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Faculty without Students: Resource Allocation in Higher Education

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Colleges and universities display substantial differences in the ratio of students to faculty across fields or disciplines. At Harvard University, for example, economics has about 16 majors (students majoring in the subject) per full-time-teaching equivalent, while in other departments such as astronomy, Slavic, German, and Celtic, the number of teaching faculty exceeds the number of majors. At the University of Virginia, the economics department teaches almost three times as many student credit hours (a measure of hours in the classroom multiplied by number of students in the class) as does the German department.

We begin by presenting some evidence on the extent of the variation in faculty resource allocation by field and the broad changes over the last several decades. We then consider potential economic explanations for these striking patterns. For example, a basic education production function, which seeks to maximize aggregate student learning subject to a faculty salary budget constraint, will require that faculty be allocated across fields so that relative marginal gains in student learning equal relative faculty salaries. Differences across fields in student–faculty ratios could then arise either from differences in the pedagogical technology across fields or variation in relative faculty salaries. Additional university goals, such as research and graduate program productivity, or adjustment costs, as imposed by the tenure system, could also generate variation across fields in student–faculty ratios. However, we have only limited evidence that these arguments can explain the ongoing

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disparities in student–faculty ratios across fields and disciplines, which suggests that a substantial part of the explanation may reside in the politics rather than the economics of decision making in institutions of higher education.

Evidence on Disparities and Slow Adjustment

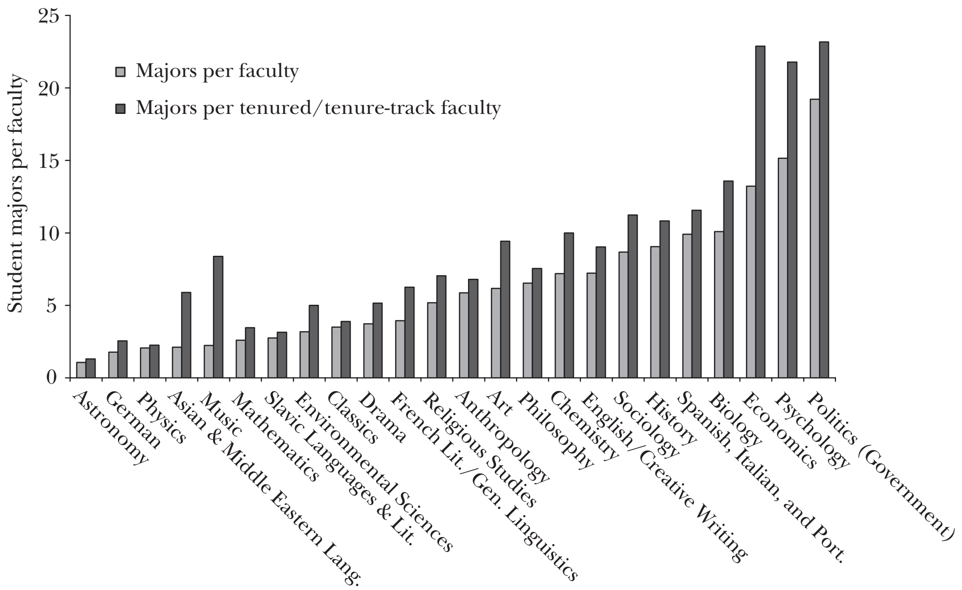
Cross-discipline Disparities

Student–faculty ratios at our home institution, the University of Virginia, a selective public institution, can serve as a useful point of departure. Figure 1 shows the distribution of undergraduate majors per faculty member. Three social science disciplines—economics, psychology, and politics—have more than 20 majors per tenure-track faculty member. Even expanding the definition of faculty to include non-tenure-track faculty (which in the case of economics are mostly graduate students teaching independently), the ratios are still in the double digits. At the other end of the distribution, we find a collection of physical sciences (notably physics and astronomy) and languages such as German and Slavic where majors per faculty are fewer than five. This variation in ratios of majors to faculty observed at the University of Virginia is not unusual; similar metrics from other colleges and universities suggest strong parallels.

No systematic data on both course-taking patterns and faculty counts by field seem to exist across all institutions of higher education; thus, to compare student–faculty ratios by field across institutions we must bridge across available data sources. We have data on faculty by field for three types of institutions: land-grant universities and private and public universities with graduate programs ranked by the National Research Council (with some overlap between public universities with ranked doctorate programs and the land-grant universities). Data on the field in which undergraduate degree recipients majored are collected nationally by institution by the Department of Education. Combining the data on majors and faculty provides a window on the systematic dispersion in student–faculty concentrations across institutions.[1] Figure 2 compares the ratio of graduating majors to faculty by field for private and public research universities (panels A and B) and land-grant public universities (panel C) with the lines indicating the range in the ratios of Bachelor of Arts (BA) degrees to faculty from the 25th to the 75th quartile in the distribution, and the square dots indicating the mean BA-to-faculty ratio. The basic patterns are clear: the social science fields of psychology, political science, sociol-

[1] Counts of faculty by rank and field at the institutional level are collected as part of the Oklahoma State University Salary Survey of land-grant universities. We are able to use data from 45 universities; note that we do not have access to the salary data at this level of disaggregation. In addition, we have cross-section data on faculty counts in addition to measures of department quality, graduate students, and research output from the 1995 National Research Council ranking of graduate programs; these data are assembled in the report *Research Doctorate Programs in the United States: Continuity and Change* (Committee for the Study of Research-Doctorate Programs in the United States, National Research Council, 1995).

Figure 1
Distribution of Majors per Faculty across Subject Areas, University of Virginia, 2004

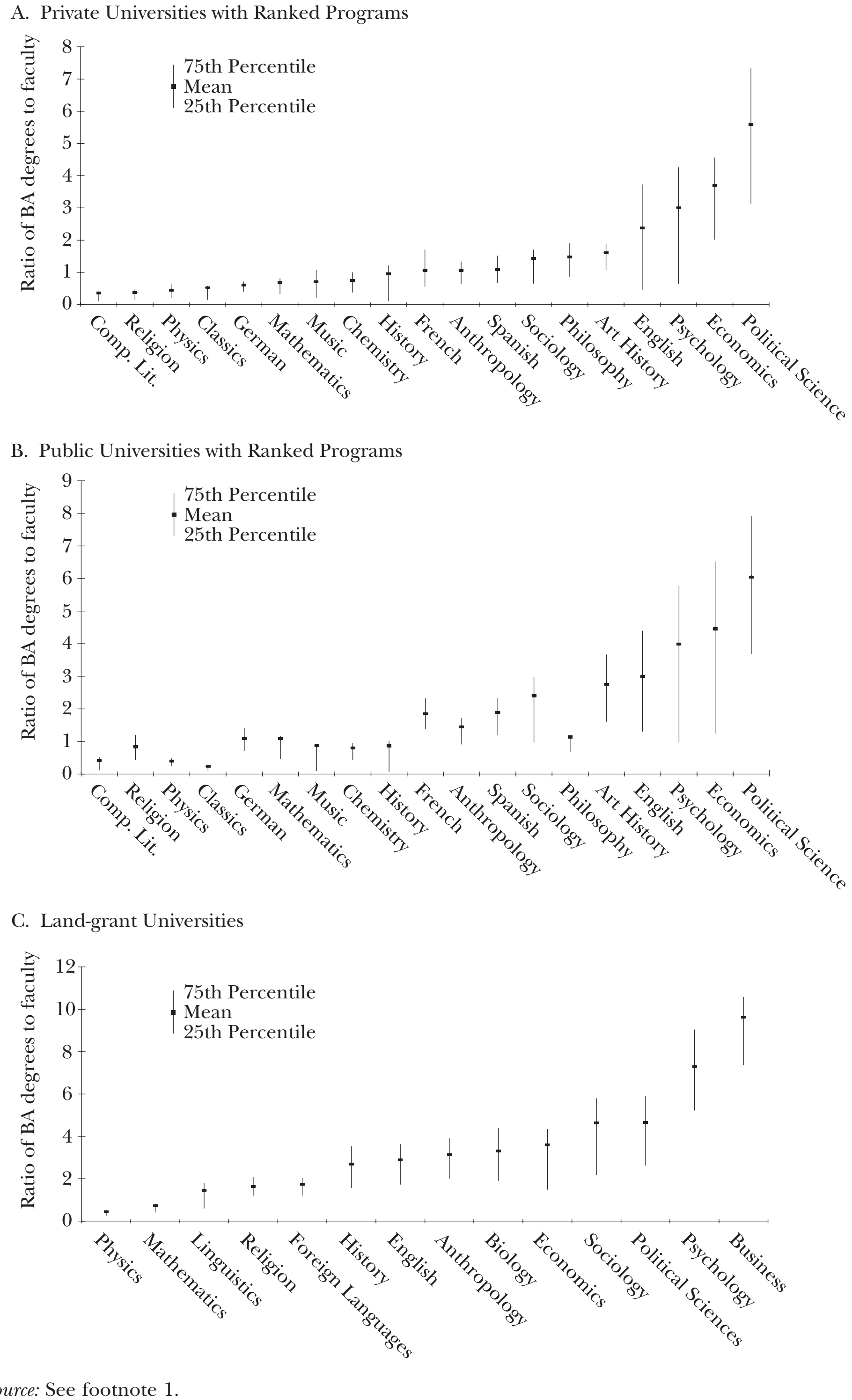


Note: "Majors" include all undergraduate students with declared major fields of study.

ogy, and economics tend to have appreciably higher ratios of majors to faculty than most departments in the physical sciences or humanities.

An obvious question is whether data on choice of major by students is a fair reflection of student demand for courses. After all, some disciplines, such as math or physics, consistently enroll many students in certain courses, but typically have relatively few majoring in the field. Many students may value the chance to take, say, several years of study in a foreign language, even if they ultimately do not choose to major in that subject. These factors imply that the number of majors may misrepresent student demand for courses. Even the observed choice of major may not entirely reflect the pure student demand for majors. If students prefer lower student–faculty ratios, but popular majors have high student–faculty ratios, then the choice of an unusual major may partly reflect student desire for lower class sizes. In this case, differences in choice of major may understate the variation in tastes for different courses of study to the extent that institutions do not fully accommodate student preferences. Indeed, some departments or university administrators make it more difficult to major in the oversubscribed fields and easier to major in the sparsely-populated disciplines, which also implies that the observed differences in major counts between more- and less-crowded disciplines will understate the variation in student demand for these disciplines.

Figure 2
Distribution of the BA Degree to Faculty Ratio across Selected Fields and Universities



Source: See footnote 1.
Note: Figure 2 compares the ratio of graduating majors to faculty by field for private and public research universities (panels A and B) and land-grant public universities (panel C) with the lines indicating the range in the ratios of Bachelor of Arts (BA) degrees to faculty from the 25th to the 75th quartile in the distribution, and the square dots indicating the mean BA-to-faculty ratio.

Universities may also attempt to affect student demand for courses outside the major. Most institutions require that courses be taken in specified areas such as foreign languages, science, humanities, English, and so on. Such general education requirements may arguably be a useful part of higher education, but to the extent that they have an effect on the courses that students actually choose, they move enrollments away from what student demand would otherwise have been. Typically departments, especially those with lagging enrollments, are intensely interested in these requirements as they afford a way to boost student enrollments in the department, an observation which suggests that political economy forces as well as economic forces may be at play here. We describe a political economy model in the final section of the paper.

Because most of our data on students concern majors rather than course enrollment, it is important to know whether the patterns we observe for majors are likely to hold for broader measures of course enrollment too. Using course enrollment data for several institutions—University of Virginia, Yale University, Williams College, UCLA, and the University of Minnesota—Table 1 shows that large differences across departments persist when the unit of analysis is credit hours taught per faculty member (that is, weekly classroom hours for the faculty member multiplied by number of students in class) rather than majors per faculty member. Because each institution measures students differently, we index the median department to 100. As Table 1 shows, departments at the 10th percentile of credit hours per faculty for their institution typically teach about two-thirds as much as the median, while departments at the 90th percentile for their institution had about 130–200 percent of the credit hours per faculty member taught by the median department. All five schools display substantial variation in the number of students served per faculty member. Still, the dispersion in credit hours per faculty member is not as large as the dispersion in majors per faculty.

Changes in Student Concentrations over Time

Aggregate trends in choice of major show a substantial "flight" from arts and sciences disciplines between the late 1960s and the mid-1980s, which can be decomposed into two factors: first, shifts in the concentration of higher education enrollment toward institutions concentrating in preprofessional preparation (Turner and Bowen, 1990); and second, changes in student demands within institutions.

The share of all BA degrees awarded by private research universities (like Harvard) and liberal arts colleges (like Williams) is small and has declined over the last four decades, falling from 5.8 to 3.6 percent for universities and from 5.7 to 3.5 percent for liberal arts colleges. In general, research universities and liberal arts colleges offer curricula based on arts and sciences fields, while many public and private institutions outside these spheres offer programs of study with greater

Table 1
Variation in Student–Faculty Ratios across Departments at Five Institutions

Department percentile (in terms of student credit hours taught per faculty member)	*University of Virginia*	*Williams College*	*Yale University*	*UCLA*	*University of Minnesota*
	Student–Faculty Ratio Relative to Median Department (Median department indexed to 100)				
10	72	62	63	67	63
25	84	83	79	91	88
75	130	128	131	121	136
90	157	137	178	133	205

Note: Student credit hours taught per faculty member for a department is the product of weekly classroom hours and the number of students in the class summed over all courses taught by the department and divided by the number of departmental faculty. UCLA is University of California, Los Angeles.

professional emphases.[2] Thus, as the concentration of undergraduate students moves away from research universities and liberal arts colleges, the concentration of majors naturally shifts to professional fields.

Within-institution changes in choice of major combine cyclical changes in labor market prospects with secular trends in areas of study. When undergraduates select among fields, their decisions are based at least in part on their long-run predictions for earnings in a particular field, as well as their own expectations for labor force participation. Engineering is an example of a field where the number of student majors responds significantly to changes in economic prospects. Freeman (1976) modeled the adjustments among college degree recipients to cyclical changes in the opportunities for U.S.-trained engineers.[3] The share of all BA degrees awarded in engineering and related technical fields has fluctuated from about 10 percent in the early 1950s, down to 5 percent in 1976, up to 10 percent in 1985 and then back down to 6 percent in 2005, with sharper fluctuations in the industry-specific subfields such as aerospace and petroleum engineering.

However, fields outside engineering exhibit much less transitory variation in student choices. Indeed, the largest changes in the distribution of students across fields of study have involved long-term shifts. Particularly visible at the comprehensive public universities has been the sustained shift from majors in education to

[2] "Research Universities," as classified by the Carnegie system, offer a full range of baccalaureate programs, offer at least 50 doctorate degrees per year, and receive substantial federal funding; "Liberal Arts Colleges" are primarily selective undergraduate colleges that emphasize baccalaureate degree programs, awarding 40 percent or more of their baccalaureate degrees in liberal arts fields.
[3] Freeman's (1976) study of the engineering labor market emphasized the responsiveness of enrollment and major choice among BA recipients to factors affecting the demand for engineering, including R&D and durable goods spending. While one might suspect that short-run labor market conditions should not affect the long-run prospects for an area of study, Kahn (2006) shows that initial salaries do have substantial implications for long-run earnings trajectories.

majors in business. In 1966, 34 percent of BAs at these institutions were awarded in education, while only 13 percent were in business. However, the late 1960s represented a peak in the demand for new teachers, with the progression of the baby-boom generation through elementary and secondary school. By academic year 2005, the proportions had flipped and only 11 percent of majors were in education while 27 percent were in business fields.

The growth in career opportunities for women outside of teaching and, more generally, the changing labor force attachment of women are closely intertwined with this observed change in the choice of majors. Women shifted from a distinct minority of BA degree recipients in the early 1950s at about 30 percent of all BAs, to parity in BA degrees around 1982, and by 2005 women earned a distinct majority of about 58 percent of all BA degrees. As this shift gained momentum in the 1960s, a common prediction was that these additional female college students would enter traditionally "female" fields. For example, when Princeton University evaluated the effects of admitting women in the late 1960s, one argument was that the marginal cost of admitting women was quite small, because women would likely concentrate in the humanities fields like English, Romance Languages, and Religion where faculty were "underutilized" (Patterson, 1968, p. 13, 40). Instead, women exited both humanities departments and the professional field of education at the national level from 1970 to 1986 and turned to business, the life sciences, and the social sciences.[4] Indeed, most of the movement in choice of discipline is attributable to this shift in the choices of female students. A primary question for our analysis is whether these significant changes in student demand were incorporated in faculty hiring decisions in subsequent years.

Changes in Faculty Relative to Student Demand

From our perspective, the ideal data to calculate student–faculty ratios would include both course enrollments by field, institution, and year for the numerator and data on faculty by field, rank, institution, and year for the denominator. While data on changes in undergraduate majors by institutions are readily available, faculty counts by field, institution, and rank are not available across the full spectrum of colleges and universities. The Department of Education collects total faculty counts by institution (not field), but no data are collected at the national level on faculty by field and institution.[5] This absence of data significantly limits our capacity to calculate staffing ratios by field across institutions and over time.

[4] In this journal, Goldin, Katz, and Kuziemko (2006) show clearly that women's early expectations for labor force participation in their 30s changed dramatically between the 1960s and the 1980s, with consequent effects on educational investments and attainment. As women's lifetime labor force participation has approached that of men, their field choices have shifted away from education.

[5] Bowen and Sosa (1989) employ data from the *Survey of Doctorate Recipients* with data on degrees conferred and undergraduate enrollments to calculate student–faculty ratios by broad field and institution type in 1977 and 1987 within the arts and sciences fields. We do not follow this strategy because the source faculty data are limited to Ph.D. recipients from U.S. institutions and will necessarily do a poor job of capturing faculty in the professional fields like business where many faculty may not hold doctorate degrees.

Although conventional data sources do not allow disaggregation of student–faculty ratios by field of study, they can be used to document substantial variation over time and across institution types in the *overall* ratio of faculty to total enrollments. Bound, Lovenheim, and Turner (2007) show that the variance across institutions in student–faculty ratios has increased over time, with the most selective institutions experiencing declines in student–faculty ratios between 1972 and 1992, while at many less selective institutions, particularly in the public sector, student–faculty ratios have actually risen.

The question of how (or whether) institutions adjust to changes in total enrollment differs somewhat from the question of how institutions adjust to changes in fields of specialization conditional on enrollment. In the first case, expansion or contraction in student–faculty ratios is the outcome of a resource allocation choice at the point of student admission or enrollment. In the latter case, an institution changes the deployment of faculty resources across fields in response to changes in student preferences for fields given a fixed number of students and expectations about the fields chosen by those students. This adjustment process is complicated by time and resource costs of hiring, contractual limitations in downside adjustments (like tenure), and the absence of viable opportunities for substitution across fields.

To measure these changes across fields within institutions, we have obtained access to a unique set of data for public universities maintained by Oklahoma State University that includes data on faculty by rank and field from 45 institutions from 1985 to 2001. These data are far from ideal—they cover only the subset of institutions who gave us permission to use their data—but it is a subset that we feel is representative of large public research universities and also represents the only available extended database covering faculty headcounts by rank.

Figure 3 uses these data to describe the broad trends over time in four categories: for each of eight fields from 1984 to 2001, the diamonds connected by a solid line show the ratio of BA degrees to faculty, measured on the left-hand axis; the squares connected by a solid line show the ratio of all degrees (including graduate degrees) to faculty, measured on the left-hand axis; the dotted line with triangles shows total BA degrees, measured on the right-hand axis; and the dotted line with *x*'s shows total degrees, measured on the right-hand axis. An immediate observation is the large difference in ratios of degrees to faculty across fields, with the ratio for areas such as business nearly five times the level observed for the one humanities field depicted, history. In many cases, student–faculty ratios expand and contract somewhat over time with changes in degrees awarded. Biology and psychology trended up throughout the 1990s, while business turned up in the latter half of the decade, reflecting increases in student demand in these fields. Overall, economics BA degrees show no rise in this data—and, indeed, some decline since the mid-1990s. The overall pattern here seems to be that while economics BAs have risen markedly at many private research universities and liberal arts colleges in recent years, many of the public universities represented in the data in Figure 3 have substantial undergraduate business programs, which are either substitutes for a major in economics or overlap substantially (as is the case when departments of economics are situated within colleges of business).

How far back do these sustained differences in student–faculty ratios across fields go? As a preliminary answer to this question, we counted faculty by field from directories at the University of Virginia going back to the 1950s. At least at the University of Virginia, the rank order of differences across fields is long-standing: for example, chemistry, physics, and the foreign languages have hovered at around 1 to 2 BA degrees per faculty member per year, or less, from the 1960s up to the 2005–2006 academic year. In contrast, economics and political science moved from 3–4 BA degrees per faculty member per year at the start of 1970s to close at about 9 degrees per faculty member in 2005–2006. Total graduates from the University of Virginia tripled from 740 to 2,492 between 1966 and 1980, which suggests that the growing numbers of students were disproportionately drawn to fields like economics and politics, and that faculty numbers did not respond proportionately.

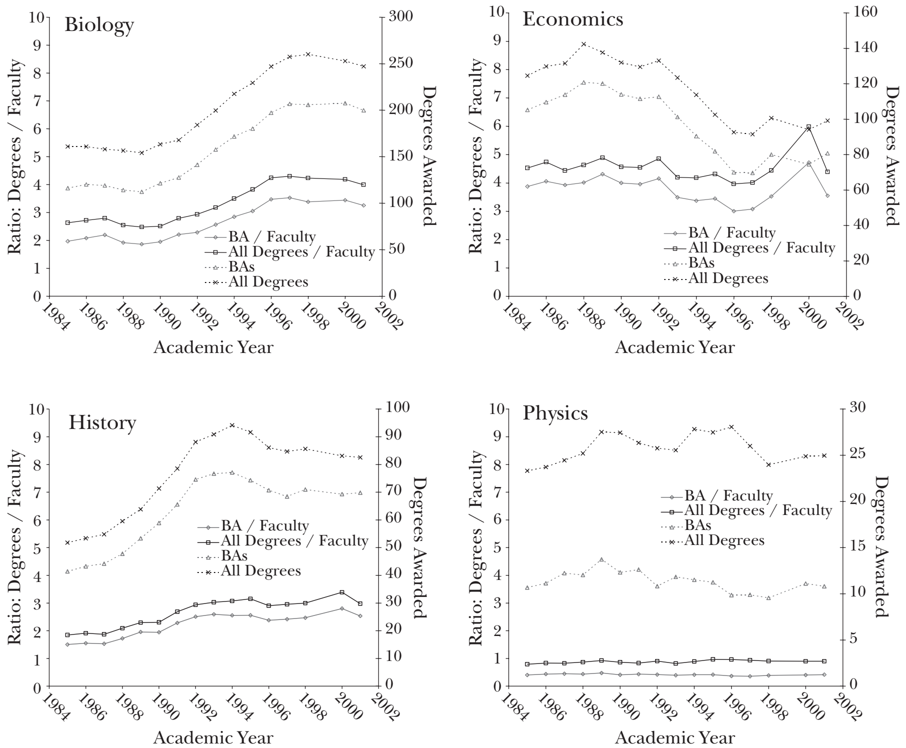
Explaining the Distribution of Faculty across Fields

University Objectives and Resource Allocation

Imagine that university administrators were to allocate faculty solely to maximize student learning or student satisfaction by equating marginal faculty outcomes across disciplines. Even in such a setting, some differences in student–faculty ratios would be expected, because differences in input prices or faculty salaries and in the "technology" for teaching different subjects would lead to differences in student–faculty ratios. For example, lectures may be a reasonably effective mode of instruction in some disciplines (arguably economics), while the teaching of, say, foreign languages may require smaller class sizes to achieve the same learning outcome. If university objectives encompass other goals such as research output or prestige, further divergence across fields in student–faculty ratios would be expected. Moreover, desired investments in other outputs of the university requiring faculty as inputs—including graduate education and research—differ across fields, producing variation in measured undergraduate student–faculty ratios.

Complicating the picture further is the extent to which different "levels" of faculty are close substitutes in production: graduate students or adjunct faculty may be close substitutes for tenure-rank faculty in some courses, but not in others. Indeed, many colleges and universities have increasingly employed adjunct faculty who specialize in teaching and hold less than full-time appointments (see Bettinger and Long, forthcoming, for a review of the literature and an analysis of whether adjuncts differ in their effect on students). Adjunct faculty may offer cost savings to universities, particularly if benefits are not offered as part of the employment package, and may be a sensible adjustment to changes in student demand that are expected to be transitory, particularly as the elimination of mandatory retirement has increased the cost of tenured appointments. Our data do not include adjunct faculty.

Figure 3
Trends in Student–Faculty Ratios in Selected Fields, 1985–2001



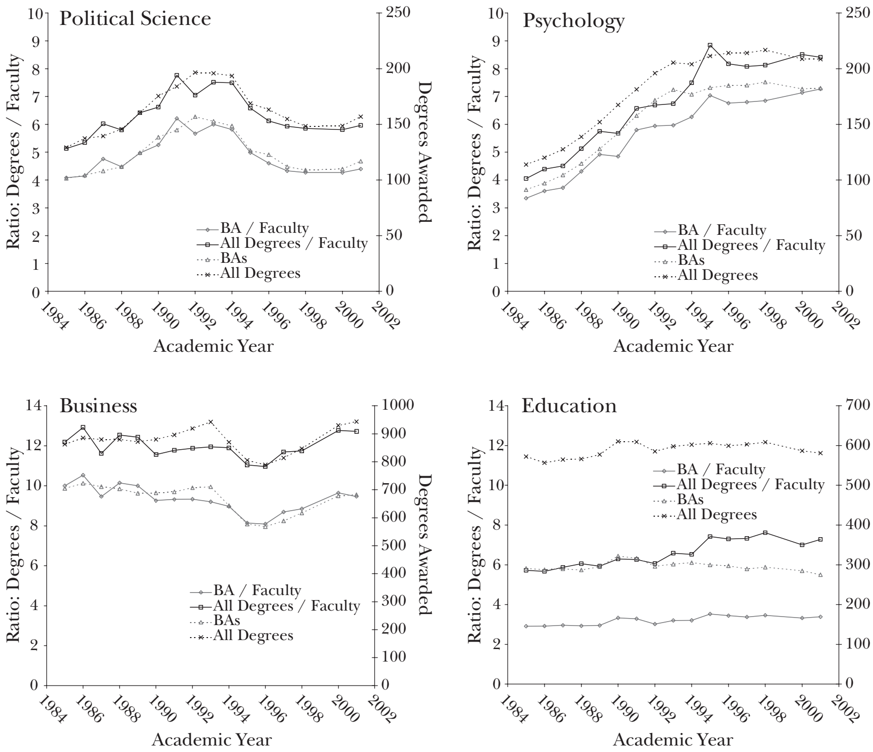
How colleges and universities solve the resource allocation question depends on the nature of university goals, relative prices (wages), and the nature of the production function.

Prices: Adjustments to Differential Salaries

Higher salaries for faculty in some disciplines will lead universities to economize more on them. To measure the importance of field-specific differences in prices or market salaries, we offer some regression evidence.

We have data on the ratio of undergraduate majors to faculty at 132 institutions observed in the National Research Council dataset. However, while we have salary data by field, we do not have salary data by institution. The only available source for data on faculty salaries at the level of specific fields is the Faculty Salary Survey assembled by Oklahoma State University which covers selected institutions belonging to the National Association of State Universities and Land-Grant Colleges. While there is not complete overlap between these institutions and the cross-sectional data from the National Research Council (NRC), we assume that the relative relationship of salaries across fields does not vary appreciably across universities.

Figure 3—Continued

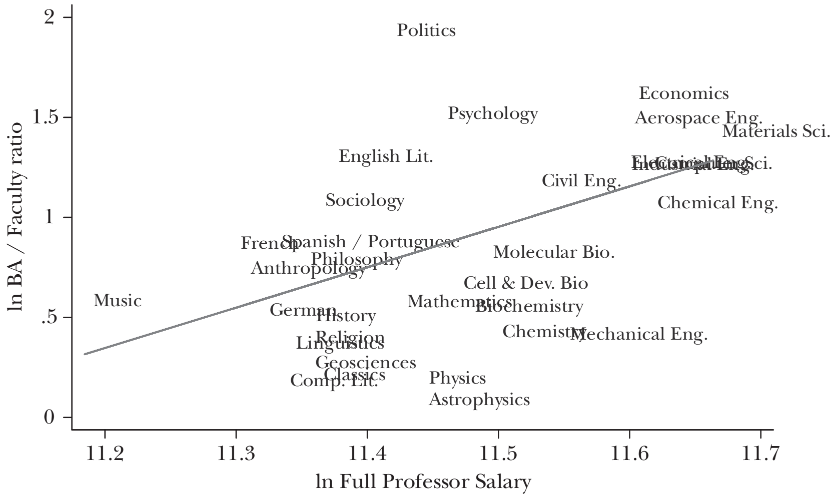


Source: Authors' calculations using Oklahoma State University Salary Survey data on faculty at 45 public research universities. Degree data are from the Integrated Postsecondary Education Data System (IPEDS).
Note: "All degrees" includes graduate degrees.

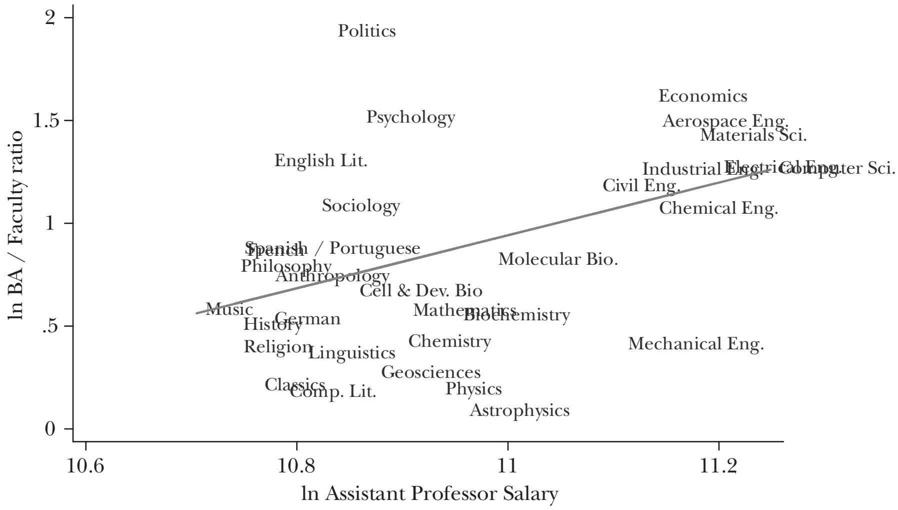
Departments with higher salaries do have systematically more students per faculty member as illustrated in Figure 4 for both assistant professors and full professors. Economics and music define the extremes of these pictures, with economics representing the high-salary, high-student–faculty quadrant and music representing the low-salary, low-student–faculty quadrant. Cross-sectional regressions of measures of BA degree students per faculty on available salary measures (which are limited to public universities) show a large and generally significant elasticity of student–faculty ratios with respect to salaries. The magnitudes of the estimates—between 1.75 and 2—are quite large and likely should be taken as an upper bound, because regressions using time-series variation in salaries within fields would likely yield much smaller effects both because response over time is sluggish and because there may be unobservable differences across fields that raise salaries and student–faculty ratios. Note that these elasticities imply both that growth over time in the dispersion of faculty salaries across disciplines widens the observed spread in student–faculty ratios and that faculty salary expenditures per student are actually lower in fields with relatively highly paid faculty.

Figure 4
Student–Faculty Ratios and Faculty Salaries, Selected Departments

A: Full Professors' Salaries



B: Assistant Professors' Salaries



Source: Data on BA degrees awarded are from the HEGIS-IPEDS (Higher Education General Information Survey–Integrated Postsecondary Data System) surveys. Data on faculty salaries are from the Oklahoma salary survey.
Note: To adjust for institution-wide differences in scale, we first regressed BA–faculty ratios on a set of field fixed effects and institution fixed effects, using the resulting field specific effects measures (in logs) as the dependent variable regressed on departmental salaries (in logs).

To the extent that salaries in economics and business programs have grown relative to those in other fields in recent decades, upward pressure on student–faculty ratios would be expected to follow. There is clear evidence that the salaries in economics and business have grown relative to those in the humanities and sciences. Curtis (2007) shows that salaries of assistant professors in economics grew from 124.8 to 151.4 percent of salaries of assistant professors in English over the past two decades and, using the elasticity estimates from above, such changes imply growth in student–faculty ratios in economics relative to English of about 40 percent. The growth in relative business professor salaries was even greater. Ehrenberg (2007) notes that the growth in inequality between professors in different disciplines may be greater than that measured by salaries to the extent that there have been divergences in teaching loads, supplemental support such as research accounts, as well as other pecuniary and nonpecuniary benefits.

Of course, the cost of hiring an additional faculty member is not just the additional salary: in the sciences, hiring a faculty member can entail start-up costs for space, equipment, and research support that dwarf salaries. Ehrenberg, Rizzo, and Jakubson (2007) report that the average start-up costs for new assistant professors in physics, biology, chemistry, and engineering range from $390,237 to $489,000. While such additional costs might be thought to put upward pressure on student–faculty ratios in the sciences, the data provides no systematic evidence supporting this conclusion.

Trading Quality for Quantity: Research and Graduate Training

Universities may view the quality of research product and of graduate training as substitutes for providing course options for undergraduates. For this reason, university administrators may in some cases effectively allow some departments to specialize in activities outside the training of undergraduates. To give one extreme example, the Princeton University Department of Mathematics, generally regarded as one of the best in the world, reported on its website in September 2008 that it had 58 faculty members and 66 undergraduate majors (including both juniors and seniors, up from 35 when we started this paper two years ago). While this student–faculty ratio is well below the levels observed in Princeton's economics and politics departments, the research productivity of the math department faculty could be high enough that a reallocation of faculty lines would not serve university interests such as prestige or contributions to knowledge.

To provide systematic evidence on this point, our cross-sectional regressions in Table 2 employ measures of program quality found in the 1995 evaluation of graduate programs by the National Research Council and National Academy of Sciences. A panel of experts on the various disciplines was asked to rank each department using a 1–5 scale on the quality of faculty and the effectiveness of the graduate program; in addition, measures of faculty headcounts, publications, and research support were also collected at the level of the department and the university.

Regression of the ratio of BA degrees to faculty on measures of program

Table 2
Cross-section Estimates of Departmental Differences in Student–Faculty Ratios

	All Universities		*Public Universities*	
	(1)	*(2)*	*(3)*	*(4)*
Faculty Quality Rank (NSF)	−0.440*	−0.368*	−0.508*	−0.384*
	(0.081)	(0.097)	(0.112)	(0.137)
Number of Ph.D. recipients/ year		−0.017*		−0.029*
		(0.007)		(0.009)
Field-specific fixed effects	Yes	Yes	Yes	Yes
Institution-specific fixed effects	Yes	Yes	Yes	Yes

Source: Data on faculty and graduate programs are from *Research Doctorate Programs in the United States: Continuity and Change;* data on BA degrees awarded are from the HEGIS-IPEDS (Higher Education General Information Survey–Integrated Postsecondary Education Data System) surveys.
Note: Data are organized by department and university with departmental-level data for the 132 universities (87 public) with 10 or more ranked departments.
* indicates statistical significance at the 1 percent level.

quality with field and institution fixed effects are shown in Table 2, in columns 1 and 3. Moving from a departmental rank of a 3 to a 4 along this quality scale (about a standard deviation) implies a drop in the ratio of BA degrees to faculty of 0.44 (all universities) to 0.5 (public universities). This result is consistent with the hypothesis that universities value program rankings and quality and, within institutions, more highly ranked departments will be less likely to shoulder the heaviest burdens of undergraduate teaching and advising. Of course, causation may go in the other direction as decisions to hire more faculty (and to reduce student–faculty ratios) may lower teaching loads and increase research productivity, in turn increasing rankings.

Doctorate-level students in a department might serve either as substitutes for undergraduates or, potentially, as complements through the provision of additional teaching resources. The link between the number of doctoral recipients at the department level and the ratio of undergraduate students to faculty is negative and significant, though not large in magnitude. Increasing the annual number of Ph.D.s by 10 is associated with a decline of 0.17 in undergraduate majors relative to faculty (Table 2, column 2). Research measures like the percentage of faculty with funded research or the number of publications per faculty do not add additional explanatory power, though these measures tend to be correlated with other assessments of departmental quality.

Small is Beautiful? Minimum Effective Size

Universities may value offering instruction in a range of subjects no matter how small the demand is for some of them, leading to a situation with some small departments with low ratios of students to faculty. One argument for maintaining these departments is that the "business" of being a university requires offering, say, classics, despite relatively low student enrollments. Alternatively, providing small departments could be the optimal solution to the problem of maximizing student satisfaction if the intensity of student preferences is greater for finding a good field match with their interests than for the quality of instruction offered within the field. Then, allocating additional faculty to satisfy the field interests of a minority of students might be more important than reducing student–faculty ratios in popular fields. A necessary additional assumption is that there be some degree of economy of scale or minimum effective size for a departmental faculty.

This minimum effective size argument has interesting implications for changes in the structure of departments over time. Going back to the early twentieth century, Goldin and Katz (1999) argue persuasively that the increased specialization of knowledge and growth of separate disciplines in the sciences and social sciences furthered economies of scale in higher education, thereby favoring the expanding public universities. Increasing specialization of knowledge and shifting intellectual and social trends create pressure for the creation of new departments, each of which must be staffed at some minimum effective size. Recent examples include environmental sciences; cognitive science; the division of many biology departments into "macro" and "micro" departments; newly popular language departments such as Arabic or Chinese; area studies; ethnic studies; gender studies; and media studies. Holding the overall student–faculty ratio constant within an institution, the birth of new small departments should raise the variance of student–faculty ratios across departments. Holding the overall number of tuition-paying students fixed, starting a new department means that a university must either raise additional resources or divert resources that otherwise would have been devoted to another department or purpose. While closing a lagging department to make way for a new area of study is possible, the incidence of department closures is exceedingly rare. One might also ask why small departments are not merged with each other to enhance efficiency. One response is that there are natural discipline boundaries that are determined by the limits of expertise in judging faculty quality. If classics and Near Eastern languages were merged, the classics faculty would be unable to judge the qualifications of potential colleagues on the Near Eastern language faculty.

An observable implication of minimum effective scale for a free-standing department is that small departments will have the lowest student–faculty ratios. To test this proposition, we ran regressions of majors per faculty at the level of the department and institution on the number of faculty in a department, specified alternatively as a continuous variable and as a categorical variable. Overall, we found no minimum scale effect, but when we limited our analysis to the humanities and social sciences there is clear evidence that small departments (6–15 faculty members) and very small departments (five or less faculty members) had much smaller student–faculty ratios. We interpret this latter result as evidence that minimum scale is part of the explanation for the low student–faculty ratios in some fields.

Dynamic Adjustment to Changes in Student Demand

Adjustment costs can be high in a university setting. After all, faculty tenure severely limits downside adjustment. On the other side, the recruiting of faculty is a costly, time-consuming, and uncertain endeavor in a specialized high-skill labor market. Many faculty searches take a year or more to complete and some searches fail altogether.

We attempted to estimate the time pattern of how changes in student demand affect student–faculty ratios by adapting the canonical model of dynamic labor demand in Sargent (1978).[6] In this sort of model, faculty demand in any period will be a linear function of last period's faculty, plus a term that depends on the forecast of student demand. Adjustment costs in this model can be understood as what is preventing the number of faculty from adjusting to what would otherwise be its "long-run" value. Our basic specification implies slow adjustment: the one period impact of a 1 percent increase in student demand implies a .044 percent rise in faculty, while the long-run effect of a sustained 1 percent rise would be a 0.6 percent rise in faculty. Thus, these estimates imply that even in the long run, faculty does not respond proportionately to changes in student demand. Interestingly, in our calculations, differences in tenure across fields and institutions do not appear to affect the speed of faculty adjustment, which implies that other more deep-rooted institutional barriers to change may be at work. In any case, this slow adjustment of faculty to student demand can surely contribute to the cross-sectional differences documented earlier in this paper.

Administrative Constraints

Instead of accommodating shifts in student demand with movements of faculty, alternative mechanisms may serve to discourage students from moving into popular fields and encourage them to study less popular subjects.

First, if student satisfaction in a field is inversely related to student–faculty ratios, and the most popular disciplines have the highest student–faculty ratios (as tends to be observed), the observed disparities in student demand as measured by degrees or credit hours taken will understate the true disparities in student interest. In other words, universities may attempt to boost enrollment in less popular fields by raising their quality relative to the more popular fields. (Of course, some students may also prefer the anonymity of relative large majors: for example, perhaps large classes allow students to pass with moderate effort, whereas in small classes, modest effort is more likely to be confronted by direct feedback.)

Second, most institutions place substantial constraints on student choices through area and distribution requirements. One interpretation of distributional requirements is that they represent an institution's paternalistic judgment of dimensions of academic experience that every student should encounter; another interpretation is that such requirements serve as a mechanism to shift student

[6] For details of this modeling approach and specific calculations, see the online appendix available with this paper at ⟨http://www.e-jep.org⟩.

demand, "creating" demand for relatively unpopular areas of study. In some cases, entrance requirements for popular majors may also restrict students' ability to choose their field of study. At some universities, students must queue for classes with excess demand and accept class slots allocated by mechanisms like waiting lists and lotteries.

Beyond regulating courses of study through curricular requirements, universities may shift demand for particular majors by offering incentives or by actively promoting the virtues of the relatively undersubscribed fields. For example, Sabot and Wakeman-Linn (1991) argue that students base part of their course selection on grades, and differences in grading policies across departments may serve to shift the choice of student-major from low-grading departments, potentially distorting the match between student aptitude and major.

Universities may also seek to influence students' choices to reduce the concentration of undergraduates in "high demand" majors. Princeton University's "Major Choices" initiative, an intensive public relations effort to encourage students to consider departments with fewer student majors, started from a baseline (not dissimilar to the data referenced at the start of this paper) in which five departments—politics, history, economics, Woodrow Wilson (public policy), and English—among the 34 departments at Princeton, accounted for 45 percent of all majors among juniors and seniors while, at the other end of the spectrum, four departments had fewer than 10 student majors, and nine additional departments had fewer than 20 majors (Stepanov, 2004). The initiative seems to have resulted in some shifts away from the oversubscribed social sciences departments to small humanities and science departments, though a number of these shifts have proven to be transitory. While the "Major Choices" initiative has been associated with sizeable gains in the first year for some departments like classics, which saw increases to 28 seniors in the class of 2007 from a norm of 12–15 (Blanter, 2007), gains have not been entirely persistent; the number of majors in classics fell to 18 for the class of 2008. A handful of departments remain in which the total number of undergraduate majors is small both in absolute terms and relative to the number of faculty.[7]

The price mechanism is perhaps the tool most natural to economists as an instrument to affect the distribution of students by major, especially since it would seem administratively simple to develop technology to monitor course taking and to bill accordingly. However, few colleges and universities use pricing mechanisms to influence the allocation of students across fields. The exceptions are typically institutions that charge differently for high-demand courses of study such as

[7] In 2007–2008, the most recent year for which data are available, the geosciences record four majors and 17 line faculty; Germanic languages, two majors and 10 line faculty; the music department, four majors for 12 faculty lines; and the Slavic languages and literature department, four majors and eight faculty along with four lecturers. The data on major counts are from the webpage of the University Registrar at ⟨http://registrar.princeton.edu/university_enrollment_sta/dgconf.pdf⟩. The data on faculty counts are based on masthead listings (not including associated faculty) from the University Record at ⟨http://www.princeton.edu/pr/catalog/ua/08/home/index.htm⟩.

engineering, business, and journalism. Examples include the surcharge of $500 per semester for business majors at the University of Wisconsin, Madison; $250 per semester for journalism students at Arizona State; and $500 per year for engineering students at Iowa State (Glater, 2007). Critics of these plans cite evidence of greater price sensitivity among lower-income students and the pedagogical desire to avoid student sorting based on price within a college.

Further Thoughts: Economics or Political Economy?

The representation of faculty relative to undergraduate student demand varies appreciably across departments or fields of study, with core social sciences such as economics and political science often facing student demands per faculty member that are substantially greater than many science and humanities disciplines. Within fields, departments with shinier research reputations often enjoy lower student–faculty ratios, suggesting that universities are not just maximizing student satisfaction or learning. Moreover, institutions understandably economize on faculty in disciplines with higher relative costs of employing faculty. We also have evidence, at least outside the sciences, that economies of scale contribute to disparities in student–faculty ratios. Field-specific differences in the pedagogical production function, which are inherently difficult to observe, may play a role too.

However, we suspect that differences across fields in the allocation of faculty relative to student demand persist even after accounting for relative salary, research preeminence, and pedagogical differences. This residual disparity might be the product of political forces within institutions that favor certain disciplines. For example, some of the disparities observed across fields as well as the stickiness of the adjustment process may well reflect a political process within the university favoring incumbency, as tenured faculty in low-demand departments create barriers to adjustment through time-intensive protest or through efforts to increase student course demand artificially through curricular requirements and other incentives.

In a pure economic model, student demand determines faculty allocations. In a political economy model, political power determines the allocation of rents within the university and arises from faculty members acting to limit the adjustment to student demand and to ensure that departments maintain faculty lines. Certainly there are potential parallels between the resource-allocation mechanism in academia and the capital budgeting process inside firms. The corporate finance literature finds that weak divisions within firms are known to hold more than their optimal allocation of cash (from the perspective of shareholders), because executives in these units have a lower opportunity cost of time and greater returns to internal lobbying to increase resources. In parallel, faculty in departments with weak student demand may also have a lower opportunity cost of time and thus be able to hold on to a disproportionate number of faculty lines by lobbying the central administration. The governance of academia in which deans and university presidents have only weak incentives to maximize the gains from allocation of faculty further exacerbates this problem as “keeping the peace” may win out over optimal faculty allocation. Notice that one implication is that universities with large endowments may be appreciably more insulated from market pressures to adjust the allocation of faculty to student demand than those heavily reliant on student tuition dollars. To this end, for-profit universities are expected to be much more responsive to student demand than their well-endowed counterparts in the non-profit sector.

Willingness of faculty members to devote time to internal politics within the university surely affects outcomes in a political economy model of faculty allocation. Faculty in disciplines with lively labor markets will have less incentive to engage in internal politics (and higher opportunity costs in doing so) and their departments will suffer correspondingly in a rent-seeking political competition. Purely anecdotal evidence on this point is that the ten members of Harvard’s Standing Committee on General Education, which decides which courses count for various general education requirements, include five humanities professors, three of them from “small” language and area studies departments, and only two social scientists.

It is difficult to make a clean distinction between the economic model and the political economy model on the basis of our empirical evidence. The fact that departments with low salaries have lower student–faculty ratios is consistent with the economic model (substitution toward cheaper factors) and also with a political economy model in which faculty in lower-paid fields invest more in institutional rent seeking. Similarly, the extreme sluggishness of faculty response to changing student demand over time could be interpreted as either evidence of formidable adjustment costs or the use of internal political power to retard adjustment to student preferences.

Administrators and faculty members who perceive these ongoing differences in student–faculty ratios to be a problem have limited options given the internal politics of their institutions. One approach is to focus on allocating new positions through specific fundraising, thereby avoiding some of the political constraints. When faced with a plethora of small departments, administrators should ask whether more efficient scale can be achieved through the combination of departments within schools or the creation of interuniversity collaborative networks. For example, an innovative program of the Associated Colleges of the South has aimed to resolve the problem of the small scale of certain departments at 14 small liberal arts colleges, where the average size of the classics faculty is less than three. Through the creation of a “virtual” department integrated across these institutions, scale was raised to 40 classics faculty, greatly increasing opportunities for peer interactions and specialized work and for students to have access to a wider range of potential advisers and mentors. However, even if these kinds of moderate changes can be enacted, a number of departments—largely in the humanities and sciences—will be left with the slack student demand for their courses and majors that they have faced for decades.

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