The Search for Economics Talent:
Doctoral Completion and Research Productivity

Wayne A. Grove (corresponding author)
Department of Economics
Le Moyne College
1419 Salt Springs Road
Syracuse, NY 13214
Phone: 315.445.4262
Fax: 315.445.4540
grovewa@lemoyne.edu

Stephen Wu
Department of Economics
Hamilton College
Clinton, NY 13323
Phone: 315.859.4645
Fax: 315.859.4477
swu@hamilton.edu

AEA Session: Jan. 5, 8:00am
The Market and Pre-Market for Graduate Students in Economics

The Search for Economics Talent: Doctoral Completion and Research Productivity

By WAYNE A. GROVE AND STEPHEN WU*

Economists hold an annual talent search in which students from around the world apply to doctoral programs and economics departments select among them. Top Ph.D. admission committees seek candidates with the preparation, aptitude, drive, and creativity to become academic professionals whose research will advance the frontiers of the discipline. The crux of the economics talent search problem, however, is the non-observability of important characteristics and aptitudes. To assess students' preparation and potential for success in an economics doctoral program, faculty must use the evidence provided in the application folders: standardized test scores, course selection and grades, the quality of the undergraduate institution, fellow economists' evaluation of them in that context, and other relevant information. Thus, an admission committee's task of matching opportunity with talent constitutes a signaling problem, as modeled by Michael Spence (1973).

What information, then, credibly signals otherwise unobservable economics talent? Viewing quantitative GRE scores as a proxy for ability, Ronald Ehrenberg and Panagiotis Mavros (1995) surprisingly found that it failed to predict Ph.D. completion or time-to-degree for 25 years of economics Ph.D. students at Cornell. Attributing that result to a poor proxy for ability, they recommended obtaining a richer set of information about a student's "true ability" by using, for example, the quality of applicants' undergraduate institution, information from letters of recommendation, and the graduate committee's rankings of them (ibid, pp. 594, 599).

* Grove: Department of Economics, Le Moyne College, Syracuse, NY 13214 (e-mail: grovewa@lemoyne.edu); Wu: Department of Economics, Hamilton College, Clinton, NY 13323 (e-mail: swu@hamilton.edu). We are thankful to Elihu Bogan, David Killian, Sergei Piatkovski, and Aliesa Shoults for providing research assistance. Financial support came from a Le Moyne College's Research and Development Grant. We thank Don Dutkowsky, John Siegfried, and seminar participants at Binghamton, Cornell and Syracuse for helpful comments and suggestions.

In this article we test whether three principal signals of economics talent available to an admission committee—GRE scores, the identity of reference letter writers, and the quality of baccalaureate schools—credibly signal either Ph.D. completion or research productivity 17 years later. Our data set, a summary of the information contained in all 344 application files to a top-five economics Ph.D. program in 1989, includes demographic variables, undergraduate institution, information on prior graduate degrees, GRE scores, and the identity of letters of reference writers. Unfortunately, the application file summaries available to us include neither the transcripts nor the contents of the letters of reference. Thus, we ask whether the quality of the undergraduate institution (irrespective of major, GPA or course selection) and the prominence of the letter writers (regardless of their assessment of the applicant) correlate with important long run career outcomes. In addition, we test the efficacy of the admission committee's subjective rating of each candidate, essentially a summary index of their potential. This rating is based on the characteristics noted above, as well as additional information not available to us such as course selection, grades, academic honors received, whether they wrote a thesis, the content of the letters of reference, and other potentially valuable records.

Our analysis breaks new ground in several ways. Since we focus on outcomes for *all applicants* to a particular PhD program, our analysis constitutes the sole predictive validity study of long run research productivity.[1] In doing so, we test whether some basic types of information function as effective signals of applicants' career success. Finally, two of the signals of potential

[1] Studies on degree completion use matriculants only (e.g., Ehrenberg and Mavros, 1995) while analyses of time-to-degree rely on completers (e.g., Ehrenberg and Mavros, 1995; John J. Siegfried and Wendy A. Stock, 001). Alan B. Krueger and Stephen Wu (2000) estimate initial job placement with the same set of *ex ante* data.

economics talent—the identity of reference writers and admission committee rankings—have not been used with any other data set.

I. Doctoral Program Completion and Publication Outcomes

By July 2006, 17 years after applying to one top-five economics doctoral programs, 226 of the 344 applicants (66%) had completed a Ph.D. in economics or a closely related field, such as business economics or public policy. Table 1 shows summary statistics of key variables for the entire applicant pool, for a sample of 259 whose files included non-missing information for all variables used in the analysis, and for a sample of 174 who obtained Ph.D.s and had complete file information. Based on the 20 percent attrition rate of the students who matriculated in this top-five program and the 36 percent rate at Cornell from 1964-78 (Ehrenberg and Mavros, 1995), there were probably a significant number of applicants who enrolled in a doctoral program but subsequently dropped out.

In addition to predicting PhD completion, we also look at long run research productivity, as measured by publication data derived from the EconLit database in July 2006. The mean number of refereed journal publications for those that completed a Ph.D. and had complete application data is 4.5, which is 50 percent higher than the overall sample mean of 3.0 articles. Because of the skewed distribution of publications (with a large number of individuals having zero), our analysis also uses a dichotomous variable equal to one if the individual has at least one peer-reviewed journal publication —70 percent published among those with complete file data and a Ph.D. To see which individuals eventually published in one of the discipline's leading journals, we also estimate the probability of publishing at least one article in the *American Economic Review (*excluding *Papers & Proceedings), Quarterly Journal of Economics, Journal of Political*

Economy, or *Econometrica*[2]; only 18 percent (31 individuals) of those with Ph.D.s and complete application files did so. Finally, we calculate a quality-adjusted number of total publications using Laband-Piette's pages-adjusted index;[3] the mean quality-adjusted number of publications is 0.79 for doctorates with complete records (with a maximum of roughly 12).

From applicants' admission file summaries, we have the following information: Quantitative and Verbal GRE scores[4], country of origin, age, gender, and whether or not an individual had a prior graduate degree. We coded the quality of two categories of undergraduate institutions: the top 30 liberal arts colleges (according to James E. Hartley and Michael D. Robinson, 1997) and the top 20 global research universities (ranked by economic research output according to Pantelis Kalaitzidakis et al., 2003).[5] For the sample size used to estimate research productivity (n=174), 18 percent graduated from a top research university but only seven percent from an elite liberal arts college. To code the identity of letter writers, we use Krueger and Wu's (2000) subjective quality groupings: Reference Group 1 includes at least one top research economist (i.e., a well-known and respected researcher), Reference Group 2 contains at least one active economist (i.e., an economist who had prominently published in the not too distant past or was known for other reasons), and Reference Group 3 includes other letter writers.[6] Sixteen percent of those with a Ph.D. and complete records had Reference Group 1 letters and 14 percent had letters categorized in Reference Group 2. Finally, 85 percent of the application folders (293 out of 344) were read by two members of the admissions committee, who independently ranked the candidates on a scale of 0-9. The sum of ratings variable reflects faculty members' evaluation of

[2] Top four publications have triple the weight of others; the results are robust to different weighting schemes.
[3] The Laband-Piette index, a "long term" impact factor (5 years) that gives higher weight to citations from better journals, values an articles in the *AER* as 100 and, for example, in *Economic Inquiry* as 4.7 and in the *JPE* as 52.0.
[4] Analytical and Subject scores were available for some, but not all of the applicants.
[5] We obtained essentially the same result coding just the top ten for each category.

the totality of the information contained in the application folder, which includes additional information not available to us from the application summaries.

II. *Ex Ante* Determinants of the Variation in Ph.D. Completion

Since a third of the applicant pool did not complete a Ph.D., we use a probit analysis to estimate what *ex ante* information contained in student application files predicts doctoral degree completion (where the dependent variable is equal to one if an individual obtained a doctorate by July of 2006). The marginal effects of these probit estimations are shown in Table 2, column 1. Foreign applicants, those with high quantitative and verbal GRE scores, and those with a letter of reference from a top or an active research economist are significantly more likely to complete a Ph.D. The probability of achieving a doctorate increases by 24 percent if an applicant had a prominent letter writer, by 15 percent if an active researcher wrote a letter, by 6 percent for a 50 point increase in an applicant's GRE quantitative score (at the mean of 740) and by 3 percent for a 50 point increase in the GRE verbal scores (at the mean of 571). Meanwhile, foreign-based undergraduates are 24 percent more likely than U.S.-based undergrads to have completed a doctorate[7], but the quality of undergraduate institutions does not affect PhD completion.

III. *Ex Ante* Determinants of the Variation in Research Productivity

To probe the predictors of research productivity, we regress three measures of refereed publications on the set of application file variables. Given the lumpy nature of the distribution of publications (30 percent of doctoral recipients with complete file data had zero publications), our

[6] These groups were mutually exclusive: letter writers could only be classified in group 2 if they were not in group 1.
[7] Prior work by Ehrenberg and Mavros (1995) found economics Ph.D. completion was positively affected by verbal GRE scores and being a foreign citizen but not by quantitative GRE scores or already holding a masters degree.

first regression uses a probit model where the dependent variable is equal to one if an individual has published at least one peer-reviewed journal article. The marginal effects shown in column 4 of Table 2 show that higher probabilities of publishing are significantly associated with both higher quantitative GRE scores and the prominence of one's reference writers. Having a prolific and well-known economist as a reference corresponds to an increase of 23 percent in the probability of publishing at least one journal article and having a reference writer who actively publishes in economics increases the probability of publishing at least one article by 18 percent, *ceteris paribus*. Meanwhile, a 50 point increase in the quantitative GRE score (from a mean value of 740) corresponds to an increase of 10 percent in the likelihood of publishing.

Might prominent or active letter writers merely proxy for the quality of undergraduate institutions? The data does show that graduating from a top research university is correlated with having a letter from a Reference 1 writer (correlation coefficient of 0.49). However, the significance of reference writers holds for regressions that exclude top research universities and liberal arts colleges (results not shown here). In addition, regressions that use other systems of ranking undergraduate schools show similar results: doctoral completion and publishing success are predicted more by the prominence of letter writers' rather than the status of the undergraduate institution. Perhaps, then, our results suggest a partial explanation for the positive relationship between undergraduate institution quality and graduate school outcomes documented by Eric Eider, Dominic J. Brewer, and Ronald G. Ehrenberg, (1998) and Liang Zhang (2005).

Analysis of two quality-based measures of research productivity reveals different influences. Only foreign undergraduates were more likely to have published in at least one of the four elite general interest journals (*AER, QJE, JPE, EMA*), while all other variables are statistically

insignificant in this regression (see column 7). However, GRE quantitative scores and the status of letter writers are significantly related to the quality adjusted index of the number of publications (based on tobit regressions using Laband-Piette's index (1994); see column 10).

IV. Do Admission Committee Ratings of Applicants Have Predictive Value?

The results from our data show that taken alone, the sum of the subjective ratings of committee members is a strong predictor of doctoral completion and all three measures of research productivity (see columns 2, 5, 8, and 11 of Table 2). In each instance, the subjective ratings are significant at the 1 percent level and meaningful in magnitude. For instance, a one standard deviation increase in the committee's subjective ratings (4.3 on a scale of 18) increases the probability of doctoral completion (by 16%), publishing at least one peer-reviewed article (by 15%), and publishing in one of the leading journals (by 9%).

When we combine the admission committee members' subjective ratings along with the rest of the application data, many coefficients change significance and magnitude compared with the estimations using only applicant file data. For example, including subjective ratings in the Ph.D. completion model does not much affect the magnitude or significance of the foreign baccalaureate and Reference 1 coefficients, but verbal GRE scores lose significance while quantitative GRE scores and the indicator variable for Reference 2 writers become less significant (from 5 percent to 10 percent) and smaller in magnitude (compare column 1 and 3 of Table 2).

Note that the pseudo R-squared values for the doctoral completion regressions using admission file information only, subjective ratings only, and both sets of information are 0.102, 0.073 and 0.145, respectively (columns 1-3, Table 2). The same pattern occurs for estimations

of the probability of publishing at least one article or publishing at least one top 4 article: a regression using a purely statistical model without human ratings has better predictive power than a regression using human ratings alone, but combining both types of information yields superior predictions (confirmation of Ehrenberg and Mavros's, 1995, suggestion that admission committee ratings offer valuable information about applicants' "true ability."). This suggests that an optimal scheme would have an admission committee use both types of information to identify economics talent.

The non-effect of including subjective ratings on foreign undergraduates' probabilities of doctoral completion and publishing in a top journal suggest to us that non-U.S. baccalaureates have an acute signaling problem. As evidence note the stark differences between U.S. and foreign baccalaureates, respectively, in the following signaling variables: 42 versus 16 percent had a reference group 1 or 2 letter writer, 14 versus 1 percent graduated from a top research university, and of those who ultimately published in a top four economics journal, 80 versus 20 percent had letter writers categorized as reference group 1 or reference group 2. Apparently, the signals used by U.S. economics Ph.D. departments provide little help identifying economics talent for those educated outside U.S. borders. This constitutes a considerable problem since non-U.S. citizens received 68 percent of the economics doctorates awarded in 2003, (T. B. Hoffer et al., 2005, p. 98).

V. Summary

Economics departments seek candidates with the preparation, aptitude, drive and creativity to succeed in their programs and become successful economists. Here we identify two credible signals to admission committees of otherwise unobservable economics talent.

According to our analysis, the prestige of an applicants' letter writer and their demonstrated quantitative ability, but *not* the prestige of the undergraduate institutions, strongly predict Ph.D. completion and research productivity 17 years later.

While the richness of our data allows us to examine new relationships and include variables not previously used, we recognize some limitations of this study. The sample is taken from applicants to a particular top five economics Ph.D. program in a particular year, 1989, and is not necessarily representative of all economics Ph.D. applicants: these individuals either enrolled in, or aspired to enroll in, an elite program. Finally, the idiosyncratic nature of two key indicator variables—the quality of letter of reference writers and the admission committees' ratings of the applicants—suggests that caution be used in generalizing our results.

Caveats aside, however, the economics Ph.D. talent search deserves greater scrutiny both due to the high-stakes nature of the admission decisions and because applicant selections for such a long training period determines the efficient allocation of valuable student, faculty, and school resources. Future work should analyze the role of the contents of reference letters, the personal statement, and course choices, as well as any other information about academic honors, theses, publications, or fellowship awards.

References

Attiyeh, George and Richard Attiyeh. "Testing for bias in graduate school admissions." *Journal of Human Resources*, 1997, 32(3), pp. 524-548.

Eide, Eric, Dominic J. Brewer, and Ronald G. Ehrenberg. "Does It Pay to Attend an Elite Private College? Evidence on the Effects of Undergraduate College Quality on Graduate School Attendence." *Economics of Education Review*, 1998, 17(4), pp. 371-376.

Ehrenberg, Ronald G. and Panagiotis G. Mavros. "Do Doctoral Students' Financial Support Patterns Affect Their Times-to-Degree and Completion Probabilities?" *Journal of Human Resources*, 1995, 30(3), pp. 581-609.

Hartley, James E. and Michael D. Robinson. "Economic Research at National Liberal Arts Colleges: School Rankings." *Journal of Economic Education*, 1997, 28(4), pp. 337-349.

Hoffer, T.B., V. Welch, Jr., K. Webber, K. Williams, B. Lisek, m. Hess, D. Loew, and I. Guzman-Barron. *Doctorate Recipients from United States Universities: Summary Report 2005*. Chicago: National Opinion Research Center, 2006.

Kalaitzidakis, Pantelis, Theofanis P. Mamuneas and Thanasis Stengos. "Rankings of Academic Journals and Institutions in Economics." *Journal of the European Economics Association*, 2003, 1(6), pp. 1346-1366.

Krueger, Alan B. and Stephen Wu. "Forecasting Job Placements of Economics Graduate Students." *Journal of Economic Education*, 2000, 14(1), pp. 81-94.

Laband, David N. and Michael T. Piette. "The Relative Impact of Economics Journals: 1970-1990." *Journal of Economics Literature*, 1994 32(2), pp. 640-666.

Siegfried, John J. and Wendy A. Stock. "So You Want to Earn a Ph.D. in Economics? How Long Do You Think It Will Take?" *Journal of Human Resources*, 2001, 36(2), pp. 364-378.

Spence, Michael. "Job Market Signaling." *Quarterly Journal of Economics*, 1973, 87(3), pp. 355-74.

Zhang, Liang. "Advance to Graduate Education: The Effect of College Quality and Undergraduate Majors." *Review of Higher Education*, 2005, 28(3), pp. 313-338.

Table 1
Summary Statistics of Key Variables

	Entire Sample (N=344)		Complete Files (N=259)		Completed PhD; Complete Files (N=174)	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Completed PhD	0.66	0.48	0.67	0.47	1	0
Publications	3.01	5.39	3.08	5.42	4.55	6.10
At Least One Publication	0.48	0.50	0.49	0.50	0.70	0.46
Quality-Adjusted Publications	0.51	1.42	0.53	1.44	0.79	1.69
Top 4 Publications	0.26	0.95	0.26	0.94	0.39	1.13
At Least One Top 4 Publication	0.12	0.32	0.12	0.33	0.18	0.38
Quantitative GRE	742.5	62.5	740.6	64.5	752.3	55.5
Verbal GRE	568.6	123.1	571.4	123.0	580.9	120.6
Female	0.26	0.44	0.27	0.44	0.28	0.45
Age 25+	0.51	0.50	0.47	0.50	0.45	0.50
Prior Graduate Degree	0.40	0.49	0.37	0.48	0.39	0.49
Foreign Undergrad	0.52	0.50	0.49	0.50	0.53	0.50
Elite Liberal Arts Undergrad	0.07	0.26	0.08	0.27	0.07	0.25
Elite Research Univ. Undergrad	0.17	0.38	0.19	0.39	0.18	0.39
Reference Group 1	0.11	0.32	0.12	0.33	0.16	0.36
Reference Group 2	0.18	0.38	0.17	0.38	0.20	0.40
Committee Ratings (0-18)	7.17	4.24	7.39	4.38	8.35	4.32

Notes: Data are derived from applicants to a top-5 economics PhD program in 1989. Publication data derived from ECONLIT search engine

Table 2
Predicting Degree Completion and Research Productivity
Probit and Tobit Analysis

	Completed PhD (Probit)			At Least One Publication (Probit)			At Least One Top 4 Publication (Probit)			Weighted Publication Index (Tobit)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Quantitative GRE	0.002***		0.001*	0.001**		0.001	0.001		0.000	0.010**		0.005
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)	(0.005)		(0.005)
Verbal GRE	0.001**		0.000	-0.000		-0.000	0.000		0.000	0.001		-0.000
	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.002)		(0.002)
Female	0.089		0.070	0.008		0.015	-0.038		-0.029	-0.187		-0.176
	(0.070)		(0.070)	(0.088)		(0.088)	(0.068)		(0.068)	(0.521)		(0.512)
Age 25+	0.002		0.037	-0.102		-0.079	-0.094		-0.076	-0.499		-0.313
	(0.065)		(0.066)	(0.077)		(0.077)	(0.060)		(0.060)	(0.460)		(0.454)
For. Undergrad	0.194**		0.192**	0.096		0.112	0.174**		0.174**	0.259		0.351
	(0.082)		(0.082)	(0.102)		(0.102)	(0.083)		(0.081)	(0.617)		(0.604)
Elite Lib. Arts	-0.031		-0.003	0.035		0.061	0.197		0.202	-0.434		-0.315
	(0.127)		(0.123)	(0.152)		(0.144)	(0.188)		(0.192)	(0.960)		(0.942)
Elite Research Univ.	-0.129		-0.125	0.008		0.032	0.044		0.063	0.069		0.338
	(0.107)		(0.108)	(0.132)		(0.132)	(0.119)		(0.123)	(0.755)		(0.742)
Reference Group 1	0.239***		0.205***	0.231***		0.178*	0.098		0.007	1.261*		0.547
	(0.070)		(0.079)	(0.084)		(0.103)	(0.122)		(0.103)	(0.732)		(0.745)
Reference Group 2	0.147**		0.132*	0.183**		0.166**	0.160		0.112	0.964*		0.710
	(0.070)		(0.071)	(0.074)		(0.076)	(0.098)		(0.094)	(0.570)		(0.561)
Committee Ratings		0.037***	0.031***		0.036***	0.028***		0.022***	0.020**		0.242***	0.191***
		(0.007)	(0.009)		(0.009)	(0.010)		(0.006)	(0.008)		(0.049)	(0.059)
Pseudo R-Squared	0.108	0.085	0.146	0.094	0.084	0.129	0.084	0.071	0.124	0.039	0.046	0.058
Observations	259	259	259	174	174	174	174	174	174	174	174	174

Notes: Standard errors in parentheses. *Significant at 10%; **Significant at 5%; ***Significant at 1%