Competing with the Best: America's Top Research Universities 2000-2020

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INTRODUCTION

Over the past two decades, we have explored a wide range of issues that reflect the complex and intense competition among America's research universities as they seek to capture the most effective participants in the academic research enterprise. We started with the notion of university improvement, the effort by most colleges and universities to make their programs better and more effective and to enhance the quality of the work they do. This led, inevitably to the recognition that the pursuit of improvement among the top research universities is primarily an intense competition for ever larger shares of the scarce talent and critical resources that sustain research performance.[1]

Our Top American Research Universities project (TARU) has always focused on those institutions with high levels of annual federal research expenditures, starting with a cut-off point of $20 million and above in our 2000 inaugural report and adjusting to a $40 million and above cut-off in the 2008 report. For this retrospective 21-year analysis, we focus on the institutions that met the higher $40M cutoff in each year since the first report. Over this period the number of institutions above the $40M marker numbered 106 in 2000 and rose to 164 in this, our final report (Figure 1). During some of these years, a few universities fell out of the over $40M group, but over the 21 years 186 institutions reached the cutoff at least once. More than one-half (54%) were in the over $40 group every year and about three-fourths (73%) of these 186 institutions met or exceeded the $40M cutoff in at least 16 out of the 21 years. The institutions that can sustain over $40 million of annual research expenditures, are all excellent universities with good faculty and staff, strong students, extensive extracurricular and support programs, and fine facilities. The intense focus on improvement is not only designed to burnish already fine operations but especially to focus on improving or maintaining a high position in the competition for research recognition and support.[2]

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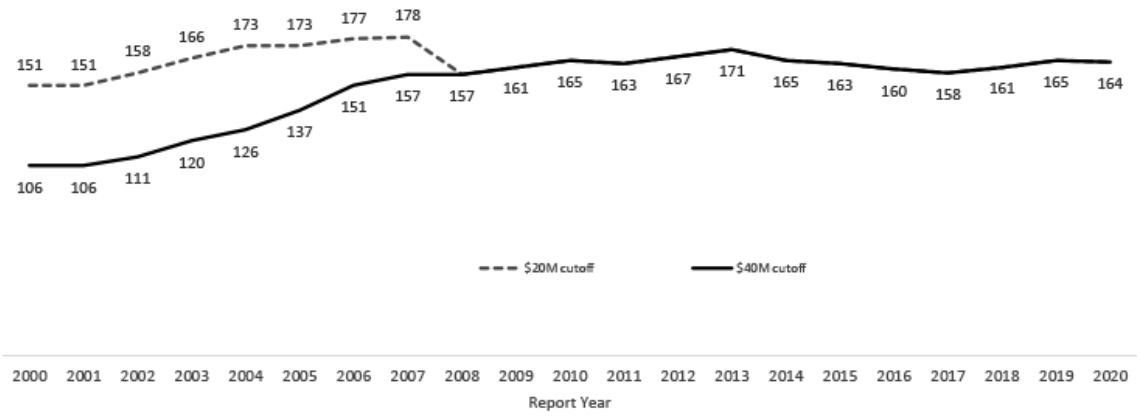
1 For an example of an institutional focus on performance that served as a basis for the eventual work of the Measuring University Performance Center see John V. Lombardi and Elizabeth D. Capaldi Phillips, *A Decade of Performance at the University of Florida (1990-1999)*, University of Florida, 1999. [http://jvlone.com/10yrPerformance.html]. Note that Elizabeth D. Capaldi became Elizabeth D. Capaldi Phillips during the years of her work with the MUP center. We cite her as Capaldi Phillips here.

2 In many of our analyses over the years, we excluded standalone medical schools and specialized academic institutions because their focus and organizational structure can differ greatly from the other more comprehensive universities in our top research group. For this review we have included them to get a more complete picture of how the over $40M academic institutions performed over the past two decades. These specialized academic institutions make up 16-19% of the over $40M institutions each year. As we have documented in the past, as a group, standalone medical and specialized institutions have fewer resources than other full spectrum academic universities in the over $40M group. The number of standalone and specialized institutions increased in the early years of our project from 17 in 2000 to 28 today, peaking at 33 in 2013. For a discussion of some of these issues see "Lombardi, Capaldi Phillips, Denise S. Mirka, Craig W. Abbey. "Deconstructing University Rankings: Medicine and Engineering, and Single Campus Research Competitiveness," *TARU Corrected, 2005*. [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2005-Deconstructing-University-Rankings-Medicine-and-Engineering-and-Single-Campus-Research-Competitiveness.pdf] **For a list of the 186 institutions included in this edition, including the standalone medical and specialized institutions, see the Appendix on page 22.**

Figure 1. Number of Institutions included in The Top American Research Universities



This competition for institutional preeminence takes place in many venues, the federal research grants competition for science and engineering support, the search for non-science and engineering funding from the federal government, the endless pursuit of foundation and private funds to support programs, the constant effort to maintain or increase state funding for public universities, the carefully curated admissions process that seeks the best students with multiple desirable credentials and characteristics, and the endlessly promoted high profile athletic competitions.[3] Although this complex system sustains much of America's international research preeminence, the data that could illustrate the operation of this competition is difficult to acquire in formats that allow institutional comparison. There is data, to be sure, but often collected by different agencies, provided by institutions using different formats and definitions that often change over time, and frequently not audited for accuracy.

Federal Research Expenditures: To capture a clear sense of the competition we, and most other observers, rely heavily on federal research data because this information is usually collected and reported in reasonably consistent and accurate ways. Best of all for our purposes, are the data on individual institution federal research expenditures. The value of this indicator is enhanced by various related characteristics.[4]

- First, it reflects the actual research work accomplished with federal financial support on an annual basis. It is not a projection of work that might be accomplished, and because it reports on payment for work done, tends to be scrutinized carefully, reducing the opportunity for institutional inflation of expected results.

3 Given the exceptionally high profile of intercollegiate athletics and the importance of this activity in building institutional brands, the MUP center staff developed an extensive review of college sports programs with particular emphasis on the relationship to research universities. See Lombardi, Capaldi Phillips, Kristy R. Reeves, Craig, Gater, Dominic Rivers. "The Sports Imperative in America's Research Universities," *TARU*, 2003. [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2003-The-Sports-Imperative-in-Americas-Research-Universities.pdf] See also the essays in *Inside HigherEd* listed in the references to this paper by Lombardi: "The Enemy Is Us: Cost Reduction in College Sports," January 31, 2005 [http://jvlone.com/InsideHE_Enemy013105.pdf]; "Too Much Money? Sports and the Budget," November 11, 2005 [http://jvlone.com/InsideHE_SportsSubsidy101105.pdf]; "Taxing the Sports Factory," September 26, 2007 [http://jvlone.com/reality_check_Blog100107.pdf]; "The Amateur Challenge of College Sports," August 10, 2008 [http://jvlone.com/reality_check_Blog081008.pdf]; "College Sports and Our Winter of Discontent," September 21, 2011 [http://jvlone.com/reality_check_Blog092311.pdf]; "Universities Should Admit that Athletes Aren't Amateurs," October 31, 2014 [http://jvlone.com/MythAmateurism2014.pdf].

4 Federal research (and total research) expenditures are reflected in data from the NSF Higher Education Research and Development (HERD) (FYs 2010-2018) [https://www.nsf.gov/statistics/srvyherd/] and the NSF Academic Research and Development Expenditures surveys (FY 1998-2009) [https://www.nsf.gov/statistics/srvyrdexpenditures/] and adjusted in a few cases to represent expenditures at a single campus. These adjustments were much more common in the early years of our project when some public university systems only reported system totals, not individual institutional results. Today most campuses report individually and very few institutions' data need to be broken apart. The market for Federal research expenditures, from which the market share is calculated, is the total dollars reported by all academic and research institutions to these two NSF surveys. For more details about which campuses have adjusted data, see the Data Notes section in each year's publication.

- Second, it is a stable, annual indicator as contrasted with the similar number that reports on federal research awards. Award data, while also quality indicators, has the defect of chronological confusion. Some awards are for one year, some for two, and some for five or more. The total of awards does not reflect research work accomplished but research work anticipated.

Since the goal is to measure research performance, the annual expenditure data is of greater utility and lies at the core of our work over the past years.

As noted earlier, we use federal research expenditures to define the competitive universe of research universities by setting a marker at $40M per year. While the institutions at the lower bound of this cutoff do not have the research presence of say the top 10 public or top 10 private universities, they nonetheless help define the competitive context. All participants, however defined, seek to capture ever larger shares of the strategic resources that mark them as winners, and institutional improvement is seen as exceeding the share captured by the institution above on the list. A review of the top universities on federal research expenditures compiled each year always shows some universities moving up a position or two, an occurrence that results in significant institutional celebration, but of course often the institution that moved up in rank on the list, did not necessarily get any better. The one above it in a previous year may well have done worse.[5]

Each annual competition denominated in federal research expenditures reflects institutional efforts to capture a share of the market defined as the total amount reported by all universities that spend any federal research dollars. As a result, for example, an improvement in an individual university's market share of 5% over the previous year is only an improvement in the competition if it exceeds the total growth in the market of research expenditures of the other institutions in its group. If the market grows by 8%, an increased market share of 5%, is a competitive loss, for some other university will have captured the additional 3%.

An important characteristic of this competition is the scale of effort required. If we look at the median expenditure of the top twenty universities in the most recent year we see a number on the order $644M (Figure 2). If we look at the median expenditure of the last twenty institutions in the over $40M group, we see a number on the order of $47M. The institutions in the top group are 14 times more successful than those in the bottom group. This gap between the median market shares of the top and bottom 20 in 2018 is the largest we have found in the past 21 years and has widened considerably since 1998 when the top group had about five times the median expenditure of the bottom group. As noted in Figure 2, the median for all institutions that met the $40M minimum each year grew about $59 million over the 21-year span compared to $412 million median growth for the top 20 institutions. While we can parse the numbers and institutional characteristics in many ways (as we have done in the periodic essays that have accompanied these reports over the years), this fundamental difference in scale is a primary characteristic of academic research competition.

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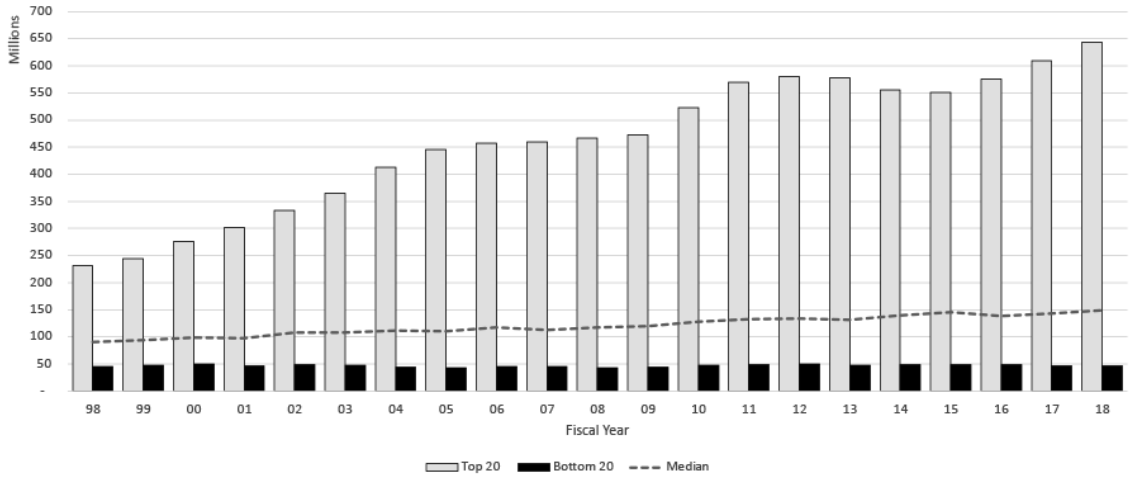
5 See the examples in Craig and Lombardi. "Moving Up: The Marketplace for Federal Research in America," *TARU,* 2011 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2011-Moving-Up-The-Marketplace-for-Federal-Research-in-America.pdf]

Figure 2. Median Annual Federal Research Expenditures: 1998-2018



The resources required to successfully compete at the $644M level are far beyond the capacity of universities at the $47M level. This says nothing about the quality of the individual projects sponsored by institutions at any level in the competition. A university with a $47M federal research expenditure will have individual faculty members whose projects win grants in competition with faculty from universities with $644M in research funding. But in the aggregate, the $644M institution will have many more competitive quality participants working in their research programs and submitting successful grants for funding. It is, then, the accumulation of research assets by individual institutions that sustains their high position within this competition.

These assets include many things, but primarily focus on supporting the work of faculty, staff, and students on research projects that can attract external funding. The assets vary depending on the types and characteristics of projects, whether nuclear power or DNA analysis, but all of them float on a sea of revenue. Money is the essential element required for high powered, successful academic research enterprises. Money does not create the enterprise nor does it ensure its competitive success. A rich university is not necessarily a competitive research institution (although it might be an outstanding undergraduate college) but a poor institution cannot be a major research university.

These considerations help explain the exceptionally intense revenue seeking behavior of research universities. The money that makes a $644M annual federal research expenditure possible each year comes from every imaginable institutional source: state appropriations, endowment earnings, annual giving, tuition and fees, services and entertainment, patents and licenses, housing and transportation, foundations and corporate contracts, funds captured from medical services and hospital contracts, and others.

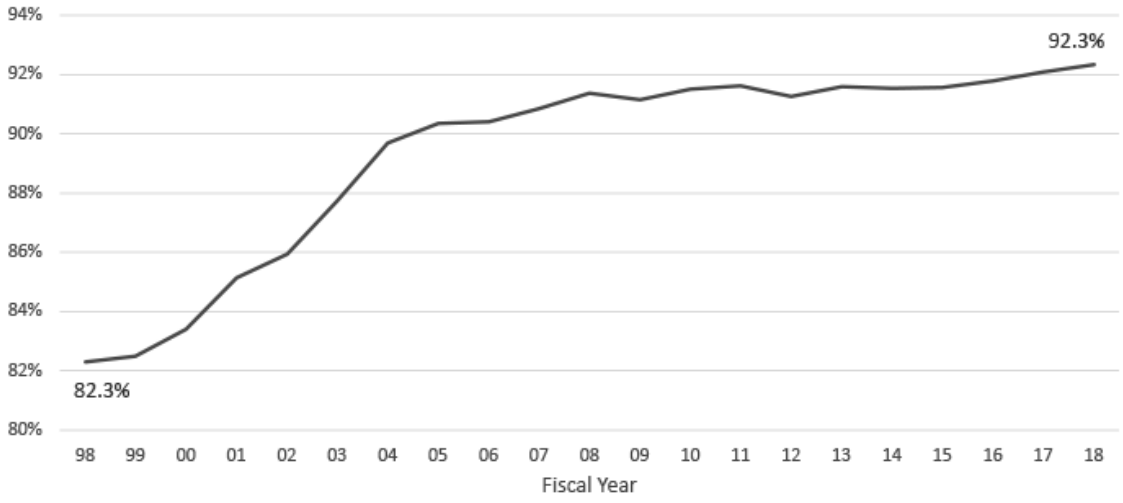
Research is an institutional loss leader, even though the large amounts of federal money spent by universities on research seem impressive. The federal government in almost all cases, however, does not pay for the full cost of the research the university accomplishes under the aegis of a grant. Instead, it pays some of the direct cost of the work, a portion of the indirect cost of heat, light, power, depreciation, and other general expenses, and only a small portion of the lost revenue from instruction as faculty divert their time from teaching to research. Revenue sources other than the grant funds make up this difference, and the amount of surplus revenue universities generate from the other sources limits the amount of federal research expenditure they can sustain.[6]

6 An excellent summary of the indirect cost issues is in Jane Radecki. "University Budget Models and Indirect Costs: A Primer." Ithaka S+R, 2021 [https://doi.org/10.18665/sr.314858].

The key elements of successful research competition are almost always the result of individual faculty, staff, and student inspiration, effort, expertise, and work. Few of these individuals work for free, and almost all expect to be compensated at competitive levels with other high performing personnel at equivalent institutions. Perhaps even more importantly, the most sought-after people believe themselves to be the best, and they believe that if provided with adequate support, they can perform at stellar levels. As a result, for a competitive research university to sustain the personnel needed for competitive success it must provide the finest, deepest, most extensive (and expensive) research support people, facilities, and services possible. Since superior research talent is relatively rare, the most competitive people will choose to work where they can perform on a platform of the highest quality and with the deepest support. For this reason, many recruited high performing research personnel, while receiving generous salary support, require in addition an investment in equipment, related support personnel, graduate student stipends, and additional allied faculty all requiring money that far exceeds the cost of paying a competitive faculty salary. Research productive faculty congregate in institutional settings that provide this kind of expensive support.[7]

Given this context, it should come as no surprise that institutions with the necessary resources to sustain this level of activity will have developed the tools needed to continue generating these resources and consequently will remain at the top of the academic research marketplace, able to fend off significant challenges from the projects proposed by competitor institutions' people.[8] We can see the result of this process if we look at the sustained success of the top institutions over time. We have two decades of data to observe, and we can easily see that the group of top universities, the institutions with over $40M of federal research expenditures, rapidly expanded their market share in the early years as their investment and their numbers grew, to capture about 92% of federal research expenses over the past decade (Figure 3).

Figure 3. Federal Research Market Share of Over $40M Group: 1998-2018



7 A useful summary of the university budget issues associated with top performing research universities see Jane Radecki and Roger C. Schonfeld, "Academic Research Budgets: A Look Ahead with Special Emphasis on Research Enablement and Support," Ithaka S+R, 2021 [https://doi.org/10.18665/sr.314860]. For an interesting perspective on the role of tenure and aculty selection in creating American research universities as world competitive institutions see W. Bentley MacLeod and Miguel Urquiola, "Why Does the U.S. Have the Best Research Universities? Incentives, Resources, and Virtuous Circles," *NBER, Working Paper 28279* (December 2020).

8 For a discussion of the resource commitments required to sustain top level academic research performance see Capaldi Phillips, Lombardi, Abbey, Craig. "Research University Competition and Financial Challenges," *TARU*, 2009 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2009-Research-University-Competition-and-Financial-Challenges.pdf]. For a discussion of the university structures that combine to produce what we have called a quality engine supporting academic research success see Lombardi, Craig, Capaldi Phillips, Gater, Mendonça, "Quality Engines: The Competitive Context for Research Universities," *TARU*, 2001 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2001-Quality-Engines-The-Competitive-Context-for-Research-Universities.pdf]

This dominance by the top performers is even clearer when we look more closely at the top institutions in the over $40M group. Twenty institutions have occupied a position within the top 25 national ranking on federal research expenditures for the entire period we have been tracking these data, and 40 institutions have consistently ranked in the top 50 every year. As we go down the stack from the most successful at the top, we find that there is more evidence of the potential for an institution to improve its position in the competition. However, this result is primarily a consequence of the smaller effort needed to move up in the hierarchy.[9]

To illustrate this circumstance, we can observe that in 2018 a move to the middle of the top 10 institutions from the middle of the second 10 would require an improvement of $125.3M. But to move from the middle of the bottom ten to the middle of the second ten from the bottom, an improvement of only $9.2M would be needed. While the percent increase needed to move is in the 20% range for both the top and bottom categories, the dollar amounts required for such improvement are significantly different. An increase of research success in the federal competition resulting in a $125.3M improvement would represent a much greater expenditure of institutional funds and a much larger number of research capable faculty/staff, and students than an increase of $9.2M. For this reason, there is much more movement among the institutions near the bottom of the stack than near the top.[10]

From this discussion it might appear that the critical issue for research universities is to mark their spot in the hierarchy of research expenditures and celebrate small movements up and avoid discussing small movements down. This misses the point. Research competition is relevant to the institution's place in a large group of similar institutions. It is belonging to a particular group of institutions with similar characteristics that matters, not whether a university is first or last in the group. Within similar groups of research universities, there are large variations in institutional context, style, characteristics, and purpose. While state or private universities might share very similar research expenditures, their programs, student bodies, faculty teaching expertise, and other characteristics would be much different. A rural university and an urban institution, each with similar research capabilities and results, would almost certainly be much different in many aspects of academic and institutional life.

This is why the inaugural essay in our publication series carried the title "The Myth of Number One." There is no number one. There are many research equivalent institutions with many different characteristics. The study of research success and competition permits a useful effort to group institutions into relatively similar categories to facilitate a clearer understanding of the elements that drive research competition.

However, such an effort must contend with some unavoidable difficulties. Everyone wants to be number one, or at least in the top ten or somewhere in a precise measurable place. Many commercial enterprises are eager to fulfill this desire with an endless variety of ranking schemes. The notion that any scheme, however cleverly devised, can capture the "best" institution in some single number ONE is easily dismissed, simply by looking at the multiple rankings that redistribute institutions based on the weighting of various characteristics.

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9 The persistence of institutions at the top level over time reflects their ability to generate more money to spend on institutional priorities than their competitors. This characteristic of the marketplace is illustrated in Lombardi and Craig, "Staying at the Top: An Essay on the Comparative Advantage of America's Top Research Universities" in *TARU*, 2019 [https://mup.umass.edu/sites/default/files/mup_2018_comparative_advantage.pdf]

10 We have approached this topic in various ways in our annual reports. See for example the section on "The Purpose of The Top Universities" in our first report, *TARU*, 2000 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2000-The-Myth-of-Number-One-Indicators-of-Research-University-Performance.pdf]. In addition, we have constantly engaged the issue of change over time, obviously a key element in the competition for research support. See for examples the sections titled "Change in Competitive Performance on Federal Research," in *TARU*, 2001 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-2001-Top-American-Research-Universities-Annual-Report.pdf]; "Change Over Time," in *TARU*, 2004 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-2004-Top-American-Research-Universities-Annual-Report.pdf]; and "Moving Up: The Marketplace for Federal Research in America, in *TARU*, 2011].

To take a hypothetical example from another context, if we measure an individual's height, weight, hair color, and speed in the 100-meter dash, and then combine these data into a single number with a different weighting for each element, we can get a ranking of individuals, but we can also reorder the weighting by small amounts and get a different ranking. Number one might well become number 10. This is because the combination of these elements, while of interest perhaps for some purposes, is not of interest for others, so the combination produces less value that a display of the actual data allowing observers to see what is of interest to them. If we are interested in athletic ability we may not care much about hair color, but we may care a lot about height, weight, and speed. We've written about the ranking process in previous reports for those with an abiding interest in the topic.[11]

A more useful discussion involves an examination of other aspects of research university performance reflected in different institutional elements. In addition to the core classification by federal research expenditures, we have consistently tracked eight other indicators that provide a more nuanced reflection of the characteristics of these top research performers.

Endowment Assets and Annual Giving: These two measures deal with a glimpse into the financial resources of research universities by tracking endowment assets and annual giving. The data for these indicators are reasonably robust, and while they are by no means complete indicators of the total wealth of institutions, the top research performers all have very substantial endowments and annual giving totals. If we look at the change in these two indicators over time, we can see the increased attention public universities now pay to the various elements of fundraising, resulting in substantial growth in public university endowments and annual giving.

As shown in Figure 4, the market share of endowment assets for the over $40M group over the past two decades ranges from a low in 1999 of 62.2% to a high in 2009 of 72.2%. Public institutions have steadily increased their market share since 2010, while their private counterparts have steadily declined over this same time period. As a result, in 2019, the market share gap between private (46.1%) and public (24.7%) is the smallest we've seen since we began tracking these data. Even so, their private counterparts, having depended for so long on private giving and endowments as they have had little access to state higher education funding, almost always have larger amounts in these categories. Note that their market share is roughly twice the share of publics but the number of public institutions is more than double the number of private institutions. As public universities discovered the limits on tuition/fee revenue and struggled with the variability of public state subsidies, their commitment to seeking private donations and developing large endowments became ever more significant.[12]

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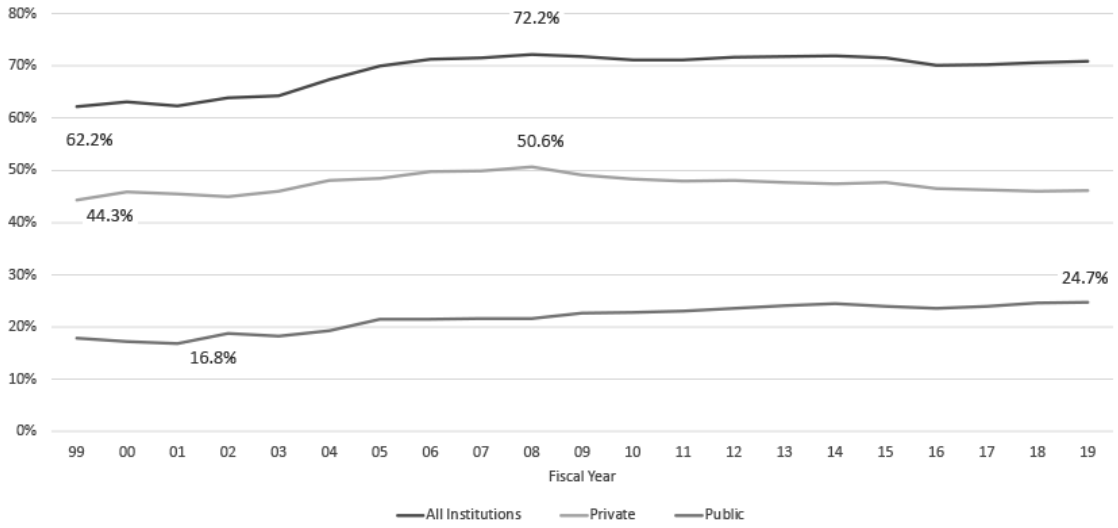
11 See the initial presentation of this issue in "The Myth of Number One," in *TARU*, 2000 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2000-The-Myth-of-Number-One-Indicators-of-Research-University-Performance.pdf]; followed by "Rankings, Competition, and the Evolving American University," in *TARU*, 2007 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2007-Rankings-Competition-and-the-Evolving-American-University.pdf]; "Competition and Restructuring the American Research University," in TARU, 2008 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-2008-Top-American-Research-Universities-Annual-Report.pdf]; "In Pursuit of Number ONE," in *TARU*, 2010 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2010-In-Pursuit-of-Number-One.pdf]. As the result of an international collaborative effort, we looked closely at alternative methods of benchmarking university performance, focused particularly on publication rates in "Measuring Research Performance: National and International Perspectives," in *TARU*, 2012 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2012-Measuring-Research-Performance-National-and-International-Perspectives.pdf]. Unfortunately, this international project was not sustained. Given the high interest in rankings, we attempted to illustrate the arbitrary result of rankings that consolidate different measures into a single ranking number in "The Best American Research Universities Rankings: Four Perspectives," in *TARU*, 2013 [https://mup.umass.edu/sites/default/files/mup-pdf/MUP-Publication-2013-Best-American-Research-Universities-Four-Perspectives.pdf].

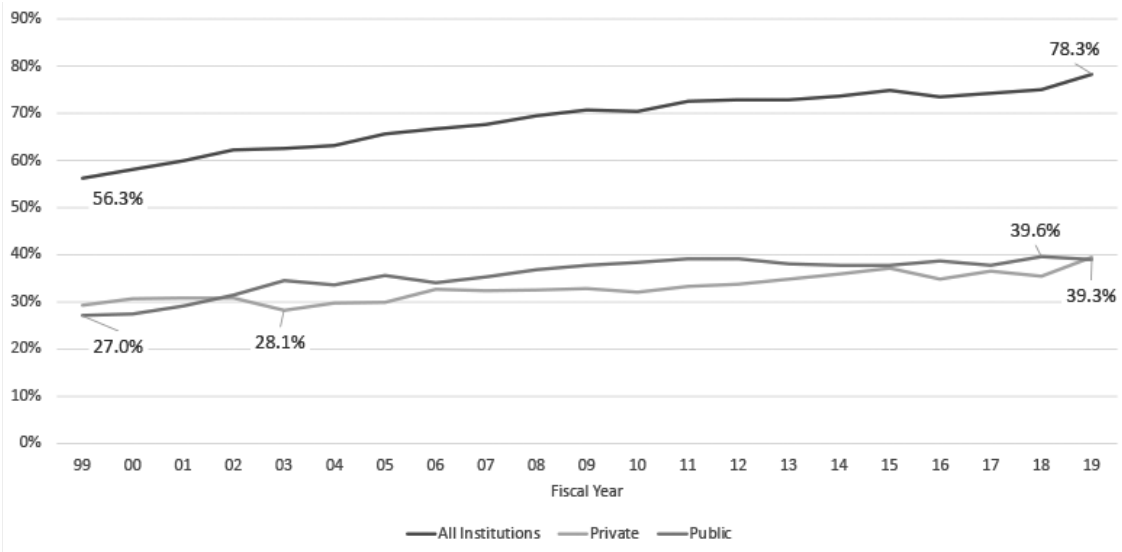
12 The endowment market is the total endowment reported for all academic institutions reporting to the NACUBO Endowment Study [https://www.nacubo.org/Research/2020/NACUBO-TIAA-Study-of-Endowments] and the CASE Voluntary Support of Education (VSE) survey [https://www.case.org/resources/voluntary-support-education-survey], with some adjustments made to break out systems into separate campuses using IPEDS data or other institutional sources such as annual financial reports. IPEDS data may also be used as a substitute (or to estimate a substitute) for any institution in the over $40 million group in a given year that did not report to the NACUBO or VSE surveys. Unlike the NSF research expenditures data, the true market value of all endowment assets (and annual giving as well) of all U.S. academic institutions is unknown because not all institutions report these data nor do all institutions report data every year. Institutions that do not report data, typically 4-5 each year, are excluded from the median trend analyses for all private giving (Figures 6-7).

Figure 4. Endowment Market Share among Over $40M Group: 1999-2019



As a group, the over $40M institutions have been very successful in attracting private funding since 1999 (Figure 5), steadily increasing their market share from 56.3% to a record high 78.3% in 2019. Compared to endowment assets, the market share of annual giving to private and public institutions is more equally distributed between the two, although again, we see greater improvement among public institutions.[13]

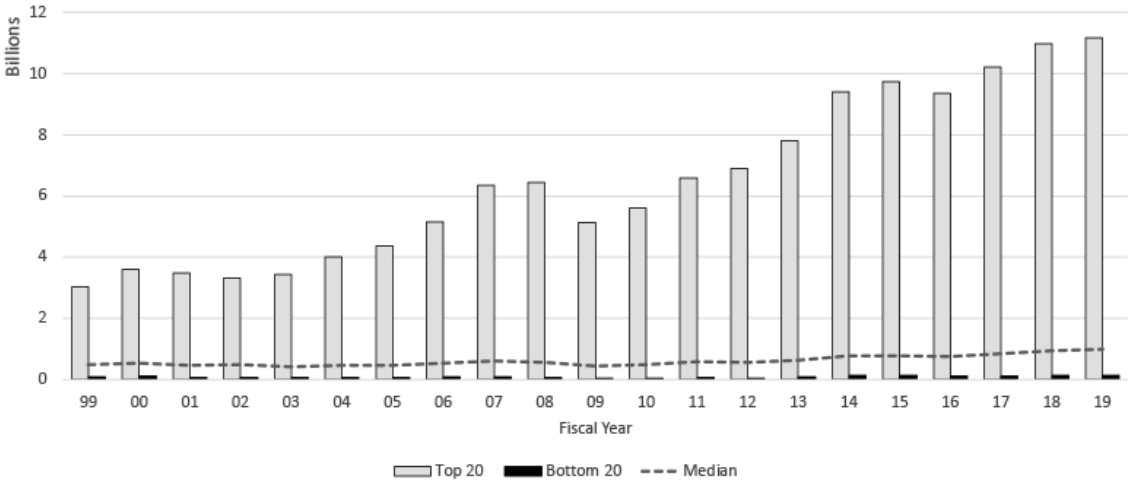
Figure 5. Annual Giving Market Share among Over $40M Group: 1999-2019



13 The annual giving market represents the total annual giving report for all academic institutions reporting to the CASE Voluntary Support of Education survey mentioned above, with some adjustments made to break out systems into separate campuses using IPEDS data or other institutional sources such as annual financial reports. The National Center for Education Statistics (NCES) IPEDS Finance data may also be used as a substitute (or to estimate a substitute) for any institution in the over $40 million group each year that did not report to the VSE survey [https://nces.ed.gov/ipeds/use-the-data/survey-components/2/finance].

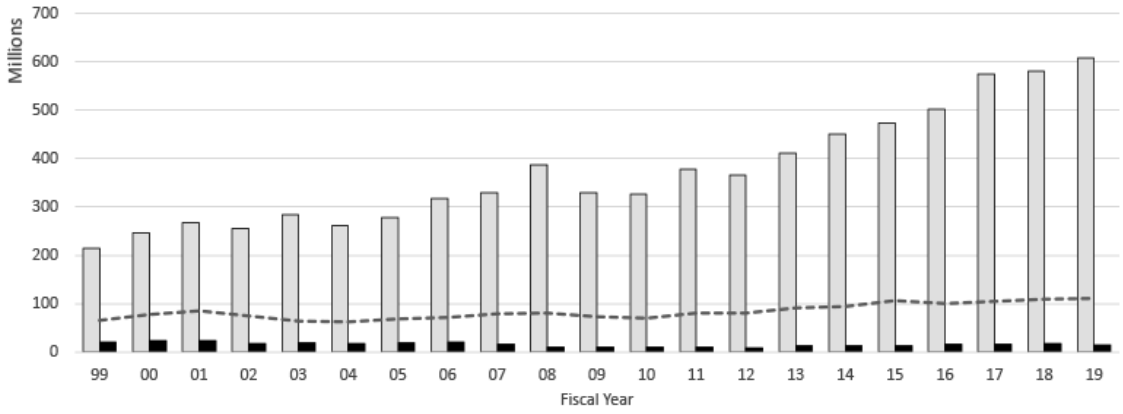
The disparity between the top 20 and the bottom 20 is particularly acute for our two private giving measures, with the gap widening greatly in the most recent six years. For endowment assets, the median for the top 20 institutions on this measure in 2019 was about $11B compared to $139M for the bottom 20, or 80 times as large (Figure 6). In 1999, the top group (median of $3B) was about 29 times as large as the bottom group ($103M). The median endowment for all institutions in the over $40M group has doubled between 1999 ($496M) and 2019 ($997M), and its placement not too far from the bottom group further demonstrates the dominance of the very top group.

Figure 6. Median Endowment Assets among Over $40M Group: 1999-2019



Annual giving shows similar although less dramatic differences (Figure 7). In 2019, the top 20 institutions on annual giving had a median value ($609M) 41 times as big as the median for the bottom 20 institutions ($15M), compared to just 11 times as big in 1999. Similar to endowment, the median annual giving has nearly doubled between 1999 and 2019.

Figure 7. Median Annual Giving among Over $40M Group: 1999-2019



Faculty Quality: As we have emphasized in these reports, high quality faculty are key to continued and sustained research success. Although any assessment of general faculty quality is sure to be incomplete and inadequate in many ways, we have followed some indicators that offer a perspective on the research university's search for the most accomplished people who can drive the institution's research competition. Memberships in the national academies of science, medicine, and engineering offer one view of success in recruiting faculty with highly visible national research reputations. Similarly, many national faculty awards recognize preeminent faculty research accomplishments. Less robust than the federal research expenditures as indicators, these reference points nonetheless offer a related perspective on the concentration of nationally recognized research faculty. As we might expect, many universities of modest research achievement,

nonetheless successfully recruit and retain some faculty who have been recognized for their scholarly achievements. These awards and recognitions have a broad reach, identifying excellence and achievement not only in science, medicine, and engineering but in many other fields.[14]

As shown in Figure 8, the top research group dominates the market for National Academy members. Nearly 97% of members are affiliated with an institution that met the $40M federal research cutoff. However, this masks the fact that far fewer institutions play in this market. The median number of members for the top 20 on National Academy membership ranges from 70 in 1999 to 120 in 2019, whereas the bottom 20 median is most often zero (Figure 9). Moreover, the median for all of the over $40M group has dropped over the past two decades, from a high of 14 in 2000 to nine in the past five years, while the top group has steadily increased.

Figure 8. National Academy Members Market Share among $40M Group: 1999-2019

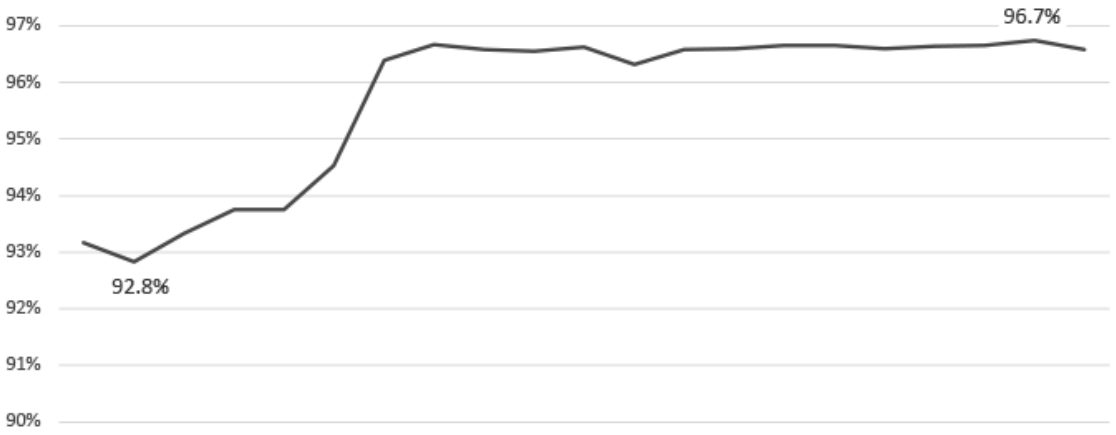
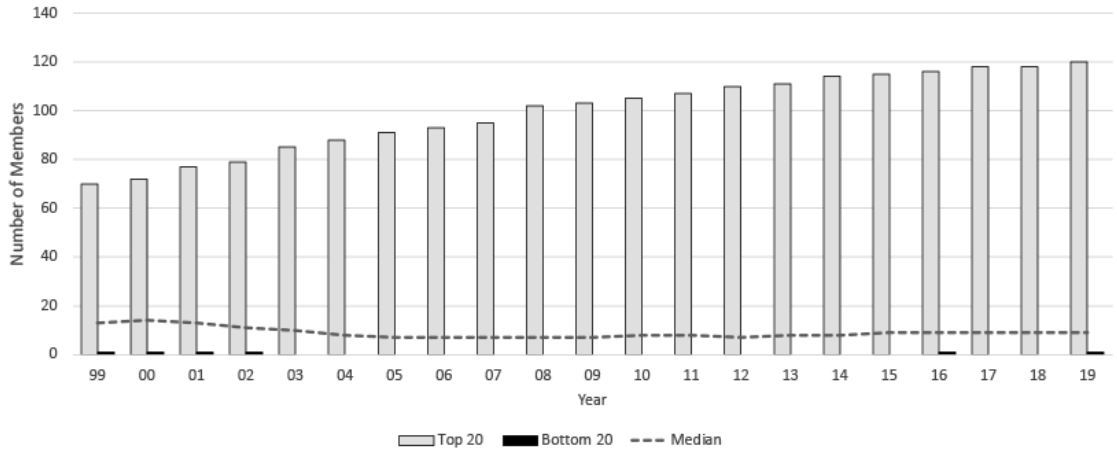


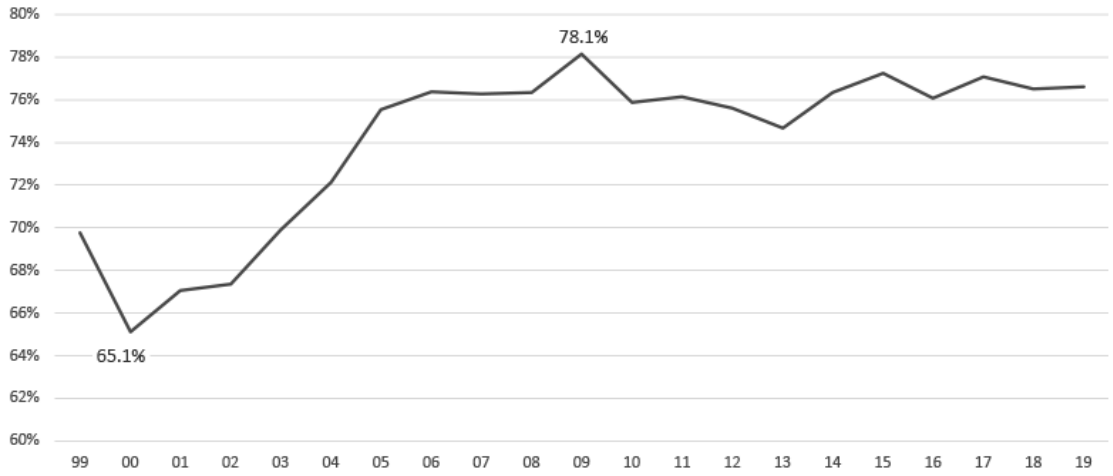
Figure 9. Median National Academy Membership among Over $40M Group: 1999-2019

Faculty awards are less concentrated among the over $40M group than are national academy members. The market share ranges from a low of 65% in 2000 to a high of 78% in 2009, and averaging about 76% in more recent years (Figure 10).



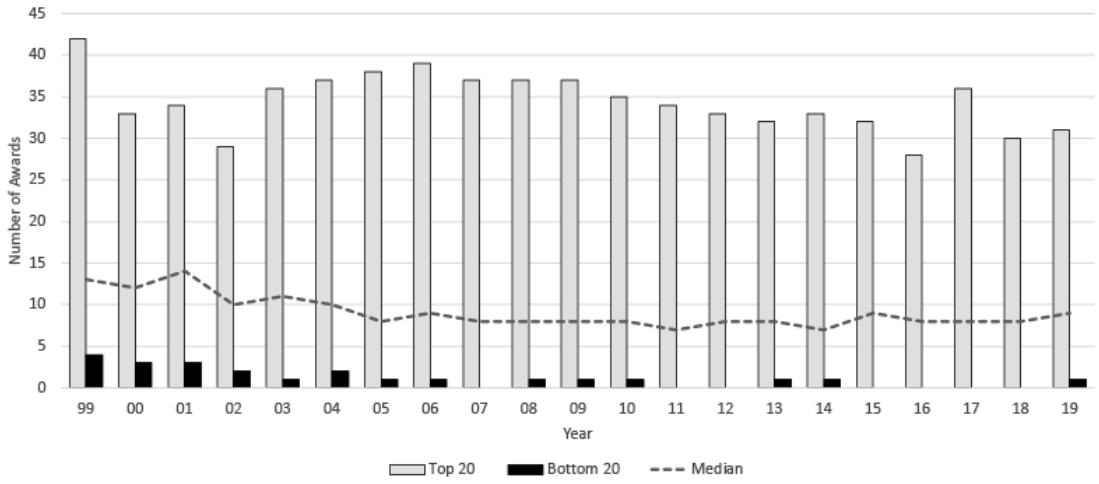
14 The market for National Academy members come from MUP center staff mining the directories of the National Academy of Sciences, National Academy of Engineering, and National Academy of Medicine (formerly Institute of Medicine) each year. Links to the individual academies are at *National Academies* [https://www.nationalacademies.org/]. We credit institutions with any new members who were inducted that year, who moved to their institution from another institution (and at the institution at least six months, or prior to July 1), or who moved to their institution from industry or some other non-academic organization. We deduct from the institution's membership any members who moved to a new institution (prior to July 1), who moved to a company or organization (prior to July 1), who went inactive in the directory (i.e., changed their institution to blank), or who died in the previous year. Adjunct and visiting professors are excluded from our membership totals. In a very few cases, an academy member may be tenured and active (i.e., not on leave or sabbatical) at two institutions and each institution is credited with that member.

Figure 10. Faculty Awards Market Share among Over $40M Group: 1999-2019



Faculty awards data collection from nearly two dozen sources has changed some over the years. Two awards are no longer given out to faculty in academic institutions, and three other awards are less frequently provided and so are not included every year. As a result, some of the change in medians shown in Figure 11 reflect these inconsistencies. Over the past two decades, like the other measures discussed so far, the top 20 institutions on faculty awards perform far better than the bottom 20, especially more recently. While the top group's median generally runs between 30-35 each year over the past decade, and the entire over $40M group ranges consistently around 7-9 faculty awards, the bottom group has a median of 1 or less.[15]

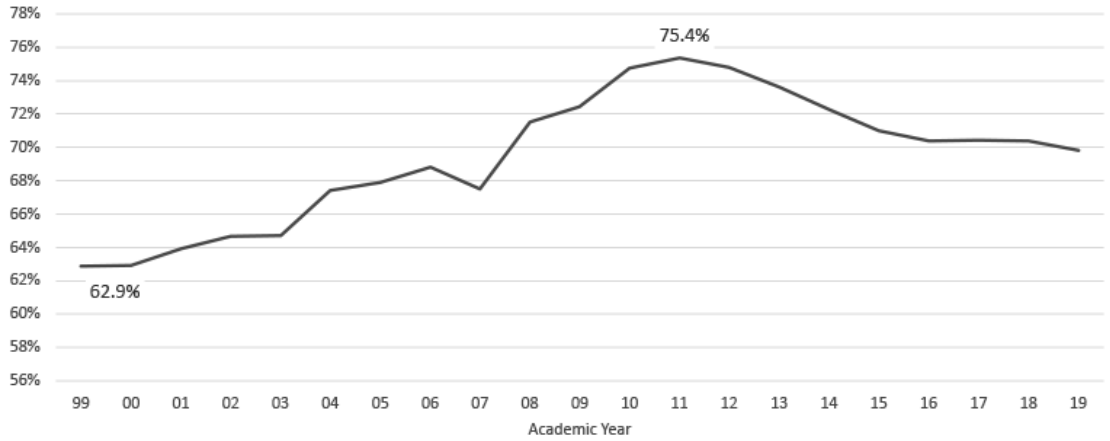
Figure 11. Median Faculty Awards among Over $40M Group: 1999-2019



15 The market for faculty awards is based on tallying the number of awards per academic institution for up to 24 award programs. For faculty awardees whose institution is unclear (for example, they identify with a state system), we use information from the institution or faculty member available on the internet to assign them to a particular campus. Data are available on the organization's website or via data download (for example., NIH-R37: Method To Extend Research in Time (MERIT) Awards, or NSF: Faculty Early Career Development Program (CAREER) awards). For details on which awards are counted in a given year, refer to the Data Sources section in each year's *TARU* publication.

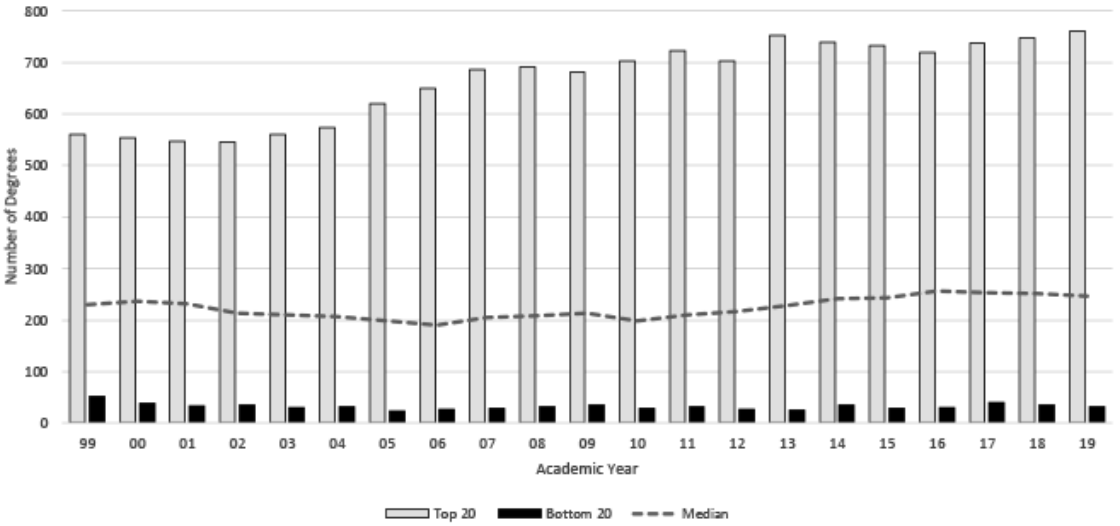
Doctorates: Again, related to the mission of research universities, we can track the number of doctorates awarded. This indicator is less precisely related to the main research competition because the doctorate data include a wide range of disciplines outside of science and engineering, particularly in education. The top research universities have a significant commitment to the production of doctorates, although many much less research-intensive universities also produce significant numbers of doctoral degrees. Over time, the percentage of all doctoral degrees awarded by our research institutions at the $40M and above level of federal research expenditures has declined as many other, less research-intensive institutions, have expanded their doctoral productivity. Also, the production of doctorates is influenced by the total size of an institution's graduate population. Among the members of our top research group, their market share of all doctorates awarded peaked in 2011 at 75% after climbing steadily since 1999 (63%) (Figure 12). This number has dropped about 5% since 2011 and stabilized in recent years at 70% market share.[16]

Figure 12. Doctorates Market Share among Over $40M Group: 1999-2019



The median number of doctorates awarded for the over $40M group has stayed fairly stable over the past two decades, ranging between 200 and 250 most years (Figure 13). The gap between the top 20 group on this measure and the bottom has widened greatly over time. In 2019, the top 20 group had 24 times as many doctorates as the bottom 20 group, up from 11 times as many in 1999.

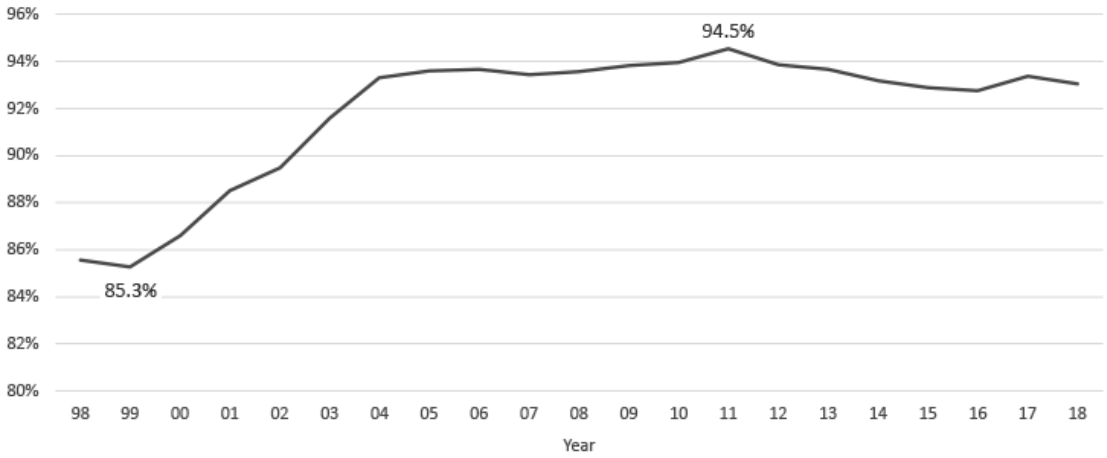
Figure 13. Median Doctorates among Over $40M Group: 1999-2019



16 The doctorate market is derived from data from all institutions reporting to the *NCES IPEDS Completions Survey* [https://nces.ed.gov/ipeds/use-the-data/survey-components/7/completions]. A few institutions in our over $40 million group do not offer degrees and are not included in the analysis of medians over time (Figure 13).

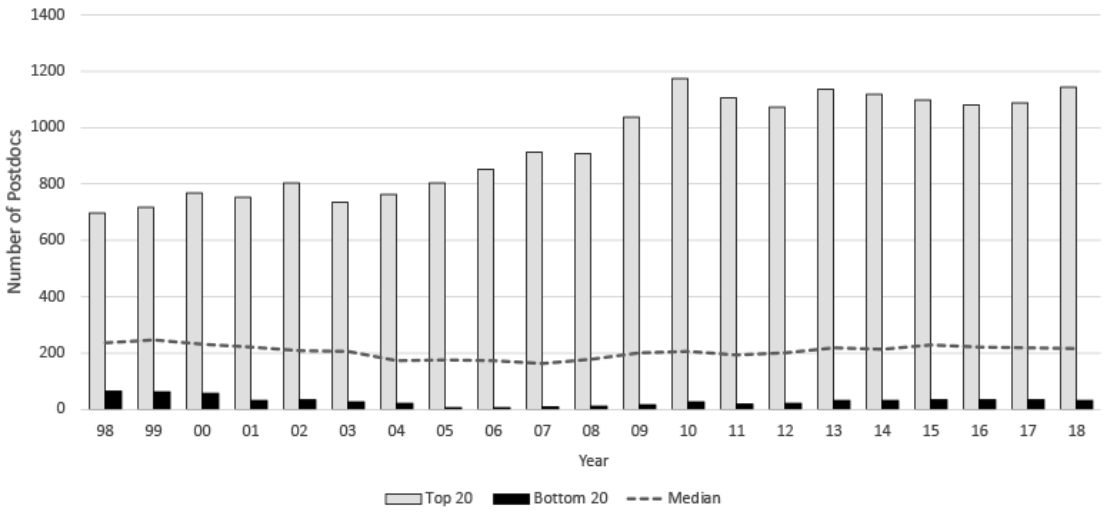
Postdoctoral Appointees: Postdoctoral appointees are a critical element in many research programs and grants, and the number of these highly trained individuals supported by grants or from institutional funds offer an additional perspective on the size of the personnel investment that sustains research performance. The over $40M group holds a significant share of the total postdoc market, ranging between 92 and 94% since 2004 (Figure 14).[17]

Figure 14. Postdoc Market Share among Over $40M Group: 1998-2018



As with many of our measures, this one is highly concentrated among a few institutions. Of the total postdocs recorded in the most recent national data, the top 50 research institutions have an almost 70% share of these appointees. Postdocs show patterns similar to what we saw with doctoral degrees – fairly stable median among the full group of top research universities and wide disparity between the top and bottom institutions (Figure 15). In 2018, the top 20 group had 35 times as many postdocs as the bottom 20 group, up from 11 times as many in 1999.

Figure 15. Median Postdocs among Over $40M Group: 1998-2018



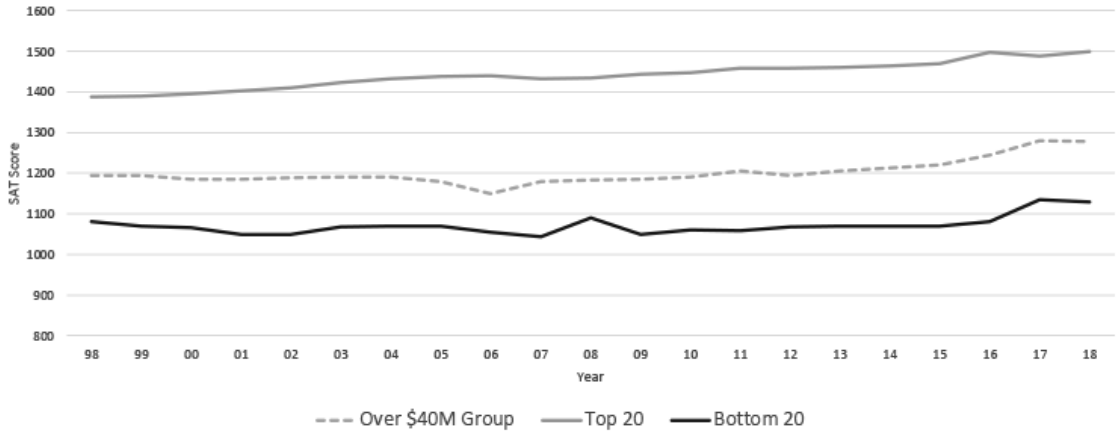
17 The postdocs market is based on data from all institutions reporting postdoctoral appointees to the *NSF Survey of Graduate Students and Postdoctorates in Science and Engineering* [https://www.nsf.gov/statistics/srvygradpostdoc/]. Not every institution hires postdocs; those institutions are excluded in the analysis of medians over time (Figure 15).

Undergraduate Quality: Clearly indicating the complexity of higher education competition, selectivity in admission to the first year of undergraduate study has long been a much discussed and criticized indicator of quality. Top research universities have always been able to maintain very selective undergraduate admissions as signaled by the SAT scores of the entering class each year. But this selectivity is mostly a reflection of brand value, enhanced by a major research reputation to be sure, but also subject to many other influences that drive brand value for all higher education institutions.

For undergraduates, the research profile of a higher education institution may well be an attractive element in their brand perception but so too are football and other high profile athletic successes, elaborate undergraduate facilities and programs, and other features of student life mostly unrelated to research. High SAT scores and the selectivity they indicate have been as much a characteristic of small, elite undergraduate colleges as they have of high-powered research universities.

This indicator, which demonstrates primarily the attractiveness of research universities to highly sought after first year applicants, is likely to become obsolete as many institutions eliminate this data point from their evaluations of student applicants (Figure 16). Because of this, tracking the median SAT score over time becomes more difficult and less useful. The top group of 20 institutions on SAT scores has ranged from about 1400 to 1500, the over $40M group taken together between 1200 and 1300, and the bottom 20 group around 1100.[18]

Figure 16. Median SAT Scores among Over $40M Group: 1998-2018



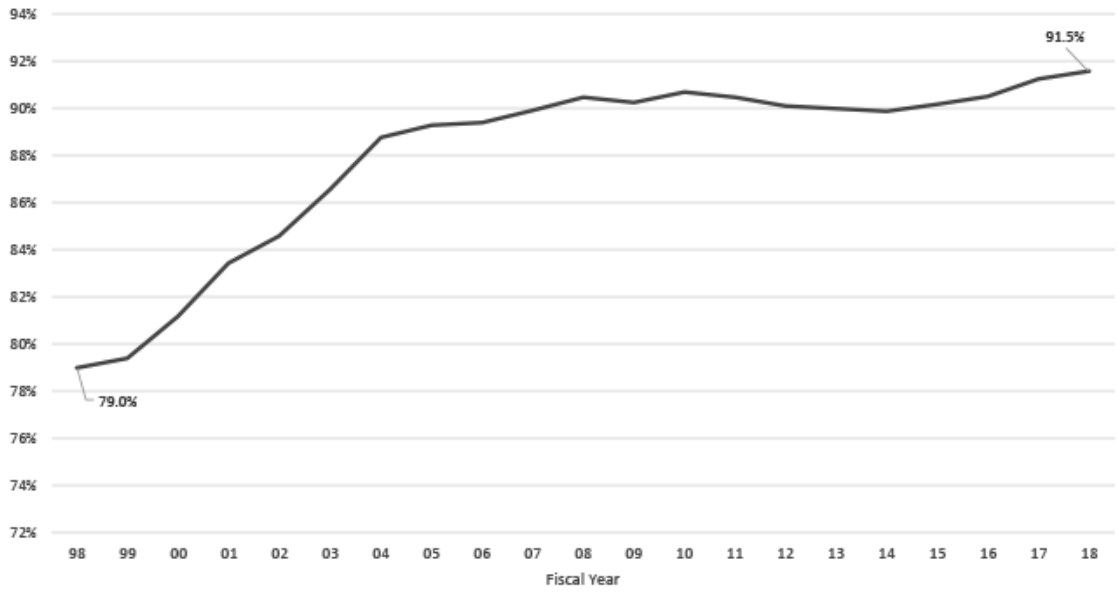
Total Research Expenditures: Finally, we return to an additional important indicator of research preeminence, Total Research Expenditures. This indicator attempts to capture all the research an institution supports each year, whatever the source of funding. This includes not only the peer reviewed federal research expenditures for science, medicine, and engineering, our core measurement, but also research expenditures supported by state agencies that only fund local projects, grants from foundation sources that may not use peer review, or awards from corporate research opportunities that are specifically targeted at particular institutions. Research funding also comes from federal programs pursuing specific research

18 SAT and ACT data in recent years comes from NCES IPEDS Admissions data, and from the Annual Survey of the College Board in the early years of our project. Both sources report the 25th and 75th percentile for verbal and quantitative scores and we calculate the median of that range. For those institutions that report both the ACT and SAT, we select the test scores which have the greatest percentage of students reporting. ACT scores are converted to an equivalent SAT score using concordance tables published by The College Board. In addition to the SAT/ACT indicator, we have looked at the impact of enrollment on various institutional characteristics. See for example the text accompanying "Table 7. Student Enrollment," in the essay "America's Research Universities: Is the Enterprise Model Sustainable?" in *TARU*, 2017 [https://mup.umass.edu/sites/default/files/annual_report_2017.pdf]. See also the discussion of enrollment in "Staying at the Top: An Essay on the Comparative Advantage of America's Top Research Universities," in *TARU*, 2018 [https://mup.umass.edu/sites/default/files/mup_2018_comparative_advantage.pdf]. Also of interest here as elsewhere is the study published in *TARU*, 2019, Lombardi, Craig, Michael M.E. Johns, and William B. Rouse,"The Unrecognized Complexity of Higher Education," [https://mup.umass.edu/sites/default/files/mup-2019-unrecognized-complexity.pdf].

initiatives of interest to congress, federal agencies, or the national defense and intelligence agencies. The value of this indicator is less as a guide to institutional competitiveness and more as a token of the level of research activity within a university. Over time, this number, which includes the federal expenditures from the core measure, has grown substantially, reflecting the importance of state and local, private and corporate interest in university research programs.

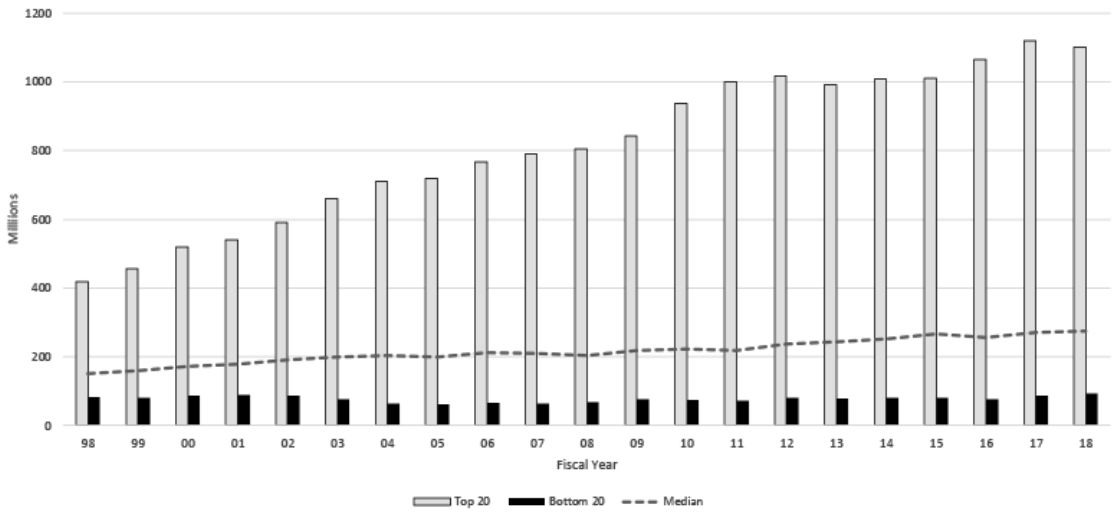
The total research expenditures of our top research group shows growth patterns similar to federal research, rapid growth in market share up until 2004 then a more steady increase and stabilization in past decade (Figure 17). Total research market share has seen an uptick in the past couple of years, reaching a record high of 91.5% in 2018.

Figure 17. Total Research Market Share among Over $40M Group: 1998-2018



Like our other measures, the growth in total research expenditures is much greater among the top 20 institutions than the bottom 20 (Figure 18). Total research among the top 20 has grown from $420M in 1998 to $1.1B in 2018, a 162% increase. In contrast, the bottom 20 has grown only 12% over the past 20 years, from $82M in 1998 to $93M in 2018.

Figure 18. Median Total Research among Over $40M Group: 1998-2018



Complexity of Higher Education Enterprise: At the beginning of this journey through research university performance indicators we took as our focus the challenge of each individual campus commitment to improvement. As our work continued, we became interested in the structure of the American university enterprise, with a particular interest in its competitive context. This led us to recognize the remarkable complexity of the higher education industry in America. This complexity is somewhat disguised by the undergraduate programs of colleges and universities that as a consequence of accreditation appear remarkably standardized. The rules and customs that define an undergraduate degree are well known, and the similarity of undergraduate programs challenges institutions to differentiate themselves from competitors as they seek funds and students.[19]

The basic content of an undergraduate degree is remarkably consistent across quite different institutions from small liberal arts colleges to major high performing research universities. Because this content is quite similar from institution to institution, and because differences that might be significant are hard to explain or illustrate to the undergraduate student marketplace, colleges and universities have developed extensive and deep context programs that surround the more or less standardized content. This context ranges from extensive and sophisticated student services that look after student health, safety, psychological stability, identity issues and support, and a host of other concerns related to the challenges of the mostly young people living and studying within these institutions.

Activities that entertain students and support their emotional, intellectual, and personal growth have expanded greatly requiring better facilities and extensive staff devoted to the non-academic interests of students. The quality of these facilities and the depth of staff commitment is a key element in the competition for enrollment and the expense to support these facilities, personnel, and programs have grown dramatically as context has become critical in the competition for student enrollment.

Even though institutions offer eloquent explanations of the importance of this context in driving student academic success, the greatly increased expenditures give a clear indication that context and content may well become increasingly defined as separate products in the university competition for student enrollment. Some indicators of this appear in the impact of successful big time athletic programs on enrollment growth. This activity bears almost no relationship to the content of the academic programs of a university, and yet the data appear to indicate a significant improvement in student recruitment success as a result of high visibility athletic programs and their role within the context of student and institutional life.

Looking toward the Future: As we close out the life cycle of this project, we are tempted to project the future of the American university marketplace. Although it is always dangerous to think we can know the future, some elements of past behavior can serve to help us anticipate what may come next.

The most useful projection into the future is to recognize that the intense competition for money will almost certainly define the adjustments and readjustments in the higher education marketplace. We can anticipate that small colleges of under 2,000 students without large endowments are likely to struggle and a number of these will disappear over the next decade. Over the last few years, we have seen at least 15 non-profit private institutions disappear from the national data, and we can anticipate perhaps a continued decline in this group as inadequately funded institutions are closed or absorbed by other colleges. Few public institutions will disappear, although some may be consolidated within larger statewide university systems as local political considerations tend to slow the elimination of small uneconomic state campuses. The rise and fall of for-profit and other innovative instructional enterprises that we have witnessed in recent years will likely result in new arrangements that seek to capture the surplus revenue possible from for-profit instructional programs subsidized by federal student aid and relatively permissive loan structures. Some for-profits will convert themselves to non-profits but retain financial linkages that transfer revenue from the non-profit's

19 We have worked on this issue with other colleagues. See the item above "The Unrecognized Complexity of Higher Education," by Lombardi, et al.

accredited instructional services to a for-profit through a wide range of service contracts. National political initiatives to subsidize the cost of student attendance and significantly increase the college-going population, may perhaps reduce the impact of demographic readjustments in the 18-24 college-eligible group.[20]

Among the many changes we can anticipate, current estimates and past behavior indicate that the national commitment to funding academic research will remain strong and continue to expand. Throughout the period of this project, through economic crises and prosperity, the total federal research commitment has continued to grow. The focus of federal investment can change over time as federal priorities change, but America's research institutions have been remarkably successful at following these policy changes with research proposals that continue to win funding in the peer review process. We do not anticipate any significant reduction, for example, in the current emphasis on medically related federal research funding, a category that has continued to expand over the years. The advantage of having a research-intensive medical school as part of a research university will continue to be significant, although our data show that it is the research intensity of a medical school that helps university competition, not just the presence of a medical school.[21]

The current structure of the higher education marketplace is likely to remain relatively stable, with institutions falling into four major categories: high intensity research universities, comprehensive universities with some research presence, predominantly instructional institutions with significant masters and professional programs, and small public and private institutions that focus almost exclusively on undergraduate education. This last category is easily subdivided into those institutions with good enrollments, perhaps over 2 to 3,000 and substantial endowments and those with smaller enrollments, low endowments, and no state funding. This last subcategory will be at constant risk of institutional closures or consolidations.

Within this higher education marketplace, however, the role of the community college is likely to remain significant and grow, not only in its traditional role as providing students from transfer programs to four-year institutions but a continued increase in the occupational programs that have been a major category of educational opportunity for students in the past. Free access to these institutions, an original characteristic of the institutional type, may become again a national or state priority and increase community colleges' strong participation in the development of a credentialed workforce with specialized critical skills. Additionally, the already robust online educational marketplace will likely expand, capturing adult students and emphasizing employment related credentials. Both traditional and online only institutions will compete aggressively in this space seeing these programs as sources of surplus revenue producers.

For our own group, the universities with over $40M, we can be almost certain that the competitive environment that we have followed over these years will continue with the top performers remaining at the top and a few challengers entering the top ranks. In every case, success will come from effective investment in all the assets required to acquire highly qualified and competitive research faculty, staff, and students.

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20 NCES Digest of Education Statistics has a table that tracks college closures, table 317.50 in the most recent digest available [https://nces.ed.gov/programs/digest/current_tables.asp]. For a perspective on the closure or consolidation of academic institutions a useful review of those since 2016 is in "A look at trends in college consolidation since 2016, *Higher Ed Dive*, January 28, 2021 [https://www.highereddive.com/news/how-many-colleges-and-universities-have-closed-since-2016/539379/]

21 For review of the federal commitment to academic R&D see the comprehensive report in National Science Board, *Academic Research and Development. Science and Engineering Indicators 2020*. National Science Foundation (NSB-2020-2), Alexandria, VA, 2020 [https://ncses.nsf.gov/pubs/nsb20202/]. A comprehensive study of the current and future research context see Tim Lieuwen and Wen Masters (Co-Chairs), *Research Next: A Landscape Analysis for the Future of University Research* (Atlanta: Georgia Tech, 2021) [https://researchnext.gatech.edu/]