Hidden in plain sight: The oversized impact of downtown universities

Scott Andes
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Executive Summary

The ideas generated at U.S. research universities are often the feedstock for tomorrow's most innovative and competitive firms. But academic research doesn't translate into products and companies without planning and effort. The knowledge economy is driven by the strategic interplay between universities, firms, entrepreneurs, research labs, and independent inventors who draw strength from each other in virtuous cycles of innovation.

Research shows that these interactions are most productive when they occur in geographically dense clusters.[1] Innovation districts—employment hubs in the cores of cities that co-locate research, entrepreneurs, housing, and mixed-use amenities—are perhaps the most recent and tangible example of innovation clusters. Economic theory suggests that universities located in the downtowns of cities should have greater commercial success than other universities because the former can take advantage of "factor markets," local ecosystems that make available numerous means of production. Yet few studies have analyzed this subject.

This paper compares the commercial outcomes of research universities located within employment-dense neighborhoods (e.g., midtowns and downtowns) in the 100 largest cities to the average research university. It finds that, compared to their peers located in smaller towns or in suburbs or rural areas on a per-student basis, "downtown" universities:

- **Produce 80 percent more licensing deals.**
- **Disclose 123 percent more inventions.**
- **Receive 222 percent more income from licensing agreements.**
- **Create 71 percent more startups.**

In addition, the paper finds downtown universities:

- **Invest $22,044 per student on research and development annually compared to $12,633 among their peers.**
- **Specialize in the STEM (science, technology, engineering, and math) fields and less in the social sciences and the arts.**
- **Receive a greater share of funding from nonprofits than their peers but a smaller share from the private sector and state and local government.**

The paper concludes with recommendations for urban universities, schools located outside of cities, and public and civic leaders.

The top five downtown universities are:

1. Rockefeller University
2. Massachusetts Institute of Technology
3. Columbia University
4. University of Pennsylvania
5. Carnegie Mellon University

Section 1: Introduction

Research universities are the crown jewels of the American innovation economy. Thirty-six of the world's top 50 research universities are located within the United States.[2] Not only do these institutions push the frontiers of science, they are anchors of regional economic growth, supporting their cities by providing a steady stream of high-skilled workers, attracting faculty research entrepreneurs, encouraging private-sector research and development (R&D) partnerships, and leading core regional technical capabilities.

However, some universities are better positioned than others to drive economic growth. This paper finds that research universities located in the downtowns and midtowns of large cities punch above their weight in terms of commercial outcomes: they produce more patents (often twice as many), licensing agreements, licensing revenue, and startups, given the size of their student populations, than those located in smaller "college towns" and in suburban and rural areas.

Research institutions co-located near large firms, entrepreneurs, private equity, and a host of other amenities within dense employment centers of cities are better able to create external relationships that facilitate the commercialization of their research. This is particularly true within life sciences and health care, where major hospital systems partnered with universities—termed "academic medical centers (AMCs)"—need to be in close proximity to large patient populations. AMCs are the life blood of advancements in health care because they connect university science with clinical applications for their patients.

As cities seek to distinguish themselves within crowded global markets, downtown universities are emerging as competitive differentiators, linking longstanding economic strengths that exist within urban cores with market-ready science and technology.

Section 2: Research universities matter for cities

Why should mayors, city councils, local philanthropies, and businesses leaders care about the presence and vitality of research universities within their cities? After all, most universities don't pay taxes, so their direct contribution to public coffers is limited. But research universities are critical growth-drivers of regional economies. In a study of 15,000 universities in 1,500 regions, Valeros and Van Reenen found that doubling the number of universities is associated with a four percent increase in gross domestic product (GDP) per capita.[3] Given that universities are sources of employment and draw external revenue from student consumption, they clearly matter.

One might say the same about stadiums and fairgrounds. But research universities matter to regional economies far beyond the spending of their faculty, staff, and students. Controlling for additional consumption driven by population change, Valeros and Van Reenen concluded that universities matter beyond consumption because they supply high-skilled workers, who increase the net productivity and wages of workers at all levels within a city. Moretti found that a one percentage point increase in the supply of college graduates raises high school dropouts' wages by 1.9 percent, high school graduates' wages by 1.6 percent, and college graduates' wages by 0.4 percent.[4] And research shows the location of where people attend school is an important indicator of employment.[5]

Universities that focus particularly on research (as compared to liberal arts schools) help move cities up the value chain by solving scientific problems for local companies, generating technology for export, and creating high-growth entrepreneurs. Valeros and Van Reenen found that the impact on regional GDP is higher if a university is "research-intensive," and Hausman found that, for each new university patent, 15 additional jobs are created outside the university.[6] These results remained consistent over a

20-year period and increased with proximity to the university, suggesting that research universities represent a stable feature of long-run employment growth.[7] Other studies have found that the quality of a university's research and faculty is a predictor of employment in high-tech and scientific sectors within a city.[8] While this finding may seem obvious, it points to an important relationship between research universities and the private sector: firms and cities that have industries at the technological frontiers tend to benefit the most from research universities.

Taking all these factors together, researchers at the University of California found that a $1 increase in university expenditures led to an $0.89 increase in average income within a city. Put another way, the overall multiplier effect of university activity is 1.9 (the university's own dollar plus the external effect).[9]

While research universities are of economic importance anywhere, they are particularly relevant to the economic vitality of cities because of their geographic proximity to firms increases the interplay between companies and schools. Economists refer to this feature as "agglomeration."

Agglomeration is the process in which firms located near one another and other relevant institutions (like universities) gain additional benefits from their proximity. Beginning with observations made by Alfred Marshall in 1826, over the last century hundreds of studies have proved the benefits of density and proximity for innovation.[10] However, relatively new geocoding techniques have allowed researchers to better understand

Defining downtown universities

Not all institutions of higher education specialize in research; for example, technical schools and many liberal arts colleges do not. But research universities hold a special place within the education system, and because of the close link between the traditional technology transfer metrics employed in this study—patents, startups, licenses, and invention disclosures—and research activity, it is illuminating to evaluate research universities separately.

For the purposes of this paper, a research university is defined as an institution with over $50 million in R&D expenditures annually.[11] Of the over 650 total universities identified by the National Science Foundation, 200 meet this definition of a research university.

In defining downtown, I limited the field to the top 100 metropolitan areas, since for a school to take advantage of its central location in a city there must be a critical mass of private-sector activity. The reasoning here is based on numerous economic studies which show that large metropolitan areas experience much stronger positive effects of proximity than smaller cities.[12] For downtown research universities, I included schools located in defined downtowns plus those within three-fourths of a mile from one or several (depending on density rates) of the most employment-dense areas of a city.[13] Employment density rates were geocoded from the U.S. Census.[14] Taken together, 44 universities were identified as "downtown research universities," and the remaining 156 research universities were classified as non-downtown. These 44 universities, 25 of which are public and 19 private, range from large public schools with sizeable student populations to smaller Ivy League institutions.

These might seem like overly strict criteria. However, this paper falls into a larger body of work on innovation districts that are defined by dense innovation hubs of cities.[15] One goal of this study is to test the innovation district hypothesis in the strictest sense to see if economic outcomes of research vary even neighborhood-by-neighborhood. Moreover, economic research shows that when it comes to knowledge sharing—such as that from universities to economic partners—the benefits of proximity can attenuate rapidly beyond a one-mile distance.[16]

the role of distance and density for firms. In many instances the value of proximity attenuates rapidly with distance. For example, Rosenthal and Strange found that for software companies the spillover benefits are 10 times greater when firms are within one mile of each other than when they are two to five; by 10 miles within-city localization benefits disappear.[17] Similarly, in a study of Manhattan advertising agencies, Arzaghi and Henderson found that the positive effects of knowledge spillovers and networking with nearby firms were strongest when firms were within 0 to 250 meters of each other but declined by 80 percent when firms were 500 meters apart.[18]

These findings suggest that knowledge sharing among universities, research labs, and firms exists at the neighborhood level.

If the geographic concentration of firms, entrepreneurs, corporate research centers, and labs improves the translation of research into new products and services, then one would expect research universities located in employment centers of cities to have stronger commercialization outcomes. As the next section shows, this is indeed the case: downtown universities make outsized economic contributions.

Ranking downtown universities

As a group, research universities located in cities perform better than their suburban, small town, and rural peers, but there is still substantial variety within downtown schools. Which downtown universities lead in terms of commercializing research? Taking together five traditional metrics of technology transfer—startups, patents, invention disclosures, licensing income, and licensing deals—as a percent of the student population gives an overall "score" for 33 of the 44 downtown schools with technology transfer data available on all indicators (see endnote 20 for methodology explanation).[19] Of the over 1,000 colleges and universities in the United States, these 33 schools represent some of the most impactful research institutions. Together they create over 220 startups and 1,700 patents each year and represent $800 million in licensing deals. These schools can be considered "tier one downtown universities." Though many other universities probably belong on this list (such as many within the University of California system and many academic medical centers), they were unable to be ranked due to insufficient data.[20]

Far ahead of the pack is New York City's Rockefeller University, which ranks number one on each of the five metrics. Rockefeller was the country's first institution to support research and graduate students solely in the life sciences. It has no formal departments and encourages faculty and students to collaborate around high-risk, high-reward science. Since its founding in 1901, 24 of Rockefeller's scientists have won the Nobel Prize.[21] In terms of the commercial outcome of its work, given its size, Rockefeller University is in a class of its own.

The Massachusetts Institute of Technology (MIT) ranks second overall and in all categories except licensing agreements, where it ranks third. Since its creation, faculty and leadership at MIT have made the economic application of research a top priority, and today no other university in the world has had the overall economic impact of MIT. According to its own accounting, 25 percent of MIT alumni start their own companies, with revenue of these firms totaling $1.9 trillion, more than the GDP of India.[22]

The remaining top five include Columbia University, the University of Pennsylvania, and Carnegie Mellon University (CMU). The first two are powerhouses in the life sciences, and CMU is a national leader in computer science and engineering, particularly in areas such as machine learning, robotics, and cyber security. CMU's high ranking is even more impressive given that it is the only school in the top 10 that does not have a medical school. Universities that specialize in the life sciences rank high on technology transfer metrics because medical devices and drug discoveries are more often patented and licensed than other technologies.[23]

CMU ranks low on patents because, according to Bob Wooldridge, associate vice provost for technology transfer and enterprise creation, "for many of our technologies, particularly software, we just don't care about patents. Some faculty prefer to put these technologies into the public domain through open source—which is fine by us. At the end of the day, we are interested in the impact of our technology."[24]

Table 1: Rank of downtown universities by licensing deals, disclosures, licensing income, patents, and startups

Institution	Rank	Licensing deals rank	Disclosures rank	Licensing income rank	Patents rank	Startups rank
Rockefeller University	1	1	1	1	1	1
Massachusetts Institute of Technology	2	2	3	3	2	2
Columbia University	3	6	4	2	4	3
University of Pennsylvania	4	8	6	5	7	4
Carnegie Mellon University	5	5	7	15	13	5
Johns Hopkins University	6	7	10	10	5	7
Temple University	7	12	8	7	11	6
Vanderbilt University	8	3	9	9	9	9
Rice University	9	21	14	21	3	11
University of Washington	10	4	11	6	18	15
Albert Einstein College of Medicine, Inc.	11	11	12	11	12	10
Thomas Jefferson University	12	15	13	19	15	8
Case Western Reserve University	13	13	16	26	6	13
Georgia Institute of Technology	14	17	17	27	8	12
Harvard University	15	16	19	13	10	14
University of Pittsburgh	16	9	18	12	16	19

Institution	Rank	Licensing deals rank	Disclosures rank	Licensing income rank	Patents rank	Startups rank
Washington University in St. Louis	17	10	20	8	14	20
University of Nebraska	18	18	21	20	25	17
University of New Mexico	19	27	23	28	19	18
Indiana University	20	25	22	24	26	16
New York University	21	24	24	4	20	22
University of Chicago	22	23	25	18	24	21
New Jersey Institute of Technology	23	28	28	31	17	25
University of Arizona	24	20	26	29	29	23
Drexel University	25	26	27	33	21	24
University of Texas-Austin	26	14	29	16	23	28
Brown University	27	29	30	23	22	26
University of Houston	28	33	31	14	31	27
Georgetown University	29	31	32	17	27	29
Boston University	30	32	33	25	30	30
University of Alabama at Birmingham	31	22	34	22	28	32
Portland State University	32	19	35	30	33	33
Universityof Cincinnati	33	30	36	32	32	31

Note: For full details on each metric, see Appendix A

Downtown universities punch above their weight in commercial outcomes

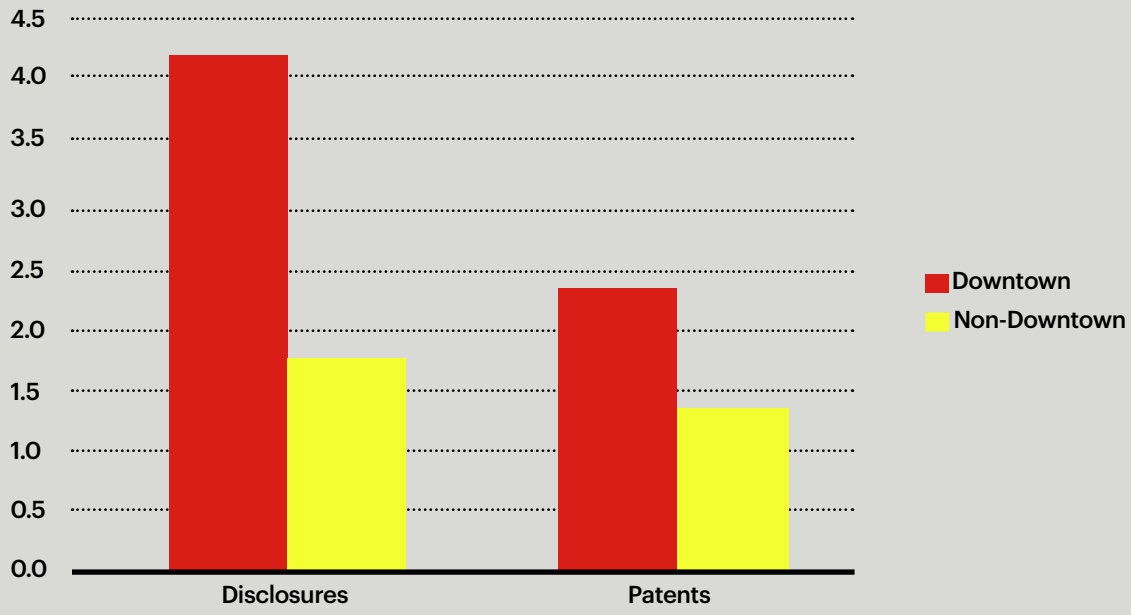
The economic literature on agglomeration and proximity suggests universities located in dense employment centers of cities should achieve greater commercial impact for their research. But do they? There are many examples of universities located outside of cities that have strong private-sector partnerships and that have been successful translating science into market-ready ideas.

However, this paper finds that research universities in cities have above-average commercial outcomes, generally outperforming schools with similarly sized student populations.[25]

Specifically, full-time students in urban schools made up a quarter of the total enrollment within research universities, but these institutions were responsible for 37 percent of startups and patents, 43 percent of of invention disclosures, and 52 percent of licensing income.

Breaking down these technology transfer metrics shows the considerable commercial strength of downtown universities. At the beginning of the commercialization process, faculty and graduate students with research discoveries that may have market value "disclose" these discoveries to their technology transfer office. If the discovery is deemed to have market value, the university will patent the technology to protect the intellectual property. Economic research has shown that in many academic disciplines patents are the leading indicator of the economic impact of research.

Figure 1: Disclosures and patents per 1,000 students, 2013 — 2015



Source: Author's calculations from AUTM and the Carnegie Classification of Institutions of Higher Education, 2016

In both invention disclosures and patents, downtown universities outperform their peers. The number of invention disclosures at downtown universities as a portion of full-time students is 223 percent that of non-downtown schools, and downtown universities received 2.3 patents for every 1,000 students compared to 1.0 at non-downtown schools.

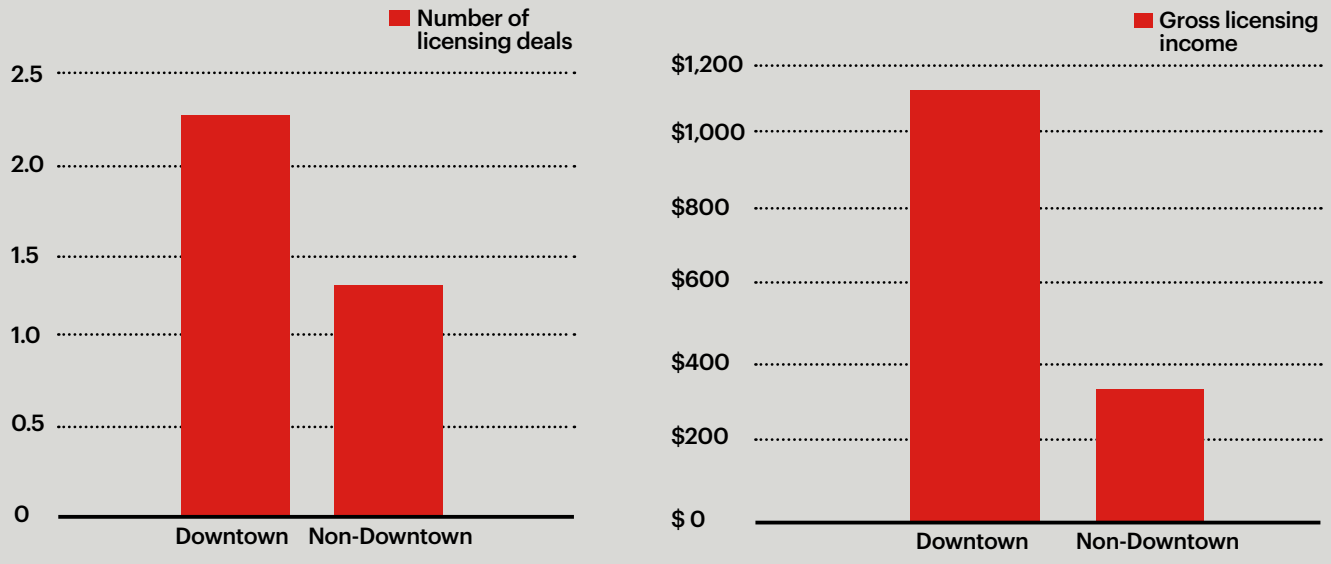
Invention disclosures and patents lay the groundwork for commercial activity, but they are still just inputs and alone do not represent the full economic impact of universities. Licensing deals, in which a university forms a contractual relationship with a firm that allows that firm to use (not own) the patented technology, the income from licensing deals, and new startups at universities are better outcome metrics because these represent actual relationships with companies or development of new companies.

Between 2013 and 2015, downtown universities made 180 percent as many licensing deals per student and received roughly three times the revenue ($1,125 in licensing revenue per student compared to $350) as did their non-urban peers.

Invention disclosures, patents, and licensing represent an important pathway for universities to commercialize research and influence the local economy. But for many scientific discoveries, creating a new company is a better strategy than licensing. According to the Kauffman Foundation, since the end of the 2009 recession, high-growth, young firms represented over half the new jobs created in the United States.[26]

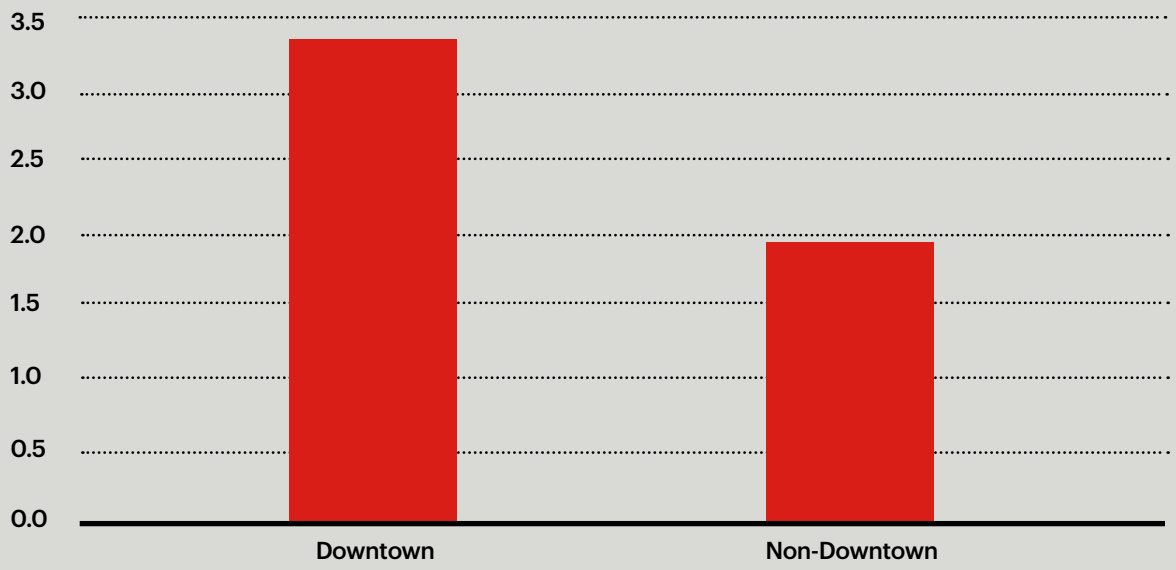
Successful technology startups are a leading indicator of the interplay between university research and the broader ecosystem

Figure 2: Licensing deals per 1,000 students and income per students, 2013—2015



Source: Author's calculations from AUTM and the Carnegie Classification of Institutions of Higher Education, 2016

Figure 3: New businesses created at universities, per 1,000 students, 2013—2015



Source: Author's calculations from AUTM and the Carnegie Classification of Institutions of Higher Education, 2016

within a city because, unlike as in licensing deals, universities give successful research entrepreneurs only their start—they are on their own for capital, mentorship, customers, workers, and opportunities to reach markets, and all of these demand strong connective tissue between universities and the city. Downtown universities create a third more startups from faculty and student research than other research universities, given their student populations. Between 2013 and 2015, urban schools established 220 new companies.

As helpful as traditional technology transfer metrics are, they represent only a portion of the engagements universities have with the private sector. Research by MIT and others shows that research partnerships, mentorship, technical consulting, and other activities are also critical ways universities support regional economic growth.[27] Unfortunately, national data on those activities do not exist. Nonetheless, in many areas of the economy—particularly those on the technological frontier—invention disclosures, patents, licensing agreements and revenue, and startup activity are important precursors to the commercial application of academic research. Ideas spawned in the lab must be carried forward by inventors, entrepreneurs, and firms to create new products and services and smarter business models and practices.

Following the economic research on the value of proximity to innovation, the research here shows that universities co-located near employment hubs in large cities have far greater commercial outcomes than the average school.

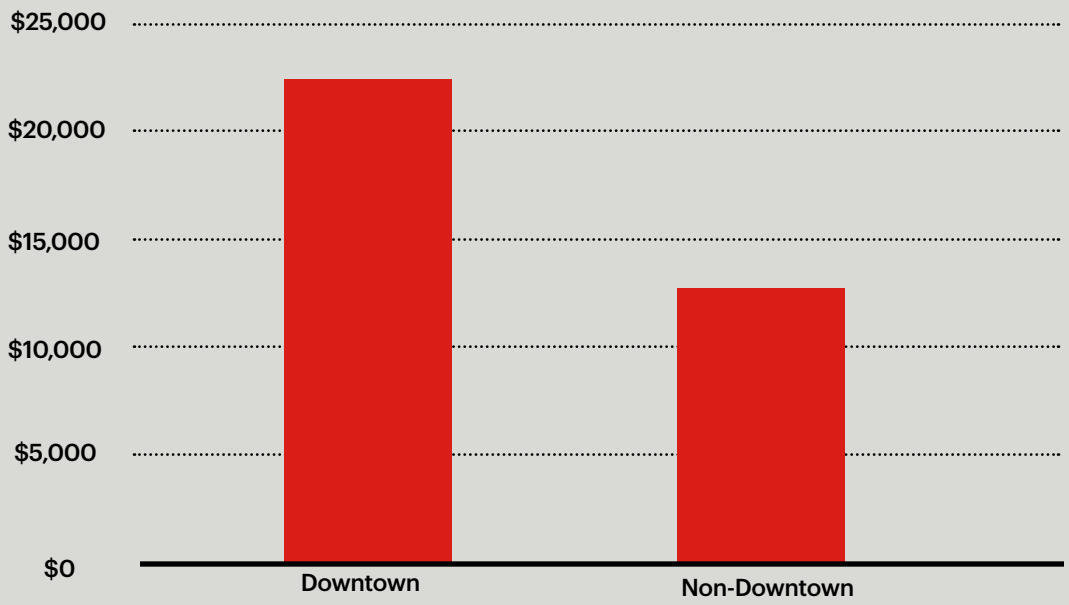
Section 3: Research strengths and funding sources

One of the most pronounced differences between urban and non-urban schools is the relative size of their research budgets. While downtown universities make up only a quarter of all research universities, they represent one-third of the nation's university R&D and invest almost twice as much in R&D per student as their peers—$22,044 per full-time student versus $12,633.

A second unique factor besides the size of their research budgets is the research strengths of urban schools. Downtown universities specialize in the hard sciences and engineering.[28] Specifically, they invest 36 percent more in general sciences, 25 percent more in computer science and math, and ten percent more in the life sciences. If life sciences was limited to health related research, urban schools would have a much higher percentage, as many land grant universities focused on biotechnology relating to agriculture.

In other academic disciplines downtown universities underperform their peers. Given their relative strength within science and engineering other fields like social sciences and the arts and humanities make up smaller portions of urban institutions research budgets than the average institution. However, urban schools also perform 34 and 74 percent of the environmental and physical sciences research, respectively, of their suburban and rural counterparts. Land grant and other colleges have historical strengths in geology and ecology, but these areas of science are

Figure 4: Research expenditures per student, 2015



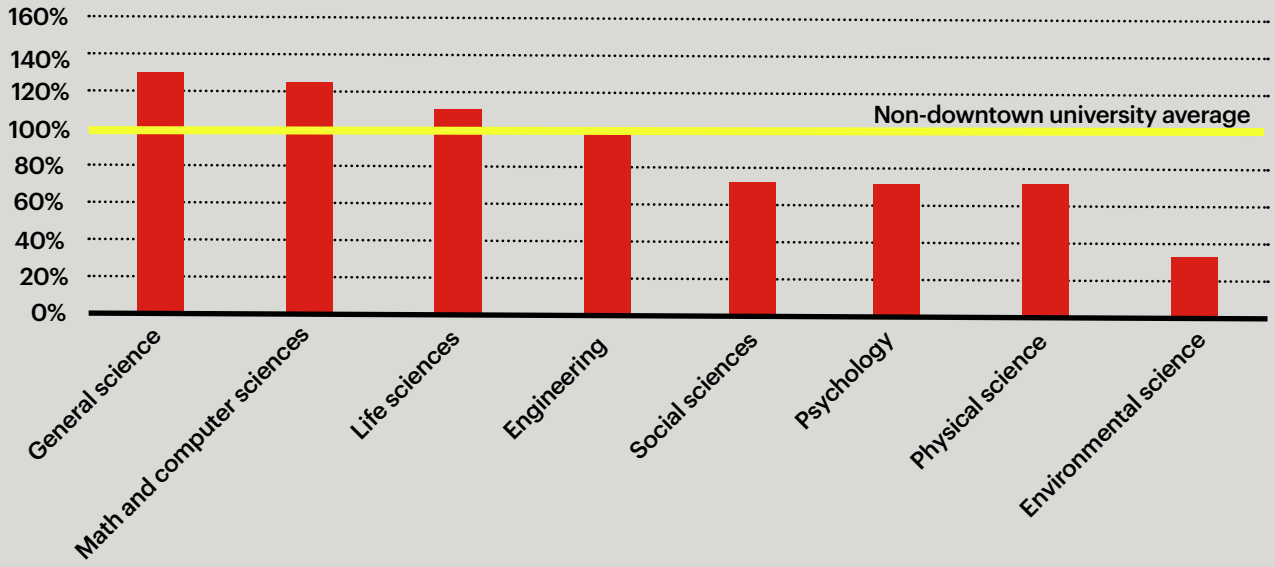
Source: National Science Foundation and the Carnegie Classification of Institutions of Higher Education, 2017

increasingly relevant to firms in the energy sector that have longstanding engineering relationships with universities located in cities, like MIT and Georgia Tech. Investing in these disciplines or partnering with colleges that have strong environmental and physical science departments likely represent a strategic opportunity for downtown universities.

In terms of funding, downtown universities have unique sources. The federal government—the major source of all university R&D—funds urban schools slightly more than those outside of big cities (by four percent), while state and local governments favor non-urban schools. However, over the last decade these trends have begun to reverse. Between 2002 and 2014 state and local governments slowly increased resources to colleges within their largest cities, while the federal government began investing less. Given that the federal government spends roughly 10 times as much as state and local governments on university R&D, this is a worrying trend for downtown universities—many of which are already feeling budgetary pressure from federal funding agencies.

Because urban universities specialize in computer science and engineering, a disproportionate share of their federal funding comes from the Department of Defense (DoD), and the average downtown research institution receives 45 percent more from DoD than does the average non-urban university. Compared to other federal agencies, DoD primarily funds applied and developed research that

Figure 5: Research funding, by subject, at downtown universities relative to non-downtown universities, 2015



Source: Author's analysis of National Science Foundation 2017

can impact military outcomes in the near term. As such, recipients of DoD resources often gravitate toward research with greater commercial value.[29] Urban schools also receive 15 percent more from the Department of Health and Human Services (through the National Institutes of Health) and one percent more from the National Aeronautics and Space Administration (NASA). However, the portion of federal research funding coming from the Department of Energy, the National Science Foundation, and the Department of Agriculture is 44, 49, and 85 percent smaller among downtown than non-downtown institutions. While it may seem obvious that the Department of Agriculture would invest less in urban schools, the number of advanced farm machinery and crop technologies derived from research originating at urban schools suggests that the department may need to reconsider its funding pipeline. For example, the scientific knowledge behind the current fleet of self-driving tractors and mowers came from partnerships with downtown universities like Carnegie Mellon and MIT.[30]

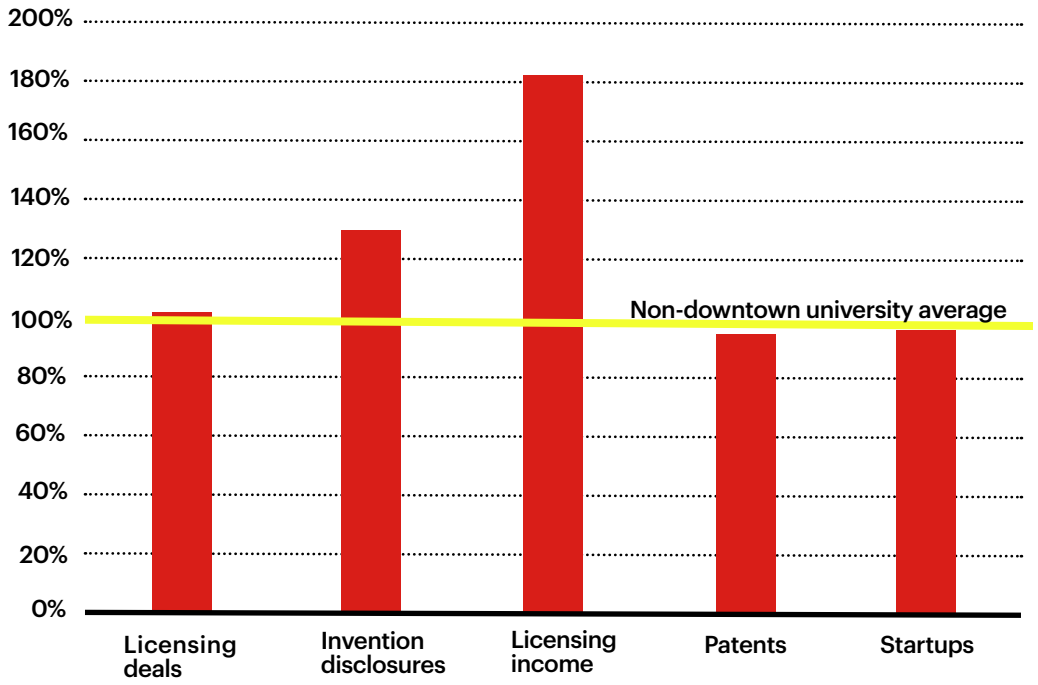
Outside of government funding, industry-sponsored research is moderately more prevalent among small town, suburban, and rural schools, making up six percent of R&D budgets at these institutions compared to five percent at urban schools. While this might seem counterintuitive, many schools outside of cities—especially public land grant universities—have historic ties to large, local manufacturers or agricultural companies

Commercial intensity of research vs. research specialization of downtown universities

To analyze the commercial strength of universities, technology transfer metrics are taken as a share of student population—which standardizes each school. Without a denominator (e.g. student population) the largest schools would simply perform the best, explaining little about what makes certain universities "good" at commercialization. However, the choice of a denominator impacts the outcome. Choosing the size of the student body controls for the size of each school but doesn't control for other important factors. Perhaps the most important factor explaining the commercial outcomes of downtown universities is their large research budgets (as the previous section highlights). This reflects these schools specialization as research-oriented institutions. However, another important question is whether downtown universities are seeing better commercial outcomes given their level of research. In other words, because of their proximity to firms and capital, do these schools create more new startups, patents, licensing agreements for each dollar of research? As the chart below shows, outside of licensing income and invention disclosures, downtown universities perform on par with non-downtown universities when research expenditures are controlled for.

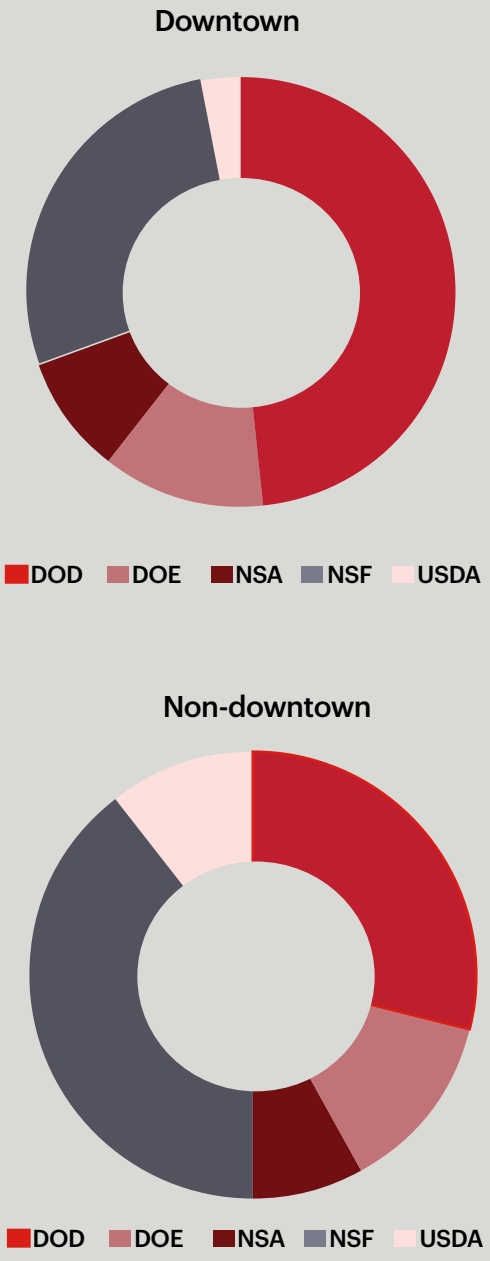
Licensing income can largely be explained by the number of academic hospitals associated with urban schools. Yet, given the importance of venture capital for startup creation—96 percent of which is deployed within the top 100 largest cities—its surprising downtown schools produce the same number of entrepreneurs per research dollar as their peers. One potential explanation for this, is while these schools have specialized in research, they have not gone far enough to connect that research with off-campus, but within city resources like accelerators.

Figure 6: Commercialization as a share of research expenditures, downtown universities relative to non-downtown universities, 2013—2015



Source: Author's calculations from AUTM and National Science Foundation, 2017

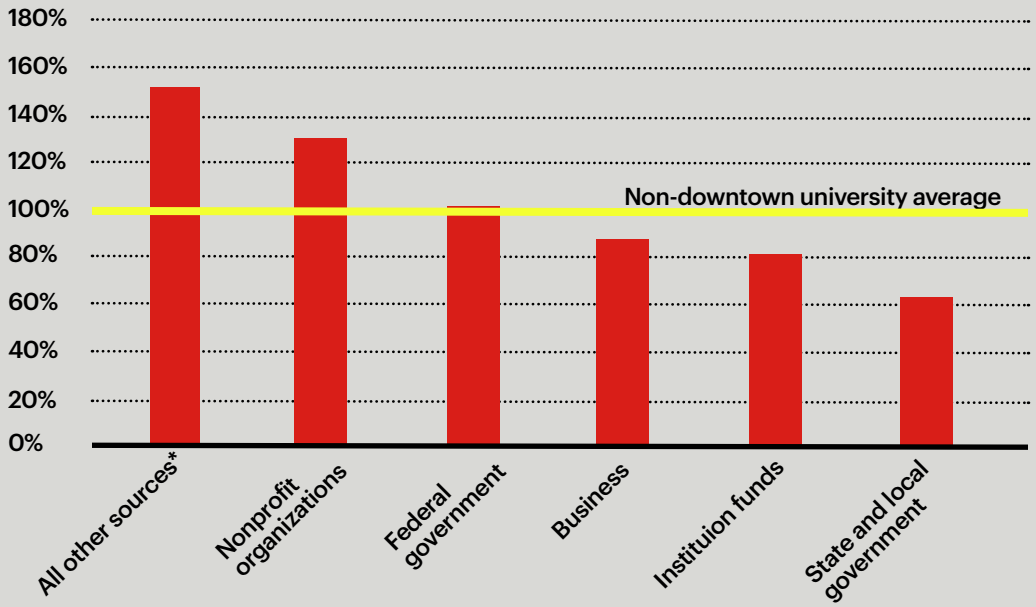
Figure 7: Non-Health and Human Services federal funding of research, downtown vs. non-downtown universities, 2015



Source: Author's analysis of National Science Foundation, 2017

that represent a sizeable share of the local employment base.[31] Institutional funds such as endowments also make up a larger share of small town, rural, and suburban universities' budgets than urban ones, a trend that may be the result of the slightly higher of well-endowed, private schools located outside of the downtown of cities. On the other hand, nonprofits and philanthropies fund more research at urban universities than at their peers. This is not surprising given the disproportionate share of foundations located in cities. Because nonprofits often have economic-development-based missions, the fact that their grants make up a larger share of downtown university R&D budgets could suggest that these institutions have a greater incentive to tie research to the regional economy. Together, these factors—research intensity, specialization in science and engineering, and greater funding from the Department of Defense, philanthropy, and others—suggest why downtown universities have stronger commercial outcomes. First, academic research is the feedstock of university technology transfer. Schools that focus predominately on teaching and not on faculty research still can play an important role in economic development, but successful university startups predominately flow from academic research. Second, by focusing on the hard sciences, these schools are well positioned to impact markets. A review of 514 case studies of the economic impact of university research within the United Kingdom shows that computer science and engineering research are more closely aligned with industry than is other academic research.[32] Moreover,

Figure 8: Funding sources at downtown universities compared to non-downtown universities, 2015



**All other sources can include foreign governments, other universities, or special research funds from donors*
Source: Author's analysis of National Science Foundation, 2017

graduate education in engineering associated with higher exports and new inventions within companies.[33] Finally, given that DoD often invests more in applied research and relatively less in theoretical science compared to many other federal agencies, greater funding from DoD is likely to be associated with more market-oriented research.[34]

Section 4: Lessons for stakeholders

This report has made a case for why downtown universities are better equipped to impact regional economies. But all research institutions, regardless of their location, can increase their interactions and proximity to firms, entrepreneurs, and workers. Given the positive economic benefits of co-location, "urbanizing" the country's research base should be a priority of public policy. And universities, cities, states, and the federal government all can play a role to ensure the nation gets more economic return from its research investments.

Lessons for downtown universities

Schools already located in urban areas should take advantage of their location by creating policies, practices, and physical spaces that induce greater collaboration between researchers, students, and businesses. To this end, downtown universities should:

- **Accelerate commercialization through industry-aligned, pre-competitive collaboration:** Technology transfer between universities and firms doesn't happen serendipitously, no matter how closely located they are. Many universities located blocks away from major corporate research centers fail to achieve the full benefits of their geography. In order to increase commercialization, universities should create or partner with pre-competitive consortia to address industry-wide technology barriers. These partnerships should have simple, flexible, and clear intellectual property arrangements or work in areas such as shared data that generally don't generate monetarily valuable patents. For example, the Indiana Biosciences Research Institute connects both academic and industry partners around metabolic disease and nutrition. Partners include life science companies such as Eli Lilly, Roche, Dow Chemical, Cook Medical (Indiana University), Purdue University, and

Notre Dame. Research is both basic (i.e., largely pre-competitive) and applied, but the industry partners have developed a framework to identify rules around shared intellectual property. The initiative is already capitalized at $150 million from industry and philanthropy.[35]

- **Connect university research with corporate research centers:** As private-sector R&D moves further from basic science and closer to the market, the need for strong partnerships between academic and applied research is growing. As such, many firms are moving their corporate research centers nearer to research universities. In order to attract and take full advantage of corporate research centers, downtown universities should align academic strengths with specific private-sector partners. This should happen through smart programming that brings applied research to the doorsteps of firms as well as through physical space. Over the last half decade, Midtown Atlanta—home to Georgia Tech—has probably been the most successful area at attracting corporate research centers: in the last several years 12 firms have set up research centers within the eight-block area around the midtown innovation district, called Tech Square.[36] Part of Atlanta's success is driven by the strong partnership between the Midtown Atlanta business improvement district and Georgia Tech. They have worked together to develop an independent nonprofit to think strategically about how the physical space around Georgia Tech can support connections between corporate research and the university.[37] On the programming side, Georgia Tech's incubator, the Advanced Technology Development Center, helps create successful startups by connecting entrepreneurs to mentors, capital, and customers. And its Industry Connects program links university startups with Fortune 1000 companies.[39]

- **Develop programming and incentives for entrepreneurship:** Generating new companies is a critical commercial output of university research. However, developing an ecosystem within the university to support startups requires the appropriate programming, support mechanisms, and physical space. Faculty and students must have the freedom and incentives to start new companies around their research and the necessary support system to succeed. Drexel University's School of Media Arts & Design has made "economic contributions" (which can include creating a company or coordinating with industry) one of four criteria that can be used in tenure and promotion decisions.[40]

- **Invest endowment dollars in strategic connections to the city:** Universities often deploy their endowment dollars within the traditional boundaries of their campuses to improve existing disciplines and climb in the academic rankings. Of course, improving academic strength is their primary mission, but schools can meet that mission while also creating stronger links with cities through real estate activities that promote private-sector connections.

Strategically placed mixed-use amenities—those that increase the critical mass of talent, not simply retail and restaurants—can connect research to commercialization within the community. For example, Harvard University is in the planning stage for building out the Allston neighborhood portion of its campus into a new "enterprise research zone." The plan is to develop a neighborhood where companies and institutions can locate to leverage research from Harvard, MIT, Boston University, and other institutions.[41]

Lessons for universities in smaller cities and suburban and rural areas

Many universities located outside of employment centers can still gain the benefits of these locations. These schools should:

- **Establish strategic partnerships with downtown universities:** Many universities in the vicinity of large cities have research and other strengths that are highly valuable to firms, startups, and downtown universities. Creating partnerships between universities can be mutually beneficial by allowing downtown universities access to research and expertise and connecting non-urban schools to networks of firms and entrepreneurs. For example, the Engineering School at the University of Illinois Urbana-Champaign has entered into a partnership with the University of Chicago's entrepreneurial hub, the Polsky Center for Entrepreneurship and Innovation. The University of Chicago's Hyde Park location is ideally situated to engage Chicago's private sector, and the University of Illinois' world-class engineering program adds technical competencies that help faculty and staff commercialize technology products and services.[42]

- **Locate satellite offices and/or create "microlabs" in urban areas:** A growing trend across the country is for remote universities and national laboratories to create microlabs in cities. For national laboratories these microlabs allow firms in cities to more easily access lab technology, and for remote universities they create physical connections to economic hubs.[43] For example, Duke University's entrepreneurship hub and incubator, the Bullpen, is located off campus in downtown Durham in order to access startups, venture capital, and mentors.[44] Several universities like Oklahoma University, the University of California, San Francisco, and the University of Arizona have their medical schools and teaching hospitals off campus within major cities in part to tap into urban life science clusters.

- **"Urbanize" suburban and rural campuses:** Many of the country's strongest research universities are located outside major metropolitan areas and will never move the lion's share of their academic assets away from their main campuses because of the significant costs. Nonetheless, these schools can still reap many of the benefits of agglomeration through strategic

programming and real estate investments that induce greater connectivity between firms, researchers, and entrepreneurs. Creating meeting spaces, shared lab facilitates, conference centers, and other amenities help these campuses become more desirable locations for research startups and external engagement. For example, the University of Maryland in College Park has recognized it can't attract investors, companies, and other actors from Baltimore and Washington to its campus because there is inadequate amenity space. Also, the school currently doesn't have sufficient space for student entrepreneurs. To meet these needs, the University of Maryland is constructing a new complex with a hotel, conference center, and incubator space. Development projects aren't just real estate plays—they can be strategic enablers of coordination and collaboration when designed and programmed appropriately.[45]

Lessons for public and civic leaders in cities

Urbanizing and connecting the nation's research universities with business centers in the heart of the city is important because it promotes commercialization and grows regional economies. Thus, mayors and other city leaders should see downtown universities as strategic assets for growth and inclusion and should therefore:

- **Make university-based economic development a priority:** Local leaders should use their bully pulpit to position universities as anchors of technology-based economic development. Often these institutions (along with national labs and military bases) are viewed as gated communities responsible solely to their faculty and students. But as entities that don't pay taxes, universities have an obligation to enhance regional economic growth, and mayors can help position these organizations to do so by making them central partners in workforce development, entrepreneurial, and economic development initiatives.

- **Connect downtown universities to regional economic clusters:** Universities are best able to support economic growth when they are addressing the needs of local industry. While this may seem obvious, often longstanding academic strengths are not the best fit for industry needs. Provosts of research will always to want to align with business around the university's core competencies, but mayors and other city leaders can help reframe the partnership around the city's economic clusters. For example, in Houston an organization called Pumps & Pipes works to link the city's research institutions around three economic clusters—health care, oil and gas, and aerospace. Beginning in 2007 the partnership brought together researchers from the University of Houston, Houston Methodist hospital, ExxonMobil, and NASA to develop cross-cutting technologies. Through insights from imaging technology on offshore wells, the coalition was able to develop the Heartbeat Simulator System for testing and imaging cardiovascular devices.

Pumps & Pipes' motto is "use the other guy's toolbox." [46]

- **Tie the economic success of downtown universities to inclusive growth in nearby neighborhoods:** Economic growth that flows from universities and other research labs needs to benefit the entire city, not just faculty and students. Mayors should work to connect research universities with low- and medium-skilled workers. As some of the largest employers within the city, universities have the potential to upskill huge swaths of the population through internal workforce development programs. This is particularly true for research universities that are affiliated with academic medical centers, because teaching hospitals offer a variety of occupations—including medical transcriptionists, nursing, and information technology managers—that do not require four-year degrees. To help community members take advantage of these positions, city leadership can sit in-between universities and the workforce to ensure an inclusive, steady stream of trained workers. For example, the West Philadelphia Skills Initiative is a coordinated program between the University of Pennsylvania, Drexel University, and Children's Hospital of Philadelphia aimed at training low-skilled workers to gain employment within universities and hospitals in occupations with high turnover rates.[47] To date, the program has placed 124 workers from the neighborhood, increasing income by an average 32 percent.[48]

Section 5: Looking forward

In a time of stagnant economic growth and mounting global competition, the United States needs new engines of growth. Yet fiscal and ideological pressure in Washington and many state legislatures is threatening the funding pipeline of America's research institutions. Although this austere approach is poor economic policy, little suggests these budgetary trends will reverse themselves in the near to moderate term. Universities need new strategies to meet these funding challenges.[49]

Some universities are doubling down on legacy strengths within by increasing pressure to publish and jostling over national rankings. Others are taking a different approach and tying their institution's future to that of their regional economies.

The nation's downtown universities are at the forefront of the latter trend. New development projects that connect traditional academic research with firms, coupled with novel programming, are underway at downtown universities in Pittsburgh; Chicago; Indianapolis; Atlanta; Austin, Texas; New York; Houston; Los Angeles; Providence, R.I.; and Oklahoma City. Many of these cities have defined the developing area around their academic anchor institutions as innovation districts, though others have not. What's important is that in each city these institutions are using the built environment to maximize the impact of research.

However, colleges and universities located outside of major city centers are also beginning to recognize that they can achieve better commercial outcomes by co-locating around economic activity in nearby cities. In many cases these institutions have moved strategic assets off their main campuses into the innovation districts of adjacent cities. Examples include Arizona State University's Downtown Phoenix Initiative, the University of Illinois Urbana-Champaign's engineering presence at the Chicago Innovation Exchange in Hyde Park, Duke's entrepreneurial hub "The Bullpen" in downtown Durham, and Cornell Tech's Roosevelt Island campus.

Going forward, universities located in cities should follow what leading research institutions around the country are already doing and position themselves as central nodes of innovation and stewards of their urban economies. Universities located in college towns, the suburbs, and rural areas should find opportunities to take advantage of nearby firms and entrepreneurs by connecting, physically and programmatically, with neighboring cities.

Appendix A: Full downtown university metrics and rankings

Institution	Overall rank	Licensing Deals per 1,000 Students	Licensing rank	Invention disclosures per 1,000 students	Invention disclosure rank	Licensing income per student	License income rank	Patents per 1,000 students	Patent rank	New businesses created per 1,000 students	New business rank
Rockefeller University	1	170.0	1	143.6	1	$137,762	1	104.0	1	6.6	1
Massachusetts Institution of Technology	2	7.0	2	24.1	3	$5,073	3	26.7	2	1.8	2
Columbia University	3	5.2	6	10.6	4	$10,166	2	6.2	4	1.2	3
University of Pennsylvania	4	4.4	8	8.8	6	$1,963	5	3.9	7	0.8	4
Carnegie Mellon University	5	6.1	5	5.2	7	$459	15	2.5	13	0.8	5
Johns Hopkins University	6	5.1	7	8.8	10	$788	10	4.4	5	0.6	7
Temple University	7	2.9	12	2.6	8	$1,147	7	2.7	11	0.7	6
Vanderbilt University	8	6.6	3	6.7	9	$966	9	3.7	9	0.5	9
Rice University	9	1.2	21	5.3	14	$263	21	7.2	3	0.4	11
Univeristy of Washington	10	6.2	4	14.6	11	$1,826	6	1.9	18	0.4	15
Albert Einstein College of Medicine, Inc.	11	3.3	11	6.1	12	$585	11	2.5	12	0.5	10
Thomas Jefferson University	12	1.9	15	2.0	13	$301	19	2.3	15	0.5	8
Case Western Reserve University	13	2.7	13	6.8	16	$155	26	4.1	6	0.4	13
Georgia Institute of Technology	14	1.7	17	3.1	17	$76	27	3.8	8	0.4	12
Harvard University	15	1.8	16	3.6	19	$554	13	3.3	10	0.4	14
University of Pittsburgh	16	4.4	9	6.2	18	$565	12	2.2	16	0.3	19
Washington University in St. Louis	17	3.4	10	1.7	20	$982	8	2.4	14	0.3	20
University of Nebraska	18	1.5	18	3.1	21	$288	20	1.0	25	0.3	17
University of New Mexico	19	0.5	27	4.2	23	$52	28	1.7	19	0.3	18
Indiana University	20	0.8	25	1.9	22	$200	24	1.0	26	0.3	16
New York University	21	1.0	24	1.4	24	$4,291	4	1.5	20	0.2	22
University of Chicago	22	1.1	23	1.7	25	$402	18	1.2	24	0.2	21
New Jersey Institute of Technology	23	0.5	28	1.9	28	$14	31	2.1	17	0.2	25

Institution	Overall rank	Licensing Deals per 1,000 Students	Licensing rank	Invention disclosures per 1,000 students	Invention disclosure rank	License income per student	Licenseing income rank	Patents per 1,000 students	Patent rank	New businesses created per 1,000 students	New business rank
University of Arizona	24	1.3	20	1.6	26	$47	29	0.7	29	0.2	23
Drexel University	25	0.6	26	2.1	27	$8	33	1.4	21	0.2	24
University of Texas-Austin	26	2.0	14	3.7	29	$444	16	1.4	23	0.1	28
Brown University	27	0.5	29	0.7	30	$201	23	1.4	22	0.1	26
University of Houston	28	0.1	33	0.2	31	$479	14	0.6	31	0.1	27
Georgetown University	29	0.3	31	0.5	32	$443	17	1.0	27	0.1	29
Boston University	30	0.2	32	0.7	33	$186	25	0.7	30	0.1	30
University of Alabama at Birmingham	31	1.2	22	1.4	34	$215	22	1.0	28	0.1	32
Portland State University	32	1.3	19	0.7	35	$15	30	0.2	33	0.0	33
University of Cincinnati	33	0.4	30	0.6	36	$12	32	0.4	32	0.1	31

Endnotes

1 Mercedes Delgado, Michael Porter, and Scott Stern, "Clusters, Convergence, and Economic Performance," Working Paper No. 18250 (Cambridge, Mass.: National Bureau of Economic Research, 2012).

2 Academic Ranking of World Universities, "Engineering/Technology and Computer Sciences" (2015), http://www.shanghairanking.com/FieldENG2015.html.

3 Anna Valero and John Van Reenen, "The Economic Impact of Universities: Evidence From Across the Globe," Working Paper No. 22501 (Cambridge, Mass.: National Bureau of Economic Research, 2016).

4 Enrico Moretti, "Estimating the Social Return to Higher Education: Evidence From Longitudinal and Repeated Cross-Sectional Data," Journal of Econometrics 121 (2004): 175-212.

5 David Card, "Immigrant Inflows, Native Outflows, and the Local Market Impacts of Higher Immigration," Journal of Labor Economics 19, no. 1, (2001): 22-64, http://davidcard.berkeley.edu/papers/immig-inflows.pdf.

6 Naomi Hausman, "University Innovation, Local Economic Growth, and Entrepreneurship," Working Paper No. CES-WP-12-11 (Washington: U.S. Census Bureau Center for Economic Studies, 2012).

7 Ibid.

8 Patricia Beeson and Edward Montgomery, "The Effects of Colleges and Universities on Local Labor Markets," Review of Economics and Statistics 75 (1993): 753-61.

9 Shawn Kantor and Alexander Whalley, "Knowledge Spillovers From Research Universities: Evidence From Endowment Value Shocks," Review of Economics and Statistics 96, no. 1 (2014): 171-88.

10 For a good review of the recent literature on agglomeration and innovation see Gerald Carlino and William R. Kerr, "Agglomeration and Innovation," Working Paper No. 15-007 (Cambridge, Mass.: Harvard Business School, 2014).

11 Stuart S. Rosenthal and William C. Strange, "Geography, Industrial Organization, and Agglomeration," Review of Economics and Statistics 85, no. 2, (2003), 377-93.

12 Mohammad Arzaghi and J. Vernon Henderson, "Networking Off Madison Avenue," Review of Economic Studies 75 (2008): 1011-38.

13 The $50 million threshold for research expenditures was reached by looking at funding levels of the Carnegie Classification of Institutions of Higher Education's R&D budgets for its R1 (highest research activity) schools. These schools are classified by whether they offer doctoral programs, so a definition was created based on R&D budgets.

14 Maryann P. Feldman and David B. Audretsch, "Innovation in Cities: Science-Based Diversity, Specialization, and Localized Competition," European Economic Review 43 (1999): 409-29.

15 Center City District, "Defining Downtown" (2014) http://definingdowntown.org/.

16 U.S. Census Bureau, OnTheMap, http://onthemap.ces.census.gov/.

17 Bruce Katz and Julie Wagner, "The Rise of Innovation Districts: A New Geography of Innovation in America" (Washington: Brookings Institution, 2014).

18 Rosenthal and Strange, "Geography, Industrial Organization, and Agglomeration."

19 Technology transfer metrics for 2013-2015 (averaged) were acquired from the Association of University Technology Managers.

20 In order to calculate an overall score, five metrics were taken as share of student population: licensing dollars, licensing deals, patents, invention disclosures, and new businesses created for the average of 2013, 2014, and 2015. Each metric was also given a weight. These weighs include 0.2 for licensing deals, 0.1 for invention disclosures, 0.2 for licensing income, 0.2 for patents, and 0.3 for new businesses.

21 For example, technology transfer metrics for California schools are collected by AUTM for the entire University of California system, and therefore it is impossible to break out downtown universities like the University of California, Los Angeles versus other schools in the system that are not located in downtowns. Other downtown schools that did not have reported metrics on all five indicators were not included.

22 Rockefeller University, "About," http://www.rockefeller.edu/about/.

23 Edward Robers, Fiona Murray, and Daniel Kim, "Entrepreneurship and Innovation at MIT," (Cambridge, MIT: 2015).

24 Scott Andes, "How Firms Learn: Industry specific strategies for urban economies," (Washington: The Brookings Institution: 2016).

25 Interview with Bob Wooldridge, associate vice provost for technology transfer and enterprise creation, May 2016.

26 Emily Fetsch, "The Economic Impact of High-Growth Startups" (Kansas City, Mo.: Ewing Marion Kauffman Foundation, 2016).

27 Leon R. Glicksman et al., "MIT's Industrial Partnerships" (Cambridge, Mass.: Massachusetts Institute of Technology, 2003).

28 Defined as environmental science, life sciences, math and computer science, physical sciences, engineering, and other sciences.

29 "National Economic Impacts From DoD License Agreements With U.S. Industry: 2000-2014" (Washington: Department of Defense, 2016).

30 Scott Andes, et. al., "Capturing the Next Economy: Pittsburgh's rise as a global innovation city," (Washington: The Brookings Institution: 2017).

31 For example, Clemson University International Center for Automotive Research (http://cuicar.com/).

32 Cristina Rosemberg et al., "Assessing the Economic Returns of Engineering Research and Postgraduate Training in the UK" (Brighton, UK: Technopolis Group, 2015).

33 Ibid.

34 "National Economic Impacts From DoD License Agreements With U.S. Industry: 2000-2014."

35 Interview with David Johnson, September 26, 2016.

36 Scott Andes and Bruce J. Katz, "Why Today's Corporate Research Centers Need to Be in Cities" (Cambridge, Mass.: Harvard Business Review, 2016).

37 Midtown Atlanta BID, Midtown Innovation District, "The Living Lab," http://www.midtownatlinnovates.com/living-lab/.

38 Georgia Institute of Technology, "Advanced Technology Development Center," http://atdc.org/.

39 Georgia Institute of Technology, Advanced Technology Development Center, “Industry Connect Program,” http://members.atdc.org/?IndustryConnect.

40 Interview with Allen Sabinson, Dean of the Drexel College of Media Arts & Design, April 2016.

41 Bruce Mohl, “The Next Kendall Square?” (Boston, Mass.: MassINC, 2016).

42 Polsky Center for Entrepreneurship and Innovation, “Chicago Innovation Exchange,” http://civicengagement.uchicago.edu/programs-partnerships-volunteering/detail/chicago-innovation-exchange/.

43 Scott Andes, Mark Muro, and Matthew Stepp, “Going Local: Connecting the National Labs to Their Regions to Maximize Innovation and Growth” (Washington: Brookings Institution, 2014). '

44 Duke University, “The Bullpen,” https://entrepreneurship.duke.edu/bullpen/.

45 Interview with Brian Darmody, January 5, 2017.

46 Pumps & Pipes, http://www.pumpsandpipes.com/index.html#rj-countdown.

47 University City District, “West Philadelphia Skills Initiative,” http://hospitaltoolkits.org/workforce/case-studies/west-philadelphia-skills-initiative/.
48 Ibid.

49 “Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future” (Washington: National Academies Press, 2007).

Anne T. and Robert M.
Bass Initiative on Innovation and Placemaking
at BROOKINGS

The Brookings Institution
1775 Massachusetts Ave., NW
Washington, DC 20036
202 797 6000
www.brookings.edu

Project for Public Spaces
419 Lafayette Street,
Seventh Floor
New York, NY 10003
www.pps.org