What Does Performance in Graduate School Predict? Graduate Economics Education and Student Outcomes

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Economists devote considerable effort to graduate student education but have conducted relatively little research on the determinants of student performance or placement in the job market. Do graduate students who do well in core microeconomics (micro) courses also do well in core macroeconomics (macro) and econometrics (metrics) courses? Are students who achieve higher grades in their first-year core classes or general exams more likely to complete their PhD and obtain higher ranked positions in the job market? In an attempt to answer these questions, we assembled a rich dataset on 1,029 economics graduate students who enrolled at Harvard University, Massachusetts Institute of Technology (MIT), Princeton University, Stanford University, or the University of Chicago in the 1990s. These schools were selected because, in 1993, they had the five highest ranked economics PhD programs, according to the National Research Council (NRC).

Our results indicate that students' grades in required core courses are highly correlated across subjects. The PhD admissions committee's evaluation of a student predicts first-year grades and PhD completion, but not job placement. First-year performance is a strong predictor of PhD completion. Most importantly, we find that first-year micro and macro grades are statistically significant predictors of student job placement, even conditional on PhD completion. Conditional on first-year grades, Graduate Record Examination (GRE) scores, foreign citizenship, sex, and having a prior master's degree do not predict job placement. Students who attended elite undergraduate universities and liberal arts colleges are more likely to be placed in top-ranked academic jobs.

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I. Data and Descriptive Statistics

After receiving permission from each university's institutional review board, in the summer of 2006, we attempted to gather information on every student who entered the economics PhD program at the University of Chicago, Harvard University, MIT, Princeton University, and Stanford University from 1990 to 1999. Specifically, we sought data on GRE scores, admissions rank, first-year course or general exam grades, PhD completion status, initial job placement, and other variables from the schools' economics department administrators and archives.

Some departments were better at record keeping than others. Data are available for Princeton (n=217) and Stanford (n=259) for students who enrolled from 1990 to 1999. Chicago (n=229) and Harvard (n=177) provided data on enrollees from 1994 to 1999. MIT provided data on students who completed their degree from 1990 to 1999. We restrict the MIT sample to 147 students who enrolled between 1990 and 1995 *and* completed their PhD degree. We drop MIT when we analyze the determinants of degree completion. The rank the PhD admissions committee assigned the students is available for Harvard, Princeton, and Stanford.

Harvard, Stanford, and Princeton (before 1996) relied on a general exam grade for their requirements in micro and macro. Chicago

relied on both course grades and general exams for PhD advancement. MIT and Princeton (after 1995) used course grades for degree requirements. We computed the average first-year course grade in micro and macro for Chicago, MIT, and Princeton (after 1995). Stanford gave first-year general exams in econometrics while the other schools gave course grades in econometrics. To convert grades into comparable units across schools, we rescaled all course and general exam grades into percentile ranks within year and school.[1]

Some schools provided information on students' initial job placements while others did not. In most cases, we were able to identify job placement even when the school could not provide it. Job placement is typically not available for those who did not complete their PhD. For 95 percent of those completing their PhD, we have initial job information. Rating the quality of job placement is inherently a subjective judgment, so we used multiple measures. First, we used the ranking of the top 200 economics departments from Pantelis Kalaitzidakis, Theofanis P. Mamuneas, and Thanasis Stengos (2003). This ranking, which is based on publications, was selected because it is relatively comprehensive, but we still needed to assign ranks to some positions ourselves.[2] Second, we created an indicator variable for placement at one of the 20 top-ranked economics departments according to Kalaitzidakis, Mamuneas, and Stengos. This group overlaps substantially with the NRC top-20 departments. Third, we created a categorical variable that equals one for jobs with independent research opportunities, such as those at research universities and the Federal Reserve; two for primarily teaching positions such as those at many liberal arts colleges; three for directed research positions such as those at the Treasury Department and four for other positions, as well as, noncompleters. Finally, we created an indicator for academic jobs.

Table 1—Mean Characteristics of Economics Ph.D. Students Entering Top 5-Departments from 1990 to 1999

Characteristics	All	Lowest school	Highest school
Female	0.25	0.19	0.30
Under represented minority	0.03	0.01	0.06
Foreign citizen	0.63	0.50	0.69
Graduated from foreign undergrad university	0.49	0.39	0.61
Graduated from top-15 university	0.22	0.13	0.32
Graduated from top-5 liberal arts college	0.04	0.00	0.06
Prio masters degree in econ/finance	0.24	0.16	0.30
GRE quantitative (percentile)	93	92	95
GRE verbal (percentile)	75	66	81
GRE analytical (percentile)	89	85	91
Admissions rank	38	36	39
PhD completion rate	0.74	0.64	0.90
Academic job (1 = yes)	0.48	0.43	0.56
Average job rank	91	61	116
Top-20 jobs (unconditional)	0.20	0.09	0.26
Top-20 jobs (conditional on PhD)	0.26	0.15	0.31
Sample Size	1,029		

Notes: Maximum sample size is 1,029. MIT is excluded from the sample used for the PhD completion rate and the unconditional top 20 jobs because the MIT data excludes dropouts.

Means for the full sample are presented in column 1 of Table 1. To conceal the identity of the individual schools but still illustrate the range of variability across the five schools, we report in column 2 the mean for the school with the lowest average value. In column 3, we report the highest average value for each variable.

Women represent a quarter of the students who enrolled in and graduated from these graduate programs. Underrepresented minority students (African American, Hispanic, or Native American) make up only 3 percent of enrolled students. Half of the students attended a foreign undergraduate institution, and 63 percent were foreign citizens. Twenty-two percent of enrollees graduated from a top-15 university as an undergraduate, based on the 2006 *U.S. News and World Report* ranking, and another

[1] For students who failed an exam or course and retook it, we used the last score available. For Chicago, however, we averaged the retake grade with the original grade because it was unclear which grade was the final one. Grades are not available for Stanford in 1990. Princeton recorded only pass/fail for econometrics before 1996, so we only include econometrics grades for Princeton for 1996 to 1999.

[2] Following Krueger and Stephen Wu (2000), if a job at a particular school was not in the economics department, we added five ranks to the institution's ranking. Jobs in the business sector were typically assigned a rank of 200 to 250, depending on whether they utilized research or teaching skills. Other jobs were assigned a rank that seemed commensurate with one of the departments ranked in Kalaitzidakis, Mamuneas, and Stengos (2003).

4 percent attended one of the top five liberal arts colleges. The average student scored in the ninety-third percentile on the math portion of the GRE, and three-quarters of students scored above the ninetieth percentile. The average student scored in the seventy-fifth percentile on the verbal portion of the GRE. The average for foreign citizens was the sixty-sixth percentile, and the average for American citizens was the ninety-first percentile.

Overall, 74 percent of enrollees completed their PhD (this figure ranged from 64 percent at one school to 90 percent at another).[3] Twenty-six percent of PhD recipients from these five schools accepted jobs at "top-20" economics departments, while 16 percent landed a job at a "top-10" economics department. More than half of graduates accepted an academic job, consistent with David Colander's (2005) finding that most economics graduate students at top programs plan to pursue an academic job at some point.

II. Grades and Completion

For the sample as a whole, first-year grades (scaled as percentile ranks) are strongly, positively correlated across subjects (0.54 for micro and macro, 0.56 for micro and econometrics, and 0.56 for macro and econometrics). These correlations are very similar in magnitude when computed separately for foreign and US citizens. The micro-macro correlation ranged from a low of 0.32 at one school to a high of 0.74 at another. The strong correlations between grades in different subjects is consistent with the view that successful course (or test) performance in economics requires similar skills across fields, as well as with the view that the study habits and personal traits that lead to success in one subject also lead to success in others.

Table 2 presents Ordinary Least Squares (OLS) regression estimates in which the dependent variable is the student's percentile rank in first-year micro, macro, or metrics. Explanatory variables are student background characteristics and admissions rank. The sample size drops nearly by half when we control for the admissions rank, as it is not available for Chicago and MIT. Several findings are noteworthy. The analytical GRE score is a stronger predictor of grades in all three subjects than is the math or verbal GRE score when a consistent sample is used. When admissions rank is excluded from the model, the math GRE has a statistically significant effect on micro, macro, and metrics grades, and the verbal GRE has a statistically significant effect on macro and metrics grades. The latter finding is partly a result of the sample, as the verbal GRE has a small and insignificant effect if the column 3 model is estimated with the column 4 sample. The analytical GRE score has a sizable effect—an increase of 20 percentile points is associated with an increase in grades of 5 to 7 percentiles in all three subjects in the models that exclude the admissions rank. Admissions rank presumably reflects, in part, GRE scores.

Students who attended a foreign undergraduate institution perform significantly better in all three subjects. The first-year grades of female students are significantly lower than the first-year grades of male students. Students who attended an elite undergraduate institution do not perform significantly differently from other students, conditional on admissions rank, with the possible exception of achieving a higher grade in macro. Students who start graduate school with a master's degree in economics or finance do not perform better in micro or metrics, but their macro grade is 11 percentile points higher, all else being equal. If we drop admissions rank, a prior master's degree is associated with an increase of 4.4 points in micro ($p = 0.099$), 10.5 points in macro ($p = 0.000$), and 3.2 points in metrics ($p = 0.34$). Lastly, the admissions rank is a strong predictor of performance—moving ahead 30 places in the ranking (from 50 to 20, say) is associated with an increase in grades of 7 percentile points in all three subjects, conditional on GREs and other factors.

We have estimated probit equations to examine the determinants of PhD completion by 2006.[4] The explanatory variables used in Table 2, as well as first-year grades, were

[3] MIT is excluded from these figures because it lacks information on dropouts.

[4] See Siegfried and Stock (2001) for an analysis of the time to degree for a broader sample of economics graduate students.

Table 2—The Determinants of First-Year Grade
Dependent Variable: Course or General Exam Grade in Percentiles

Student characteristics	(1) Micro	(2) Micro	(3) Macro	(4) Macro	(5) Metrics	(6) Metrics
GRE quantitative (percentile)	0.432**	0.137	0.409**	0.057	0.357*	−0.123
	(0.150)	(0.186)	(0.152)	(0.191)	(0.183)	(0.256)
GRE verbal (percentile)	0.063	−0.063	0.149**	0.034	0.118**	−0.120
	(0.044)	(0.060)	(0.045)	(0.061)	(0.052)	(0.078)
GRE analytical (percentile)	0.383**	0.422**	0.361**	0.349**	0.283**	0.484**
	(0.080)	(0.112)	(0.081)	(0.115)	(0.094)	(0.153)
Female	−7.295**	−7.277**	−8.300**	−9.966**	−1.584	−0.718
	(2.100)	(2.706)	(2.131)	(2.781)	(2.494)	(3.513)
Undergrad top-15 university	5.669**	0.082	8.745**	9.630**	6.950**	−0.988
	(2.592)	(3.393)	(2.627)	(3.480)	(3.107)	(4.523)
Undergrad top-5 liberal arts	2.228	−1.922	3.953	8.505	−1.812	−3.837
	(4.856)	(5.750)	(4.864)	(5.793)	(5.790)	(7.285)
Undergrad foreign university	16.651**	10.038**	17.387**	11.503**	19.134**	10.098**
	(2.422)	(3.343)	(2.453)	(3.435)	(2.906)	(4.511)
Admissions rank	—	−0.238**	—	−0.243**	—	−0.241**
		(0.052)		(0.054)		(0.063)
Prior masters in econ/finance	—	1.575	—	10.999**	—	3.153
		(2.981)		(3.058)		(3.846)
R-squared	0.12	0.15	0.13	0.18	0.09	0.13
F-test (All 3 GRE Scores)	0.0000	0.0003	0.0000	0.0015	0.0000	0.0188
Observations	893	486	895	483	751	355

Notes: Standard errors are shown in parantheses. Chicago and MIT do not have admission rank information. The mean (standard deviation) grade percentile is 58 (28) for micro, 58 (29) for macro, and 60 (30) for econometrics.

* Indicates p-value < 0.10.

** p-value < 0.05.

included as predictors. (MIT was excluded from this analysis because its sample omits dropouts.) These models indicate that first-year micro, macro, and econometrics grades are strong predictors of PhD completion. An increase in first-year micro and macro grades of 20 percentile points, for example, is associated with an increase in PhD completion of 12 percentage points, which would cut the dropout rate nearly in half. One concern, however, is that grades have a mechanical relationship with completion, as students who fail to pass their first-year courses or general exams are forced to leave the program. Even if we restrict the sample to those who scored above the thirtieth percentile on micro and macro—and are therefore unlikely to be forced out of the program—the effect of grades is about half as large but still statistically significant.

Conditional on grades, the only variable that significantly predicts completion in our sample is matriculation at a non-US undergraduate institution. Those who completed their undergraduate education abroad have about a 10 percentage point higher completion rate than American students. Students who attended an elite undergraduate college are more likely to complete their degree, but the effect is marginally significant and depends on the specification. If grades are omitted, the admissions rank is a significant predictor of completion, with students who are ranked 30 places ahead being 4.5 percentage points more likely to complete a PhD.

III. Job Placement

Table 3 presents results of our job placement analysis. Columns 1–3 present OLS estimates where the dependent variable is the rank of each student's initial job. Columns 4–6 present probit estimates where the dependent variable equals one if the student was placed in a job in a top-20 position and zero otherwise. The sample for the probit estimates consists of all enrollees, whereas the sample for columns 1–3 is mainly restricted to those who completed their degree. (In columns 1–3, we include placements for 40 students who did not complete their degree.) In

TABLE 3—DETERMINANTS OF INITIAL JOB PLACEMENTS

	Job Rank			Top 20		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Micro grade (percentile)	—	−0.463**	−0.544**	—	0.00289**	0.00321**
		(0.128)	(0.173)		(0.00058)	(0.00084)
Macro grade (percentile)	—	−0.271**	−0.360**	—	0.00185**	0.00207**
		(0.126)	(0.172)		(0.00057)	(0.00081)
GRE math (percentile)	−0.098	0.089	0.065	0.00353	0.00134	0.00439
	(0.501)	(0.496)	(0.631)	(0.00268)	(0.00247)	(0.00370)
GRE verbal (percentile)	−0.202	−0.146	−0.079	0.00076	0.00056	0.00015
	(0.150)	(0.148)	(0.202)	(0.00070)	(0.00071)	(0.00100)
GRE analytical (percentile)	−0.333	−0.086	0.062	0.00458**	0.00235	0.00177
	(0.273)	(0.273)	(0.381)	(0.00149)	(0.00146)	(0.00209)
Female	4.064	−3.105	−3.203	−0.00516	0.04988	0.03957
	(7.073)	(7.079)	(9.682)	(0.03093)	(0.03411)	(0.04832)
Undergrad top-15 university	−19.562**	−16.035*	−10.433	0.15254**	0.11870**	0.11515*
	(8.965)	(8.845)	(12.297)	(0.04611)	(0.04552)	(0.06656)
Undergrad top-5 liberal art	−16.313	−17.071	−22.813	0.19380**	0.20211**	0.26646**
	(15.660)	(15.386)	(19.483)	(0.09038)	(0.09133)	(0.11745)
Undergrad foreign university	−4.433	6.708	2.152	0.07885**	−0.00558	0.06809
	(8.456)	(8.524)	(12.013)	(0.03799)	(0.03893)	(0.05966)
Admissions rank	—	—	−0.196	—	—	−0.00002
			(0.186)			(0.00094)
Masters in econ/fin	—	—	−6.881	—	—	−0.04904
			(10.246)			(0.04617)
R-squared	0.02	0.06	0.06	0.05	0.12	0.10
P-value for GRE Scores	0.1023	0.6750	0.9821	0.0002	0.1263	0.3758
Observations	725	717	397	887	855	468

Notes: Columns 1-3 estimated by OLS. Coefficients in columns 4-6 reexpress probit coefficients as changes in probability. Students who never completed the PhD are classified as not having top 20 jobs in the probit model. P-value for GRE scores is from an F-test that the 3 scores jointly equal zero. Mean [standard deviation] of job rank is 91 [81]; mean top 20 is 0.20 [0.40]. The mean of top 20 differs from Table 1 because MIT is included in the probit sample but not in Table 1 top 20 (unconditional). Pseudo R-squared reported for columns 4–6.

* = p-value < 0.10.

** = p-value < 0.05.

all of the models, a Chow test does not reject the null hypothesis that data can be pooled across the five schools.[5]

In columns 1 and 4, we predict job placement from variables that could be observed prior to the start of graduate school. Only the analytical GRE score is statistically significant in predicting placement in a top-20 job. Because this sample is conditional on acceptance to a top-5 economics department, the weak predictive power of GRE scores may be an artifact. Students with low GRE scores who were admitted probably had other distinguishing characteristics that improved their job prospects. Krueger and Wu (2000) find that GRE scores are a significant predictor of job placement in a sample of all applicants to one top-5 economics department, but not of grades for matriculants. Students from top undergraduate institutions are substantially more likely to secure highly ranked positions after graduate school. The effect is large. In column 4, we show attending a leading liberal arts college is associated with a 19 percentage point increase in the chance of job placement at a top-20 economics department.

Columns 2 and 5 add first-year grades, and columns 3 and 6 add admissions rank and a

[5] We also note that our conclusions are not qualitatively altered if we add unrestricted entry year dummies or school dummies to the models in Table 3.

dummy for a prior master's degree. Micro and macro grades are significant predictors of job placement. An F-test fails to reject the hypothesis that micro and macro grades have an equal effect. An increase in both core grades by 20 percentile ranks is predicted to increase a student's chance of being placed in the top-20 by 9.5 percentage points. In results not presented here, we added econometrics grades to the models and found they are not significantly related to job rank, but are significantly and positively related to placement in the top-20. To maximize our sample size, however, we present results without the econometrics grade.

Admissions rank is not a significant predictor of job placement, even if it is the only variable in the model. This also may be a feature of analyzing a sample matriculating at the top-5 programs. Nevertheless, the insignificance of admissions rank calls into question the practice of tying graduate fellowships to this variable.

None of the models displays a statistically significant difference in job placement between female and male students. When grades are excluded, female students are placed in slightly lower ranked jobs; and when grades are included in the model, female students are placed in slightly higher ranked jobs. Separate regressions by gender indicate that the micro grade is about an equally strong predictor of job placement for males and females. Note that we do not know which jobs students were *offered*. We know only the job they accepted from their offers. It is possible that gender differences in tastes influence job selection, conditional on job opportunities.

We also do not find much of an advantage on the job market for foreign-trained students, despite their higher first-year grades, on average. The stronger job placement performance of students who attended elite undergraduate colleges and universities holds, even conditional on grades. Thus, something about their backgrounds that is not reflected in their first-year course performance helps raise their job placement.

In results not shown here, two additional outcome measures were analyzed: (a) an ordered categorical variable that groups students into independent research jobs, teaching positions, directed research, and other positions; and (b) a dichotomous variable that equals one if the student is initially placed in an academic job and zero otherwise. The same qualitative conclusions emerged from these alternative measures of job placement, with two noteworthy exceptions. First, students whose undergraduate education is from a non-US institution are more likely to be placed in the independent research end of the job spectrum. Second, without controlling for grades, a smaller fraction of women than men are placed in jobs that allow for independent research after they complete graduate school.

IV. Conclusion

First-year grades in core required courses are a strong predictor of economics graduate students' job placements. The reasons for this relationship are unclear and a worthy topic of further research. One possibility is that mastering the content of first-year courses directly helps prepare students to be successful researchers.[6] Other possibilities are that students who do well in their first-year courses gain self-confidence or create positive "first-impressions" with faculty members, putting them on a positive trajectory irrespective of the direct utility of the course content. Yet another interpretation is that the traits that enable a student to do well in the first-year of graduate school, such as high cognitive ability and diligence, are also important when it comes to writing a dissertation and searching for a job.

Our results raise an interesting question: Why are some characteristics much stronger predictors of grades than they are of job placements? Foreign-trained and male students achieve substantially higher first-year grades, on average, but do not appear to be placed into much higher ranked jobs. Likewise, admissions committees' rankings strongly predict grades but not job placements. Some background characteristics, such as attendance at a top undergraduate institution, do a better job of predicting job placement than grades. Additional research is necessary to discover why some characteristics predict job placement in ways that are not captured by grades.

One final observation is that the job placement models in Table 3 have limited explana-

[6] Consistent with this interpretation, Stock and W. Lee Hansen (2004) conclude that a majority of new economics PhDs believe that "the emphasis given in their PhD programs to many economic proficiencies was 'about right.' "

tory power. The R-squared in all cases is 0.12 or less. The difficulty predicting job placement may, in part, result from the noise in our data, ambiguity in ranking jobs, the incompleteness of our measures, and inherent randomness in the academic job market. Diligence, perseverance, and creativity—factors that surely matter for successful research careers and job placement—are difficult to define and measure. Our results suggest that there is not an easily recognizable star profile or single path to success for an economics graduate student.

REFERENCES

Colander, David. 2005. "The Making of an Economist Redux." *Journal of Economic Perspectives*, 19(1): 175–98.

Kalaitzidakis, Pantelis, Theofanis P. Mamuneas, and Thanasis Stengos. 2003. "Rankings of Academic Journals and Institutions in Economics." *Journal of the European Economic Association*, 1(6): 1346–66.

Krueger, Alan B., and Stephen Wu. 2000. "Forecasting Job Placements of Economics Graduate Students." *Journal of Economic Education*, 31(1): 81–94.

Siegfried, John J., and Wendy A. Stock. 2001. "So You Want to Earn a Ph.D. In Economics? How Long Do You Think It Will Take?" *Journal of Human Resources*, 36(2): 364–78.

Stock, Wendy A., and W. Lee Hansen. 2004. "Ph.D. Program Learning and Job Demands: How Close Is the Match?" *American Economic Review (Papers and Proceedings)*, 94(2): 266–71.