

The Labor Market for New Agricultural and Natural Resource Economics Ph.D.s

Wendy A. Stock and John J. Siegfried

We describe the characteristics and labor market experiences of new agricultural and natural resource economics Ph.D.s. Women earned roughly 27% of the Ph.D.s earned during 1996–97 and 2001–02; 36% of the Ph.D.s awarded were earned by U.S. citizens. About half of the employed graduates found jobs in academe, with the remainder divided roughly equally among government, international or research organizations, business, industry, and consulting. The median salary of new Ph.D.s holding full-time jobs in the United States was \$62,500 in 2002, up from \$47,500 five years earlier.

Five years ago, we reported the results of a comprehensive survey of the labor market for economics Ph.D.s graduating in 1996–97 (Siegfried and Stock, 1999). We recently updated those data to include information on economics Ph.D.s graduating in 2001–02 (Siegfried and Stock, 2004). Although these papers generated some interest within the agricultural and natural resource (ANR) economics community (see, e.g., Offutt), they did not explicitly examine labor market outcomes for new Ph.D.s specializing in these fields. Indeed, the papers included only those agricultural and natural resource (ANR) economists earning their Ph.D.s in general economics departments. This, of course, omitted ANR economists who earned their degrees from specialized agricultural economics departments.

This paper focuses exclusively on ANR economists, using survey data collected from the 1996–97 and 2001–02 cohorts of new Ph.D.s in ANR economics who earned their degrees in either general economics departments or in specialized agricultural economics departments. We provide information on time-to-degree, employment, salaries, and job satisfaction among new Ph.D.s. This information should be of interest to current and prospective ANR economics Ph.D. students, of use to advisors of undergraduates considering graduate study in ANR economics,

- Wendy A. Stock is associate professor of Economics at Montana State University.
- John J. Siegfried is professor of Economics at Vanderbilt University and Secretary/Treasurer of the American Economic Association.

and of assistance to faculty concerned with the employment prospects of applicants they admit to their doctoral programs.

The Survey

There are several alternative measures of the ANR economics population of new Ph.D.s, but each is incomplete. For example, the *American Journal of Agricultural Economics* (AJAE) list of Ph.D.s earned each calendar year tends to undercount those earning their degrees from general economics departments (e.g., University of Colorado, Duke, Massachusetts Institute of Technology). A list of Ph.D. recipients also appears annually in the *Journal of Economic Literature* (JEL). The JEL list tends to undercount those who earn their degrees from specialized agricultural economics departments (e.g., Oklahoma State Agricultural Economics, Louisiana State Agricultural Economics and Agribusiness, Rhode Island Environmental and Natural Resource Economics).

Despite this shortcoming, we identified our survey population from the listings of Ph.D. dissertations in the December 1997 and December 2002 issues of the JEL, sending two surveys to this population. The first, conducted in 1998, included individuals who earned a Ph.D. in economics between 1 July 1996 and 30 June 1997. The second, conducted in 2003, included individuals who earned a Ph.D. in economics between 1 July 2001 and 30 June 2002. Starting from the JEL lists, respondents were selected into the ANR economics sample used in the present paper if: (1) they reported specializing in JEL category Q (ANR Economics) on our survey form; or (2) they reported that they earned their degree from a department of agricultural economics; or (3) their dissertation was classified in category Q in the JEL dissertation list.¹ We divided the graduates into subfields of agricultural economics and natural resources economics based on their dissertation titles. For the 1996–97 cohort, there are fifty-six useable responses from graduates and there are fifty-eight for 2001–02.

When we were unable to elicit a survey response from a graduate, we sent a shorter survey to the graduate's dissertation advisor, asking only those questions we are confident the advisor could answer. We received fourteen supplemental advisor surveys for each of the two cohorts. Consequently, we have some information on seventy of the 1996–97 ANR economics graduates and seventy-two of the 2001–02 graduates.

Because there is no comprehensive listing of new Ph.D.s in ANR economics, and because our sample is defined in part by responses to our surveys, it is difficult to measure our survey response rate. The AJAE reported 166 (148) ANR Ph.D.s earned from U.S. universities in 1996 (1997) and 146 (151) degrees earned in 2001 (2002). Taking a simple average of these numbers across the two sets of years generates the prediction that about 157 Ph.D.s were earned in ANR economics in academic-year 1996–97 and 149 were earned in 2001–02.

The AJAE lists are incomplete, however, since forty (twenty-four) of the ninety (seventy-four) graduates listed under category Q of the 1996–97 (2001–02) JEL list are excluded from the 1996 and 1997 (2001 and 2002) AJAE lists. Thus, it appears that roughly 40% of the new ANR Ph.D.s included in the JEL list each year are not reported in the AJAE list. Alternatively, about half of those on the AJAE list are not reported in the JEL list. This mismatch appears primarily because the JEL tends to undercount those who earn their degrees from specialized agricultural

economics departments (e.g., Oklahoma State Agricultural Economics, Louisiana State Agricultural Economics and Agribusiness, Rhode Island Environmental and Natural Resource Economics). The AJAE, in contrast, undercounts those earning their degrees from general economics departments (e.g., University of Colorado, Duke, Massachusetts Institute of Technology).

Adding the missed graduates specializing in category Q from the *JEL* list to the AJAE predictions above implies that 197 and 173 new Ph.D.s were earned in ANR economics in 1996–97 and 2001–02, respectively.² This broad count of the ANR population implies that our data cover 36% of the 1996–97 cohort and 42% of the 2001–02 cohort, somewhat smaller coverage rates than those we obtained for economics overall (Siegfried and Stock, 1999; Siegfried and Stock, 2004).

Our sample of 142 Ph.D.s earned their degrees from forty-four different universities.³ There are twenty-six graduates of California-Berkeley, twelve graduates of Purdue, eleven of Illinois, eight each of Cornell and Wisconsin, and six graduates of Minnesota in the sample. No other institution has more than five graduates in the sample. All but sixteen of the graduates earned their Ph.D. at a public university, and of those 126, 91% were awarded by 1862 Land Grant Universities.

The Sample and Its Representativeness

Table 1 reports summary statistics for the sample. For each cohort, we first report information on the graduates who returned our survey. Because there is likely response bias that is correlated with some of the information in the table, we also report information provided by the thesis advisors of nonrespondents. Advisor response rates are less likely to be correlated with characteristics of the graduates. For example, because of the difficulty of contacting graduates who live overseas, the percent of graduates who are U.S. citizens as revealed from graduate responses is likely biased upward (compare the 64% and 57% U.S. citizen rates based on graduate responses in columns one and four to the 36% and 14% rates, respectively, based on advisor responses in columns two and five). To project statistics for the entire population, we inflate the advisor responses to represent the entire set of nonrespondents and combine the result with the actual graduate responses (columns three and six). The validity of the projections depends on the accuracy of the assumption that the responses from the thesis advisors are an unbiased sample of nonrespondents.

The share of new Ph.D.s awarded to women in ANR economics is virtually the same as in economics more generally, about 27% averaged over the two cohorts (Siegfried and Stock, 2004).⁴ This implies an increase in female representation over time, since Zepeda, Marchant, and Chang report that only 15% of Ph.D. degree recipients in agricultural economics were women in 1989–90. Caution is required in comparing these statistics, however, since Zepeda, Marchant, and Chang also found that women were more likely to attend the top Ph.D. programs. Because our sample seems heavily weighted in that direction, it may overrepresent women. Moreover, because Zepeda, Marchant, and Chang sampled a different population (American Agricultural Economics Association [AAEA] members), our results are not directly comparable to theirs.

The proportion of new ANR economics Ph.D. graduates who are not U.S. citizens is also similar to economics more generally. In the 2001–02 cohort, for example, 71% of the new ANR economics Ph.D.s were non-U.S. citizens,

Table 1. Characteristics of ANR economics Ph.D. graduates by response source, with population projections

	1996–97 Cohort			2001–02 Cohort		
	1 Graduate Responses (<i>n</i> = 56) ^a	2 Advisor Responses (<i>n</i> = 14)	3 Population Projections ^b (Based on <i>n</i> = 197)	4 Graduate Responses (<i>n</i> = 58)	5 Advisor Responses (<i>n</i> = 14)	6 Population Projections (Based on <i>n</i> = 173)
Percentage female	26.8	30.8	29.7	27.6	21.4	23.5
Percentage U.S. citizen	64.3	35.7	43.8	56.9	14.3	28.6
Percentage white	74.1	–	–	70.4	–	–
Median age at degree	33.0	–	–	31.9	–	–
Percentage with prior degree in economics ^c	67.9	–	–	82.8	–	–
Percentage with prior master's degree ^c	64.3	–	–	70.7	–	–
Median time to degree (years)	5.3	4.7	4.9	5.3	5.2	5.2
Percentage unemployed	0.0	0.0	0.0	1.7	0.0	0.6
Percentage of employed with full-time job	92.7	83.3	86.0	96.4	100.0	98.8
Percentage of employed with permanent ^d job	72.7	75.0	74.3	89.1	91.7	90.8
Percentage of employed with job in United States	78.2	66.7	70.0	74.5	50.0	58.2
Distribution by employment sector (percentage): ^e						
Percentage of employed in higher education	52.7	16.7	26.9	65.5	41.7	49.7
Percentage of employed in bus/ind/consulting	16.4	16.7	16.6	12.7	41.7	32.0
Percentage of employed in government	10.9	33.3	26.9	12.7	16.7	15.4
Percentage of employed in international or research organization	20.0	33.3	29.5	9.1	0.0	3.0
Distribution by field of specialization (percentage): ^{e,f}						
Agricultural economics	44.6	21.4	28.0	67.2	64.3	65.3
Natural resource economics	50.0	78.6	70.5	29.3	35.7	33.6

Source: Authors' survey.

^aSample size varies by row; reported *n* is maximum. All reported data are based on at least five observations.

^bProjections = (0.284 (0.335 × graduates' response) + (0.716 (0.665) × advisors' response) [0.284 = 56/197; 0.335 = (58/173)] is the predicted number of 1996–97 (2001–02) U.S. Ph.D.s in ANR economics, as described in the text.

^cFor the 1996–97 cohort, we asked for information only about the *highest* degree held when the respondents began their Ph.D. program. Thus, the *prior degree in economics* response reflects those with their *highest* prior degree (as opposed to *any* prior degree) in economics. Similarly, the *percent with prior master's degree* for this cohort reflects those with a master's as their *highest* degree held when they started their Ph.D. program.

^dPermanent means the job has no specific termination date. Untenured faculty are in permanent jobs if they are on a tenure track.

^eDistributions do not always sum to 100 because some categories are not reported.

^fField is the characterization of the graduates' specialization, based on their dissertation title.

compared to 63% for the rest of economics. In economics, the share of degrees earned by non-U.S. citizens has grown by about one percentage point per year for four decades. Similarly, the share of Ph.D.s awarded to international students in ANR economics rose from about 45% in 1987–88 to 54% in 1992–93 (Marchant and Zepeda) and then surged from 56% in 1996–97 to 71% by 2001–02.

Based on the 2001–02 cohort, we find that 83% of new U.S. ANR economics Ph.D.s earned a prior degree in economics or agricultural economics; another 7% held a prior degree in some other agriculture field. Over two-thirds held a terminal master's degree prior to entering their Ph.D. program.⁵ Combining both bachelor's and master's degrees, we find that 28% of the cohort held at least one degree in agricultural economics at the time they began their Ph.D. study.

There is an obvious response bias in favor of the graduates who found employment in academe. Again combining the two cohorts and using the projections for each year's entire population, it appears that about 38% of the Ph.D.s secured a job in higher education; 24% in business, industry, or consulting; 21% in government; and 16% in international or research organizations (e.g., World Bank, International Food Policy Research Institute [IFPRI]). The distribution of the graduates among the agricultural economics and natural resources economics subfields differs substantially between the two cohorts, but averages about equal shares in each subfield for the cohorts taken together.

Time-to-Degree

Based on matriculation and graduation information from the graduates and their thesis advisors, we project the median time-to-degree for the class of 2001–02 as 5.2 years, up 0.3 years from 1996–97. Examining the two cohorts together, the range extended from 2.7 to an extraordinary 29.7 years, for a person who received his Ph.D. at the age of fifty-nine (compared to the median age of thirty-two for the full sample). Only fifteen of the 140 graduates for whom we have data completed their Ph.D. within four years. For the 2001–02 cohort, we have time-to-degree apportioned into various categories for fifty-three of the graduates. The results show a median of 0.8 years to complete first-year or core preliminary examinations, an additional 2.0 years to complete all other nondissertation requirements, and a further 2.1 years to complete the dissertation.⁶ Note that these data tell us nothing about completion rates, since everyone in our sample completed the Ph.D.⁷

To examine variations in time-to-degree, we estimated a duration (hazard) model based on a Weibull distribution⁸ for the 101 graduates who answered all the necessary questions, excluding the one graduate whose time-to-degree (29.7 years) exceeded twelve years.⁹ The variables expected to affect time-to-degree include: particular graduate programs (i.e., binary variables for programs with at least five observations in the regression sample), whether the Ph.D. was earned in a department of agricultural or general economics, an indicator to distinguish the cohorts, type of financial support received while in the Ph.D. program, specialization in agricultural economics or natural resources economics, and socio-demographic and educational background characteristics. Table 2 reports the regression results. We discuss below the estimated coefficients for variables that are statistically significantly different from zero at the 10% significance level (two-tail tests). The *mean* time-to-degree for the regression sample is 5.5 years.

Table 2. Determinants of elapsed time to degree: duration model

	1	2	3	4	5
	Mean	SD	Estimated Exponentiated Accelerated Failure Time Coefficients	z-Value	Predicted Change in Time to Degree for Statistically Significant Attributes (in Months) ^a
Years to degree	5.53	1.46	—	—	—
Female	0.267	0.445	0.917	−1.28	—
Age at time of matriculation	28.30	6.93	0.992	−1.80	−0.51
Married at time of degree	0.653	0.478	0.933	−1.18	—
Had children at time of degree	0.396	0.492	1.03	0.44	—
Female * had children at time of degree	0.059	0.238	1.03	0.35	—
White	0.743	0.439	0.832	−3.19	−11.13
U.S. citizen	0.614	0.489	1.07	1.69	4.88
Held prior master's degree	0.663	0.475	0.937	−1.13	—
Held prior economics degree	0.762	0.428	1.00	0.04	—
Natural resources ^b	0.386	0.489	0.797	−3.05	−13.51
ANR program ^c	0.683	0.477	0.891	−1.21	—
Any assistantship	0.911	0.286	0.909	−0.94	—
Any fellowship	0.505	0.502	0.985	−0.29	—
Cornell	0.079	0.271	0.887	−1.47	—
Ohio State	0.050	0.218	0.854	−1.78	−9.66
Purdue	0.079	0.271	0.680	−5.97	−21.27
Berkeley	0.208	0.408	0.942	−0.71	—
1996–97 Cohort	0.495	0.502	1.03	0.49	—
Wald statistic			90.43		
(p-value)			0.000		

Note: $N = 101$. Estimates result from a Weibull regression and use heteroskedasticity-robust standard errors (a Cox proportional hazard model yielded qualitatively similar results). The sample includes ANR economics graduates who provided all information included in the regressions.

^aPredicted change in time to degree is reported if the estimates are significant at the 0.10 level or better.

^bIndicator for graduates who specialized in environmental or natural resource economics (those specializing in agricultural economics are the comparison group).

^cIndicator for graduates from agricultural or natural resources (or similar) economics Ph.D. programs (the comparison group is those from general economics Ph.D. programs).

There are at least five graduates in the regression sample from four different Ph.D. programs: California-Berkeley Agricultural and Resource Economics, Purdue Agricultural Economics, Cornell Applied Economics and Management, and Ohio State Agricultural, Environmental, and Development Economics. Binary indicators for each of these four programs are included in the regression. The empirical results indicate that Ph.D. students completed their degrees faster at each of the four programs we specifically identified, although time-to-degree was statistically significantly less than the benchmark (all programs without an indicator in the regression) only for Purdue and Ohio State. Students in Purdue's agricultural

economics department finished twenty-one months faster at the mean than the benchmark. Ohio State students finished ten months faster.

There is no significant difference in time-to-degree between agricultural economics department and general economics department graduates. Nor is there any difference in the time taken to earn degrees across the two cohorts.

We asked graduates to report the number of years they received each of two types of financial aid (e.g., teaching or research assistantship, or no-work fellowship). The regression includes binary variables that indicate whether each graduate ever received an assistantship (91% did), or ever received a no-work fellowship (50% did). The estimated coefficient on neither financial aid variable is statistically significant.

Students who specialized in natural resources economics completed their degrees, on average, 13.5 months faster than those specializing in agricultural economics, *ceteris paribus*. Some of this gap can be attributed to differences in the type of dissertations that the graduates completed. We have information on the type of dissertation written by the 2001–02 graduates (although not for the 1996–97 cohort, which is why type of dissertation is not included in the regression analysis). Among the fifty-one ANR economics graduates for whom we have complete information, 57% wrote a traditional single-topic treatise, while 43% combined a set of essays into a dissertation.¹⁰ Sixty-four percent of those specializing in natural resources and 35% of those specializing in agricultural economics wrote essay-style dissertations. When we estimate the duration model for these fifty-one graduates and include a binary indicator for type of dissertation, the results indicate that those who wrote a dissertation consisting of a set of essays had a statistically significant shorter time-to-degree by nine months (p -value = 0.05), while the estimated difference in time-to-degree between those specializing in natural resources and those in agricultural economics becomes smaller and statistically insignificant.

Gender, marital status, dependent children, and educational background (whether a graduate held a prior master's degree or a prior degree in economics) showed no relationship with time-to-degree. However, we did find that, *ceteris paribus*, older students systematically finished faster (0.5 months per year of age), United States citizens took an average of five more months than noncitizens to complete their degrees, and white graduates finished eleven months faster than non-whites.

Employment Outcomes

We asked graduates (and their advisors) about the employment status of the 1996–97 cohort for the week of 13 October 1997, and of the 2001–02 cohort for the first week of December 2002. Only one of the 141 who reported employment status from the two cohorts was unemployed, while six (four women and two men) were not in the labor force. Thus the unemployment rate among the cohorts is remarkably less than 1%. Based just on our actual graduate and advisor responses (not projecting outcomes for the full populations), 80% of the 134 employed graduates in the cohorts held full-time permanent positions during the year after their graduation; 14% were in full-time temporary positions. The remaining 6% held part-time jobs. Ten percent (thirteen) of the employed graduates

were in postdoctoral appointments, in contrast to only 6% of general economics graduates (Siegfried and Stock, 2004). Only the Centers for Disease Control and IFPRI employed more than one postdoc in our sample.

Various branches of the U.S. government (e.g., the Federal Reserve and the Environmental Protection Agency) hired ten graduates from the two cohorts; the World Bank, four; and American Express, three. No other employer hired more than two of our survey respondents. Thirty-six of the 134 reporting graduates found jobs outside the United States, the largest number in Canada (five). Washington, D.C. is the most common employment location for the 134 new ANR Ph.D.s (eighteen jobs), followed by California (twelve), Texas (nine), and Georgia (eight).

According to the graduates and their advisors, 70% of the employed graduates of the class of 2001–02 took a job in the United States, down from 76% five years earlier. Most of this twelve percentage point change can be attributed to the growing proportion of international students. About 91% of the U.S. citizens who graduated in the two cohorts accepted employment in the U.S., compared with only 52% of the noncitizens. Thus, the fifteen-percentage point decline in the proportion of graduates who are U.S. citizens from 1996–97 to 2001–02 implies a 5.9 percentage point drop in the proportion employed in the United States, with no behavioral change in job location decisions of the graduates.

We asked graduates in the 2001–02 cohort about the allocation of their work time among teaching, research, academic service (e.g., advising committees), management or administration, consulting, and professional service activities. Averaging across all employment sectors, graduates spend 43% of their time on research, 28% on teaching, 8% on academic service, 7% consulting, 6% on professional service, and 5% in management or administration. Of course, the percentage of time spent in various activities differs across employment sectors. Those working for government report devoting 74% of their time to research, those working for research organizations or international organizations, 45%, and those in academe about 44%. Research constitutes less than 3% of the time of those employed in business, industry, or consulting. They instead spend almost three-quarters of their time in consulting or professional service.

Not surprisingly, graduates' descriptions of their level of overall job satisfaction and their perception of how well their jobs match their expectations are related to the percentage of time they spend in different job activities. As was the case with economics graduates generally, 86% of the employed 2001–02 graduates answered yes to the question, "Had you known then what you know now, would you still have enrolled in a Ph.D. program in economics?" This group spends an average of 45% of their time in research and 28% teaching. For those who report that they would not seek a Ph.D. if they could rewind their life, the percentage of their time spent teaching is similar to those who would do it again (26%), but the percent of time spent in research is lower (34%). This difference between the two groups is statistically significant at the 10% level. When we asked the 2001–02 graduates how they feel about their jobs, 47% said they like it very much and 44% said they like it fairly well (for general economics, the percentages were fifty-five and thirty-nine, respectively). The other 9% dislike it at least somewhat. Those who said they like it very much spend an average of 50% of their time in research and 29% teaching. Among those who disliked their jobs at least somewhat, the

Table 3. New ANR economics Ph.D.s' annual salaries for full-time jobs in the United States

	Median	Mean	Low	High	N
Panel A: 1996–97 Cohort, 1997 nominal salaries					
All full-time jobs in the United States	\$47,500	\$49,900	\$31,800	\$90,000	40
Permanent positions	49,800	51,300	35,000	90,000	32
Academic	47,000	48,000	35,000	62,000	16
9–10 month	43,000	44,700	35,000	56,000	9
11–12 month	54,000	52,400	45,700	62,000	7
Nonacademic	55,000	54,500	35,000	90,000	16
Temporary positions	41,500	44,300	31,800	60,000	8
Panel B: 2001–02 Cohort, 2002 nominal salaries					
All full-time jobs in the United States	\$62,500	\$69,700	\$30,000	\$133,000	39
Permanent positions	67,000	71,900	30,000	133,000	35
Academic	61,000	62,000	30,000	83,000	23
9–10 month	60,000	61,400	44,500	83,000	15
11–12 month	65,800	63,300	30,000	86,000	8
Nonacademic	91,000	90,700	56,000	133,000	12
Temporary positions	52,400	50,700	42,000	56,000	4

Source: Authors' survey. See notes to Table 1.

percentage of time spent teaching is similar to those who like their jobs (27%), but the time spent in research is only 29% (the p -value for the difference in the means between the two groups is 0.13).

Finally, it appears that more time spent on (academic and professional) service is correlated with less job satisfaction. Those who said they would enroll in a Ph.D. program again spent 12% of their time on service, compared with 20% for those who would not (p -value = 0.10). The graduates who liked their jobs fairly well spent 9% of their time on service; those who disliked their jobs spent 16% (p -value = 0.14). Finally, those who reported that their job is similar to what they expected to be doing when they began their Ph.D. program spent 10% of their time on service versus 24% for those whose expectations were dashed (p -value = 0.01).

Salaries

Table 3 reports nominal salaries for employed new Ph.D. ANR economists in both cohorts who held a full-time (*permanent* or *temporary*) job in the United States. The median annual December 2002 salary for 2001–02 graduates was \$62,500, up from \$47,500 five years earlier. Comparable figures for the new general economics Ph.D.s are \$74,000 in December 2002 and \$55,000 five years earlier.

The median salaries for new ANR Ph.D. economists imply a compounded annual increase of 5.7% from 1997 through 2002. The mean annual salary for those in full-time permanent jobs is \$71,900 in December 2002, significantly higher than the \$51,300 earned in such jobs by the 1996–97 cohort.

The median salary for all permanent full-time jobs is 28% higher than for all temporary full-time jobs in 2002. This premium was only 20% for ANR economists five years earlier. For economists in general, the permanent versus temporary job premium skyrocketed from 27% in 1997 to 60% by 2002 (Siegfried and Stock, 2004). New ANR Ph.D. economists with permanent jobs outside academe earned almost 50% more than those with permanent jobs in academe in 2002, up substantially from a comparably calculated premium of 10% for 1997. This salary differential is not statistically significant once we control for other factors related to starting salaries, however.

Although based on relatively small samples reported in table 3, we find that the proportion of eleven month academic contracts declined from 44% in 1997 to 35% in 2002. This is consistent with earlier findings by Thilmany, who attributed the change to recent attempts by some universities to use nine-month contracts to encourage faculty to pursue external funds to fill out their yearly salaries. Perhaps even more significant is the fact that the 11–12 month versus 9–10 month median salary premium has declined from 26% in 1997 to only 10% in 2002. The decline in the premium reflects compounded annual starting salary increases of 6.9% over the five years for those in 9–10 month contracts, but only 4.0% for those in 11–12 month contracts. A similar pattern does not appear in economics more generally, where the 11–12 month versus 9–10 month median salary premium grew from 1997 to 2002. At the same time, the percent of new academics on 9–10 month contracts rose from 78% to 82% (Siegfried and Stock, 1999, Siegfried and Stock, 2004).

In order to isolate independent relationships between graduates' characteristics and their starting salaries, we conducted a rudimentary cross-section regression analysis. Our sample is restricted to members of the 2001–02 cohort¹¹ employed in full-time permanent positions in the United States commencing no earlier than January 2001. This specification eliminates those graduates who had already settled into permanent employment prior to the 2001–02 job market. Academic-year salaries were not inflated to match calendar-year salaries because most assistant professors work in the summer whether they are compensated or not. We did not ask graduates about temporary summer compensation or fringe benefits because their responses would be too difficult to quantify comparably across individuals. Finally, for the regression analysis, salaries were adjusted to reflect cost-of-living differentials at the job location relative to Washington, D.C. The adjustments used the fourth-quarter 2002 American Chamber of Commerce Researchers Association cost-of-living index (available at www.acra.org).

Table 4 reports the regression estimates that include controls for demographic characteristics (sex, age, marital status, dependents, race, and citizenship), educational background characteristics (whether the graduate held a prior master's degree or a prior degree in economics), the elapsed time between entering the Ph.D. program and earning the degree, an indicator for whether the graduate specialized in natural resources economics (as opposed to agricultural economics), and an indicator for whether the graduate was employed in academe. In columns one and two, we limit the analysis to ANR economists, while in columns three and four we include all new 2001–02 economics Ph.D.s (including those in columns one and two) in the analysis. Because of the small sample for the ANR regression, and because the regressions do not control for *ex ante* productivity indicators

Table 4. Salary regressions for 2001–02 Ph.D.s employed in full-time permanent jobs in the United States

	ANR Economics ^a (N = 30)		All Economics (N = 208)	
	1 Coefficient (SE)	2 Mean (SD)	3 Coefficient (SE)	4 Mean (SD)
Ln (annual salary)	–	11.35 (0.313)	–	11.37 (0.280)
Female	–0.370** (0.156)	0.133 (0.346)	–0.022 (0.043)	0.303 (0.461)
Age	0.004 (0.005)	33.75 (10.88)	–0.001 (0.004)	31.44 (5.22)
Married at time of degree	0.234* (0.122)	0.633 (0.490)	0.040 (0.045)	0.495 (0.501)
Had children at time of degree	–0.047 (0.141)	0.267 (0.450)	–0.005 (0.056)	0.202 (0.402)
White	–0.090 (0.190)	0.867 (0.346)	0.043 (0.053)	0.779 (0.416)
U.S. citizen	–0.166 (0.153)	0.800 (0.407)	–0.047 (0.047)	0.577 (0.495)
Held prior master's degree	–0.204* (118)	0.633 (0.490)	–0.016 (0.048)	0.428 (0.496)
Held prior economics degree	0.103 (0.144)	0.800 (0.407)	–0.004 (0.053)	0.832 (0.375)
Time-to-degree (years)	–0.089** (0.034)	5.37 (1.61)	–0.040*** (0.013)	5.65 (1.55)
Employed in academe	–0.161 (0.117)	0.667 (0.479)	–0.018 (0.040)	0.615 (0.488)
Natural resources ^b	0.017 (0.123)	0.300 (0.467)	–	–
ANR graduate ^c	–	–	–0.032 (0.059)	0.144 (0.352)
R ²	0.561		0.067	
Adjusted R ²	0.294		0.014	

Note: Estimates result from ordinary least squares and use heteroskedasticity-robust standard errors.
 ***significant at 0.01 level; **significant at 0.05 level; *significant at 0.10 level.

^aColumns one and two include new ANR economics graduates only. Columns three and four include all new economics graduates (including those in columns one and two).

^bIndicator for graduates who specialized in environmental or natural resource economics (those specializing in agricultural economics are the comparison group).

^cIndicator for graduates who specialized in ANR economics (the comparison group is those specializing in all other fields of economics).

(publications, grants, etc.), caution is warranted in interpreting the results too broadly. The regression for the ANR economics sample explains 56% of the variation in the natural logarithm of salaries. Unless noted to the contrary, all relationships described below are significant at the 10% level or better (two-tailed tests).

The results indicate a 31% salary penalty for females relative to males in the ANR economics sample, but not among new doctoral economists in general.¹² Similarly, graduates in the ANR sample who were married earn a 26% premium relative to their unmarried counterparts, a difference that is smaller and not significant among the general economics sample. The regression indicates no statistically significant difference in starting salaries based on the doctorates' age, race, U.S. citizenship, or whether they had children at the time they earned their degrees. Nor is there a significant difference in salaries for those who held a degree in economics prior to beginning their doctorate study or between those who specialized in natural resource economics and those specializing in agricultural economics. There is, however, an 18% salary penalty for those ANR graduates in the sample who earned a master's degree prior to entering their Ph.D. program. Each year of elapsed time to earn the degree is associated with a 9% salary penalty among the ANR sample; this penalty is only 4% among economists more generally.

Finally, once we control for other factors in our regression, the salary differential between academics and nonacademics becomes statistically insignificant. Similarly, ANR Ph.D. economists suffer a 14%–15% nominal salary deficit compared to new Ph.D. economists generally (Siegfried and Stock, 2004, table 3). However, the difference is not statistically significant in the regression.

Comparisons among Employment Sectors

Table 5 compares demographic characteristics, employment outcomes, and responses to attitudinal questions across employment sectors. A distinct pattern is immediately evident—ANR economists employed in business, industry, or consulting differ from those employed in other sectors, as do those in academe. Graduates in business, industry, or consulting are more likely to be male and to hold a full-time permanent job. They earn a 50% salary premium over their colleagues employed in other sectors, but they appear less satisfied with their jobs. They view their jobs as less closely related to their field, less commensurate with their education and training, and further from what they expected to be doing when they began their Ph.D. program. Only 71% of them would have pursued a Ph.D. in economics if they had known at matriculation what they know after graduation. Twenty-nine percent in permanent jobs are actively seeking a new job, compared with 21% for the overall sample of ANR economists. Thus, the 50% compensating salary differential earned by those in the business, industry, and consulting sector is apparently insufficient to fully compensate for perceived differences among the jobs. The graduates employed in academe, on the other hand, earn lower salaries than those employed in other sectors, but view their jobs as more closely related to their field, more in line with their graduate education and training, and closer to what they had expected to be doing when they matriculated in their Ph.D. program.

Finally, the gap between the average response to whether their position is commensurate with their education and whether their current job is what they expected when they began their Ph.D. program, is the largest for those in business, industry, and consulting. The patterns described above are consistent with academia (and perhaps government) being the expected career path of graduates

Table 5. Comparisons of ANR economists among employment sectors

	Academic (<i>n</i> = 72) ^a	Business, Industry, Consulting (<i>n</i> = 23)	International or Research Organization (<i>n</i> = 20)	Government (<i>n</i> = 19)	Total (<i>n</i> = 134)
Background characteristics					
Female ^b	0.23	0.13 ^{<c}	0.35	0.37 ^{>c}	0.25
U.S. citizen ^b	0.58	0.48	0.50	0.58	0.55
Married at end of program ^b	0.66	0.63	0.63	0.62	0.65
Had children at end of program ^b	0.40	0.38	0.31	0.23	0.36
Employment outcomes					
Full-time permanent job ^b	0.76	0.96 ^{>c}	0.70	0.84	0.80
Median 2001–02 cohort salary, full-time permanent job in U.S. (\$) ^c	61,000 ^{<c}	90,000 ^{>c}	— ^d	— ^d	67,000
Permanent job and looking for a new job ^b	0.20	0.29	0.20	0.13	0.21
Attitudes (5 = strongly agree; 1 = strongly disagree); mean is reported					
Position is related to my field	4.71 ^{>c}	3.43 ^{<c}	4.20	3.71	4.37
Position is commensurate with my education and training	4.46 ^{>c}	4.14 ^{<c}	4.20	3.86	4.31
Position is what I expected to be doing when I began my Ph.D.	3.63 ^{>c}	2.86 ^{<c}	3.40	3.57	3.50
How do you feel about your job? (4 = like it very much; 1 = dislike it) ^e	3.36	3.29	3.00	3.71	3.36
Had known? ^{e,f}	0.86	0.71 ^{<c}	0.80	1.00	0.85

Source: Authors' survey. See notes to Table 1.

^aSample size varies by row. Reported *n* is maximum. All reported data are based on at least five observations.

^bProportions.

^c">" ("<") = value is statistically significantly higher (lower) than the mean for the rest of the sample at the 0.10 level (one-tailed tests). For variables for which we report the median, we tested for differences in the mean of the variable among the groups.

^dToo few observations to disclose.

^eReported only for 2001–02 cohort.

^fProportion with yes response to: "Had you known then what you know now, would you still have enrolled in a Ph.D. program in economics?"

(Hine and Cheney), so that those who obtain nonacademic positions see less match between their jobs and their education and training.

Conclusion

Approximately 185 individuals earned Ph.D.s in ANR economics in each of the years 1996–97 and 2001–02. We report findings from surveys representing 36% and 42%, respectively, of these cohorts of graduates. Our surveys reveal that an increasing fraction (now roughly two in three) of the Ph.D.s in ANR economics are earned by non-U.S. citizens, and roughly one quarter of the Ph.D.s are earned by women.

The vast majority of new ANR economics Ph.D.s find full-time career-tracking (i.e., permanent) jobs that pay well. Among the 2001–02 cohort, these jobs paid an average starting salary of \$71,900 for those employed in the United States. As is the case in economics more generally, there does not appear to have been an increased fraction of new graduates taking temporary jobs between 1997 and 2002, but the gap in pay between permanent and temporary jobs in the United States has grown substantially since 1997.

Graduates report being satisfied with their degrees and their jobs. Eighty-five percent agreed that had they known at matriculation what they know now, they still would have pursued their Ph.D., and 91% of the employed respondents reported that they like their job at least fairly well. On the other hand, however, 19% of the employed graduates are in temporary jobs and an additional 20% of those in permanent jobs report that they were looking for other employment at the time of our surveys. This suggests that the labor market will be an ongoing, longer-term exercise for one in five new ANR economics Ph.D.s.

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Endnotes

¹The JEL list also includes degrees earned from Canadian universities. We eliminated these graduates from the sample.

²According to the Survey of Earned Doctorates (SED) sponsored by the National Science Foundation, 133 doctorates in agricultural economics were awarded in 1996–97, and 119 in 2001–02. The SED asks individual graduates to classify their dissertation into an academic discipline (economics) and field (i.e., economics, agricultural economics, or econometrics). Therefore, SED data should include ANR economists who graduate from regular economics as well as specialized agricultural economics departments. However, because the SED identifies the field as “agricultural economics,” it is possible that many natural resource economics graduates may instead classify their field as economics more generally, leading the SED to also undercount the number of ANR economics graduates.

³The universities represented in our sample are: American University, Boston College, Boston University, Colorado School of Mines, Clark University, Cornell, Duke, George Washington University, Howard, Iowa State, Michigan State, MIT, North Carolina State, Northeastern, Ohio State, Oklahoma State, Pennsylvania State, Purdue, Stanford, SUNY-Binghamton, Texas A&M, California-Santa Barbara, Colorado, Connecticut, Delaware, Florida, Illinois, Kentucky, Maryland, Minnesota, Missouri, New Mexico, Tennessee, Texas, Utah, Washington, Wisconsin-Madison, Wyoming, California-Berkeley, California-Davis, UCLA, Utah State, Washington State, and Washington University-St. Louis.

⁴Comparisons to economics more generally are based on the results reported in Siegfried and Stock (2004), which include 398 graduate surveys and 121 advisor surveys for the 2001–02 cohort and include a very small number of graduates of general economics departments who had a field in agricultural and natural resource economics (fourteen of the responding graduates and four of the responding advisors). The appendix table provides additional comparisons between economics and ANR economics graduates.

⁵Terminal master's degrees exclude those earned routinely as part of a Ph.D. program.

⁶Note that medians of the program components do not have to sum to the median of the total elapsed time-to-degree.

⁷Because we use a sample of Ph.D. graduates rather than a cohort of Ph.D. program entrants, we risk biasing the level of median time-to-degree. For example, if the size of entering cohorts is decreasing, successively smaller cohorts will be unable to fully replace faster recipients from previously larger cohorts (Bowen, Lord, and Sosa; reproduced in Bowen and Rudenstine, p. 351). Conducting an analysis of the entering cohorts of this graduating class, however, would require us to have begun our study in the 1970s.

⁸Estimation using a Cox proportional hazards model yielded qualitatively similar results.

⁹For similar analyses for 1996–97 and 2001–02 general economics doctorates, see Siegfried and Stock (2001) and (2004), respectively.

¹⁰Among the economics profession as a whole, 56% of the theses completed in 2001–02 consisted of a set of essays (Siegfried and Stock, 2004).

¹¹We excluded 1996–97 graduates from the regression because of difficulty in comparably adjusting their salaries for geographical and time-related cost-of-living differences.

¹²The estimated percent differences in salary are computed as $[e^{\hat{\beta}} - 1] * 100$, following Halvorsen and Palmquist.

Appendix. Comparisons among general and ANR economics Ph.D. graduates of 2001–02

	All Economics Graduates			ANR Economics Graduates		
	1 Graduate Responses (<i>n</i> = 398) ^a	2 Advisor Responses (<i>n</i> = 121)	3 Population Projections ^b (Based on <i>n</i> = 850)	4 Graduate Responses (<i>n</i> = 58)	5 Advisor Responses (<i>n</i> = 14)	6 Population Projections ^b (Based on <i>n</i> = 173)
Percent female	28.3	27.7	28.0	27.6	21.4	23.5
Percent U.S. citizen	48.5	26.3	36.7	56.9	14.3	28.6
Percent white	70.1	–	–	70.4	–	–
Median age at degree	31.0	–	–	31.9	–	–
Percent with prior degree in economics	75.9	–	–	82.8	–	–
Percent with prior master's degree	44.5	–	–	70.7	–	–
Median time-to-degree (years)	5.7	5.2	5.4	5.3	5.2	5.2
Percent unemployed	1.5	2.7	2.1	1.7	0.0	0.6
Percent of employed with full-time job	96.6	98.1	97.4	96.4	100.0	98.8
Percent of employed with permanent ^c job	80.6	88.0	84.5	89.1	91.7	90.8
Percent of employed with job in U.S.	82.3	58.7	69.7	74.5	50.0	58.2
Distribution by employment sector (percentage): ^d						
Percent of employed in higher education	60.7	57.1	58.8	65.5	41.7	49.7
Percent of employed in bus./ind./consulting	10.3	7.6	8.9	12.7	41.7	32.0
Percent of employed in government	15.8	19.1	17.6	12.7	16.7	15.4
Percent of employed in int'l or research org	13.2	16.2	14.8	9.1	0.0	3.0

Source: Authors' survey and Table 2 of Siegfried and Stock (2004).

^aSample size varies by row; reported *n* is maximum. All reported data are based on at least five observations.

^bProjections for All Economics Graduates = 0.468 (graduates' response) + 0.532 (advisors' response) [0.468 = 398/850]; 850 is estimated population of 2001–02 U.S. Ph.D.s in economics. Projections for ANR Economics Graduates = (0.335 * graduates' response) + (0.665 * advisors' response) [0.335 = (58/173)]; 173 is the predicted number of 2001–02 U.S. Ph.D.s in ANR economics, as described in the text.

^cPermanent means the job has no specific termination date. Untenured faculty are in permanent jobs if they are on a tenure track.

^dDistributions do not always sum to 100 because some categories are not reported.

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