Research in Higher Education, Vol. 46, No. 4, June 2005 (© 2005)
DOI: 10.1007/s11162-005-2969-y

POST-BACCALAUREATE WAGE GROWTH WITHIN 4 YEARS OF GRADUATION: The Effects of College Quality and College Major

Scott L. Thomas*,† and Liang Zhang**

This paper examines the impact of college quality and academic major on the earnings of a nationally representative sample of baccalaureate recipients. We extend previous work in this area by analyzing the magnitude of change in the influence of these factors at two points in the early career of these graduates. Our results demonstrate that, despite significant variation, graduates from higher quality colleges enjoy a greater rate of growth in earnings during their early career. We also show that growth in earnings varies significantly by the graduates' major field of study. Wage growth for women and racial minorities is also examined.

KEY WORDS: college quality; academic major; labor market outcomes; human capital.

INTRODUCTION

The purpose of this study is to examine the rate of wage growth among early career college graduates that can be attributed to college quality and academic major. After first revisiting earlier estimates of economic returns to the baccalaureate degree (with especial focus on differences relating to major field of study and institutional quality) we compare changes in early career earnings reported by a nationally representative group of baccalaureate recipients receiving degrees in 1993. Most work on economic returns has focused on the modest returns to college quality at discrete points in time (usually 1–5 years after graduation) and very little is known about the ways in which institutional factors such as "quality" or "prestige" influence the wage growth of college graduates in the early stages of their careers. This analysis extends previous research in

*Institute of Higher Education, University of Georgia.
**School of Industrial and Labor Relations, Cornell University, Ithaca, NY 14850.
†Address correspondence to: Scott L. Thomas, Institute of Higher Education, 206 Meigs Hall, University of Georgia, Athens, GA 30602. E-mail: slthomas@uga.edu

0361-0365/05/0600-0437/0

this area by providing a detailed examination of changes in the earnings of graduates from colleges of different quality and academic majors across a 4-year window in the early career.

Our research builds on earlier work by Thomas (2000, 2003) and Rumberger and Thomas (1993) that examined initial earnings of college graduates. Among other contributions, this earlier work provided more rigorous insight to the economic returns to the baccalaureate and used institutional characteristics to explain significant differences in the earnings of graduates from different types of colleges. Consistent with most work preceding it, this more recent research documented a modest earnings return to college selectivity after controlling for academic major, performance, and a host of background factors. The findings from Thomas' (2000, 2003) earlier studies are particularly important for our analysis. Key to the present examination is a substantively important shift in findings across these two earlier studies. Namely, the economic returns to college quality in Thomas' (2000) study were existent but quite small when observed only 1 year after graduation. In contrast, the impact of college quality on earnings was found to be substantially, but not uniformly, larger when examined 3 years further into the career span of these graduates. These observations prompt a key question that we address in this paper: How do college quality and academic major systematically impact earnings at different points in one's early career, net of other relevant influences?

We begin from the premise that graduates from different colleges and academic majors may have different earnings trajectories over their careers. While a great deal is known about the earnings trajectories of particular occupations (and we often draw on this knowledge to make inferences about the earnings trajectories of graduates from particular academic majors) we know very little about how these wage trajectories may be impacted by the colleges from which students graduate. Due to the lack of available longitudinal data, most work on economic returns to college quality has focused on these returns at discrete points in time.

Because nationally representative longitudinal data on labor market outcomes of distinct cohorts of college graduates are still a recent phenomenon, there is little data allowing the comparison of earnings at different points in the career path. Our knowledge about changes in earnings related to college quality and academic major is based on findings from numerous studies examining earnings of college graduates at discrete points in time. Many studies on this subject examine the 1986 earnings for the well-known NLS-72 cohort, a span of about 10 years after college graduation (e.g., James, Alsalam, Conaty, and To, 1989). Others employ data from HS & B (e.g., Brewer and Ehrenberg, 1996) or data from non-governmental sources such as the Cooperative Institutional Research

Program (e.g., Smart, 1988). Few studies have employed samples representative of college graduates and none have used statistical designs that allow for the systematic assessment of changes in effects over time.[1] So while Brewer, Eide, and Ehrenberg (1999) note a trend of increasing impact of college quality during the early stage of graduates' careers, no systematic analysis of potential changes in this impact over time has been conducted.

We cast our inquiry in terms of the relative earnings gap between graduates from lower and higher quality colleges. Given that graduates from low-quality colleges earn less than those from high-quality colleges, we would expect that the absolute earnings gap (in actual dollar terms) widens over time, assuming that all graduates share the same growth rate. If this pattern can be borne out empirically, one could conclude that, in real dollars, college quality has a more powerful influence on earnings at the end of one's career relative to the early years (e.g., a 12% premium on $80,000 is considerably greater than a 12% premium on $30,000). But perhaps there is more to the story. What if the data were to show that the earnings of graduates from high-quality institutions grow at a faster pace than those from low-quality institutions? This would result in a widening *relative earning gap* among graduates from colleges of different quality and powerfully differentiate calculations of the longer-term return on investment implicit in the human capital framework.

If earnings partially reflect one's occupational position, this widening earnings gap would probably suggest quite different career paths among graduates from colleges of varying quality. If the influence of college quality on earnings varies over the career span, the relatively small effect of college quality on earnings usually examined at the early stage of graduates' career could be valid but prove problematic as an indicator of the effect over one's lifetime.

PERSPECTIVES

A close look at the corpus of work on the private benefits of higher education that has developed in this area over the last 40 years shows that at least two primary factors influence the magnitude of the wage premium that is associated with college attendance. First, research consistently shows that academic major has a substantial impact on the earnings of college graduates (Berger, 1988; Eide, 1994; Grogger and Eide, 1995; James et al., 1989; Rumberger, 1984; Rumberger and Thomas, 1993; Thomas, 2000). This finding is important because the choice of academic major has minimal implications for direct costs borne by the student. While there are a number of constraints on such choices (e.g., academic preparation or capacity within the major at any institution) there is little if

any additional direct investment cost in a student's choice of major field of study.

A second factor shown to impact earnings is the perceived "quality" of the baccalaureate granting institution (Brewer et al., 1999; Fox, 1993; James and Alsalam, 1993; Mueller, 1988; Rumberger and Thomas, 1993; Sewell and Hauser, 1975; Smart, 1988; Solmon, 1973, 1975; Thomas, 2000; Trusheim and Crouse, 1981). While institutional "quality" and "prestige" are difficult concepts to operationalize, the findings are remarkably consistent across a large number of studies: Graduates from more prestigious, more selective, and higher academic quality colleges enjoy small but significant wage premiums relative to peers graduating from less academically distinctive institutions. Unlike the choice of academic major, students' choice of institution is often constrained by their ability to pay—a reality central to human capital theory. Other characteristics such as academic performance are also known to positively impact the salaries of college graduates (James et al., 1989; Jones and Jackson, 1990; Rumberger and Thomas, 1993; Thomas, 2000, 2003; Wise, 1975), but the two largest drivers of post-baccalaureate earnings are student choice of academic major and institutional type. In short, all else being equal, students graduating in higher demand majors (e.g., engineering and business) from higher quality institutions (where quality is usually measured by a single index of institutional selectivity) tend to command higher salaries than their peers from lower quality colleges and/or alternate academic majors.

While a large body of empirical work provides strong support for these conclusions, there exists considerable controversy over the mechanisms by which these advantages manifest themselves in enhanced earnings. The controversy centers on whether these advantages result from genuine improvements in human capital (Becker, 1993; Schultz, 1961)—where one might assume that more prestigious institutions provide greater opportunities for improvement—or whether credentials from more prestigious institutions send signals to employers about a graduate's capabilities (Spence, 1974). While this is not an either/or proposition, both of these possibilities have been explored over the years. The vast majority of studies in this area employ the human capital framework. In its simplest form, human capital theory asserts that the labor market rewards investments individuals make in themselves (e.g., their education or training) and these investments lead to higher salaries (Becker, 1993).

In most early work examining the returns to improvements in human capital conceptualizations were usually confined to investments in the quantity of education (i.e., years of schooling). Subsequent work expanded this conceptualization to incorporate both the quantity and

quality of education experiences presumed to improve one's stock of human capital. High-quality colleges, which usually possess quality academic faculty, capable and motivated students, large libraries, well-equipped laboratories, and so on, would appear to provide their students with better resources for human capital improvement than low-quality colleges. The quality component has thus come to be a central feature of econometric work in this area.

Students and their families often make great financial sacrifices to attend higher prestige institutions—sacrifices often predicated on the belief that such "investment" will pay off in the post-graduation labor market. This highlights the importance of accurate knowledge about the returns to college at different junctures in graduates' lives. Thomas (2000, 2003) reported that over half the graduates in the sub-sample he analyzed reported borrowing to pay for costs associated with their undergraduate education. This proportion varied across majors from 48% in the social sciences to over 63% in engineering. Of those borrowing, average total debt across majors ranged from $9458 for graduates in education to $12,845 for graduates in health fields. Among borrowers, this translated into first-year earnings to total educational debt ratios as small as .43 (engineering) and as large as .62 (humanities).[2] Students attending more prestigious schools paid higher tuition prices than their counterparts attending less prestigious schools—real costs that resulted in higher levels of indebtedness that persisted years after graduation. These findings point to the economic stakes involved with decisions about students' choice of college and academic major—decisions often made on the basis of very limited information about the true longer-term payoff to particular types of colleges.

So to the degree that the human capital framework can guide inquiries in this area, we would expect individuals to be willing to bear a greater economic burden to attend colleges that are believed to subsequently confer greater labor market rewards. But while much of the previous work in this area is built on the premise that college quality may significantly influence earnings, the bulk of these studies have demonstrated only a relatively small effect.

This study provides comparisons of growth in early career earnings attributable to academic major and college quality. This examination of early career earnings shifts related to students' choices of institution and major advances our understanding of the economic returns to the baccalaureate degree by providing a more complete picture of the extent to which wages grow or stagnate for graduates from different academic majors and types of institutions.

METHODS AND DATA

Our analysis draws on data from individual college graduates and on data from the colleges conferring their degrees. The individual level data come from the 1997 follow-up of the Baccalaureate and Beyond study (B & B:93/97). The B & B: 93/97 is part of a national longitudinal study designed to provide information concerning education and work experiences after completion of the bachelor's degree (National Center for Education Statistics, 1999). The second follow-up survey was administered to over 10,000 baccalaureate recipients who received a degree in 1992 or 1993. The restricted B & B: 93/97 data set is used to enable the connection of students and institutions. All analyses reported in this paper have been weighted by the B & B: 93/97 panel weight, normalized on the final sample.

College-level data come from two sources: the Integrated Postsecondary Education Data System 1992–1993 (IPEDS) and the 1994 edition of Barron's *Profiles of American Colleges*. Institutional control (i.e., public vs. private) is extracted from IPEDS. College selectivity data is from Barron's *Profiles of American Colleges*. The Barron's ratings categorize institutions into six selectivity groups on the basis of entering students' class rank, high school grade point average, average SAT scores, and the percentage of applicants admitted (see Fox, 1993). In this analysis, we follow the conventional approach by collapsing six institutional categories into three based on a rating of most competitive or highly competitive (with Barron's rating of 5 or 4), very competitive or competitive (with Barron's rating of 3 or 2), and less competitive or non-competitive (with Barron's rating of 1 or 0).[3] Different categorizations can be used in order to single out the effect of the specific classes of institutions. Since perceptions of public and private institutions are quite different, we further distinguish between privately and publicly controlled institutions in each group, yielding six college types: highly selective privates, highly selective publics, middle selective privates, middle selective publics, low selective privates, and low selective publics.

Recent research has employed model based approaches (e.g., multilevel modeling) to address problems associated with analyzing data collected through complex sample designs and to bring empirical models into closer congruence with inherently multilevel theoretical models being used (e.g., Rumberger and Thomas, 1993; Thomas, 2000, 2003). While the increasing use of these more refined techniques is encouraging, in this analysis we chose to use more traditional OLS and GLS estimates for two practical reasons. First, the multilevel model yields similar results at discrete points in time.[4] Second, the multilevel model is difficult to implement when comparing differences at multiple points in time [see

Heck and Thomas (2000) for a complete consideration of these modeling issues].

As in all studies of this type, our estimates are subject to bias resulting from self-selection of graduates into their respective colleges and majors (see Brewer and Ehrenberg, 1996; Heckman, 1979, 1980; Stolzenberg and Relles, 1997). Since the models developed in this paper include a large number of variables typically associated with selection bias [intellectual ability, family socioeconomic background, etc. (see Karabel and Astin, 1975)] and the technique being used allows for the independent control of these variables, we do not expect there to be a large bias in the estimates reported here.[5]

Our main goal is to determine if substantively and statistically significant differences exist in the economic return to various factors being modeled, especially college quality and academic major, across two points in time, net of other factors included in our models. In other words, we test the degree to which there is a significant change in the salary determination structure (i.e., the combination of effects of independent variables on how much one earns at any given point in time) across the two points in time. We then attempt to isolate the role played by college quality among the factors that initiated the observed structural change. In effect, we estimate separate models of earnings determination at two points in time.

$$Y_{i97} = X_{i97}\beta_{97} + \varepsilon_{i97} \tag{1}$$

$$Y_{i94} = X_{i94}\beta_{94} + \varepsilon_{i94} \tag{2}$$

where Y_{i97} and Y_{i94} represent log annual salary in 1997 (roughly 4 years after graduation) and in 1994 (roughly 1 year after graduation) respectively, and X_{i97} and X_{i94} represent vectors of exogenous variables capturing graduates' demographic characteristics, family background, academic experiences, labor market experiences, and college characteristics at these two points in time respectively. Treating the two models separately yields estimates of β_{97}, and β_{94}, and their variance terms. Assuming the error terms of these estimates are not correlated between the two models, we can construct the difference between these two estimates $(\beta_{97} - \beta_{94})$ and the estimated variance of these differences $(Est.Asy.Var(\hat{\beta}_{97}) + Est.Asy.Var(\hat{\beta}_{94}))$. Based on these estimates, we can test whether each independent variable has different effect on earnings between 1994 and 1997.

While intuitively appealing, this approach makes a strong assumption about the independence of the error terms between Model 1 and Model 2. An easy way to understand this is to rewrite the models as:

$$Y_{i97} = X_{i97}\beta_{97} + \theta_i + \mu_{i97} \tag{3}$$

$$Y_{i94} = X_{i94}\beta_{94} + \theta_i + \mu_{i94} \tag{4}$$

Eq. (3) and Eq. (4) assume that the error terms in Eq. (1) and Eq. (2) are composed of two components: an individual specific time-invariant term θ_i and time-variant terms μ_{i97} and μ_{i94}. Clearly, the existence of time-invariant component creates the correlation between the error terms in Eq. (1) and Eq. (2). Ignoring this correlation will have two immediate consequences in our analyses. First, the OLS estimation of Eq. (1) and Eq. (2) will be inefficient. Second, the variance of $\beta_{97} - \beta_{94}$ is incorrect since the covariance between β_{97} and β_{94} is ignored. Thus GLS proves a more appropriate estimation strategy—an approach that allows the incorporation of the error structure directly into the analysis.[6] Effectively, we will estimate the following system of equations:

$$\begin{bmatrix} Y_{i97} \\ Y_{i94} \end{bmatrix} = \begin{bmatrix} X_{i97} & 0 \\ 0 & X_{i94} \end{bmatrix} \begin{bmatrix} \beta_{97} \\ \beta_{94} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i97} \\ \varepsilon_{i94} \end{bmatrix} \tag{5}$$

Zellner's seemingly unrelated regression estimator (Zellner, 1962, 1963; Zellner and Huang, 1962) is used to estimate this system of equations along with the asymptotically efficient, feasible generalized least-squares algorithm (Greene, 2000).

There are two points that warrant mention with regard to the specification of our models. First, the specification of each of the models in our analysis is informed by the long line of related research using very similar specifications. Models used in previous research have not attended to the potential for endogeneity of variables included nor do we attempt to address this issue here. We did however run several variations of our models to determine the impact of potentially endogenous relationships such as that between academic major and labor market experiences. In no case did the systematic inclusion or removal of such variables alter the statistical or substantive significance of our main findings.

Second, some of the variables included in our models are modestly intercorrelated. The threat of problematic multicollinearity was assessed using traditional indicators (i.e., VIF and Condition Indices, see Ethington, Thomas, and Pike, 2002). For each model we determined that

none of these intercorrelations were sufficiently strong to necessitate the removal of variables or adjustments to our models.[7]

The sample of students used in the study is divided into two overlapping subsets. The first subset is based on the B & B: 93/94 sample (the first B & B follow-up 1–2 years after graduation) students who (1) received bachelor's degrees during the period between July 1992 and June 1993 (2) were working full-time, as of April 1994, earning between $1,000 and $500,000 per year, (3) were not enrolled in school full-time, and (4) had institutional-level data available. This results in a 1994 sample of 4,961 graduates from 512 colleges. The second subset of students is based on the B & B: 93/97 sample (the second B & B follow-up 4–5 years after graduation). Using the exact criteria as described for the first subset, the second subset (1997) is limited to 3,965 students from 500 institutions. The union of these two samples, those employed at both time periods and meeting the criteria described above, is used for the current analysis. Table 1 contains descriptive statistics for the final overlapping sample of these 2,990 students. This table displays 1994 and 1997 values for each of the variables used in the models. The variables are broken out into several different conceptual categories that include institutional characteristics, demographic characteristics, family background, educational experiences, and labor market experiences.

RESULTS

The results of our analysis are presented in Table 2. The estimated effect of college quality in 1994 earnings equation (1–2 years after graduation) confirms Thomas' (2000) earlier findings. Net of all other variables in the model, the effects of college quality are small though statistically significant. For example, relative to graduates from low-quality public institutions (the comparison group in each model), graduates from high-quality public colleges enjoy a roughly 9% earnings advantage [see the log coefficient value of .0911 in the middle column (1994) of Table 2]. This earnings advantage is about 7% for graduates from high-quality private institutions relative to those from low-quality public colleges. Graduating from a middle-quality college provides even smaller earnings advantages (for example, Table 2 also shows that graduates from middle quality public institutions in 1994 enjoyed 4.68% advantage over their peers from lower quality public colleges, or roughly one-half the advantage of those graduating from high quality public institutions). Thus it appears that, on average, while graduating from a high-quality college yields an earnings advantage immediately after college graduation, such advantages are considerably smaller than those reported in other studies.

TABLE 1. Descriptive Statistics of Variables

	1997 sample		1994 sample	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Log earnings	10.3610	0.4790	10.0009	0.4532
Institutional Characteristics				
Low-quality, public institution	0.1472	0.3543	0.1472	0.3543
Middle-quality, public institution	0.4722	0.4993	0.4722	0.4993
High-quality, public institution	0.0498	0.2176	0.0498	0.2176
Low-quality, private institution	0.0559	0.2298	0.0559	0.2298
Middle-quality, private institution	0.2076	0.4056	0.2076	0.4056
High-quality, private institution	0.0673	0.2506	0.0673	0.2506
Historically black colleges and institutions	0.0249	0.1558	0.0249	0.1558
Demographic Characteristics				
Female	0.5098	0.5000	0.5098	0.5000
White	0.8526	0.3546	0.8526	0.3546
Indian American	0.0051	0.0713	0.0051	0.0713
Asian	0.0340	0.1813	0.0340	0.1813
Black	0.0619	0.2410	0.0619	0.2410
Hispanic	0.0422	0.2012	0.0422	0.2012
Family Background				
Family income (in $10,000)	4.7184	4.7549	4.7184	4.7549
First generation college graduate	0.5088	0.5000	0.5088	0.5000
Academic Background				
Merged SAT/ACT quartile	1.9709	1.3475	1.9709	1.3475
Business major	0.3123	0.4635	0.3123	0.4635
Engineering major	0.0655	0.2474	0.0655	0.2474
Health major	0.0564	0.2308	0.0564	0.2308
Public affair major	0.0356	0.1854	0.0356	0.1854
Biological science major	0.0238	0.1525	0.0238	0.1525
Math science major	0.0558	0.2296	0.0558	0.2296
Social science major	0.0865	0.2811	0.0865	0.2811
History major	0.0145	0.1194	0.0145	0.1194
Humanity major	0.0695	0.2543	0.0695	0.2543
Psychology major	0.0314	0.1744	0.0314	0.1744
Education	0.1046	0.3061	0.1046	0.3061
Other major	0.1442	0.3514	0.1442	0.3514
Labor Market				
Age	29.9570	6.3686	26.9570	6.3686
Age squared/100	9.3797	4.8483	7.6723	4.4690
Tenure	2.9385	3.4330	1.6370	3.2939
Tenure squared/100	0.2042	0.7073	0.1353	0.6312
Number of hours per week	45.5920	8.9755	43.7847	8.4673
N	2990		2990	

TABLE 2. SUR Estimation of Earnings Equations in 1994 and in 1997 (absolute *t* included)

	1997		1994		Differences	
Variable	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	8.6744	39.93	8.2379	47.90	0.4366	1.94
Institutional Characteristics						
Middle-quality, public institution	0.1059***	4.53	0.0468*	2.20	0.0591*	2.34
High-quality, public institution	0.1976***	4.82	0.0911*	2.44	0.1066*	2.40
Low-quality, private institution	0.0528	1.35	−0.0010	0.03	0.0537	1.26
Middle-quality, private institution	0.1227***	4.58	0.0661**	2.71	0.0566	1.95
High-quality, private institution	0.2043***	5.35	0.0723*	2.08	0.1320***	3.19
Historically black colleges and institutions	−0.1159*	2.00	−0.1033*	1.96	−0.0126	0.20
Demographic Characteristics						
Female	−0.1099***	6.63	−0.0613***	4.05	−0.0486*	2.69
Indian American	0.1461	1.36	0.1112	1.13	0.0349	0.30
Asian	0.1005*	2.34	0.0531	1.36	0.0474	1.02
Black	−0.0397	1.05	0.0357	1.04	−0.0754	1.85
Hispanic	0.0445	1.15	0.0929**	2.63	−0.0483	1.15
Family Background						
Family income (in $10,000)	0.0066***	3.74	0.0060***	3.75	0.0006	0.30
First generation college graduate	−0.0408*	2.45	−0.0042	0.28	−0.0366*	2.03
Academic Background						
Merged SAT/ACT quartile	0.0039	0.46	0.0206**	2.67	−0.0167	1.82
Business major	0.2845***	10.12	0.2070***	8.05	0.0775*	2.54
Engineering major	0.4284***	10.70	0.4011***	11.00	0.0273	0.63

TABLE 2. (*Continued*)

Variable	1997		1994		Differences	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Health major	0.4430***	11.00	0.4374***	11.92	0.0057	0.13
Public affairs major	0.1377**	2.89	0.1205**	2.77	0.0172	0.33
Biological science major	0.0676	1.21	0.0775	1.53	−0.0099	0.16
Math science major	0.4149***	10.12	0.2594***	6.93	0.1556***	3.50
Social science major	0.2186***	6.10	0.0925**	2.83	0.1262***	3.25
History major	−0.2322***	3.37	−0.0144	0.23	−0.2178**	2.92
Humanities major	0.1377***	3.62	0.0628	1.81	0.0749	1.81
Psychology major	0.1131*	2.28	0.0325	0.72	0.0806	1.50
Other major	0.1467***	4.66	0.1012***	3.52	0.0455	1.33
Labor Market						
Age	0.0478***	4.17	0.0450***	4.58	0.0029	0.24
Age squared/100	−0.0563***	3.81	−0.0459***	3.38	−0.0104	0.64
Tenure	0.0096	1.92	0.0340***	6.14	−0.0243***	3.45
Tenure squared/00	0.0059	0.25	−0.0681*	2.46	0.0740*	2.17
Number of hours per week	0.0101***	12.10	0.0136***	16.83	−0.0035***	3.21
Number of observations	2990		2990			
F statistic	11.61		22.97			

*$p < .05$, **$p < .01$, ***$p < .001$.

While the wage returns to college quality are relatively small immediately after graduation, larger differences do emerge several years later. The results in column 1 of Table 2 (1997) show that graduates from high-quality public and private colleges enjoy a more than 20% earnings advantage relative to graduates from public low-quality colleges (log coefficients of .1976 and .2043, respectively). Graduating from a middle-quality college also yields a considerable earnings advantage in 1997. Consider that the relative earnings advantages of graduates from middle-quality colleges over those from low-quality public colleges is about 11–12% in 1997, while this advantage is only 5–6% in 1994. Interestingly, the estimated effect of low-quality private colleges relative to low-quality public colleges is negative in 1994 and positive in 1997, although both are non-significant.

Testing the hypothesis that there are no differences in returns to sector and selectivity between 1994 and 1997, the last column of Table 2 suggests that significant wage growth attributable to college quality occurred among graduates from high-quality public and private institutions. For example, the estimated effect of graduating from a high-quality private institution is .0723 in 1994 and .2043 in 1997, representing a .1320 (see the "Differences" coefficient in column 3 of Table 2) increase in the estimated effect in 1997. In other words, the wage gap between graduates from high-quality private colleges and those from low-quality public institutions has almost tripled between 1994 and 1997 (a 7% gap in 1994 vs. a 20% gap in 1997). This increase in the wage gap is statistically significant with a t value of 3.19 (see the "Differences" t value in column 3 of Table 2). Similarly, the wage gap between graduates from high-quality and low-quality public institutions has increased from about 9% to 20%, suggesting that the wage gap has more than doubled between 1994 and 1997. The estimated effects of middle-quality institutions have also increased more than 5% points in 1997 compared with 1994. So while Thomas' (2003) analysis suggested that, on average, earnings of graduates from all types of colleges grew significantly between these two time periods, those graduates from highly selective private institutions enjoyed the greatest wage growth across this window. This confirms that different pictures emerge when examining returns to college quality at different post-graduation time periods.

Other, non-college differences are also revealed in Table 2. The results point to the changing nature of returns associated with a number of individual level characteristics. These individual level changes include widening wage gap between male and female graduates and increasing earnings penalty for first-generation graduates. College graduates from majors in the fields of business, math/science, and the social sciences have

enjoyed an increasing return relative to graduates in education. In contrast, graduates from history fall further behind during this period.

Educational experiences have important impacts on earnings at both time periods. Graduates from fields in business, math/science, and the social sciences enjoyed significant increases in their net advantage over peers graduating from education related majors. These majors started out with large earnings premiums and continued to enjoy high growth momentum. In contrast, history majors started with similar earnings with education majors but lost ground over time. Also interesting are those majors displaying a relatively stable earnings advantage over education majors. These include graduates from health and engineering who started out with large earnings advantages over graduates from most other majors while the earnings trajectory emerging over time is relatively flat. Thus we see distinct shifts in earnings emerge among graduates from different academic majors. Focusing on either point in time independently disguises the important dynamic of the role of college major in earnings determination over time.

Demographic variables were also tightly bound to earnings in both 1994 and 1997. Race and gender have significant impacts on earnings during at least one of the time periods under consideration. Consistent with earlier findings, women experience a significant earnings penalty: about 6% in 1994 and 11% in 1997. The difference between these two estimated effects is statistically significant and suggests that the gender gap in earnings is actually increasing over the time period considered. Other things being equal, there do not appear to be large earnings gaps between racial groups, although Hispanics (in 1994) and Asians (in 1997) enjoy a slight earnings premium on average. Notably, the incomes of blacks, net of all other variables in the model, were statistically indistinguishable from those of whites. None of these effects were found to have shifted across the two time periods. Family background plays a significant role in earnings at both time points. Family income is shown to be positively related to earnings in both 1994 and 1997 with no significant shift between the two periods. First generation college graduates, on the other hand, experience a small but increasing earnings penalty across this window.

Consistent with the large literature in labor economics, earnings are found to be a concave function of both age and job tenure in most cases. From a human capital perspective, this could largely be explained by the accumulation and depreciation of general and specific human capital (Becker, 1993). Human capital theory suggests that, if individuals invest their time and resources in general human capital optimally over their lifetime, they will tend to undertake most of the investment at younger ages, suggesting a concave age-earnings profile (Ehrenberg and Smith,

2003). Similarly, individuals acquire firm-specific human capital faster early in their tenure.

The number of hours worked per week has a significant impact on earnings in both time periods but this had much less of an impact in 1997 than it did in 1994. This is somewhat intuitive as the number of hours worked per week has a larger impact in determining earnings at the beginning of one's career than at later points in time after the graduate has been able to actually demonstrate the value of more important characteristics such as productivity. In essence, the valuation of a worker's contribution can be based more on the employer's perception of quality rather than quantity of hours worked alone. It is therefore not surprising to us that this effect starts to wane in the later time period.

DISCUSSION

College Quality

The real impact of college quality has long been a controversial issue in higher education and economics research. Findings from studies of these effects are not totally unequivocal. Some studies, for example, demonstrate substantial economic benefits associated with attending high-quality colleges. Brewer et al. (1999) provide an outstanding overview of such results. After controlling for gender, race/ethnicity, family size, parents' education, test scores, and part-time job status, they found that students who attended private elite institutions enjoyed a relatively large salary premium. This finding was echoed by Thomas (2003) who also found substantial economic benefits associated with graduating from high-quality colleges, 5 years after college graduation. In contrast, other studies have indicated either statistically non-significant or even negative effects of college quality on earnings. For example, Dale and Krueger (1999) found that college quality had either non-significant or negative effects on earnings after controlling for some salient, confounding variables.

The results of our study have shed new light on this controversy by illuminating the potentially changing pattern of this influence over time. Our findings serve to demonstrate that at least some of the controversy about the effect of college quality may be an artifact of the post-graduation time periods on which different studies have focused. Our findings are also consistent with the possibility that college quality does not have an important effect on earnings in the early career whereas its stronger effects may emerge eventually emerge over the years.

Academic Major

Many studies have demonstrated that academic major field of study yields one of the largest influences on post-graduation earning (e.g., Berger, 1988; Griffen and Alexander, 1978; James et al. 1989; Rumberger, 1984; Rumberger and Thomas, 1993; Thomas, 2000). Our results are consistent with this long line of work showing that fields of study such as business, engineering, and health have a very large positive effect on graduates' earnings.

This previous work has not systematically evidenced the potential for the change in this effect over time, however. While relative earnings advantages associated with most academic major areas remain stable across these two time periods, when compared with the earnings of education graduates, our results highlight significant divergences in advantages realized by graduates from business, math and science, social science, and history. While two points in time do not constitute a base from which we are comfortable arguing that these divergences represent true long-term earnings trajectories, what is clear is that shifts in these areas can serve to obscure the real benefits associated with specific majors when these are assessed at discrete points in time.

Gender

The increase in the wage gap between men and women is noteworthy. Between 1994 and 1997 relative penalty faced by women almost doubled (from 6% to 11%). A rich literature exists documenting this gap and its underlying dynamics. Both human capital theory and occupational crowding theory dominate this literature (Borjas, 1996; England, 1982, 1992; MacPherson and Hirch, 1995). Human capital explanations center on women's tendency to choose occupations with work schedules that better conform to daily schedules, longer term workforce intentions, and the pursuit of occupations in which a deterioration of skills through disuse will have little effect. Occupational crowding explanations focus on a general socialization which emphasizes distinct categories of "men's work" and "women's work." "Female" occupations are fewer in number and result in a surplus of women workers willing to fill them. This surplus, in turn, leads to a general depression of women's wages.

Of most interest in our analysis of this gap is that it increases between the two time periods we examine. This growth could be explained by men being promoted at a faster rate than women and/or by wage growth in female dominated occupations being lower than that enjoyed by men in male dominated occupations. This growing gap concerns us because it

challenges the notion that evidence of gender discrimination is more of an artifact of a less enlightened past than it is the existence of blatant wage discrimination against women. Hecker (1998) shows that the gap between older college educated women and men is greater than that observed among 25–34 year old women and men with comparable credentials. The decrease in the gap observed by Hecker corresponds with a significant shift in the 1980s by women who increasingly majored in areas leading to traditionally male dominated occupations such as business, computer science, and engineering. Despite this shift, women are still significantly less likely to major in areas that have historically been dominated by men (Eide, 1994). Our results, taken in this context, encourage the more pessimistic view that the larger gender gap Hecker (1998) observed among older women is at least in part a function of women's less pronounced opportunities for wage growth across their career spans.

Race

Like gender, race and ethnicity also figure into patterns of economic status. Farley (1980) shows that the average black family's income was less than 60% of that of the average white family during that period. A more recent study by Kominski and Adams (1994) suggests that, in 1993, earnings among 25–34 year old black males were only 83% of that of white males in the same age range. Similar to explanations of the gender gap in earnings, educational attainment has been identified as a primary factor of this considerable earnings gap between racial groups. For example, the Kominski and Adams study shows the proportion of 25–29 year old black males who are college graduates to be only half that of white males in the same age range (12.6% relative to 24.4%).

Considering the influential impact of college education on earnings, we would reasonably expect that earnings differences by race should be much smaller, if not eliminated entirely, among college graduates. Indeed, our results are consistent with that expectation in that they do not reveal a significant earnings gap between white and black graduates after controlling for college quality. The lack of a significant black–white earnings gap is consistent with recent evidence of similar patterns in academic major between whites and blacks (Simpson, 2001). Unlike the uneven distribution of men and women across academic majors—a distribution presumed to affect occupational attainment and earnings—the distribution of blacks and whites across majors is generally similar.[8]

The lack of a significant black–white earnings gap is consistent with human capital theory and with changes in the subscription patterns to

academic majors. While statistically non-significant, the switch in the direction of the black coefficient between our 1994 and 1997 models warrants further observation, however. Although relative parity exists between blacks and whites within academic majors (enabling greater occupational mobility for blacks) recent work suggests an increase within occupation wage disparities between blacks and whites in the private sector (Grodsky and Pager, 2001). This shift in our earnings coefficients for blacks may be the result of such within occupation wage disparity between blacks and whites.

Theoretical Perspectives

These observations encourage further consideration of the ongoing debate over the role of college credentials as signals to employers (e.g., Spence, 1974) or as genuine value-added in terms of human capital development (Becker, 1993). Clearly, many of our findings are consistent with the human capital framework. But these results suggest that other frameworks can also provide important insights to the dynamics defining the relationship between baccalaureate education, occupational attainment, and earnings. For example, to the degree that baccalaureate credentials are signals to prospective employers, these signals contain messages about social class background, race, and gender—dimensions on which the workforce is powerfully stratified and reproduced (Bourdieu and Passeron, 1977). A more comprehensive understanding of these differences and the influences defining them requires the thoughtful consideration of multiple theoretical frames.

Potential Biases

Patterns of baccalaureate attainment shade our findings and conclusions in important ways. Ignored in this analysis are those students starting college but not completing the requirements for the baccalaureate and those students opting to continue on to obtain graduate degrees. Both of these alternative outcomes have significant implications for the relationship between college quality, race, gender, occupational status, and earnings. Blacks and Hispanics enrolling in college are less likely to complete requirements for a baccalaureate degree by age 25–29 (Mortenson, 2003) and are therefore at a proportional disadvantage in terms of access to higher earning occupations. On the other side of the baccalaureate, race and family background are known to influence attendance in programs leading to graduate degrees (Eide and Waehrer, 1998; Mullen, Goyette, and Soares, 2003), credentials that confer significant

occupational and earnings advantages. Eide and Waehrer (1998) show that many higher quality colleges serve as staging grounds for students to gain entry into prestigious graduate programs. Thus the economic benefit of graduating from such institutions is in the signal sent to potential employers and the option value resulting from the signals sent to potential graduate programs. The true effects of college quality are likely understated here as a result of our exclusive focus on terminal baccalaureate recipients.

SUMMARY

The results of this study are the first to confirm that, net of other salient influences, the effects of college quality actually increase in the early period of graduates' careers. While conclusions about wage growth attributable to college quality have been based on the results of separate studies—often using different samples and model specifications—our results are based on a longitudinal sample, one that is nationally representative of college graduates as opposed to secondary school students, employees of a large corporation, or some other, less appropriate population. We also show significant earnings shifts for graduates from a number of academic fields of study. While earnings growth was observed among graduates from every field except the biological sciences (no real wage growth) and history (a statistically significant decline in wage growth) relative to majors in education, graduates with majors in business, engineering, and math fields enjoyed earnings increases greater than those observed among education graduates. An increasing gender gap and relatively little racial disparity in earnings and growth were also shown.

A number of policy issues emerge from this analysis. Our demonstration of time-variant wage returns attributable to college quality may inform future considerations of the longer-term impacts of education related investments and indebtedness associated with college costs. From the student or family point of view, the results of this study may serve to provide a better framework for understanding the magnitude of the college payoff as well as its timing. A longer-term view such as this may thereby importantly influence decisions of college choice and financing. The results of this approach and analysis should encourage scholars to focus on other periods of graduates' earning years in an effort to understand the stabilizing or destabilizing effects of the various types of college experiences on lifetime earnings and to examine the many nonpecuniary labor market benefits (e.g., benefits packages) that constitute the total economic payoff to college.

ACKNOWLEDGMENTS

This research was supported by a grant from the American Educational Research Association which receives funds for its AERA Grants Program from the National Science Foundation and the U.S. Department of Education's National Center for Education Statistics of the Institute of Education Sciences under NSF Grant #REC-9980573. Opinions reflect those of the authors and do not necessarily reflect those of the granting agencies. We are indebted to two anonymous reviewers for their insightful comments and criticism of an earlier draft of this paper.

ENDNOTES

1. It is noteworthy here that the B & B is representative of baccalaureate recipients whereas most surveys such as HS & B, NLS-72, and NELS-88 are not.
2. The debt to annualized earnings ratios used in this earlier work were calculated by dividing a graduate's total outstanding education related debt by his or her annualized salary. Debt-to-earning ratios exceeding 1.0 indicate that outstanding education-related debt exceeds annual income, 1.0 indicates that debt is equal to annualized income, and ratios less than 1.0 indicate that debt is less than the graduate's annualized income.
3. College "quality" has been operationalized in many different ways over the years (e.g., Carnegie Classification system, mean or median SAT score of entering freshmen class, tuition and fees, per FTE educational expenditure, Gourman ratings, and recently Barron's ratings). We suggest, as have others, that selectivity is a key component of institutional quality (Hansmann, 1999; Winston, 1996, 1997; Winston and Yen, 1995; Winston and Zimmerman, 2004). Not only is selectivity tightly correlated with other measures of quality such as student/faculty ratios, endowment per student, expenditure per student, etc., but it also importantly informs students' educational and social experiences on campus (Hansmann, 1999).
4. We used both OLS and HLM in estimating the model for our dataset. These two methods yield very similar coefficient estimates. Regression results are available upon request from the authors.
5. Adjustments for sample selection bias are theoretically important (Heckman, 1979) but have yielded little substantive difference in the interpretation of college effects (see Brewer et al., 1999 as an example). In the current analysis, a standard Heckman type model is also estimated. It turns out that the selection terms (λ) are not significant in the second stage wage equations, and that the unconditional earnings differentials which take self-selection into account are similar to the conditional earnings differentials which do not.
6. To test the correlation between the error terms across these two equations, the likelihood ratio statistic $\lambda_{LR} = T\left(\sum_{i=1}^{M} \log \hat{\sigma}_i^2 - \log|\hat{\Sigma}|\right) = 555$, where $\hat{\Sigma}$ is the estimated variance structure. For detailed discussion of seemingly unrelated regression (SUR), see Greene (2000).
7. Condition Index values and VIF scores were evaluated at 30 and 5, respectively. Estimates from models without the squared terms (age and tenure) fell well within these limits. While, as expected, estimates of the age and tenure parameters exceeded these limits when their squared terms were included, other parameters in the model were

relatively unchanged. Results of these tests and alternative specifications are available from the authors upon request.

8. Simpson's (2001) findings diverge from those of authors examining this issue in the 1980s. Trent (1984) and Thomas (1985) demonstrate different patterns in academic major for blacks and whites in this earlier time period.

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Received October 2, 2003.