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STUDYING OURSELVES: THE ACADEMIC LABOR MARKET

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ABSTRACT

This paper addresses three academic labor market issues; the declining salaries of faculty employed at public colleges and universities relative to their private institution counterparts, the growing dispersion of average faculty salaries across academic institutions within both the public and private sectors, and the impacts of the growing importance and costs of science on the academic labor market and universities.

The decline in the salaries of faculty in public institutions relative to their private sector counterparts is attributed primarily to private institutions' tuition levels rising by more in real terms than public institutions' tuition levels. The growing dispersion in average faculty salaries across institutions within each sector is attributed primarily to the growing disperion of endowmentper student levels across private institutions and the growing dispersion of state appropriations per student across public institutions. Finally, controlling for other factors, those universities whose real research expenditures per faculty from institutional funds are growing the most experience the greatest increase in their student/faculty ratio, other variables held constant.

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I. Introduction

The study of academic labor markets by economists goes back at least to Adam Smith's suggestion in *The Wealth of Nations* that a professor's compensation be tied to the number of students that enrolled in his classes.[1] This paper focuses on three academic labor market issues that students at Cornell and I are currently addressing; the declining salaries of faculty employed at public colleges and universities relative to the salaries of their counterparts employed at private higher education institutions, the growing dispersion of average faculty salaries across academic institutions within both the public and private sectors, and the impacts of the growing importance and costs of science on the academic labor market and universities. To introduce these topics, I first briefly survey the reawakening of economists' interest in academic labor markets, which lay dormant for almost two centuries after Smith.

Projections of future shortages of faculty in the United States made during the 1970s led to a revival of scholarly interest in the academic labor market and, more specifically, in the determinants of the number of PhDs granted by American universities.[2] In a series of important papers and books written in the 1970s, Richard Freeman developed cobweb models of the supply of professionals and his models subsequently were extended by others to incorporate various assumptions about the role of cohort size and expectations about the future time path of professionals' salaries.[3]

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[1] Adam Smith (1976), p. 282-284. These pages are from Book V, chapter 1, Part III, Article II "Of the Expense of Education of Youth"

[2] Allan M. Cartter (1976)

[3] See for example, Richard Freeman (1971, 1975), David Stapleton (1989), Dennis L. Hoffman and Stuart A. Low (1983) and Aloysius Siow (1984).

To adequately model the supply side of the academic labor market requires much more complicated models. One needs to consider the determinants of undergraduates' choice of majors, the determinants of the flows of college graduates to PhD study from different majors both directly after graduation and with a delay, the determinants of PhD students' time to degree and completion rates, the changing role and lengths of postdoctoral appointments, the decision by new PhDs to accept academic employment rather than nonacademic employment, the flows of PhDs from the academic to the nonacademic sectors and vice versa and the retirement behavior of faculty. While research has been conducted on many of these topics during the last 30 years, our knowledge about many of them remains very imprecise.[4]

What is also imprecise is our knowledge of the determinants of the supply of foreign students to PhD study and the role of foreign PhDs in the academic labor market. When I received my PhD degree in 1970 only about 11.4% of all new PhDs and 18.6% of new PhDs in economics granted by American universities went to foreign students (students on temporary visas); in 2000 the comparable figures were 28.9% and 49.4%.[5] Foreign students make up an even larger share of new PhDs in some science and engineering fields and they and their countrymen who received their PhDs outside of the United States also make up a large share of all postdoctoral fellows working on biomedical research in the United States.[6] Foreign residents' ability to enter the country for study, let alone to stay and work in the United States either temporarily or permanently, depends

[4]. Much of the research though the early 1990s on these topics is summarized in Ronald G. Ehrenberg (1991, 1992). Ronald G. Ehrenberg and Panagiotis G. Mavros (1995) study the determents of time-to-degree and completion rates.
[5] These figures come from WebCaspar
[6] National Research Council (1998)

upon both employment opportunities in the United States and other nations and our immigration policies.

While concern has been expressed by some that the growth of foreign PhD students has been at the expense of underrepresented minority groups in the United States, the one study that examined this subject found that the best U.S PhD programs tend to discriminate against foreign students and in favor of under represented minority students in their admissions process.[7] That is, holding measures of applicant quality such as GRE scores constant, foreign students were less likely to be admitted to these programs and under represented minority students more likely to be admitted, than other U.S. citizen applicants.

The late 1980s saw the publication of an important book by William Bowen and Julie Ann Sosa that focused on demand side of the academic labor market and presented projections of a forthcoming shortage of faculty in Arts and Science disciplines.[8] A critique of the Bowen and Sosa book that I published in 1991, pointed out that their projections were based on a number of strict assumptions, the relaxation of any one of which could substantially alter their results.[9] One key assumption was that the student/tenure track doctorate faculty ratio, which had declined during the 1980s, would not increase in the future. However, it did increase during the 1990s, as American institutions of higher education increased their reliance on part-time and adjunct faculty members. This, along with tremendous inflows of foreign graduate students, kept the market for new faculty in balance. For example, between 1987 and 1998, the proportion

[7] Gregory Attiyeh and Richard Attiyeh (1997)
[8] William G. Bowen and Julie Ann Sosa (1989)
[9] Ronald G. Ehrenberg (1991). See National Research Council (2000) for a more recent critique of projection models of the demand for doctoral scientists and engineers.

of faculty members employed part-time in the United States rose from 33 to 42 percent.[10] As a result, real salaries of faculty did not increase substantially during the 1990s, which one might have expected to observe if shortages of new PhDs were materializing.

Why has the use of part-time and nontenure track faculty grown so rapidly in the United States? This growth flies in the face of models of prestige maximizing academic institutions employed by a number of economists to explain the "arms race of spending" that is taking place in selective private higher education.[11] A major reason for the growing use of part-time and nontenure track faculty is that the ability of a large fraction of American higher education institutions to generate the revenues necessary to pay for higher salaries for tenure track faculty is greatly limited.

The vast majority of American college and university students attend public higher education institutions and thus the vast majority of American professors are employed in these institutions. State appropriations to their public higher education institutions have not kept up with expenditure per student growth in private higher education during recent decades because of several recessions, because of the increased priority being placed on other uses of state tax revenues (such as elementary and secondary education, health, welfare, and criminal justice) and because of the pressure to reduce, rather than increase, state income and sales tax rates. In addition, in many states governors and state legislatures firmly are committed to the belief that in-state tuition should be kept low, which limits another major source of revenue for public higher education institutions.

As a result, the salaries of faculty in public higher education institutions have declined relative to the salaries of faculty in private higher education institutions over the

[10] Robin Wilson (2001)
[11] See, for example, Gordon Winston (1999) and Ronald G. Ehrenberg (2000)

last two decades. For example, in the fall of 1978, the average salary of professors at public research and doctorate granting institutions was 91 percent of the average salary of professors at private research and doctorate granting institutions. By 1993, this ratio had fallen to 79% and it has hovered around that level ever since.

The declining public/private academic salary ratio in the United States is well known and has been discussed in several places.[12] What is less recognized is that within both the public and private academic labor market sectors, an increase in the dispersion of average faculty salaries across universities has also taken place. As figure 1 indicates, the variance of the logarithm of average real full professor salaries across universities increased between 1978 and 2001 in both the public and private sectors and similar trends have been observed for associate professor (figure 2) and assistant professor (figure 3) salaries. Moreover, the increasing dispersion of faculty salaries across academic institutions is not confined to the major research universities. As figure 4 indicates, the variance across institutions in the logarithm of average real faculty salaries increased between 1973 and 1998 at all ranks in private liberal arts colleges as well.

II. Changing Public/Private Faculty Salary Differentials

The forces behind the decline in the average salaries of professors in public universities relative to the average salaries of professors in private universities are easy to identify. The weighted average real state appropriation per FTE student at public research universities remained roughly constant between 1985 and 1997[13]. While some publics

[12] See for example, F. King Alexander (2001), Ronald G. Ehrenberg (2000), chapter 2, Linda Bell (2000), Daniel Hamermesh (2002) and Cindy Zoghi (forthcoming)

[13] The statistics that follow come in large part from the NSF WEBCASPAR system. Weighted average real state appropriations per student actually declined between 1988 and 1993 and then rose in real terms between 1993 and 1998. It is this latter increase that partially explains why the average salaries of professors at public research universities did not decline relative to their private counterparts' salaries after 1993.

sought to increase their tuition levels at percentage rates that exceeded the percentage rates of increase of private tuitions, they were starting from a much lower absolute level and thus their real tuition level per student increased in absolute terms less than did the real tuition levels of their private counterparts. Not surprisingly then, the real expenditure per FTE student gap between public and private research and doctoral institutions has widened considerably since 1979.

In work in progress, Andrew Nutting and I have estimated logarithm of average salary equations, by rank, separately for public and private institutions using panel data that span the 1973-1998 period. Our models include as explanatory variables endowment per student, tuition (in-state tuition for the publics) and state appropriations per student, as well as institutional fixed effects. We find that between 50% and 60% of the change in the ratio of average public to average private professor salary at each rank between 1973 and 1998 can be explained by differences in the change in real tuition levels in the two sectors. The preoccupation with percentage rates of growth of tuition has led observers to forget that unless state appropriations per student increase at a rate of 2 to 3 percent a year above the rate of inflation, which is the rate at which historically private tuition growth has exceeded inflation, public tuition increases that are less in dollar terms than private tuition increases almost guarantee that faculty salaries at public higher education institutions will fall further behind those of their counterparts employed at private institutions.[14]

[14] William Bowen (1965) showed that tuition levels at a set of major private research universities outpaced the rate of inflation by an average of 2 to 3 percent a year for the first two-thirds of the 20th century and Ronald G. Ehrenberg (2000), chapter 1, presents evidence that the trend continued during the last third of the century.

The decline in the ratio of public university professors' salaries relative to private university professors' salaries surely makes it more difficult for public universities to hire and retain top faculty, especially at the senior level.[15] Anecdotal stories abound about public universities being raided by privates for their young tenured faculty members. In one recent year the University of Arizona, whose average faculty salaries at each rank was about at the mean of the average salaries across all public research and doctoral universities, lost 75 faculty members to other institutions in spite of the efforts it made to retain them with counter offers.[16]

National data on the turnover rates of tenured faculty is not readily available. However, each year the American Association of University Professors collects, as part of its survey of academic salaries, institutional level data on the numbers of full-time faculty in each rank in the previous year, that the institution also employs in the current year, regardless of what their ranks are in the current year.[17] Subject to some qualification, this permits one to compute a continuation rate for faculty members in each rank in each institution.[18] The continuation rate, or more precisely one minus the continuation rate, for assistant professors cannot be used as a measure of voluntary turnover as some assistant professors leaving an institution may do so because they are

[15] Dan Hamermesh informed me that in preliminary work he found no evidence that the increasing salary gap between public and private research universities led to a systematic decline in the number of public institutions ranked among the top 5 or 10 in the arts and science and engineering fields between the 1980s and 1990s National Research Council studies of faculty quality. However, when Nutting and I regressed the change in an economics department's NRC faculty quality rating between the 1980s and 1990s on its 1980s faculty quality rating and the percentage change in average full professor salary at the institution between 1982 and 1993, we found for institutions ranked in the top half of economics PhD programs in the 1980s, that higher salary growth was associated with a greater increase in the faculty quality rating.

[16] Scott Smallwood (2001)

[17] This means, for example, that faculty members who are associate professors in one year who are promoted to full professor in the second year are counted as continuing associate professors in the second year.

[18] These qualifications relate to the treatment of faculty who are serving as administrators or who are on leave in either the current or previous year.

involuntarily leaving because they have been denied tenure. The continuation rate for professors is "contaminated" by faculty departures due to retirement, disability and death. The continuation rate of associate professors, most of whom are tenured faculty, comes closest to approximating a voluntary retention rate.

When Hirsch Kasper, Dan Rees and I used the AAUP continuation rate data for the 1988-89 academic year we found that, other factors held constant, institutions with higher continuation rates tended to have higher average faculty salaries than their competitors. Moreover, the magnitude of this relationship was largest for research and doctoral institutions.[19] So given the falling ratio of the average salary of professors at public research and doctoral universities to the average salary of professors at private research and doctoral universities that had taken place by the early 1990s, it is reasonable to expect that the private institutions would have lower voluntary turnover rates and thus higher associate professor continuation rates than their public university counterparts during the decade of the 1990s.

The AAUP has provided Matthew Nagowski and me with institutional level data that has permitted us to compute continuation rates annually for associate professors at research and doctoral institutions during the decade of the 1990s. The weighted (by faculty size) and unweighted average continuation rates for a set of institutions that were in the sample in each year appear in figure 5. It is not surprising, given the gap between average salaries in the two sectors, that the average continuation rate for associate professors at private research and doctoral institutions did exceed the average

[19] Ronald G. Ehrenberg, Hirschell Kasper and Daniel I. Rees (1991)

continuation rate for associate professors at public research and doctoral institutions in every year.[20]

III. The Growing Dispersion in Average Faculty Salaries

The causes of the growing dispersion in the logarithm of average faculty salaries across institutions differ for private and public institutions. Our models attribute the vast majority of the growing dispersion across private institutions to the growing dispersion of endowment wealth. To understand why this is true, it is important to realize that even if two institutions experience the same percent increase in endowment per student during a period of time, the institution that has the highest initial level of endowment per student will gain more absolutely in endowment per student than the institution with the lower initial level of endowment per student.[21] If other sources of institutional income, such as tuition per student are not growing at rates that are as high in percentage terms as the rate at which endowment per student is growing, the institution with the larger initial endowment per student will see its total income per student growing by a greater percentage than its relatively poorer counterpart. Thus, it will be able to increase its average faculty salary level by a greater percentage during the period.

To illustrate why this is true, table 1 presents data relevant to the experience of two institutions, Princeton and Cornell, during the decade of the 1990s.[22] For simplicity,

[20] The associate professor rank is not a tenured rank at some private research institutions and thus some departures of associate professors at the privates are involuntary. This strengthens the conclusion that voluntary turnover is higher at the public institutions.

[21] See Ronald G. Ehrenberg and Christopher L. Smith (2001) for a more detailed discussion of this point.

[22] Cornell is a very complex institution. Three of its undergraduate colleges, the statutory colleges, receive financial support from New York State and in return, charge students from New York State much lower tuition levels. Faculty in these colleges have considerably lower average salaries than the average salaries of faculty in Cornell's endowed, or private colleges and it is the latter's average salaries that are used in the comparisons below. Finally, a substantial share of Cornell's endowment is "owned" by its medical college, which is located in New York City and these assets cannot be used to finance faculty salaries on the Ithaca campus. If I had subtracted the endowments owned Cornell's medical and statutory colleges, the Cornell

I assume in this table that the only sources of income to support faculty salaries are tuition revenues and spending from endowment.[23] Princeton, which has the largest endowment per student in the nation, saw its endowment per student grow from roughly $390,000 on July 1,1990 to about $1,323,000 on July 1, 2000, an increase of about 240%. During the same period of time, Cornell's endowment per student grew from about $51,000 to $186,000 an increase of over 260%. So Cornell actually experienced a greater percentage rate of growth of its endowment per student during the period.

Most academic institutions aim to spend roughly 5% of the value of their endowment, averaged over a number of years, each year on current operations.[24] To keep things simple, I further assume that during each academic year Cornell and Princeton each spent 5% of the value of its endowment as of July 1 of the year. With this assumption, Princeton's endowment would have provided the institution with $19,500 to spend per student in 1990-91 and $66,150 per student to spend in 2000-2001, an increase of about $46,650 per student over the decade. In contrast, Cornell's endowment would have provided it with spending of $2,550 per student in 1990-91 and $9,300 per student in 2000-2001, an increase of $6,750 over the decade. In spite of the fact that Cornell's endowment per student increased by a greater percentage than Princeton's during the decade, Cornell fell further behind Princeton in terms of the absolute number of dollars it had available to spend per student each year from its endowment.

Why this is important is that the level of the other source of revenue, tuition revenue per student, was initially very similar at the two institutions and then grew at

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endowment per student figures would be about 20 percent larger in both 1990 and 2000, but the increase would not be large enough to substantially alter my conclusions.

[23] I am ignoring other sources of revenue such as annual giving and research funding but these omissions do not change my argument in any way.

[24] Ronald G. Ehrenberg (2000), chapter 3, provides a discussion of why this is true

roughly the same rate during the decade; a rate that was much smaller than the rate of endowment growth. Cornell' s tuition grew from $15,164 to $24,852, an increase of 64%. Princeton's tuition grew from $15,440 to $25,430, an increase of 65%. Because Princeton's spending from endowment comprised a much greater share of its spending in 1990-91 than did Cornell's and tuition at both institutions grew at a much slower rate than endowment wealth did during the decade, the net result of these changes was that Princeton's total spending per student grew by 162% during the decade, while Cornell's "only" grew by 93%.

In this simple example, Princeton's total spending per student was 1.97 times Cornell's total spending per student in 1990-91. By 2000-2001, this ratio had increased to 2.68. You thus should not be surprised to learn that while the average salary of full professors at Princeton was 15% higher than the average salary of full professors at Cornell in 1990-91, by 2000-2001 Princeton's relative salary advantage had grown to 22%. [25]

More generally, Nutting and my estimates suggest that at the professor, associate and assistant professor levels about 75%, 90% and 95%, respectively, of the increases in the variance of the logarithms of average real faculty salaries across private research universities that are displayed in figures 1 to 3 can be explained by the growing inequality of endowment wealth across the private research universities during the period. For the private liberal arts colleges, the comparable percentages of the increases in the

[25] One might reasonably ask why the relative salary advantage of Princeton's faculty did not grow still more. The answer undoubtedly is that Princeton also used the increases in the spending that its endowment was generating for other purposes such as improving its undergraduate students financial aid packages, increasing the size of its graduate student stipends, reducing (relative to Cornell) its student/faculty ratio, improving the funding of its athletic programs and, in the future, will increase the size of its undergraduate student body and expand its graduate programs.

variances of the logarithm of average faculty salaries displayed in figure 4 that can by explained by the growing inequality of endowment wealth are 95%, 100% and 81% for the three ranks.

Our models suggest that for public research universities the growing variance in the logarithms of average real salaries is due both to growing endowment per student differences and growing differences in state appropriations per student. However for all three ranks changes in endowment per student play at best a minor role, never explaining more than 30% of the growing dispersion in the logarithm of average real faculty salaries. Most of the increase in the variances of the logarithm of average real faculty salaries across research institutions is due to growing differences in state appropriations per student across these institutions. Indeed, for assistant and associate professors, virtually all of the increase in the variances in the logarithm of faculty salaries is due to this factor.

The increased dispersion of average faculty salaries across institution in both the public and private sectors suggests that it is becoming increasingly difficult for some institutions to attract and retain high quality faculty. To the extent that faculty quality now differs more across institutions, where students go to college is likely to matter even more in the future than it has in the past.[26]

IV. The Growing Importance and Cost of Science

Scientific research has come to dominate many major American university campuses and this is reflected in the way that universities are ranked. *U.S News & World Report's* annual ranking of national universities as undergraduate institutions places heavy weight

[26] See Dominic J. Brewer, Eric R. Eide and Ronald G. Ehrenberg (1999) and Eric R. Eide, Dominic J. Brewer and Ronald G. Ehrenberg (1998)

on the volume of external research funding that faculty members at universities receive.[27] The 1994 Carnegie Foundation classification of PhD granting institutions into Research I, Research II, Doctoral I and Doctoral II institutions was similarly heavily based on the institutions' volumes of external research funding and institutions strove mightily to increase their funding to receive a higher classification in the next Carnegie classification revision.[28] Concerned that this behavior was causing universities to place too much weight on the volume of their faculty members' external research and not enough weight on the quality of their graduate programs, the foundation collapsed its four PhD categories into two in 2000 and based an institution's new classification solely on the number of PhDs that the institution produced each year.[29]

Viewed in terms of 1998 dollars, the weighted (by faculty size) average volume of total research and development expenditures per faculty member across 228 American research and doctoral institutions doubled from roughly $70 thousand dollars per faculty member in 1971 to about $140 thousand dollars per faculty member in 1998.[30] This growth in scientific research, which was driven by the availability of government, corporation and foundation funding, does not derive primarily from the various ranking and classification schemes, but rather derives from the major advances being made in science and the importance of these advances to our society. To take an example, recent advances in decoding the human genome, in advanced materials, and in information sciences promise major advances in health care treatments in the years ahead. Any university worth its salt wants to be a leader in these fields so that it can attract top

[27] *U.S News & World Report* (2001)
[28] Carnegie Foundation for the Advancement of Teaching (1994)
[29] Carnegie Foundation for the Advancement of Teaching (2001)
[30] The figures that follow are all computed from the NSF WEBCASPAR system

faculty, undergraduates and graduate students, as well as increased funding for its programs.

What many people do not recognize, however, is that in spite of generous external support for research, increasingly the costs of research are being borne by the universities themselves. During the same period of time, the weighted average institutional expenditures on research per faculty member at these institutions more than tripled. As a result, the weighted average percentage of total research expenditures per faculty member coming from institutional funds rose from about 11 to 20 percent. Increasingly academic institutions are bearing a greater share of the ever-increasing costs of scientific research.

As I have discussed in detail elsewhere, there are a number of forces that have led the costs of research borne by universities to soar over the past three decades.[31] Theoretical scientists, who in a previous generation required only desks and paper and pencil, now often require access to supercomputers. Experimental scientists increasingly rely on sophisticated laboratory facilities that are expensive to build and operate. Research administration now includes strict monitoring of financial records and environmental safety, as well as the detailed review and monitoring of experiments involving human subjects.

Historically the federal government and other external funders through their provision of indirect cost recoveries have funded much of the costs of the research infrastructure that universities operate, as well as their research administration costs. Each institution was allowed to "mark-up" the direct cost that its faculty members requested of external funders for their research funding by a multiple called the indirect cost rate and the

[31] Ronald Ehrenberg (2000), chapter 6

indirect cost revenues received on successful grant applications went to support the institution's research administration and infrastructure costs.

As panel A of figure 6 indicates, the average indirect cost rate across the 228 research and doctorate institutions was about 50% in 1983 and this rose to about 51.5% in 1989. Then, in a well-publicized case involving Stanford University in the early 1990s, government auditors alleged that items some expenditures included in Stanford's indirect costs were not legitimately related to research and that Stanford had overcharged the federal government for these costs by as much as $200 million to $400 million over a ten-year period.[32] The two-parties ultimately agreed to settle the dispute by Stanford's repaying $1.5 million to the government and without its making any admission of wrong doing. However, the damage had been done, auditors began to take a much harder look at universities' requests for indirect cost recoveries and put caps on the percentages that institutions could claim for expenses in the various categories. As result the average indirect cost rate fell to about 49.5 percent in 1997.

Averages can be misleading, however, because as panel B of figure 6 indicates, in 1983 the average indirect cost rate at private research and doctoral universities was over 60 percent, while the average at public research and doctoral universities was about 45 percent.[33] By 1997 the average private indirect cost rate had fallen to about 55 percent

[32] See Donald Kennedy (1997), p. 164- 175 for an insider's view of this incident.

[33] The lower average indirect cost rate for public universities does not imply that they spend less on research administration and infrastructure than their private counterparts. Rather, much of the funding they receive for infrastructure comes from their states in the form of financial support for buildings and the states usually do not require their universities to recoup these costs and return them to the state government. Since faculty believe that high indirect cost rates result in a reduction in their probability of winning grants and/or a reduction in the amount of direct costs that they can apply for, they put pressure on public university administrators to keep their indirect cost rates low. The administrators have obliged but, as state support became tighter in the 1990s, many publics allowed their indirect cost rates to float up a bit. Interestingly, the only study of the effect that indirect cost rates have on the size of direct cost awards and

while the average public indirect cost rate had risen slightly. So the decline in indirect cost rates was felt primarily by the private research universities and on average, for any given level of direct cost research funding that their faculty members received, they received about 8.3 percent less funds from the federal government to support their research infrastructure and administration in 1997 than they did in 1983.

What is the likely response of an institution faced with such a reduction in external support for research infrastructure and administration? On the one hand, it might try to reduce its expenditure in these areas to match the decline in the external support it was receiving. But such a strategy would alienate its faculty, who would see the institution's commitment to research declining.[34] In addition, if reductions were made in areas in which the institution was not spending more than the maximum that the federal government permitted it to charge, the federal auditors would respond by further reducing its indirect cost rate in the next year. Hence the university would get a double whammy, irate faculty and still lower indirect cost revenue the next year. So invariably administrators made up the reduction in external funding for research administration and infrastructure out of institutional funds.

The reduction in indirect cost rates for external research has been matched in recent years by increasing pressure on institutions to provide "matching" institutional funds for any research proposals that they submit. Put another way, to compete for external funding increasingly institutions had to bear a share of the direct costs of their

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the probability of winning an award, Ronald G. Ehrenberg and Jaroslava K. Mykula (1999) found no evidence that faculty members' perceptions about the adverse effects of high indirect rates is correct.

[34] Picture a Cornell provost contemplating the length of his future tenure in office if he announced to the faculty that he was going to reduce the budget of the library by $3.5 million dollars because the federal government had reduced the support that it had provide for the library budget by that amount (which it did one year).

faculty members' research out of their own pockets. This further increased institutional costs for research.

Finally, as scientists' equipment became more expensive and the competition for top-quality young scientists intensified, the start-up funds that universities needed to provide to attract young scientists and engineers increased by the late 1990s it was not unusual to find universities providing $500,000 to $1,000,000 of funding to young scientists to help them set up their laboratories. The costs of attracting distinguished senior scientists were even larger.

How have universities responded to the increasing importance and costs of science? One might expect that the growing importance of science has provided an incentive for universities to allocate a greater share of their faculty positions or faculty salary dollars to scientists. However, using data from a set of liberal arts colleges at leading private research universities, a study that Julia Epifantseva and I conducted found, on balance, that over a recent 20-year period neither the share of faculty positions nor the share of the faculty salary budget devoted to the sciences in these research universities' liberal arts colleges had systematically increased during the period.[35] Controlling for the growth of enrollments in the various disciplines or for whether overall faculty size was increasing or decreasing did not alter these conclusions.

Of course it may well be that the increasing costs of science are felt throughout a university's budget. To the extent that more funds from annual giving and endowment income are directed towards support of the scientific infrastructure, it may put upward pressure on undergraduate tuitions or cause cut backs in other areas. Since the faculty salary bill represents a large chunk of institutional costs, it is possible that the increased

[35] Ronald G Ehrenberg and Julia Epifantseva (2001)

costs of science are distributed throughout the university in the form of slower rates of increase of faculty salaries and/or slower rates of growth of faculty employment than would other wise be the case, all other factors held constant.

In research in progress, Michael Rizzo and I have tried to test for the effects of the increased costs of science on faculty salary and employment levels using panel data and models similar to those discussed earlier. Using 22 years of data and a panel of 228 research and doctoral institutions we estimate whether the average faculty salary level at an institution or its student/full-time faculty ratio is related to the level of its research expenditures per faculty member out of institutional funds, after one controls for institutional and year fixed effects, endowment per student, annual giving per student, undergraduate tuition levels, state appropriations per student and enrollment. While we find no evidence that more rapidly increasing institutional research expenditures are associated with slower growth rates in average faculty salaries, we do find strong evidence that they are associated with increases in the institutions' student/full-time faculty ratio.[36] On average, holding all other factors constant, an increase in institutional research expenditures of $10,000 per faculty/ member (in real terms) is associated with an increased student/faculty ratio of close to one. Moreover the magnitude of this relationship is larger at the private research universities, where indirect cost rates declines have occurred.[37]

Of course reducing the total number of faculty salary across all fields may not be the only route via which the increased costs and importance of science are felt at

[36] Our faculty salary results are very preliminary because we have yet to solve the endogenity problem posed by faculty salary levels being a major determinant of research costs.
[37] Our estimates suggest then, that undergraduate tuition dollars are increasingly being used to subsidize research in the sense that higher student/full-time faculty ratios imply fewer courses offered, larger class sizes, more use of teaching assistants, and/or more use of adjunct and other part-time faculty.

universities. It is possible that in spite of the increased demand for teaching placed on colleges of arts and sciences at these institutions, as professional programs require more and more liberal arts courses, that the share of faculty positions in major private research universities going to colleges of arts and sciences has declined over time, as the shares going to more colleges that are much more heavily oriented towards scientific research, such as engineering and medicine, have increased. This conjecture cannot be tested in a straightforward manner because external research funding provides the support for a large fraction of faculty positions in some universities in engineering and medical colleges.

The growth of science may have crowded out things other than faculty at universities. For example, increased institutional provision of research assistants for the scientists may have led to the decreased availability of internal funds to support teaching assistants in the humanities or social sciences. Or increased institutional support for scientific research facilities and start-up costs for scientists may have reduced the funding that otherwise would have been available for travel and other "perks" in the humanities and the social sciences. Research on the impact of science on the university is clearly still in its infancy.

V. Concluding Remarks

The study of academic labor markets by economists has encompassed many more topics than I have touched upon. For example, because faculty salary data are often public information and measures of productivity can sometimes be developed, labor economists have estimated how faculty productivity varies with age, whether faculty salaries are tied to productivity and the extent that gender and racial/ethnic differences in

faculty salaries and promotion probabilities exist.[38] We have investigated whether universities have monopsony power in the market for senior professors, built models to provide explanations for the tenure system and estimated whether there are compensating wage differentials for low tenure probabilities.[39] We have studied how the end of mandatory retirement has influenced faculty retirement behavior and estimated the effectiveness of retirement incentive programs for faculty.[40] We have estimated the impact of unions on faculty salaries and working conditions, as well as on college and university staff members' salaries and tried to infer the values of university trustees from studying the compensation changes of university presidents.[41]In spite of all of these contributions, research on academic labor markets and, more generally, the economics of higher education, is still at an early stage. I hope that this paper will encourage more economists to study these issues.

[38] Sharon Oster and Daniel Hamermesh (1998), Daniel Hamermesh, George Johnson and Burton Weisbrod (1982), James Monks and Michael Robinson (2000) and Alison Booth, Jeff Frank and David Blackaby (2001)

[39] Michael S. McPherson and Morton O. Schapiro (1999), Aloysius Siow (1998) and Ronald G. Ehrenberg, Michael W. Matier and David M. Fontenella (2000)

[40] Orley Ashenfelter and David Card (2001), Robert L. Clark, Linda S. Ghent and Junita Krebs (2001) Ronald G. Ehrenberg, Michael W. Matier and David Fontenella (2001) and John Pencavel (2001)

[41] Daniel Rees (1993, 1995), Debra Barbezat (1989), Daniel B. Klaff and Ronald G. Ehrenberg (2002) and Ronald G. Ehrenberg, John Cheslock and Julia Epifantseva (2001)

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Figure 1
R1 Full Professor Variance of Log Salary

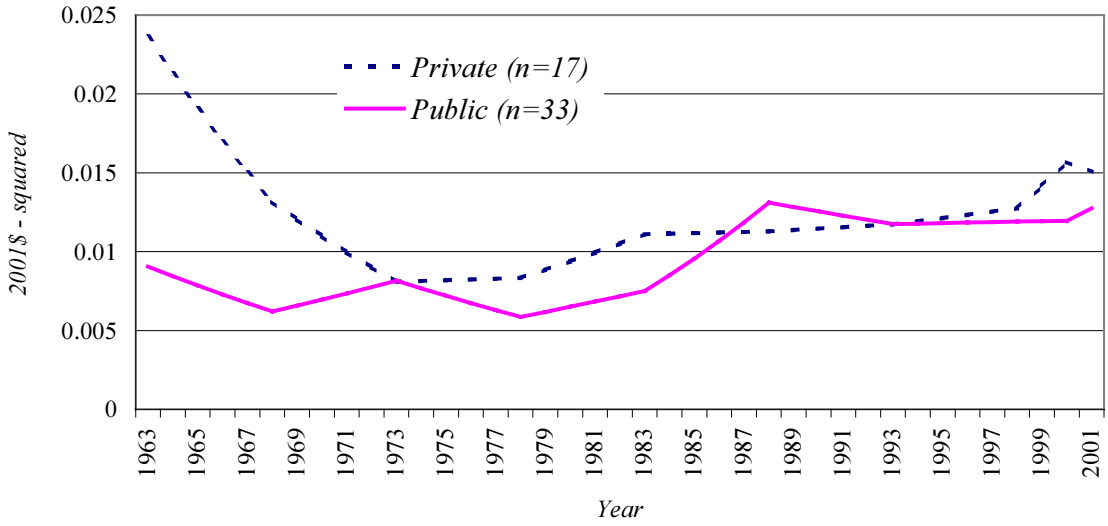

Figure 2
R1 Associate Professor Variance of Log Salary

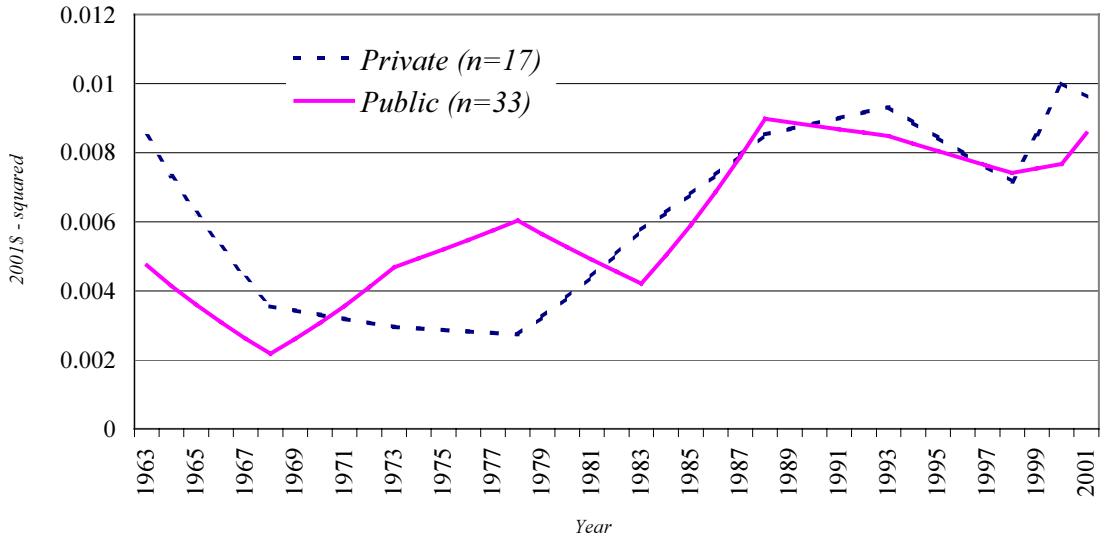

Figure 3
R1 Assistant Professor Variance of Log Salary

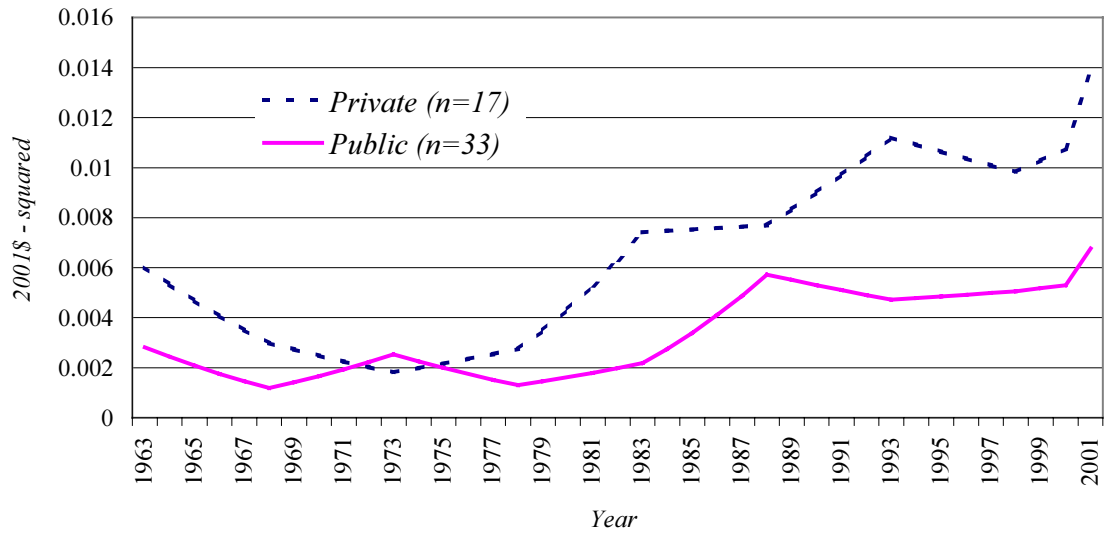

Figure 4
Liberal Arts Colleges Variance of Log Salary

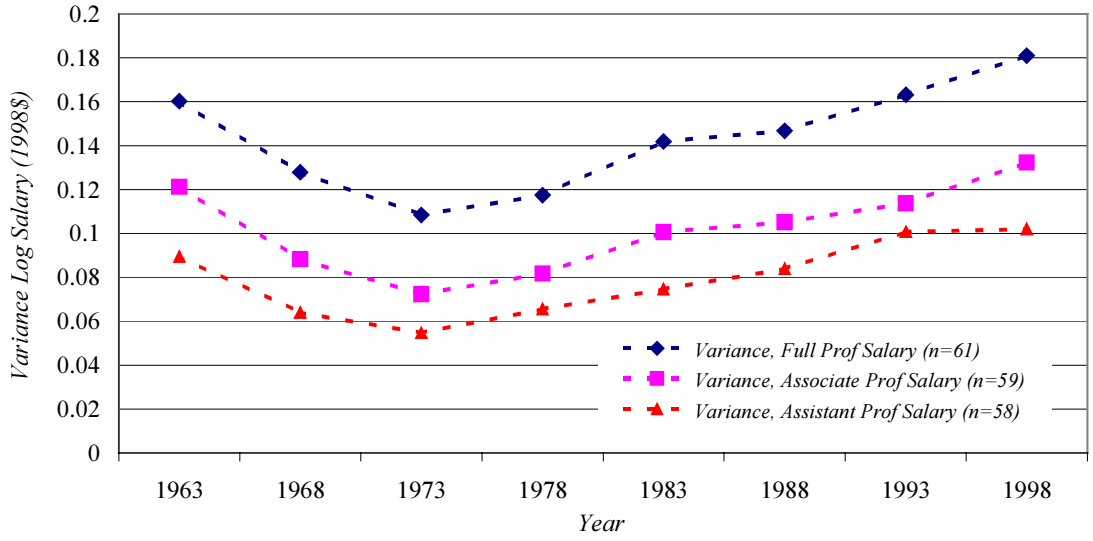

Figure 5
Continuation Rate of Associate Professors at Private and Public Universities

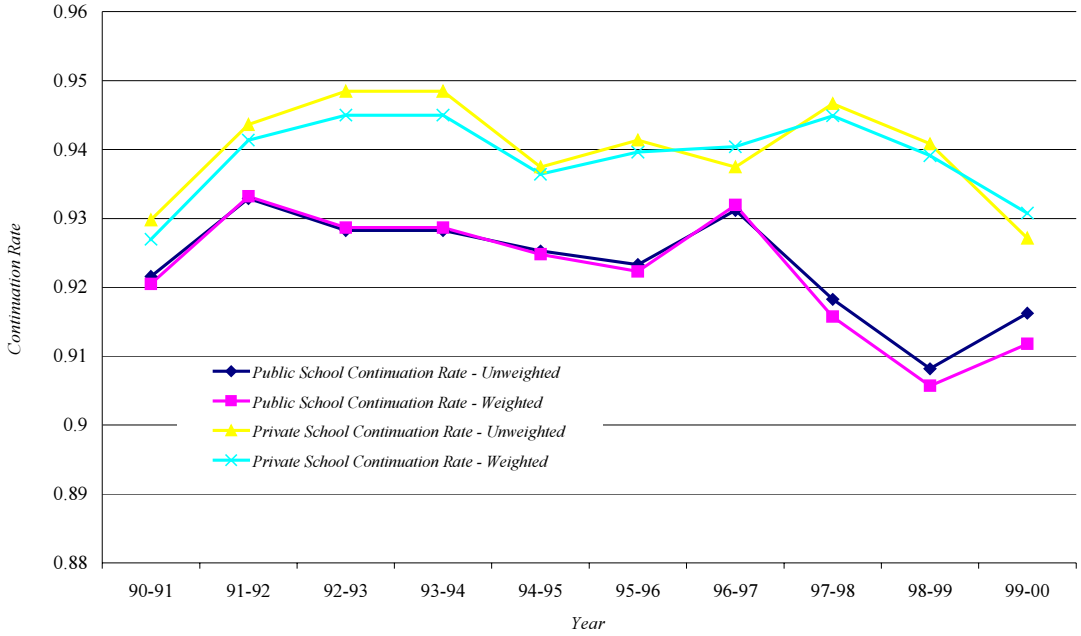

Table 1

Hypothetical Comparison of Cornell's and Princeton's Spending Per Student and Average Professor Salary Levels*

	Cornell	Princeton	Ratio(P/C)
1990-91			
(1) July 1 Endowment/Student	51,000	390,000	
(2) 5% of July 1 Endow/Stud.	2,550	19,500	
(3) Tuition	15,164	15,440	
(4) Spending Per Student ((2)+(3))	17,714	34,940	1.97
(5) Average Professor Salary	71,500	82,400	1.15
2000-01			
(1) July 1 Endowment Per Student	186,000	1,323,000	
(2) 5% of July 1 Endow/Stud	9,300	66,150	
(3) Tuition	24,852	25.430	
(4) Spending Per Student ((2)+(3))	34,152	91,580	2.68
(5) Average Professor Salary	103,000	125,700	1.22
Growth Rates Over The Decade			
Endowment	265%	239%	
Tuition	64%	65%	
Spending Per Student	93%	162%	

*** These comparisons are hypothetical because they assume that the institutions each spent 5% of the July 1 value of their endowments in each year and the comparisons ignore all sources of spending other than endowment and tuition income.**

Figure 6
Indirect Cost Recovery Rates at
All Research and Doctoral Institutions: 228 Schools

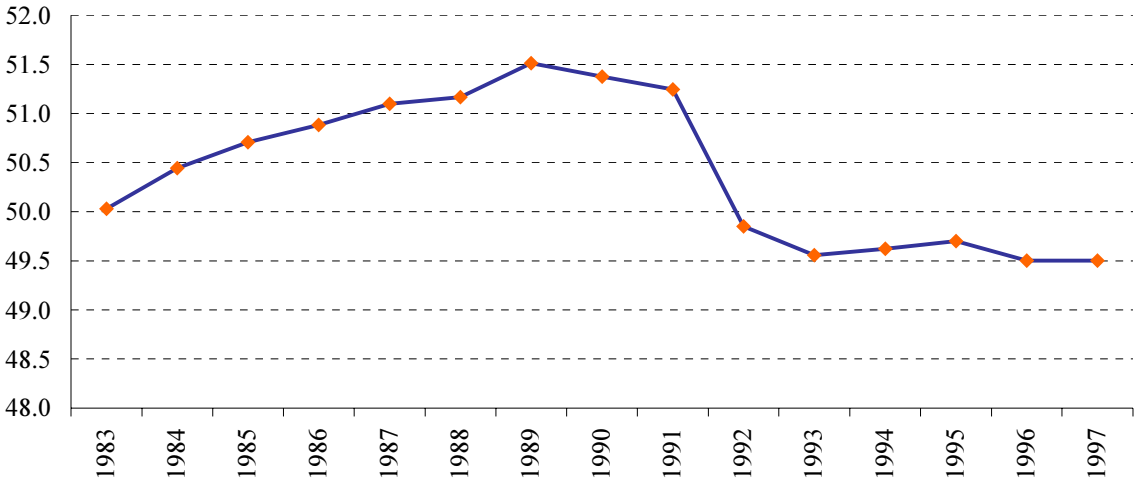

Figure 6
Indirect Cost Recovery Rates at
All Research and Doctoral Institutions
228 Schools by Institutional Control