Like Nobody’s Business is a remarkable piece of work. The book describes all aspects of the enormously complicated business of higher education in terms of the flow and utilization of resources—human but predominantly financial. In doing so, the author addresses all the issues that are perennially discussed and contested in the popular media, in both governmental and nongovernmental policy forums, and in academic studies. This book simply provides a wealth of information on topics large and small, but especially on the chief foci of policy and controversy in American higher education.

— Roger Lewis Geiger, distinguished professor of education at Pennsylvania State University

How do university finances really work? From flagship public research universities to small, private liberal arts colleges, there are few aspects of these institutions associated with more confusion, myths or lack of understanding than how they fund themselves and function in the business of higher education. Using simple, approachable explanations supported by clear illustrations, this book takes the reader on an engaging and enlightening tour of how the money flows. How does the university really pay for itself? Why do tuition and fees rise so fast? Why do universities lose money on research? Do most donations go to athletics?

Grounded in hard data, original analyses, and the practical experience of a seasoned administrator, this book provides refreshingly clear answers and comprehensive insights for anyone on or off campus who is interested in the business of the university: how it earns its money, how it spends it, and how it all works.

As with all Open Book publications, this entire book is available to read for free on the publisher’s website. Printed and digital editions, together with supplementary digital material, can also be found at www.openbookpublishers.com

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Cover design: Anna Gatti

Like Nobody’s Business
An Insider’s Guide to How US University Finances Really Work
8. Research

8.1 What’s in the research budget, and how big is it?

Discovery, inquiry, the search for meaning, creative activity: all of these and more comprise the academic quest for original new knowledge that we include under the banner of research. Furthermore, like love, knowledge isn’t really knowledge until it is shared, and therefore research also includes communication of its outcomes through publication, presentation and performance. Research can be undertaken for the sake of knowledge and curiosity alone, as well as for broader application and problem-solving: it can be carried out by lone scholars and by large groups of researchers; and, most relevant to our purposes here, depending on the topic, it can be done at very little cost beyond time and expertise or it can require significant and sustained investment.

Many kinds of science and engineering research simply cannot be accomplished without research funding to cover the costs of equipment, supplies, specialized labor, and unique facilities. Faculty members and other researchers in these areas expend a lot of time and effort in the pursuit and acquisition of research funds to enable their research, much of it through intense national competition. Naturally, those who garner such support are judged as successful by their peers. Because money (and publications) can be counted easily, it was probably inevitable that these two metrics came to be used as convenient proxies for research productivity in promotion and tenure as well as in university rankings. Of course, research funds are not an end in

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1 Vannevar Bush, who in 1945 delivered *Science, the Endless Frontier* (Bush 1945), the enormously influential report that ultimately led to the creation of the National Science Foundation and the unprecedented rise in research funding for US universities, made the unidimensional distinction between basic and applied research. Donald Stokes, in his book, *Pasteur’s Quadrant* (1997), transformed this view into two dimensions to explain use-inspired research. He contrasted the work of Niels Bohr (purely basic) and Thomas Edison (purely applied) with that of Louis Pasteur and the discovery of penicillin, an example of use-inspired research that simultaneously contributed to basic biological knowledge and solved a practical problem.

2 Two points on competitive research grants: (1) open competition adjudicated by rigorous peer review in the US research funding system is a driver of high overall quality, and (2) those faculty members and others who are outside the grant-active disciplines often don’t appreciate just how intense and time-consuming the competition can be, with funding rates under 20% in many fields.

3 I’ve often referred to this pair as “fame and fortune” when discussing research productivity with faculty colleagues. While they can be empty personal attributes, as Elvis Presley told us in his 1960 song of the same name, in this case they are a droll reminder of the necessity for research support and for communicating research findings.
themselves. Still, at a successful research university they are vital, and they represent a sizable portion of the overall institutional budget.

We celebrate grants when they are awarded, and we’ll typically quote the entire award amount, “Professor Famous just received a $1M grant from the NIH to study a promising cancer treatment.” What this doesn’t say is that it might be a five-year grant at, say, $200,000 per year, and it might be split among several universities collaborating on the work. Also, research grants are not the only kind of grants and contracts coming in to the university—they fund instruction and public service too. These complications make it difficult to track research revenues alone, but more importantly they are quite uneven from year to year: large grants can arrive all in one award year or be unevenly spread over the multiple grant years they are intended to cover. And, you shouldn’t be shocked to learn that sometimes the money arrives late.

So, to avoid these issues, the convention is to track research expenditures instead. Research expenditures include not only expenditures on government agency-funded research grants that make up the biggest category, but they also include research funded by private sector, state and local, and institutional sources. The latter includes staff and facilities costs for research centers and institutes, the central research and/or sponsored programs office, research compliance, and so forth. Note that research expenditures do not account for faculty time allotted to research during the regular semesters (a potentially large number given that this may be as much as half of the faculty’s effort at an R1 school; see Section 6.10 on faculty effort), but faculty summer salaries paid on research grants are included in research expenditures.

To make the above distinctions plain, Figure 8.1 illustrates grant and contract revenues versus research expenditures by institution type. Several things are immediately apparent: the R1 schools are by far the dominant players in terms of sheer dollars of either kind; federal funds comprise the lion’s share; and, for the reasons cited above, research expenditure totals do not equate neatly to grant and contract revenue (although they are nonetheless closely related). At the beginning of Chapter 3 we observed that, across all university types, research expenditures comprise about 8% of the budget. At R1 institutions, those with the greatest focus on research, the budget share for research expenditures is about 20% and second only to instruction.

Which universities are the biggest players nationally? The go-to data source for research expenditures is the National Science Foundation (NSF) Higher Education Research and Development (HERD) survey, and the top 25 institutions are shown in Figure 8.2. These are, by definition, among the most prominent research institutions in the country (and the world). For most of them the dominant share of research expenditures is associated with health sciences and funding from the National Institutes of Health (NIH); see more on NSF and NIH funding later in this chapter.

Note, for example, that the University of Texas MD Anderson Cancer Center is, on

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4 Professor Famous might be the lead principal investigator (PI), but she could be a co-principal investigator, a co-investigator, a subcontractor, etc., and her role may or may not correlate with the proposed budget share allocated to the work done by her individually or by her lab.
Figure 8.1. FY2017 revenues from all grants and contracts (research and non-research) by source, and expenditures on research from all sources (external and institutional), by Carnegie classification and control. Source: IPEDS (2020).

Figure 8.2. FY2017 total research and development expenditures for the 25 highest-ranked institutions. Source: NSF HERD (National Science Foundation, National Center for Science and Engineering Statistics 2018a).
its own, ahead of the regular UT Austin campus (which is number 35). Counter to the health sciences point, Johns Hopkins University, at the top if the list, includes its Applied Physics Laboratory (APL), a huge research center with over 6,000 employees that receives funds from the Department of Defense (DoD) and NASA. Much like the point I made in Chapter 2 about university budgets sometimes including hospitals and sometimes not, the same goes here for hospitals as well as the units that carry out DoD-funded research and development—some of the latter are part of the university, like APL at Hopkins, and some are independent entities such as the MIT Lincoln Laboratory. Over half of Hopkins’ $2.6B research expenditures ($1.4B in FY2016) are associated with APL (National Science Foundation, National Center for Science and Engineering Statistics 2018a).

In addition to clarifying that the research expenditure totals are not always an apples-to-apples comparison, there are a couple of other issues related to research expenditures in general that are worth clearing up. First, while faculty members bring their unique and specialized expertise to bear on a research project, and they do the intellectual heavy lifting of applying for grants and carrying out the research, some novice faculty members are surprised to learn that the grant is not “theirs.” The funding agency awards the grant (or contract) to the institution (or its board) and the faculty member (in the role of principal investigator) carries out the work as an employee of the institution. Technically, if the faculty member cannot complete the work for some reason, the institution can substitute another suitable researcher to do so or return the remaining funding to the agency. In practice, and in most cases, should a faculty member move to another institution, most universities will work with the funding agency to enable the grant to follow the investigator. For its role, the institution handles the mostly invisible but nonetheless essential administration of the research including accounting, contracting, compliance processes, legal issues, etc. that are paid for through overhead charges (see Section 8.4).

The second issue is one of terminology and public perception. Research expenditures as a term makes sense in the context outlined in this section, vis-à-vis incoming grant awards, but it is easily confused by those outside the university. Consider, for example, that the latest research rankings are released, and our university proudly puts out a press release about how its research expenditures have risen. If not explicitly stated, there will be some commentators or politicians who are unaware that we really mean separately-funded revenues (most of which are externally-funded) when we say expenditures; so, in fact, when we say expenditures, we really mean income, the exact opposite. “There goes that university again,” they might say, “wasting our precious tuition or tax money.” Moral of the story: whenever you mention research expenditures outside of a research audience, always append a comment to the effect that they mostly reflect outside investment that the university has brought to the community. If you are talking with politicians or business people, you can further underline that most of those dollars are spent in the community on salaries, goods, services, and taxes (see also Section 14.3 on economic impact).
8.2 What are the trends in research expenditures?

University research expenditures from all sources have increased steeply for over sixty years. Even after adjusting for inflation, research expenditures at all universities have been doubling every twenty years, with about 5–6% annualized growth (Figure 8.3). Each of the major meanders in this unprecedented expansion of research investment has a story that we can unpack by funding source. Figure 8.4 shows the relative share of this research funding trend by source. Note that the National Institutes of Health (NIH) are part of the Department of Health and Human Services (HHS) and, for our purposes of university research funding, HHS and NIH are synonymous. The predominance of federal funding is clear, and we can see the increase due to the 1960s space race, several decades with episodes of slowing and growth, the effects of the NIH budget-doubling in the early 2000s (naturally, expenditures lagged the 1998–2003 appropriation increases by a couple of years), the Great Recession, and immediately thereafter a brief spike from the stimulus.\(^5\) The federal share trends slowly downward for much of the record, not because federal spending has shrunk, but because institutional investments by universities have grown steadily as well, thereby increasing in share over time (it’s not shown in the figure, but if we exclude institutional investments, all external funding sources have maintained relatively steady shares.

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\(^5\) The American Recovery and Reinvestment Act of 2009 (ARRA) was an economic stimulus package enacted in response to the Great Recession. It included federal research funding increases of almost 25% focused in FY2009 and FY2010.
over time, with the federal share between 70% and 80%). The institutional investments comprise the university’s infrastructure to help carry out research, and as mentioned in the previous section they include staff and facilities costs for research centers and institutes, the central research and/or sponsored programs office, and research compliance (the expense of which has been increasingly borne by universities; see Section 8.6 on research compliance costs). By comparison, research funding from state and local governments, from private business, and from nonprofits and other sources has increased only modestly over time, with their shares each staying under 10% of total research expenditures.

Figure 8.4. Trends in shares of higher education research and development expenditures by source, in FY 2016 dollars by fiscal year. Source: NSF HERD (National Science Foundation, National Center for Science and Engineering Statistics 2018a).

Figure 8.5 delves deeper into the federal portion of the research funding trend, illustrating financial support to universities by agency. Note that these are funding allocations and not expenditures, and thus the inflections in the trend lead those in the preceding figures by a couple of years. Again, the space race, NIH doubling, and the stimulus are quite clear. After its initial growth in the 1960s, federal research funding was flat through the 1970s in real terms, and then doubled in the two decades from the early 1980s to the early 2000s. Except for the stimulus, the inflation-adjusted trend in federal research funding to universities has been downward to flat in the last fifteen years. Despite this recent trend, the competition among universities for those resources continues unabated, as seen in the growth of institutional expenditures noted above and in diminished funding success rates for those faculty members and other researchers writing the proposals (see Box 8.1 on Research Grant Funding Success Rates).
Figure 8.5. Trends in federal science and engineering research and development funding to universities by agency, in FY2016 dollars by fiscal year. Agency acronyms are for the Department of Health and Human Services (HHS, which includes the National Institutes of Health, NIH), the National Science Foundation (NSF), the Department of Defense (DOD), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the US Department of Agriculture (USDA). Source: NSF Federal Support (National Science Foundation, National Center for Science and Engineering Statistics 2018b).

Looking at the funding mix by agency in Figure 8.5, perhaps most the notable feature for the uninitiated is the relative size of NIH funding, about three times that of NSF and over half of all federal research funding to universities. Incidentally, this is why it is tough for a university without health sciences to rise into the top ranks of research university funding. DoD funding to universities is slightly less than that from NSF, followed by the Department of Energy, NASA, USDA, and other agencies that fund smaller amounts. The relative sizes of federal agency support amounts have waxed and waned over the decades, albeit dominated by NIH that moved from about 50% to about 60% of the total during its doubling phase. The DoD more than doubled its share of federal research funding from 7% in the 1970s to over 15% in the mid-1980s before declining again in the 1990s; NASA’s peak share was in the 1960s, as one might expect, but the USDA’s share has dropped from about 11% in the mid-1970s to just 3% of the total in FY2017.

Defense funding to universities is generally non-classified and non-military, and it covers the gamut one might expect from a large government organization, including not only technology but also health and biosciences, environment, economics, and game theory, to mention just a few examples. Many universities prohibit classified work on campus; some are affiliated with independent organizations for that purpose.
Box 8.1. Research Grant Funding Success Rates

Success rates for competitive peer-reviewed research grants average about 20% nowadays, about half what they were a generation ago when today’s senior researchers were starting out (Figure B8). At NIH the number of proposals has quadrupled over a half-century while awards doubled, and at NSF applications almost doubled over a quarter-century while award counts stayed about the same. We know that the numbers of faculty and principal investigators (PIs) have increased at a far slower rate than proposals based on data from IPEDS (2020) and NSF (National Science Foundation, National Center for Science and Engineering Statistics 2018a), and thus proposals per person have also increased. Of course, grant budgets have increased over time to cover rising labor and other costs, so we have more PIs submitting more proposals per person, all vying for limited funding (Lauer 2018). The number of grant awards per PI has not changed markedly over time, they are not going disproportionately to the successful few, and the number of applications per PI does not correlate with the percentage of funded applications (Rockey 2011; 2012). Therefore, declining funding success rates are largely a problem of our own making, a symptom of intensified competition for research funding.

Figure B8. Overall research grant funding success rates at NIH and NSF (left) and associated proposal and award counts (right). NIH data show similar patterns for research project grants and all R01-equivalent grants, therefore they are combined here. Sources: NIH (National Institutes of Health 2018) and NSF (National Science Foundation 2018).

8.3 What is the research funding mix by discipline?

Academic disciplines and fields differ enormously in their levels of extramural research funding. Not only do they differ in the level of support necessary to enable productive
research (labs, equipment, etc.) but they also differ in funding level accorded them by funding agencies (based on topic, strategic priority, history, etc.). Figure 8.6 illustrates federal research funding by field and by agency, grouped into several science subfields, engineering, and non-science and engineering fields.

We saw the dominance of NIH funding in the previous section, and it is clearly visible here in the amounts for health sciences and biosciences. Unfortunately, these NSF
Higher Education Research and Development (HERD) survey data do not distinguish between the many disciplines in these two large fields, which exaggerates their relative size. All other fields total roughly the same as the combined health sciences and biosciences funding levels. Among the other fields, the next largest are electrical engineering, computer science and physics, with most remaining fields receiving far smaller amounts of federal research funding.

Separately from whether disciplinary research funding levels are high or low, the mix of agency funding across fields varies by relevance of the topic to the agency, as expected (Figure 8.6). NIH funds are prominent in social work, psychology, bioengineering and several social sciences. The largest fields of support for the NSF are computer and information science, biosciences, physics, and electrical engineering. For the DoD, it’s not surprising that electrical and computer engineering is top, but health sciences is its second largest funding area, followed by computer and information science, mechanical and aerospace engineering, and the biosciences. The DoE’s funds go in large part to physics, as well as chemistry and several engineering fields. NASA funding is largest in astronomy, of course, but is also important in geological and atmospheric sciences, aerospace engineering, and physics. Unsurprisingly, USDA funding goes predominantly to agricultural sciences, biosciences and natural resources.

8.4 Why do universities lose money on research?

When Professor Famous brings in that $1M research grant it certainly supports more research but, counterintuitively, it costs the university money. For all the effort put into research as a major mission area of the university, and for all the grants awarded, most faculty members are shocked to hear that research actually loses money for the university. How can that be, and why do we keep doing it? The answer to the latter question is simple—the quest for knowledge is fundamental to the university mission and, especially for research universities, high levels of research are synonymous with quality, strong graduate programs, productivity and prestige. Like so many other things universities do, we cross-subsidize critical activities in research from other sources for the benefit of the whole institution.

To understand why the financial support of federal agencies, private foundations and others generally doesn’t cover the full cost of research, we need to examine what is known variously as overhead, facilities and administrative (F&A) costs, or indirect cost recovery (ICR). Let’s work through a simplified example research grant budget to help explain things (Table 8.1).

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7 The health sciences include dentistry, clinical research, gerontology, medicine, mental health, nursing, optometry, pharmacy, public health, radiology, rehabilitation, veterinary medicine, and others. The biosciences include animal biology, biochemistry, biophysics, bioinformatics, biotechnology, plant biology, cellular biology, epidemiology, genetics, immunology, molecular medicine, neuroscience, pharmacology, toxicology, physiology, and more.
### Table 8.1. Example of a simple one-year research grant budget, showing major categories including direct and indirect costs. See text for explanations.

<table>
<thead>
<tr>
<th>Line</th>
<th>Item</th>
<th>Detail</th>
<th>Amount ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Salaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Principal Investigator</td>
<td>Dr. V. Famous, 1 month, summer</td>
<td>11,000</td>
</tr>
<tr>
<td>3.</td>
<td>Graduate Research Assistant</td>
<td>0.5 FTE, 9 months Fall &amp; Spring</td>
<td>25,000</td>
</tr>
<tr>
<td>4.</td>
<td>Fringe Benefits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Faculty @ 32%</td>
<td></td>
<td>3,520</td>
</tr>
<tr>
<td>6.</td>
<td>Graduate Assistants @ 11%</td>
<td></td>
<td>2,750</td>
</tr>
<tr>
<td>7.</td>
<td>Other Direct Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Equipment (&gt;5K)</td>
<td>Real-time rapid cycling PCR system</td>
<td>34,000</td>
</tr>
<tr>
<td>9.</td>
<td>Materials &amp; Supplies</td>
<td>Lab glassware, tools, chemicals, etc.</td>
<td>8,000</td>
</tr>
<tr>
<td>10.</td>
<td>Travel</td>
<td>Conference registration, airfare, hotel, food</td>
<td>2,000</td>
</tr>
<tr>
<td>11.</td>
<td>Tuition Remission</td>
<td>2 semesters, in-state amount</td>
<td>12,000</td>
</tr>
<tr>
<td>12.</td>
<td>TOTAL DIRECT COSTS:</td>
<td></td>
<td>98,270</td>
</tr>
<tr>
<td>13.</td>
<td>Indirect Costs (F&amp;A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Modified Total Direct Costs</td>
<td>Excluding equipment &amp; tuition: $52,270</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Indirect Cost</td>
<td>Negotiated rate @ 50% of MTDC: $26,135</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>TOTAL INDIRECT COSTS:</td>
<td></td>
<td>26,135</td>
</tr>
<tr>
<td>17.</td>
<td>TOTAL COST:</td>
<td>Direct plus Indirect costs</td>
<td>124,405</td>
</tr>
</tbody>
</table>

Starting with the salary section (line 1), we have just the PI and a grad student (lines 2 and 3) on this proposal. In the fringe benefits section (line 4) we calculate those amounts at the applicable rates (lines 5 and 6). The section for other direct costs (line 7) includes equipment, supplies, travel, and tuition for the grad student (lines 8 through 11). Together, the total direct costs for this grant proposal are $98,270 (line 12).

Now, here’s where it gets interesting: so far, this is a bare bones budget for just the actual research activity and it does not include necessary supporting activities such as accounting, janitorial services, lab safety, regulatory reporting, space, utilities, hazardous waste disposal, internet services, and more. All of those are facilities and administrative (F&A) costs that also should be covered by the research sponsor. Rather than itemizing them for each grant, F&A costs are calculated using an overall rate that is negotiated with the Federal Government (and which universities often use for external grants with other sponsors too). In our example budget, we use a 50% F&A rate that is applied to something called MTDC or modified total direct costs (lines 14 and 15). MTDC includes all the allowable direct costs (according to federal regulations) that can be included in the base amount to which the rate is applied;
items such as major equipment and tuition remission are excluded from that base. The total indirect costs (line 16) are added to the total direct costs (line 12) to obtain the overall proposed total grant cost of $124,405 (line 17). Note that our institutional F&A rate of 50% is not the same as the effective rate, which is a little over 26% in this example because of the M in MTDC—the modified costs can be quite a bit less than the total direct costs.

The F&A rate varies from institution to institution (typically 40–60%) and from year to year (typically fractions of a percent), and it is calculated using audited amounts that detail the myriad costs associated with research. A university proposes a fully-accounted rate (often with the help of consultants) to its cognizant federal agency (either the Office of Naval Research or the Department of Health and Human Services, which stand in for all federal agencies); that agency’s accountants go through the proposal and a final reimbursement rate is set. If you were paying attention in the previous sentence, you will have noticed that I said reimbursement—that’s because the university pays these indirect costs from institutional funds until it gets the money back from the sponsor. There are separate F&A rates established for sponsored instruction, special facilities, on or off campus, and so on; we’ll stick with research here to keep it simple.

A common misconception is that F&A rates somehow represent a margin or profit on research (the colloquial use of the term “overhead rates” may fuel that misunderstanding). Quite the opposite: they are, as their other name states, a means of indirect cost recovery, and for most institutions the negotiated rate is less than the full set of indirect costs. The administrative portion has been capped at 26% since 1991, although compliance and other administrative mandates have increased over time, moving more of the cost burden to universities (Council on Government Relations 2019). It is not unusual for the overall F&A differential between the proposed and negotiated rates to be on the order of 5%. So, in our example above, the negotiated rate is 50%, but the true indirect cost might be 55%, a difference of $2,600 in this case. Taken across all sponsored projects at an R1 university, that structural shortfall of a few percent can add up to millions of dollars annually.

Furthermore, many private foundations stipulate that they will only pay a greatly reduced F&A rate (often zero or 10%, sometimes 15% or 20%). The logic, explicit or implicit, is that they want to stretch their nonprofit philanthropic dollars, and/or that they like to see a cost-sharing contribution from the university. Certain foundations will allow some kinds of F&A costs to be listed as direct costs. On the other hand, some contracts with private companies can be fully costed so that the indirect costs are all included as direct costs. University sponsored project offices typically have policies and procedures to enable proposals that are in line with institutional and other regulations when the regular F&A approach is not applied.

While it is in the university’s best interests to recoup F&A costs to the full extent possible, historically this reimbursement logic has been poorly communicated to the
faculty at many institutions. From a PI perspective, if a grant agency has a fixed pot of dollars available to fund projects, the higher the F&A amount, the less there is to fund the direct research costs. Even though winning proposals are selected on quality rather than price, keeping the price down in a grant competition is a deeply rooted instinct. At many institutions there is a steady stream of requests to the vice president or vice chancellor for research for F&A cost waivers on grant proposals, often with compelling arguments as to why a waiver is worth it to win the award. Each time, though, the financial decision is about shifting the costs from the individual project to the institution (i.e., all the other projects and revenue sources).

There is a further angle to how the funds returned to cover indirect costs are handled on campus: F&A recovery funds (that are a type of revenue, even if reimbursed) enter the institutional coffers as a different “color” of money to the funds that may actually pay for the various items making up F&A costs. These are unrestricted funds (see Section 2.11) and the practice on many campuses has been to return a portion of the F&A recovery to the college and/or department and sometimes the lab of the PI. The good intentions here are to incentivize further grant-getting and to provide local funds in the unit to cover many of the smaller costs in support of research. But those good intentions also help pave the road to hell, as the saying goes, by creating an implied sense that the funds somehow “belong” to the PI or to the local unit doing the research, contributing to the myth of margin or profit from grant awards.

Many sponsored projects are grants, but some come in the form of contracts. There are numerous technical differences between the two for government funders and in the private sector, most of which are not worth detailing here. But one form of contract, the fixed-price contract, is worth a mention in answering the overarching question of this section on why research loses money. For most research grants and contracts, if some portion of the grant activities cannot be carried out or amended to satisfy the original scope, the relevant funds and any others remaining at the end of the project must be returned to the sponsor (“use it or lose it”). However, a fixed-price contract is not bound by any alteration that lowers or increases the cost to the contractor (the university). This kind of contract carries high risk and can obligate the institution to unforeseen and unrecoverable costs, but for the savvy project director who budgets well and knows how to save a buck, the opportunity exists to perform the work for less than the agreed budget and for the institution to pocket the difference. The latter is an enticing prospect to some on campus; needless to say, the associated risks mean that special permissions are typically required.

We’ve now reviewed how research grants generally cost the university money in a net sense, because of F&A reimbursement shortfalls. You will recall from previous sections that the university also invests institutional funds in research infrastructure such as centers and institutes. The point is to advance research, after all, and not make money. Still, there is yet one more way in which universities make massive investments in underwriting research. At R1 and R2 institutions especially, a standard faculty
member’s workload includes a large portion of their time for research and scholarship (see also Chapter 5). Thus, a truly complete description of the full costs of university research must include the tens of millions of dollars in salaries and fringe benefits necessary at research universities to support faculty research time during the academic year. Those funds must come from some source, and it’s not research-specific revenue like grants—it’s many of the other sources we reviewed in Chapter 2, including state appropriations or investment/endowment income at public or private institutions respectively.

Lest I give the impression that research is a burdensome cost to be paid, let me conclude this section with an acclamation of the vital importance of the research mission. To be sure, research is expensive, and it is important to be informed about what it really costs and the business model that pays for it all. That said, for the better part of seventy years, the US has tended a unique partnership between the government (as well as the private sector) and higher education that has produced the finest quality and quantity of research in history, by any measure. This system has produced more Nobel prizes, more life-saving and life-changing discoveries, more critical insights, than any other. Furthermore, research and graduate education are inextricably bound together in the quest for new knowledge, and their combination in the US has produced the best system of graduate education in the world. Certainly, there are costs to performing research, but its value far outweighs them.

8.5 Which are costlier to support, graduate assistants or postdocs?

One of the key elements of graduate education (see also Section 6.7) is the intimate link between it and research. Many graduate degrees, and the PhD in particular, in fact require the student to learn and demonstrate production of original and new knowledge (i.e., to do professional-level research). In practice, this educational model is a modern-day apprenticeship—in addition to advanced coursework, graduate students learn their craft by training with faculty members and other researchers for several years. The culture and practice of this critical element of graduate education varies considerably across the disciplines, and even across faculty advisors within individual graduate programs. In some disciplines (e.g., many in the humanities) the core day-to-day work is solo scholarship, while in others (especially in the sciences) the work necessitates working in small or large teams that are likely funded by a research grant. Either way, the student’s direct experience of the process of knowledge creation is key to advanced graduate education and, at universities, is also a critical component of the research enterprise.

Postdoctoral scholars are another important part of the research enterprise, and they are found most frequently across the sciences.\(^8\) Importantly, postdocs are

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\(^8\) The biosciences have long had postdoc positions and over the last few decades many other sciences have followed suit. The role and nature of postdocs has expanded into the social sciences and even the
simultaneously research staff employees (unless supported by independent fellowship funding) as well as being trainees (National Postdoctoral Association 2019). Ideally, postdocs bring their expertise to the lab that they join while they also learn additional fields and skills in the new setting. Thus, both postdoc positions and graduate assistantships have an educational component to their research role that distinguishes them from regular research technician and staff scientist jobs.

For a principal investigator deciding on the kinds of position on a research grant, questions arise as to the costs and benefits of graduate assistants versus postdocs. There are obviously important educational and research considerations that must be included in the decision, such as the need to support students in a graduate program, the specific expertise needed for the project, and so on. Still, this decision is often boiled down to hiring a less-experienced graduate assistant versus a more-experienced postdoc. In this simplified view, the graduate assistant will need to be trained but then will likely remain in the lab for a longer period, while the postdoc can get up to speed fast and will require less oversight, but will likely depart after a couple of years. The question is often oversimplified even further to ask whether graduate assistants or postdocs are more expensive to fund. There isn’t a single answer, because it depends on who is paying for the various associated costs, and that mix varies by institution.

Table 8.2 shows a comparison of basic costs for graduate research assistants at public and private institutions (separated because tuition can be so different) and postdocs. Line A details the cost of a twelve-month appointment for each, using the typical 0.5 FTE (half-time) rate for the graduate students and the full-time rate for postdocs. I’ve included fringe benefits at 20% in Line B, which is likely a higher rate than many institutions use but it’s a neutral term here because we’re assuming it is equivalent across positions for simplicity (both types of position can have lower fringe benefit costs than regular employees, but this can vary widely). If we stop the calculation here, Line C shows that graduate assistant costs are about 60–70% of postdoc costs. However, tuition is included with an assistantship at most institutions, so we add that amount in Line D. As we saw in Section 2.6, non-discounted tuition and fees are substantially higher at private institutions, and institutions will generally charge the grant sponsor for that amount. Thus, the fully-costed totals in Line E completely change the cost implications depending on the type of institution. Some institutions will charge tuition at a special rate, such as in-state only at some publics (as assumed here), or otherwise waived or discounted. Postdoc salaries and graduate stipends can be slightly higher at private institutions, but they do not make as significant a difference as tuition in this comparison.
Table 8.2. Example comparative annual costs of graduate research assistants (for public and private institutions) and postdoctoral scholars. Round-number estimates of tuition are from Figure 2.8 with graduate and postdoc stipends rounded from FY2018 NIH rates (twelve-month).

<table>
<thead>
<tr>
<th>Line</th>
<th>Item</th>
<th>Grad Research Assistant (0.5 FTE; Public)</th>
<th>Grad Research Assistant (0.5 FTE; Private)</th>
<th>Postdoc (1.0 FTE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Stipend</td>
<td>24,000</td>
<td>29,000</td>
<td>48,500</td>
</tr>
<tr>
<td></td>
<td>(twelve-month)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Fringe Benefits @20%</td>
<td>4,800</td>
<td>5,800</td>
<td>8,800</td>
</tr>
<tr>
<td>C.</td>
<td><strong>Subtotal</strong></td>
<td><strong>$28,800</strong></td>
<td><strong>$34,800</strong></td>
<td><strong>$52,800</strong></td>
</tr>
<tr>
<td>D.</td>
<td>Tuition</td>
<td>10,000</td>
<td>45,000</td>
<td>-</td>
</tr>
<tr>
<td>E.</td>
<td><strong>TOTAL</strong></td>
<td><strong>$38,800</strong></td>
<td><strong>$79,800</strong></td>
<td><strong>$52,800</strong></td>
</tr>
</tbody>
</table>

As an aside, one can do a very similar set of calculations for graduate teaching assistants versus instructors. In that case, the department will typically pay the stipend and the college or institution will account for the tuition, so that the discussion is also about cost to whom. So, for all graduate assistantships, who pays tuition and how much are both determinative in assessing comparative costs. Returning to research assistants, principal investigators have certainly noticed the increased tuition in recent decades—anecdotal information suggests that principal investigators have shifted to employing postdocs instead of graduate research assistants, although that trend is hard to document explicitly.

8.6 How much does research compliance cost?

Many faculty members, especially those outside the life sciences and hi-tech fields that are subject to a greater range of compliance activities, know the Vice President (or Vice Chancellor) for Research (VPR) principally as (i) the person who invests institutional funds in support of research, such as for faculty startup funds or centers and institutes, and (ii) the person responsible for F&A rates and the sponsored projects office that processes grant proposals. However, the VPR is also responsible for making sure the university is in continual compliance with complex federal and state regulations that govern the conduct of research by faculty, staff and students. At an R1 university, research compliance functions include these areas:

- Human subjects research via the Institutional Review Board (IRB), often with multiple IRBs for clinical or social and behavioral sciences, plus health data privacy for the Health Insurance Portability and Accountability Act (HIPAA);

- Animal welfare for laboratory and other animals via the Institutional Animal Care & Use Committee (IACUC);
• Laboratory safety, radiation safety, and biosafety (e.g., involving recombinant nucleic acid molecules, stem cells, or select agents/pathogens);
• Export compliance for high technology items and information deemed to be of a sensitive nature for national security;
• Conflict of Interest (COI) disclosure and management, both for individual researchers and for the institution;
• Responsible conduct of research promotion through training and ethics education;
• Research integrity and allegations of misconduct involving falsification or fabrication of data, plagiarism, or other kinds of unethical research conduct, overseen by a research integrity officer;
• Research data management, retention, and repository requirements;
• Financial oversight of sponsored grants and contracts, pre-award and post-award, including accounting, effort tracking, and subcontracting.

Regulations and policies are, of course, absolutely necessary for the appropriate and safe conduct of research, but over time the associated administrative burden and costs of unfunded mandates accumulate. While regulatory costs to universities are undoubtedly increasing over time as they are incurred over and above the 26% F&A administrative cap (see the trends in share of university research spending in Figure 8.4), there are surprisingly few studies that systematically detail the costs of research compliance. Broad surveys have consistently shown that faculty members spend 42% of their research time on meeting requirements rather than doing research itself (Schneider et al. 2014). The relative time commitment on each compliance responsibility is illustrated in Figure 8.7, and it is clear that faculty members working with animal or human subjects and clinical trials spend substantial time on compliance in those areas, while financial and personnel-related compliance is time-consuming for most faculty (given that those roles are ubiquitous across almost all projects). A study across 13 institutions of varying sizes found that research-related compliance costs ranged from 11–25% of research expenditures, with a negative scale effect such that the highest relative amounts were at institutions with the lowest research expenditures (i.e., there are economies of scale in handling research compliance costs); also, consistent with the discussion above, research institutions doing more biomedical research experienced higher associated compliance costs (Vanderbilt University 2015).
8.7 How does the university earn money from technology transfer?

The Bayh-Dole Act of 1980 incentivized the development of economic benefits from government-funded research and subsequent patents, which had been stagnant prior to its enactment, by awarding universities and other recipients of federal research funding ownership of their intellectual property (IP or, simply, inventions) and the right to license it. In the decades since the act’s passage, research universities have grown sophisticated technology transfer and commercialization offices to develop and earn revenue from their inventions. This is an area where a relatively small number of blockbuster successes have led to fabulous financial rewards for a handful of universities. Some of these outliers have become household names (e.g., Warfarin, Gatorade, Google) while other lesser-known pharmaceuticals and engineering

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9 University technology transfer, licensing and commercialization operations are often performed by an associated foundation or similar entity. I’ll refer to the parent university for consistency and clarity in this section.

10 Warfarin is a blood-thinning drug discovered in the 1930s at the University of Wisconsin, known widely today by its trade name, Coumadin. The research was funded by the Wisconsin Alumni Research Foundation (WARF), established in 1925 as the first university office for what would become known as technology transfer—its name was used as the first four letters of the new drug (Pirmohamed 2006). Gatorade was created in the 1960s at the University of Florida and named for its football team, the Gators. The University initially turned down the patent rights, but in 1973 it and the faculty inventor were part of a settlement that awarded annual royalties (Kays and Phillips–Han 2003). Google’s co-founders famously invented the PageRank algorithm while they were graduate students at Stanford. In the late 1990s they and the University patented the technology, which Google licensed for 1.8M shares in the company. Stanford sold its shares for $336M in 2005; if it had waited another week it would have received twice that amount (Krieger 2005).
inventions have been similarly lucrative, earning their parent institutions tens to hundreds of millions of dollars annually (Merrill et al. 2016). However, the odds of that kind of windfall are like winning the lottery and cannot be relied upon to turn around a university’s finances—the FY2017 median gross license revenue for R1 universities was a comparatively modest $4.6M (AUTM 2020).

The majority of university technology transfer activity takes place at R1 institutions; activity at R2 schools, for the under half of those that report it, is typically 20% or less than at R1 schools depending on the metric and negligible at smaller schools (AUTM 2020). Licensing income is a widely-used financial metric in technology transfer. A university’s gross license revenue typically includes a set of annual payments from companies using its inventions. Occasionally, rather than annual payments, a university may sell all or part of a license depending on circumstances, such as when Northwestern sold portions of its Lyrica license to Pfizer for over $1.1B in 2008–2010 before the fibromyalgia pain-relief and epilepsy drug went off-patent (Tech Transfer Central 2011). Consequently, licensing income can be highly variable from year to year.

Figure 8.8 illustrates gross license income by quintiles across R1 institutions, averaged for public and private schools within each quintile for three years. Licensing revenue is exponentially larger in the upper quintiles, by a factor of about 100 between the top and bottom quintile, and it is relatively higher at private versus public universities. NYU, Columbia, the UC System and Northwestern are consistently among the very top earners (Merrill et al. 2016; DeVol et al. 2017) and they, like many of the most active schools, have a large presence in the health sciences and biotechnology.

![Figure 8.8. Gross license income averaged for public and private institutions by quintile of all R1 institutions in FY2015, FY2016 and FY2017 (current dollars). Source: AUTM (2020).](image-url)
Institutions spend their licensing dollars on covering the costs of technology transfer and on strategic investments such as internal funds for commercialization and patenting, research equipment and facilities, or endowing graduate fellowships. These revenues don’t flow only to the overall institution, they are typically shared with the department, individual lab and the inventors (faculty members, postdocs, and graduate students who were employed by the university at the time). Institutional rules regarding the ownership and licensing of IP (federally-funded or not) and its proceeds are set out in each university’s IP policy. Not all university IP is commercialized or held by the institution: some work is released to the public domain (research software code is a common example) while other IP is almost universally assigned to the individual, such as lecture content or books produced by the faculty.

Among the earliest steps as an idea transitions from research into something that might be commercialized is the requirement for new inventions to be disclosed to the university, an obligation of the Bayh-Dole Act. A subset of inventions is suitable for perfection into patents, which are the formal means by which inventions are made public and protected. Patent applications are filed (in the US and often internationally too, both at some expense) and a further subset of those pending patents is subsequently issued. Figure 8.9 shows trends in these three metrics increasing steadily over time as commercialization activities have expanded on campuses. Invention disclosures have more than doubled since the early 1990s and now average 200 per year. Patent applications have increased from about 25 per year to over 100 per year in the same period, with issued patents rising from about 20 to 60 per year. If a patent is infringed and the university litigates then large settlements can result, such as the $750M that Carnegie Mellon received in 2016 regarding its technology for data transfer accuracy in hard drives (Stempel 2016).

License agreements are made with established companies as well as with new start-up companies. A license option agreement is used when a company wants to evaluate the technology before licensing it. Many start-up companies are spun off from the university by the inventors (e.g., as with Google), usually with the assistance of the technology transfer office and sometimes via an associated small business incubator or accelerator. Figure 8.10 shows the rising trends in licenses and options, gross license income, and the number of start-up companies formed at R1 institutions. The increase in licenses and options is relatively smooth when compared to the more volatile annual figures for gross license income, as mentioned above. Universities saw a run-up in their inflation-adjusted licensing income before the Great Recession; since then these revenues have been comparatively flat despite the increases in underlying activity. The number of startups formed has also increased steeply, from about 2 per year in the mid-1990s to an average of 9 per year in FY2017.

In addition to licensing technology to a start-up company, a university may also take equity in a spinoff (i.e., a share of ownership). It’s often easier for a cash-strapped fledgling company to offer a share of its potential future success along with a reduced license payment, and this gives the university an incentive to keep initial license costs
Figure 8.9. Invention disclosures, new patent applications and patents granted, averaged across R1 institutions by fiscal year. Source: AUTM (2020).

Figure 8.10. Total licenses and options, gross license income in FY2016 dollars and new start-up companies formed, averaged across R1 institutions by fiscal year. Source: AUTM (2020).

down and advance the success of the company while retaining a stake if the company becomes successful.

While universities certainly have a self-interest in advancing technology transfer, it’s important to note that the growth in these programs has produced broader economic
and health benefits from university research, just as the Bayh-Dole Act intended. Because university IP is protected, business and industry are prepared to make high-risk investments to turn discoveries into products, creating wealth and jobs in the process. Not all applaud these and associated industry partnerships: some critics take a dystopian view and charge that corporate priorities have undermined the role of the academy (Lazerson 2010; Perry and Katz 2018). Still, technology development at universities has become inextricably linked to their mission of public service because community and public investment in higher education is predicated in part on the expectation of innovation and economic development. Talking of public service, that’s the perfect segue to the next chapter.