THE EXPERIENCE-EARNINGS PROFILE: PRODUCTIVITY-AUGMENTING OR PURELY CONTRACTUAL? EVIDENCE FROM THE UK

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ABSTRACT

This study provides a test of the human capital interpretation of the experience-earnings profile. Does the upward sloping portion of the experience-earnings profile reflect on-the-job training which in turn causes the experience-productivity profile to slope upwards, or do purely contractual factors determine the nature of life-cycle earnings? Devising tests that would distinguish between the human capital model and the class of alternative theoretical models has been problematic primarily because it is difficult to obtain data measuring individual worker productivity. In the present study, we provide additional evidence on the relationship between productivity and earnings by examining earnings differentials in the UK academic labor market for economists, where constructing direct measures of productivity is less problematic. Using a test first suggested by Mincer, we find that the empirical results are consistent with human capital theory. We find that, while the positive relationship between earnings and experience persists when individual productivity measures are included in the salary equations for lecturers and senior lecturers, the positive relationship becomes statistically insignificant when the same productivity measures are included in the salary equations for professors. For lecturers and senior lecturers, the experience-salary profile properly reflects the structure of the national pay scale rather than variations in individual research productivity. At the professor level, where individual salaries are not determined by a pay scale, the data support the human capital explanation of the positive experience-earnings profile.

Interest in the academic labour market for economists has generated a substantial literature in the US, dating back to the 1960s. While interest among UK economists in their own academic labour market must have been equally keen, systematic empirical analyses of academic economics in the UK has only recently appeared in print.[1] For example, the *Economic Journal* recently published three papers from a symposium on the state of the British academic labour market. Blackaby and Frank (2000) examine the representation of ethnic and other minority groups among UK academic economists. Booth, Burton and Mumford (2000) focus on the representation of women within the profession. Machin and Oswald (2000) provide some preliminary explanations for the decline in the numbers of UK-born economists who elect to pursue academic employment. Blank (2000) and Freeman (2000) compare the US and UK academic labour markets for economists.

In the present study, we use data culled from vitae of individual faculty members in the UK to examine several additional issues. These issues relate in one way or another to the nature of the incentive structure faced by academic economists in the UK system. Many of the issues have been previously addressed in the literature relating to US markets are considered here. In addition, though, we are able to exploit some of the institutional differences between the US and the UK academic labour markets to provide new insights into the nature of the relationship between individual pay and productivity. How does the market value research productivity and what is the relationship between the quantity and quality of research output and pay? In particular, can observed earnings differentials among academic economists in the UK system be

[1] One of the first empirical studies conducted in the UK examined earnings differentials among university faculty members in three subject areas—Arts, Science and Technology. The study did not, however, provide an analysis of earnings differentials within particular disciplines. See Bowen (1963). Bowen's study was updated by Metcalf (1970).

related to observed research productivity differentials? Obviously, the relationship between productivity differentials and earnings differentials should be muted for lecturers and senior lecturers covered by the national pay scale and substantially more pronounced for professors. It is this particular feature of the UK academic market, however, that permits us to address a more fundamental economic question regarding the underlying determinants of life-cycle earnings. The issue is discussed in the following section.

1. The Human Capital/Contractual Interpretation Debate

It is widely recognized that individual earnings grow with labor market experience. Human capital theory explains the observed concave pattern of life-cycle earnings as a direct result of a similar pattern in life-cycle productivity. The essence of this model is that productivity growth results from optimal investments in on-the-job training that diminish gradually over the life-cycle. Thus the higher relative earnings of more experienced workers reflect higher relative productivity.

The human capital model has been the subject of considerable debate concerning its interpretation of the positively sloped experience-earnings profile. Several alternative explanations for the relationship between experience and earnings have been advanced in the literature. In each, productivity growth plays only a minor role in explaining earnings growth. Early work by Becker and Stigler (1974) showed that under certain conditions it might be optimal for firms to divorce earnings from productivity in order to prevent workers from shirking. Others, for example Lazear (1979), have suggested that many types of implicit contracts provide workers with earnings growth independent of changes in their relative productivity growth. Jovanovic (1979) developed job-

matching models under imperfect information, which also generate upward-sloping concave wage profiles. Harris and Holmstrom (1982) explain wage growth based on an insurance motive.[2]

These alternative theoretical explanations have presented an interesting challenge to empirical economists. Does the upward sloping portion of the experience-earnings profile reflect on-the-job training which in turn causes the experience-productivity profile to slope upwards, or do purely "contractual" factors determine the nature of life-cycle earnings? Early on in the debate, Mincer (1974) suggested a fairly simple test--the human capital model would be contradicted by the data if it could be shown that earnings growth was largely independent of productivity growth. Unfortunately, devising tests that would distinguish between the human capital model and the class of alternatives is problematic, primarily because it is difficult to obtain data measuring an individual worker's productivity.

Despite the data limitations which plague attempts to structure refutable hypotheses, a few empirical studies have emerged. Since productivity measures are not available in public data sets, direct tests of the human capital model have relied on information drawn from the personnel records of large corporations. Medoff and Abraham (1980, 1981) were the first to employ such data. Using performance ratings for managerial and professional employees in three large companies, they find no evidence that experience raises wages because it augments productivity. In contrast, Bartel (1995), also using data generated from personnel records of a large company, finds that formal training increases wage growth and job performance. Her results are consistent with a human capital model interpretation. While these company-specific studies are useful, they are difficult to generalize to other settings.

[2] Other important work in this area includes Nickel (1976), Freeman (1977), Rothschild and Stiglitz (1976), Lazear (1981), and Guasch and Weiss (1982).

Empirical tests using national data bases have examined the issue indirectly, relying on the implied relationship between intensity of on-the-job training and wage growth. For example, Brown (1989) finds that firm-specific wage growth occurs almost exclusively during periods of on-the-job training, thus confirming the predictions of the human capital model.[3] Brown concludes that once training is held constant, there remains virtually no firm-specific wage growth that can be attributed to contractual factors. In summary, however, any reasonable assessment of the current empirical literature would almost certainly conclude that the issue of what role productivity versus other "institutional" factors play in determining earnings differentials remains an open question.

In the present study, we provide additional evidence on the relationship between productivity and earnings by examining earnings differentials in the UK academic labor market for economists, where constructing direct measures of productivity is less problematic. Our data enable us to more thoroughly explore the empirical issues in the debate since they permit more precise measures of past and current relative productivity of individuals engaged in comparable work. Thus, it is possible to compare the relative earnings and relative productivity of individuals in fairly homogeneous jobs who have different amounts of experience and institution-specific seniority. Well-specified productivity measures, coupled with observations from a labor market where investments in firm-specific human capital are minimal, provide an opportunity to explore alternative hypotheses from recent theoretical conjectures about life-cycle earnings.

2. Institutional Setting

[3] For additional tests see Altonji and Shakoto (1987), Abraham and Farber (1987) and Topel (1986 and 1991).

In the UK, most university teachers below the rank of professor are paid according to a set of salary scales negotiated by the Association of University Teachers and the University and Colleges' Employers Association. The salary scales set a minimum and maximum figure for each grade up to the professor level.[4] These scales also specify an annual increment figure within each grade. Currently, there are three different salary schedules, which cover approximately seventy eight percent of university teachers.

Professor salaries are not covered by the national salary schedules. A professor's salary is instead determined by negotiations between the University and the individual professor. The UK system does, however, impose a minimum on professor salaries and on the average salaries paid to professors within the university as a whole. Thus, if one professor is paid more than the average, at least one of his colleagues must receive less.

The institutional arrangements in the UK differ substantially from the operation of the academic labour market in the US. By in large, academic salaries in the US are determined at the individual level within each department and discipline. Furthermore, in the US, annual increments are based on the individual's recent productivity. With rare exceptions (e.g., unionized environments), there are no automatic increments to an individual's annual salary.

Universities compete with each other to hire both junior (assistant and associate professors) and senior faculty. Since universities in the US differ in terms of their role, scope, mission, prestige, quality and ability to pay, salaries differ substantially between universities, not only within a particular discipline, but across disciplines as well. In contrast, with the exception of medical pay, there are not supposed to be inter-discipline pay differentials under the UK national salary scales.

[4] We simplify the analysis by defining only three ranks: Lecturer, Senior Lecturer/Reader, and Professor. Senior Lecturers and Readers are combined into a single category because they are rewarded on the same pay schedule and are considered to be similar.

3. The Data and Variable Definitions

The data for this study are taken from individual vitae of full-time faculty members employed in UK universities. Approximately 1000 individuals at 60 economics departments were contacted by email and asked to provide a copy of their vita along with their annual academic salary. Each individual was informed as to the nature of the project and how we were going to use the information. Each individual was assured that we would keep all information strictly confidential. We obtained complete information from 129 economists. The data set is particularly appropriate for our study since it provides detailed information on individual characteristics such as experience, seniority, sex, the quality of graduate training, as well as a variety of individual productivity measures. The sample excludes individuals who currently occupy administrative positions above the level of department chairperson.

Table 1 provides information about the sample percentages by rank, Research Assessment Exercise (RAE) ranking, and gender. We also compare our sample composition with previous surveys conducted by Blackaby and Frank (2000), Booth and Burton and Mumford (2000), Machin and Oswald (2000), and the Higher Education Funding Council for England (HEFCE). Our sample contains a higher proportion of professors and a lower proportion of lecturers than the other surveys. We also have a higher proportion of faculty members from RAE rank 4 and a lower proportion from RAE rank 3. Overall, however, the composition of our sample does not deviate substantially from the other samples and hence, we feel confident that our sample is generally representative of academic economists in the UK.

The dependent variable in all of the regressions is the log of the 1999-2000 academic year salary reported by each individual. We do not include any outside income (consulting fees,

royalties, or income earned outside the university). We begin by defining the independent variables as they appear in the analysis below.

The *experience* variable measures the years of academic employment subsequent to the date of the highest degree earned. Experience is typically found to have a positive influence on earnings in nonacademic labour markets, a result that generally holds for academic labour markets as well (Katz 1978; Ferber 1974; Tuckman and Leahey 1975).

Seniority is defined in this study as the number of years employed at the current institution. Unlike studies of nonacademic labour markets, virtually all of the extant studies find a *negative* seniority-earnings gradient in academic labour markets for specifications of the simple human capital earnings regressions (Gordon et al. 1974; Hoffman 1976; Ransom 1993; Moore et al. 1998, 2001). Moore et al. (1998) find, however, that once detailed measures of individual research productivity are added to the earnings regressions, the anomalous seniority effect disappears.

All models include a dummy variable for *Sex*, which takes the value of unity for males. Numerous studies of academic labour markets in the US have reported a statistically significant earnings differential for male economists. Blackaby and Frank (2000) estimate earnings equations on a national sample of UK academic economists and reported a negative earnings gap of 9.1 percent for married women and a 14.1 percent for unmarried women. We are however, hesitant to place too much emphasis on our estimations, since we have a relatively small number of females in our sample and they are all concentrated in the lecturer and senior lecturer ranks.

We also include a variable to capture any salary effects of Ph.D. quality, using a dummy variable that equals one if the individual received his Ph.D. from Oxford, Cambridge or the

London School of Economics. The Ph.D. quality variable is included in the models to capture possible unobserved quality dimensions of a heterogeneous faculty.

Finally, we include measures of individual productivity in research and administration.[5] Publication of scholarly work represents a direct measure of productivity in the academic labour market. We start by constructing a measure of overall research activity, unadjusted for quality, which we denote as *Total Publications*. This variable is defined as the total number of books, monographs, conference papers, research papers, and refereed journal publications listed on the individual's vita. As a measure of research quality, we define two additional variables that count only publications appearing in the major academic journals. We thus, define one variable, which captures articles published in the top-tier journals and another, which captures publications in second-tier journals. Journals designated as *Level I Publications* are those generally considered to be the most distinguished general interest journals. Level I publications include the number of articles appearing in the *American Economic Review, Econometrica, Economic Journal, Economica, International Economic Review, Journal of Economic Theory, Journal of Political Economy, Quarterly Journal of Economics, Review of Economic Studies,* and the *Review of Economics and Statistics.*

Level II Publications is defined as the number of articles published in the second-tier general interest journals and in the top field journals. The list of the 50 journals in this category can be found in the appendix. This list of journals uses the impact-adjusted citations per capita rankings by Liebowitz and Palmer (1984) as a broad guideline. The list includes what many economists would agree are the top field journals in most of the broadly accepted economic specialties. Although our two quality measures together cover 60 journals, these journal represent only a fraction of the total number of possible outlets for economic research; for

[5] We were unable to obtain any proxy for teaching productivity from individual vitae.

example, the *Journal of Economic Literature* currently provides a list of contents for over 250 periodicals.[6]

Our final productivity measure is years of experience as department chair. This variable is included in the model to capture the acquisition of administrative skills. *Years As Chair* is defined as the number of years an individual has served as a department chair, either currently or in the past.[7] We are not sure exactly what kind of productivity effects are being measured by this variable. It is possible that a chairperson may be rewarded for the ability to enhance the teaching and research productivity of other faculty members by creating an environment conducive to such activities or by successfully obtaining additional resources for the department. Positive rewards for chairs may also merely reflect compensating wage payments for performing a difficult or dissatisfying job. Finally, chair rewards may represent a premium necessary to offset the high opportunity cost of forgone research time and the atrophy of research skills while in office.

Table 2 presents summary statistics for the individuals in our sample. Professors represent roughly 37 percent of our sample with an average salary of £47,141. They have an average of 24 years of experience, with about 59 percent of that time spent at their present institution (14 years). Most publish regularly, with an average of 73 career publications. About

[6] We also collected data on individual career citations, which we obtained from the Web of Science Citation Databases (wos.isihost.com). Moore et al. (1998, 2000) use career citations as a proxy for the influence an individual's body of research has had on the profession. Their results suggest that citations reflect an important measure of research quality and further, the return to citations is higher for those individuals who publish a smaller number of frequently cited papers than for those who publish a greater number of less frequently cited papers. Unfortunately, we were unable to eliminate self-cites and we could not assign citations to coauthors on all published papers prior to 1984. This meant that we have a potentially serious systematic undercounting for all coauthors who were publishing papers prior to 1984; that is, most senior scholars who were not listed as the first author on their early-career papers. Our attempts to incorporate career citations into the analysis produced results that were not plausible. Thus, despite our strong priors that citations represent an important measure of quality and hence, should influence relative earnings among research scholars, our citation data are obviously not adequately measuring true citations for all multiple authors.

[7] Alternative models using a dummy variable to capture chair experience yielded the same qualitative results as those reported for the chair variable as defined here.

5.8 percent of these publications are in the top-tier journals, and 12.7 percent in second-tier journals. A little over 10 percent of the professors in our sample have published 10 or more top-tier journal articles over their career. The maximum number of top-tier publications for individuals in our sample is 24. On the other hand, approximately 30 percent of the professors have never published a level I paper. As one might expect, however, most economists are more prolific at publishing in second-tier journal articles. Only 4 percent of the professors failed to produce a level II article, while 43 percent have produced 10 or more level II articles. The maximum number of level II articles published by a single individual is 30.

Figure 1 depicts the cumulative distribution of publications by journal quality and rank. The top panel shows the cumulative percent of number of publications by journal quality for professors. The cumulative percent rises rapidly up to 10 level I publications with about 87 percent of professors having less than 10 level I publications over their entire career. This illustrates the level of difficulty associated with publishing in the top-tier journals. Even among economists with an average of 24 years of experience, very few have more than 5 level I publications.

The senior lecturers in our sample have about 17 years of professional experience, 13 of which have been spent at their current institution. About 5 percent of their total publications appear in level I journals, and 10.5 percent in level II journals. While the average number of level I publications among senior lecturers is 1.41, about 15 percent of senior lecturers have 3 or more. Also, approximately 15 percent of senior lecturers have 5 or more level II journal articles.

Lecturers represent roughly 36 percent of the sample with an average of approximately 9 years of professional experience and a little over 6.5 years of seniority. On average, lecturers in our sample have .31 level I publications. Only 12 lecturers in our sample have published in level

I journals. Lecturers have been more successful at publishing in second-tier journals. While the modal number of level II journal articles is still zero, about half of the lectures have published at least one paper in a second-tier journal. The maximum number of level II publications among lecturers is 5.

The bottom panel of Figure 1 presents the cumulative distribution of article production in level I and level II journals among lecturers and senior lecturers combined. Again, the cumulative percent of publications in both quality dimensions rises rapidly. For example, over 90 percent of the lecturers and senior lecturers have published less than 2 level I papers. Also, over 90 percent of lecturers and senior lecturers have published less than 6 level II papers. Clearly, the distinction between overall research output and those research papers actually appearing in level I and level II journals represents a significant measure of quality.[8]

4. Empirical Design

The human capital explanation has a relatively straightforward assumption: the observed higher relative earnings of more experienced workers reflect higher relative productivity. More experienced workers have acquired valuable skills and as a result, their productivity exceeds that of workers with less experience. Suppose at any point in time t an individual's productivity, denoted as Q, is a function of the stock of human capital accumulated from past and current investments. That is,

$$Q_t = f(I_t) \qquad (1)$$

[8] We recognize that other types of research production may be of equal or higher quality, e.g., some published conference proceedings. We were, however, uncertain how to make the quality distinction for these types of published research. Therefore, our two quality measures do not capture all of the possible high-quality research conducted by individuals in our sample.

where I_t represents the individual's stock of human capital at time t. The typical approach is to assume some proportionality between wages and productivity leading to the standard semi-log earnings function in which an individual's earnings proxies productivity and labor market experience and job-tenure each proxy investments in human capital. We begin with such a function:

$$\ln (y) = \mathbf{X}\beta + \varepsilon \qquad (2)$$

where y equals the individual's earnings, **X** is a vector whose elements include experience and seniority, β is a vector of parameters to be estimated, and ε is the equation error.

We then augment equation (2) with a vector of grade-level dummy variables representing academic rank **R** so that

$$\ln (y) = \mathbf{X}\beta + \mathbf{R}\delta + \varepsilon. \qquad (3)$$

This specification provides additional information on within-rank earnings differentials and helps us determine what fraction of the higher earnings associated with experience occurs within ranks as opposed to more experienced faculty with higher ranks earning higher than average salaries.

Finally, with access to direct measures of individual productivity, we can augment this earnings equation in the following way:

$$\ln (y) = \mathbf{X}\beta + \mathbf{R}\delta + \mathbf{P}\alpha + \varepsilon \qquad (4)$$

where **P** is a vector of individual productivity measures. If the human capital model is a valid interpretation of the experience-earnings profile, the introduction of direct measures of productivity into the earnings equation would move the estimated coefficients on experience and seniority toward zero. Equations (2) through (4) provide the econometric framework for the estimates that follow.

5. Empirical Results

Table 3 presents estimates of equations (2) through (4). In Table 3, as in all subsequent tables, the dependent variable is the logarithm of the annual salary as reported by individual faculty members in our sample. Model (1) represents what is often justified as a simple human capital earnings equation, excluding individual productivity measures. In this model, the log of salary is regressed on experience, its square, seniority, and controls for sex and the quality of the individual's Ph.D. degree.[9]

The estimates from model (1) depict an increasing concave experience-earnings profile for academic economists in the UK.[10] This is consistent with virtually all of the previous studies that have estimated earnings functions for academic labour markets. Seniority, on the other hand, has a negative and significant effect on relative earnings. While this result is in stark contrast to what is generally found in the empirical earnings literature dealing with non-academic labour markets, as noted earlier, it is consistent with the numerous studies of academic labor markets in the US. Whether this relationship is robust remains to be seen. The coefficients on the two demographic variables are significant and of the anticipated signs. More will be said about these two demographic controls later.

Model (1b) augments the human capital earnings equation by adding two dummy variables indicating the rank of the individual (*Senior Lecturer* and *Professor*) in order to provide additional information on the within-rank earnings differentials. The object of model (1b) is to determine what fraction of the higher earnings associated with additional market experience occurs within ranks rather than as a result of more experienced faculty members with higher

[9] Regressions using a quadratic form in both experience and seniority were estimated as well. In no case did the quadratic in seniority attain significance at conventional levels.

[10] The quadratic experience terms are jointly significant ($F_{2,122} = 37.44$).

ranks having higher than average salaries.[11] The coefficients on both rank variables are positive and significant. The results suggests that, holding market experience and seniority constant, Senior Lecturers earn approximately 15.5% more than Lecturers and Professors earn about 49% more than Lecturers.[12] Obviously, the introduction of these rank dummies increases the explanatory power of the model substantially (from 51 to 76 percent). In addition, adding controls for academic rank reduces the measured effects of experience on earnings by approximately 46 percent, yet the experience-earnings relationship remains significantly positive and concave ($F_{2,120} = 9.70$). Note also, that the coefficient on *Seniority* falls substantially and becomes statistically insignificant at conventional levels.

In model (2), we introduce a measure of an individual's overall research activity, *Total Publications*, as well as quality-adjusted measures of research productivity, *Level I* publications and *Level II* publications. The two variables measuring publications in the top- and second-tier journals are included to control for the effects of different quality publications, as measured by journal reputation. Comparing the estimates from models (1) and (2), we find that the productivity variables relating to total publishing as well as the quality of the work are significant and substantially improve the explanatory power of the equation. The coefficients on the *Level I* publications and *Level II* publications measure the differential effects of top- and second-tier publications, respectively, over and above publications in other outlets (the marginal effect of which is captured by the *Total Publications* coefficient). These estimates strongly suggest that *quality* research is highly rewarded among our sample of UK academic economists. As one can see, the marginal effect on relative earnings of a paper in a top-tier journal is

[11] Note that these augmented models are not completely unrestricted since the specifications permit only the intercept to vary across ranks. A fully interactive specification revealed no significant differences in the slope coefficients between lecturers and senior lecturers.

[12] Theses rank effects are measured at the mean. The relative effect of rank on earnings is measured as $exp(\delta) - 1$.

significantly greater than the marginal effect of a paper in a second-tier journal, which is in turn greater than the marginal return to a publication in an alternative outlet. When we add the rank dummies, model (2b), the marginal effect of a Level II article, relative to the payoff of a publication in other outlets, becomes insignificant. We will return to this issue below.

In model (3), we add the department chair experience variable. There appears to be positive and significant return to experience as chair, which is consistent with virtually all of the previous research on this topic.[13] Even holding rank constant, model (3b), chairs in our sample receive almost a 1.5 percent premium for each year of service. Under this specification, the payoff to the payoff to a chairperson with the sample average of 5.04 years of chair experience is about 7.28 percent; an estimate very close to those reported in similar specifications for the US.[14]

All of the models reported in Table 3 reveal a positive and significant return for individuals who received a Ph.D. from one of the three top programs. Using the most complete specification, model (3b), estimates suggest that relative salaries are about 6 percent higher for individuals with degrees from Cambridge, Oxford or the London School. This suggests that the Ph.D. quality variable is possibly capturing unobserved quality differentials, which are not fully accounted for by our research productivity measures. Our earnings models also suggest that men earn about 6.8 percent more than female economists with comparable experience and publishing records. We do not wish, however, to make too much of these results due to the relatively small number of female economists in our sample. Furthermore, the male premium, while remaining

[13] Previous studies have dealt almost exclusively with the academic labour market in the US. For a brief review of these studies see Moore, Newman and Turnbull (1998).

[14] In a recent study of the academic labour market for economists in the US, Moore, Newman and Turnbull (2000) report a total payoff to chair experience of 9.6 percent. The estimated marginal return for each year of chair experience in their study is 1.7%. The average chair experience was 5.63 years for their sample drawn from nine Ph.D. programs in the US.

positive, becomes statistically insignificant when we stratify the sample by rank in the analysis below.

Turning to our primary focus, the introduction of individual productivity measures in the standard human capital model does not totally eliminate the effect of experience on relative earnings. In model (3b), which includes measures of both the quantity and quality of research as well as chair experience and rank dummy variables, the experience-earnings relationship remains significantly positive and concave ($F_{2,115} = 5.05$). This suggests that some portion of earnings growth among UK academic economists is largely independent of productivity growth. Given the existence of national pay scales for most of the economists below the rank of professor, our findings are not unexpected. Even Mincer (1974) recognized that the positive association between experience and earnings might "reflect the prevalence of institutional arrangements such as seniority provisions in employment practices" [p. 80]. In light of the prevalence of an institutional arrangement like the UK pay scales, it would have been a surprise had the "Mincer test" resulted in the statistical elimination of the independent effect of experience on earnings.

As a further test of the productivity-augmenting hypothesis implicit in the human capital interpretation of the experience-earning profile, we restructure the data in order to conduct the Mincer test separately for individuals covered by the national pay scales (lecturers and senior lecturers) and those who are not (professors). To the extent that the national pay scale dictates earnings growth among lectures and senior lecturers, such practices would contradict the productivity-augmenting hypothesis—earnings growth should be largely independent of productivity growth. On the other hand, with no explicit contractual arrangement governing earnings growth among professors, there is good reason to believe that the Mincer test would confirm the productivity-augmenting hypothesis.

Table 4 reports the results of this conceptual experiment. The first four columns present estimates for lecturers and senior lecturers. In the simple human capital specification (1), we once again find an increasing concave experience-earnings profile. However, unlike the equivalent specification for the pooled sample, seniority has a positive yet statistically insignificant effect on relative earnings. Adding the *Senior Lecturer* dummy variable reduces the measured effects of experience by about 32 percent, but experience still has a strong and significant influence on an individual's relative earnings.

Models (2) and (2b) augment the simple human capital earnings function by adding research productivity measures with and without the rank dummy variable. With the exception of Level II publications, differentials in research productivity among faculty members do not contribute significantly to the explanation of earnings differentials among lecturers and senior lecturers.[15] Further, while publications in Level I journals and publications in other outlets (captured by the *Total Publications* variable) are not individually significant in model (2), the three measures of research productivity are jointly significant ($F_{3, 71} = 3.77$). However, once we control for rank in model (2b), the three research productivity variables are no longer jointly significant ($F_{3, 70} = 1.63$). This suggests that the positive return to publications in general that is estimated in model (2) is primarily attributable to more productive faculty members *with* a higher rank having higher than average salaries. Thus, as anticipated in a regime where contractual arrangements dictate earnings growth, the augmented specification suggests that the

[15] This does not imply that a publication in a top-tier journal carries no weight. First, among lecturers and senior lecturers a publication in one of the top-tier journals is a rare event. Note that the mean number of Level I publications in this group is .80 with a standard error of 1.46. The empirical significance of having a Level I publication may be outweighed by the importance of the salary scale. Second, the payoff for research publications in top-tier journals may be deferred; that is, it increases the probability of promotion to professor. Thus, while within the ranks of lecturers and senior lecturers the marginal effect of Level I publications cannot be detected, it does generate positive rewards through promotion.

productivity-augmenting hypothesis does not hold; earnings growth among lecturers and senior lecturers is largely independent of productivity growth.[16]

Even after research productivity measures are introduced, the experience-earnings relationship remains significantly positive and concave ($F_{2, 70} = 3.97$), despite the possibility that there may be a negative within-rank correlation between experience and unmeasured ability. For example, it is possible that within a rank more experienced faculty members are less able (and hence, less productive) than less experienced faculty members, since the more able individuals have been promoted. Medoff and Abraham (1981) show that the expected value of the estimated experience coefficient has a downward bias, with the extent of the bias determined by the negative covariance between experience and ability. Furthermore, the expected value of the experience coefficient in an earnings regression, which includes productivity measures, is closer to zero than the expected value of the experience coefficient without controls for productivity. To the extent that a negative covariance exist between experience and ability, augmenting the model with research productivity controls should drive the experience coefficient toward zero, even if within the entire sample there is zero correlation between experience and ability. The presence of a negative covariance between experience and ability would, therefore, make it easier to accept the productivity-augmenting hypothesis and reject the contractual hypothesis. Thus, the failure of the experience coefficients to be "driven to zero" in models (2) and (2b) provides a fairly strong contradiction of a human capital interpretation of the experience-earnings profile among academic economists at the lecturer and senior lecturer levels.

[16] It is certainly possible that productivity growth in other dimensions such as teaching may contribute to earnings growth. It seems unlikely, however, that measures of relative teaching performance would contribute more to earnings growth than research productivity. Nonetheless, we emphasize that our conclusion applies only to research productivity.

In the last two columns of Table 4 we perform the same test for professors. In the simple human capital specification, model (1), we find that the quadratic experience terms are jointly significant ($F_{2, 43} = 2.61$). Also, seniority has a significant negative effect on relative earnings—a result consistent with existing studies of academic labour markets in the US. Once measures of research productivity and chair experience are introduced in model (2), neither experience nor seniority has a significant effect on relative earnings.[17] Thus, as Moore, Newman and Turnbull (1998) find in their study of academic economists in the US, once improved measures of faculty productivity are introduced, the anomalous negative seniority-earnings relationship found in many earlier studies virtually disappears. Furthermore, the experience coefficients are not significantly different from zero. These results, unlike those for lecturers and senior lecturers, are consistent with the productivity-augmenting hypothesis based on the human capital interpretation of the observed concave age-earnings profiles.

One might argue that estimates of the experience coefficients should also be biased downward and that augmenting the model with research productivity controls should drive the experience coefficients toward zero. This would mean that we have only obtained results that are driven by the negative covariance between experience and ability, not results consistent with the productivity-augmenting hypothesis. However, there is no reason to assume that such a negative covariance exist among professors since there are no additional ranks above this level. Therefore, the more able are still present within the rank of professor—there is no possibility that they have been "promoted out of that rank."

Finally, we provide an alternative test of the human capital interpretation of the experience-earnings profile among professors. Ordinarily, an earnings equation would be estimated with a sample of workers, which contains both "younger" and "older" workers. In a

[17] For the joint test of the linear and quadratic experience terms in model (2) the calculated test statistic is $F_{2, 38} = .09$.

cross-section data set, such as ours, workers would be scattered along the full range of the synthetic experience-earnings profile. In contrast, our sample of professors contains only "older" workers. Note that the average experience level among professors in our sample is 24 years, which implies that they tend to be clustered along the flatter end of the experience-earnings profile.

Another way to view the reward structure for academic economists in the UK is to treat it as a tournament, with the competitors seeking promotion to professor. Despite the national pay scale, which dictates earnings growth up to that point, winning the game (promotion to professor) requires individuals to distinguish themselves in their research output. For those who are promoted, the game starts over; that is, future earnings growth will be related to productivity growth *subsequent to promotion*. In this view, post-promotion research output should be the relevant measure of productivity differentials among professors. In the following conceptual experiment we redefine the three publication variables such that they count only publications an individual has made after promotion to professor.

The Mincer test also requires that we restart the experience clock for this group by moving the origin to zero at time of promotion. Using this redefined experience variable magnifies the relative experience differentials among individuals in the restricted sample.

Table 5 reports the results of this alternative test. Model (1) is the standard human capital specification without controls for individual productivity. In this specification, we observe a significant effect of experience on earnings. Even among professors with an average of 10 years of post-promotion experience, we are able to detect an increasing concave experience-earnings

profile.[18] Years of seniority and Ph.D. quality do not appear to have significant independent effects on an individual's relative salary.

Model (2) introduces quality-adjusted measures of research productivity and chair experience. The productivity variables substantially improve the explanatory power of the model. Again, our results suggest that quality research is highly rewarded in our sample of UK economists. Though the marginal effect of level II publications does not appear to be greater than publications in alternative outlets, the marginal return to a paper in a top-tier journal is significantly greater than publishing in alternative outlets.

More importantly, we again find the same pattern obtained earlier—once more refined measures of individual productivity are introduced in the simple human capital model, the coefficients on experience are driven to insignificance. While the coefficients of the quadratic experience terms depict a positive concave experience-earnings profile, they are neither individually nor jointly significant.[19] This result suggests that earnings growth among professors is largely dependent on productivity growth, a result consistent with the human capital interpretation of the experience-earnings profile.

6. Summary and Conclusion

One of the implications of human capital theory is that the widely observed positively sloped experience-earnings profiles primarily reflect the growth in individual productivity over time rather than institutional or other incentives factors. Experience per se does not affect earnings. Instead, it simply picks up the salary effects of unmeasured individual productivity. In principle, Mincer's (1974) suggested test is straight forward: under human capital theory, the

[18] The test statistic for the linear and quadratic experience terms is $F_{2, 42} = 9.99$.
[19] For the joint test of the linear and quadratic experience terms in model (2) the calculated test statistic is $F_{2, 38} = 1.54$.

positive experience-salary profile should disappear once adequate individual productivity measures are included in empirical salary models. Although such a test is conceptually simple, the empirical literature has been hampered by the lack of adequate data with sufficient detail on individual productivity.

This paper reexamined the human capital explanation of the experience-earnings relationship, using individual productivity and earnings data from academic economists in the UK. The relationship between the national pay scale for lecturers and senior lecturers and the more-or-less individually contracted salaries at the professor rank offers an opportunity to shed additional light on these empirical questions. We estimated how the UK market values research, using detailed measures of individual productivity to test the human capital experience-earnings profile explanation.

The empirical results are consistent with human capital theory. We found that, while the positive relationship persists even when individual productivity measures are included in the salary equations for lecturers and senior lecturers, the positive relationship becomes statistically insignificant when the same productivity measures are included in the salary equations for professors. For lecturers and senior lecturers, the experience-salary profile properly reflects the structure of the national pay scale rather than variation in individual research productivity. Indeed, it would have been troubling for the human capital model if the Mincer test yielded support at these ranks. At the professor level, on the other hand, the UK academic labor market appears to function much like the US market. And at that level, as in the US, the data strongly support the human capital explanation of the positive experience-earnings profile.

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Table 1. Composition of Sample and Comparison with other Studies

	Present Study	Blackaby & Frank (2000)	Booth & Burton (1999)	Machin & Oswald (2000)	HEFCE (1996)
Percent Within Rank:					
Lecturers	35.7	37.8	44.8	44.1	--
Senior Lecturers/Readers	26.9	20.1	21.4	25.2	--
Professors	37.3	25.3	18.8	20.1	--
Researchers	0	4.7	12.0	10.6	--
Distribution of Faculty by Department RAE Score:					
5+	7.1	12.9	11.4	--	13.4
5	22.8	23.7	20.8	--	27.8
4	51.9	28.1	20.1	--	32.2
3[a]	14.2	25.6	34.3	--	21.2
2	3.9	8.5	12.4	--	4.2
1	0	1.3	1.0	--	1.2
Percent Female by Rank:					
Lecturer	20.0	--	19.0	--	--
Senior Lecturer/Reader	9.0	--	11.24	--	--
Professor	0	--	4.06	--	--
Sample Size	129	516	81	44	

[a] This category combines "3 upper" and "3 lower."

Table 2. Summary Statistics for Faculty by Rank: Means and Standard Deviations

Variable	Lecturers	Senior Lecturers	Professors
Salary	27,634 (4,263)	34,220 (3,460)	47,141 (7,940)
Experience	8.91 (8.12)	16.97 (8.58)	24.06 (8.77)
Seniority	6.64 (7.0)	13.47 (9.98)	14.21 (10.42)
Sex (male=1)	.80	.91	1.0
Ph.D. Quality	.16	.15	.29
Total Publications	10.37 (15.61)	26.85 (14.51)	73.62 (58.67)
Level I Articles	0.31 (0.56)	1.41 (1.98)	4.28 (5.72)
Level II Articles	0.93 (1.21)	2.82 (2.81)	9.32 (7.65)
Sample Size	45	34	47

Table 3. Earnings Equations for Academic Economists in the United Kingdom

Variable	Mean	Model (1)	Model (1b)	Model (2)	Model (2b)	Model (3)	Model (3b)
Experience	16.64	.0367*	.0198*	.0254*	.0165*	.0241*	.0157*
		(4.97)	(3.52)	(4.14)	(3.19)	(4.13)	(3.09)
Experience^2	388.85	-.0005*	-.0003*	-.0005*	-.0003*	-.0005*	-.0003*
		(2.47)	(2.37)	(3.17)	(2.68)	(3.20)	(2.58)
Seniority	11.34	-.0070*	-.0028	.0003	-.0002	.0005	-.0002
		(2.78)	(1.54)	(0.12)	(0.01)	(0.21)	(0.09)
Sex (male=1)	.91	.1326*	.0697	.0911**	.0622	.0920**	.0660**
		(2.14)	(1.59)	(1.81)	(1.56)	(1.93)	(1.69)
Ph.D. Quality	.21	.1043*	.0698*	.0574**	.0544*	.0652*	.0595*
		(2.49)	(2.35)	(1.63)	(1.96)	(1.95)	(2.18)
Total Publications	38.31			.0018*	.0011*	.0012*	.0009*
				(4.67)	(3.58)	(3.05)	(2.67)
Level I Articles	2.09			.0112*	.0092	.0114*	.0094*
				(2.62)	(2.70)	(2.79)	(2.83)
Level II Articles	4.55			.0080*	.0011	.0074*	.0013
				(2.34)	(0.39)	(2.27)	(0.48)
Years as Chair	5.04[a]					.0258*	.0144*
						(3.81)	(2.44)
Senior Lecturer	.27		.1442*		.1262*		.1310*
			(4.24)		(4.04)		(4.27)
Professor	.37		.4007*		.3199*		.2959*
			(11.02)		(8.49)		(7.75)
Intercept		9.9809*	10.0392*	10.0117*	10.0460*	10.0217*	10.0483*
		(158.39)	(224.93)	(195.93)	(247.38)	(206.73)	(252.61)
d.f.		122	120	118	116	117	115
Adjusted R^2		.51	.76	.68	.80	.71	.81

(| t | - value)
[a] Mean is conditional on chair experience
* Significant at .05
** Significant at .10

Table 4. Earnings Equations by Rank

Variable	Mean	Model (1)	Model (1b)	Model (2)	Model (2b)	Mean	Model (1)	Model (2)
Experience	12.38	.0338* (4.85)	.0229* (3.37)	.0235* (3.10)	.0193* (2.67)	24.06	.0159[a] (1.43)	.0032[b] (0.38)
Experience^2	236.66	-.0008* (3.80)	-.0006* (2.68)	-.0005* (2.29)	-.0004* (2.03)	654.35	-.0002[a] (0.91)	-.0001[b] (0.31)
Seniority	9.58	.0038 (1.03)	.0024 (0.73)	.0034 (0.94)	.0027 (0.08)	14.02	-.0043** (1.65)	-.0023 (0.97)
Sex (male=1)	.85	.0437 (0.96)	.0527 (1.29)	.0497 (1.15)	.0564 (1.40)	1.00		
Ph.D. Quality	.15	.0593 (1.43)	.0650** (1.72)	.0547 (1.37)	.0585** (1.62)	.29	.0601 (1.15)	.0386 (0.93)
Senior Lecturer	.43		.1318* (4.15)		.1087* (3.15)			
Total Publications	17.52			.0005 (0.43)	-.0001 (0.07)	73.61		.0010* (2.98)
Level I Articles	0.78			.0089 (0.82)	.0002 (0.02)	4.28		.0122* (3.47)
Level II Articles	1.75			.0187* (2.37)	.0151* (2.02)	9.32		-.0019 (0.63)
Years As Chair						5.04[c]		.0158* (2.70)
Intercept		10.0054* (208.95)	10.0232* (231.95)	10.0146* (217.85)	10.0226* (232.63)		10.5585* (94.33)	10.5757* (124.19)
d.f.		74	73	71	70		43	38
Adjusted R^2		.44	.54	.49	.55		.08	.49

(| t | - value)
[a] Jointly significant: $F_{2, 43} = 2.61$
[b] Jointly insignificant: $F_{2, 38} = 0.09$
[c] Mean is conditional on chair experience
* Significant at .05
** Significant at .10

Table 5. Earnings Equations for Professors Using Post Promotion Experience and Publications

Variable	Mean	Model (1)	Model (2)
Experience	10.49	.0293*	.0130
Post Promotion		(4.00)	(1.83)
Experience^2	178.45	-.0008*	-.0005
Post Promotion		(3.07)	(1.88)
Seniority	14.47	-.0029	-.0029
		(1.41)	(1.56)
Ph.D. Quality	.29	.0529	.0567
		(1.08)	(1.36)
Total Publications	43.79		.0013*
Post Promotion			(2.81)
Level I Articles	2.30		.0173*
Post Promotion			(3.09)
Level II Articles	4.83		-.0065
Post Promotion			(1.19)
Years as Chair	5.04[b]		.0130*
			(2.16)
Intercept		10.603*	10.609*
		(212.11)	(242.42)
d.f.		42	38
Adjusted R^2		.30	.52

(| t | - value)
[a] Jointly insignificant: $F_{2, 38} = 1.82$
[b] Mean conditional on chair service
* Significant at .05