ON THE RELATIONSHIP BETWEEN THE STUDENT–ADVISOR MATCH AND EARLY CAREER RESEARCH PRODUCTIVITY FOR AGRICULTURAL AND RESOURCE ECONOMICS PH.D.S

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We use a unique data set on students receiving their Ph.D.s from top-ranked agricultural and resource economics programs to investigate how the ranking of a student's dissertation advisor affects his or her early career research productivity. After controlling for program reputation, we find that the higher the relative research productivity of a student's dissertation advisor the greater the student's early career research productivity. Allowing the estimated effects of advisor rank to vary with program reputation suggests that students from lower-ranked programs working with relatively more prominent advisors outperform their peers at highly ranked programs working with less prominent advisors.

Keywords: advisor effect, matching, negative binomial, production of science.

The academic labor market is an important concern for nearly all members of the profession. Hiring new faculty represents a significant, long-term investment for an academic department. Ehrenberg, Rizzo, and Condie (2003) estimate that the typical start-up cost for a new assistant professor in the sciences and engineering is between \$300,000 and \$500,000. As such, academic departments have significant interest in hiring junior faculty that they expect to become successful members of the department. At the same time, pursuing a Ph.D. represents a significant investment for individuals in terms of time, effort, and opportunity and other cost.[1] Accordingly, graduate students have significant interest in making decisions that maximize their likelihood for achieving career success and for publishing in leading journals, which has consistently been demonstrated to have a positive effect on future earnings (Barrett and Bailey 1999; Hilmer and Hilmer 2005; Moore, Newman, and Turnbull 1998; and Sauer 1988). For the many students wishing to one day receive academic positions, this means making choices, such as dissertation advisors, that maximize their chances of both receiving those highly coveted positions and of successfully maneuvering through the tenure-granting process.

Unfortunately, academic hiring is an uncertain proposition. According to Ginther and Kahn (2004) roughly 62% of students within a sample of 1972–1991 economics Ph.D. recipients holding tenure-track positions were granted tenure by their 10th year post-degree receipt. A main reason that junior faculty members fail to achieve tenure is that they wind up being less productive than their hiring departments expected them to be. Hence, for the hiring department, an important question becomes how is it possible best to predict which students are most likely to be sufficiently productive researchers? From the student's perspective, the question becomes how can students indicate to hiring departments that they will likely be productive researchers? While faculty members likely possess deeply held beliefs as to which observable factors are associated with early career research

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[1] An interesting additional cost associated with the academic job search is highlighted by a newly minted Ph.D.'s diary in the Chronicle of Higher Education (http://chronicle.com/jobs/2002/01/2002012301c.htm). As the student writes, "During my job hunt, I've applied for about 160 jobs; at a total cost of \$4,906, that's about \$31 a job. So if a university receives 150 applications for every job announcement (and that's not an exaggeration in my field in the humanities), the applicants altogether will have spent around \$4,650 applying for that one position. Last year in my discipline, about 950 positions were advertised. That means folks in my field spent upwards of \$4 million just applying for jobs."

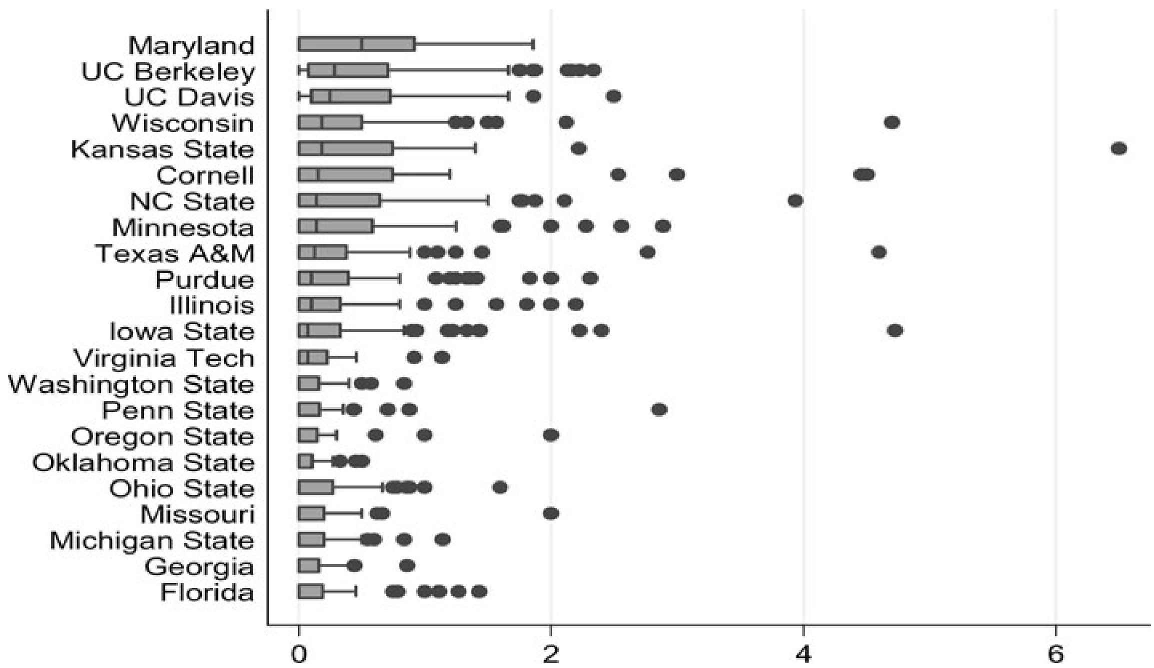
productivity, regrettably little attention has been devoted to empirically validating the relationships. Without detailed knowledge of such factors, the likelihood that departments make suboptimal hiring decisions increases, as does the likelihood that students are not able to optimally signal their true research potential to hiring departments.

The current study uses observations about the results of the Ph.D. student–dissertation advisor matching process to argue that the relative prominence of a student's advisor is likely a more informative indicator of his or her research potential than the relative reputation of the program from which he or she receives the Ph.D. Examining a unique data set on students receiving their Ph.D.s from top-ranked agricultural economics programs (according to Perry 1999) between 1987 and 2000 we find that, all else equal, controlling for program reputation the higher the relative research productivity of a student's dissertation advisor the greater the student's early career research productivity. Allowing the estimated effects of advisor rank to vary with program reputation suggests that students from lower-ranked programs working with relatively more prominent advisors outperform their peers at highly ranked programs working with less prominent advisors.

The Overlapping Distribution of Agricultural and Resource Economics Ph.D.s

One of the most observable aspects of a student's doctoral training is the program from which he/she receives the degree. A commonly held belief is that, *ceteris paribus*, graduates of highly ranked programs are significantly more likely to be productive in their early careers than graduates of lower-ranked programs. Indeed, previous studies controlling for the reputation rank of an economics Ph.D.'s program have found that top program graduates are more likely to publish in core economics journals (Coupe 2003; and Buchmueller, Dominitz, and Hansen 1999) while graduates of programs with more active faculty publish more total journal articles (Hogan 1981).

An important question is the degree of certainty with which the student's graduate program predicts his or her likelihood for future success. Figure 1 explores this question for students receiving their agricultural and resource economics Ph.D.s between 1987 and 2000 by presenting box-plots of the distributions of graduates from Perry's top 22 Ph.D. granting programs. Because we have an uneven-aged sample, the publication data in figure 1 are calculated on a per-year since Ph.D. receipt basis.



Note: Vertical line in the box represents the median, the lower hinge is the 25th percentile, the upper hinge is the 75th percentile, the vertical lines outside of the box are lower or upper adjacent values and the dots represent outside values.

Figure 1. Within program distributions of the number of total articles published per year since Ph.D. receipt by program graduates

The box-plots should therefore be interpreted as follows: the ends of the boxes represent the number of articles published per year since Ph.D. receipt by students at the 25th and 75th percentiles within each program, while the line in the middle of the box represents the number of articles published per year since Ph.D. receipt by the median student and the right most whisker represents the number of articles published per year since Ph.D. receipt by the student at the top end of one and a half times the interquartile range. As such, the box-plots indicate that there is significant overlap in the distributions of early career research productivity across top Ph.D. granting programs in agricultural economics. Specifically, it appears that top graduates from nearly all programs outperform the median students from the highest-ranked programs. Moreover, with the exception of two programs, UC Berkeley and UC Davis, the bottom quartiles of students publish zero articles while among the bottom nine programs even the median students publish zero articles. While such cross-program differences at the bottom of the distribution might reflect differences in the types of positions accepted by graduates, the differences at the top end of the distribution suggest that highly ranked programs by no means have a monopoly on the production of highly productive publishers.

In other words, a simple but valuable lesson that can be drawn from figure 1 is that the program from which a student graduates appears to be a far-from-perfect indicator of his or her likelihood for early career research success. This fact might explain the anecdotal phenomenon that has often been related to us about how departments (especially those of lower-rank) hire students in large part on the reputation of the program from which their Ph.D. is minted and end up disappointed enough with their early career performance that they either counsel them out or deny their application for tenure. At the same time, we note that many lower-ranked programs produce outliers who outperform the vast majority of graduates from top-ranked programs, suggesting that programs making such hiring decisions may have missed out on lower-ranked program graduates who had the potential to be highly productive. Given the significant resources exhausted in making a hire and in mentoring a junior faculty member for up to six years, programs would clearly prefer not make such mistakes.

The Student–Advisor Matching Process

So how can departments distinguish between the likely future productivity of graduates of the same Ph.D. program and how can those highly productive graduates of lower-ranked programs indicate to potential employers that they will indeed be highly productive? We posit that important insights can be drawn from the process through which students become matched with their Ph.D. programs and their dissertation advisors. The quality of program from which a student graduates is the result of the initial decision, likely made five to six years prior, whether to accept the student into the particular Ph.D. program. Unfortunately, the information that is readily observable when making the initial acceptance decision consists primarily of the student's standardized test scores, prior academic performance, and letters of recommendation. As Cushing and McGarvey (2004) argue, such observable measures vary little across advanced degree aspirants, as those desiring to further their educations are mostly drawn from the upper tail of the student distribution and thus are nearly all high achieving students with top references. Consequently, little variation exists in the serious applicant pool, meaning that acceptance decisions are based in large part on "ad hoc procedures, partial information, and intuition" (Kruger and Wu 2000, p. 81). As such, at the initial acceptance stage there exists "considerable uncertainty in forecasting which applicants will be successful economists" (Krueger and Wu 2000, p. 93).

The student's match with his or her dissertation advisor might reduce this uncertainty. To see this, consider that the advisor–advisee decision is made significantly later in the graduate education process than the initial acceptance decision. As a result of this timing, the decision makers will have access to much better information when making their decisions. Specifically, because students typically will have taken their core Ph.D. courses before seeking an advisor they will have a better idea of their own potential. Hence, we would expect successful students to have a better sense that they possess the skills and motivation required to merit working with an elite advisor and we would expect them to be the most likely to ask highly productive faculty to lead supervise their dissertations. Similarly, at the point where they must decide whether to accept students as their advisees, faculty members will have more information as to the research potential of fledgling students and assuming that advisors prefer to invest their time and effort in students with the greatest potential we would expect the most productive advisors to become matched with highest potential students. As a result, the signal provided by the student–advisor match should be less noisy than the signal provided by the student–program match and we would expect students with higher ranked advisors within a given Ph.D. program to be more productive in their early careers than students with lower ranked or unranked advisors.

Data

This study is the first to construct a comprehensive data set that matches agricultural and resource economics Ph.D.s to their dissertation advisors, graduate programs, dissertation fields, sex, domestic/international status, initial job placements, and peer-reviewed publication histories. In 1987, the Dissertation Abstracts database (published by ProQuest Information and Learning) started including the name of the student's dissertation advisor for the majority of dissertations accepted at accredited North American educational institutions.[2] From this, we collect information on 1,527 dissertations filed in agricultural and resource economics fields between 1987 and 2000 for students graduating from top Ph.D. granting agricultural economics programs. We restrict our sample to top programs because they are the most likely to value research productivity and we define top programs as those 22 with good enough reputations to be ranked by Perry.[3] We define unique program tiers based on whether a program's average reputation rank was greater than 4 (tier 1), between 3 and 4 (tier 2), or less than 3 (tier 3).[4] While it is clear why we start with 1987 degree recipients, we cut off our time frame in 2000 to allow sufficient time for students to start their publishing careers. Finally, to make sure that we only include students writing on agricultural and resource economics topics, we cross-reference our list with the "Ph.D. Recipients Annual List" published each December in the *American Journal of Agricultural Economics*, meaning that students are only included in our sample if they are included in the *AJAE* list.

Individual-specific, peer-reviewed publication data as of December 2004 are collected from Econlit, which is the American Economic Association's bibliography of economics literature throughout the world. The database contains information on articles published in more than 700 journals, including all the major field and general interest agricultural and resource economics journals, articles in collected volumes, books, monographs, and working papers from selected series. Because the publication standard is presumably more uniform for peer-reviewed journals than for the remaining types of publications, we limit our analysis to such articles. To quantify research productivity in peer-reviewed journals we consider several traditional metrics. Perry defines the top four agricultural and resource economics journals (henceforth referred to as "core" journals) in terms of Social Science Citation Index citations per article as the *American Journal of Agricultural Economics,* the *Journal of Environmental Economics and Management, Land Economics,* and the *Journal of Agricultural Economics*.[5] Beilock and Polopolus demonstrate the importance of regional journal citations for agricultural and resource economists (henceforth referred to as "regional" journals).[6] Accordingly, we consider three separate categories of articles: (1) total peer-reviewed

[2] According to its description, this database contains information on "dissertations on all academic topics accepted at accredited institutions since 1861, including more than 1.2 million citations (with abstracts since 1980) to doctoral degree dissertations by accredited North American educational institutions and more than 200 institutions elsewhere. Dissertation Abstracts represents original academic research from over 1,000 universities throughout the world. It is the most comprehensive information resource covering doctoral dissertations and master's theses."

[3] Perry (1999) developed a reputation ranking based on surveys of 62 of the most prominent members within the profession. While Peterson's Guide to Graduate Programs in the Humanities, Arts and Social Sciences, claims that 32 different departments in the U.S. offer Ph.D. degrees in agricultural economics, according to Perry only 22 were included on more than 16% of his survey responses and thus merited a reputation ranking. We thus limit our sample to only those 22 programs earning a reputation ranking.

[4] Those reputation rankings are based on a 5-point scale, where "a ranking of 5 indicated an excellent program, 4 corresponded to an above average program, 3 being average, 2 below average, and 1 being a poor program." Tier 1 programs are UC Berkeley, UC Davis, Maryland, Iowa State, NC State, and Minnesota. Tier 2 programs are Wisconsin, Purdue, Cornell, Texas A&M, Michigan State, Illinois, Ohio State, and Oregon State. Tier 3 programs are Virginia Tech, Penn State, Kansas State, Florida, Missouri, Oklahoma State, Washington State, and Georgia.

[5] Perry chooses these four journals because according to the Social Science Citation Index (SSCI) they are the only journals to have citation rates close to or higher than the citation rate for the *AJAE*.

[6] In their study, Beilock and Polopolus (1988) identify as regional journals the *Western Journal of Agricultural Economics* (now the *Journal of Agricultural and Resource Economics),* the *Southern Journal of Agricultural Economics* (now the *Journal of Agricultural and Applied Economics),* the *Northeastern Journal of Agricultural Economics* (now the *Agricultural and Resource Economics Review),* the *Northcentral Journal of Agricultural Economics*, and the *Canadian Journal of Agricultural Economics*. In this study we do likewise.

articles, (2) articles published in one of the four "core" agricultural and resource economics journals, and (3) articles published in one of the "regional" agricultural and resource economics journals. Finally, as is standard in the literature (Moore, Newman, and Turnbull 1998), we exclude replies, comments, and other errata from our publication counts, as we only want to account for original research.[7]

Overall, we observe 430 faculty members directing at least one dissertation during our time frame. To compare students by the relative research productivity of their advisors, we quantify the advisors' relative standing (for his or her own research) by constructing a "Hall of Fame" similar to that constructed by Coupe (2003) for the top 1,000 global economists. Coupe's relative productivity rankings are calculated as a weighted-average of eleven different historically utilized metrics of research productivity. The importance of weighting an individual's relative ranking across several different metrics as opposed to relying on any one particular metric is that doing so diminishes the likelihood that "we were disadvantaged by the specific weighting scheme (Coupe 2003, p. 1310)." The weighted average we calculate is based on the total number of articles and author-weighted pages published in all peer-reviewed journals, core agricultural and resource economics journals, and top 36 economics journals. While it is possible to quibble over whether a given individual should be ranked say 25th or 26th out of 430, we think that broader groupings accurately reflect significant differences across the spectrum of research productivity.[8] Hence, we define an advisor as either being ranked among the top 100 (for lack of a better name, "elite" advisors), ranked between 101 and 300 ("middle" advisors), or ranked between 301 and 430 ("bottom" advisors). Please see the technical appendix (Hilmer and Hilmer 2006) for a listing of all elite advisors. Clearly it could be argued that our chosen cutoffs are arbitrary. In response, we note that we estimated our models with a wide variety of groupings as well as a continuous measure of advisor rank and that our findings are consistent across all specifications.[9]

In the descriptive analysis that follows, we divide students into several broad ranking groups based on their early career productivity. To define these groups, we calculate a student Hall of Fame in a manner similar to that employed above. The primary difference is that because we have an uneven aged panel, some who have had their Ph.D.s as many as 17 years and some who have had theirs as few as 4 years, our weighted average is based on the total number of articles and author-weighted pages per year since Ph.D. receipt. The student ranking groups we define are the top 10% of all students ("top" publishers), students falling between 11% and 25% ("middle" publishers), students falling between 26% and 58% ("bottom" publishers), and students falling in the bottom 42% because those students never publish any articles ("nonpublishers"). Please see the technical appendix (Hilmer and Hilmer 2006) for a listing of the top 10% of advisees.

Finally, as previous studies by Davis, Huston, and Patterson (2001), Collins, Cox, and Stango (2000), and Buchmueller, Dominitz, and Hansen (1999) indicate, an important determinant of a student's future productivity is whether he or she holds a research-oriented job. To determine a student's first postgraduation job our initial source is the self-reported information contained on various Ph.D. programs' websites. For students whose information was not listed, we turn to the author affiliation in Econlit for the first article published after the student received his or her Ph.D. We note that these sources do not provide the richness of detail we would prefer. Specifically, the sources generally only report a broad affiliation without providing specific detail as to the exact nature of the position. As a consequence, we are generally

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[7] An additional concern is the fact that "an article is not an article." To account for differences in article length and author configuration, we also examine differences in the total number of author-weighted pages published in each journal. The author-weighted results, however, do not differ significantly from the unweighted, number of article results and thus for the sake of brevity we do not include them here.

[8] This feeling is similar to that of Kingston and Smart (1990, p. 149) who suggest that such a categorical approach is preferable to a linear specification when comparing graduates of different quality colleges because "it is likely that differences throughout most of the academic hierarchy are inconsequential [which would imply only a small overall effect of program rank] ... but that going to an elite school does make a difference."

[9] For example, in the results presented table 3 below, when entered as a series of dummy variables with bottom ranked advisors being the omitted group, our estimated marginal effect (and standard error of the marginal effect) for elite advisors is 1.368 (0.305) while for middle advisors it is 0.688 (0.237). When entered as a continuous measure, the estimated coefficient is 0.004 (0.0008). This latter result suggests that, all else equal, every one-position increase in an advisor's relative standing is associated with his or her student averaging 0.004 more total articles. Given that the middle ranking in the elite advisor category (advisors ranked 1–100) is 315 positions above the middle ranking in the bottom advisor category (advisors ranked 301– 430), the results suggest that a student of the former advisor would average 1.336 more total articles than an student of the latter advisor, *ceteris paribus*.

only able to observe that a student initially received a position at a given university, not whether the position was in economics or agricultural economics (or another discipline), if in agricultural economics whether the student was primarily teaching/research or extension/research, or whether the position was a tenure-track line or a soft-money or postdoctoral position. Nonetheless, out of all possible positions (academic, government, or private sector) the previous research noted above, and our summary statistics, suggest that the most important predictor of research productivity is whether the student initially receives a domestic academic position. Accordingly, we control for the students initial job type by including a dummy variable indicating whether we could identify the student's first postgraduation job as being with a U.S. academic program.

Summary Statistics

Table 1 presents individual characteristics across program, student, and advisor ranks. Overall, 81% of our students are male, 51% are international and, as of December 2004, the average number of years since Ph.D. receipt was 9.94. These numbers are broadly consistent with those in Siegfried and Stock (2006) and Gempesaw and Elerich (1989). Looking across program tiers, while the field remains male-dominated, females are somewhat more likely to graduate from tier 1 programs with 21% of all tier 1 graduates being female as opposed to only 16% of tier 3 graduates. The majority of Ph.D. recipients from tier 2 and tier 3 programs are international students while the majority of tier 1 Ph.D. recipients are domestic. Turning to student productivity, nearly 88% of top publishing students are male while 80% to 82% of students in the three less productive groups are male. At the same time, only 23% of top publishing students are international and this percentage increases monotonically across groups to a high of roughly 61% for nonpublishing students.

Table 2 presents summary publication statistics across program, student, and advisor rank. Overall, students in our sample had published an average of 2.98 articles by December 2004, or considering the sample average of 9.94 years

Table 1. Summary Individual Characteristics by Program Tier, Student Rank, and Advisor Rank

	Observations	Male	International Student	Years Since Ph.D.
All students	1,527	0.814	0.508	9.941 (3.927)
Program tier:				
Tier 1	529	0.790	0.440	10.002 (3.987)
Tier 2	622	0.818	0.521	9.847 (3.881)
Tier 3	376	0.840	0.583	10.011 (3.923)
Student rank:				
Top publishers	154	0.877	0.227	9.909 (4.153)
Middle publishers	229	0.808	0.380	9.266 (3.943)
Bottom publishers	507	0.815	0.519	10.355 (3.720)
Nonpublishers	637	0.801	0.614	9.862 (3.994)
Advisor rank:				
Elite	583	0.801	0.449	9.887 (3.996)
Middle	636	0.830	0.527	9.926 (3.871)
Bottom	308	0.799	0.581	10.075

Note: standard deviations in parentheses.

Table 2. Summary Articles and Pages Published Statistics by Program Tier, Student Rank, and Advisor Rank

	Total Articles	Core Articles	Regional Articles
All students	2.977	0.666	0.523
	(5.757)	(1.780)	(1.554)
Program tier:			
Tier 1	4.371	1.216	0.599
	(6.925)	(2.519)	(1.613)
Tier 2	2.688	0.455	0.537
	(5.497)	(1.187)	(1.745)
Tier 3	1.495	0.242	0.394
	(3.501)	(0.976)	(1.048)
Student rank:			
Top	14.955	4.253	2.896
	(10.622)	(3.669)	(3.535)
Middle	5.699	0.939	0.974
	(3.343)	(1.099)	(1.484)
Bottom	1.850	0.290	0.256
	(1.172)	(0.545)	(0.538)
Non	—	—	—
	—	—	—
Advisor rank:			
Elite	4.523	1.208	0.732
	(7.320)	(2.481)	(1.764)
Middle	2.241	0.362	0.453
	(4.438)	(0.919)	(1.423)
Bottom	1.571	0.269	0.273
	(3.850)	(1.198)	(1.328)

Note: Standard deviations in parentheses.

since Ph.D. receipt, an average of roughly 0.30 articles per year. Of the total number of articles published, 0.67 appeared in core journals and 0.52 in regional journals. It is potentially interesting to compare these averages to the absolute values for students at the top-end of our Hall of Fame. In the 11 years since he or she received a Ph.D., our most productive graduate published a total of 52 Econlit listed articles, with 18 appearing in core journals and 5 appearing in regional journals.

Comparing across the remaining panels suggest that students graduating from better programs and students working with better advisors average more publications of every type. These differences are largest for core journals, as tier 1 graduates and students with elite advisors average roughly three times as many articles in those outlets as students in the remaining groups. A notable exception to this trend is that tier 2 graduates average almost as many regional publications as tier 1 graduates. Finally, it is noteworthy that the top 10% of all Ph.D. recipients in our sample average nearly 15 total publications (or roughly 1.5 per year), of which 4.25 are in core journals, and 2.90 are in regional journals. These numbers drop dramatically, even to the immediately lower group of students ranked between 11% and 25%, for whom the averages are 5.70 total articles, 0.94 core articles, and 0.97 regional articles.

Because different types of jobs have different peer-reviewed publication requirements, a clear concern with respect to future productivity is the student's initial job placement. Overall, roughly one-fourth of the students in our sample initially received domestic academic placements. Looking across our various rankings groups, the results are as expected: students graduating from tier 1 programs are nearly twice as likely as students graduating from tier 3 programs to receive such positions while more than one-third of students with elite advisors, as opposed to less than one-sixth of students with bottom advisors, do so.

Empirical Results

Our empirical work focuses on assessing the degree to which the reputation rank of a student's Ph.D. program and the relative productivity rank of a student's dissertation advisor affect his or her early career productivity. The ideal experiment for conducting such an analysis would be to randomly assign students to programs of different reputations and advisors of different ranks, observe how those students perform under each possible combination, and compare the outcomes. Such an ideal experiment is clearly not possible, as we only observe student outcomes for the particular program and advisor that they did choose. In other words, given the nature of our data, our analysis is based on student outcomes that are conditional on the particular program and advisor choices that each student actually makes. We have no means to control for the obvious nonrandom selection processes that guide those choices. But given that the objective in this analysis is to identify the expected future productivity conditional on factors observable in the academic labor market, not the structural, causal impact of a given program or advisor on student productivity, this reduced form approach suffices.

In this context, we attempt to isolate the relative impact of program reputation and advisor rank on a student's early career research productivity by estimating the following equation

$$(1)\quad P_i = B_0 + B_1 Q_i + B_2 A_i + B_3(Q_i \cdot A_i) + B_4 J_i + \boldsymbol{B_5 X_i} + B_5 O_i + \varepsilon_i$$

where P_i represents one of the three productivity measures, Q_i is the reputation tier of the student's Ph.D. program, A_i is the relative productivity ranking of the student's dissertation advisor, $(Q_i \cdot A_i)$ is an interaction term allowing the effect of advisor rank to differ across program reputation tiers, J_i indicates whether the initial job placement is in a domestic academic program, $\boldsymbol{X_i}$ is a vector of individual characteristics, and ε_i is an error term. The individual characteristics we consider are whether the student is male or an international student, the field in which the student's dissertation is written, and the number of years since the student received his or her Ph.D. (because of our uneven-aged panel). As discussed above, advisors differ greatly in their propensity to take on advisees. We can envision the total number of dissertations that a student's advisor directs having competing effects on his or her future productivity. On one hand, the increased time pressures associated with the increased student-load might force a popular advisor to devote less time to each student, thereby harming each student's learning. On the other hand, we have heard numerous anecdotes of advisors who become popular because they love to mentor students and due to this love they are able to devote more time to and instill more passion in each of their students, despite the increased student load, thereby increasing each student's learning. To account for these possibilities, our vector of individual characteristics also includes O_i, which indicates the number of other completed dissertations lead supervised by the advisor during our sample period.[10] Our main parameters of interest are B_1, B_2, and B_3, which indicate the effect that the reputation rank of a student's Ph.D. program and the relative research productivity rank of a student's dissertation advisor have on his or her early career productivity, all else constant.

An important estimation concern is that we are unable to observe students publishing negative numbers of articles and thus all of our productivity measures are truncated at zero. In the presence of such truncated models, the traditional Gauss–Markov assumptions are violated and OLS estimation results in biased and inconsistent parameters estimates. Truncated count data models such as these are normally estimated by functional forms that account for the skewed distributions of the dependent variables. The two models most commonly used in the literature are the Poisson and the Negative Binomial (Cameron and Trivedi 1998). The primary difference between those two potential models is that the Poisson implicitly assumes the equality of the conditional mean and variance functions (equidispersion) while the Negative Binomial does not. Because the data in our analysis fail tests of equidispersion for each productivity measure, suggesting that the assumption of equidispersion is violated, we estimate each of our productivity functions with the Negative Binomial regression model.

We start by examining the degree to which the reputation rank of the student's Ph.D. program is associated with his or her early career research productivity. Because tier 3 is the omitted program tier, the coefficients presented in first three columns of table 3, which have been converted to marginal effects, represent the estimated differences in productivity between tier 1 or tier 2 graduates and tier 3 graduates. The results suggest that, all else equal, students graduating from more highly ranked programs are statistically more likely to publish in their early careers than students graduating from lower-ranked programs. This finding is consistent with previous findings by Coupe (2003), Buchmueller, Dominitz, and Hansen (1999), and Hogan (1981) for the economics profession. The estimated coefficients indicate that tier 1 graduates average 2.06 more total articles, and 0.55 more core articles than tier 3 students while tier 2 graduates average 1.19 more total and 0.21 more core articles. The notable exception to the above findings is that we estimate no statistically significant cross-tier differences in the likelihood of publishing regional articles. In other words, statistically speaking tier 3 students are as likely as tier 1 and tier 2 students to publish articles in those outlets.

To examine what can be learned from considering the student–advisor match in addition to the initial student–program match, the final six columns of table 3 present results that add advisor rank to the previous estimates. The first three panels enter advisor rank by itself

[10] One could potentially argue that due to a highly productive advisor's increased skill, he or she may be able to advise more students without observing a significant drop-off in his or her ability to work with students and author research papers. To test this proposition, we interacted the number of other advisees with the relative standing of the student's advisor and found that holding the advisor's rank constant a one student increase in the number of advisees does not affect a student's average number of articles in a statistically significant way.

Table 3. Marginal Effects for Negative Binomial Regressions Controlling for Program Tier and Advisor Rank

	Total Articles	Core Articles	Regional Articles	Total Articles	Core Articles	Regional Articles	Total Articles	Core Articles	Regional Articles
Advisor Rank:									
Elite	—	—	—	1.368**	0.351**	0.227**	2.500**	0.598**	0.392*
	—	—	—	(0.305)	(0.083)	(0.084)	(0.781)	(0.239)	(0.205)
Middle	—	—	—	0.688**	0.106*	0.157**	0.869**	0.210	0.231*
	—	—	—	(0.237)	(0.062)	(0.067)	(0.432)	(0.135)	(0.127)
Program reputation tier:									
Tier 1	2.055**	0.547**	0.034	1.517**	0.343**	−0.010	1.415*	0.451*	−0.050
	(0.314)	(0.094)	(0.061)	(0.302)	(0.081)	(0.062)	(0.750)	(0.240)	(0.172)
Tier 2	1.189**	0.209**	0.068	1.087**	0.164**	0.059	1.622**	0.322**	0.184
	(0.245)	(0.066)	(0.057)	(0.238)	(0.062)	(0.056)	(0.502)	(0.152)	(0.132)
Interaction terms:									
Elite * Tier 1	—	—	—	—	—	—	−0.422	−0.117	−0.001
	—	—	—	—	—	—	(0.669)	(0.153)	(0.213)
Middle * Tier 1	—	—	—	—	—	—	−0.025	−0.130	0.000
	—	—	—	—	—	—	(0.677)	(0.121)	(0.201)
Elite * Tier 2	—	—	—	—	—	—	−1.134**	−0.211**	−0.178*
	—	—	—	—	—	—	(0.379)	(0.089)	(0.099)
Middle * Tier 2	—	—	—	—	—	—	−0.245	−0.091	−0.095
	—	—	—	—	—	—	(0.461)	(0.118)	(0.110)
Individual characteristics:									
Years since Ph.D.	0.115**	0.033**	0.025**	0.110**	0.031**	0.025**	0.109**	0.031**	0.025**
	(0.021)	(0.005)	(0.006)	(0.021)	(0.005)	(0.005)	(0.021)	(0.005)	(0.005)
International	−0.401**	−0.217**	−0.218**	−0.346**	−0.200**	−0.202**	−0.360**	−0.203**	−0.201**
	(0.170)	(0.044)	(0.047)	(0.166)	(0.042)	(0.046)	(0.165)	(0.041)	(0.046)
Male	0.905**	0.163**	0.210**	0.848**	0.152**	0.199**	0.831**	0.149**	0.197**
	(0.162)	(0.039)	(0.039)	(0.160)	(0.037)	(0.039)	(0.160)	(0.037)	(0.039)
Advisor demand:									
Other advisees	0.015	0.003	0.004	−0.005	−0.002	0.000	−0.008	−0.003	0.000
	(0.014)	(0.003)	(0.004)	(0.014)	(0.003)	(0.004)	(0.014)	(0.003)	(0.004)
First Job Type:									
U.S. academic	3.926**	0.674**	0.609**	3.778**	0.632**	0.580**	3.819**	0.628**	0.588**
	(0.405)	(0.090)	(0.096)	(0.390)	(0.084)	(0.092)	(0.392)	(0.083)	(0.093)

Continued

Table 3. *Continued*

	Total Articles	Core Articles	Regional Articles	Total Articles	Core Articles	Regional Articles	Total Articles	Core Articles	Regional Articles
Dissertation field:									
Consumer demand	0.418	0.306*	0.224	0.464	0.281*	0.218	0.539	0.298*	0.247
	(0.503)	(0.178)	(0.179)	(0.502)	(0.167)	(0.174)	(0.513)	(0.171)	(0.182)
Production	1.068**	0.203*	0.432**	1.162**	0.203**	0.450**	1.077**	0.197**	0.432**
	(0.434)	(0.105)	(0.160)	(0.438)	(0.101)	(0.161)	(0.428)	(0.099)	(0.157)
Agricultural products	0.077	0.008	0.155	0.090	0.020	0.151	0.129	0.029	0.157
	(0.319)	(0.081)	(0.108)	(0.312)	(0.079)	(0.105)	(0.314)	(0.080)	(0.106)
Agricultural inputs	0.526	0.176	0.159	0.496	0.184	0.139	0.455	0.169	0.128
	(0.449)	(0.129)	(0.137)	(0.433)	(0.124)	(0.129)	(0.428)	(0.121)	(0.126)
Resources	−0.047	0.084	0.048	0.000	0.085	0.048	−0.004	0.083	0.059
	(0.305)	(0.089)	(0.092)	(0.303)	(0.086)	(0.090)	(0.300)	(0.085)	(0.092)
Environmental	1.050**	0.512**	0.162	0.920**	0.435**	0.150	0.843*	0.434**	0.139
	(0.483)	(0.175)	(0.127)	(0.455)	(0.155)	(0.123)	(0.442)	(0.154)	(0.120)
Agriculture & food policy	0.757*	0.161	0.083	0.834*	0.163	0.091	0.773*	0.157	0.092
	(0.450)	(0.114)	(0.112)	(0.453)	(0.111)	(0.111)	(0.444)	(0.108)	(0.111)
Economic development	0.693*	0.028	−0.080	0.897**	0.064	−0.065	0.864**	0.058	−0.065
	(0.371)	(0.081)	(0.071)	(0.390)	(0.084)	(0.072)	(0.384)	(0.082)	(0.071)
International economy	0.685	0.030	0.091	0.776	0.034	0.122	0.749*	0.041	0.115
	(0.440)	(0.097)	(0.112)	(0.446)	(0.093)	(0.117)	(0.441)	(0.094)	(0.115)
Industrial org.	−0.737**	−0.123*	0.015	−0.626**	−0.108	0.030	−0.668**	−0.110	0.025
	(0.300)	(0.074)	(0.113)	(0.313)	(0.074)	(0.115)	(0.303)	(0.073)	(0.113)
Pseudo-R2	0.068	0.125	0.085	0.072	0.135	0.089	0.073	0.138	0.090
Log-likelihood	−3,001.08	−1,350.79	−1,219.80	−2,988.89	−1,335.43	−1,215.11	−2,984.71	−1,331.95	−1,213.42
Alpha	1.590	1.767	2.855	1.547	1.643	2.783	1.534	1.612	2.761
	(0.088)	(0.184)	(0.294)	(0.087)	(0.175)	(0.289)	(0.086)	(0.173)	(0.287)

Notes: Standard errors of marginal effects in parentheses. Value listed in the column heading is the dependent variable. Two (**) and one (*) asterisks are significant at 5% and 10% levels, respectively. The specific fields listed in the *AJAE* dissertation by subject list are: (1) consumer demand; (2) production economics & supply; (3) agricultural products: price analysis, subsector models, marketing, futures; (4) agricultural inputs: land, labor, finance; (5) natural resources: energy, conservation, land use, water, forestry, fisheries; (6) environmental economics: pollution, regulation, nonmarket valuation; (7) agricultural and food policy: regulation, taxation, welfare; (8) economic development: developing economies, aid, regional, general equilibrium; (9) international economics: trade, integration; (10) industrial organization and market structure; and (11) general: teaching, extension, research methodology, professional. General is the omitted group. Alpha represents the degree of overdispersion in the data. An alpha of zero means that the negative binomial model has the same distribution as the Poisson model.

without including the program reputation/advisor rank interaction terms. Because advisor rank is entered as a set of dummy variables, with the omitted group being students with bottom advisors, the marginal effects represent the estimated differences in each of our productivity measures for students having an advisor belonging to a given ranking group or graduating from a program within a given tier relative to tier 3 students with bottom advisors.

Overall, the results suggest two major findings. First, after adding controls for the relative productivity rank of a student's advisor, the estimated differences between tier 1 and tier 3 graduates shrink by 25% to 33% in magnitude and the estimated log likelihoods increase by amounts large enough to suggest that together our controls for advisor rank are statistically significant.[11] These results combine to suggest that significant portions of the difference between top program graduates and bottom program graduates might be explained by the matching of the student to his or her dissertation advisor.

Second, after controlling for the quality of program from which a student graduates, students with elite or middle advisors are statistically more likely to publish across all metrics than students with bottom advisors. In particular, holding program tier and other observable factors constant, we estimate that students with elite advisors average 1.37 more total, 0.35 more core, and 0.23 more regional articles while students with middle advisors average 0.69 more total, 0.11 more core, and 0.16 more regional articles. Moreover, the estimated differences between tier 1 and tier 2 students for total articles published lose their statistical significance once our controls for advisor quality are added. Hence, the estimated differences suggest that even within a given program reputation tier, the student–advisor match provides a strong signal as to whether and in which types of journals the student will publish in his or her early career.

The final three columns of table 3 add the program reputation/advisor rank interaction terms. Care must be taken when interpreting these results, however, as the total effect of each variable included in the interaction term is a combination of the estimated values for each of the different variables to which each term belongs. Specifically, looking at the total articles results, the effect of having an elite advisor at a tier 1 program relative to the base of having a bottom advisor at a tier 3 program is 2.500 + 1.415 – 0.422, or 3.493, which suggests that all else equal students in the former group average 3.493 more total articles in their early careers than students in the latter group.

To make the effects more explicitly clear, table 4 presents differences in predicted values for students choosing different advisor rank/program tier combinations. In essence then, the results in table 4 replicate the experiment of: (1) sending a hypothetical student to a program in each quality tier and having him work with an elite, a middle, or a bottom advisor, (2) observing his or her early career productivity in each instance, and (3) comparing the results. In so doing, the results allow us to use our conditional estimates to somewhat replicate the desired random experiment outlined above.

The predicted productivity differences in the top two panels of table 4 reinforce the findings in table 3. Namely, holding advisor rank constant, tier 1 students average more articles than tier 2 students while holding program reputation tier constant students with elite advisors average more articles than students with middle advisors, all else equal. In other words, it appears that comparing the relative prominence of the dissertation advisors for two students who graduate from the same program tier might help predict which student is likely to be more productive in his or her early career. More surprisingly, the bottom panel of table 4 suggests that the student–advisor match might also help predict where students fall in the cross-program research productivity distributions. Specifically, both tier 2 and tier 3 students with elite advisors are predicted to publish either more or the same number of total articles than tier 1 students with either middle or bottom advisors. Similarly, tier 2 students with middle advisors are predicted to publish more total and nearly identical numbers of core articles as tier 1 students with bottom advisors. The lone exception to the trend is that tier 3 students with middle advisors are predicted to publish fewer total but statistically the same

[11] The log likelihood function for the restricted model without controls for school tier or advisor ranking is –3,030.6303. The log likelihood function for the model with controls for school tier but without advisor ranking is –3,001.84, the log likelihood function with controls for advisor ranking but without school tier is –3,006.0743, and the log likelihood function with controls for both advisor ranking and school tier is –2,988.89. Using a likelihood ratio test, the school tier and advisor ranking is significant at a 0.01 level. The interaction effects between school tier and advisor ranking are significant at the 0.1 level for total articles but insignificant for core and regional articles.

Table 4. Predicted Differences in Research Productivity Measures

	Total Articles	Core Articles	Regional Articles
Same advisor rank, different program tier:			
Elite, tier 1 versus elite, tier 2	0.505**	0.222	−0.057
	(0.130)	(0.175)	(0.215)
Middle, tier 1 versus middle, tier 2	0.012	0.090	−0.139
	(0.153)	(0.226)	(0.267)
Same program tier, different advisor rank:			
Elite, tier 1 versus middle, tier 1	1.234**	0.401**	0.160
	(0.150)	(0.205)	(0.266)
Elite, tier 2 versus middle, tier 2	0.742**	0.268	0.078
	(0.141)	(0.204)	(0.233)
Different program tier, different advisor rank:			
Middle, tier 1 versus elite, tier 2	−0.730**	−0.179	−0.217
	(0.167)	(0.236)	(0.287)
Middle, tier 1 versus elite tier 3	−0.242	−0.067	−0.211
	(0.245)	(0.347)	(0.409)
Bottom, tier 1 versus elite, tier 2	−1.573**	−0.259	−0.448
	(0.270)	(0.386)	(0.528)
Bottom, tier 1 versus elite, tier 3	−1.085**	−0.147	−0.442
	(0.324)	(0.466)	(0.605)
Bottom, tier 1 versus middle, tier 2	−0.832**	0.009	−0.370
	(0.259)	(0.375)	(0.514)
Bottom, tier 1 versus middle, tier 3	0.546**	0.241	−0.281
	(0.268)	(0.397)	(0.523)

Notes: Standard errors of predicted effects in parentheses. Value listed in the column heading is the dependent variable. Two (**) and one (*) asterisks are significant at 5% and 10% levels, respectively.

amount of regional articles than tier 1 students with bottom advisors. Taken together, these results might suggest that in most cases, students from lower-ranked programs who work with relatively more prominent dissertation advisors are likely to outperform students from highly ranked programs who work with less prominent advisors. As such, these results underscore the importance of the mentoring relationship between faculty and their students, over and seemingly above that of the department's overall program ranking.

Implications for Faculty and Students

This paper examines the relationship between the relative reputation of a student's Ph.D. program, the relative research productivity rank of his or her dissertation advisor, and the student's early career research productivity. Within a sample of 1987–2000 agricultural and resource economics Ph.D. recipients we find that that even after controlling for program reputation students working with relatively more productive dissertation advisors average significantly more early career publications than students working with relatively less productive advisors.

So what should programs and students make of these results? For academic programs, the implications should be clear. All else equal, programs interested in hiring faculty who are likely to be productive researchers should hire students attending top programs and working with top advisors. However, because there are only so many to go around and they likely end up with positions in top programs, lower-ranked programs might not have the luxury of recruiting such students. If so, our results suggest that programs should seriously consider students from lower-ranked programs who might be signaling their potential productivity by working with the most prominent members of their graduate program's faculty.

What does this mean for prospective or current students in agricultural and resource economics Ph.D. programs? In his 1993 address to students at the ASSA meetings Daniel Orr stated "you will write a better dissertation if your chosen subject is congruent with the interests and writings of a well-known supervisor. That will help your job placement, too" (Orr 1993). Our finding that even within the same program tier students with more highly ranked advisors outperform students with lower ranked advisors demonstrates that this sentiment also applies to the student's early career research productivity. Hence, the results suggest that it is in the student's best interest to work with the best possible advisor. Our estimated cross-program differentials also suggest a more provocative possibility. Namely, if academic programs consider other factors in addition to the program from which a student graduates, then it might be in the strategic student's best interest to consider attending a lower-ranked program where he or she might be able to work with a top faculty member. In other words, for many students it might well pay to be a "big fish in a small pond."

The current research suggests that students who work with highly ranked advisors tend to be more productive early in their careers. A future question might be the root cause of this finding. On one hand, it might be argued that a human capital effect is at work through which highly productive advisors are able to instill in their students many of the qualities that make themselves highly productive, thereby leading to their students having significantly more early career publishing success. On the other hand, we might simply be observing the results of a signaling effect through which highly productive advisors become associated with better students due to their relatively higher prominence despite their having no tangible productivity effect on their students. Our inclination is that, as Weiss (1995) argues for the positive return to higher education, our results likely derive from some combination of the two theories. Nonetheless, more research would be needed to attempt to determine the degree to which each effect contributes to the observed relationship between the relative prominence of a student's dissertation advisor and his or her early career research productivity.

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