – (8) in Table 3 is that faculty research is largely unrelated to Ph.D. creation rates when academic tier or college characteristics are included in the specification. One question not addressed in Table 3 is whether faculty scholarship might be related to Ph.D. creation rates *within* academic tiers. To investigate this, four regression models were estimated. Each was identical to model (1) in Table 4 but the data was restricted to just tier one (n = 33), tier two (n = 29), tier three (n = 29), or tier four (n = 33) colleges. For each of these four regressions, the coefficient estimate on faculty publications is never statistically significant with p-values always exceeding 0.30.

5. Discussion

Although having students eventually go on to receive a Ph.D. is not the sole objective of economics departments or colleges, it is one possible objective and is an important outcome measure used to compare colleges. To this end, the argument has been made by others that college deans should reward faculty research and try to hire faculty who will be successful in carrying out a research agenda that would encourage students to also pursue a graduate degree. The results of this paper, however, question the original presumption. Employing research-active faculty may produce many worthy benefits to a college, but there is little empirical evidence that research activities among economics faculty are a driving force behind having more graduates complete a Ph.D. in economics. On the surface, the link between faculty scholarship and Ph.D. creation is strong (see Figure 1), but after other factors are taken into account (most notably, the abilities of in-coming students) the original positive relationship between faculty scholarship and Ph.D. creation is mitigated at best and eliminated at worst.

Despite the generally "negative" result that faculty scholarship is not related to Ph.D. creation in economics, there are two important points to note. First, the empirical work does not document a negative relationship between research and Ph.D. creation. That is, the result does not say that deans who hire research-active economics faculty are in effect reducing the number of students who go on to earn a Ph.D. in economics. Rather, the result is simply that there is no relationship between faculty research and Ph.D. creation. Second, the result makes no judgments as to other possible benefits of

faculty research at liberal arts colleges. Research may inform professors' teaching. Successful research almost certainly allows a college to generate more grant money, and successful research may offer other on-campus and off-campus benefits. Finally, some might contend that successful faculty research improves the quality of the application pool to the college. If so, while the direct effect of research on Ph.D. creation rates is nil, there may be a positive indirect effect.

The empirical work here also shines light on the relationship between research and teaching (or advising). Some contend that good research informs teaching, while others contend that good research takes time away from teaching and/or advising. The results here suggest that, when measured by Ph.D. creation, good research in economics department simply has no effect in either direction, or that if the effects exist, they cancel each other out. It does not appear from this data that economics departments with the best researchers are any more successful at advising their students towards graduate school than their counterparts who do not engage in as much research at other colleges, nor are they any worse.

An interesting extension of this project could be carried out with data on individual faculty scholarship linked to individual faculty advising of students. Information on individual research readily exists, and some work has been done on this. Bauhman and Goldman (1999), Bodenhorn (1997, 2003), Hartley and Robinson (1997), Kasper (1991), and Thursby (2000) all find a great disparity of scholarship across faculty members within the same economics department. The difficulty arises in matching differentiated research effort across faculty to efforts made in advising students. Ehrenberg (2005) provides a personal account suggesting that research-active faculty can have a substantial effect on the decision to pursue a graduate degree. Still, a study tracking student goals and education choices along with their interactions with faculty members would allow for better understanding of the effects individual faculty and their scholarship have on the decisions made by students whether to pursue a Ph.D. in economics.

Lastly, the results here pertain to creating future Ph.D.s in economics. At the time of the sample (and even today) it was the rare student who enrolled in an economics Ph.D. program who had already published work as an undergraduate. Whereas REUs (Research Experiences for Undergraduates) are popular among students in the natural sciences and may currently have risen to the point of being almost necessary for entrance into a good Ph.D. program, this was not and is not the case in economics.[6] As the degree of the empirical relationship between faculty scholarship and Ph.D. creation is almost certainly discipline specific and also likely affected by the type of undergraduate institution, it is important to recognize that the results presented in this paper apply only to the research of economics faculty at elite liberal arts colleges and the eventual creation of economics Ph.D.s among their students. Further research can and should be done in for other disciplines.

[6] See Boylan (2009) for a description of various REU programs and an attempt to assess their value (especially in the natural sciences) in moving students toward graduate school.

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Appendix Table A1. Colleges with 1992 Tier, Faculty Publication Record, and Ph.D. creation rate (per 1,000 graduates).

College	Tier	Fac. Pubs	Ph.D. Rate	College	1992 Tier	Fac. Pubs	Ph.D. Rate
Agnes Scott College	2	2.67	4.227	Lewis and Clark	3	1.00	0.486
Albion College	3	0.33	0.283	Luther College	4	0.33	0.000
Allegheny College	3	1.67	2.192	Macalester College	2	1.00	4.368
Alma College	3	0.33	0.766	Middlebury College	1	3.08	0.477
Amherst College	1	2.50	2.872	Mills College	3	5.00	0.574
Augustana College	4	0.00	0.423	Morehouse College	4	0.13	0.723
Austin College	3	0.18	0.351	Mount Holyoke	1	2.29	1.383
Bates College	1	1.57	0.962	Muhlenberg College	2	0.20	0.242
Beloit College	3	0.29	1.731	Oberlin College	1	3.63	3.940
Birm.-Southern	3	0.33	0.532	Occidental College	1	2.43	1.775
Bowdoin College	1	2.33	3.203	Ohio Wesleyan	4	0.83	2.307
Bryn Mawr College	1	1.17	0.798	Pitzer College	2	0.20	0.000
Bucknell University	1	1.18	1.133	Pomona College	1	1.76	4.486
Carleton College	1	0.84	7.605	Presbyterian College	4	0.67	0.000
Centre College	2	0.37	1.024	Randolph-Macon	3	0.00	0.842
Claremont McKenna	1	3.44	2.122	Rand.-Macon Wom's	3	2.00	0.638
Coe College	3	0.00	3.132	Reed College	2	2.29	1.924
Colby College	1	4.10	2.614	Rhodes College	2	1.67	0.666
Colgate University	1	2.60	1.921	Ripon College	3	0.25	0.000
College of Wooster	2	4.58	1.025	Saint Olaf College	2	0.65	1.293
Col. of Holy Cross	1	2.00	0.772	Scripps College	1	1.50	2.183
Colorado College	2	0.20	0.765	Siena College	4	0.20	0.258
Connecticut College	1	0.50	0.975	Skidmore College	2	2.57	0.364
Cornell College	3	0.00	1.258	Smith College	1	1.50	1.650
Davidson College	1	0.63	1.612	Southwestern	4	0.50	0.000
DePauw University	2	0.90	0.197	Spelman College	4	0.38	0.533
Denison University	2	3.00	0.213	St. Lawrence Univ.	2	2.43	1.157

Dickinson College	2	1.57	0.619	St. Mary's Col. (MD)	4	1.00	0.972
Drew University	2	0.67	1.152	Swarthmore College	1	2.78	15.570
Earlham College	2	0.40	3.203	Sweet Briar College	2	1.00	0.000
Eckerd College	3	1.50	0.255	Transylvania Univ.	4	0.00	1.010
Franklin & Marshall	1	1.75	2.131	Trinity College	1	4.02	1.809
Furman University	2	0.25	1.081	Union College	1	2.46	0.461
Gettysburg College	2	1.00	0.646	University of Dallas	3	0.20	0.129
Goucher College	3	0.80	0.510	Univ. of Puget Sound	4	0.88	0.943
Grinnell College	1	3.29	7.145	Univ. of the South	1	0.17	1.410
Guilford College	4	0.30	0.594	Ursinus College	3	1.65	0.588
Gustavus Adolphus	3	0.25	0.789	Vassar College	1	1.73	1.404
Hamilton College	1	3.78	1.172	Virginia Military Inst	2	0.44	1.130
Hampden-Sydney	3	0.50	1.051	Wabash College	2	0.60	2.254
Hanover College	3	0.33	0.000	Washington College	3	0.60	0.000
Hartwick College	4	0.25	0.000	Wash & Jeff	3	0.33	0.000
Haverford College	1	0.69	2.518	Washington and Lee	1	2.00	1.011
Hendrix College	3	4.33	0.489	Wellesley College	1	2.65	3.735
Hiram College	4	0.00	0.758	Wells College	3	0.40	1.112
Hobart & Wm Smith	2	2.71	1.579	Wesleyan University	1	3.42	2.180
Hollins University	3	0.75	0.395	Wheaton College	2	1.40	2.492
Hope College	3	0.60	0.931	Wheaton College	3	0.50	0.146
Illinois Wesleyan U	4	0.00	2.089	Whitman College	2	0.19	0.704
Kalamazoo College	2	1.40	2.750	Whittier College	4	0.33	0.252
Kenyon College	2	1.69	1.308	Willamette Univ	3	1.29	0.329
Knox College	3	0.40	1.814	Williams College	1	2.55	6.965
Lafayette College	1	2.00	1.937	Wittenberg Univ	4	0.40	0.413
Lake Forest College	2	1.86	1.216	Wofford College	4	0.00	0.386
Lawrence University	2	0.20	1.174				

Notes: See the text and the notes to Table 1 for variable definitions and data sources.