TheCenter

Quality Engines: The Competitive Context for Research Universities

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July 2001

The Top American Research Universities
An Annual Report from
The Lombardi Program on Measuring University Performance

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Acknowledgments

The authors gratefully acknowledge the support of Mr. Lewis M. Schott, whose generous contribution established the Lombardi Program on Measuring University Perfomance.

The University

The American Research University: A Perspective

American Higher Education and the Research University

Any effort to summarize American higher education struggles with the large variety of missions, structures, and characteristics represented by the over 4,700 institutions offering some form of post-secondary education. Community colleges, trade schools, denominational colleges, liberal arts institutions, small and large state colleges and universities, elite private colleges and universities, and medical institutions all inhabit overlapping parts of the same educational space.

This diversity of institutions represents one of the great strengths of American post-secondary schooling. Institutions exist to serve virtually any student, whatever their preferences, needs, values, and abilities. The system lacks formal, structural elegance, but it more than compensates with its comprehensive scope and its remarkable resilience and dynamism.

This lack of formal structure poses a major challenge for those who would analyze, categorize, and evaluate these institutions, because few fit into neat categories suitable for data collection and comparative analysis. Institutions as different as community colleges, research universities, and elite liberal arts colleges teach students a relatively standardized curriculum for the first two years. All undergraduate institutions, from large comprehensive state-supported universities to small privately endowed sectarian colleges, compete for college-bound high school graduates. Although these colleges and universities teach students within the context of a four-year undergraduate curriculum leading to a bachelor's degree, they nonetheless differ substantially in size, characteristics of student populations, and overall institutional mission. Nationally competitive research takes place at approximately the same scale whether in public institutions with as many as 50,000 students or in small private universities with less than 1,000. No effort to understand these institutions on a single scale can hope to succeed.

The overlapping missions, diverse governance mechanisms, and multiple sources of funding tend to obscure the highly competitive behavior of American higher education. Institutions compete with each other for funding, students, faculty, and recognition. The nature of this competition, more than the specific characteristics of the institutions themselves, defines groups of institutions: liberal arts colleges compete primarily with other liberal arts colleges, comprehensive state institutions compete with others like themselves, research institutions compete with other research universities.

Institutions also compete across categories, not only within them. Community colleges and comprehensive state universities often compete for the same students within a defined geographic area. All public institutions in a given state compete with each other for tax-based support. Prestigious public and private universities compete with small elite liberal arts colleges for top students.

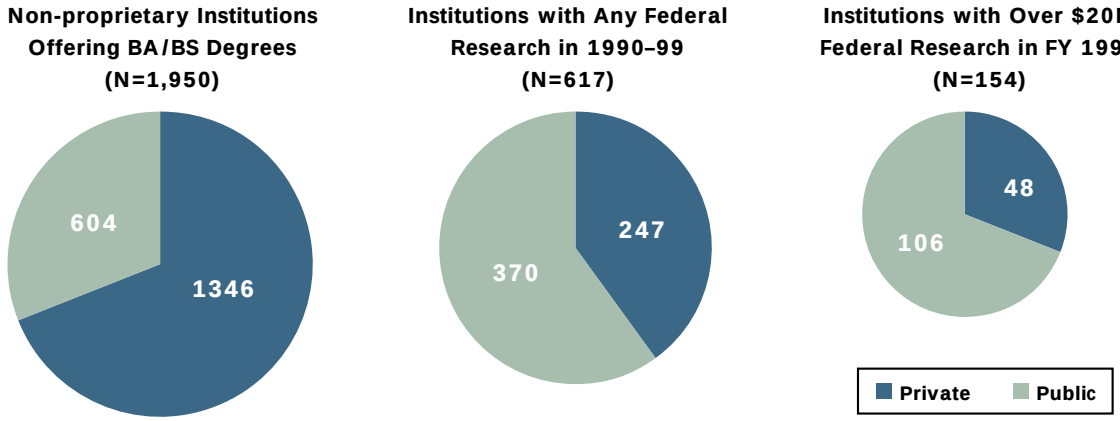
Some forms of competition, however, define institutions sufficiently to create a category of analytical interest. Research provides a defining characteristic for a set of institutions whose performance in many areas of academic life sets the standards for most of American higher education.

The overlapping missions, diverse governance, and multiple sources of funding tend to obscure the highly competitive behavior of American higher education.

The definition of a research university for the purposes of this report involves two primary characteristics.

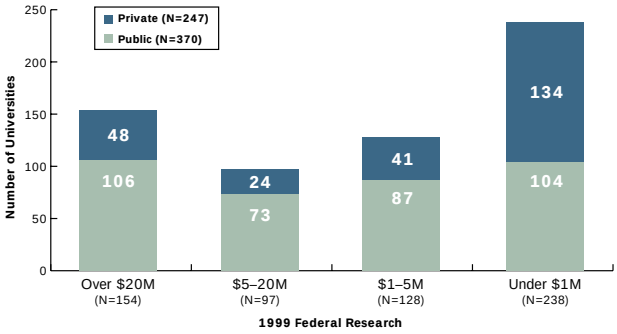
- First, these universities compete successfully for federal research funds. Major research institutions spend at least $20 million a year from these sources, while other research institutions spend less.
- Second, research universities are regionally accredited institutions whose academic programs award accredited academic degrees.

The following figures provide a perspective on this group of institutions. Of the 1,950 non-



proprietary postsecondary institutions that offer at least a bachelor's degree, some 617 reported expenditures from federal sources on research in at least one year during the period 1990–1999. Within this group of institutions that compete for federally sponsored research, only 154 major research universities spent over $20 million on research from federal sources in fiscal year 1999.

The Four Research Groups

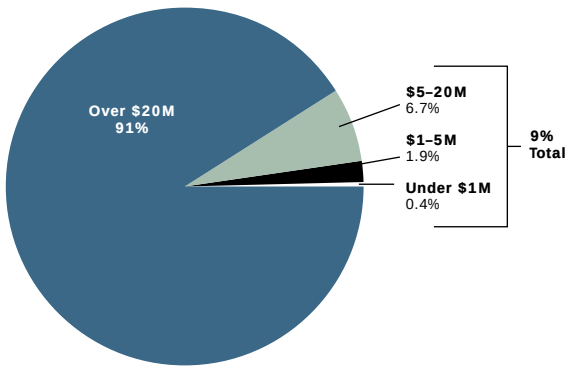


These 154 institutions account for 91% of annual federal research expenditures. The other 463 universities, taken together, account for the other 9% of the total, and our report divides this larger group into three additional categories for some analysis based on the institution's 1999 federal expenditures. *TheCenter* has an interest in all research universities and provides data online for all categories of federal research spending [http://thecenter.ufl.edu]. However, this report continues to focus primarily on those institutions with over $20 million in federal research expenditures, as in the previous *Top American Research Universities* report issued in 2000.

The highly evolved and complex American research universities in this top category share many things in common, but they differ significantly in size, structure, organization, and finance. Some have student populations as large as 30,000 to 50,000, while others have fewer than 1,000 students. Some have a majority of their students in undergraduate programs, others have a majority of graduate and professional students, and a few have no undergraduates at all.

Research universities operate with significantly different formal organizational structures. Some operate as private, not-for-profit corporations and display clearly defined organizations governed by

Federal Research Market Share by Research Group



self-perpetuating boards. Others operate as public entities under state constitutional or legislative provision with ownership or control assigned to boards of trustees or regents. These boards are selected, appointed, or elected in accord with differing criteria. Some public research universities may share a governing board with other institutions, only some of which may emphasize research. Public research universities also have complex relationships that link them directly to state legislatures and statewide coordinating commissions. On occasion, they have both local and statewide governing boards.

These research universities do many things in addition to research, further complicating an analysis of their research performance. As educational institutions, research universities can sustain any number of academic specialties, support a wide array of professional schools, engage in extensive off-campus educational activities in continuing professional education, and perform services for public and private constituencies. Individual universities combine these functions in many different ways, ensuring that no two universities will have identical missions.

For all of their complexity, American research universities serve as primary institutions for advancing knowledge in virtually all fields of human activity, from the arts and humanities through the social and behavioral sciences and from the professions to the mathematical, physical, and biological sciences. No university cultivates research in all areas of human inquiry, but there is at least one university with a research program in almost every area of knowledge.

The strength of the American research university results from a combination of reinforcing elements. For most institutions, the standard mission includes the education of undergraduate students to become useful and productive citizens in what are traditionally four- or five-year programs; the preparation of graduates in the professions of education, law, medicine, business, engineering, or journalism; and the training of advanced students in Ph.D. programs in a number of specialized fields. Research universities in particular emphasize intensive and extensive research programs in many academic and professional areas. Local, state, and national agencies, recognizing the high social and economic value of these institutions, provide significant tax-based assistance to private and public universities through research grants, facilities funding, financial aid for students at all levels.

In return, the research university generally implements its obligation to the public by producing educated and useful citizens, transferring academic research results into products and services that enhance national prosperity and defense, and engaging the university in a wide range of public service work. Although there is great variation in the methods and techniques, in the mix and balance, and in the success of American research universities in delivering this combination of functions, almost every institution participates in most aspects of this combined activity.

Quality Engines: The American Research University Prototype

Even though these institutions demonstrate a bewildering variety in the details of their organization, all of them express a common research university prototype. This prototype models the behavior of research universities as organizations, even if, like all synthetic constructs, it does not represent the operations of any particular institution in detail.

American research universities serve as primary institutions for advancing knowledge in virtually all fields of human activity.

The model presented here views research universities as organizations with two related but relatively independent structures.

- The first is an academic core, composed of a group of faculty guilds that have primary responsibility for the academic content and quality of the enterprise.
- The second is an administrative shell, responsible for the acquisition and distribution of resources and for the management of the enterprises that support the faculty guilds.

The Academic Core: Faculty guilds are the most important part of the university because they define

and create the university's academic substance. The guilds enable the university's many other functions related to teaching and research.

Disciplinary considerations define guilds such as chemistry, history, physics, psychology, philosophy, medicine, and law. Moreover, within the university, each faculty guild serves as the local branch of a national guild of the same specialty. For example, all of the professors in a university history department belong to the same national guild, even though the local university employs them. The national guild establishes the intellectual standards for their work; the local university deals with their employment and work assignments. The same holds true for chemists, psychologists, and the members of other guilds.

Faculty guilds are the most important part of the university because they define the university's academic substance and maintain its quality.

Each guild defines itself in terms of the intellectual methodology that its members apply to their field of study. Historians, for example, have a methodology for the use of historical evidence in the development of explanations about past events. The guild's definition of standards based on these methods and the evaluation of quality based on the standards are what define the guild's responsibility. Members of the guild must meet these academic and methodological standards, or the guild will not recognize the validity of their work.

As has been the case for all guilds since medieval times, the methodological standards guarantee that the members' products meet guild criteria. If a guild-certified historian writes a biography of Simón Bolívar, for example, we can have confidence that the interpretation presented uses documents and evidence in accord with the history guild's standards of accuracy and reliability. The guild does not guarantee the correctness of the resulting interpretation, only that the guild-certified historian used appropriate methodology properly in ways that permit other expert members of the guild to review and validate that work.

The same is true in science, which perhaps offers a better illustration. Scientists have precise methodologies, both for doing their work and for validating its results. When physicists, for example, present the results of their work, most people lack the expertise to evaluate the scientific validity of the process used to arrive at the announced result. Instead, the public relies on a validation by the physics guild before accepting the result as a reliable scientific finding.

Each guild has its own process for validating the work done by its members and for reviewing results presented by aspirants for membership or advancement in the guild. All guilds, however, rely on a variation of the peer review system that mobilizes the talents of expert guild members to validate the work of other guild members. This process often involves experts replicating the experiments and a peer review of results before presentation to the public through publication. Whatever the process, however, the guild sets and enforces the standards for the field to ensure the quality of guild-certified results.

The analytical methodology, more than the subject matter studied, distinguishes one guild from another. For example, although historians and sociologists study similar phenomena (revolution, poverty, social change), they employ significantly different methodologies, and these differences separate the sociologists' guild from the historians' guild.

The expanding range of knowledge constantly produces new information and suggests new explanations. These, in turn, often require new methodologies. Over time, new guilds emerge with definable methodologies that serve to advance understanding. In other cases, efforts to create new guilds do not succeed because no coherent, intellectually sound, and distinct methodology emerges.

The guild does not pass judgment primarily on whether a scholar's idea is right or wrong, but rather it ensures that scholarly ideas receive rigorous analysis and proof regardless of the political or personal interests that may surround them. Scientists may believe that they have found the key to eternal life, but public acceptance of this result requires

validation by other members of the appropriate science guilds through a critical review according to applicable methodological standards.

The guilds also define the university's undergraduate curriculum in a negotiated conversation with other guilds. This negotiation establishes the content and delivery of knowledge contained in the traditional frame of four- or five-year undergraduate degree programs. Each component of this degree reflects guild-certified knowledge. Doctoral and other advanced degree programs belong exclusively to the guilds.

Finally, the guild controls the acquisition, promotion, tenure, and retention of faculty. Although other actors in the university (administrators, union officials, students, and others) influence this process in various ways, the guild holds primary responsibility for the quality of the faculty. Because their own members hire and retain their successors, guilds behave as self-replicating organizations.

If the guilds replicate themselves at the same quality level, the university overall will maintain its current level of quality. If they replace themselves at a lower level, the university declines, and if they hire their replacements at a higher level of quality, the university improves. Research universities pay close attention to guild management of faculty talent, because they know that the university's quality and productivity depend on the faculty.

A diagram of the core structure of the model research university would show a number of guilds, each separate from the others, linked by their common participation in the instructional enterprise and by their common concern for the support and promotion of research. They would appear as separate entities because the members of one guild cannot generally participate in the work of another except as guests or in jointly owned interdisciplinary projects. Members of one guild may not normally transfer their academic standing directly to another guild without a complete review of their qualifications by the other guild.

The guilds would also appear as separate entities to emphasize that they belong intellectually more to their national guild than to their local university. This feature of guild behavior requires some discussion. The national guild sets the same methodological standards for determining the quality and reliability of its products everywhere. Local guilds apply these same methodological standards, whether they operate in New York or Texas, Minnesota or California. However, the level of productivity and quality required for membership by each local guild will vary from university to university.

In major research universities, as an example, the local history guilds will require new members to possess not only a Ph.D. with a dissertation completed and approved according to the standards of the guild, but also a record of publication in significant peer-reviewed journals and the promise of a major scholarly book. For permanent status within these high-quality local guilds, historians will publish at least two major peer-reviewed books. At a comprehensive state university, the level of research quality and productivity expected by the local history guild for permanent status will include perhaps only the completion of a Ph.D. and the publication of one or two peer-reviewed articles.

The university's academic standing is the aggregate result of the success of the guilds in the recruitment and retention of faculty.

A university's quality and competitiveness depend on the quality and competitiveness of its faculty, and the local guild sets the level of performance for new and continuing faculty members. The university's academic standing, then, is the aggregate result of the success of each of these local guilds in the recruitment and retention of faculty. This model of guild behavior applies to competitive research universities and sets the standards for almost all other colleges and universities.

The Administrative Shell: The second structure within the American research university is the administrative shell. Most observers see the shell when they first encounter the university. The shell contains a traditional corporate structure: hierarchical and orderly, with a chain of command as well as the other accouterments of modern corporate America. It provides the formal, legal governance

mechanism of the university, including a board of trustees or regents, a president, and vice presidents, deans, other administrators, and members of faculty senates who carry out corporate line and staff functions on behalf of the university and manage governance as well as administrative issues.

To most people, this is the university's management. In one sense, this is true. The board owns the university. The president is legally responsible for the institution's management. The vice presidents and deans report through an administrative hierarchy. The faculty senate approves new degrees and curricular changes.

The criteria for distributing money create much stronger incentives for guild behavior than do strategic plans or mission statements.

At the same time, the people in the shell do not actually do the work that makes the university valuable. That work takes place primarily in the guilds or under guild supervision. The shell mobilizes and distributes resources that support the work of the guilds, and it protects the guilds from harmful external forces. The shell manages the interactions between guilds. Most importantly, the shell manages the university's money and creates the incentives that motivate guild behavior.

Participants in the administrative shell typically demonstrate a fondness for public displays of institutional homogeneity, as expressed in the form of mission statements, strategic plans, and the like. These high-minded products generally have minor impact on the guilds and their work — unless the shell administrators match these plans with the incentives created by the distribution of money. The criteria for distributing money create much stronger incentives for guild behavior than do strategic plans and mission statements articulated by institutional leaders.

Deans and department chairs occupy a special intermediate role between the functions of the shell and those of the core guilds. While deans, and chairs to a somewhat lesser extent, serve as administrative officers in the formal organization of the university, they serve more as guild representatives to the shell than as administrative managers of the core. Deans receive their appointments from vice presidents and presidents, and they recognize their responsibility to these shell officers. Deans also know that their success depends on their ability to earn and retain the respect and support of their fellow guild members and to successfully represent guild interests in the competition for resources managed by the shell organization. Department and program chairs respond even more closely to the interests of their guild colleagues than do deans. We might think of deans and chairs as "guild masters," for they manage the operation of the guilds both on behalf of the guild members and on behalf of the shell organization.

In this model, it is important to focus on institutional purpose. Some might say that the research university produces students, research products, economic development, and public service. While the university does produce these things, the delivery of goods and services to society is actually a secondary benefit from the university's primary pursuit of internal quality, as represented by research and students.

Quality Engines: Research universities, in our view, exist to accumulate the highest level and the greatest amount of internal academic quality possible. The goal is to gather inside the university the most research-productive faculty, the brightest students, and the highest-quality academic and cultural environment achievable. Although the research university delivers a wide variety of products to external constituencies, such as graduates, technology, economic development, and public service, its primary focus is on the creation of internal quality. This is why we call research universities "quality engines."

In pursuing the goal of maximum internal quality, the research university will almost automatically graduate its students, promote economic development, and serve the public interest. However, the production of these goods and services does not drive university success, although it may motivate others to help the institution to succeed.

The model clearly illustrates a relationship between the academic core of guilds and the university's shell. The shell's primary responsibility is to

find the money needed to compete effectively for the best faculty (including all of the subsidies for their research) and for the best students (including all of the amenities and academic and educational enhancements that attract them).

The shell organizes structures and systems to raise private endowments and gifts, to lobby for public funds, to compete for federal dollars, to seek foundation revenue, and to create a hospitable and supportive academic and cultural environment. The shell raises this money and creates this environment so that the guilds succeed in recruiting and retaining quality faculty, in subsidizing research, and in promoting similar activities that create internal quality.

Shell participants often take a more direct role in the recruitment and retention of undergraduate students, in whom the guild has less of a direct interest. The interactions between the guilds and the shell, and also between the shell and the external environment, are much more complex and more closely interrelated than presented here. Nonetheless, the model of quality engines focuses our attention on the research university's revenue-seeking behavior in support of the guild's success and by extension the institution's success in the competition for quality.

The model sees the university as an enterprise that is its own primary customer. On the surface, this appears a bit contradictory, since the revenue that supports the university comes from outside the institution and the institution organizes itself to capture relentlessly as much revenue from all of these sources as possible. Most observers would assume that the university sells a product or service directly to those who provide it with money. While the university does provide value to those who pay, the process that it uses to provide the value and the mechanisms for payment dilute much of the relationship between buyer and seller that characterizes transactions in the for-profit world.

For example, research universities sell the talent of their research faculty and staff to the federal government to do research that is in the national interest. At the same time, universities also purchase access to (and a competitive advantage in) the federal competition for grants through subsidies of research facilities and talent. The universities compete against each other for federal grants, but they also invest their internal funds heavily for the opportunity to compete. The funds that universities use to subsidize the competition for federal research come from annual giving, earnings on endowment, state agencies, returns on patents and licenses, internal savings, and other surplus-generating activities of the institution.

The university maximizes its revenue to purchase quality research, quality students, quality faculty, and a quality academic environment.

Instead of seeing the university as a producer of goods and services *for* an external competitive marketplace, we can think of the university as a consumer of the quality that it purchases *from* the external marketplace. In this view, the university maximizes its revenue from all sources to purchase quality research, quality students, quality faculty, and a quality academic environment. It then uses the existence of this quality environment to attract additional external investors who buy access to the environment and contribute to its creation rather than purchasing ownership of any particular university product.

The goal of research universities, then, is to accumulate the highest level and the largest amount of quality it can through the competitive purchase of scarce quality elements. Whether the institution is an elite private institution with a $14 billion endowment and $266 million of federally funded research or a public institution just barely over the $20 million level of federal research with an endowment of only $15 million, they behave in remarkably similar ways.

The details of the revenue-seeking behavior of individual universities vary depending on circumstances, history, opportunities, and private or public control. *TheCenter*'s annual reports track the performance of research universities as they pursue the maximum accumulation of research and undergraduate student quality.

The Competitive Context for Research Universities

The research university's essential elements are scarce. Universities and their people live in an environment of competition for everything: outstanding students, good grades, faculty positions, promotion and tenure, publication opportunities, grants, research and teaching space, and resources to support academic specialties are a few examples.

The most important competition for faculty begins with the hiring process, when one open position attracts many applicants but the applicant pool contains only a few top candidates. Potential faculty members compete with each other to appear in the top group of aspiring research faculty, and universities compete with each other to purchase the services of the individuals in the top group.

Availability of Research and Teaching Talent: The discussion of the process for recruiting, promoting, tenuring, and retaining faculty is long, and we will not engage it fully here. For our purposes in charting the performance of research universities, a critical distinction about this competition for the best faculty requires emphasis.

Research university competition for faculty is about research, not about teaching. Much confusion and rhetoric attaches to this view, as observers of university life argue about the relative merits of teaching and research. For our purposes, this argument is beside the point. The issue is not whether teaching or research has more intrinsic value, but whether teaching talent is more plentiful than research talent.

Research talent and productivity are much less available and much less predictable than is teaching talent.

Research talent and productivity is much less available and much less predictable than teaching talent, and this difference determines the university's focus on research rather than teaching in the acquisition and management of faculty. Although teaching requires skill, knowledge, creativity, and commitment, this is not the issue. The issue is that almost all faculty with the basic credentials for a research university appointment (a Ph.D. or its equivalent and a reasonable record of scholarly accomplishment) will teach well. The likelihood is high that a university, in hiring promising research faculty members, will also acquire excellent teachers.

Like teaching, research also requires skill, knowledge, creativity, and commitment, but research talent is scarce. The guilds cannot predict with high levels of confidence which of the most promising research graduates of the best doctoral programs in the country will sustain a high level of nationally competitive research productivity over a working career. By selecting and reviewing credentials carefully, the guild can improve its chances of hiring and retaining people who will indeed perform as researchers throughout their careers, but the risk nonetheless remains substantial.

As time goes on, even with the most careful screening, the proportion of a cohort of promising faculty who remain productive in research will decline. A few will not produce nationally competitive research at all; many will produce well for six to eight years and then cease to compete at national levels. Others will create sustained and productive research programs and will maintain their vitality and competitiveness over a career of thirty or more years. By contrast, in any given cohort of faculty hired by a research university, all but a very few will teach effectively, and many will teach superbly for the thirty or more years of their careers.

From a management perspective, this creates a problem, because the labor force required for universities to succeed in the national research competition is relatively inflexible. Once the long six-year period of probation ends, faculty become permanent university employees. Tenure confers this security of employment and is the structure that creates an inflexible labor force, but it is also a requirement for a successful university research enterprise.

The topic of tenure is complex and has an extensive and often polemical literature. Suffice it to say here that university research that extends human knowledge does not prosper where the investigator's livelihood is dependent on evaluations of short-term success. The pursuit of short-term research results often leads people to work on the things they already

know well rather than on the things they do not know. The pursuit of new knowledge entails a substantial risk of being wrong (scholars can only be right all of the time if they already know the answers to the questions they ask). The employment security of tenure is a necessary requirement to encourage this risky exploration of the unknown, and it represents a cost in the university's support of research.

Universities compete with each other by paying a premium in the faculty marketplace for successful research faculty at various stages in their careers because such individuals are scarce. Universities pay almost no premium for successful teaching faculty at any stage in their careers because such individuals are abundant. Indeed, the emergence of a lively market in inexpensive adjunct and part-time teaching talent indicates a negative premium for teaching experience.

The limited availability of research talent and the competition to acquire this talent explain why the conversation about mobilizing resources for institutional quality focuses primarily on the competition for and support of research faculty.

Supporting Research Competition: This model of research universities as quality engines highlights the close relationship between competitive success and money. Money makes it possible for the institutions to compete for the scarce talent of research faculty and to support all of the elements of plant, equipment, personnel, and university environment that they require.

University people see themselves as pursuing a higher mission and do not like to think of themselves as part of enterprises that generate and spend revenue. Yet in no university does the higher mission prosper without the investment of money in people, plant, and equipment.

The centrality of money to this competition affects every single program, whether it is fine arts and music or physics and chemistry. The art department needs studio space and materials; the music school needs rehearsal space, instruments, and recording equipment. The physics and chemistry departments require laboratory space and scientific instruments. The best faculty in every guild want nationally competitive salaries, and the best students want nationally competitive undergraduate programs and financial aid packages.

The quality engine's success depends in the first instance on its ability to generate money. All things being equal, the more money the university can invest effectively in the competition for quality, the better it will become. Research university shells, as predicted by our model, organize the mechanisms for maximizing revenue.

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The competition among universities for people and resources is fierce. If a research project will take five years to develop, the university that starts first will finish first. The university that gets the three best faculty in the world in a particular field will have a competitive edge. While research faculty move from institution to institution for higher salaries and better research support, they do not move every year. If the faculty with the critical talent needed for a research project moved last year, they will not likely move this year.

The advantage in the competition goes to those who have the money today to buy the services of talented people and the equipment and resources needed. What matters most for the research university is not its total assets or the aggregate value of its endowment, buildings, and equipment. Rather, what matters most is the cash generated by these assets and other activities, which the university can immediately spend to compete.

Competitive university research operates at the outside edges of human knowledge, and small differences in talent and ability often make big differences in research success. If a university fails to recruit the top quantum physicists for its project, it will find itself disadvantaged in competing against the university that has those top physicists. The disadvantage will rapidly become serious as the competing university moves quickly ahead in the process of discovery.

Research is also a high-risk business, and institutions find it difficult to predict exactly which research investment will produce the most competitive result in the medium term of five to ten years. The larger the cash flow that a university can mobilize to invest in different research initiatives, the greater the chance that it will have successful results, and the better its ability to withstand failures.

Individual scientific research programs may have a lifespan of ten years, and in that time the institution will invest many millions from its own resources (in addition to whatever it can win in grants and external support) for salaries, space, equipment, and support personnel. If it spends its revenue well, the university will see returns on this investment in the form of discoveries, publications, grants, contracts, and scholarly reputation. If it invests ineffectively, it will see its quality decline despite that investment.

Universities frequently use decision mechanisms that rely primarily on traditions, politics, or personal preferences that limit the effective use of rational criteria.

Universities encounter significant challenges in managing the institution's investment choices. Universities and their faculty engage in many activities, produce many things, and have multiple constituencies. Every activity can benefit from the investment of additional dollars, and all activities have internal and external support groups that argue for additional investment in their preferred activity. Almost all of these activities reflect quality programs.

As the model would predict, the process for making investment decisions in a university is complex. This is because the guilds have their own interests centered on guild advancement, and the shell often lacks the technical and political support to make effective investment choices. Deans and chairs represent not the interests of the university but those of the guilds or collections of guilds under their administration. Pressures from both the academic core and the external constituencies of revenue providers, combined with often remarkably poor management data, inhibit the effective use of resources to build competitive quality.

Universities frequently use decision mechanisms that reflect the complicated relationships of their many constituencies and that rely primarily on traditions, politics, or personal preferences. These common mechanisms limit the effective use of the rational criteria that will guide the institution to identify the optimal choice for acquiring internal quality. When a university has large amounts of discretionary revenue, it can often afford ineffective systems and nonetheless remain competitive. However, universities with fewer resources will find that these ineffective decision methods inhibit their efforts to improve.

Decisions about spending money have a disproportionate impact on research because research is a money-losing proposition with significant multiplier effects. Universities must generate as much revenue as possible so that they can buy as much quality research as possible. Each investment of internal funds creates the opportunity to acquire additional external funds in support of research. Good investments create large multipliers and research grows rapidly; poor investments have small multipliers and produce much slower growth.

Research, even though it can serve as a multiplier, creates an expense, not a surplus. Although externally funded grants and contracts are large items in any research university's revenue stream, they represent the multiplier effect of the additional university funds that these projects always require to pay their full cost.

Some of these required payments from internal resources appear explicitly: for example, underpayment for indirect costs is a characteristic of federal, state, and especially foundation sponsored projects. Although the effective recovery of indirect costs varies from institution to institution, no university recovers the full audited costs of research. The difference between the audited and the reimbursed expenses is a cost to the university of the successful competition for grant-funded research projects.

Universities subsidize research in many other ways. Released time from teaching for faculty who

do research in the humanities, social sciences, arts, and professions (fields with fewer substantial external grants) is a cost of research for the university. Funded grants from federal and other agencies often require an explicit university payment from internal funds, called "cost sharing," as a condition for acquiring the grant.

The competition for quality human resources impels universities to fund endowed positions for research faculty, the cost of which they rarely charge in full to research grants. Institutions also subsidize graduate students through stipends both to attract the quality research faculty who teach them and to provide talented labor for research projects.

The direct competition for research faculty often involves even larger subsidies. When a university succeeds in attracting a highly productive faculty member in the sciences from another institution, for example, the recruitment package usually includes many expenses beyond the individual's increased salary and benefits. The university will pay for the cost of moving the scientist's laboratory to the new university, the cost of laboratory renovations and set up, the cost of new equipment to replace equipment belonging to the prior institution. It will also pay to acquire the newly hired faculty member's students and assistants, costs that include moving them and setting up their research space.

Universities do this because the newly acquired faculty member's team will bring larger and more significant research grants to the university, thereby increasing institutional quality. The institution also knows that it will never recover most of these relocation costs. Instead, the increased research grants and contracts brought by the newly acquired faculty member will require additional subsidies. The gain is in the acquisition of internal quality for the institution, thus improving the multiplier of university investments in research, but the university must first generate the revenue that it needs to invest in this quality.

As the quality engine model shows, university success comes from the ability to spend wisely an ever-increasing revenue stream. For a research university, spending it well means increasing research productivity by acquiring the best faculty and programs, competing successfully for the most prestigious grants, and ultimately, publishing the most significant advances in the arts, humanities, social sciences, professions, and sciences.

Universities and colleges sell undergraduate education primarily as an experienced process rather than as a purchased product.

The Undergraduate Competition: Competition among research universities also includes an aggressive effort in the teaching enterprise. While the research competition focuses on the acquisition of scarce faculty research talent, undergraduate programs compete for the limited number of top-quality students.

The perceived quality of a university's undergraduate program depends in considerable measure on the quality of its student body. The better the quality of students that the university can recruit, the better the quality of undergraduate program it will have. This assumption about undergraduate quality is an important reality of the university marketplace.

The undergraduate competition focuses primarily on non-academic issues that parents and students assume are relevant to the educational experience. This is an interesting phenomenon because undergraduate education is ostensibly about acquiring the defined body of knowledge that the degree certifies. If we decompose undergraduate education into its component parts, however, we find that the formal academic curriculum follows a relatively standard form at most universities and resembles a commodity product.

This is true because accreditation agencies, financial aid organizations, public regulatory agencies, legislatures, and consumers of undergraduate education prefer a relatively standardized curriculum. Over time, the formal content of the undergraduate degree has tended towards a high degree of standard content from one university to another. While the curriculum may vary in terms of electives and the degree of emphasis placed on science, humanities, ethics, or religion, the basic content of a four- or five-year bachelor's degree has become

almost a commodity product, even if the way it is delivered and the faculty who deliver it vary significantly from institution to institution.

In addition, even though the quality of the undergraduate content and the quality of the teaching may differ from institution to institution, the consumers generally cannot easily recognize these differences directly. Undergraduate consumers do not constitute repeat buyers in the marketplace for the most part. The differences in quality from institution to institution, while perhaps significant in some instances, have no obvious external measure. Instead, consumers look for indirect measures of presumed academic quality. As a result, universities tend to compete for students based more on the quality of the experience that students will receive at the university while pursuing the standard curricular structure, rather than on highly differentiated content within the curriculum.

Without clear indicators of undergraduate quality, consumers take the quality of students as a signal of quality content.

Universities and colleges sell undergraduate education primarily as an experienced process rather than as a purchased product. They issue a token of successful participation in that process — the degree or diploma — but the degree certifies participation that meets relatively generic standards and does not necessarily guarantee a particular result or a defined level of competence. Different participants will take away different results from the experience, even though they all receive the same degree.

Universities and colleges imply that the degree represents a product containing a measurable and standard amount of education or knowledge. Efforts to measure this learning in some clear and reliable way have so far failed to establish a definition of the content of a standard undergraduate degree. The apparent commodity characteristic of the content and the difficulty of measuring the result of the process lead universities to compete for students based on the quality and variety of experiences and opportunities that the process provides.

As is the case with all providers of name-brand commodities, universities invest heavily in differentiating the presentation and the context of their undergraduate process to compete for quality students. The differentiation involves such things as smaller classes, enhanced extracurricular activities, and elaborate entertainment for participants through sports, art, music, theater, and similar amenities. Universities enrich the basic commodity content with learning experiences such as overseas campuses, honors programs, off-campus fieldwork, internships, and individualized study.

Universities offer a wide range of experiences to accompany the commodity content by providing activities such as leadership opportunities in clubs and student government. They offer special non-academic services such as psychological counseling and travel opportunities, as well as elaborate recreation, intramural sports, and fitness programs.

Success in this competition comes from attracting a high-quality student population to the campus. This is a self-reinforcing phenomenon. Without clear and direct indicators of quality, consumers take the quality of enrolled students as one of the most important signals of quality content. The high quality of existing students attracts high-quality applicants, and from this group the university can select an even higher-quality student body.

All of this activity in pursuit of the quality student costs money. Enhanced facilities consume revenue. High-quality students expect preferential treatment in the form of tuition discounts and other financial aid considerations. In large, public universities with low tuition, a tuition discount is not a major benefit, but special housing, small classes for honors students, and special extracurricular opportunities all cost money and help to attract the best students. Indeed, the competitiveness of the honors programs at public institutions is such that their admissions standards are often higher than those at most elite private colleges (and of course much higher than the general admission standards of the public institution itself). The undergraduate financial model that supports this competition varies by institutional control.

Private institutions use substantial subsidies drawn from endowment income and annual gifts to support the tuition discounts that attract the best students. This limits the size of the student body that they can support. Public universities, with tax-supported payments for instruction, often respond to the political process and state funding systems when setting enrollments. Public institutions use their discretionary dollars to create special programs and enrich the educational experience that they offer to the most desirable students.

The undergraduate financial system depends less on the sale of admission to students and more on the acquisition of funds from multiple sources to support the experience of students. Many who do not participate directly in undergraduate education nonetheless pay for its success. Some funding comes by virtue of social policies such as state and federal payments for student financial aid. Alumni and other private individuals contribute to scholarships and programs for undergraduates because they value a continuing identification with the undergraduate experience. Others support quality undergraduate programs through bequests, endowments, and capital gifts that secure the immortality of permanent recognition. The motives for these purchasers of undergraduate quality are many, but each purchase recognizes value in the process, although many of those who contribute to the cost of undergraduate education (state and federal legislators and private donors in particular) do not actually receive a direct benefit.

Colleges and universities invest heavily in enhancements to the undergraduate experience, because they know that the quality of students and of student life attracts other students and signals the overall quality of the institution to donors, alumni, faculty, legislators, and others. For the same reasons, colleges and universities invest in elegant campuses, ivy-covered buildings, student recreation facilities, cultural entertainment programs, alumni halls, intercollegiate sports, and other non-academic features of college life. The techniques used to fund the endless additions to the undergraduate process and to enhance the physical and experiential elements of college life vary among institutions, but the drive to generate revenue for investment in this competition for high-quality students is visible in all institutional types.

The Combination of Undergraduate and Research Competition:

High-quality research universities compete directly with the single-function, elite undergraduate colleges for the scarce talent of superior students. It is no surprise, then, to discover that the undergraduate part of the research university functions in ways that mimic the elite college. However, where the elite college emphasizes the benefits of a smaller size, the research universities tend to emphasize the benefits of their nationally preeminent research faculty and the breadth of their offerings. In this competition for quality undergraduates, the research university has some advantages. Research universities, by virtue of the complexity of their activities, find ways to cross-subsidize research from teaching, and teaching from research.

Research universities, by virtue of the complexity of their activities, cross-subsidize research from teaching and teaching from research.

The most obvious example involves the physical plant. Facilities that the university builds for research often support some forms of teaching as well, either through laboratory use or by housing faculty who teach. Similarly, facilities constructed in support of teaching also house faculty who conduct research. Libraries serve both teaching and research, but the support of a research program allows a much larger and richer library for undergraduates than the university could afford based on its undergraduate program alone. At the same time, in public universities, tax-generated funding for libraries often follows formulas based on enrollment, and the existence of a larger undergraduate population may make possible a richer research library than the university could afford on the basis of its research activity alone. Computing resources, like libraries, often have a scale in support of teaching and research that they could not reach based on one or the other alone.

The most important shared element, of course, is the faculty. Research universities can have a larger

faculty than they could justify by the teaching mission alone, because the institution subsidizes a portion of faculty time for research purposes and competes for research dollars that sustain additional parts of the faculty's costs. The university will not necessarily have more faculty members teaching smaller classes. Instead, the students will have the opportunity to engage a wider range of high-quality research faculty talent.

The key distinction is the word "opportunity." In the competition that surrounds the standard content of undergraduate education, the opportunity for participation is often just as important as a student actually engaging research faculty. Many students do not care to engage faculty beyond the minimum requirements, while others anticipate that they will engage but do not actually do so.

Some institutions avoid confronting the data, but those who seek improvement know that they must monitor the numbers reflecting their competitive position.

Research faculty may not teach many of the large, lower-division undergraduate courses, but they frequently teach upper-division courses for majors. As a result, students in general may not have many encounters with distinguished research faculty, but they usually will have at least some encounters, thus validating the opportunity for participation.

Both the presence of the research enterprise and the high national visibility of such activity enhance the institution's ability to generate revenue from other sources in support of undergraduate education. Donors, for example, in giving to scholarships and other funds that the university uses to recruit the best undergraduate students, may be responding just as much to the institution's research reputation as they are to the actual quality of the undergraduate program.

Conversely, undergraduate education also supports research. The best research faculty often value their membership in an academic community that includes quality undergraduate programs and student life. They seek an academic environment that includes sports facilities, recreation, music, fine arts, and other entertainment and culture brought by the existence of the quality undergraduate experience. All faculty value their membership in a university community that they perceive to be intellectually elite, and the quality of the undergraduates is one of the tokens of elite status that universities use in recruiting stellar faculty. Many research faculty also seek the opportunity to teach talented undergraduates.

In some circumstances, the relationship between undergraduate education and research is more direct and revenue-related. In public universities, the undergraduate mission — seen by state agencies as a primary activity — often generates an amount of revenue that exceeds the direct cost of undergraduate education. In such cases, undergraduate students become a profit center, generating revenue above their costs that the university can then reinvest to subsidize quality research.

States sometimes fund universities based on formulas that anticipate providing the university with some research support for every undergraduate student enrolled. This reflects the belief that faculty research contributes to the quality of undergraduate education. As mentioned above, states often use formulas based on undergraduate enrollment in funding facilities for infrastructure, library, or computing, thus creating a subsidy for research facilities at the same time.

This revenue synergy between teaching and research at public universities offsets their relatively small endowments as compared to their private university competitors. It also helps to explain the relatively large size of undergraduate populations at public research institutions. In a private institution, which lacks publicly funded subsidies for education, the size of the undergraduate population is more a function of the revenue available to subsidize quality students. Increasing the size of the student body usually does not increase available revenue, especially if the university must pay more to educate the students than their discounted tuition can cover.

The drive to acquire quality students and research faculty creates a universal imperative: to generate the revenue needed to compete for these scarce but

essential elements. The university, represented by its shell structure, organizes its systems into a revenue-generating organization on behalf of faculty research and student quality. In this competition, institutions require both the availability of the revenue and its effective investment to produce a top American research university.

Measuring Institutional Competitiveness for Research Universities

Ranking and Measuring

The operation of research universities is a required topic for everyone interested in improving institutional performance. Often, the rhetoric of improvement implies a positive-sum game in which everyone can improve by doing the right thing. In one sense, this is true, for every university can improve its internal operations and enhance its performance as a result.

The message of positive-sum improvement, however, implies that the choice of what to improve is a local concern. If every university could improve without regard to other participants in the higher education environment, then improvement relative to others would not be particularly important. The significant question would then be internal: how well does the institution perform on whatever internal agenda it defines?

University improvement programs often appear in this format, proposing to enhance some aspect of the local environment as if what happens elsewhere is of minor concern or serves primarily as a source of examples of desirable programs and activities. The advantage of this perspective is that such improvement programs generally have weak mechanisms for determining success or failure, since any change can appear to be beneficial. Its inherent flaw, however, is that it ignores the reality of competition for scarce but essential resources.

As the quality engine model shows, quality elements are scarce, and universities acquire them through competition against other institutions. Competition for students, faculty, and research defines the performance of the research university. Some institutions may prefer to avoid confronting the data that describe their success in this competition; however, those who seek improvement know that they must monitor the numbers reflecting their competitive position.

Universities and their constituents often focus on process issues rather than on performance. They worry about the process for distributing revenue, for hiring faculty, and for recruiting students. They pay much less attention to the results and especially to the comparative results. However, if the process for distributing revenue to the guilds produces internal harmony and high levels of participation but fails to improve either undergraduate quality or research performance, then it is actually a failed process, regardless of the state of internal harmony.

Sustaining undergraduate programs and research at nationally competitive levels of quality and productivity requires constant measurement, close attention to revenues and expenditures, and close faculty and administrative management. A few universities perform at top competitive levels; others compete more effectively in some things and less so in others.

TheCenter's data identify some of the characteristics of the institutions that excel in this national competition. The data in this publication (presented in more detail online) display these characteristics.

Institutions are often frustrated by the lack of tools that are currently available for measuring their success in the competition for faculty, students, and dollars. In part, this is the result of the location of universities within corporate space. As not-for-profit enterprises, they enjoy a self-justifying existence that requires them to provide only a limited number of validated references to the public. Although universities provide an endless stream of

The drive to acquire quality students and research creates a universal imperative: to generate the revenue needed to compete for these scarce but essential elements.

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reports and surveys to external agencies and governing organizations, these rarely offer the data necessary for effective management or for reliable institutional comparison. Detailed, standardized information does exist for a variety of accounting purposes that are useful for demonstrating the fulfillment of the institution's fiduciary responsibilities, but these data do not usually serve a useful management purpose.

Systems for ranking and classifying universities abound, and many of these systems use data that are unreliable or inappropriate for this purpose. Many rankings attempt to capture in one number an aggregate evaluation of the institution's worth relative to others. No currently available data offer sufficient reliability or coverage to accomplish this task. The widely varying results from year to year of the most popular of these rankings, outlined in a paper published online by *TheCenter*, offer eloquent testimony to the unreliability of the measures, since colleges and universities in the top categories rarely change their competitive performance significantly from one year to the next. These popular rankings will often move institutions up and down in ways that do not reflect real changes in performance.

In addition, universities compete in the marketplace of public opinion based on prestige or reputation, which is often a highly subjective evaluation. Prestige is a form of name-brand recognition derived from historical visibility, from promotional campaigns that project institutional identity, and from the halo effect of real accomplishments. As a result, colleges and universities emphasize what is unique and different in their environment. They collect information that identifies them as unique in a comparative context. Special characteristics demonstrated by institutionally unique data are a hallmark of much university-generated public relations information. Prestige, or reputation, also reflects past behavior and publicity more than current performance, and its unreliability severely limits the validity of rankings that use reputation as an indicator.

Various national groups publish many rankings of universities, colleges, and programs, and these rankings fill a vacuum created by the inability of universities to agree on standard, validated measures of performance or on common criteria for judging competitiveness. Although many universities complain bitterly about the unreliable nature of the rankings (and they truly are often quite unreliable), these same universities nonetheless advertise their own success in spurious rankings with great enthusiasm.

In the competition for the best students and faculty, universities embrace positive rankings in the effort to enhance their reputations. They also use positive rankings from virtually any source to persuade donors and other revenue providers that the institution's unique and valuable mission deserves a gift or grant or additional state or federal subsidy. The highly publicized but methodologically questionable rankings serve this purpose. They create an illusion of distinction and differentiation, offer a presumably impartial validation of qualities promoted by the institution, and create an opportunity for self-promotion that outsiders find difficult to challenge and that insiders find difficult to resist. Within the many rankings done by organizations with different purposes and using different methodologies, universities can usually find at least one that ranks them highly on some criteria.

These rankings, in spite of their visibility, do not help university managers, although they may indeed help the public relations effort. No business, not-for-profit or otherwise, can allow promotional materials alone to serve as accurate measures of its competitive success. To do so is to forfeit the opportunity to improve the university's performance.

Without clear measurement and a commitment to competitive success, universities tend to replicate themselves at the same level (or at slightly declining levels) of performance. Absent institutional commitment, the external competition for the best students and faculty will slowly erode a university's quality. Beyond the minimal requirements of enrollment

and meeting the institution's steady state financial commitments, nothing in the external environment compels a self-generating research university to become better than it already is. The drive to compete at a high level generally comes from within the institution.

For research universities, the risks inherent in unmeasured management are significant. This is because success is so heavily dependent on the institution's ability to generate the money for effective investment in research and student subsidies. An institution that manages its money poorly loses the opportunity to generate surpluses to invest in research and student quality. An institution that raises too little endowment to generate income or inadequate annual giving to sustain its subsidies, for example, will eventually fail to maintain its market share in the research competition, thus losing its competitive edge in recruiting the best students. An institution that invests without measuring results will waste its resources.

In the competition for quality undergraduates and research performance, the total size of the university's budget does not matter as much as the way that the institution uses its money. If a large institution with a budget in excess of a billion dollars spends large portions of its revenue on activities that are unrelated to research or undergraduate quality, it will have a less competitive research university than a much smaller institution that spends most of its money on research and undergraduate quality.

The first requirement for a successful research university is to generate revenue. The second requirement is to spend it well. The detailed and specific methods that universities use internally to make good choices vary from place to place and from time to time, but a number of measures do exist that serve as reasonably reliable indicators of an institution's competitiveness in the national marketplace. A discussion of these measures appears below.

Defining the Competition: Although the quality engine model depicts research universities operating two theoretically separable economies for teaching and research, most institutional accounting systems do not separate the revenue and expenses clearly enough to analyze these economies separately. Rather than trying to identify research or teaching revenue and expenses as separate elements, it is more useful to imagine that the university purchases its undergraduate and research quality by drawing the money from one common fund. This is not true in detail, of course, since most university money is restricted to specific purposes in both private and public institutions.

Nonetheless, universities gain more by thinking of all of the revenue as being available for any purpose: money is money. Institutions that first identify the best uses for their revenue (whether in improving the quality of the undergraduate student body or in improving the quality of the research enterprise), before considering various restrictions and limitations created by the providers of the revenue, will make better choices. They will identify the highest and best use of each dollar, and then, if necessary, they can make adjustments, reallocations, or transfers to meet required fund restrictions.

By making their choices first, however, many universities find that they can accommodate fund restrictions and still stay on track with their optimal expenditure plan. If the university begins its budget plan by considering the limitations on funds, it will have considerable difficulty identifying the highest and best uses for the money.

The first requirement for a successful research university is to generate revenue. The second requirement is to spend it well.

The most useful measures of a university's competitiveness mark the institution's success in securing quality research, a quality student body, and quality faculty. The university with the most research, the highest student quality, and the most distinguished faculty is thus the most competitive.

Of course, such measures do not mean that universities with smaller numbers are of less intrinsic value or that their smaller number of research faculty are less distinguished or less productive than the larger number at the more competitive institution. The data only identify which institutions compete most successfully for the largest share of the quality elements that all universities seek.

These data help to clarify general impressions about university performance. The differences between institutions with similar performance characteristics are not great, which is why *TheCenter* classifies institutions into groups based on their performance within the top 25 or the top 50 institutions on a variety of measures. More important than the classification of institutions into these groups, the comparable data provided by *TheCenter* allows universities to measure the effectiveness of their improvement initiatives.

Indicators of Competitiveness: Although we cannot measure research university competition directly at the institutional level, a number of comparable indicators exist that, when taken together, give a reasonably good sense of a university's competitiveness. This publication reports on these indicators, which the 2000 edition of *The Top American Research Universities* described in detail.

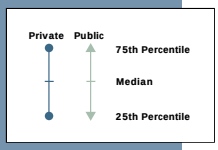
In the following summary of each of the measures, we have included a high-median-low graphic that captures the range of performance of private and public research institutions on each measure within each of the four research groups or categories (over $20 million, $5 to $20 million, $1 to $5 million, and under $1 million in federal research expenditures). To reduce the effect of outliers, the high represents the 75th percentile and the low represents the 25th percentile.

Briefly, the most important indicator of research competitiveness is the institution's annual federal research expenditures. This number, reported by the National Science Foundation (NSF), reflects an institution's research expenditures in the areas of science and engineering from funds awarded by the various programs of the National Institutes of Health (NIH), the National Science Foundation, and other agencies of the federal government, including the departments of Defense and Energy. These dollars, generally distributed through an intensely competitive peer-reviewed process, reflect the active scientific community's judgment on the competitiveness of the faculty at each institution.

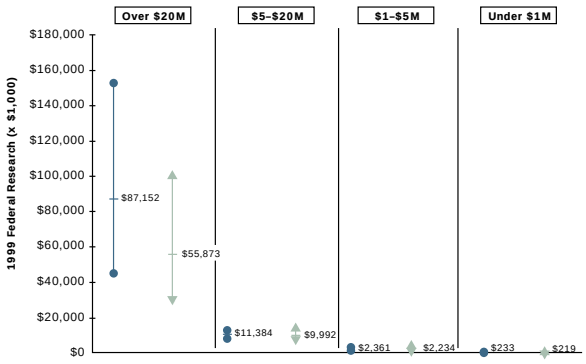
An additional value of this measure is that it indicates the effectiveness of the institution in supporting research, for the more money a university spends in support of research, all things being equal, the more research it will get. Of course, if a university spends its money in support of research that does not result in publication or other peer-reviewed results, its standing in this competition will not improve. For these reasons, most observers of the competition among American research universities watch the federal research expenditure number as the most reliable single indicator of research competitiveness.

NSF also reports the annual federal awards of grants and contracts for research received by each institution, which is a significantly less useful measure. Awards often reflect multi-year commitments; expenditures capture the actual work done on projects during a given year. Awards also include dollars that subsequently flow to other universities under subcontracts. For institutions moving rapidly ahead on a research promotion agenda, the awards number may help to demonstrate their growing success in competing for greater amounts of research funding, but as a comparative measure of current university performance, the expenditure data are more reliable.

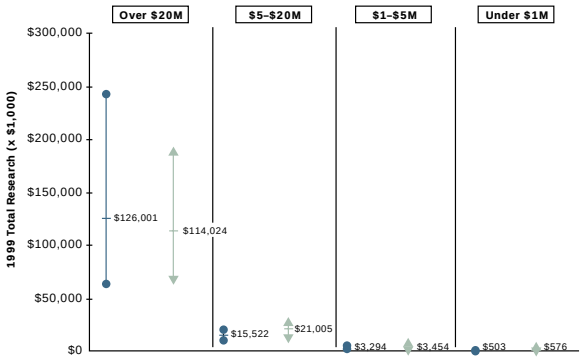
Universities, both private and public, in addition to the federal expenditures, report expenditures from non-federal sources, including corporations, state governments, and foundation or for-profit research enterprises. These expenditures, more broadly defined than the federal number, include a variety of specially designated state funds that are allocated to institutions within the state for agriculture or other research purposes. Such funding may not be nation-



Federal Research by Research Group and Control



Total Research
by Research Group and Control



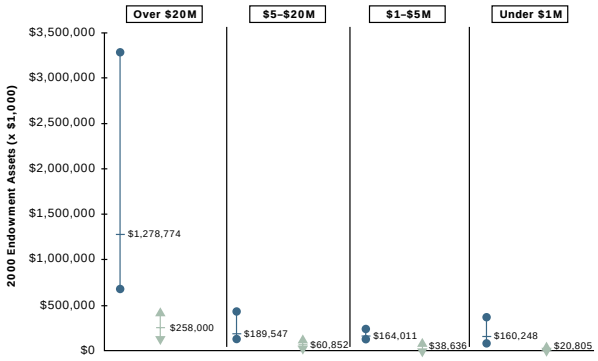
ally competitive. Nonetheless, these expenditures, combined with the federal expenditures, reflect total research activity and provide a useful indicator of research performance, even if the national peer review process does not referee all of the projects included in this number. Most of the non-federal portion of this total research, especially when funded by foundations, requires institutional subsidies as well. Thus, many observers recognize total research expenditures as another useful indicator of research competitiveness.

Universities that do not have large portfolios of corporate or agricultural research will argue that the total research measurement puts them at a disadvantage in any comparison. While that may be true, institutions still make many choices in how they will spend their revenue in support of research. Some will take advantage of medical schools; others will leverage their opportunities in agriculture. Some will take advantage of successfully constructed linkages between industry and programs in engineering to generate corporate funding. Others will benefit from alumni who direct large foundations that make research grants. The issue here is not the relative value of the different types of research but rather the strategies and successes of universities in creating the revenue necessary to expand their research portfolios.

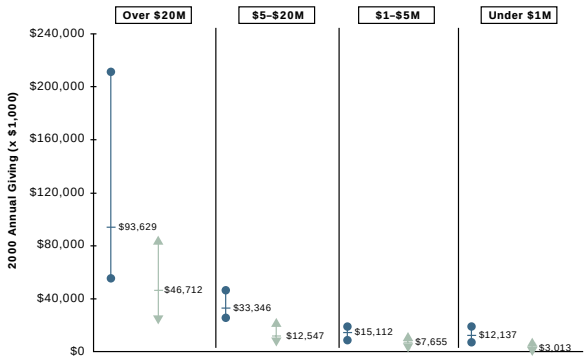
In making choices about how to compete for external research funding, some universities compete in all sectors of the research market, while others compete only in the parts of the market where they identify a comparative advantage. The federal and total research expenditures capture most of this activity, and together these two serve as useful indicators of competitive research success. In the discussion of changes in research competitiveness included in this edition of *The Top American Research Universities*, however, we maintain our focus on federal research expenditures.

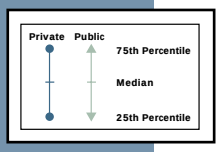
Although it is difficult to derive a valid measure of the total financial resources that are available to a research university, two measures provide some indication of the university's ability to compete for private funds. Endowment represents the university's permanent fund that continues to generate income each year. Annual giving includes the total gifts received by the university in the most recent year. While endowment reflects a long history of private giving, as well as the growth of the fund through retained earnings and appreciation, it also serves as

Endowment Assets
by Research Group and Control

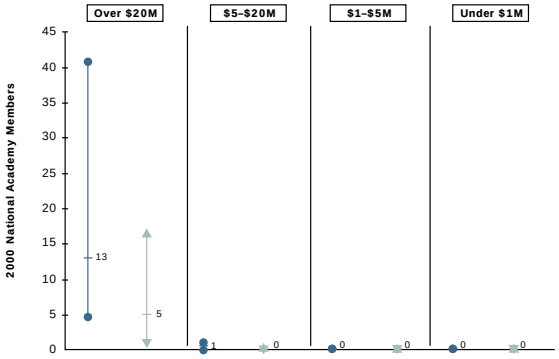


Annual Giving
by Research Group and Control

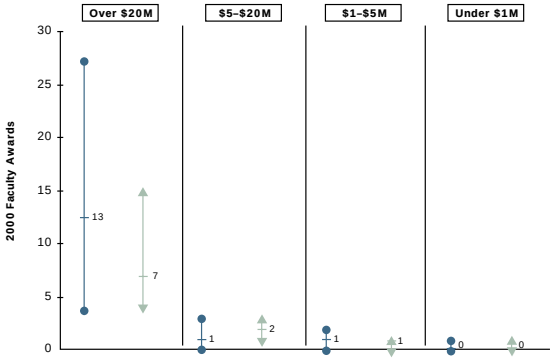




National Academy Membership by Research Group and Control



Faculty Awards by Research Group and Control



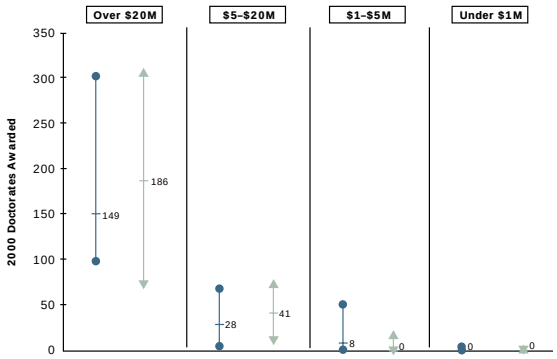
an indirect indicator of the annual income available from this source for current competitive expenditures. Annual giving reflects the most recent efforts of the institution in the private marketplace for donations.

Data that directly measure faculty quality and productivity at the institutional level are rare, but national figures do exist on the numbers of National Academy memberships and prestigious faculty awards of various kinds. These distinctions, which recognize individual faculty merit in a wide range of scholarly disciplines, serve as useful indicators of an institution's success in acquiring scarce faculty talent. Taken together, the two measures identify faculty recognized for distinction in the sciences, the humanities and social sciences, as well as most other fields of academic scholarship.

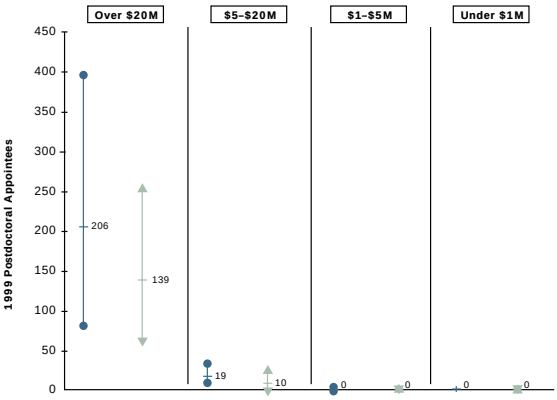
The number of doctorates awarded reflects the university's commitment to advanced study in all fields. Postdoctoral appointees demonstrate the commitment of the institution to subsidizing the cost of advanced training, much of which is in support of research, as well as their success in competing for grants that include post-doctoral support.

Finally, as our model indicates, the best research universities spend a significant portion of revenue on the maintenance of high-quality undergraduate programs, and the median SAT score of the entering freshman class serves as an indicator of success in this competition. Graduate student quality would also be a useful indicator, but the data for such an indicator are not available in a form we can use in this project.

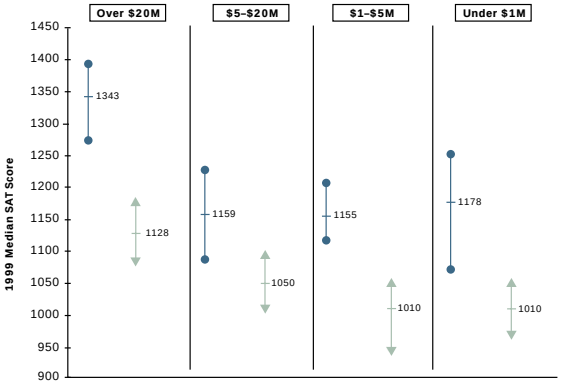
Doctorates Awarded by Research Group and Control



Postdoctoral Appointees by Research Group and Control



Median SAT Scores by Research Group and Control



These nine measures provide the basis for categorizing *The Top American Research Universities*. We believe that it is useful to identify those institutions that compete at the top levels (within the top 25) and at the next level (within the top 26–50) on one or more of these measures. Although we continue the practice of showing private and public institutional categories separately, we focus primarily on the categorization that includes all research universities within a national context. In some ways, we find this to be more useful, since the competition for faculty, students, and revenue often puts private and public universities into direct competition with each other on a national basis.

The Impact of Enrollment and Medical Schools on Research Competitiveness

Some universities have remarkable success in the competition described by these data, but the critical determinants of university performance do not appear so clearly. In conversations among university people, two elements receive much attention. Some argue that increasing undergraduate enrollments brings a major competitive advantage. Others believe that the presence of a medical school gives universities a competitive advantage in today's research marketplace. While our data indicate that enrollment and medical schools may very well make some difference, the impact is not as straightforward or as significant as one might assume.

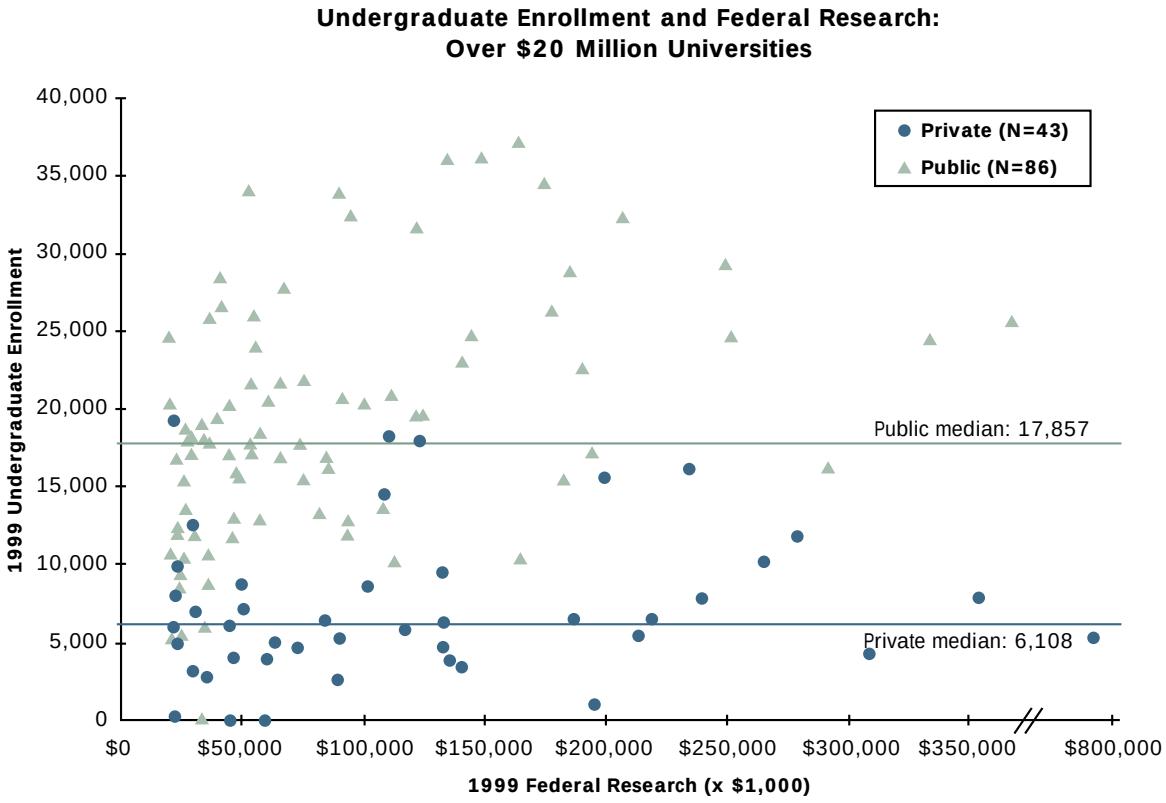
Private and Public University Enrollment, Federal Research, and Faculty Numbers: Most observers of American research universities recognize that private universities tend to have smaller enrollments than their public counterparts. As indicated above in our discussion of the quality engine model, enrollment size responds to many pressures but probably reflects the financial model underlying the institution. Because research universities are complex organizations, however, simple assumptions about the relationship of enrollment to institutional competitiveness in research and student quality generally do not hold.

To explore the impact of enrollment, we first examined the relationship between undergraduate headcount enrollment and federal research. We made a few adjustments to the data. For the analysis, we excluded stand-alone medical institutions. These institutions are significant competitors in the research marketplace but do not include undergraduate education within their primary mission. After these adjustments, the universe that we examined included those 575 universities reporting any federal research between 1990 and 1999, although we focused primarily on institutions with over $20 million in federal research.

The scatterplot displays undergraduate enrollment and federal research for the 129 major research universities in this adjusted universe with over $20 million in federal expenditures. It clearly illustrates that private universities generally have smaller enrollments than do their public counterparts, but at the same time, it shows no simple linear relationship between undergraduate enrollment size and success in the federal research competition. Large and small institutions, private and public, appear at all levels of research performance.

Large and small institutions, private and public, appear at all levels of research performance.

The same pattern also holds for those research universities with less than $20 million. At every level of federal research, public universities tend to



be larger than are their private counterparts, but the relationship between undergraduate size and federal research success is weak.

Enrollment size is of some significance, nonetheless, in understanding the different financial models that underlie private and public research university competition. In our model of research universities described above, what matters is the availability of funds to invest in the acquisition and support of research faculty and of quality undergraduate programs.

In the case of public universities, the size of an institution's undergraduate enrollment responds to many pressures. In some instances, public universities grow in response to state mandates for increased public access to undergraduate education. Such institutions may well have many students and may use the revenue from enrollment to support a large portfolio of instructional and service enterprises that are of significant value but are unrelated to research or to the acquisition of quality students. In the event that teaching and service do not produce revenue exceeding their costs, their contribution to research or student competitiveness will not be great. Large institutions may also incur a quality penalty. In accommodating the large number of undergraduates required by state access goals, they may not have the resources to invest in the programs and other amenities that attract the highest quality undergraduates.

Nonetheless, because most public universities receive substantial portions of their total budgets based on undergraduate enrollments, it is not surprising to discover that they generally grow larger than their private counterparts, whose revenue is not as enrollment driven. Indeed, private universities have between one-fourth to less than one-half of the median undergraduate enrollment of public institutions at every level of federal research.

However, undergraduate enrollment has an obvious impact on the number of faculty members at an institution. In public universities, the larger number of students can support a larger number

of faculty than at their smaller private counterparts. Nonetheless, if the larger public institution hires mostly teaching faculty — individuals who do not perform significant amounts of competitive research — then the increased faculty size will enhance research competitiveness less than the increase in faculty numbers might suggest.

While public institutions support larger undergraduate student bodies and have larger complements of personnel than their private counterparts, this added size does not necessarily enhance their ability to capture large research portfolios or to enhance the quality of their students. Although the best public research competitors have substantial undergraduate enrollments (the five top public university performers in federal research have enrollments in the 15,000 to 30,000 range), the four private universities in the same range all have less than 12,000 in undergraduate enrollment. Again, we believe that this speaks to the underlying financial models. Public university enrollments may help to generate the revenue that allows them to compete for research faculty, but private universities may not gain much benefit from larger undergraduate enrollments.

Unlike public universities, whose undergraduate enrollments respond to public policies and funding priorities, private universities may set their enrollments to meet programmatic needs. Private universities need enough students to populate the academic programs that they offer. An institution with a small number of academic specialties may require a smaller undergraduate student body than an institution with many specialties. Elite private universities often subsidize the tuition of their students from internal funds (using endowment earnings as well as various forms of federal and state financial aid) in order to compete successfully for the best students. Consequently, for private universities, increasing the size of the undergraduate student body may not produce a financial benefit but may instead increase their costs.

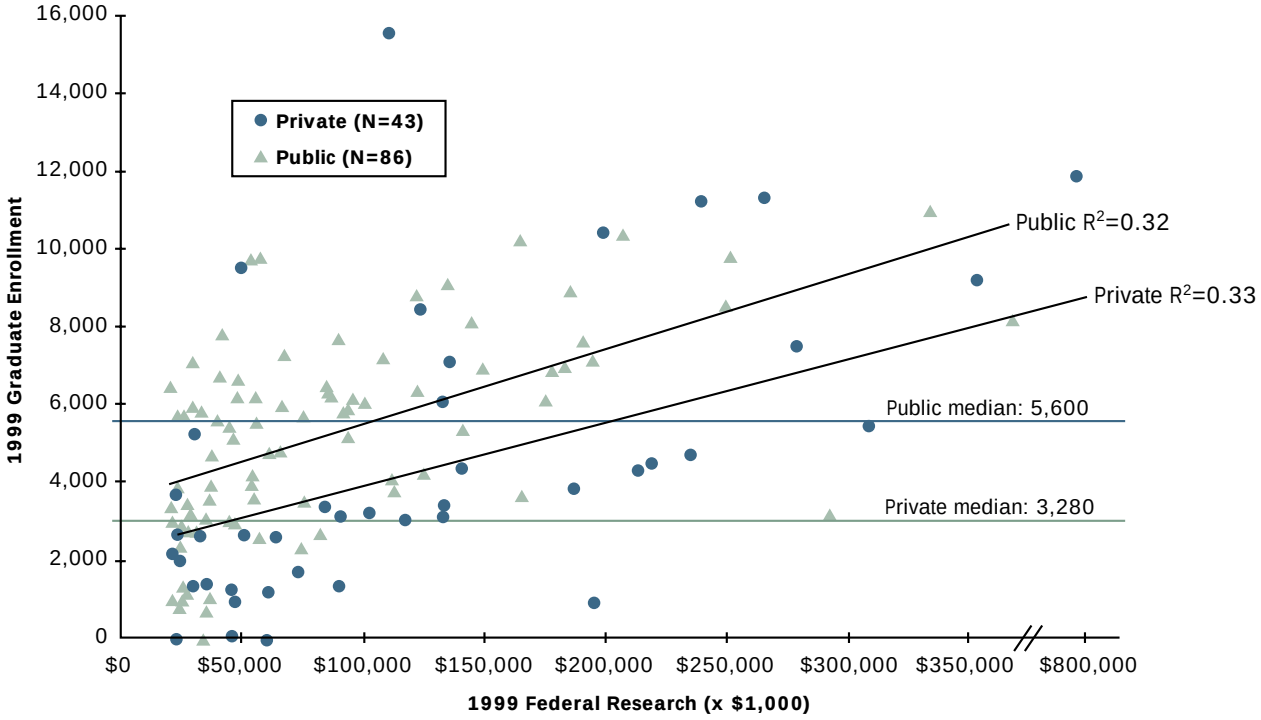
For these reasons, it is likely that private institutions have a self-limiting enrollment structure scaled to match the academic complexity of the institution as well as its investment in competing for high-quality students. As a result, the benefit that a larger enrollment brings to the private university's research competitiveness is relatively limited. This may help to explain the narrower range of enrollment sizes for private universities compared to the wider range observed in comparable public institutions.

An additional perspective on the issue of enrollment size involves the relationships between graduate student enrollment and federal research. Some graduate student enrollment, especially of those in the pursuit of Ph.D.s, reflects the size and capacity of research programs, but other graduate students are in various forms of terminal master's degree programs that have much less of a relationship to the university's research agenda. Universities with larger undergraduate enrollment gain an opportunity to support a larger number of graduate students as teaching assistants. The plot of graduate student headcount and federal research for the major research universities with over $20 million in federal research is instructive. Among both private and public institutions, approximately the same relationship exists between the number of graduate students and the size of the institution's federal research expenditures.

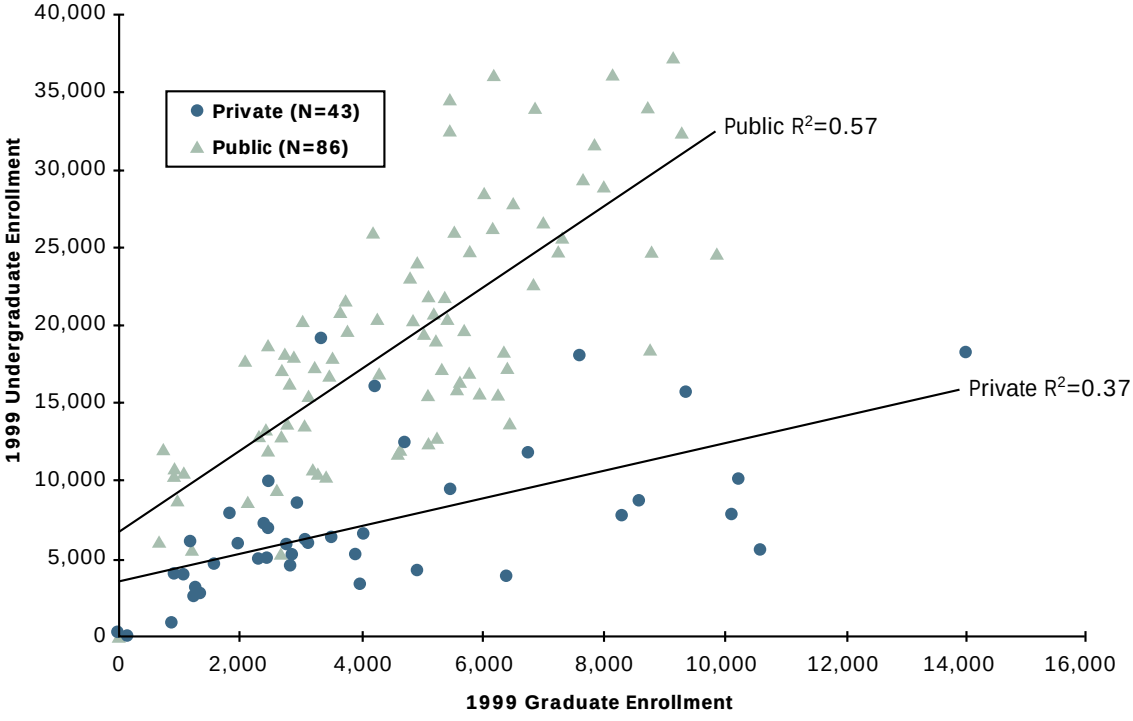
For public universities, increasing undergraduate enrollment may help to generate the revenue that allows them to compete for research faculty. For privates, more students may not provide a financial benefit but instead increase costs due to tuition subsidies.

The difference in the median size of the graduate student populations of private and public universities is somewhat less than the difference observed for undergraduate student enrollment but it is still substantial. The scatterplot of undergraduate and graduate enrollment illustrates that while both private and public universities demonstrate a relationship between undergraduate and graduate enrollment, the relationship is substantially higher for public universities, as we would expect given the role of graduate students in the teaching mission of large public institutions.

Graduate Enrollment and Federal Research:
Over $20 Million Universities



Undergraduate vs. Graduate Enrollment:
Over $20 Million Universities



While enrollment, both undergraduate and graduate, helps us to understand some of the competitive elements in the construction of a successful research university, we do not have a measure for the most important element: the number of active research faculty. Unfortunately, no methodology currently exists to capture this number accurately. While all universities report various faculty counts to national agencies and in response to a variety of surveys, the methodologies used to produce these numbers vary significantly by institution, as described in a paper published on *TheCenter* website. The result is that comparisons based on faculty counts are unreliable, mostly because the data from the institutions are not comparable. Further complicating the use of faculty counts is the wide range of faculty functions in universities of different types. Some institutions have many individuals classified as faculty in instructional and service activities, while other institutions have most of their faculty in research functions.

If we could identify the full-time equivalent research faculty on a standard basis across institutions, our hypothesis predicts that this number would be an excellent predictor of institutional research success, as it often is in comparing the research success of individual guilds. Reliable data on research faculty would also permit an analysis of comparative faculty productivity by institution, a task not possible with currently available faculty data.

Medical Schools and Federal Research: Medical schools offer another point of comparison between institutions. A common perception holds that institutions with medical schools have an advantage in a research competition where significant sums go to biomedical and life science projects. Indeed, only eight institutions out of the top 50 in federal research succeed at this level without a medical school. The importance of life science research for many high-performing universities (which is visible in the data table of Institutional Characteristics for Institutions with Over $20 million in Federal Research) reinforces the belief in the importance of a medical school in the competition for federal research dollars.

Although medical schools frequently have high-quality research faculty who compete successfully for federal grants and contracts, the data do not demonstrate that the existence of a medical school alone guarantees a nationally competitive research university faculty. Universities with and without medical schools appear at all levels of research competition. Although only one institution without a medical school competes among the top ten institutions in federal research, many institutions without medical schools compete successfully in each subsequent group of ten among the top 130 institutions (excluding stand-alone medical schools) ranked by federal research.

Comparisons based on faculty counts are unreliable, mostly because the data from the institutions are not comparable.

The primary functions of medical schools, which include preparing future physicians and participating in the clinical enterprise, do not necessarily require high levels of federally funded basic research. Universities without medical schools often have significant investments in biomedical research in departments of biology, microbiology, bioengineering, and similar disciplines, and they often compete effectively against the medical school research faculty at other institutions.

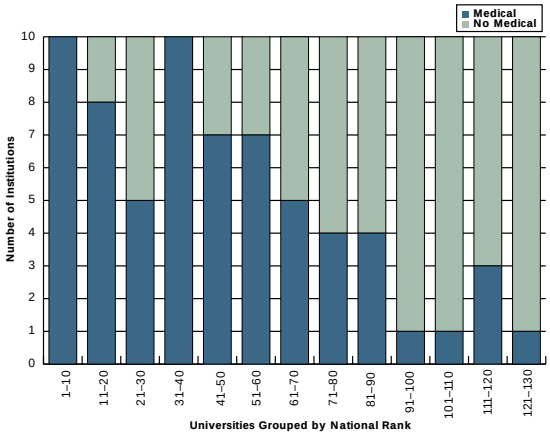
The key contribution that a medical school makes to a research university is the generation of surplus revenue that can subsidize the development of high-quality biomedical and life science research. Most, but not all, medical schools prove capable of generating such surpluses and have the commitment to invest such funds into research. Nonetheless, universities with and without medical schools perform at comparable levels of research competitiveness.

The chart included here shows the top 130 research universities divided into groups of ten based upon federal research, with each cluster divided by those institutions with medical schools and those without. In this chart, we removed the institutions that are stand-alone medical schools,

as our discussion here focuses on comprehensive research universities that include medical schools.

Universities with and without medical schools appear in all clusters of federal research within the top 130 universities represented by this chart. Of the 80 universities with medical schools, 14 institutions do not have sufficient federal research activity to rank among the top 130 institutions included in this chart.

Universities with and without Medical Schools by 1999 Federal Research Rank



When a medical school generates a surplus and invests that in support of research, its presence as part of the university will make a major contribution to its research competitiveness. The existence of a medical school with the capacity to support research, then, contributes to the university's research competitiveness. A medical school alone does not guarantee competitiveness.

Change in Competitive Performance on Federal Research

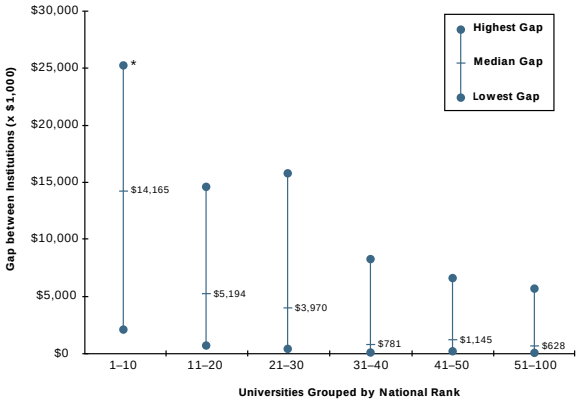
Competition in university research implies gains and losses. University faculty offer more quality research proposals than the various federal agencies can support. Primarily through the process of peer review, although sometimes through the direct appropriation of federal dollars to individual research projects or institutions without peer review (this process is called earmarking), some faculty projects receive funding while others do not. The performance of a university in terms of its federal research comes from the success of its faculty in competing for these funds. While this is obvious, it bears emphasis that this competition is fierce.

Success rates for proposals submitted to the NSF and NIH vary, but in recent years, over all projects, about 30% of the proposals submitted received funding. The resulting expenditures by universities from federal funds reflect the aggregate success of the institution in acquiring and supporting research faculty who compete successfully for these funds. Universities increase or decrease in their research performance based primarily on this competition.

Change in Rank Order: Many observers focus on the ranking of research universities, including the authors of this report. However, overemphasis on rank order as the primary reflection of competitiveness can obscure some important distinctions. Ranking, by virtue of its evenly spaced series from number one on down, gives the impression that ranking also reflects an even distribution of performance. That is certainly not the case here.

In fact, the performance gap between universities at the top of the ranking scale is much greater than the difference separating universities farther down the scale. As the following figure illustrates, the distance that separates universities (median, low, and high) within groups of ten decreases rapidly as rank declines.

Gap between Adjacent Ranked Universities by 1999 Federal Research Rank



* The gap between Johns Hopkins and the second-ranked institution ($402 million) is atypical and therefore excluded from this analysis.

For example, the median gap between each of the universities ranked 1–10 is about $14.2 million, while the median gap for ranks 11–20 is less than two-thirds of that at $5.2 million. Thus, to improve in rank, holding all other elements constant, a university in the top ten might need to increase its federal expenditures by roughly 6% while a university in the 11–20 range would only need to increase by about 2%.

In practice, not all elements are constant, since a change in the rank of any particular university is a function of its position relative not to the median of its group but to the performance of institutions immediately above and below. The variation in the gap between institutions of similar research performance is large, and the amount of change required to move up one rank varies substantially by institution.

Improvement or decline in rank also depends on the behavior of other universities. If the institution one position higher declines in performance, the university below may improve its rank without having improved its performance at all. A university that improves its performance may nonetheless decline in rank because the institution below it made a greater improvement and the institution above it improved by the same amount.

The figures included here clarify these relationships. We looked at all universities with $20 million or more in federal research over a period of ten years (1990–1999). We divided them into two groups: those whose federal research increased in constant 1998 dollars, and those whose federal research declined. We then tracked the change in rank for each group and arranged them by the size of their 1999 federal research expenditures.

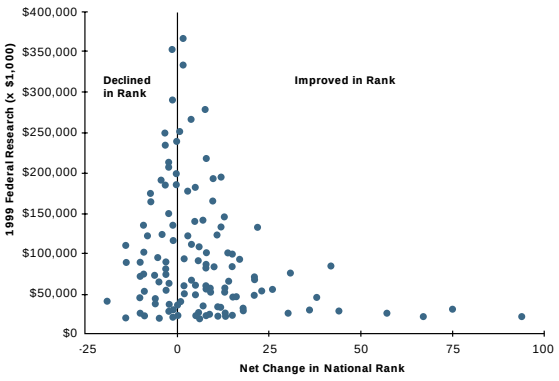
Of those who gained in expenditures, some also improved their rank, but many did not. The amount of rank change over the ten-year period increases as the amount of federal research decreases, illustrating the impact of the smaller gap between universities at lower ranks.

The second chart shows the rank change for institutions that experienced a decline in federal research during the ten-year period. All of those in the higher ranks declined significantly in research volume and declined somewhat in rank with the exception of Johns Hopkins. Although Hopkins lost $29.8 million in constant dollars over the ten years, it easily maintained its top position in the ranking.

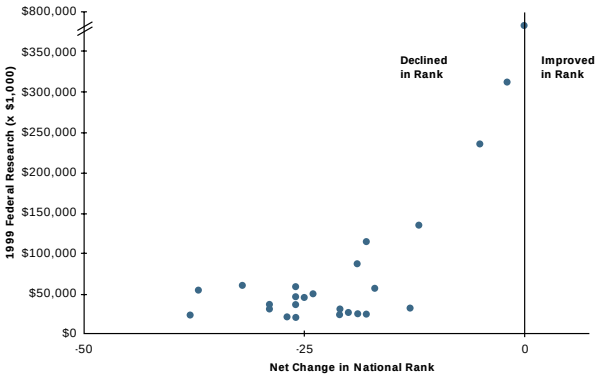
The ranking of universities helps to illustrate the general characteristics of research competitiveness, but change in rank is less helpful as an indicator of individual university performance over time. A better indicator is the actual change in federal research expenditures, expressed in constant 1998 dollars, which gives a useful comparative context for assessing institutional performance.

An absolute decline in constant-dollar federal research expenditures is a relatively clear event for this decade, since there was an increase in the total federal dollars available. An absolute increase,

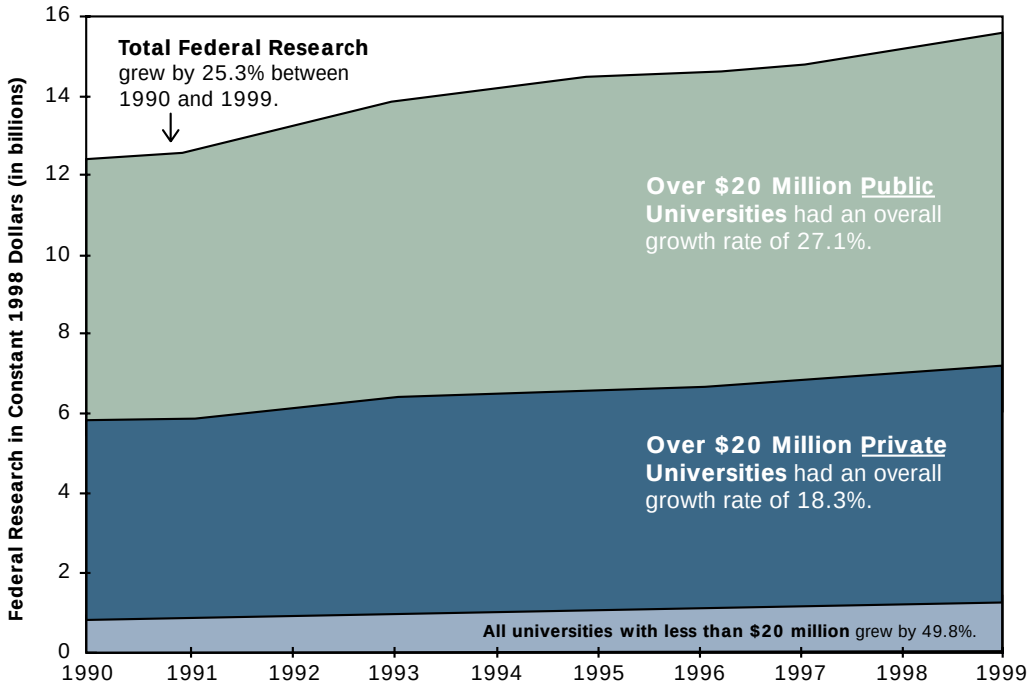
Over $20 Million Universities with an Increase in Federal Research: Change in National Rank, 1990–99



Over $20 Million Universities with a Decrease in Federal Research: Change in National Rank, 1990–99



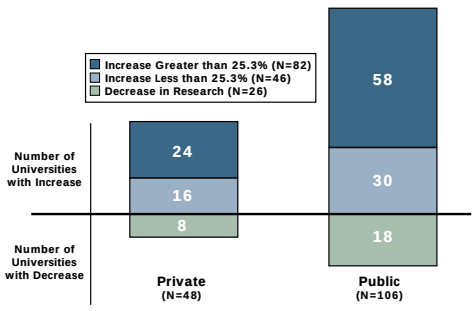
Growth in Federal Research, 1990–99
(in Constant 1998 Dollars)



however, offers two possible interpretations. In the first case, an institution might increase its research expenditures, but at a rate less than the rate of increase for all research university federal expenditures. In this decade, the overall increase was 25.3%. In a relative sense, this may reflect a decline in an institution's share of federal research, as it has not grown at the same rate as the pool of funds.

In the second case, an institution might increase its constant-dollar research expenditures at a rate in excess of the increase of the pool, thus also increasing its share. The table below displays those universities with over $20 million that experienced each of these three cases over the past ten years.

Change in Federal Research, 1990–99: Over $20 Million Universities
(in Constant 1998 Dollars)

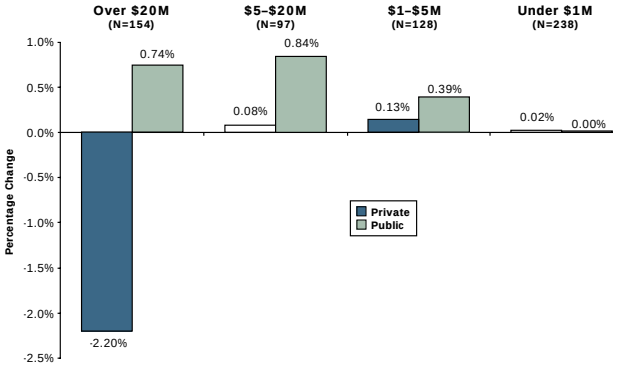


Private and Public University Shares of Federal Research: The shifts in market share offer some additional insight. The past decade has seen the emergence of a number of public universities competing successfully for federal research dollars. As a result, the distribution of market share in federal research expenditures has shifted over the period of 1990–1999.

Private universities with over $20 million in federal research lost 2.2% market share during the decade. This was the only category of universities amount our four research groups that lost market share. Because the total amount of federal dollars grew during those ten years, the private institutions in this category gained $896 million, but because the total federal expenditures grew at a faster rate, they actually lost market share.

Public research universities with over $1 million gained 1.97%, with most of the gain occurring in

Change in Federal Research Market Share, 1990–99: By Research Group and Control
(in Constant 1998 Dollars)

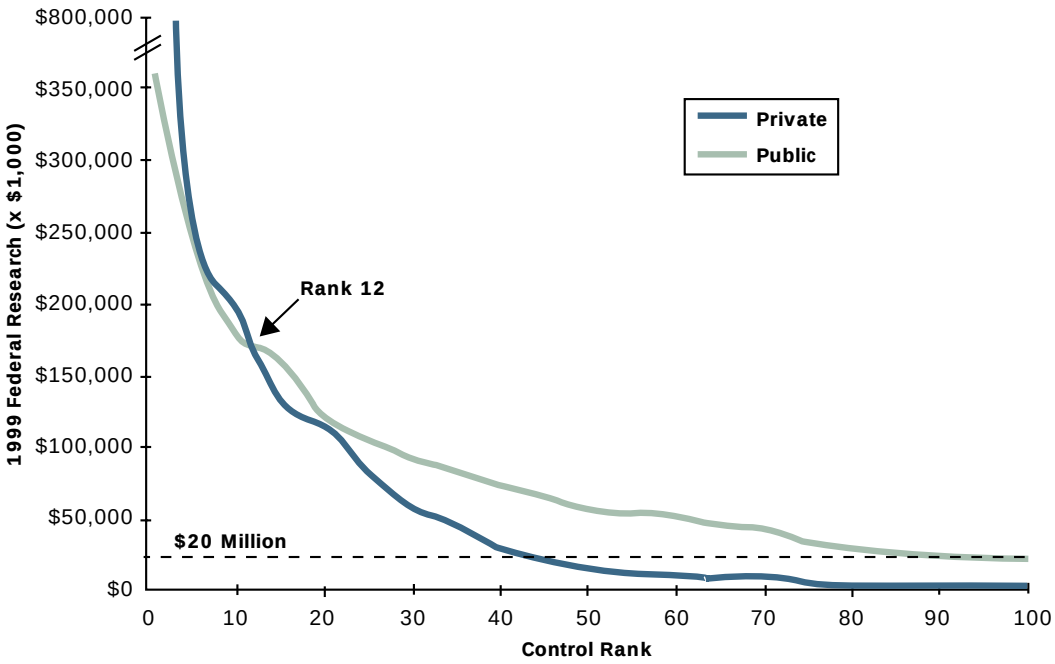


the $20 million and $5–$20 million categories. Private universities with less than $20 million gained 0.23% market share in the decade.

A final reflection on the private-public distribution of federal research compares private and public university research expenditures. The graph includes two lines plotted on the same scale: one for the top 100 private universities and the other for top 100 public universities, both arranged in order of their federal research expenditures. The purpose of this graph is to show the relative competitiveness of private and public research universities in acquiring federal research support. For the first 12 private and the first 12 public universities, the private universities have a higher level of federal research. After than, this pattern reverses, and from rank 13 on down, public universities have greater federal research expenditures than private universities.

This pattern indicates that the top private universities continue to succeed in maintaining their preeminence as competitive research performers. However, the number of private universities that can compete with their public counterparts falls off after rank 12. Although we have not yet analyzed this pattern in detail, we expect that tax-based funding provides the revenue supporting many public universities' investments in research-competitive faculty and facilities. Private universities often find it more difficult to generate the revenue required to compete for faculty and to provide the necessary research support. As a result, while many private universities remain competitive, they find themselves at a

Top 100 Private vs. Top 100 Public Institutions: 1999 Federal Research



disadvantage compared to their public competitors on one side and their better-endowed private competitors on the other.

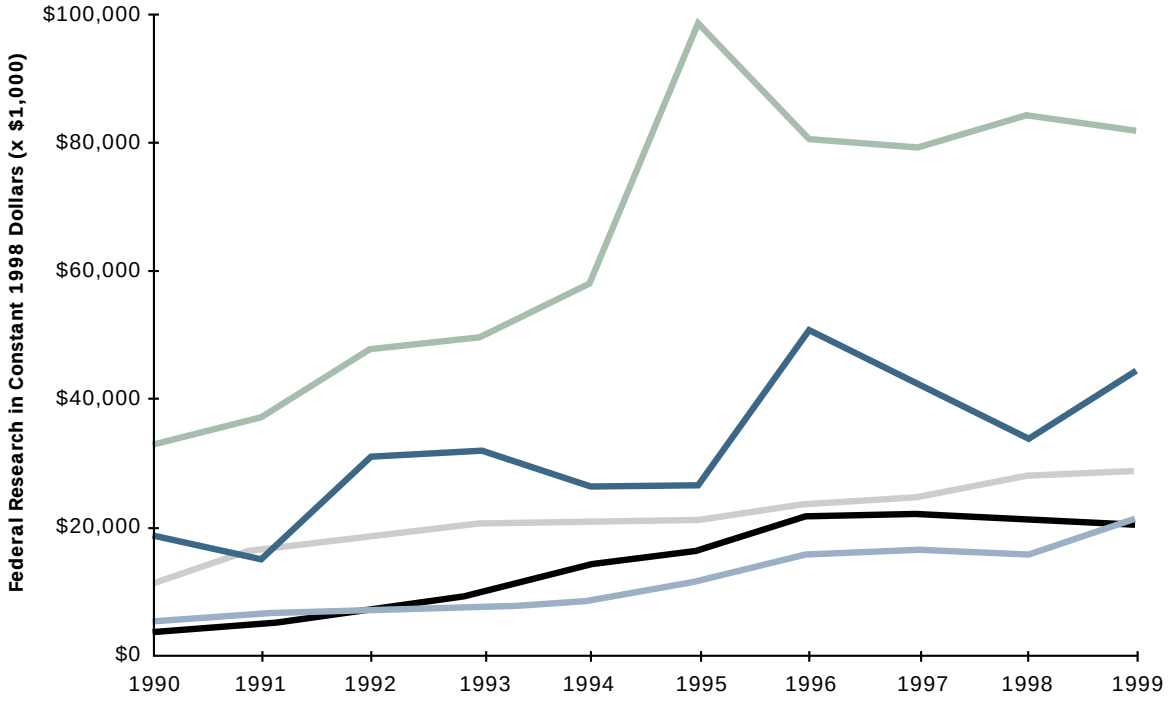
Patterns of Improvement and Decline in Federal Research Expenditures: Although we can summarize the aggregate behavior of research university competitiveness over time, as measured by federal research expenditures, the patterns of change for individual universities pose a different challenge. Some institutions demonstrate predictable patterns, with a steady increase or decrease in their expenditures. For others, the data change substantially over the ten-year period, rising many millions in one year and falling an equal or greater amount in subsequent years.

These larger changes reflect many circumstances that are particular to each university. Institutions can receive grants that include capital expenditures. As the university spends these one-time dollars, the reported federal expenditures for that year will spike upward, only to fall back to a normal level in subsequent years. Institutions can gain or lose large grants, producing major fluctuations in their expenditure patterns. Sometimes, universities improve their methods of data reporting to the federal government, producing a one-time increase in the reported revenue.

Whatever the case, an explanation for the particular history of any university's research competitiveness requires a specific and detailed understanding of that institution's research activities in comparison to similarly competitive counterparts. The explanations for a rise or fall in reported results will vary significantly from institution to institution.

An illustration of the complexity of a university's research performance as reflected by federal expenditures is visible in the graphs of ten universities displayed in the two figures below. The first figure graphs the ten-year performance of five universities (1 private, 4 public) that showed the greatest percentage improvement in their research performance (excluding stand-alone medical institutions). The second figure graphs a comparable group of five universities (3 private, 2 public) that declined the most in research performance during the same ten-

Research Universities with the Largest Percentage Increase in Federal Research: 1990–1999



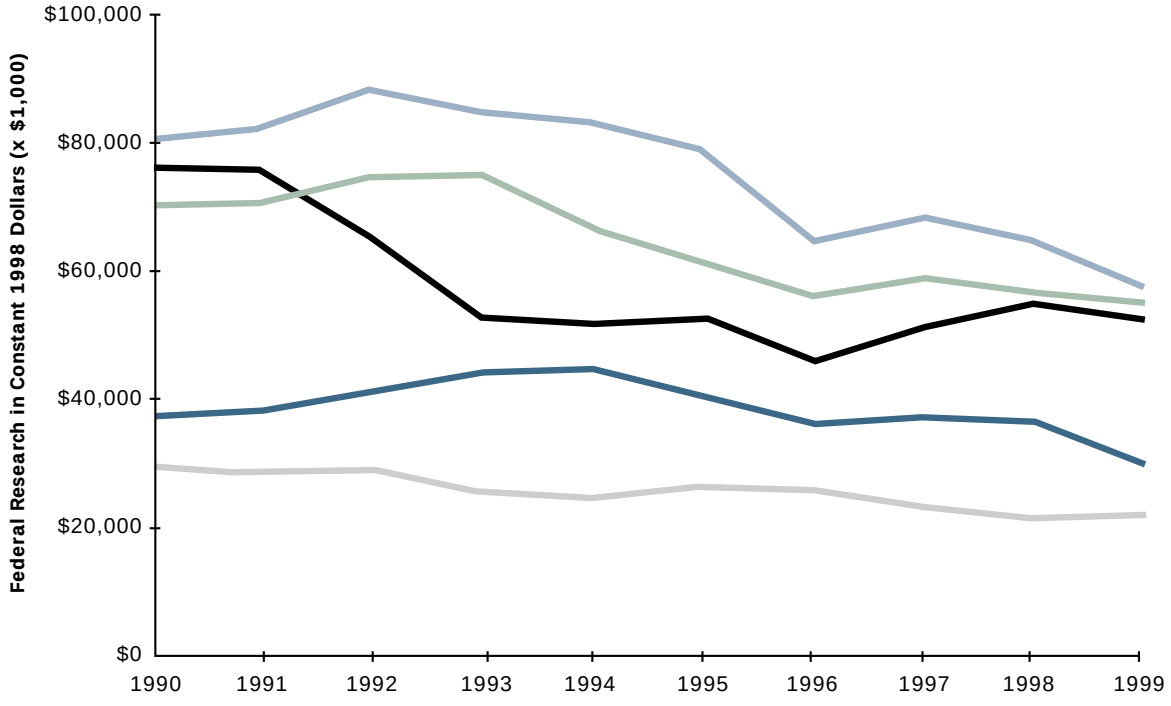
year period. The institutions all fall within a group reporting expenditures in the $20–$90 million range in 1999. The graphs display expenditures in constant 1998 dollars.

Some of these institutions report a steady rise or fall in expenditures; others show major changes from one year to the next. To understand the competitive circumstances of the federal research marketplace that these data reflect, each institution would need to review its ten-year data and compare this performance history with its near competitors.

For all of the similarity in their organizational models, American research universities have many different strategies for success. No single pattern explains the success or difficulty encountered by universities in competing for federal research and outstanding students. Our understanding of research university behavior indicates that the most important element is the creation of revenue to subsidize the acquisition of high-quality scarce faculty and student talent and support for the research enterprise. At the same time, each university has an internal strategy for the effective investment of its revenue. Many characteristics determine a university's ability to compete for the scarce elements that make a research institution. No single characteristic appears to explain competitive achievement, but instead, the right combination of elements matched with an institution's resources and opportunities is what appears to drive the most successful institutions.

To maintain or improve their competitiveness in these marketplaces, universities almost certainly need to understand the relationship between their investments in research and student support and the results that they achieve. Some universities may be wealthy enough to avoid the discipline of measuring results, but most institutions are not. Our goal in this publication is to provide useful data that present institutions within their competitive context as a tool for measuring and improving research university performance.

Research Universities with the Largest Percentage Decrease in Federal Research: 1990–1999



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