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AUTHOR	Milam, John
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ABSTRACT

This study examines some of the literature on college faculty supply and demand and asks whether it is possible to adopt assumptions from the previous research to construct a complex model of faculty workforce using the available data. The study involved a comprehensive review of the literature; numerous interviews conducted by telephone, e-mail, and in person to discuss available datasets and various approaches to faculty supply and demand; analysis of 14 national datasets; and, finally, in-depth review of four datasets to assess their utility for modeling. The model developed had the following components: enrollment (undergraduate, masters, doctoral) broken out by gender and ethnicity; degrees (masters and doctoral); postdoctoral appointments; nonfaculty research staff; faculty population (full-time, instructional, research, and public service) broken out by rank within tenure status by discipline and by tier of institution, and including retirement rates, quit rates, and mortality by discipline; faculty workload for full-time faculty; and research activity, including the need for post-doctoral students, nonfaculty research staff, and degree productivity. This study suggests that it is impossible to construct a complex model of faculty supply and demand with currently available data. The report concludes with recommendations for improved data collection. (Contains 31 references.) (CH)

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The Glut of Ph.D.s – Complex Models for the Faculty Workforce

John Milam
George Mason University

HE 031 582

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The Glut of Ph.D.s - Complex Models for the Faculty Workforce

Of the many topical interests for research on higher education, few are as critical to the policy arena or have as significant an impact on the infrastructure of colleges and universities as faculty supply and demand. This paper addresses two questions of interest: (1) What do the national datasets have to offer studies of faculty supply and demand? and (2) Is it possible to adopt the assumptions of previous research and construct a complex model of the faculty workforce using all available data? The results suggest that that while existing data collection efforts allow for many types of complex policy studies about faculty, it is impossible to construct a complex model of faculty supply and demand.

The Glut of Ph.D.s - Complex Models for the Faculty Workforce

I. Introduction

Of the many topical interests for research on higher education, few are as critical to the policy arena or have as significant an impact on the infrastructure of colleges and universities as faculty supply and demand. This research serves many purposes and involves many different approaches. At one end of the spectrum are the production and utilization projections of Massy and Goldman (1995), the faculty prospects models of Bowen and Sosa (1989), and the study of graduate education by Bowen and Rudenstine (1992). These complex analyses are supplemented by the cumulative knowledge base of hundreds of descriptive studies conducted by individual scholars and by federal agencies such as the National Science Foundation (NSF) and the National Center for Education Statistics (NCES) to examine combinations of faculty characteristics such as age, tenure, rank, discipline, gender, citizenship, and ethnicity.

The common thread to studies as disparate in purpose as calculating availability statistics for affirmative action, examining faculty workload, analyzing doctoral unemployment, and predicting the effect of early retirement programs is their reliance on national data about the faculty population. On the surface, the potential for new research on faculty seems inexhaustible. Yet when the data behind the research are separated from the many assumptions and models which are put forward, it is clear that researchers have some strict limitations placed on their work.

This paper attempts to clarify the types of research on faculty supply and demand which are possible, given the inherent limitations of the national data, and to suggest the types of assumptions and models which may be supported. This represents somewhat of a departure from the traditional approach to conducting research on faculty. Usually, the existing literature is reviewed and the weight of previous research is used to document the validity of a new model or set of assumptions. Scholars then look to the various national datasets or conduct a new data collection effort to test their hypotheses. For the purposes of this study, this order is reversed. The questions of interest are:

(1) What do the national datasets have to offer studies of faculty supply and demand?

(2) Is it possible to adopt the assumptions of previous research and construct a complex model of the faculty workforce using all available data?

This proposed review of data elements, sampling techniques, and weighting issues in the national datasets has little utility if not first informed by the types of assumptions and models which occur in the literature. What are the basic studies of faculty characteristics which have been conducted by scholars and are most relevant to current policy concerns? What kinds of models are present in the literature?

A review of the literature on faculty supply and demand suggests that there are at least 19 different types of assumptions or dimensions related to this topic of research. In Table 1, these are arrayed by the major studies in which they appear. Table 2 arrays these assumptions by those national data sources which collect relevant fields.

Each type of assumption will be discussed in terms of how it informs models of faculty supply and demand, its use in the current research literature, and its availability in the national data. Specific focus will be given to the problems of using each assumption in particular kinds of studies. It is hoped that out of this discussion will come insights into the most appropriate and meaningful ways to use the national datasets. After the discussion of assumptions, a complex model of faculty supply and demand will be constructed based on what is learned from previous research and the utility of the datasets.

II. Methodology

Four related research efforts were undertaken as part of this study:

(1) A comprehensive literature review was conducted with the bibliographic search tools ERIC, Education Index, and Higher Education Abstracts and the commercial search engines of the World Wide Web. As a result, the research of Massy and Goldman (1995), Bowen and Sosa (1989), Bowen and Rudenstine (1992), and COSEPUP (1995) were examined in depth, along with relevant published studies by the National Research Council (NRC), the NSF, and the Council of Graduate Schools (CGS). Literature review essays such as Geiger (1997) and Hartle and Galloway (1996) also helped inform this study.

(2) Numerous interviews were conducted by phone, email, and in person to discuss the datasets and various approaches to faculty supply and demand. These included conversations with Ernie Benjamin, AAUP; Sam Bettinger, Pinkerton; Joan Burrelli, NSF; Lawrence Burton, NSF; Michael Cohen, NCES; Valerie Martin Conley, Virginia Tech; Mary Golladay, NSF; Theresa Grimes, Quantum Research Corporation (QRC); Linda Hardy, NSF; Susan Hill, NSF; Steve Hunt, U.S. Dept. Of Education; Rolf Lehming, NSF; Linda Parker, NSF; Carolyn Shettle, NSF; Peter Syverson, CGS; Veerle Van Meel, QRC; Jim Voytuk, National Academy of Sciences (NAS); and Linda Zembler, NCES.

(3) Fourteen different national datasets on faculty are discussed in the literature. Each of these was reviewed to evaluate its utility for research on faculty supply and demand. This review included an examination of the survey sample, data elements, weighting procedures, methodology reports, and published and unpublished studies. In some cases, interviews were conducted with the agency staff in charge of each survey.

(4) Finally, several of the national datasets were selected for more in-depth review and analysis to better evaluate their utility for modeling. These include the Survey of Earned Doctorates (SED), the Survey of Doctorate Recipients (SDR), the National Study of Post-secondary Faculty (NSOPF), and the NSF-NIH Graduate Student Survey (GSS). Microdata licenses were obtained from NSF for the SED and SDR. The CD-Rom version of the Public Access Data Analysis System (DAS) was used for the NSOPF. The raw data for the GSS were obtained from the Quantum Research Corporation. Summary data for the SED and the GSS were also obtained using the online WebCaspar system and for the SDR using the on-line, public version of NSF's SESTAT system.

A methodological log was maintained throughout the course of this research and various kinds of peer debriefings were held. The results of the review of the literature and the national datasets were presented in a paper at the 1997 Forum of the Association of Institutional Research in Orlando (Milam, 1997). Numerous discussions with NCES and NSF staff were held as a result of this paper and these helped guide the choice of datasets to review in depth. The author is grateful to NSF, NCES, and the Association for Institutional Research (AIR), which made this study possible through the funding of an NSF/NCES/AIR Research Fellowship.

III. Assumptions and Dimensions of Faculty Supply and Demand

Table 1: Assumptions/Dimensions by Research Study

Assumption	Massy & Goldman	Bowen & Sosa	Bowen & Rudenstine	COSEPUP	NSF Issue Briefs	NRC	CGS
UG enrollment/projections	Yes						
MA enrollment/projections	Yes			Yes			
DR enrollment/projections	Yes	Yes		Yes			
Time to degree	Yes		Yes	Yes			
Financial support			Yes	Yes	Yes		
Degree productivity	Yes	Yes	Yes	Yes	Yes		
Employment plans/rate	Yes	Yes		Yes	Yes		Yes
Ethnicity/citizenship/gender	Yes		Yes	Yes	Yes		
Post-docs	Yes		Yes	Yes	Yes		Yes
Faculty workload	Yes	Yes					
Rank	Yes					Yes	
Tenure		Yes					
Quit Rates	Yes	Yes					
Retirement	Yes	Yes					
Mortality/Disability	Yes	Yes					
Departmental behavior	Yes		Yes			Yes	
Tier/sector structures	Yes	Yes	Yes				
Research activity	Yes					Yes	
Disciplines	Yes	Yes	Yes	Yes	yes	Yes	

Undergraduate enrollment/projections

In their model of departmental behavior, Massy and Goldman (1995) use various cross-sectional 1980 data to produce regression equations to predict departmental demand for the endogenous variables of graduate students, faculty, and post-doctoral fellows. One of their exogenous variables is undergraduate FTE enrollment by institution. While the number of bachelors degrees awarded by major is also an exogenous variable, the use of enrollment data is particularly interesting. This documents the common perception that the need for faculty and for graduate teaching assistants (GTAs) is driven in part by undergraduate enrollment and that research and doctoral-granting Carnegie institutions rely more heavily on GTAs to meet teaching needs. The U.S. News, College Board, and other admissions guide surveys use this as a measure of quality in undergraduate education.

Table 2: Assumptions/Dimensions by Source of Data

Assumption	SED	SDR	NSOPF	GSS	NRC	S	SA	EF	C	F	CGS
UG enrollment/projections								Yes			
MA enrollment/projections								Yes			Yes
DR enrollment/projections								Yes			Yes
Time to degree	Yes	Yes	Yes								
Financial support	Yes	Yes	Yes	Yes						Yes	
Degree productivity	Yes								Yes		
Employment plans/rate	Yes	Yes	Yes								
Ethnicity/citizenship/gender	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes		
Post-docs	Yes	Yes	Yes	Yes							
Faculty workload			Yes								
Rank			Yes			Yes	Yes				
Tenure			Yes			Yes	Yes				
Quit Rates		Yes	Yes								
Retirement		Yes	Yes								
Mortality/Disability		Yes	Yes								
Departmental behavior											
Tier/sector structures	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Research activity	Yes	Yes	Yes	Yes	Yes					Yes	
Disciplines	Yes	Yes	Yes	Yes	Yes			Yes	Yes		Yes

While undergraduate enrollments are discussed by the NRC's Committee on Science, Engineering, and Public Policy (COSEPUP, 1995) in its study Reshaping the Graduate Education of Scientists and Engineers, particularly in regard to changing demographics, none of the complex models of faculty and supply and demand utilize enrollment data to any large extent. Massy and Goldman do not make use of the discipline-specific data by institution which are collected by the annual NCES IPEDS survey of Fall enrollment (EF). This survey enrollment data by discipline at the CIP code and by student level, full/part-time student status, gender, and ethnicity.

Bowen and Sosa (1989) use enrollment as part of their calculation of faculty workload predictions and their impact on supply and demand. While they start with enrollment projections based on the IPEDS EF survey, they use data aggregated by institution. This is probably because they relied on data available to the public in the late 1980s and few researchers were using the CIP-specific data which were collected but not released. They write that "Data showing enrollments by field of study exist only at the level of the individual institution, and even then they are often incomplete or incompatible with data from other institutions" (p. 46). To obtain discipline-specific enrollments, they used the IPEDS Completions (C) survey and applied percentages of degrees conferred by clusters of disciplines to their enrollment projections. These were then used to calculate discipline-specific student-faculty ratios.

There are some problems in using degree data as a proxy variable for enrollment. Bowen and Sosa (1989) recognize that "students who go on to receive one kind of degree can cross-register in courses taught by faculty members who are in other fields of study," so that "we almost certainly underestimate shares of enrollment in the arts and sciences when we look only at degrees conferred" (p. 46). A similar argument may be made about the problem of using enrollment by major. An Induced Course Load Matrix (ICLM) model shows the relationships of departmental consumption and contribution. Many majors take courses outside of their major and many departments serve non-majors in their courses. This presents a problem with using enrollment data by major for documenting faculty workload.

Clearly these studies recognize the importance and also some of the problems of using enrollment data to predicting faculty demand. However, none make use of the discipline-specific enrollment data which are available. The IPEDS EF data files available on the NCES web site and on WebCaspar are at the level of the first two digits of the CIP code. The IPEDS

CD-Rom provides access to the full 6 digit CIP code data. It is also possible for researchers to request special cross-tabulations of these data from the National Data Resource Center (NDRC).

Future researchers using the methodology of Massy and Goldman (1995) and Bowen and Sosa (1989) now have discipline-specific, enrollment data readily available. These data are critical to calculating faculty workload and to projecting faculty demand based on workload. Both studies use student full-time equivalencies (FTE) instead of headcount, using the standard NCES calculation which equates 1 full-time headcount to 1 FTE and 3 part-time headcount to 1 FTE. While the IPEDS Institutional Characteristics Survey (IC) has in the past included questions about student credit hours (SCH) by level, these are not at the discipline level and these data are not being reported in the raw data files, in part because of recognized problems in institutional reporting methods. Without SCH data, researchers must rely on the NCES calculation. The results of this calculation are suspect for those institutions which have significant part-time enrollments such as urban institutions and community colleges.

The benefit of using the IPEDS EF Survey is that collects data on the entire student population, not just a sample. While some institutions do not respond, these are usually proprietary and technical schools and the previous year's data may be substituted. When assumptions about time-to-degree and graduation rates are applied to cohorts of students, it is possible to predict the enrollment component of supply by discipline.

The "BA-PhD Nexus" is described by Bowen and Rudenstine (1992) as a problem in tracking Ph.D. cohorts. If Ph.D. recipients of a given year are used for analysis, then the data on year of B.A. varies widely. For this reason, the authors build cohorts of Ph.D. recipients based on the year they receive their B.A., not the year of the doctorate, allowing for "more precise matching of numbers of doctoral recipients with conditions that prevailed at the time most of them began graduate study" (p. 42). Using time-to-degree calculations based on B.A. cohorts and graduation rates, undergraduate enrollment may be used to project doctoral enrollment.

Master's enrollment/projections

In Massy and Goldman's (1995) departmental behavior model, one of the exogenous variables is masters degrees by major. As in the use of undergraduate enrollment data, these data are simply one variable in a complex regression equation, recognizing that "Faculty size depends on general undergraduate degrees, in-major degrees, masters degrees, and doctoral degrees because of instructional needs" (p. 3-5). While masters degrees are included with total degrees in Bowen and Sosa's (1989) calculation of faculty workload and applied to overall enrollment ratios, no special significance is given to masters enrollment data.

Masters students are one consideration of departmental activity considered by Bowen and Rudenstine. Still, most of these complex models do not incorporate masters enrollment in any significant way in predicting faculty supply and demand. However, meaningful statistics may arise from calculating student-level, faculty workload. With this method, assumptions could be made about the pipeline of graduate students. The NSOPF, SDR, and SED surveys collect data on graduation dates by degree for each respondent and could be used to calculate time to the BA, MA, and doctorate. While time-to-degree and cohort tracking methodologies are quite complicated, these survey data have not been used to their fullest extent.

Degrees conferred and enrollment data for masters programs are also useful in projecting potential community college faculty, which traditionally do not need the doctorate. Most faculty demand models do not adequately capture community college needs. Massy and Goldman (1995) only address research and doctoral institutions and Bowen and Sosa (1989) only predict results for four-year institutions and above.

In addition to the SDR, the NSF SESTAT system includes the National Survey of Recent College Graduates (NSRCG) and the National Survey of College Graduates (NSCG). All three SESTAT surveys include occupation codes for postsecondary faculty in 29 clusters of disciplines. These provide some estimates of the faculty population weighted to census estimates. With models based on the NSRCG, masters enrollment data could be used to project faculty supply and demand for those with masters degrees, similar to the ways in which the NSOPF, SDR, and SED could be used to project supply and demand for those who will earn doctorates.

This discussion suggests that masters enrollment and degree data are useful but little used components of complex faculty supply and demand models. While Bowen and Rudenstine pay great attention to the "BA-PhD Nexus," a similar potential relationship for predicting enrollment exists with MA-Ph.D. cohort enrollment tracking. Once established, there are other sources for data besides the IPEDS EF and IPEDS C reports which can be used to project enrollment and degree variables for supply and demand. Perhaps the most important and consistent of these is the annual CGS-GRE Graduate Survey, which collects full- and part-time data by discipline/ program by institution. The GSS is similar and includes relevant data on financial support, but only collects data on science and engineering disciplines.

Doctoral enrollment/projections

Significant efforts have been made in predicting discipline-specific doctoral enrollment using data from the IPEDS EF, CGS-GRE, and GSS surveys. Bowen and Sosa (1989) include doctoral enrollments in their calculation of overall faculty workload and use these ratios in their projections of demand. Massy and Goldman (1995) include headcount doctoral enrollment as one of their three endogenous variables in their departmental behavior model. Yet it is doctoral degree productivity trends, not enrollment projections, which are at the heart of these two re-

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search models. There is much still to be learned from enrollment data if assumptions about time-to-degree and graduation rates by cohort tracking years are incorporated.

While only the IPEDS EF data are available for undergraduate enrollment by discipline, the CGS-GRE survey and the GSS between them provide detailed data on gender, ethnicity, full- and part-time status, and funding. While the GSS is limited to science and engineering disciplines, this sample includes social science fields such as psychology. The CGS-GRE are not readily available to the public in electronic format. They are published in annual studies by CGS and are the subject of much discussion among graduate deans. Both surveys are collected by program, with breakouts for masters and doctoral programs within field specialties. The GSS is more detailed in its disciplinary breakout, in part because of its collection of postdoctoral data on medical residency specialties.

In conjunction with undergraduate and masters enrollment, doctoral enrollment projections are a primary feeder for predicting degree productivity. Again, these data are underutilized in faculty and supply models, in part because previous researchers did not have access to them at the appropriate disciplinary level and in part because of the need to understand data administration issues surrounding the best way to use each survey.

Time to degree

Attainment rates and time-to-degree are combined as "propensity to graduate" and "propensity to drop out" by Massy and Goldman (1995). The authors build an equation that factors in phases in which students gestate, progress, sustain, erode, and stagnate. These issues of equally of interest to Bowen and Rudenstine (1992), who also examine issues of cost and student financial support.

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Time-to-degree is a factor mentioned above in relationship to using enrollment and graduation rates to predict degree productivity. While this is examined fully by Bowen and Rudenstine (1992) in their discussion of the "BA-PhD Nexus," differentiated enrollment, graduation, and time-to-degree rates have not been applied to cohorts of masters students. This is particularly needed if prediction is to be done of community college needs.

Data on time-to-degree are available in the SED, the SDR, and the NSOPF by investigating completion dates in individual survey responses. The SDR is a sample of faculty and non-faculty, while the SED is collected from the entire population of research doctorate recipients. Using the SED, researchers can study cohorts of recipients based on graduation year and discipline of BA and MA.

Financial support

Bowen and Rudenstine (1992) recognize the impact of financial aid and research funding support on graduate education. This factor does not appear, however, in any of the complex models of faculty supply and demand. While much financial aid research has been conducted on the factors affecting student attrition, retention, and graduation, this is usually focused on the undergraduate degree. The data exist, though, for sophisticated and useful work to be done on the impact of financial support on predicting doctoral degree productivity and therefore faculty supply.

The GSS includes funding types by each federal agency, self-support, and other forms of aid (NSF, 1995). These data are reported in the NSF Institutional Profile series for researchers to examine trends by institution and by field of study. It is possible, using the GSS and the SED, to investigate departmental behavior at an individual institution and to aggregate these data up to tiers of Carnegie/control to make assumptions about the impact of aid on graduation. A robust model of faculty supply needs to account for variations in graduate student funding patterns in predicting doctoral degree productivity.

Degree productivity

The SED and IPEDS C data represent the entire population of degree recipients at the doctoral level. The IPEDS C is available in most sources at the 2 digit CIP code level, while the SED has a different but equally complex disciplinary taxonomy. A crosswalk between the two taxonomies is available as part of WebCaspar. The SED only includes research doctorates, while the C includes all doctorates. This distinction is troubling when comparing data from the two surveys, and it is important to reconcile any assumptions about the SED population by discipline with data from the C. For example, data on the percentage by discipline who plan to enter academe could be applied to the discipline data from the C to obtain the a higher number of potential faculty. If only the SED data are used, the number of potential faculty could be underreported. The SED data allow for breakouts by type of doctoral degree, something not collected with the C. Assumptions about type of degree could be incorporated along with post-doctoral plans in better understanding and predicting faculty career paths. One problem with comparing the two reports is the slightly different survey year.

One problem in using the SED is that the data continue to be collected after the reporting year is over. This increases the response rate but allows for different results obtained with the most recent versus published versions of the data. The IPEDS C is completed by each institution based on official census data, while the SED is completed by the doctoral recipient, usually as a requirement of graduation.

Data on many characteristics of the doctoral degree population are available from the SED, including such fields as dissertation topic, family educational history, post-doc status, and

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employment plans. In the interviews conducted with NSF staff as part of this study, some dissatisfaction was expressed about the disciplinary taxonomy of the SED, particularly in relationship to the taxonomy of the SDR. The changing structure of the disciplines is difficult to map and the SED has been criticized for failing to adequately document the changing nature of the disciplines. A similar methodological issue surrounds the NSOPF, which failed to collect adequate responses from health science faculty.

The SED is the basis of the NRC's Doctorate Records File and is used to create the biennial sample for the SDR. The SDR data elements include all fields available in the SED and allow for interesting comparisons of contrast, such as whether students who plan to enter academe or a post-doc actually do so. The SDR is also used extensively for the calculation of unemployment rates.

A number of publications use the SED data, including agency reports from NSF and NCES. These depict trends in degree productivity by discipline and are the most visible type of research on disciplinary behavior and its relationship to faculty supply and demand.

Data from the SED are published annually by the NRC and are used by affirmative action and equal opportunity officers (AA/EEO) to calculate faculty availability statistics. In the National Study of Faculty Availability and Utilization (NSFAU), the author documents that NRC publications on the SED are the primary source of faculty availability data by discipline used for AA/EEO statistics (Milam, 1995a, 1995b).

Complex faculty availability models produced at the University of Washington, the University of Colorado, and elsewhere weight the SED data by degree year to estimate gender and ethnicity percentages for each faculty rank. In these models, the current year's data are used for estimating the gender and ethnicity availability for new assistant professors. For associate and

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full professor hires, AA/EEO officers sometimes combine and weight different years of data, reflecting different assumptions about time from degree and rank transitions.

Sixty-six (52.0%) of the 127 doctoral-granting institutions which participated in the NSFAU reported that they rely on current year NRC data to complete the eight factor analyses which are required by the OFCCP and the EEOC. Thirty-eight institutions (29.9%) use trend data to aggregate across SED survey years. These models inform those of faculty supply and demand, particularly in the way they incorporate SED data for estimating faculty availability by rank.

Employment plans/rate

Only the SED provides data on whether doctoral recipients intend to find work in academe. The AA/EEO models discussed above are somewhat flawed because they are not based on the percentage of doctoral recipients who wish to enter academe. This statistic varies widely by discipline. In the past, these data were often unpublished and unavailable to researchers without a microdata license. The newest online version of WebCaspar now includes these data, aggregated to the appropriate CASPAR disciplinary taxonomy. Table 3 provides these data for clusters of disciplines. Additional products will be prepared from this research to provide AA/EEO officers with detailed trends over time of the percent of women and minorities who wish to enter academe.

COSEPUP (1995) and NRC (1995) report on these data, explaining that "More New Ph.D.s Have Uncertain Employment Plans." These studies also show that there is growing reliance on post-doctoral appointments, perhaps because of increased difficulty in obtaining traditional, academic appointments.

The number and percentage of new recipients seeking or with definite positions in academe serve as the basic component of faculty supply estimates. As part of this study, the author obtained the SED microdata for 1993 and calculated this statistic by discipline. The results were verified against those data produced with WebCaspar (which were not available at the time of the site license request for microdata).

Table 3: 1993 Doctoral Recipients Entering Academe

Academic Discipline	Total Number of Doctorate Degrees	Doctorates w/ Definite or Seeking Post-Sec/Med Appt	Percent Seeking Post-Sec/Med Appt
TOTAL OF ALL ACADEMIC DISCIPLINES	39,801	11,438	28.7%
+ S&E TOTAL (INCL MEDICAL/OTH LIFE SCI)	26,640	4,973	18.7%
+ S&E TOTAL (EXCL MEDICAL/OTH LIFE SCI)	25,443	4,514	17.7%
+ ENGINEERING	5,698	710	12.5%
+ PHYSICAL SCIENCES	3,699	233	6.3%
+ GEOSCIENCES	771	110	14.3%
+ MATH AND COMPUTER SCIENCES	2,026	682	33.7%
+ LIFE SCIENCES	7,257	987	13.6%
PSYCHOLOGY	3,420	737	21.5%
+ SOCIAL SCIENCES	3,769	1,514	40.2%
+ HUMANITIES	2,973	1,971	66.3%
RELIGION AND THEOLOGY	500	206	41.2%
ARTS AND MUSIC	862	485	56.3%
ARCHITECTURE AND ENVIRONMENTAL DESIGN	54	20	37.0%
+ EDUCATION	6,689	2,601	38.9%
BUSINESS AND MANAGEMENT	1,282	785	61.2%
COMMUNICATION AND LIBRARIANSHIP	391	228	58.3%
LAW	29	4	13.8%
SOCIAL SERVICE PROFESSIONS	237	94	39.7%
VOCATIONAL STUDIES AND HOME ECONOMICS	57	32	56.1%
OTHER NON-SCIENCES OR UNKNOWN DISCIPLINES	87	39	44.8%

With multiple survey years, it is possible to track the perception of opportunity in academe. However, respondents only report their desire to enter academe. It is necessary at some point to qualify the results by investigating with the SDR and its base file, the Doctorate Records

File (which is taken from the SED), whether doctoral recipients follow through with their intention to enter academe.

Ethnicity/citizenship/gender

Ethnicity and gender data from the SED are critical to calculations of AA/EEO faculty availability. These and other demographic data are also collected with the samples of the SDR and the NSOPF and in the population surveys of the IPEDS S and SA, the GSS, and the CGS/GRE. All models of faculty supply and demand may be qualified by ethnicity and gender, but few are. COSEPUP (1995) incorporates gender and ethnicity in its statements about trend data. Various NRC, NSF, and NCES reports document demographic characteristics. However, no attention is given by Massy and Goldman (1995) or Bowen and Sosa (1989) to these variables. Bowen and Rudenstine (1992) briefly discuss trends in doctoral recipients by race and ethnicity, but give somewhat more focus to issues facing women graduate students.

Demographic breakouts of the population surveys of the IPEDS EF, the GSS, and the CGS/GRE provide data on gender and ethnicity trends and patterns by tier and type of institution. These are sufficient for the enrollment by discipline component of faculty supply and demand models. The IPEDS SA provides gender by rank within tenure status for the entire population of full-time, instructional faculty and the IPEDS S provides gender within ethnicity by rank within tenure status for the entire population of full-time, instructional, research, and public service faculty. Since neither IPEDS survey is by discipline, they are of less utility in supply and demand models. When the sample SDR and NSOPF surveys of faculty are analyzed, problems arise in preparing cross-tabs by demographic variables, due to the small cell sizes involved.

In the paper "Developing Benchmarks for Faculty Hiring" (Milam, 1997), this author assesses whether the national datasets may be used to construct the critical cross-tab of interest for

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AA/EEO studies. This cross-tab includes gender within ethnicity for the columns and rank within tenure for the rows, for each discipline at each institution. The results of this analysis show that it is impossible to construct this cross-tab, even aggregated by combinations of Carnegie classification and control. While the SDR and NSOPF may be used to estimate gender and ethnicity data, weighted perhaps by the IPEDS S, the cell sizes are still inadequate. Some variable has to dropped in the estimation of the faculty population in order to increase cell sizes. Unfortunately, ethnicity is often the first to go, followed by gender.

One variable which must be retained for purposes of faculty and supply and demand is citizenship. Non-resident alien, doctoral students returning to foreign institutions and holding temporary visas should be excluded from consideration as potential faculty members. In documenting the WebCaspar reports on postdoctoral plans, it was discovered that the SAS program used by QRC to report on the percentage of students with plans to enter academe includes some non-resident aliens. In reporting of ethnicity, it is necessary to use the citizenship field carefully so as not to over-report the number of potential faculty.

For those AA/EEO officers who wish to calculate faculty availability within the critical cross-tab of interest, it is possible to construct models of the population by gender and ethnicity by rank and tenure using the IPEDS S, then weight these data by Carnegie and control to the disciplinary breakouts which are possible of the SDR and NSOPF surveys.

Post-docs

The GSS, SED, and SDR each collect data on post-doctoral appointments. The GSS documents post-doctoral enrollment by discipline, gender, and ethnicity by institution. The SED collects individual responses from those who expect to enter post-docs, while the SDR sample

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survey includes data from the SED about post-doctoral intention and also provides verification with current data about whether the respondent actually obtained a post-doctoral appointment.

Unfortunately, the GSS only collects data on science and engineering post-docs. The SDR, in contrast, has two components - science and engineering and humanities. Using the SDR for data on post-docs is problematic, though. The cell sizes are small at best at the discipline level. The results of the GSS differ too from those obtained when using the SDR to estimate the number of post-docs, for the total and by discipline.

On cursory reading, it appears that the NSOPF collects data on the entire faculty career. However, a review of the questionnaire and data elements shows that no data are collected about post-doctoral appointments, only about appointments such as teaching assistantships held in graduate school.

Given these constraints, a complex model of faculty supply and demand needs to incorporate data on post-doctoral appointments in several different ways. The number of SED respondents with definite plans or seeking post-docs must be taken into account as a factor which reduces the number of potential faculty members. Post-docs also must be considered as competing with recent doctoral recipients for academic appointments. To predict this movement, researchers need to make assumptions about the average length of post-doc appointments. Massy and Goldman (1995) use the estimate of one year.

According to NSF staff, the preliminary results from a current NSF research study about post-docs suggests that the average is much longer, perhaps as long as three years for some fields. This obviously confounds the modeling of the faculty pipeline. Assumptions need to be made about each discipline and the career paths of new faculty, particularly about the growing use of post-doctoral appointments.

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Massy and Goldman (1995) use post-docs in their equations for predicting departmental behavior, suggesting a plausible relationship between the number of post-docs and research funding. Certainly, centers of research at individual institutions and patterns of research funding by discipline have an impact on the training and marketability of post-docs. Neither Bowen and Sosa (1989) or Bowen and Rudenstine (1992) incorporate post-docs in their analysis of faculty supply models.

Faculty workload

As stated in the discussion of enrollment, Massy and Goldman (1995) incorporate overall institutional enrollment and the number of majors in their regression equations and Bowen and Sosa (1989) include workload in their projects of demand. Bowen and Sosa are much more simple in their approach, calculating ratios based on student FTE. Workload must be seen along with enrollment as a critical indicator of demand.

Despite problems in the NCES definition of FTE, this is the only student measure of workload worth considering. To be consistent, faculty FTE must be based on the IPEDS S and SA definitions of full-time faculty. Data on workload by faculty discipline are not collected except in the NSOPF survey, which has a different definition of faculty from that used by the IPEDS S and SA and the SDR.

The same problems of documenting the faculty population by discipline outlined above apply to workload. However, average workload in terms of number of courses taught is a much less problematic measure in the NSOPF data. Assumptions may be made based on the NSOPF data about the average number of courses taught and the number of student credit hours generated per full-time faculty member by discipline. It may even be possible to estimate this workload ratio by rank and tenure status, though the cell sizes begin to diminish if broad clusters of disciplines are used.

The NSOPF collects student credit hours awarded and enrollment for each course taught. Once these are equated to student FTE, more complex SCH or FTE ratios per faculty FTE may be calculated. Estimates of student FTE workload by discipline become a useful tool for estimating potential faculty demand.

One problem with this approach, besides the inability to properly weight the NSOPF data by discipline to the total faculty population, is the need to also account for faculty workload by part-time faculty and by non-instructional staff. If student SCH are used as the denominator and full-time faculty FTE are used as the numerator, the average faculty workload will be overestimated. Therefore, complex models of faculty demand based on workload must account for all sources of teaching FTE. This justifies some of the confusion which exists in comparing the definition of faculty used for the NSOPF with that of the IPEDS S and SA.

Even when data on part-time faculty by discipline are available, as they are in the NSOPF, the calculation of part-time faculty FTE and workload is problematic. Hopefully, ratios of student SCH to full-time faculty, while slightly over-inflated, are consistent over time, making them more useful in predicting faculty demand. Also, it is clear from studies of the growing reliance on non-tenure track faculty that many of these new positions, created to meet growing enrollment needs, are being filled with part-time, visiting, or restricted faculty . While there is growth in enrollment, its impact may be to increase the need for part-time faculty, not to generate need for those SED respondents seeking academic work.

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Rank

In estimating the faculty population, the SDR and NSOPF sample surveys and the IPEDS S and SA population surveys collect data about the critical variables of rank and tenure status. It is also possible to make assumptions about the tier structures of Carnegie classification and control using the IPEDS surveys.

When the data are examined closely, some important components of faculty supply and demand variables are missing. For example, while the IPEDS S collects the number of new full-time faculty hires by tenure status, data are not collected on new hires by rank. This makes it impossible to document patterns in the hiring of new assistant professors.

If the IPEDS S were collected every year, changes in the number of faculty by tenure status could be analyzed in relationship to the new hire data and assumptions could be made about new hires by rank. With biennial data, it is difficult to build this type of model. The S also documents the part-time faculty population. Data on new hires among part-time faculty are suspect, though, since returning part-time faculty are sometimes considered new because of their contract length.

The IPEDS SA is particularly useful for mapping the growing reliance on non-tenure track faculty. The AAUP Faculty Salary Survey, which is identical in many respects to the IPEDS SA, also includes a section on continuing faculty. From this section, it is possible to estimate the number of new faculty by rank and tenure status, though the report is not intended to be used in this manner and some of the results may be suspicious. Since many schools simply submit their IPEDS SA survey to AAUP, patterns in the AAUP data on continuing faculty may be unsupported in the total population.

The NSOPF Institutional Survey includes survey items about the number of instructional and non-instructional faculty hired in Fall 1992, but these also are not broken out by rank. The annual CUPA survey includes new assistant professors as a special category of faculty for data collection and these data could be used to estimate hiring patterns among certain types of institutions. Still, this critical piece of faculty supply and demand models is missing from the data.

The NSOPF Faculty Survey includes a question which documents faculty rank and the year in which it was obtained. Using data on year of degree, estimates may be made about the length of time necessary to earn rank promotions. Obviously, assumptions may be made about standard practices for awarding the associate professor rank upon granting tenure in the seventh year. This practice will vary, of course, by discipline and tier of institution.

The SDR and NSOPF sample surveys may also be used to estimate the faculty population by rank. However, since these surveys are inadequate for estimating the population by discipline, the value of the rank data is greatly diminished and it makes better sense to use the IPEDS S and SA.

Central to the use of SED data for faculty availability and supply and demand models are assumptions about rank transitions. It is unfortunate that the NSOPF does not document the year of each rank change, only that of the current rank. It is possible, though, to build estimates of rank transitions and length of time in rank by discipline. The SDR only collects current rank and does not include year of rank, making it even less useful for predicting these transitions.

Massy and Goldman recognize that NSOPF data are insufficient for modeling rank transitions. For their projections, they collected rosters on 3, 970 faculty by field at ten institutions for periods of time ranging from 1968 to 1992. From these data, they estimate rank transitions, quit rates, and retirements. For each reporting period, faculty members could have remained at

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their current rank, received a promotion, or left. The results are calculated as percentages for each combination of Carnegie and control. This author had hoped that the SDR data could be used in this manner, but the cell sizes of the number of faculty who appear more than once in the SDR sample over time are very small. If more detailed data were collected in the SDR or the NSOPF about faculty histories by rank and tenure status, this type of research would be much more fruitful.

Tenure

As explained above, the tenure data collected in the NSOPF allow for some estimates of tenure change and length of time in tenure status by discipline. These calculations could be applied along with rank transition data to the faculty population, with projections of future promotions and their impact on openings for new hires. The data on tenure and rank could also be used in conjunction with faculty workload to better estimate faculty supply and demand. For example, it may be assumed that senior faculty will generate fewer SCH. If enrollment growth is to be accommodated given a greying professoriate, there needs to be increased hiring of new assistant professors.

Fortunately, the IPEDS S collects data on new hires by tenure status. These data do not seem to appear in the literature, except for NCES publications. At least they do not appear in models of faculty supply and demand. They are particularly telling and should not be overlooked.

As in the rank data, estimates of tenure status by discipline may be made using the NSOPF data. Once expanded to estimates by Carnegie classification and control, the cell sizes may be too small, but the data are available at the discipline level.

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Studies of the IPEDS S and SA data in the same survey year may yield interesting results in the patterns of growth in research and public service faculty, something also little documented in the literature. These data may be particularly telling for non-tenure track research faculty. This author suspects that, except in land grant institutions, the use of public service faculty is minimal and probably on the decline, given decreases in state appropriations and support for agricultural and extension programs.

Surprisingly, Massy and Goldman (1995) do not address issues of tenure track status in their supply and demand models. Bowen and Sosa (1989) use tenure as a factor when calculating quit rates, assuming in their standard model that 0.5% of tenured faculty will leave higher education each year.

Quit Rates

Massy and Goldman (1995) collect their own data on rank transitions and exits using faculty rosters. Bowen and Sosa's (1989) model of faculty mobility is based on data from the SDR and previous research by Radner and Kuh (1978). This model includes a combination of assumptions about faculty quit rates, age cohorts, tenure status, and discipline.

The SDR data, as well as the NSOPF data, may be used to estimate the faculty population by age. While the surveys were not stratified by discipline, it is reasonable to use both for age data by field, in part for reasons which will be noted below in the discussion of discipline data. Bowen and Sosa build cohorts of age groups based on age and tenure status by clusters of disciplines. A high quit rate of 1% for tenured and 10% for non-tenured faculty is applied, along with standard quit rates of 0.5% and 5% respectively. Surprisingly, there is no differentiation in this model between tenure track and restricted faculty. Although there is increased reliance on restricted faculty and decreased hiring of tenure track faculty, it is to be expected that restricted faculty are much more likely to leave higher education, largely because of mobility issues and decreased job stability. Another problem is that lateral movement at the same rank and tenure status between institutions is not accounted for by these models.

Data from the 1987 Humanities Profile based on the SDR and analyzed by the NRC (1989) are used by Bowen and Sosa for validation of their results. The authors calculate an average quit rate of 1.8% for all faculty, comparable to the NRC's calculation of 1.85%. However, both sets of assumptions are for cohorts of age groups and need to be examined closely. To use the SDR, survey items about age, occupation code, previous job code, and current work responsibilities must be all taken into account. While previous researchers have exercised due caution in using these variables, the methodological reports for the SDR and item response rates suggest that the some of the validity of the data need to be questioned. For example, the imputation of missing data using hot and cold deck procedures may be questioned for the variables which are selected. The sample selection for the SDR is drawn based on the field of doctorate, using SED discipline codes, and does not attempt to stratify by discipline or build a base of faculty data.

Retirement

A significant body of research has been conducted about faculty retirement projections and this will not be reviewed here. Massy and Goldman (1995) assume that their quit rate model based on faculty rosters will include some retirements. They include multiplier retirement rates of 0.025 and 0.030 in the simulation results, without any variation by field. Bowen and Sosa (1989) rely on AAU data on public universities collected by Lozier and Dooris (1987) which provide a distribution of retirements by age groups. These data suggest, for example, that the average retirement age is 65.1 years. The authors apply these rates by age group to the SDR data.

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Once a set of assumptions are made about retirement rates by age, the data on rank and tenure status in the SDR and NSOPF data become more useful for predicting exits. In addition, the NSOPF collects data on expected retirement age. Using these data by discipline, projections may be made about exits. It would be interesting to compare the average retirement age by discipline obtained with the NSOPF, which does not include retired faculty, with that of the SDR, which does (until age 76). Partly in response to this question, an analysis was done of the SDR microdata on year of retirement. These data show that, for whatever reason, few respondents are retired (or report retirement year).

Mortality/Disability

Bowen and Sosa use gender-specific mortality rates supplied by TIAA-CREF for each five-year age cohort. These are used alongside data on quit rates, rank promotions, and retirement to predict overall survival rates. The results of these survival ratios range from 83.1% for faculty age 30 to 34 to 40.1% for those age 60 to 64. The authors hope that these data will facilitate research on the impact of changes in pension plans and retirement laws.

The SDR also collects data on deceased faculty, since techniques for ensuring high response rates code documentation about whether this is the reason for non-response. It may be possible somehow to validate mortality rate estimates, since the TIAA-CREF mortality tables are not specific to faculty.

Departmental Behavior

The research of Massy and Goldman on departmental choice is perhaps the most interesting aspect of their supply and demand model. Based on interviews with 344 faculty at 19 institutions, they found that "the natural production rate of doctorates is driven by departmental needs for research and teaching assistants, and that departmental doctoral-student intake is limited by financial constraints rather than output-market considerations" (p. 1-4). "The labor market was not referenced as a formal criterion to determine the number of students to admit, but many faculty believe it influences the application pool and the types of jobs that graduates obtained" (p. 1-5).

Bowen and Rudenstine (1992) discuss a number of factors related to department and program evaluation, including issues of quality and scale; the evolution of top tier programs; requirements and program content; and program design oversight, and culture.

While it is important to consider these factors as relevant to faculty supply and demand, it is very difficult to quantify them as part of a complex model. Perhaps the most important insight is that drawn by Massy and Goldman that it is departmental needs, not information about the labor market, which determines the number of doctoral students who are admitted. While the authors build complex regression equations based on variables which are associated with departmental behavior, the results are less informative than the descriptive summaries of the interviews.

Tier/sector structures

Many reports from NCES, NSF, and NRC detail faculty data by Carnegie and control. Depending on the degree of breakout, numerous combinations of cells may be produced for stratification. Decisions about reporting results in this manner become particularly important since the cell sizes of the NSOPF and SDR samples are so small in the cross-tabs of interest.

Data from the IPEDS surveys lend themselves to reporting by Carnegie and control, because most of the universe of institutions is included. Using the total population of faculty provided by the IPEDS S or SA, it is possible to weight disciplinary data from the SDR or the NSOPF to the population. Many reports about SDR data use the population estimates by occupation code or Carnegie/control which are weighted to census data. However, in trying to us the SDR weighting scheme to estimate the population by discipline, NSF staff observed that it is very difficult to understand the stratification which was used and therefore the appropriate table of standard errors and weightings.

In using the microdata for the SDR, a data administration error in the 1993 file was found which suggests that reported information about Carnegie and control is seriously in question. Cross-tabulations of Carnegie classification by other variables which indicate the type of educational institution resulted in Research I universities being coded as Two Year College employer types. This problem was not detected in the methodological report. It is possible to work around it by relying on institutional identifiers such as FICE codes. However, FICE codes are assigned based on the name of the institution reported by each respondent. If the name is not completed or not found on the current list, it is left blank. Institutional type variables are then imputed, in part based on the same erroneous variables.

Massy and Goldman invest a significant amount of their research in constructing new types of tiers of institutions. Using data on faculty, degrees, finance, and post-docs, they conduct factor analyses and use the loading results to place institutions into categories for each of the 12 disciplines examined. "As might be expected, the more prestigious schools tend to come out at the top" (p. 5-11). These segments of schools suggest meaningful relationships between the variables of interest.

There is another reason for paying attention to issues of faculty supply and demand by Carnegie and control or other types of segments. It must be assumed, following the analysis of graduate programs from Bowen and Rudenstine (1992), that not all graduate programs are equal. This suggests that a tier structure is in effect in regards to hiring new faculty and in faculty mobility. The elite segment of institutions is not open to potential faculty from what are considered to be second class institutions.

To demonstrate this phenomena, it would be interesting to use the SDR to produce a cross-tab with the Carnegie classification of the doctorate against the Carnegie classification of the faculty position. If the SDR Carnegie data cannot be cleaned up, the NSOPF data may be used for the same analysis.

Further assumptions may be made, based on this type of analysis, about movement between institutions. If Harvard, Stanford, and MIT only hire faculty from within a select segment of institutions, then a separate faculty supply and demand model needs to be constructed and models that are not sensitive to this tier phenomena will be inadequate. Similarly, four-year, public comprehensive institutions can not hope to attract doctoral recipients from elite institutions. This calls for further investigation of faculty pipeline issues surrounding graduate education, such as mentoring, research sponsorship, and maintaining cadres of doctoral students to work with senior researchers both during and after the Ph.D. It is difficult to quantify these issues. It seems doubtful that simply including more of these related variables in a regression equation, such as done by Massy and Goldman, will have any effect on the endogenous variables.

Research activity

Research activity impacts the financial support of graduate students, the support of post-docs, and the need for faculty. This is a basic measure of departmental behavior used by Massy and Goldman (1995) to predict faculty and supply. Research and development expenditures and research equipment expenditures data by discipline and institution are calculated from CASPAR are included used in their factor analysis for institutional segmentation.

It is assumed in the authors' regression model of departmental behavior that research monies are tied to doctoral enrollment. However, a somewhat surprising result of the simulation is that "without changes in academic production norms, increases in sponsored research tend to hurt long-term doctorate employment at rates that can easily exceed half the favorable short-term effect" (Massy and Goldman, 1995, p. 1-34).

Table 4: Non-Faculty, Doctoral Research Staff

Graduate Student Survey Academic Discipline	Non-Faculty Research Staff
+ SCIENCES AND ENGINEERING (EXCL HEALTH FIELDS)	7,707
+ SCIENCES (EXCLUDING HEALTH FIELDS)	6,739
+ ENGINEERING	968
+ PHYSICAL SCIENCES	1,635
+ EARTH, ATMOSPHERIC, AND OCEAN SCIENCES	510
+ MATHEMATICAL AND COMPUTER SCIENCES	148
AGRICULTURAL SCIENCES	281
+ BIOLOGICAL SCIENCES	3,604
+ PSYCHOLOGY	365
+ SOCIAL SCIENCES	196

This suggests that the relationship between patterns of sponsored research by discipline and faculty supply and demand is not simplistic. Increased reliance on post-docs and on non-tenure track faculty may decrease demand for the tenure track appointments which many doctoral recipients believe they can obtain.

One additional "holding pattern" or alternative career path which needs to be explored is the use of non-faculty research staff with doctorates. These data are collected on the GSS, but are rarely reported on. These staff are defined by the survey as "all doctoral scientists and engineers who are involved principally in research activities but are not considered either postdoctoral appointees or members of the regular faculty" (NSF, 1995, p. 53). It may be assumed that they could compete with recent doctorates and post-docs for faculty jobs. Table 4 documents these research staff by discipline.

Disciplines

Much of the discussion about assumptions centers around the availability of data by discipline. Statements have been made about problems in the SDR and NSOPF sampling methodologies and about the ability to build crosswalks in taxonomies between different datasets.

Many policy issues may be investigated by examining faculty characteristics individually. Data on faculty age, for example, document the continued greying of the professoriate. If this analysis is extended to the question of whether growth in tenured faculty is preventing new appointments, a second characteristic may be added. For these two and three-way cross-tabulations, the cell sizes of the SDR and NSOPF samples are adequate. If these are extended, however, to make assumptions about institutional segments or tiers, the cell sizes are inadequate. Sometimes, researchers fail to acknowledge this and prepare analyses, weighting them with approved weights to the population. While the standard errors may fall within acceptable ranges, the weighting methodology becomes suspect. In the SDR 1993, it is impossible to construct new cross-tabs of interest and weight them to the population, because the stratification, sampling, and weighting processes were so complex and even now not fully understood by some NSF staff. This is true for many different cross-tabs of characteristics, but is particularly important to recognize in issues surrounding discipline.

The SDR does not collect detailed data on faculty member's discipline. Many reports use the discipline of the Ph.D., in part because the only departmental affiliation which is recorded in the survey is occupation code. For post-secondary faculty, there are only 29 occupation codes for scientists and engineers and a comparable number for those in the humanities. The method-

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ology report for the 1993 SDR suggests that this variable is much misunderstood for many reasons. In examining the administration and "cleanliness" of the microdata, it is apparent that the data files are not intended to be used in this way. For example, some post-secondary occupation codes are held by persons who do not work at higher education institutions. Some Research I institutions are listed as Two-Year College employer types.

The SDR occupation code data are weighted to U.S. Census data and its projected annual increases. The author would feel more confident if the post-secondary data were weighted to the population of faculty provided with the IPEDS S or SA. NSF staff report that estimates of the population are roughly comparable to those calculated with the NSOPF.

Problems in the NSOPF study have been discussed, most notably that the measure of size of 41.5 for sampling with certainty among research and doctoral institutions is questionable. While standard errors for cross-tabs of interest may fall within acceptable levels, methodological concerns are raised when this MOS is used to predict the faculty population by discipline. This is particularly vexing because the NSOPF could have been stratified by discipline and wasn't, even though discipline was available in the faculty rosters from whom the sample was drawn. Numerous conversations have been held with NCES, AAUP, NSF, and other agency staff about this issue. Out of this, the author has put forward the statement that while the methodology provides a valid estimate of the faculty population, it is not a good estimate.

The most difficult part of this discussion is that there is no single source of data for the faculty population by discipline to which the NSOPF results could be compared. The SDR post-secondary occupation codes are inadequate. Furthermore, no crosswalk has been built between the WebCASPAR taxonomy and the occupation codes. This is not because NSF and QRC have

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Table 5: Comparison of Random Sample vs. Population of NRC Data by Discipline

Discipline	N Random Sample	Discipline % in Sample	Discipline % in Pop	%Change Sample vs. Pop.	N of Estimate	N of Population	N Over-estimate	% Over-estimate
12	520	4.9%	4.6%	-0.3%	4,319	4,082	237	5.8%
13	159	1.5%	1.6%	0.1%	1,321	1,420	-99	-7.0%
14	111	1.0%	1.4%	0.4%	922	1,235	-313	-25.3%
15	357	3.4%	1.0%	-2.3%	2,965	925	2,040	220.6%
16	52	0.5%	0.7%	0.2%	432	621	-189	-30.5%
17	33	0.3%	0.8%	0.5%	274	700	-426	-60.8%
18	24	0.2%	0.6%	0.4%	199	547	-348	-63.6%
19	49	0.5%	1.0%	0.5%	407	889	-482	-54.2%
20	31	0.3%	0.7%	0.4%	257	578	-321	-55.5%
21	17	0.2%	0.4%	0.2%	141	357	-216	-60.4%
22	33	0.3%	0.4%	0.1%	274	381	-107	-28.1%
23	620	5.8%	4.4%	-1.4%	5,150	3,881	1,269	32.7%
24	541	5.1%	4.9%	-0.2%	4,493	4,285	208	4.9%
25	432	4.1%	5.0%	1.0%	3,588	4,436	-848	-19.1%
26	235	2.2%	2.6%	0.4%	1,952	2,284	-332	-14.5%
27	222	2.1%	2.3%	0.2%	1,844	2,028	-184	-9.1%
28	73	0.7%	1.1%	0.4%	606	983	-377	-38.3%
29	40	0.4%	0.6%	0.2%	332	522	-190	-36.4%
30	479	4.5%	3.9%	-0.6%	3,978	3,443	535	15.6%
31	306	2.9%	2.9%	0.0%	2,542	2,543	-1	-0.1%
32	143	1.3%	1.5%	0.1%	1,188	1,284	-96	-7.5%
33	153	1.4%	2.1%	0.7%	1,271	1,845	-574	-31.1%
34	122	1.1%	1.3%	0.2%	1,013	1,188	-175	-14.7%
35	1,075	10.1%	5.7%	-4.4%	8,929	5,043	3,886	77.1%
36	245	2.3%	3.1%	0.7%	2,035	2,694	-659	-24.5%
37	295	2.8%	3.7%	0.9%	2,450	3,278	-828	-25.3%
38	228	2.1%	2.7%	0.5%	1,894	2,365	-471	-19.9%
39	169	1.6%	2.3%	0.7%	1,404	2,039	-635	-31.2%
40	82	0.8%	1.5%	0.8%	681	1,363	-682	-50.0%
41	37	0.3%	0.6%	0.3%	307	551	-244	-44.2%
51	879	8.3%	7.0%	-1.3%	7,301	6,186	1,115	18.0%
52	779	7.3%	6.5%	-0.9%	6,470	5,718	752	13.2%
53	247	2.3%	3.3%	1.0%	2,052	2,899	-847	-29.2%
54	328	3.1%	3.3%	0.2%	2,724	2,934	-210	-7.1%
55	396	3.7%	3.0%	-0.7%	3,289	2,657	632	23.8%
56	486	4.6%	4.8%	0.2%	4,037	4,201	-164	-3.9%
57	384	3.6%	3.4%	-0.3%	3,189	2,968	221	7.5%
61	57	0.5%	0.7%	0.2%	473	618	-145	-23.4%
62	65	0.6%	1.1%	0.5%	540	959	-419	-43.7%
63	48	0.5%	0.6%	0.2%	399	570	-171	-30.1%
65	68	0.6%	0.8%	0.2%	565	708	-143	-20.2%
Total	10,620	100.0%	100.0%	0.0%	88,208	88,208	0	0.0%

not had time or funding to do so, but because the premise that occupation codes are useful in this manner is flawed. NCES staff have already undergone severe methodological criticism for the under-sampling of health science faculty. When the standard errors fall within acceptable ranges, it is difficult to raise another design issue. For this reason, the author constructed a simulation to determine whether the MOS of 41.5 by institution is a good predictor.

One source of faculty data by discipline is the NRC study of doctoral program rankings conducted in 1982 and in 1993. Surprisingly, Massy and Goldman (1995) use the 1980 NRC data in their prediction of faculty supply and demand. They recognized it as the only source of population data, albeit of a small segment of the faculty population, that of research and doctoral institutions and departments with research doctorate programs.

The current NRC doctoral ranking data are available on CD-Rom and include a roster of all 88,208 faculty, including data on their institution and discipline. A SAS program was written to select a random sample from the 88,208 faculty, drawing 41.5 faculty at random from each institution. As in the NSOPF methodology, for those institutions with less than 41.5 faculty, all faculty were selected. Table 5 depicts the results of this analysis. The percent of faculty in each discipline are calculated from the sample of 10,620 faculty, then weighted to the population. In only a few disciplines was the prediction of faculty by discipline close to the actual data.

While it is possible to use the NRC doctoral rankings data, as Massy and Goldman have done, to estimate the faculty population by discipline, discussion with NRC staff suggest that the data were never intended to be used in this manner. They are useful, though, in suggesting that while the NSOPF design is a valid estimate, it is not a good estimate.

IV. Constructing a Complex Model

A complex model of faculty supply and demand may be constructed based on the 19 types of assumptions which appear in the research. This model has the following components:

(1) **Enrollment** - with undergraduate, masters, and doctoral enrollment from the IPEDS EF reports. These data may be broken out by gender and ethnicity.

(2) **Degrees** - with IPEDS C and SED data used to document masters and doctoral degrees and recipient characteristics. Degree data are qualified with assumptions about the percent of graduates who plan to enter academe by discipline. Doctoral data by discipline are qualified with assumptions about financial support and time-to-degree.

(3) **Post-docs** - with data by discipline on the number and percentage of students with the appointments. Assumptions about length of appointment need to be developed.

(4) **Non-faculty research staff** - this temporary holding pattern needs to be included with data from the GSS. Assumptions need to be made about this type of position.

(5) **Faculty population** - documentation of the population of full-time, instructional, research, and public service faculty, broken out by rank within tenure status by discipline and by tier of institution. Assumptions need to be made about rank transitions, retirement rates, quit rates, and mortality by discipline.

(6) **Faculty workload** - projections need to be calculated based on workload data for full-time faculty. Assumptions need to be made about other teaching FTE.

(7) **Research activity** - need for post-docs, non-faculty research staff, and degree productivity are linked to research funding by discipline.

Are the data for this model available in the national datasets? With each assumption, the data availability and data administration issues were described. There are only incomplete data on post-docs. No data are available on rank transitions, only year of current rank and tenure. No discipline data are available to weight a sample to the population.

Many critical components of the model can be completed, however. The NSOPF and SDR are very useful in constructing age cohorts for retirement and mortality assumptions. The SED and NSOPF are helpful in assumptions about time-to-degree. The SED is essential for documentation of employment plans and the NSOPF for faculty workload issues. The population data of the IPEDS C and EF are critical to the enrollment component, and the CGS/GRE and GSS provide additional breakouts by graduate program. No other data on non-faculty research staff exist besides what is collected with the GSS.

This research suggests that *while existing data collection efforts allow for many types of complex policy studies about faculty, it is impossible to construct a complex model of faculty supply and demand. The studies of Massy and Goldman (1995) and Bowen and Sosa (1989) are flawed because they do not adequately document the faculty population by discipline.*

Only simple descriptive statistics may be produced to test questions about Ph.D. overproduction. This is somewhat of a disappointment, given the promise of existing research and the efforts of this current study to investigate the microdata. The best approach to estimating overproduction is to calculate the total number of potential job seekers (from the SED) as a ratio of total full-time instructional faculty (from the IPEDS SA), over time. While doctoral unemployment studies using the SDR are interesting, they are not valid when applied to the faculty population. Table 6 presents the results of this analysis:

These ratios of the number of doctoral graduates seeking academic employment to the number of full-time, instructional faculty suggest that job hunting was much easier in the early

1970s, but became increasingly more difficult by the late 1980s. Current data are comparable to the late 1970s.

Table 6: Trends in Academic Job Seekers/Total Full-Time Faculty

Year	#Job Hunters	# Faculty	#Fac per Graduate
71	12,989	320,844	25
72	12,546	328,234	26
73	12,076	341,998	28
74	10,802	na	na
75	10,571	369,281	35
76	10,236	377,157	37
77	9,299	386,880	42
78	8,622	389,001	45
79	8,478	395,968	47
80	8,224	396,402	48
81	7,952	400,772	50
82	7,430	406,795	55
83	7,221	407,799	56
84	6,823	na	na
85	6,795	395,912	58
86	6,710	395,857	59
87	6,661	na	na
88	6,824	430,740	63
89	7,087	na	na
90	8,407	437,128	52
91	9,594	450,356	47
92	10,123	446,930	44
93	10,203	454,104	45
94	10,712	454,008	42
95	11,293	457,913	41
96	10,588	457,692	43

V. Conclusions and Recommendations

Good data on the faculty population by discipline are badly needed if scholars and policy makers are to verify critical projections about the overproduction of Ph.D.s. Discipline-specific data inform many other types of studies. It should not be assumed that early retirement programs will affect all disciplines in the same way or that changing structures of tenure are uniform across

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fields. Research about rank transitions, the growing reliance on non-tenure track faculty, faculty workload, and faculty salaries must be differentiated by discipline to address policy issues at the appropriate unit of concern.

Several attempts have been made by agencies to collect data by discipline on a larger proportion of the faculty population, including an early version of the NSF-NIH Graduate Student Survey. This author has recommended that the NSOPF survey be stratified by discipline. He has also proposed at an NPEC-sponsored meeting of the IPEDS Technical Review Panel that the IPEDS S be modified to collect information at the discipline level. Such as report would be similar to the section on gender and ethnicity by rank and tenure. The column headers would be rank within tenure and the rows would leave room for each discipline offered at an institution, using two-digit CIP codes.

While there are many types of data to collect by discipline, the critical cross-tab of interest for faculty supply and demand is counting the number of full-time, instructional, research, and public service faculty by rank within tenure status at each institution. Any data collection effort besides headcount, such as faculty salary outlay, gender, ethnicity, or FTE, would require that this report be much more complex and unwieldy. While even this single page presents an additional reporting burden for institutions, unit record data are already being collected to produce other IPEDS S and SA reports. As far as which taxonomy of disciplines to use, IPEDS respondents already use CIP codes, these are used by CUPA and Oklahoma, and a crosswalk already exists to CASPAR.

This proposed table of rank by tenure for each 2 digit CIP code would provide a significant boost to researchers' ability to conduct policy studies on faculty. It would be the first time

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ever that data are collected on the faculty population discipline are collected. These data would provide an invaluable baseline for weighting all sample-based studies.

Several other recommendations arise from this study. In addition to stratifying the NSOPF, it would be very helpful to collect more information about faculty members history of rank promotions and tenure awards. As for the SDR, it would be very useful if better occupational code data were collected and if the sample was stratified by discipline. For data on new hires, the IPEDS S would be much more useful if the data on new full-time faculty hires by tenure status were expanded to include rank.

VI. References

Bowen, William G., and Neil L. Rudenstine. (1992). In Pursuit of the Ph.D. Princeton, NJ: Princeton University Press.

Bowen William G., and Julie Ann Sosa. (1989). Prospects for Faculty in the Arts and Sciences. Princeton, NJ: Princeton University Press.

Brown, Prudence, Ramal Moonesinghe, and Susan Mitchell. (1996). Methodological Report of the 1993 Survey of Doctorate Recipients. Washington, D.C.: National Research Council, Office of Scientific and Engineering Personnel.

Committee on Science, Engineering, and Public Policy (COSEPUP, 1995). Reshaping the Graduate Education of Scientists and Engineers. Washington, D.C.: National Academy Press.

Geiger, Roger. (1997). "Doctoral Education: The Short-Term Crisis Vs. Long-Term Challenge." Review of Higher Education 63 (3):89-94.

Hartle, Terry W., and Fred J. Galloway. (1996). "Too Many Ph.D.s? Too Many M.D.s?" Change (September/October, 1996):27-33.

Hill, Susan T. (1997). "Doctorate Awards Increase in S&E Overall, but Computer Science Declines for First Time." Data Brief. NSF 97-325. Washington, D.C.: National Science Foundation, Science Resources Studies Division. .

Johnson, Jean M. (1996). "Western Europe Leads the United States and Asia in Science and Engineering Ph.D. Production." Data Brief (1996) 12. Washington, D.C.: National Science Foundation, Science Resources Studies Division. .

Massy, William F., and Charles A. Goldman. (1995). The Production and Utilization of Science and Engineering Doctorates in the United States. Stanford, CA: Stanford Institute for Higher Education Research.

Milam, John H., Jr. (1997). "Developing Benchmarks for Faculty Hiring." Paper presented at the annual meeting of the Association for Institutional Research, Orlando, May 1997.

Milam, John H., Jr. (1995a). The Myth of Affirmative Action Data. Monograph Series, #94-6. Houston: University of Houston, Institute for Higher Education Law and Governance.

Milam, John H., Jr. (1995b). "The National Study of Faculty Availability and Utilization: Report of Findings." Paper presented at the annual meeting of the Association for the Study of Higher Education, Orlando, November 1995.

National Center for Education Statistics. (1997). Characteristics and Attitudes of Instructional Faculty and Staff in the Humanities: 1993 National Study of postsecondary Faculty. NCES 97-973. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement.

National Center for Education Statistics. (1994). Faculty and Instructional Staff: Who Are They and What Do They Do?: 1993 National Study of postsecondary Faculty. NCES 94-346. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement.

National Center for Education Statistics. (1996). Institutional Policies and Practices Regarding Faculty in Higher Education. NCES 97-080. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement.

National Center for Education Statistics. (1997). Instructional Faculty and Staff in Higher Education Institutions: Fall 1987 and Fall 1992: 1993 National Study of postsecondary Faculty. NCES 97-470. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement.

National Center for Education Statistics. (1996). Integrating Research on Faculty: Seeking New Ways to Communicate About the Academic Life of Faculty. NCES 96-849. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement

National Center for Education Statistics. (1997). Methodology Report: 1993 National Study of postsecondary Faculty. NCES 97-467. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement.

National Center for Education Statistics. (1997). Retirement and Other Departure Plans of Instructional Faculty and Staff in Higher Education Institutions: 1993 National Study of postsecondary Faculty. NCES 9-254. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement

National Center for Education Statistics. (1994. Salaries, Tenure, and Fringe Benefits 1993-94. NCES 94-395. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement

National Center for Education Statistics. (1997). Strategies for Improving Accuracy of Postsecondary Faculty Lists. Working Paper 97-26. Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement

National Research Council. (1995). "Ph.D.s and Postdoctoral Appointments." Issues Brief. Washington, D.C.: National Research Council, Office of Scientific and Engineering Personnel.

National Research Council. (1995). Research-Doctorate Programs in the United States: Continuity and Change. Washington, D.C.: National Academy Press.

National Science Foundation. (1997). 1993 Survey of Doctorate Recipients: Summary File Documentation. Washington, D.C.: National Science Foundation.

National Science Foundation. (1996). Characteristics of Doctoral Scientists and Engineers in the United States 1993. NSF 96-302. Washington, D.C.: National Science Foundation, Division of Science Resources Studies.

National Science Foundation. (1996). Characteristics of Recent Science and Engineering Graduates: 1993. NSF 96-309. Washington, D.C.: National Science Foundation, Division of Science Resources Studies.

National Science Foundation. (1987). "Recent-Doctorate Faculty Increase in Engineering and Some Science Fields." Science Resources Studies Highlights. NSF 87-310. Washington, D.C.: National Science Foundation.

Regets, Mark. (1997). "What's Happening in the Labor Market for Recent Science and Engineering Ph.D. Recipients?" Issue Brief. NSF 97-321. Washington, D.C.: National Science Foundation, Division of Science Resources Studies.

Shettle, Carolyn. (1997). "S&E Ph.D. Unemployment Trends: Cause for Alarm?" Issue Brief. NSF 97-318. Washington, D.C.: National Science Foundation, Division of Science Resources Studies.

Syverson, Peter D. (1997). "It's Not Just Employment/Unemployment Anymore - Realities of Ph.D. Labor Market Lead to More Complex Measures of Postgraduation Employment." CGS Communicator. Washington, D.C.: Council of Graduate Schools

Syverson, Peter D., and Lorna E. Forster. "New Ph.D.s and the Academic Labor Market." Washington, D.C.: National Research Council, Office of Scientific and Engineering Personnel.

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