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An Overview of Trends in University Research

Introduction. Faculty members at U.S. colleges and universities are reported to spend an average of 15-20% of their time on research (1) and this number is likely higher at a research-intensive institution such as the University of Utah. Basic research has the objective of gaining more comprehensive understanding of the subject under study without specific applications in mind, whereas applied research seeks to gain knowledge or understanding to meet a specific recognized need. Development is the systematic use of the knowledge derived from research in producing commercial products, processes or services. Taken together, these three activities are referred to as research and development (R&D) (2). Research grants and contracts supply about 12% of the University of Utah's annual budget, a larger proportion than either student tuition or the state appropriation in fiscal year 2007 (3). Because of the significant investment that society makes in supporting university research, there is considerable interest in monitoring and measuring the research output of universities, frequently by means of comparative ranking schemes.

University Rankings. A number of university ranking systems intended for academic, government and business purposes are produced regularly. Some rankings rely heavily on survey-based assessments of reputation, while others use only generally available objective data, most of which are related to university research activity. The most commonly used data are the number of honors or awards won by faculty; number of research grant awards and amount of funding; number of publications in prestigious journals; number of literature citations of papers; and number of patents. There are some serious limitations of university ranking schemes, including their frequent failure to account for the widely varying number of faculty across ranked institutions. For example, among the ten public research universities used as a peer comparison group for University of Utah research, published faculty numbers for 2007 (4) range from 1,642 (University of New Mexico) to 6,265 (University of Florida)-an almost four-fold difference. Since all of the usual measures in rankings vary with the number of faculty members in the academic units being compared, failure to use *per capita* data in a ranking makes it difficult to interpret the meaning of differences in rank. Another limitation of current ranking schemes is their reliance on traditional disciplinary categories, which increasingly fail to capture the dynamism of modern collaborative multi-disciplinary research. There is reason to believe that more empirical and objective categorization of research areas will soon permit more detailed, timely and informative analyses of a university's research portfolio (5).

There are five commonly cited university ranking systems. The U.S. National Research Council periodically produces a ranking of U.S. graduate programs. In the past (most recently in the 1995 report), they have used only survey-based reputational data but promise to include objective data in the forthcoming report (6). In the U.K.-based *Times Higher Education-QS Top Universities of the World*, which weights survey-based reputation 40% and objective data 60%, the University of Utah is ranked 246th overall and 268th in the natural sciences among the

world's universities for 2008 (4). In the 2008 *Shanghai Jiao Tong University* ranking system, which does not use reputational surveys, the University of Utah ranks 46th among U.S. universities and 79th in the world (7). Academic Analytics, a U.S. company, has produced a "faculty scholarly productivity" ranking of all U.S. departments with graduate programs, using objective data analyzed on a *per capita* basis. Although the University has not purchased the full survey, it is known that Utah departments corresponding to the following disciplinary categories have appeared in the top-ten list for their discipline in the 2006 and/or 2007 rankings (8): Anatomy; Bioengineering; Computer & Information Science; Educational Psychology; Foundations of Education; Near and Middle Eastern Languages and Cultures; Pharmaceutical Sciences & Medicinal Chemistry; Special Education; Speech and Hearing Science; and Theater Literature, History and Criticism.

The National Science Foundation produces detailed annual reports on science and engineering indicators, including university rankings based on research funding. Based on total federal R&D funding for federal fiscal year 2006, the most recent year for which data are available, the University of Utah ranked 53rd among the 123 U.S. universities (public and private) with medical schools (2). The Center for Measuring University Performance at Arizona State University compiles an annual report (9) using a variety of objective data to rank universities. The University of Utah is consistently included in the middle of a group of about 50 institutions listed as the "top 25 public universities" based upon their ranking in the top 25 on at least one of nine different measures of university performance.

Trends in Research Funding. Ninety-six percent of the world's R&D is done in the 30 developed countries that are members of the Organization for Economic Cooperation and Development (OECD), where aggregate real (i.e., inflation-adjusted) annual R&D expenditures increased from \$450 billion to \$750 billion between 1995 and 2005 (10). The United States spent 2.57% of its gross domestic product on R&D in 2006. In that year U.S. universities and colleges performed about \$47 billion of R&D, one-fifth the amount performed by U.S. businesses, but accounted for 56% of the nation's basic research (10). In 2007, 62% of the funding for academic research came from the federal government, whereas 20% came from institutional funds, 6% from state and local governments, 5% from industry, and 7% from all other sources (2). Over the past three decades, federal research funding as a percentage of non-defense discretionary spending has rarely deviated much from the long-term average of 10.8%, suggesting a stable political consensus on the appropriate level of funding for research relative to other national priorities (11). Interestingly, however, between 2004 and 2007, 51% of the growth in university research funding came from non-federal sources, reflecting both declining real federal expenditures and increased research funding from major foundations, industry, and institutional funds (11). The state-funded Utah Science Technology And Research (USTAR) program is a local example of this national trend toward increased non-federal support for university research (12). Because most of the non-federal sources of funding for research are more focused on solving particular societal problems (particularly health- and energy-related ones) than on supporting curiosity-driven research, there is an increased university emphasis on developing centers and institutes that support multi-disciplinary teams working on these problems (11). Maintaining a healthy balance of curiosity-driven disciplinary research and problem-focused multi-disciplinary work is an important goal for research universities.

The Research Environment at the University of Utah. Research universities provide their faculty with environments conducive to carrying out high-quality research. For most disciplines, well-prepared graduate students are an important part of the environment, as are library and computing resources. Faculty in sciences and engineering also require a variety of research facilities, ranging from field research stations to laboratories to major research instruments, as well as extramural funding to support their research activities. Most full-time Utah faculty engage in research and during each of the past three calendar years (2006-8) there were about 800 faculty members acting as principal investigators for about 1800 sponsored research projects, for which the university received and spent about \$320 million per year. The largest single source of research funds for the University of Utah is the National Institutes of Health, followed by the National Science Foundation. These and other federal sources of research funding pay, in addition to the direct costs associated with carrying out research projects, indirect costs (also termed overhead or Facilities & Administration costs) to fund the institutional infrastructure needed for high-quality research. The university uses these overhead funds to support faculty recruiting and retention, graduate student programs, dean's funds, capital facilities, research compliance, research computing, and research equipment.

Because the NIH provides about one-half of the University of Utah's total research funding and about three-quarters of its federal funding, trends in NIH funding have a large effect on our research enterprise. The NIH underwent a nominal doubling of its funding between 1998 and 2003 but subsequent funding has not kept pace with inflation, with the result that NIH funds in 2008 are equivalent in purchasing power to the NIH appropriation in 2002 (13). There have been two main impacts of the NIH budget trends since 2003 on research universities: increased competition for grants and declining purchasing power of grant funds. Between 1998 and 2005, both the number of new applicants and the number of grant applications to NIH nearly doubled and the average size of funded grants increased, with the inevitable result that the success rate for applications declined, from about 33% to about 20%. This difficulty in getting grant funding has exacerbated a longer-term trend toward delaying investigators' independent careers: the average age for first appointment as an assistant professor in a U.S. medical school is now 39 and the average age for receipt of the first NIH grant was 42.6 in 2007 (14). The indirect costs paid by NIH grants have been eroded by inflation, with the result that for the University of Utah the purchasing power of the overhead funds received from the NIH in 2008 is similar to that for funds received in 2000. Since it is not clear when or if the NIH will see a real increase in funding, universities must attempt to diversify their sources of research funding and become more effective in competing for NIH funds; recent grant and contract award data suggest that University of Utah faculty are doing well in both regards.

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