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RESEARCH TO RENEWAL: ADVANCING UNIVERSITY TECH TRANSFER

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ABOUT HEARTLAND FORWARD

Heartland Forward's mission is to improve economic performance in the center of the United States by advocating for fact-based solutions to foster job creation, knowledge-based and inclusive growth and improved health outcomes. We conduct independent, data-driven research to facilitate action-oriented discussion and impactful policy recommendations.

The views expressed in this report are solely those of Heartland Forward.

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As the director of regional economics research at the Milken Institute, a think tank in Santa Monica, she led a team examining the role of innovation and human capital in regional growth. Through her research, she has developed a deep understanding of the best practices that have aided economic competitiveness. Minoli has spoken with media and policymakers in cities around the country to help local communities understand and use her work. Minoli holds a bachelor's degree in Philosophy and Economics from the London School of Economics, and a Master of Science in Public Policy and Management from Carnegie Mellon University.

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PRESIDENT'S NOTE

The American research university is a unique institution that much of the world has long tried to emulate. Many times under-appreciated in the U.S., research universities are one of the most important knowledge assets of cities and states for economic development purposes. These universities influence the economic prospects of their regions and the nation overall in multiple ways.[1]

In this analysis, we evaluate which universities are most proficient at creating new knowledge; embedding it in their science, technology, engineering and mathematics (STEM) graduates; and transferring both to new and existing enterprises. Research and discovery are fundamental objectives of universities, but they must be absorbed and infused into private industry to yield an economic return on the investment.

We believe that states, cities and rural areas can more effectively partner with universities in their pursuit of prosperity. Correctly channeled, this approach can create jobs paying top 5% incomes, as well as a wide variety of middle-income jobs, and be inclusive.

This should resonate in heartland states as they attempt to close the gap in economic performance with coastal locations. Greater emphasis is needed on patenting, licensing and startup activity, and these factors should be weighted more heavily in faculty tenure and promotion decisions. Doing so will assure young researchers that their university passionately supports technology transfer and entrepreneurial activities[2] and would nudge many in the direction of working collaboratively with businesses.[3] Universities with major financial success in startups or royalties from licenses underscore the value of tech transfer and its potential, and contribute additional resources to support the process.

The metrics incorporated in our university benchmarking are among the most comprehensive ever compiled. For formal commercialization and tech transfer of intellectual property, we use invention disclosures, the number of licenses and options, licensing income and startups formed; less formalized modes include citations of university articles contained in patents granted to firms. This demonstrates the value of academic research in the private sector. These metrics are normalized by research expenditures to obtain a measure of efficiency in converting inputs into outputs.

The graduation ceremony at American universities is the biggest single annual technology transfer. While all forms of university education are valuable, our criterion for evaluation incorporates the number of STEM graduates with bachelor's and master's degrees and their proportion of total degrees. This yields 14 metrics for the evaluation performed from 2017 to 2019.

We acknowledge the challenges of developing a comprehensive set of performance metrics because a single index cannot capture the nuances and unique circumstances of individual universities. However, a university that does not benchmark its position and measure changes relative to its peers will not be motivated to improve. We provide this assessment in the spirit of improving collective performance across universities simply by incorporating best practices in different functional areas.

Index of University Tech Transfer and Commercialization

It stands to reason that many of the top-performing research universities are among the elite institutions in the U.S.; however, it's unlikely that many experts would have predicted that Carnegie Mellon University would be first. The relatively small private school has a combination of top-tier computer science and engineering departments, as well as interdisciplinary research programs with a unique entrepreneurial culture and focus. Carnegie Mellon led an economic renaissance in Pittsburgh after steel production and other heavy manufacturing fell on hard times. At second, the University of Florida is the top public university. It has a huge student body (enrollment upwards of 53,000 in 2020) and research enterprise. Its technology transfer prowess was seeded in the 1960s with its creation of Gatorade.

Third through sixth places are occupied by large, elite, private institutions: Columbia, Stanford, Harvard and the University of Pennsylvania, respectively. All have rich research budgets and have placed more emphasis on technology transfer in recent years (except Stanford, which was a pioneer in commercialization) and annually graduate huge amounts of STEM talent.

However North Carolina State, at seventh, demonstrates a public university that believes commercialization is central to its mission can be a top performer. Since joining N.C. State in 2010, Chancellor Randy Woodson has elevated its position by improving STEM programs and elevating support of entrepreneurship and tech transfer. Woodson is an internationally recognized plant molecular biologist who joined N.C. State from Purdue, another strong STEM school and supporter of tech transfer and academic entrepreneurs. Today, North Carolina State anchors the Research Triangle.

The eighth-ranked University of California San Diego was founded as a STEM school and has experienced commercialization success in semiconductor giant Qualcomm and a number of biotechnology firms. Its sibling to the north, the University of California Los Angeles, holds down ninth place. UCLA has long been a research powerhouse, having received the second-greatest funding total by the National Institutes of Health over the past three decades. Chancellor Gene Block brought an emphasis on commercialization and entrepreneurial support of faculty when he came aboard in 2007.

At 10th, the University of Minnesota is the highest-ranked heartland university and stands fifth among public universities. Minnesota has a highly regarded technology commercialization office and several strong STEM academic departments. The university works closely with outside companies and its Minnesota Innovation Partnerships program provides a low-risk option to license technologies through its Try & Buy contracting program. Further, UM has streamlined processes for company-sponsored research.

The Massachusetts Institute of Technology shares the 11th spot with Purdue University. MIT has a world-class engineering, technology and science faculty and was the East Coast pioneer in supporting technology commercialization. Purdue is second among heartland universities and excels in startup creation within the biotech and life-science space. Like MIT, its engineering school is top shelf. The private, nonprofit Purdue Research Foundation supports patenting, licensing and entrepreneurship, and is a model that other heartland universities should consider. Here again, leadership matters. When former Indiana governor Mitch Daniels became Purdue president in 2013, he renewed focus on tech transfer and commercialization, and bolstered the institution's academic stature.

Northwestern University is the heartland's top private institution at 13th overall. It ranks second in gross licensing income and when normalized for research expenditure. Its Innovation and New Ventures Office started KQ, a new startup accelerator located close to campus that fosters entrepreneurship and successful technology commercialization. Volexion, a battery technology startup based upon research from the McCormick School of Engineering and Applied Sciences, is an important tenant. University president and economist Morton Shapiro is a firm believer in Northwestern's engagement in the marketplace.

Cornell University is 14th, followed by Duke University in 15th. The heartland's University of Michigan is 16th and boasts an impressive research and commercialization performance, with more than 64,000 students and $1.5 billion in annual research expenditures. Further, Michigan ranks fourth in invention disclosures and fifth in licenses and options issued.

New York University is 17th, followed by the University of Washington at 18th and the California Institute of Technology at 19th. The University of Texas at Austin completes the top 20. UT-Austin is embedded in a leading technology cluster and played a key role in incubating it. Tech transfer is supported by the Texas Innovation Center and is a catalyst for helping faculty and graduate students in STEM fields commercialize their research.

The University of Pittsburgh is 21st, followed by Princeton University at 22nd and Brigham Young University at 23rd. 24th is the University of Chicago, where technology transfer is funneled through the Polsky Center for Entrepreneurship and Innovation. The private school ranks seventh in normalized academic articles that are cited in industry patents. It has a number of innovative collaborations with the Chicago

Quantum Exchange, the University of Illinois at Urbana-Champaign and the Argonne National Laboratory. The University of California Berkeley ranks 25th.

Several heartland universities stand just outside the top 25. The Ohio State University is 32nd and ranks seventh in invention disclosures and in STEM bachelor's degrees awarded. The University of Houston is 36th and a remarkable third in licensing income normalized by research expenditures. Its practices are worthy of additional investigation. The University of Wisconsin-Madison is 38th overall, 11th in invention disclosures and 12th in STEM bachelor's degrees awarded. Case Western Reserve is 39th overall. The heartland is home to many premier research universities, as evidenced in holding 13 of the top 50 positions and 34 of the top 100.

Future Measurement Enhancements and Policy Recommendations

Most of the indicators contained in our benchmark evaluate near- to medium-term effectiveness of technology transfer and talent creation. We would like to include other longer-term metrics, as I outlined previously:

"... post-market metrics of technology transfer and commercialization performance, such as job creation, employee wages, sales and market capitalization of academic-derived enterprises and firms which license IP. If data were more readily available, a comprehensive and longer-term series of impact metrics could be developed."[4]

For example, MIT found that alumni had started more than 25,000 active firms, including 6,900 that reside in Massachusetts. Collectively, 3.3 million people were employed at these firms and accounted for worldwide revenues of nearly $2 trillion.[5,6] Stanford alumni created 18,000 California-based firms with annual worldwide sales of $1.27 trillion. The point is that a major research university that sees commercialization, transfer of technology and STEM talent creation as central to its mission can shape the structure of an entire knowledge-based metropolitan economy.

A number of policy recommendations at both the national and state levels support universities in creating middle-class jobs contained in the report summarized here.

- Renew the promise of innovation-driven economic growth for the entire U.S. through investments of federal funds in scientific and technological innovation.
- Bolster technology transfer out of regional university research-based centers of excellence.
- Dedicate funding to university formal technology transfer.
- Increase technology transfer efficiency by adopting best practices.
- Pool invention disclosure and patents.
- Alumni foundation investment in venture capital.
- The need for more data.

Heartland states should consider several factors to boost performance.[7] Governors and legislatures may want to consider providing direct funding for technology transfer offices as an economic development initiative. Heartland elected officials should advocate for commercialization and tech transfer to be stated objectives in the mission statements of universities. State leaders should advocate for a consortium of universities to be formed across heartland states to exchange and implement best practices in commercialization. A pooling of invention disclosures and patents across state borders is worthy of investigation. Providing alumni foundation investments into venture capital funds pooled over multiple states would reduce the risk of these investments and potentially spur greater success.

I encourage you to review and digest the material in this report. It will be well worth the read. Each university can investigate its position by individual metrics and compare itself to others with similar research profiles.

Ross DeVol
President and CEO
Heartland Forward

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EXECUTIVE SUMMARY

It's said that ideas rule the world, but the best ideas, if not shared, have no more impact on humanity than a solitary tree falling in the depths of a forest. When innovative ideas spread across individuals and organizations, however, they bring the power to transform communities for the better. And therein lies the importance of university technology transfers, an old-school term with evergreen significance when it comes to economic growth and prosperity. The need for economic renewal in many places across the United States gives effective university technology transfer greater importance.

Universities are in the idea business. They explore ideas (new and old), teach them to students, bring out creativity in students, and refine ideas with rigorous research.

Technology transfers is sharing the fruits of that research and results in innovation – the implementation of new ideas and creative ways of doing things. And innovation moves us forward by introducing useful products, offering technological solutions and processes that revitalize industries and supply chains, and finding strategies that promote the greater public good.

This report takes an in-depth look at the transfer activities of universities across the United States and provides data, insights, and recommendations that will help schools increase their impact on the communities they serve.

Our University Technology Transfer and Commercialization Index offers a benchmark ranking of universities based on a variety of data sources related to formal and informal technology transfers.

Carnegie Mellon University (CMU) in Pittsburgh, Pennsylvania claims first place on the list, demonstrating how a combination of top-tier computer science and engineering departments and interdisciplinary research programs can create economic opportunities beyond the campus.

While private institutions such as Columbia University (third), Stanford University (fourth) and Harvard University (fifth) ranked high, so too did public institutions such as the University of Florida (second), North Carolina State University (seventh), the University of California, San Diego (eighth), the University of California, Los Angeles (ninth), and the University of Minnesota (tenth).

TABLE 1: TOP 25 UNIVERSITIES- TECHNOLOGY TRANSFER & COMMERCIALIZATION INDEX

RANK	INSTITUTION	INDEXED SCORE
1	Carnegie Mellon University	100
2	University of Florida	98.72
3	Columbia University	98.37
4	Stanford University	95.50
5	Harvard University	94.96
6	University of Pennsylvania	93.88
7	North Carolina State University	92.79
8	University of California, San Diego	92.64
9	University of California, Los Angeles	91.47
10	University of Minnesota	91.01
11	Massachusetts Institute Technology	90.81
11	Purdue University	90.81
13	Northwestern University	90.58
14	Cornell University	90.35
15	Duke University	88.29
16	University of Michigan	87.56
17	New York University	87.05
18	University of Washington	86.51
19	California Institute of Technology	86.36
20	University of Texas at Austin	85.97
21	University of Pittsburgh	85.78
22	Princeton University	85.62
23	Brigham Young University	84.50
24	University of Chicago	84.46
25	University of California, Berkeley	83.57

It's understandable that universities would take pride in ranking high on our list, but the greater purpose is to glean insights about the best operational practices of top-performers so that other universities – regardless of their unique contexts – can address limiting factors, chokepoints, or bottlenecks and thereby improve their outcomes.

The benchmark data identifies metrics of commercialization, but these metrics also can initiate or extend conversations around commercialization activities and how universities can contribute to economic development. Every university has the potential to participate in economic renewal.

Emerging economies, notably China, are investing heavily in research universities to create their own national advantage. It's imperative, therefore, that American universities increase their commitment to and investment in research and to the adoption of new practices and procedures to strengthen our competitiveness and continued high standards of living.

Many of the top 25 have long-established TLOs, some schools have intentionally built successful initiatives more recently by making tech-transfer a priority and learning from their peers. When adjusted for research expenditures, the list reveals the best performers who have more limited capacity. These universities can be leveraged to boost innovation and spread middle class job creation in diverse locations across the country.

The best performers ranked well on both formal and informal measures, which are mutually reinforcing and are both essential contributions universities make to their regional innovation ecosystem.

Based on our findings, we believe universities can boost economic development and help create middle class job in their home states and regions if the follow recommendations are adopted and put into practice:

- **Renew the promise of innovation-driven economic growth in the United States through investments in scientific and technological innovation.** Academic research provides long-term economic benefits by allowing universities to tackle problems that have a low probability of quick commercial success but has potential to deliver high returns to firms and to create entire new industries. Increasing the geographic spread of federal funding and building on local expertise provides a means to create increased prosperity throughout the United States. In many places, local industry needs to be revitalized and infused with the new ideas that academic research can provide. Federal, state and local government and university officials need to work together to be strategic in investing and deploying resources.

- **Bolster technology transfer out of regional university research-based centers of excellence.** Every university has the potential to be actively engaged in technology transfer so that good ideas benefit the general public. There is a potential for every university to engage further with external organizations, especially local firms, and increase their impact on commercial and non-profit activity. There are opportunities to initiate new bachelors and graduate programs in partnerships with local industry that would provide gainful employment and enable graduates to stay in the region.

- **Dedicate funding to university formal technology transfer.** Universities demonstrating greater formal technology transfer success are better funded while other programs struggle. Bayh-Dole created a mandate for universities to commercialize their discoveries but did not provide resources to carry out this mandate. Recognizing the importance of commercialization success, state governors might provide funding as an economic development initiative. Further, to boost national innovation and competitiveness, the federal government should direct funding to Technology Licensing Offices at research universities that commit to make commercial engagement by faculty and students as a priority.

- **Increase technology transfer efficiency by adopting best practices.** At the state level, policies should be implemented that incentivize the adoption of best practices in commercialization at Technology Licensing Offices. Efficiency gaps between universities outside of the top 25 in our Technology Transfer and Commercialization Index should be narrowed. In heartland states, governors and legislatures should advocate for commercialization to be made a core mission of universities and form consortiums to exchange information and adopt best practices. Innovative educational programs should reinforce the advantages of local industry.

- **Pool invention disclosure and patents.** A pooling of invention disclosures and patents for universities without a critical mass of IP is worthy of consideration as it allows hiring tech transfer professionals and the creation of synergies. Pools could be based on regional considerations or technology specialization and could help smooth licensing income across time.

- **Alumni foundation investment in venture capital.** Alumni foundations and retirement funds of universities could allocate more of their portfolios to venture capital funds pooled across states to diversify risk.

- **Develop more data.** The initial effort to collect TLO data by AUTM was a great public service that only whets the researcher and policy makers appetite for additional information. Greater participation by the AUTM survey as well as additional variables on startup firm survival, commercial and financial success would allow for a fuller understanding of impact. Many offices already collect these data but not in a uniform and easily available manner. In addition, data on informal methods of tech transfer, such as engagement with local communities and social entrepreneurship would provide a more complete picture of the full impact of American research universities.

Through our efforts we hope to encourage progress in technology transfer and participation – in terms of technology transfer reporting and in overall focus – of more universities. We will continue to refine our measures and seek additional data to add to our rankings, which serves as a proxy for what we ultimately care about – economic renewal, prosperity, and high quality of life.

UNIVERSITIES AND INNOVATION

American universities are committed to advancing the public good; arguably, it is the reason for their existence. They accomplish this mandate through multiple, reinforcing activities.

First and foremost, is the education of students, which ideally nurtures everyone's creative spark and enables them to engage in productive activity and contribute to innovation. Graduation day is perhaps the most impactful technology transfer event at any university, because the ideas and know-how generated within the walls of the institution are transferred to new positions in companies and communities at large.

Second, universities conduct research that is central to advancing the greater public good and reinforces the objectives of teaching. Research creates new ideas, breaks through existing limitations, and suggests new topics that become the basis for new courses and degrees. Research conducted at a university is fundamentally different from research conducted at for-profit firms because the emphasis is on exploration and understanding with a focus on public benefit rather than profit.

Third and relatedly, universities translate research findings into practical uses. Traditionally, research was disseminated through publications and presentations, but an increasing number of university research results are licensed through a formal technology transfer process. University technology transfer can take place either formally, through the licensing of intellectual property, or informally as ideas, technical know-how, inventions, and skills move to from the university to other organizations.

"Creativity is thinking up new things. Innovation is doing new things."

Theodore Levitt
Harvard Business Review 1963.

University tech transfer is at the center of technology based economic development and innovation.[8] University research creates opportunities to invent new products and more efficient processes, create new firms, and develop pioneering industries.

This is a long-standing tradition. University agricultural research was the foundation of the revolution in crop science and hybrid corn in the 1920s and 1930s. University science was instrumental in the Second World War, creating a social contract for science that relied on the ability of academic discoveries to create new technological frontiers that would provide endless opportunity.[9] More recently, industries such as the digital computers, lasers, material science, and biotechnology trace their origins to university research.[10]

Even so, universities are a necessary, but not sufficient environment for economic development to occur. Investing in university research without corresponding consideration of how to increase the output of resulting inventions and their subsequent commercial and social benefits will not yield the anticipated benefits to society.

"The greatest invention of the nineteenth century was the invention of the method of invention... One element in the new method is just the discovery of how to set about bridging the gap between the scientific ideas, and the ultimate product. It is a process of disciplined attack upon one difficulty after another."

Alfred North Whitehead
Lowell Lectures 1925.

Of course, it is important to remember that each research university is unique. American research universities are a diverse set of institutions with differing operational mandates, resources, and capabilities. And each institution has its own history, culture, and administrative constraints that affect outcomes.

These differences are one of the strengths of the American higher education system. Institutions with varied but complementary missions and can develop expertise tailored to the objectives of their constituents and local industry. Public universities have a greater focus on educating large numbers of students and prioritizing local industry and state government needs, while private universities have more latitude in defining their mission. Land-grant institutions, a subset of public universities with one chartered in every U.S. state, have specific mandates to engage in extensive outreach activities. Moreover, some private universities, notably Drexel and Northeastern, have traditionally sponsored industrial extension activities, internships, and active industry engagement, while other universities have been more removed from the market.

University policies governing formal technology transfer differ with regards to offering incentives for faculty engagement and managing conflict of interest policies.[11] The technology licensing offices (TLOs)[12] at some universities are large and well-funded while others operate on a shoestring, almost as an afterthought.[13,14,15] Universities that do well at formal tech transfer have typically benefited from home-runs – major successes in terms of public benefit or revenue that bring attention to tech transfer, demonstrate to the faculty and the university what is possible, and encourage further focus on and funding for tech transfer.

Beyond factors internal to the university is the reality that institutions operate in different ecosystems, which affects receptivity to new ideas and the ability to put ideas into use.[16]

Universities contribute to the vibrancy of their local ecosystems as important economic and social institutions. They specialize in the creation and open sharing of ideas. They serve as cultural beacons and provide resources for community engagement. And university towns are among the most highly rated places to live in America, making them good locations to locate and grow companies.

> Ecosystems are "a set of interconnected entrepreneurial actors, institutions, entrepreneurial organizations and entrepreneurial processes which formally and informally coalesce to connect, mediate and govern the performance within the entrepreneurial environment."
>
> **Mason, Colin & Brown, R.**
> *Entrepreneurial Ecosystem & Growth Oriented Entrepreneurship (2014)*

But it's a two-way synergistic relationship. The ideal situation is a local ecosystem with firms that are ready to implement new technologies and hire university graduates and with incubators, accelerators, and investors that allow university startups to flourish.[17,18,19] Universities have experimented with different strategies to augment their local ecosystems but realizing the benefits takes time and an element of luck.[20]

Despite this complexity and variability, the ability of American universities and research institutes to transfer technology to the commercial sphere is simply too important to go unmeasured.[21] No matter how much money is spent on research and development, society will not benefit unless there are tangible outcomes. The path from research to societal benefit is circuitous and uncertain, but our globally competitive economy demands accountability and transparency.

Since the passage of the Bayh-Dole Act more than 40 years ago, the U.S. has developed a model of formal university technology transfer that has served as a blueprint and an exemplar for the rest of the world. By granting universities the intellectual property rights over discoveries from federally funded research, Bayh-Dole motivated universities and their faculty members to take an active role in commercialization.

There are suggestions that Bayh-Dole created perverse incentives that motivated universities to manage intellectual property solely for the purpose of generating revenue.[22] Many universities facing dwindling state funding for higher education now come to view technology transfer is a potential revenue source. Yet technology transfer fundamentally aligns with a university's overarching mission of education research and service.

Technology transfer is the mechanism by which universities ensure that the public investment in science has impact and that such investments enhance economic development and serve the public interest. University tech transfer advances teaching and learning at the same time it contributes to economic and social outcomes that help advance the national interest. These efforts serve the best interests of society, enhance national competitiveness, and affect the economic vibrancy of their local areas.

TOWARD MORE COMPREHENSIVE RANKINGS

Many American families with children observe an annual ritual of marking the inside of a door frame with the height of each child, noting the progress made as the children grow. The simple act of recording, sharing results, and reflecting on both the past and expectations about the future is a shared universal human experience.

Without measurement, it is impossible to understand where we stand and assess if growth occurred. Without charting progress, we have no benchmark for performance. And when comparing performance to peers, there can be aspiration as well as a pathway for improvement. Yet just as parents consider the annual measurement of children without judgement, so too do we examine the success of universities with an understanding of their constraints and their unique situations. The intent in ranking universities in our index is not to reward nor to punish but simply to capture this moment in time and to comprehend where we stand and what needs to be addressed moving forward.

It is in this spirit that we offer an assessment of the technology transfer outcomes of American universities and research institutions. Often these types of rankings become beauty contests or horse races – a chance for the winner to boast and other contestants to walk away unsatisfied. This is not our intention. Rather, there is a need to understand why certain universities succeed and others lag on technology transfer outcomes. Although no simple answers exist, examining the data allows us to chart progress, understand limitations, and develop strategies that promote growth and new opportunities.

To make those rankings more meaningful, however, we need a more comprehensive understanding of what technology transfers are as they relate to research universities.

Technology transfer is an old term whose meaning has evolved in response to an increased understanding of the process of innovation. In today's economy, technology transfer describes the flow of knowledge from one organization to another, and knowledge is notoriously difficult to contain and to measure.

Technology transfer was prominent during the Kilgore-Bush debates that defined the post-war social contract for science and increasing federal funding for research. The once dominant linear view of innovation as a unidirectional flow has been replaced by the concept of an innovative ecosystem, which highlights the complexity of the creation and use of knowledge and the formation of authentic and mutually beneficial relationships.[23] Flows of knowledge, in other words, are multidimensional, interconnected, and recursive – a living organism rather than a machine or an old house remodeling rather than new construction project.

This is relevant for universities, which often exist within localized innovative or entrepreneurial ecosystems.[24] An entrepreneurial ecosystem includes all companies – big and small, entrepreneurial, and established, high-tech, and service-oriented – the availability of finance and investment capital, and the quality of government services and regulation. This ecosystem is defined by workers and their skills, entrepreneurs who create value and recycle their resources, and the local champions who make long term investments in their communities.[25]

Technology transfer is often simply associated with patenting just as invention is associated with innovation and economic development is associated with economic growth. So before moving forward to measurement, we need to clarify these terms.

Invention is the creation of a new idea, artifact, or prototype that becomes the basis for an innovation, while innovation itself occurs when value, either economic or social, is realized from that new concept. Economic growth is an increase in aggregate output while economic development is the creation of wealth that materially affects well-being and quality of life. Economic growth leads to economic development when yields are equitably distributed. Patents, meanwhile, are ownership of a piece of intellectual property – nothing more. For universities, patents are an intermediate-stage outcome of formal technology transfer and do not capture software and digital products that are covered by trademarks.[26]

> "If you look at history, innovation doesn't just come from giving people incentives; it comes from creating environments where their ideas can connect."
>
> **Steven Johnson**
> *Where Good Ideas Come From. 2011.*

Technology transfer occurs at the intersection of research and productive organizations, and it is driven by both the supply of ideas and the demand for solutions. Technology transfer can be conceptualized as a marketplace for ideas rather than the purchase of specific pieces of intellectual property.

Our index reflects this enhanced understanding by measuring success at multiple stages of the formal technology transfer process as well as metrics of informal technology transfer. Formal technology transfer is important and easy to track. Informal technology transfer is more complex, but it can be captured by measuring interactions with industry and through the release of university graduates who carry knowledge and know-how with them as they assume productive roles in the economy.

FORMAL TECHNOLOGY TRANSFER

Formal technology transfer begins when federal funds used for research result in a discovery with commercial potential. This requires a faculty member to file an invention report or invention disclosure, which then becomes the basis for intellectual property protection.

Typically, IP protection takes the form of a patent, but trademarks are also used, especially for software. IP protection allows universities to license an invention to a commercial entity, either an established organization or a new startup, to use in product creation. By licensing an invention, universities can generate financial returns in the form of royalties and licensing income. This is a simplified version of the process, and there are variations depending on the technology and the specific university or research organization in question.[27]

Formal technology transfer is a popular subject in academic literature.[28] Academics study this process because it is linear and well-defined, with data readily available from surveys and from TLOs themselves. Many prior indices have been based off formal tech transfer, including those published by the Milken Institute. Those results, however, are not directly comparable with this report, which also includes informal tech transfer indictors.

There are four considerations to keep in mind about measuring and comparing formal tech transfer.

First, outcomes associated with innovation in general, and formal technology transfer more specifically, are highly skewed.

While we use averages to describe much of human activity, innovation leading to spectacular and rare outcomes are often extremely impactful.

Examples of lucrative commercialization outcomes include *Lyrica* from Northwestern, which brought in $1.4 billion of licensing income from Pfizer, and Eli Lilly's cancer therapy *Alimta*, which led to Princeton University collecting $524 million in licensing income. Other examples include the cancer treatments *Taxol* from Florida State University and Cisplatin from Michigan State University, a Hepatitis-B vaccine from UCSF, the antiretroviral *Zerit* from Yale University, and the glaucoma treatments *Xalatan* from Columbia University and *Trusopt* from Michigan State University.

These home runs and their lucrative licensing deals enrich university endowments but also divert attention away from more frequent, incremental innovation. The allure of potential monetary rewards from formal technology transfer threatens to erode the traditional scientific norms that were instrumental in creating American technological leadership.[29]

Second, and more replicable as a practice, is the lesson that technology transfer relies on consistent transactions.

Building relationships with companies to sponsor research allows universities to refine and develop ideas more fully, which can result in multiple licenses and the hiring of students.

MIT, as a case in point, has not had technology transfer licenses that would be considered a home run, but has been able to reliably engage in formal tech transfer. Rather than aiming for the one big success, a portfolio of multiple options offers a more reliable long-term strategy. Companies that license technologies while also sponsoring additional research, hiring graduates, and making use of university expertise are effective technology transfer partners. There is, however, currently no easy way to track the depth of these relationships.

Third, internal university organizational practices are key to understanding performance.[30]

The formal university tech transfer system is still emerging. In contrast to other university functions, such as sponsored research, there is great experimentation and adaptation taking place. Universities that do well with formal tech transfer have typically devoted resources and manpower to this process for a long time. The University of Wisconsin Alumni Research Foundation (WARF) started in 1925 to commercialize discoveries related to vitamin fortification. The invention, made by Harry Steenbock, a professor of biochemistry, added back vitamins that were taken out of foods during pasteurization. Not only did this discovery provide increased benefit to the public, but the invention also helped Wisconsin's economically important dairy industry. Rather than manage the patent as an individual, Steenbock worked with university officials to create WARF as an independent, nonprofit corporation that would manage the university's patented technologies and re-invest licensing revenues to support future university research. This model was codified in the 1980 Bayh-Dole Act and has diffused among American universities in the form of technology licensing offices.

University technology licensing offices (TLOs) operate as an interface between the supply of academic science and the demand for university inventions. Rather than a deterministic relationship based on the dollar amount of research funding received, formal technology transfer outcomes are influenced by the incentives offered to faculty, university support, and the ease of engaging with the TLO.[31,32]

Among universities there is great experimentation with different incentives for faculty to engage in tech transfer, such as offering higher royalty splits and including tech transfer activity as part of tenure and promotion decisions. The impact of small changes in distribution formulas is not a strong motivator for faculty because the outcomes are uncertain.[33] Support services and the ease of working with the TLO appear more important.

The operations, organization, and strategies of the university also factor into the differences in outcomes.[33] TLOs have different reporting relationships, levels of autonomy, and commitments of resources. For example, some offices report directly to the chancellor or university president. This signals that the TLO is an institutional priority with access to key decision-makers. A few TLOs are independent entities such as the WARF. There is also experimentation with licensing consortium involving multiple universities.[34]

Different organizational strategies yield different outcomes as universities trade off different objectives. Some universities focus on start-up firms while other universities have relationships with established firms that license technologies; most universities balance the two strategies. Inventions are typically licensed when they are still in an early stage of development, which has an effect of reducing royalty rates but may increases the likelihood the licensee will sponsor subsequent research to move the invention forward.[35]

Universities are experimenting with different programs to support and enhance technology transfer. Most American universities have mobilized resources around teaching and promoting entrepreneurship for both students and faculty.[33] Many universities have, or are affiliated with, incubators, accelerators, angels, and venture capital investment funds.[36] Many of these programs actively engage with the larger local community and provide great social benefit. Some universities, notably Carnegie Mellon, have actively engaged in building entrepreneurial ecosystems that have benefited their region.

Universities have also worked to further the development of their technologies. One example, San Diego State University's Pilot Innovation Fun provides prototyping grants to move inventions closer to the market and reduce risk to potential corporate partners, investors, or customers. Many universities have National Science Foundation's Innovation Corps (I-Corps™) programs that engage researchers with commercialization.

Another factor when evaluating outcomes is the financial investment made by the university. Formal technology transfer activity is typically underfunded, with an expectation that licensing royalties will cover operating costs. Bayh-Dole provided the means to patent and license technology, but there is no corresponding funding or ear-marked federal research expenditures to fund technology licensing activities. Many offices struggle to accomplish their mission: patenting is expensive and defending IP requires vigilance for possible infringement and expensive litigation when infringement occurs.

The most successful TLO operations have typically befitted from a lucrative licensing agreement and subsequently invested in greater capacity. For example, Columbia University has reinvested revenues in building capacity, staffing their TLO with professionals with specialized expertise, and providing opportunities to engage students in all aspects of the process. Well-developed technology transfer offices have resources to develop new strategies to smooth the transition of research discoveries to market. Not every university has these resources. Valdivia (2013) calculates that 87% of TLOs did not break even after covering wages of their staff and the legal costs for the patents.[37]

Fourth, academic institutions differ in terms of the amount and type of research conducted.[38]

The formal technology transfer process starts with federally funded R&D. In 2018, the federal government provided $42 billion in funding (53% of university research expenditure).[39]

The major contributors of federal funding are agencies such as the Department of Defense, Health and Human Services (HHS), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and the Department of Agriculture (USDA) who advance a specific mission. HHS, which includes the National Institutes of Health, is by far the largest funding agency, providing more than half (55%, or $22.9 billion) of federal support for academic research in 2018. Life sciences research dominates nationally funded academic research and is a major contributor to formal technology transfer.

The Department of Defense (14%, or $5.9 billion), DOE (4%, or $1.8 billion), NASA (4%, or $1.5 billion), and USDA (3%, or $1.2 billion) provide significant funding that is may be tied to specific initiatives. DOD and DOE allocated funding to labs that are run by universities for the government and may have restrictions on formal tech transfer due to national security concerns.

The National Science Foundation (NSF), which broadly funds investigator-initiated research funded $5.3 billion (13% of federal research expenditures) and actively supports startup and industrial outreach activities. The consideration to keep in mind is the sources of university research funding dictate the raw materials available to TLOs.

Organizations, such as for-profit firms, foundations and non-profits, and state and local governments also fund university research. Research funded by non-federal sponsors typically specify technology transfer stipulations in their sponsored research contract agreements.

For-profit firms are responsible for about seven percent of university R&D expenditures overall, with significant variation between universities. Inventions from firm-funded research requires a different process, as for-profit firms search for research to advance firm's goals.[40]

Since federal funded research is the focus of formal tech transfer, firm related activity may not be reflected in the numbers used in our index. Therefore, universities that receive significant funding for other sources should scale their numbers according.

INFORMAL MODES OF TECHNOLOGY TRANSFER

Technology transfer occurs outside of formal channels in two important and measurable ways: engagement with industry and the education of students. These informal means are more difficult to capture but are important to any consideration of the impact of university technology transfer.

Technology transfer occurs with industry through the creation of joint ventures, participation in partnerships, and cooperative research agreements. Further engagement involves a myriad of activities such as co-authorships, sponsoring research, serving as advisors and board members, and providing philanthropic contributions that set strategic directions.

Systematic data on these interactions is limited, although surveys of R&D managers find that university research has a crucial effect on industry innovation though informal channels.[41]

An important informal way firms use academic research is through reading the academic literature, attending academic conferences, and having discussions and interactions with researchers.[42] The relevance of these interaction is demonstrated by their use a frequent policy instruments enacted by local and national policymakers to foster pre-competitive research and firm innovation activities.[43] This bi-directional sharing of information is mutually beneficial.

One reliable and available measure of informal interactions is citations to prior articles contained in patents granted to firms. Patent applications contain references or documents which may be used to determine if the patent application meets the criteria of novelty, usefulness, and non-obviousness of claimed subject matter. These citations reference earlier patents and printed documents instrumental in defining the invention described in the patent application. Citing references is required so that anyone reading a patent may identify and retrieve the cited publications and replicate the invention. If the author is an academic, their university affiliation is included or relatively easy to identify in a patent's bibliography.

These data provide insights into the academic articles useful to firms in their invention process. The important aspect of patent citations of university research for our purposes is that we have an artifact that reveals the transfer of ideas from the university to the firm. The inclusion of a reference in the patent indicates that the academic article contributed materially to the firms' patent filing.

"The act of learning itself is no longer seen as simply a matter of information transfer, but rather as a process of dynamic participation, in which students cultivate new ways of thinking and doing, through active discovery and discussion, experimentation and reflection."

Susan C. Aldridge
President University of Maryland System (2006 – 2012).

The graduation of students and their release into the labor force is perhaps the single largest act of technology transfer at any university. A primary objective of academic institutions is to educate students. University research provides an intellectual framework for training professionals who are then able to transfer what they have learned to their employers. The education of the workforce and the human capital developed is tied to the economic growth of the economy of the nation, the region, and the state.[44,45]

While all university education is valuable, degrees in science, technology, engineering, and math (collectively known as STEM) are particularly relevant to the transfer of ideas to industry. Research institutions impart research and problem-solving skills as a critical component of STEM baccalaureate degrees.

Universities have introduced new master's degrees aimed at providing specialized training.[46] While the market for Ph.D. trained scientists is national or even international, markets for undergraduate and master's degree candidates are more regional, so measures of STEM graduates at the bachelor's and master's level can be thought of as an indicator of human capital creation at a more localized level. Graduates will join existing companies and start new companies. While formal technology transfer only tracks new firms that license technology, there are many other firms that are started by recent graduates.

Finally, it is important to recognize that there are certainly other ways that universities transfer technology that are not amenable to easy measurement but should still be acknowledged. Consider the COVID dashboard created at Johns Hopkins which became a reliable source for information on infection and hospitalization rates.[47] This invention was recognized with the 2020 *Making a Difference Award* by the Environmental Systems Research Institute (ERSI). The initial idea of Ensheng Dong, a doctoral student, the iconic dashboard was developed through cross-campus collaborations.[48]

Similarly, much university research has a significant public impact but does not involve proprietary licensing. AUTM, the Association of American Universities (AAU), and the Association of Public and Land-grant universities (APLU) all have efforts to emphasize balancing income generation and public benefit in tech transfer.[49] Efforts such as APLU's *Public Impact Certification document* and codify these practices yet data are qualitative and not yet amendable to inclusion in rankings.

Emphasizing societal benefit can be challenging due to the difficulty of systematic measurement. Without an office like the TLO, faculty, students, and staff contribute broadly to society yet there is little gatekeeping, nor is it clear how this tracking might become operational without undue burden on faculty. However, the degree of formal technology transfer activity is correlated with informal tech transfer: faculty members who participate in formal tech transfer are more likely to engage informally in activities that create social benefit.[50] This societal orientation is one of the factors that defines academic behavior.

In the spirit of measuring progress and providing information to improve the process of technology transfer, we generate our rankings relying on many of the measurable formal and informal tech transfer activities. The next section describes our methodology and the weighting given to different indicators.

TABLE 2: UNIVERSITY TECHNOLOGY TRANSFER INDEX VARIABLE WEIGHTS

PERCENT OF TOTAL WEIGHTING				
	SOURCE	**AVERAGE VALUE (2017 – 2019)**	**NORMALIZED AVERAGE VALUE (2017-2019)**	**TOTAL VARIABLE WEIGHT**
Invention Disclosures	AUTM (2019)	5.55	5.55[1]	11.11
Licenses and Options Issued	AUTM (2019)	5.55	5.55[2]	11.11
Gross Licensing Income	AUTM (2019)	11.11	11.11[1]	22.22
Startups formed	AUTM (2019)	11.11	11.11[1]	22.22
Academic works citing patents	Lens.org	5.55	5.55[1]	11.11
STEM Bachelors Graduates	JobsEQ, IPEDS	5.55	5.55[3]	11.11
STEM Masters Graduates	JobsEQ, IPEDS	5.55	5.55[3]	11.11
Total		**50**	**50**	**100**

1 Normalized by the average dollar amount of reported research expenditures (2017-2019).
2 Normalized by the average number of invention disclosures received (2017-2019).
3 Normalized by the total student population for the relevant category. STEM bachelors' degree as a percentage of undergraduate students. STEM masters graduates as a percentage of all graduate students.

TRANSFER DATA - OUR JUSTIFICATION AND CHOICES

Our rankings relied on four data sources to broadly cover the technology transfer activities for 166 universities. The AUTM[51] annual licensing survey know as Statistics Access for Technology Transfer (STATT) covers formal technology transfer activity, while Lens.org. Data from IPEDS and JobsEQ captures the transfer of technology via human capital. Each of these is detailed in this section. Table 2 provides an overview of the variables and their weighting. Additional information and the full rankings can be found in the Appendix.

AUTM is a professional organization that supports "the formal transfer of new discoveries and innovations resulting from scientific research conducted at universities and nonprofit research institutions to the commercial sector for public benefit."[52] AUTM conducts an annual licensing survey that provides quantitative data about licensing activities at U.S. universities, hospitals, and research institutions. Participation in the AUTM annual survey is voluntary.

The AUTM data are proprietary and are the most reliable and comprehensive indicator of formal technology transfer. Data are self-reported, and we accepted values as reported.[53] We based our analysis on the 2020 AUTM licensing survey and averaged values for fiscal years 2017, 2018, and 2019. This allowed us to smooth out single-time events and yearly fluctuations.

There are two caveats in making comparisons between institutions.

First, many public institutions are affiliated with state university systems, which are typically geographically distributed but aligned both in name and governance. Data are reported to AUTM for 15 university systems. To generate a fair comparison, we considered only individual universities in our calculations.

Notably, the University of California system, with nine individual universities, and the University of Texas, with eight individual universities, dominate performance due to their size. These two systems, however, report technology licensing activity for their individual institutions on websites and/or in annual reports. We used this data for the individual institutions of the University of California system and the University of Texas system in our index calculations. This allowed for an apples-to-apples comparison.[54]

Other university systems which report to AUTM as a system but did not make data on individual campuses publicly available were not included in this analysis. A related issue is that some universities report data including research output from affiliated hospitals while other universities report to AUTM separately for the university and the affiliated hospital. There is no uniform reporting format and interpretation of the results should consider this variation.[55]

A second caveat is that universities differ in terms of mission, with public institutions prioritizing access to education, local engagement, and economic development more than private universities. Public institutions are also subject to greater oversight and constraints than private institutions. Private universities tend to have access to greater resources and more operating flexibility.

The distribution of formal technology transfer activity among universities reflects wide disparities that are prevalent within the U.S. university system where resource distribution of endowments, and public and private funding of research is heavily lopsided. For these reasons, we present ranking separately for public institutions (Table 4), and for universities that do not have medical schools (Table 5). We also present results based on quartiles of the university research expenditures to facilitate peer assessments (Table 6–9). Invention disclosures or invention reports are from the

AUTM annual licensing survey. Faculty are obligated to report discoveries with commercial potential to the TTO in the form of an invention disclosure. An invention disclosure may result in one or more patent applications being filed or multiple invention disclosures may be combined into one patent application. Invention disclosure serves as a measure of faculty receptiveness to participation in formal tech transfer.

Our rankings notably do not include patent applications or granted patents. Patent applications are highly correlated with university research expenditures and reflects differences in TLO strategy. Many universities only file for patents when they are ready to issue a license. Granted patents are highly correlated with patent applications and reflects the vagaries of the U.S. Patent and Trademark Office.

Licensing is a next step in the commercialization process. The number of licenses executed signals the commercial development of new products and services and is a leading indicator of future licensing revenue. An option is issued as a step toward signing a licensing agreement and serves as an indicator of commercial interest. The number of licenses and options also reflects TLO hustle and the ability of the staff to execute on the inventions received. In 2019, the average was 8.35 licenses/options per licensing staff (AUTM 2018).

Licensing revenue, which is a result of a successful tech transfer, is double weighted. Seven universities (4.22%) either did not report values for gross licensing income or reported having no gross licensing income over the three years (2017-19). The average for all universities was just over $10.7 million, while the median value for all universities was approximately $1.28 million. Just two universities, Carnegie Mellon University and Northwestern University, reported licensing income greater than $250 million. Due to the highly skewed nature of licensing revenues, we used a log transformation when analyzing this variable.

Startups, the formation of new firms around university licenses, were also double weighted. The AUTM definition of startups is narrow in that it is restricted to companies that were dependent on a license from the university. More formally, these new ventures are considered spinoffs and do not consider the many new firms started by university faculty staff and students that do not rely on a formal license.[56,57,58] Such numbers are more difficult to track but certainly significant.

Overall, the mean number of startups reported to AUTM was 5.5 per year, with a median of three firms per year and a mode of two startups per year. The distribution of startups is highly skewed (standard deviation of 8.7) – some universities generate many startups. Some TTOs, such as the University of Utah, have focused their attention on start-up activity. Other universities, such as the University of California San Diego and MIT, are in ecosystems that provide generous support services and lower the barriers to new firm formation. In contrast, 21 universities (12.65%) reported no start-up activity in the three years considered in this index.

To measure informal technology transfer, we used Lens (www.lens.org), the flagship product of the social enterprise Cambia, which provides a publicly available patent database that tracks citations to academic articles, their authors and institutions. We obtained counts of scholarly works that have been cited by patents issued between January 1, 2017 and December 31, 2019.

To measure human capital, we used the Education Data Explorer from JobsEQ for Education, a software tool provided by Chmura Economics. We pulled the number of STEM (science, technology, engineering, and math) degrees awarded for bachelor's and master's degrees for each of the 166 institutions for 2017, 2018 and 2019. Both the average number of STEM master's graduates and STEM bachelor's graduates, respectively, were incorporated in the index.

In sum, the index is measured using three-year averages (2017-19) for seven key indicators of technology transfers.[59] We used four indicators from AUTM: invention disclosures, licenses and options issued, licensing income, and startups formed. For citations, we used the total count of non-patent citations for industry patents granted from 2017 through 2019. Finally, we included measures of human capital transfer through the inclusion of STEM bachelors' and masters' graduates.

A primary consideration in the formation of this index is the balance between the absolute and relative measures of commercialization. Absolute outcome measures are tangible and easily understood but the productivity or efficiency of formal tech transfer required that we normalize by some measure of capacity.

Each variable is included in the index both directly as a count or, in the case of licensing income as a dollar amount, and as a normalized value. Invention disclosures, licensing income, startups, and citations are normalized by the three-year average of research dollars received by each university. Licenses and options issued were normalized based on the three-year average number of invention disclosures received by each university.

STEM graduates were normalized by the total relevant student population (bachelors student population and graduate student population, respectively) obtained from (IPEDS). Additionally, STEM master's graduates as a percentage of all graduate students, and STEM bachelors' graduates as a percentage of all undergraduate students were included as variables in our index. The total number of graduate students and undergraduate students were obtained from the National Center for Education Statistics' (NCES) Integrated Postsecondary Education Data System (IPEDS).

In addition, performance relative to the top performer for each measure gives us insight into how each institution performs against the highest standard of achievement. To gauge this relative performance, the score for each variable was indexed to the highest performer, yielding a score of 100 for the top-ranked institution. This indexing was conducted for both the direct value and normalized value for each variable.

Finally, Table 2 describes the weighting scheme used in the overall index creation, which combines both the count or dollar amount value and the normalized value of each variable. We double weight licensing income and the number of startups. STEM bachelors and masters' graduates are separately included in the index, such that the weight of human capital generation in the index is also twice that of other, single-weighted variables. The composite scores are once again scaled against the top performer to generate the overall indexed score of each university. We then ranked the composite scores in descending order to define our overall ranking.

TABLE 3: TOP 25 WITH SCORES FOR EACH COMPONENT

RANK	INSTITUTION	LICENSES AND OPTIONS ISSUED SCORE	GROSS LICENSING INCOME SCORE	INVENTION DISCLOSURES RECEIVED SCORE	STARTUPS FORMED SCORE	CITATIONS TO INDUSTRY PATENTS SCORE	STEM BACHELOR'S DEGREES SCORE	STEM MASTER'S DEGREE SCORE	INDEXED SCORE
1	Carnegie Mellon University	10.82	100.00	31.53	37.21	9.60	17.70	63.56	100
2	University of Florida	28.83	92.37	43.28	52.33	17.11	74.36	44.78	98.72
3	Columbia University	9.08	91.17	51.39	87.21	21.22	26.42	100.00	98.37
4	Stanford University	17.35	90.87	66.24	86.05	55.44	20.76	36.07	95.5
5	Harvard University	13.29	92.54	58.83	58.14	100.00	29.85	34.25	94.96
6	University of Pennsylvania	20.02	93.23	45.22	56.98	36.35	26.22	40.24	93.88
7	North Carolina State University	19.01	79.59	35.00	65.12	8.67	54.39	43.85	92.79
8	University of California, San Diego	7.65	86.83	47.54	80.23	34.34	89.19	37.41	92.64
9	University of California, Los Angeles	6.26	92.65	41.27	69.77	34.42	100.00	35.03	91.47
10	University of Minnesota	25.70	86.65	49.52	58.14	25.86	73.54	31.51	91.01
11	Massachusetts Institute of Technology	17.66	90.44	100.00	100.00	45.95	16.76	27.12	90.81
11	Purdue University	15.34	80.54	44.02	73.26	12.93	63.84	30.12	90.81
13	Northwestern University	5.53	99.79	27.02	37.21	25.90	25.75	35.45	90.58
14	Cornell University	10.05	84.82	55.44	56.98	33.76	42.04	39.14	90.35
15	Duke University	13.49	91.51	40.46	50.00	25.55	26.03	26.09	88.29
16	University of Michigan	24.07	84.93	59.16	63.95	30.12	74.98	63.53	87.56
17	New York University	6.65	95.29	21.39	45.35	16.65	39.15	66.14	87.05
18	University of Washington	44.36	86.52	36.37	45.35	35.11	78.96	42.27	86.51
19	California Institute of Technology	7.88	81.80	31.82	58.14	12.78	3.33	3.54	86.36
20	University of Texas at Austin	11.48	84.64	19.90	43.02	17.19	75.99	28.25	85.97
21	University of Pittsburgh	18.16	78.81	43.81	63.95	22.96	45.91	21.44	85.78
22	Princeton University	3.44	88.75	13.12	23.26	11.27	15.14	13.46	85.62
23	Brigham Young University	4.91	75.72	9.02	51.16	1.47	41.12	6.54	84.5
24	University of Chicago	3.32	80.61	16.96	29.65	17.54	21.19	28.05	84.46
25	University of California, Berkeley	3.59	82.83	24.39	45.35	24.35	89.99	38.48	83.57

THE RANKINGS

Rankings are provided for the comparable sets of universities.

First, we examine the 25 universities with the highest score and provide a deep dive on their performance. Next, we consider the rankings for public universities and then the rankings for universities without medical school. Finally, we consider the performance of universities that have similar research capacity.

We split the 166 universities into four quartiles and present the top 10 performers. Full rankings are presented in the Appendix.

TOP PERFORMING UNIVERSITIES

Each institution in our top 25 is ranked on performance for the 14 component indictors (Table 3). Our objective is to provide greater transparency and to provide details on each institution's strengths and weaknesses.

1. CARNEGIE MELLON UNIVERSITY (CMU)
Pittsburgh, Penn. (Index value 100)

CMU is the highest performer and the benchmark for the scoring of other universities. This private school has used research in computer science, material science, robotics, artificial intelligence, and cyber-security to create significant economic impact and reap the rewards of commercialization. Notably, CMU does not have a medical school but does collaborate with the University of Pittsburgh (No. 21).

CMU established formal tech transfer activities in 1993 at a time when the Pittsburgh region was undergoing significant industrial restructuring after the loss of its traditional manufacturing base.[60] Over time, working in partnership with the City of Pittsburgh and the business community, CMU has built a vibrant entrepreneurial ecosystem with the university at its center.

CMU ranks first in Gross Licensing Income, outperforming its peers both in dollars and when normalized for research expenditure. The ability to support faculty entrepreneurs contributes to this achievement. Luis von Ahn, founder of reCAPTCHA and Duolingo, has grown both businesses while continuing on the faculty. reCAPTCHA was acquired by Google in 2009 and is part of a long-term research relationship.[61] Duolingo spun out of Carnegie Mellon in 2011 and went public 10 years later, and in 2020 the app was used by 300 million to learn new languages.[62]

The Swartz Center for Entrepreneurship (which grew out of Project Olympus which helped incubate Duolingo) and the Center for Technology Transfer and Enterprise Creation (CTTEC) lead the technology transfer and university entrepreneurship support.[63] The external-facing Center for Business Engagement leads sponsored research and co-location programs.[64] Many companies, including Apple and Facebook, opened co-located operations in the Carnegie Mellon Collaborative Innovation Center building and then outgrew the space and moved to tech campuses spread across Pittsburgh.

CMU graduates a large number of STEM master's students, ranking fifth for the number and third for the share of their master's STEM graduates. Demand for their well-trained students and connection to Carnegie Mellon researchers have lured many technology companies to the Pittsburgh region and demonstrates how top-tier computer science and engineering departments and cutting-edge new interdisciplinary research programs, such as robotics, can create economic opportunities beyond the campus. Uber located its autonomous driving unit in Pittsburgh, and Google announced in 2021 that it would expand its local office space to 320,000 square feet to accommodate its growing workforce.[65]

2. THE UNIVERSITY OF FLORIDA (UF)
Gainesville, Fla. (98.72)

Florida is the highest performing public institution over the period analyzed. What distinguishes this university is not its performance on any one indicator, but rather its strong performance across the board, contributing to the successful transfer of technology on all dimensions. UF Innovate reports that its innovation ecosystem has created more than $10.4 billion in private investment and that its technology licensing has launched more than 200 startups.

Florida ranks third for licenses and options issued and eighth for both the raw and normalized gross licensing income generated. This indicates a strong portfolio of intellectual property with commercial value.

Gatorade, the iconic beverage that launched the sports drink industry, was invented in 1965 (pre-Bayh-Dole) and provides an example of the tensions and rewards of prudent management of university inventions. Rather than a license for a patent, Gatorade is licensed as a brand.[66] Licensing revenues accrue to the Gatorade Trust, with a royalty split yielding $20 million annually and over $300 million to UF cumulatively.[67,68] These funds have seeded university research projects, which have been leveraged into additional funding that further contributes to the university enterprise.

Gatorade set the tone for UF tech licensing and demonstrated the potential of formal technology licensing, and the university has benefited from multiple pharmaceutical and agri-tech patents, including the blockbuster glaucoma drug Trusopt.[69] UF ranks third in licenses and options, indicting future licensing potential of continuing innovation and licensing revenues. Businesses and entrepreneurs interested in licensing University of Florida innovation can search a database of available solutions and technology. The technology transfer office also markets technologies to generate leads and connect innovators with potential client businesses.

Startups founded out of the University of Florida continue to put innovation to work. The university ranked 16th for the number of start-up firms launched. Entrepreneurial support is provided through *UF Innovate|Accelerate* at two venues – The Hub in Gainesville and at Sid Martin Biotech in Alachua, North Central Florida, thus extending the geographic reach of UF.[70]

The latter, awarded Rural Entrepreneurship Center of the Year in 2020, focuses on biotech business incubation and has graduated ventures like AxoGen, Inc., a Florida-based biotech firm focused on peripheral nerve regeneration and repair that licenses UF technology.[71,72] These ventures draw on the graduates with large numbers of bachelor's (11th) and master's (12th) students graduating with STEM degrees and taking what they learned into the workforce.

3. COLUMBIA UNIVERSITY
New York, N.Y. (98.37)

This private university, with 45 professional staff assisted by more than 30 graduate students and postdoctoral fellows known as CTV fellows, provides broad support to the Columbia community and other stakeholders.[73] Columbia Technology Ventures (CTV) is well positioned to leverage its location in a major global economic and financial hub to convert relevant university research and inventions into economic activity.

Columbia ranks second for the number of startups formed. And building on its long history of successful technology transfer, the university continues to innovate to better connect its intellectual property to entrepreneurs and businesses that can use it. The Columbia Lab-to-Market Accelerator Network takes the expertise from the many field-focused accelerators and industry partnerships at Columbia and builds cross-sector best-practices and shared resources.

To build on this success, Columbia has launched the Startup Fellows program where entrepreneurs will work on campus in partnership with Columbia researchers using university resources to tackle urgent social needs.[74] These collaborations will involve startups that have raised less than $1 million with a climate and engineering focus.

Columbia University is also a major source of STEM talent. More students graduate with a STEM master's

degree from Columbia than any other university on our ranking, showcasing the importance of the knowledge transfer graduates carry into their first employers. Although it cannot compete on raw numbers with some of the public universities on this list at the undergraduate level, Columbia ranks sixth for the share of bachelor's degrees granted that are in STEM disciplines.

An example of how university technology transfer can power knowledge-based economic development strategies is the public-private partnership between CTV and the New York City Economic Development Corporation (NYCEDC).[75] Together they have launched a new cyber-security focused early stage accelerator and talent matching platform called Inventors to Founders, which aims to develop the New York City cyber-security hub into a global leader.

4. STANFORD UNIVERSITY
Stanford, Calif. (95.50)

This private university is a trailblazer in technology transfer. Stanford's role in the development of Silicon Valley as a source of talent, technology, and entrepreneurs is well-established. In the 50 years between 1970 and 2020, Stanford generated more than $2.1 billion in licensing revenue, launched more than 400 startups, and signed more than 21,000 industry research agreements.

By advocating for the Bayh-Dole act in 1980, Stanford helped pave the way for other universities and research institutions to commercialize federally funded research. The early successful licensing of the Cohen-Boyer patents provided an exemplary case of formal tech transfer.

Looking beyond patent applications and licensing agreements, the Office of Technology Licensing (OTL) aims to maximize the value from patented technologies developed at Stanford. It actively markets technology to companies that might be interested in licensing it, seeking to maximize return and help the technology succeed.

Stanford ranks third for the number of startups formed. A wealth of information on resources available for potential founders is available on the OTL website. OTL staff work with inventors to assess and shepherd their ideas through the process. Graphite Bio, a startup co-founded by Stanford researchers that uses gene editing therapy to treat diseases, secured $150 million in its Series B funding round in 2021.[76]

Industry partnerships, through sponsored research and industry affiliate programs, harness Stanford's expertise and equipment to conduct research relevant to the challenges facing private sector partners. The university performs well on measures of relevance of its research, ranked second for the number of academic articles cited in industry patents.

These commercialization successes are built on a rich supply of innovation at Stanford. The university ranked second for the number of invention disclosures received, and during the COVID-19 crisis, aimed to make it easier to put this research to work for the public good. Along with other leading research universities, including Harvard and MIT, Stanford participated in the COVID-19 technology access framework to smooth the use of university inventions to address the crisis.[77] In the framework, these universities committed to implementing "rapidly executable non-exclusive royalty-free licenses to intellectual property rights that we have the right to license, for the purpose of making and distributing products to prevent, diagnose and treat COVID-19 infection during the pandemic and for a short period thereafter."

5. HARVARD UNIVERSITY
Cambridge, Mass. (94.96)

Housed in the Office of the Provost and operating university-wide, the Office of Technology Development (OTD) anchors the technology transfer initiatives for this private university.

With the top-ranked medical school in the U.S., Harvard research has yielded innovations that improved human health by building understanding of the functioning of diseases, including cancers and Alzheimer's, and by developing new therapies.

In keeping with the university's reputation as a premier research institution, the number of academic articles cited in industry patents indicates the scope and relevance of Harvard research and inventions. The university ranks first in the number of academic articles cited in industry patents and second when scaled to reflect research expenditures. This prominence has also brought licensing income back to the university – Harvard ranks seventh for its gross licensing income.

Harvard is part of the University Technology Licensing Program (UTLP), a collaboration of 15 research universities that facilitates the licensing of university intellectual property and technologies.[78] Participating universities contribute specific material science patents to the pool managed by UTLP, and technology firms wishing to license anything from the pool can do so in a more streamlined way from this central repository. This initiative hopes to speed and smooth the licensing of university patents to contribute to economic growth.

Looking beyond the ivory towers for ideas and support, the OTD shares a range of resources with potential university entrepreneurs from within Harvard, within the broader New England innovation ecosystem, and beyond with the aim of putting innovation to commercial use.[79] For example, Verve Motion is a Harvard startup that creates wearable support for staff that helps reduce the risk of on-the-job injuries for warehouse and freight industry workers.

Two accelerators help develop and launch Harvard startups. The Blavatnik Biomedical Accelerator funds and supports research with commercial potential and works to grow projects into meaningful industry partnerships.[80] The Physical Sciences and Engineering Accelerator focuses on developing technologies through proof of concept to the point where they are ready to form the basis of a startup, a license, or to secure additional research funding from a private sector partner.

6. THE UNIVERSITY OF PENNSYLVANIA
Philadelphia, Penn. (93.88)

This private school's impressive performance was aided by its high gross licensing income, which ranked fifth overall.

The University of Pennsylvania is home to the Penn Center for Innovation, which combines the Office of Technology Transfer with other commercialization programs and resources.[81] In addition to licensing support, the Office of Technology Transfer helps with the formation of corporate alliances, where university researchers partner with corporate or not-for-profit organizations, joining forces on mutual-interest research topics, and securing additional funding for research efforts and intellectual property creation.

The school ranks 14th overall for the number of startups formed. These startups are supported with resources open to both students and faculty, including Penn I-Corps, a program provided in conjunction with the NSF to provide education, coaching, and up to $2,000 to test potential startups. The Penn Center for Innovation is home to PCI Ventures, which helps develop early stage, tech-focused businesses.[82] The school excels in the biotech space, with numerous startups focused on diagnostics, therapeutics, and medical devices.

7. NORTH CAROLINA STATE UNIVERSITY
Raleigh, N.C. (92.79)

This public university anchors North Carolina's Research Triangle Park and has a comprehensive Office of Research Commercialization, which aids both university innovators and corporate and community partners in the commercialization process.[83] The office is especially focused on assessment of invention disclosures and licensing processes, holding the eighth-highest number of licenses and options issued. The office also provides resources toward startup creation. These include mentorship opportunities for students, workshop series for faculty, creative services for all affiliates, and guidelines for commercializing licensed university technology by building a startup. These resources

appear to have worked well, leading NC State to the seventh-highest number of startups generated out of all universities considered.

The school also has a high number of STEM master's students relative to other institutions, ranking 13th overall. NC State prioritizes a wide variety of STEM degree programs beyond courses of study typically offered at institutions.[84] Its College of Textiles, for instance, includes degree programs such as Polymer and Color Chemistry and Textile Engineering, and its College of Natural Resources is home to degree programs including Paper Science and Engineering.[85] Many students make an impact in industry immediately after graduation, providing valuable human capital to the surrounding area and the country at large. The focus on STEM also is seen in the attention to resources for STEM students.

8. THE UNIVERSITY OF CALIFORNIA, SAN DIEGO (UCSD)

San Diego, Calif. (92.64)

The school started as a campus for graduate students in physics, chemistry, and earth sciences, and today has a plethora of STEM graduate programs, including a medical school, the Skaggs School of Pharmacy and Pharmaceutical Sciences, and the Scripps Institution of Oceanography.[86,87] UCSD graduated the fourth-highest number of students with STEM bachelor's degrees, and the 20th-highest number of STEM master's students.

Although the University of California's system-wide Technology Transfer Office was founded in 1978, two years prior to the Bayh-Dole Act, the UCSD campus created its own Office of Technology Transfer in 1994, which became the Office of Innovation and Commercialization (OIC) in 2015.

UCSD's research activity is extensive and relevant, with research expenditures of nearly $1.2 billion and the seventh-highest production of research cited by patents. The university also places an emphasis on innovation, ranking fourth for the number of startups created. The Basement, an on-campus OIC resource, launched in 2015 and provides mentorship and startup resources for students.[88] The school has a close continuing connection to semiconductor giant Qualcomm, co-founded by former UCSD faculty. The Qualcomm Institute Prototyping Lab allows UCSD researchers to use prototyping and engineering services and machinery for their projects.[89]

9. THE UNIVERSITY OF CALIFORNIA, LOS ANGELES (UCLA)

Los Angeles, Calif. (91.47)

UCLA's output of human capital is particularly impressive – it ranked first in terms of STEM bachelor's graduates and eighth in terms of STEM bachelor's graduates as a percentage of all undergraduate students. STEM students are supported in entrepreneurial activity while their degrees are in progress.

The school has invested in creating the Samueli Makerspace, a project creation space for engineering students to use free of charge.[90] The engineering and medical schools help UCLA's standout performance in the startup space, ranking sixth overall in terms of average number of startups formed per year.

With research expenditure just shy of $1.2 billion, UCLA has proven capable of creating significant technology transfer and commercialization outputs with these research funds. The UCLA Technology Development Group (TDG) assists in technology transfer efforts, including working with industry partners for funded research project agreements.[91] These industry-sponsored research projects help build closer and more relevant research, which contributes to UCLA's high number of academic works cited by patents (ranking sixth overall).

To develop proof-of-concept for new technologies in the advanced therapeutics, medical devices/diagnostics, and digital health domains to prepare these findings for commercialization, UCLA offers the Innovation Fund.[92] The TDG recently revised its Industry Funding Opportunities portal in response to stakeholder input, continuing to reduce the friction for technology transfer. Also notable is UCLA's strong performance in gross licensing income, ranking sixth overall.

10. THE UNIVERSITY OF MINNESOTA (UM), Minneapolis, Minn. (91.01)

The fifth-ranked public schools, the University of Minnesota performed consistently well across all parameters, but excelled in the average number of licenses and options issues (ranking fourth overall), invention disclosures received (ninth overall), and startups formed (10th overall).

The university has a well-developed Technology Commercialization Office (TCO), which is home to five technology sectors, each with teams to provide more specific support and guidance: Agriculture and horticulture, creative works, engineering and physical sciences, life sciences, and software and information technology.

Beyond advising and aiding in licensing and patent processes for university affiliates, the TCO has also been groundbreaking in its approach to working with outside companies. Minnesota Innovation Partnerships (MN-IP) provides low-risk opportunities for companies to license University of Minnesota technologies through its "Try & Buy" contracting program. They also have streamlined processes for company sponsored research.

The University of Minnesota provides resources to students and university affiliates interested in entrepreneurship. The Venture Center, housed within the TCO, provides students and faculty with webinars on the startup process and advises on commercialization. It connects individuals with additional resources through its Discovery Launchpad, a startup incubator with more formal startup coaching, and Discovery Capital Funding, an equity-based investment opportunity. According to the school's TCO, over 75% of startups created since 2006 are still active today. Community involvement and integration also play a part in the successful startup ecosystem. Approximately 3 out of 4 startups created are headquartered in Minnesota, keeping the flow of innovation and community investment close to the school.

11. (TIE) MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT) Cambridge, Mass. (90.81)

With a world-class engineering, technology, and science faculty, MIT had the best record for invention disclosures, an indication of the innovation and invention created by its research.

Entrepreneurship is also core to the institution – MIT's Technology Licensing Office (TLO) recorded the most startups formed over the period examined. To make it easier for businesses to access select MIT commercial offerings, the TLO has Ready to Sign license agreements that private firms can execute quickly to license a series of MIT-developed software programs with transparent pricing and terms. One technology available for this type of licensing is ASWING, software that analyzes the aerodynamic, structural, and control-response of aircraft wings, which was developed out of research conducted in the MIT Department of Aeronautics and Astronautics.[93]

11. (TIE) PURDUE UNIVERSITY
West Lafayette, Ind. (90.81)

Purdue excels in startup creation, placing fifth for the number of ventures launched, many in the biotech and life-sciences space. The Office of Technology Commercialization is run by the Purdue Research Foundation (PRF), a private, nonprofit foundation established in 1930. In addition to patenting and licensing, the PRF fosters entrepreneurship through the Purdue Foundry and administers the Trask Innovation Fund, which was established in 1974 and offers short-term grants to develop the commercial potential of Purdue research.

13. NORTHWESTERN UNIVERSITY
Evanston, Ill. (90.58)

This private university has generated commercially valuable intellectual property, and ranks second for both the raw and normalized gross licensing income components of our index.

The Innovation and New Ventures Office at Northwestern recently announced the creation of KQ, a new startup accelerator located near the Northwestern campus and intended to foster entrepreneurship and successful technology commercialization. Firms like Volexion, a material science startup focused on battery technology and based on research out of the McCormick School of Engineering and Applied Sciences, will be housed in the new complex.

14. CORNELL UNIVERSITY
Ithaca, N.Y. (90.35)

The research conducted at Cornell is relevant to industry, and the school ranks eighth for the number of academic articles cited in industry patents. The commercial potential of research is recognized by the community, with the sixth-highest number of invention disclosures received by the Center for Technology Licensing at Cornell University. The private school's Ignite gap funding initiative aims to help develop technologies to the point where they can be commercialized.

15. DUKE UNIVERSITY
Durham, N.C. (88.29)

The commercialization of innovations at Duke through licensing has been fruitful and the private university ranks ninth for gross licensing income generated.

A large share of the students Duke trains graduate with bachelor's degrees in STEM fields, the second highest share among the schools on this index. In 2021, two firms using Duke i innovations were acquired – biopharma firm AskBio was bought by Bayer and biotech startup Phitonex was acquired by ThermoFisher Scientific.

16. THE UNIVERSITY OF MICHIGAN
Ann Arbor, Mich. (87.56)

Looking at the raw numbers, the university's contribution to transferring knowledge and technology out of academia is clear – it ranks fourth for the number of invention disclosures received, fifth for the number of licenses and options issued, eighth for the number of startups formed, and graduates large numbers of students with STEM bachelor's (10^{th}) and master's (sixth) degrees.

The scale of the university, with more than 64,000 students enrolled in fall 2020 and more than $1.5 billion in research expenditures, means the normalized components act as a drag on the overall performance on our index.

17. NEW YORK UNIVERSITY (NYU)
New York, N.Y. (87.05)

NYU, a private university, generates significant revenue from its inventions, and ranks fourth for the total gross licensing income and 5th on this measure when it is scaled to research expenditures.

The NYU Entrepreneurial Institute recently launched two fellowships targeted at women and first generation to college founders, providing mentorship, training, and access to additional funding to underrepresented potential entrepreneurs in the NYU community.[94]

18. THE UNIVERSITY OF WASHINGTON
Seattle, Wash. (86.51)

This public university has a rich research environment and strong connections to the technology conglomeration in Seattle. It ranks fifth for academic articles cited in industry patents and second for licenses and options issued. Its large cohort of STEM bachelor's degree graduates (eighth overall) help fuel Seattle's private sector firms' innovation in technology and engineering.

University startups have access to CoMotion Labs incubator which operates in three locations on campus.[95] It recently introduced Husky FAST Start, a process that streamlines licensing for University of Washington-based startups using university intellectual property.

19. THE CALIFORNIA INSTITUTE OF TECHNOLOGY (CALTECH)
Pasadena, Calif. (86.36)

Home to top tier engineering, materials, and science research, Caltech faculty are working on cutting-edge technologies.

In 2019, the private university embarked on a partnership with Amazon Web Services to create a new Center for Quantum Computing.[96] By co-locating researchers and working collaboratively on both the hardware and theoretical framework needed, they hope to speed the development of quantum computing.

Although Caltech does not have a medical school, the university has launched a number of startups in the biotech and life-sciences space, including Switch Therapeutics which is developing novel RNAi therapies that can target specific cell types.

20. THE UNIVERSITY OF TEXAS, AUSTIN
Austin, Texas. (85.97)

Austin has a vibrant technology cluster, which this public university supports by graduating many students with STEM bachelor's degrees (ninth).

Technology transfer efforts are supported by the Texas Innovation Center, which provides programming, networking, lab space and funding with a focus on helping faculty and graduate students in STEM fields commercialize their research.[97]

21. THE UNIVERSITY OF PITTSBURGH
Pittsburgh, Penn. (85.78)

The university ranks ninth for the number of licenses and options issued and eighth for the number of startups formed. Faculty at the University of Pittsburgh's medical school have created varied life science and biotech startups, including cancer treatments, pain management, and organ regeneration.[98]

22. PRINCETON UNIVERSITY
Princeton, N.J. (85.62)

This private university ranks seventh for normalized gross licensing income. Research conducted at Princeton has fueled life science innovations such as the genome mapping system used by BioNano Genomics. The university offers grants through the Intellectual Property Accelerator Fund to help researchers promote the commercialization of their research inventions.[99]

23. BRIGHAM YOUNG UNIVERSITY (BYU)
Provo, Utah. (84.50)

A strong technology transfer focus and a history of successful entrepreneurs associated with the university has made BYU an essential part of the economic success of Utah's "Silicon Slopes."

The private university sends clear signals to faculty that it values research commercialization, for example by including a Technology Transfer Award for faculty among its annual faculty awards.[100]

Leveraging National Science Foundation I-Corps funds, BYU expanded its entrepreneurial mentoring, supported venture competitions, and built entrepreneurial awareness and capacity among its students.

When scaled for research expenditures, BYU ranks first on both the number of startups launched and for invention disclosures received, demonstrating the university's very effective use of resources. It's overall impact and ranking is limited by its size and the smaller share of STEM degrees awarded at the bachelors and master's level.

24. UNIVERSITY OF CHICAGO
Chicago, Ill. (84.46)

Technology transfers at this private university are run through the Polsky Center for Entrepreneurship and Innovation.

The school ranks seventh for normalized academic articles cited in industry patents, demonstrating the commercial relevance of the research conducted by faculty. STEM fields are prominent at the University of Chicago, and it ranks 10th for the share of its undergraduates who earn bachelor's degrees in STEM disciplines.

In partnership with the Chicago Quantum Exchange, the University of Illinois Urbana Champaign, Argonne National Laboratory, and P33, the Polsky Center recently launched Duality, a new quantum technology startup accelerator.[101]

25. UNIVERSITY OF CALIFORNIA, BERKELEY
Berkeley, Calif. (83.57)

This public university ranks third for the number of STEM bachelor's degrees granted. The Office of Intellectual Property and Industry Research Alliances (IPIRA) has a strong focus on industry research partnerships and has developed six industry-sponsored institutes, including the Immunotherapeutics and Vaccine Research Initiative.[102]

TOP PERFORMERS BY INDEX COMPONENT

Many of the institutions in the Top 25 also are the best performers on the individual components of the index. An engineering powerhouse, Massachusetts Institute Technology (No. 11) ranks first for the raw number of invention disclosures received and the number of startups formed. Reflecting its effective transformation of more modest research dollars into inventions and new firms, Brigham Young University (No. 23) takes first place on both measures when normalized for research expenditures.

The No. 1 school overall, Carnegie Mellon University, is also the best performer on both the raw and normalized gross licensing income measures. Building on its reputation of research excellence, Harvard University (No. 5) scores highest on the raw number of academic articles cited in industry patents. UCLA (No. 9) awarded the most STEM degrees to undergraduate students, while Columbia (No. 3) ranked first for the number of STEM Master's degrees awarded.

Institutions outside the Top 25, however, outperformed on certain components. The **University of Oregon** (No. 48) took the top spot for both the number of licenses and options executed and the number of licenses and options executed per invention disclosure. Oregon was the second-best performer among the universities with research expenditures in the second lowest quartile. The Early Childhood Precision, Innovation, and Shared Measurement (EC PRISM) framework was developed at the University of Oregon and spun out into a startup.[103] The EC PRISM team provided consulting services that helped early childhood programs improve their programs.[104,105]

Unexpectedly, the **Catholic University of America** (No. 156) claimed the most academic articles cited in industry patents per dollar of research expenditures. This is a reflection of an impressive number of academic articles cited in industry patents (ranking 84th in raw terms) despite having the 15th-lowest research expenditures of all the universities considered.

Brandeis University (No. 65), a private university based in Waltham, Massachusetts, had the highest concentration of STEM bachelor's degrees among all degrees awarded based on the U.S. Census STEM definitions. The **New Jersey Institute of Technology** (No. 139) a public university in Newark, New Jersey, provides technical education and had the highest share of STEM master's degrees awarded.

TABLE 4: TOP 25 PUBLIC UNIVERSITIES

RANK: PUBLIC SCHOOLS	RANK	INSTITUTION	INDEXED SCORE	FORMAL TECHNOLOGY TRANSFER								INFORMAL TECHNOLOGY TRANSFER					
				INVENTION DISCLOSURES		LICENSES AND OPTIONS		GROSS LICENSING INCOME		STARTUPS FORMED		CITATIONS OF PATENTS		STEM BACHELORS GRADUATES		STEM MASTERS GRADUATES	
				RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK
1	2	University of Florida	98.72	15	36	3	15	8	8	16	47	23	58	11	46	12	64
2	7	North Carolina State University	92.79	21	30	8	19	45	63	7	22	44	99	22	47	13	17
3	8	University of California, San Diego	92.64	10	104	34	97	16	41	4	62	7	45	4	18	20	13
4	9	University of California, Los Angeles	91.47	16	118	42	103	6	16	6	78	6	44	1	8	24	54
5	10	University of Minnesota	91.01	9	69	4	22	17	34	10	76	13	55	13	48	29	104
6	11	Purdue University	90.81	13	32	13	37	41	67	5	27	30	85	16	58	31	50
7	16	University of Michigan	87.56	4	108	5	31	21	68	8	108	9	87	10	37	6	22
8	18	University of Washington	86.51	19	138	2	9	19	53	22	115	5	51	8	35	14	57
9	20	University of Texas at Austin	85.97	44	134	20	17	23	35	26	70	22	60	9	57	32	67
10	21	University of Pittsburgh	85.78	14	62	9	29	48	92	8	46	16	47	29	53	41	87
11	25	University of California, Berkeley	83.57	36	130	59	105	31	57	22	79	15	35	3	20	18	33
12	26	University of California, Davis	82.71	28	110	26	38	26	49	25	81	23	74	2	12	68	111
13	29	University of California, Irvine	80.74	48	99	80	122	42	52	38	51	33	34	6	27	47	43
14	30	Washington State University	78.6	56	31	46	27	53	33	33	15	81	104	38	83	104	122
15	32	Ohio State University	78.41	7	45	33	110	36	78	21	89	20	76	7	66	38	115
16	33	Arizona State University	78.1	20	49	27	48	96	133	10	30	46	119	14	85	15	12
17	34	University of Arizona	77.98	22	71	19	36	49	85	20	53	41	116	21	78	50	108
18	35	Rutgers University New Brunswick	77.87	38	119	38	45	18	25	48	120	29	81	18	69	30	90
19	36	University of Houston	77.44	76	83	106	134	11	3	58	31	69	53	25	110	51	77
20	37	University of Utah	77.29	35	76	55	87	34	38	35	75	39	78	44	92	44	80
21	38	University of Wisconsin - Madison	77.21	11	112	31	86	20	50	30	128	19	110	12	41	34	84
22	40	University of South Florida	75.27	34	95	14	16	66	97	31	72	52	132	23	73	27	48
23	41	University of California, Santa Barbara	74.92	65	87	92	118	27	18	74	91	55	48	15	21	98	36
24	41	University of Kansas	74.92	75	122	40	14	28	19	56	55	48	36	80	113	83	128
25	43	Iowa State University	74.88	46	79	37	32	56	66	55	97	55	98	24	60	52	25

Of the
166 universities
used in our index:

123 (74%)
are public institutions

Among the
Top 25 universities
on our index:

44% are private

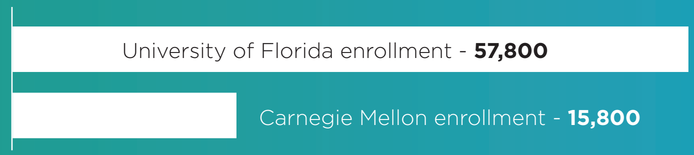
66% are public

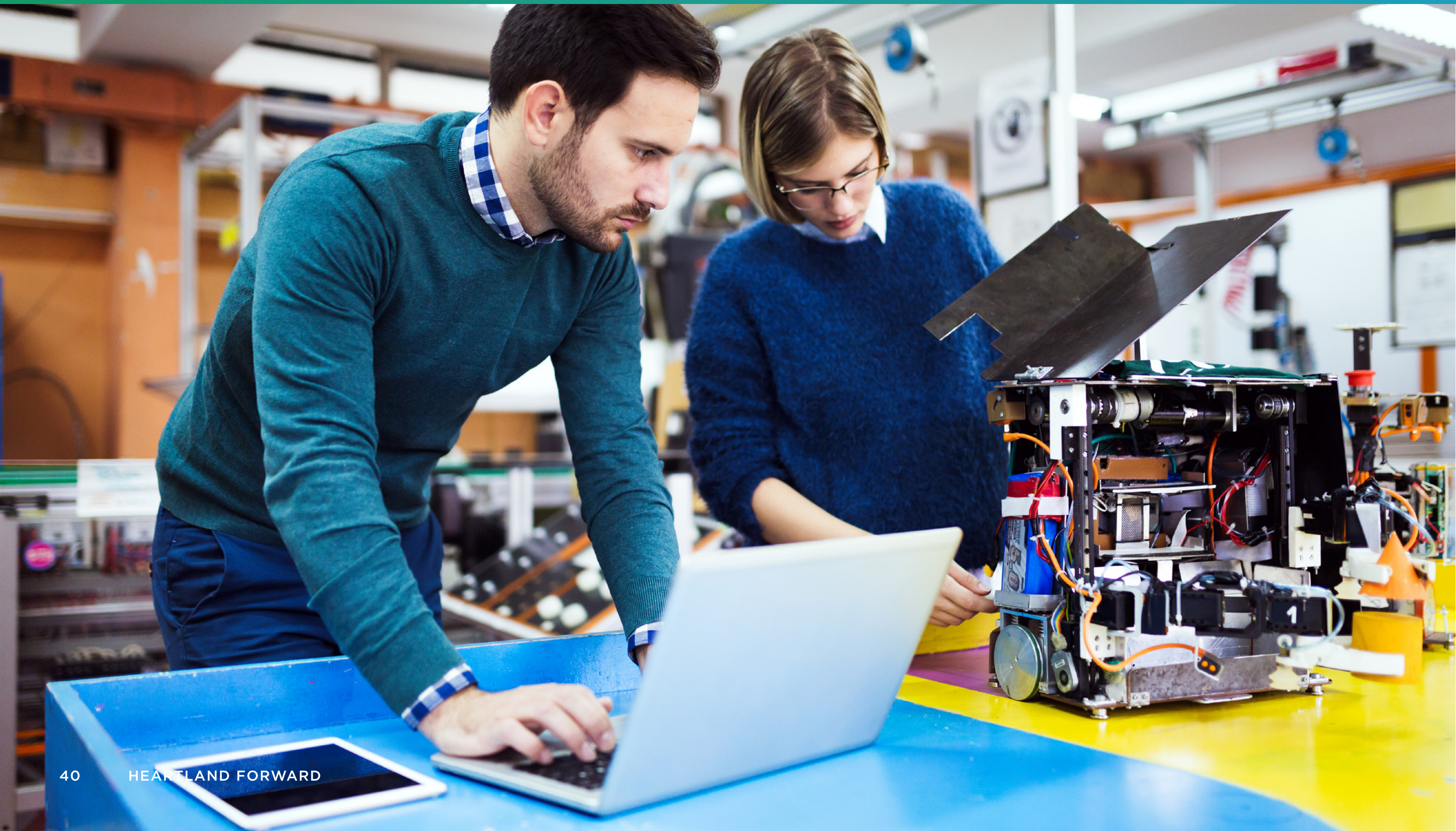
Representing the
two groups:

No. 1 Carnegie Mellon University

No. 2 UF University of Florida

They also represent the size range, with the University of Florida's total **student enrollment more than 3.5 times higher** than Carnegie Mellon's enrollment:





TOP PERFORMING PUBLIC UNIVERSITIES

Of the 166 universities used in our index, 123 (74%) are public institutions. Among the Top 25 universities on our index, 66% are private and 44% are public, with No. 1 Carnegie Mellon and No. 2 University of Florida representing the two groups. They also represent the size range, with the University of Florida's total student enrollment (57,800) more than 3.5 times higher than Carnegie Mellon's enrollment (15,800). The smaller size, narrower mission, and greater resources of private universities can make technology transfer easier at private institutions.

Table 4 presents a ranking for the top performing public universities. Scores refer to the overall ranking and have not been recalibrated for the inclusion of only public institutions. Scores from individual components part can be found in the technical appendix. These rankings yield greater geographic diversity.

The heartland is home to many exemplary colleges and universities, which hints at the industrial complex that once inhabited the region. This is evident in the rankings reflected in this report: 13 of the top 50, and 34 of the top 100, institutions are located in the region. The top 10 schools in the heartland are listed below, based upon the metrics used in this report, and the list includes both public and private institutions, and schools with and without medical schools.

TOP 10 HEARTLAND SCHOOLS

RANK	INSTITUTION	OVERALL RANK	RELATIVE STRENGTH
1	University of Minnesota	10	Invention Disclosure (9), Licenses and Options (4)
2	Purdue University	11	Startup Formation (5)
3	Northwestern University	13	Gross Licensing Income (2)
4	University of Michigan	16	Invention Disclosure (4), Licenses and Options (5), Startup Formation (8), Patent Citations (9), STEM Master's Degrees (6)
5	University of Texas at Austin	20	STEM Bachelor's Degrees (9)
6	University of Chicago	24	Patent Citations (7, normalized)
7	Ohio State University	32	Invention Disclosures (7), STEM Bachelor's Degrees (7)
8	University of Houston	36	Gross Licensing Income (3, normalized)
9	University of Wiscon-sin-Madison	38	Invention Disclosures (11), STEM Bachelor's Degrees (12)
10	Case Western Reserve University	39	Invention Disclosures (21, normal-ized), Patent Citations (20, normalized)

Among the relative strengths of this group, Northwestern ranks second of all institutions for gross licensing income, both in terms of raw value and when normalized. The University of Houston is eleventh for raw gross licensing income and third when normalized by total research expenditures. Several institutions demonstrate expertise in producing inventions, like Universities of Minnesota and Michigan rank fourth and fifth, respectively, for volume of licenses and options generated, while the Ohio State University is seventh overall for the volume of invention disclosures. Purdue University ranks fifth overall for startup formation, while University of Michigan ranks eighth. These numbers emphasize the potential of the heartland to innovate.

Examining the information technology transfers, again several heartland universities stand out. University of Chicago ranks seventh for the normalized volume of patent citations, while the University of Texas at Austin ranks ninth for the volume of STEM graduates with a bachelor's degree. Several schools already mentioned also appear in the top 10 overall for STEM graduates. The workforce development capacity exists in the heartland to generate the next generation of innovators and technology leaders.

The challenge facing the heartland seems to be commercializing innovation and talent into new products, services and businesses. Certainly, heartland leaders can look at regional peers like the University of Houston and Northwestern for models, but they should also learn from institutions on the coasts that generate significant income from licensing and form startups. In this way, heartland institutions of higher education could establish themselves as economic development anchors in their cities and states.

TOP PERFORMERS WITHOUT MEDICAL SCHOOL

Much of formal technology transfer occurs as the result of research conducted at medical schools and affiliates such as schools of pharmacy, dentistry, and public health. Table 5 presents rankings for the top-performing universities without directly affiliated medical schools.

Researchers at these universities may work in partnership with experts at regional hospitals or local universities with medical schools, but in general terms these universities may be seen to be in a more challenging technology transfer environment. This is supported by the rankings. Although there were 90 (56%) institutions without medical schools among the universities ranked, they made up only eight of the top 25 (32%), including No. 1 Carnegie Mellon University.

Scores refer to the overall ranking and have not been recalibrated for the inclusion of only institutions without medical schools. Scores from individual components part can be found in the technical appendix.

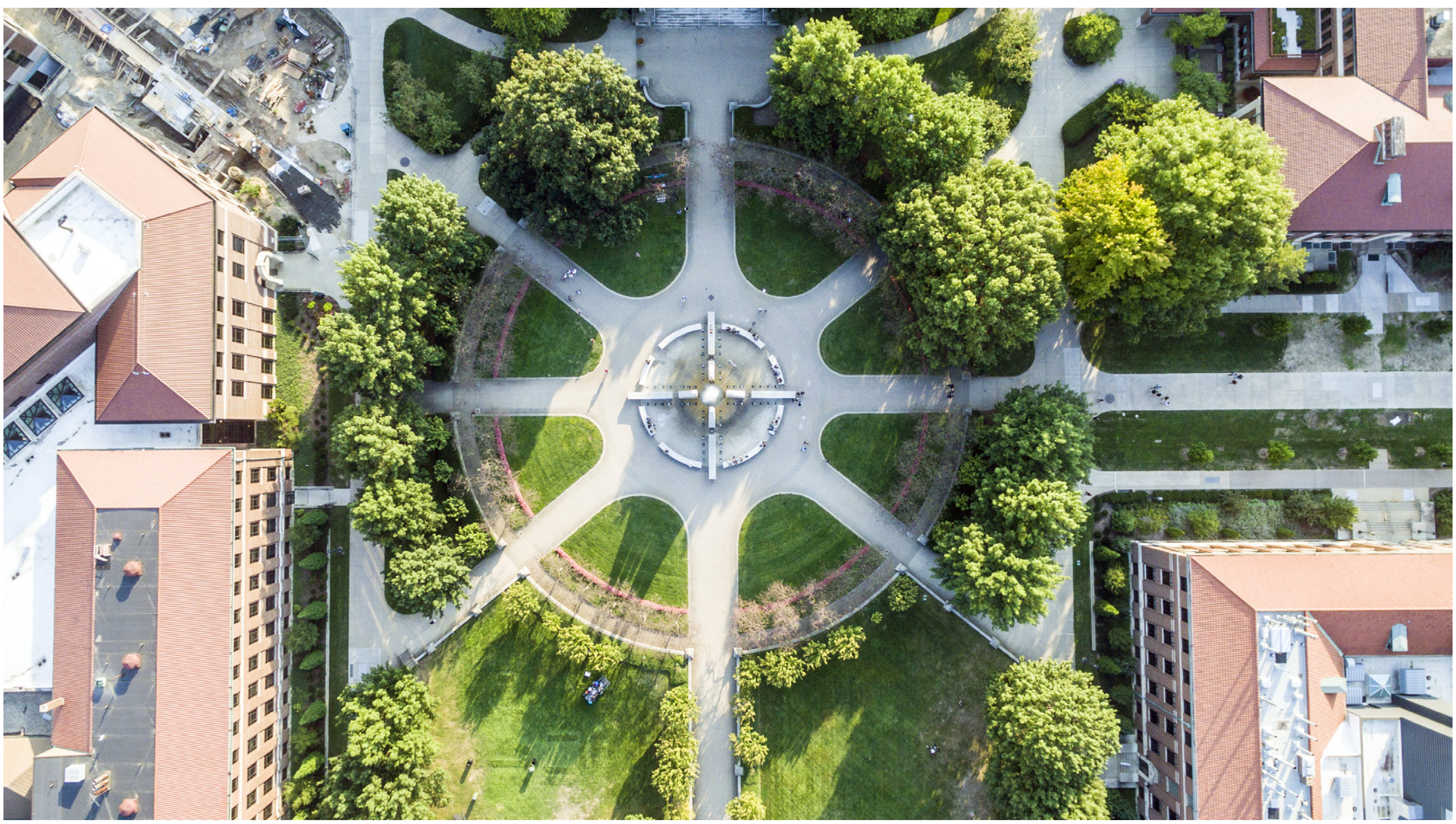


TABLE 5: TOP 25 UNIVERSITIES WITHOUT A MEDICAL SCHOOL

RANK: NO MED SCHOOL	RANK	INSTITUTION	INDEXED SCORE	FORMAL TECHNOLOGY TRANSFER								INFORMAL TECHNOLOGY TRANSFER					
				INVENTION DISCLOSURES		LICENSES AND OPTIONS		GROSS LICENSING INCOME		STARTUPS FORMED		CITATIONS OF PATENTS		STEM BACHELORS GRADUATES		STEM MASTERS GRADUATES	
				RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK
1	1	Carnegie Mellon University	100	24	10	21	39	1	1	28	19	42	23	113	30	5	3
2	7	North Carolina State University	92.79	21	30	8	19	45	63	7	22	44	99	22	47	13	17
3	11	Massachusetts Institute of Technology	90.81	1	56	10	92	13	29	1	83	3	57	116	3	36	19
3	11	Purdue University	90.81	13	32	13	37	41	67	5	27	30	85	16	58	31	50
5	19	California Institute of Technology	86.36	23	23	32	59	35	32	10	18	31	28	165	4	149	56
6	22	Princeton University	85.62	58	89	60	55	15	7	44	48	38	21	124	23	69	14
7	23	Brigham Young University	84.5	72	1	51	20	67	10	17	1	106	10	35	106	124	93
8	25	University of California, Berkeley	83.57	36	130	59	105	31	57	22	79	15	35	3	20	18	33
9	30	Washington State University	78.6	56	31	46	27	53	33	33	15	81	104	38	83	104	122
10	33	Arizona State University	78.1	20	49	27	48	96	133	10	30	46	119	14	85	15	12
11	36	University of Houston	77.44	76	83	106	134	11	3	58	31	69	53	25	110	51	77
12	41	University of California, Santa Barbara	74.92	65	87	92	118	27	18	74	91	55	48	15	21	98	36
13	43	Iowa State University	74.88	46	79	37	32	56	66	55	97	55	98	24	60	52	25
14	45	University of Georgia	74.81	32	57	6	12	29	31	62	118	49	103	27	77	80	135
15	46	Northeastern University	74.69	59	27	84	117	100	105	54	24	58	19	60	51	11	9
16	48	University of Oregon	74.42	110	46	1	1	33	6	99	39	137	146	41	52	102	78
17	52	Rice University	71.28	63	26	91	120	90	82	62	26	44	4	142	9	89	41
18	56	Oregon State University	70	70	117	23	11	54	51	75	104	70	96	28	62	65	72
19	57	University of Texas at Dallas	69.3	81	37	93	101	57	24	117	125	64	8	57	94	9	10
20	59	Colorado State University	68.26	53	109	53	43	62	74	48	90	74	133	39	82	42	51
21	60	Georgia Institute of Technology	67.48	18	81	67	143	72	121	43	121	28	95	33	24	7	37
22	61	Worcester Polytechnic Institute	67.4	83	2	82	70	143	135	65	4	101	6	132	13	61	5
23	65	Brandeis University	65.66	88	12	118	137	59	14	117	74	117	91	126	1	69	7
24	66	Clemson University	65.54	85	58	85	80	105	108	65	29	87	88	43	65	54	38
25	69	University of Arkansas, Fayetteville	64.92	92	77	61	23	77	58	75	44	94	115	79	129	75	60

TOP PERFORMERS BASED ON RESEARCH EXPENDITURES

Many of the top-performing universities on the overall index have well-established and well-funded technology transfer programs, with large pools of potentially patentable research results. Successful commercialization generates income that can fund additional technology transfer investments and infrastructure, as well as convince faulty and key stakeholders that these actions have value. Universities that attract significant federal research funds are more likely to have inventions that form the seed of the technology transfer process. By including components of technology transfer normalized by research expenditures, we can see more of the schools that are working effectively with the smaller pool they have available.

To explore this further, we divided schools into four groups based on their research expenditures and looked at the top performers within each of these groups. As expected, the list of the top 10 schools in quartile 4 (the universities with the highest research expenditures) is made up entirely of schools in the top 25 (No. 2-11). The top school in quartile 3 is our No.1 overall, Carnegie Mellon, followed by No 19. California Institute of Technology and other schools in the top 40 overall.

The top 10 schools in quartile 2 all lie outside the Top 25 overall. **Northeastern University** in Boston, Massachusetts (No. 46 overall) performs best, closely followed by the University of Oregon (No. 48), the top school for the number of licenses and options issued. Northeastern has established an express license that simplifies and shortens the time needed to process the licensing of university intellectual property, making it easier for the private sector to commercialize research. To support university startups, Northeastern has the Spark Fund, which supports the testing, prototyping, and proof of concept work needed to make an invention attractive to potential investors.[106] Tantu Therapeutics, a biotech firm developing gastrointestinal therapies, is one firm to emerge from the Spark Fund process and attract a private sector partner.[107]

In the quartile with the lowest research expenditures, Brigham Young University (No. 23) significantly outperforms its peers with an indexed score of 84.50 as compared to 67.40 at **Worcester Polytechnic Institute** (No. 61) in Massachusetts. Like BYU, Worcester has placed a strong emphasis on technology commercialization, and its three-person staff has been able to launch several successful startups, including Inq-ITS, an online science education tool.[108] To scale and support more entrepreneurs, Worcester has secured an NSF I-Corps grant and offers prototyping funds to startups that complete the program.[109] With a strong focus on multiple manufacturing disciplines, Worcester has the potential to continue to grow its technology transfer impact and the office's growth shows what can be achieved in a decade with the right approach.[110]

TABLE 6: TOP 10 BY RESEARCH EXPENDITURE QUARTILE

Quartile 1

RANK	OVERALL RANK	INSTITUTION	INDEXED SCORE
1	23	Brigham Young University	84.50
2	61	Worcester Polytechnic Institute	67.40
3	72	University of North Carolina Charlotte	63.14
4	73	University of Akron	62.71
5	76	Rochester Institute Technology	61.43
6	79	University of Toledo	61.32
7	80	San Diego State University	61.24
8	87	University North Texas Denton	58.45
9	89	Stevens Institute Technology	57.13
10	104	East Carolina University	51.05

Quartile 2

RANK	OVERALL RANK	INSTITUTION	INDEXED SCORE
1	46	Northeastern University	74.69
2	48	University of Oregon	74.42
3	52	Rice University	71.28
4	55	Drexel University	70.08
5	57	University of Texas Dallas	69.30
6	65	Brandeis University	65.66
7	66	Clemson University	65.54
8	69	University of Arkansas Fayetteville	64.92
9	76	Tulane University	61.43
10	82	Oklahoma State University	60.39

Quartile 3

RANK	OVERALL RANK	INSTITUTION	INDEXED SCORE
1	1	Carnegie Mellon University	100.00
2	19	California Institute of Technology	86.36
3	22	Princeton University	85.62
4	24	University of Chicago	84.46
5	28	Tufts University	81.12
6	29	University California Irvine	80.74
7	30	University of Miami	78.60
8	30	Washington State University	78.60
9	36	University of Houston	77.44
10	39	Case Western Reserve University	75.54

Quartile 4

RANK	OVERALL RANK	INSTITUTION	INDEXED SCORE
1	2	University of Florida	98.72
2	3	Columbia University	98.37
3	4	Stanford University	95.50
4	5	Harvard University	94.96
5	6	University of Pennsylvania	93.88
6	7	North Carolina State University	92.79
7	8	University California San Diego	92.64
8	9	University California Los Angeles	91.47
9	10	University of Minnesota	91.01
10	11	Massachusetts Institute of Technology	90.81

POLICY IMPLICATIONS AND RECOMMENDATIONS

When the Bayh-Dole Act was passed in 1980 there was an expectation that easier commercialization of the results of federally-funded research would create new products, more efficient processes and result in new industries, jobs and economic growth. Unfortunately, over these 40-years we have seen a widening income gap, as many regions have been unable to harness the opportunities created by university research.[111,112] The Biden Administration has proposed a series of new initiatives that represent a seismic shift in policy and the role of government and renewed belief in the power of science and scientific discovery. As we created these rankings, the U.S. Senate passed a sweeping $250 billion bill that will invest in scientific innovation. Called the *U.S. Innovation and Competition Act*, the 2,400-page bill provides $200 billion for scientific and technological innovation over the next five years, prioritizing semiconductors, artificial intelligence, robotics, biotechnology, and space exploration.[113]

Universities figure prominently in the Act, which subsequently passed the House of Representatives. In particular, the *U.S. Innovation and Competition Act* encompasses the *Endless Frontier Act*, which would significantly overhaul the National Science Foundation by establishing a directorate for technology and innovation and investing $10 billion in new technology hubs throughout the country. As these initiatives are still underway, there is opportunity to influence their ultimate design and implementation.

For the *U.S. Innovation and Competition Act* to have its desired impact, it is imperative that universities have well-functioning tech transfer programs. Universities are a necessary but not sufficient condition for economic development to occur. In the 40 years since the passage of the Bayh-Dole Act, there have been meaningful developments in experimentation and learning about what works in university technology transfer. With additional funding, there will be increased expectation for universities to engage in building regional centers of excellence. Understanding the intricacies of university technology transfer, both formal and informal, is important to achieving this vision. Investing in university research without corresponding consideration of how to increase the output of resulting inventions and their subsequent commercial and social benefits will not yield the expected results. This is the next challenge for American universities to address.

There's no shortage of suggestions and advice on how to improve tech transfer outcomes. Much of this advice focuses on formal technology transfer and advocates for greater transparency and accountability, the need for standardized reporting forms, and for faculty to have easy access to resources to assist in moving their research out of the lab and towards commercialization.

One item rarely discussed is that technology transfer is an unfunded federal mandate. The Bayh-Dole Act did not provide for financial support for the set up

and operating costs for the TLOs that are required to manage university intellectual property. The universities that do well in our ranking have benefited from successful inventions that created a revenue stream while most university TLOs are underfunded. The fact that universities maintain TLOs even as they operate as loss centers demonstrates a commitment to their public mission.[114]

New federal legislation could provide a budget item set aside from federally funded research grants. State government could also fund TLO operations as a component of economic development.[115,116] Some states, such as Ohio, have turned over economic development to private entities. There is no evidence that privatizing economic development helps or hurts economic development; however, these entities are primarily engaged with business relocation decisions rather than fostering entrepreneurship and innovation and creating vibrant ecosystems.

The discussion around President Biden's policies alternatively focuses on economic recovery, competitiveness, national security, and addressing regional inequality. Economists typically deal with trade offs, yet a new conceptualization predicated on place-based economic development has the potential to create virtuous self-reinforcing cycles of prosperity. One enduring principle is the tendency for industrial activity to cluster spatially, with similar activities benefiting from localization economies, creating a jurisdictional advantage for a specific industrial activity.

Universities figure prominently in agglomeration economies. Creating new firms and industries in locations that have been hard hit by international trade and the decline in manufacturing can increase American competitiveness while addressing critical gaps in the nation's supply chains. However, the de-industrialization of the American economy has rendered many places simply distribution or assembly hubs, with little value added and few opportunities upon which to build.

Simultaneously, there is also a realization that corporate strategy should consider more than simple shareholder value and focus on the greater good. This idea gained momentum in 2019 with the Business Roundtable statement that corporations should consider all stakeholders.

Certainly, profitability is an important objective, though increasingly, there is recognition that better treatment of workers and suppliers and greater investment in local communities pay off in terms of increased productivity. Corporations are embracing a new understanding that corporate social responsibility can be an essential aspect of operations rather than a subsidiary feature: considering the social implications of their actions and working toward the public benefit also benefits their bottom line. Rather than defaulting to the old trade-offs between wages and profits, there is a realization that higher wages lead to increased profitability – the creation of virtuous self-reinforcing cycles.

The role that universities play in defining a prosperous future for America cannot be taken for granted. The notion behind place-based economic development is that it aims to build capabilities beyond the investment horizon and scope of firms, no matter how well-intentioned individual firms may be. The older model predicated on providing a favorable business climate focused on cutting taxes and regulations and providing hefty incentives to relocating firms has not yielded high quality jobs but has largely been a race to the bottom. Lower taxes and tax rebates starve investments in public infrastructure, including education.

A prosperous future demands building capacity in vibrant regional innovation ecosystems. Investment in university research and technology transfer make this future possible. A pooling of invention disclosures and patents for universities without a critical mass of IP is worthy of investigation. Further, as universities have different specializations, collaboration on technology transfer could create synergies and could smooth licensing income across time. There are further opportunities for alumni foundations and university retirement funds to allocate more of their portfolios to venture capital funds.

If the objective is to generate future prosperity it is imperative to focus on enhancing the flow of technology to create lasting and meaningful economic impact. Through our efforts here we hope to center university technology transfer, both formal or informal, as key to American competitiveness and innovation.

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TECHNICAL APPENDIX

Full Index Table with Component Rankings

The following table includes all universities considered in the overall index creation. The table includes the overall rank and indexed score of the institution as well as the institution's name. Finally, we list the ranks for each variable (both the scaled, labeled "raw" below, and normalized and scaled, labeled "normalized" below, versions) considered in the index calculation, as specified above.

RANK	INSTITUTION	INDEXED SCORE	FORMAL TECHNOLOGY TRANSFER								INFORMAL TECHNOLOGY TRANSFER					
			INVENTION DISCLOSURES		LICENSES AND OPTIONS		GROSS LICENSING INCOME		STARTUPS FORMED		CITATIONS OF PATENTS		STEM BACHELORS GRADUATES		STEM MASTERS GRADUATES	
			RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK
1	Carnegie Mellon University	100	24	10	21	39	1	1	28	19	42	23	113	30	5	3
2	University of Florida	98.72	15	36	3	15	8	8	16	47	23	58	11	46	12	64
3	Columbia University	98.37	8	44	30	93	10	13	2	28	17	59	70	6	1	16
4	Stanford University	95.5	2	72	11	53	12	22	3	69	2	15	93	14	22	28
5	Harvard University	94.96	5	34	18	66	7	12	10	67	1	2	58	15	26	121
6	University of Pennsylvania	93.88	12	84	7	25	5	11	14	80	4	24	71	45	16	58
7	North Carolina State University	92.79	21	30	8	19	45	63	7	22	44	99	22	47	13	17
8	University of California, San Diego	92.64	10	104	34	97	16	41	4	62	7	45	4	18	20	13
9	University of California, Los Angeles	91.47	16	118	42	103	6	16	6	78	6	44	1	8	24	54
10	University of Minnesota	91.01	9	69	4	22	17	34	10	76	13	55	13	48	29	104
11	Massachusetts Institute of Technology	90.81	1	56	10	92	13	29	1	83	3	57	116	3	36	19
11	Purdue University	90.81	13	32	13	37	41	67	5	27	30	85	16	58	31	50
13	Northwestern University	90.58	30	86	50	71	2	2	28	71	12	13	75	16	23	69
14	Cornell University	90.35	6	59	24	89	22	56	14	84	8	31	34	22	17	15
15	Duke University	88.29	17	103	17	42	9	17	19	95	14	61	72	2	37	65
16	University of Michigan	87.56	4	108	5	31	21	68	8	108	9	87	10	37	6	22
17	New York University	87.05	41	129	39	44	4	5	22	63	26	67	40	91	4	73
18	University of Washington	86.51	19	138	2	9	19	53	22	115	5	51	8	35	14	57
19	California Institute of Technology	86.36	23	23	32	59	35	32	10	18	31	28	165	4	149	56
20	University of Texas at Austin	85.97	44	134	20	17	23	35	26	70	22	60	9	57	32	67
21	University of Pittsburgh	85.78	14	62	9	29	48	92	8	46	16	47	29	53	41	87
22	Princeton University	85.62	58	89	60	55	15	7	44	48	38	21	124	23	69	14
23	Brigham Young University	84.5	72	1	51	20	67	10	17	1	106	10	35	106	124	93
24	University of Chicago	84.46	47	78	63	77	40	40	38	41	21	7	92	10	33	63
25	University of California, Berkeley	83.57	36	130	59	105	31	57	22	79	15	35	3	20	18	33
26	University of California, Davis	82.71	28	110	26	38	26	49	25	81	23	74	2	12	68	111

RANK	INSTITUTION	INDEXED SCORE	FORMAL TECHNOLOGY TRANSFER								INFORMAL TECHNOLOGY TRANSFER					
			INVENTION DISCLOSURES		LICENSES AND OPTIONS		GROSS LICENSING INCOME		STARTUPS FORMED		CITATIONS OF PATENTS		STEM BACHELORS GRADUATES		STEM MASTERS GRADUATES	
			RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK
27	Johns Hopkins University	81.71	3	124	15	63	14	36	17	131	10	111	110	19	3	26
28	Tufts University	81.12	86	107	81	61	39	23	58	37	47	16	108	11	40	24
29	University of California, Irvine	80.74	48	99	80	122	42	52	38	51	33	34	6	27	47	43
30	University of Miami	78.6	60	115	65	57	32	27	35	35	40	43	86	55	74	107
30	Washington State University	78.6	56	31	46	27	53	33	33	15	81	104	38	83	104	122
32	Ohio State University	78.41	7	45	33	110	36	78	21	89	20	76	7	66	38	115
33	Arizona State University	78.1	20	49	27	48	96	133	10	30	46	119	14	85	15	12
34	University of Arizona	77.98	22	71	19	36	49	85	20	53	41	116	21	78	50	108
35	Rutgers University New Brunswick	77.87	38	119	38	45	18	25	48	120	29	81	18	69	30	90
36	University of Houston	77.44	76	83	106	134	11	3	58	31	69	53	25	110	51	77
37	University of Utah	77.29	35	76	55	87	34	38	35	75	39	78	44	92	44	80
38	University of Wisconsin-Madison	77.21	11	112	31	86	20	50	30	128	19	110	12	41	34	84
39	Case Western Reserve University	75.54	27	21	36	58	78	101	40	32	34	20	133	29	73	106
40	University of South Florida	75.27	34	95	14	16	66	97	31	72	52	132	23	73	27	48
41	University of California, Santa Barbara	74.92	65	87	92	118	27	18	74	91	55	48	15	21	98	36
41	University of Kansas	74.92	75	122	40	14	28	19	56	55	48	36	80	113	83	128
43	Iowa State University	74.88	46	79	37	32	56	66	55	97	55	98	24	60	52	25
44	University of Southern California	74.84	26	121	48	76	38	80	31	109	25	84	46	71	2	42
45	University of Georgia	74.81	32	57	6	12	29	31	62	118	49	103	27	77	80	135
46	Northeastern University	74.69	59	27	84	117	100	105	54	24	58	19	60	51	11	9
47	Emory University	74.61	25	65	43	75	30	46	35	93	18	29	111	32	109	148
48	University of Oregon	74.42	110	46	1	1	33	6	99	39	137	146	41	52	102	78
49	University of New Mexico	71.9	52	53	41	26	79	89	27	16	76	117	77	90	84	95
50	Washington University in St. Louis	71.67	31	116	16	21	24	44	40	111	122	160	90	26	43	76
51	University of North Carolina at Chapel Hill	71.47	39	143	28	28	37	75	40	116	11	39	30	38	96	156
52	Rice University	71.28	63	26	91	120	90	82	62	26	44	4	142	9	89	41
53	Vanderbilt University	71.24	37	123	25	30	25	45	48	132	27	80	83	7	105	133
54	University of Virginia	70.81	29	70	29	41	60	88	46	112	43	101	37	39	58	102
55	Drexel University	70.08	54	13	68	81	111	117	48	14	70	18	82	84	45	85
56	Oregon State University	70	70	117	23	11	54	51	75	104	70	96	28	62	65	72
57	University of Texas at Dallas	69.3	81	37	93	101	57	24	117	125	64	8	57	94	9	10
58	University of Connecticut	68.29	71	97	74	64	89	99	65	68	61	56	31	36	39	55
59	Colorado State University	68.26	53	109	53	43	62	74	48	90	74	133	39	82	42	51
60	Georgia Institute of Technology	67.48	18	81	67	143	72	121	43	121	28	95	33	24	7	37
61	Worcester Polytechnic Institute	67.4	83	2	82	70	143	135	65	4	101	6	132	13	61	5

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			INVENTION DISCLOSURES		LICENSES AND OPTIONS		GROSS LICENSING INCOME		STARTUPS FORMED		CITATIONS OF PATENTS		STEM BACHELORS GRADUATES		STEM MASTERS GRADUATES	
			RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK
62	University of Massachusetts Boston	66.98	33	105	45	62	3	4	34	96	129	161	121	111	120	99
63	Indiana University	66.78	42	93	52	65	51	72	45	102	35	64	49	140	60	125
64	Virginia Commonwealth University	66.71	49	39	71	107	55	47	58	66	61	72	50	98	118	150
65	Brandeis University	65.66	88	12	118	137	59	14	117	74	117	91	126	1	69	7
66	Clemson University	65.54	85	58	85	80	105	108	65	29	87	88	43	65	54	38
67	Dartmouth College	65.16	82	106	88	94	50	30	81	88	59	38	131	5	131	75
68	Brown University	65.08	80	91	115	138	73	61	81	77	53	22	100	28	77	21
69	University of Arkansas Fayetteville	64.92	92	77	61	23	77	58	75	44	94	115	79	129	75	60
70	Kansas State University	64.69	69	82	58	34	58	43	81	94	88	131	65	76	85	79
71	University of Kentucky	63.64	64	120	73	73	61	65	46	61	57	82	61	105	103	142
72	University of North Carolina Charlotte	63.14	112	15	118	114	124	116	75	8	112	42	42	81	48	29
73	University of Akron	62.71	79	3	100	121	115	91	65	6	91	3	119	125	116	59
74	University of Louisville	61.55	66	48	75	85	81	77	62	38	72	63	118	133	101	123
75	University of Rochester	61.51	50	102	66	78	47	60	75	122	51	90	109	31	99	117
76	Rochester Institute Technology	61.43	130	68	110	54	118	110	72	10	122	102	81	64	46	6
76	Tulane University	61.43	114	132	112	102	76	59	75	45	83	77	129	59	55	30
76	University of Central Florida	61.43	54	43	57	51	70	69	99	119	65	70	20	139	63	127
79	University of Toledo	61.32	88	8	89	88	63	15	117	59	96	27	134	148	111	109
80	San Diego State University	61.24	118	28	22	2	95	54	140	137	99	32	36	107	67	45
81	University of California, Riverside	60.93	74	67	115	142	44	21	117	141	63	30	32	50	108	89
82	Michigan State University	60.39	45	139	35	33	52	87	65	142	50	138	19	79	66	134
82	Oklahoma State University	60.39	109	127	86	49	64	39	81	65	134	155	68	101	71	32
84	Colorado School of Mines	59.92	97	18	82	56	137	138	89	20	101	69	126	17	100	8
85	University of Cincinnati	59.84	51	50	72	108	101	123	65	87	67	89	55	128	28	44
86	University of Notre Dame	59.69	62	75	75	90	99	120	48	36	75	107	84	33	123	118
87	University of North Texas at Denton	58.45	107	6	105	99	125	100	89	7	112	14	54	143	79	119
88	Boston University	57.95	68	151	100	136	68	95	81	138	37	65	52	70	10	40
89	Stevens Institute of Technology	57.13	112	16	129	141	133	125	93	11	116	50	155	44	25	2
90	University of Texas at San Antonio	57.02	88	20	100	115	129	132	89	23	91	41	51	122	82	61
91	University of Alabama Birmingham	56.78	61	153	56	40	43	64	56	124	36	83	140	149	88	143
92	University of California, Santa Cruz	56.47	91	60	123	140	107	115	99	85	77	49	26	25	110	18
93	Ohio University	55.85	120	42	141	148	46	9	114	42	122	109	88	137	92	126
94	Temple University	55.81	67	74	86	111	103	122	58	49	66	62	64	142	72	140
95	Auburn University	55.54	73	98	75	68	82	86	89	103	93	136	48	99	64	81
96	George Washington University	55	78	131	106	131	91	113	81	110	72	97	73	49	8	34
97	Georgetown University	54.92	97	96	114	126	65	37	140	145	79	71	114	40	21	39

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			RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK
98	University of Tennessee Knoxville	54.42	40	63	69	119	69	90	81	134	68	130	56	108	78	105
99	Florida State University	54.22	87	114	79	52	98	112	95	105	85	113	17	56	56	110
100	University of Delaware	53.64	101	101	100	106	119	134	72	40	78	73	63	95	86	71
101	South Dakota State University	52.56	105	22	98	96	86	42	117	86	125	126	139	112	127	20
102	University of Texas at Arlington	52.4	95	52	106	116	116	126	95	52	95	93	76	157	19	49
103	University of Iowa	52.17	57	135	44	24	75	104	65	123	54	118	69	120	126	161
104	East Carolina University	51.05	127	24	115	69	123	96	111	17	106	11	91	146	134	154
105	Michigan Technological University	50.85	116	64	93	46	113	98	117	101	118	121	135	34	87	4
106	Penn State University	50.5	43	148	75	133	83	131	48	139	32	123	5	118	57	149
107	University of New Hampshire	48.88	93	61	12	3	87	73	140	144	137	154	89	67	129	94
108	James Madison University	48.72	152	5	141	49	146	70	117	2	155	12	94	138	162	153
109	University of Wisconsin - Milwaukee	48.33	94	11	97	104	149	148	99	21	115	75	87	134	93	97
110	West Virginia University	47.98	99	51	126	147	93	79	117	117	79	33	59	97	115	132
111	Marquette University	46.9	139	47	141	124	92	28	134	56	131	79	125	63	154	155
112	University of Alabama Huntsville	46.16	102	29	129	151	127	128	107	58	89	46	149	116	119	27
113	University of Alabama	46.01	96	19	126	149	132	136	111	50	89	25	47	135	121	136
114	Portland State University	45.97	141	136	70	8	97	62	136	129	134	141	66	100	76	82
115	Southern Illinois University	45.89	136	41	129	109	85	26	146	146	132	100	103	43	117	88
116	Wayne State University	45.35	84	128	106	130	94	114	99	126	60	68	104	127	49	96
117	North Dakota State University	44.96	121	149	47	6	84	71	117	136	120	145	120	88	130	86
118	University of Vermont	44.46	108	100	120	123	109	119	93	60	98	125	96	68	143	98
119	Western Michigan University	43.88	147	35	148	132	136	103	99	5	149	94	130	152	91	92
120	Utah State University	42.29	116	161	61	13	71	81	146	146	100	147	84	151	106	70
121	Mississippi State University	41.94	115	156	100	72	120	143	75	99	110	150	78	104	94	53
122	University of North Carolina Wilmington	41.28	152	88	96	10	139	111	114	9	162	159	115	119	147	129
123	University of Nevada, Las Vegas	40.74	103	33	95	84	110	102	107	57	143	148	112	158	146	163
124	Montana State University	40.54	131	154	53	5	108	118	117	133	106	135	107	114	133	52
125	Ball State University	40.19	134	4	49	4	131	76	146	146	151	66	147	161	107	130
126	Loyola University Chicago	39.84	161	163	158	158	80	20	146	146	97	9	106	86	114	124
127	Rowan University	39.03	125	17	138	135	117	83	140	107	129	52	99	115	140	137
128	University of Idaho	38.6	126	144	120	74	74	48	146	146	128	144	141	103	122	62
129	Northern Illinois University	38.41	148	40	156	156	154	152	140	54	141	37	97	75	81	66
130	Augusta University	37.95	111	73	98	82	104	94	95	43	163	163	162	155	165	165
131	University of South Alabama	37.87	119	55	138	145	88	55	117	92	121	120	153	141	151	164

RANK	INSTITUTION	INDEXED SCORE	FORMAL TECHNOLOGY TRANSFER								INFORMAL TECHNOLOGY TRANSFER					
			INVENTION DISCLOSURES		LICENSES AND OPTIONS		GROSS LICENSING INCOME		STARTUPS FORMED		CITATIONS OF PATENTS		STEM BACHELORS GRADUATES		STEM MASTERS GRADUATES	
			RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK	RAW RANK	NORMALIZED RANK
132	University of Nevada, Reno	37.33	128	137	112	60	112	109	117	114	112	129	74	87	141	141
133	Georgia State University	37.13	122	158	129	127	130	147	99	113	82	108	53	123	59	91
134	Northern Arizona University	36.47	100	14	129	152	148	146	117	64	125	106	62	124	138	147
135	University of Southern Mississippi	36.4	151	141	123	18	141	130	111	13	134	92	154	156	152	138
136	Cleveland State University	35.89	140	147	110	35	128	129	117	106	145	151	117	93	90	74
137	Morgan State University	35.58	128	7	141	139	152	140	99	3	155	140	159	144	156	113
138	University of Dayton	35.19	138	160	126	91	102	107	117	135	145	157	137	74	95	35
139	New Jersey Institute of Technology	34.34	104	113	147	157	140	151	146	146	103	139	95	42	35	1
140	Louisiana Tech University	33.8	145	66	141	98	121	84	140	100	148	112	150	145	153	68
141	University of Texas at El Paso	32.79	133	145	125	95	138	144	107	73	119	137	101	150	112	101
142	University of Hawaii	32.13	106	155	89	67	114	142	107	143	109	153	105	89	128	146
143	University of South Carolina	31.24	77	111	122	146	134	150	114	140	86	128	45	109	124	158
144	Wright State University	30.27	144	146	137	82	145	145	136	130	137	142	138	96	62	11
145	University of Denver	29.84	159	157	146	47	126	106	146	146	163	163	145	54	53	83
146	University of Alaska Fairbanks	28.14	124	140	129	125	150	153	81	33	160	162	163	162	160	103
147	Miami University	27.87	161	152	153	127	159	158	146	146	137	54	67	80	97	23
147	University of South Dakota	27.87	150	54	153	150	160	162	136	25	132	17	164	165	158	160
149	University of Northern Iowa	27.83	146	125	138	79	147	141	117	34	157	158	152	132	161	144
150	University of Mississippi	27.67	143	150	152	155	106	93	134	127	103	86	122	147	144	152
151	University of Rhode Island	27.56	122	133	129	127	122	127	146	146	105	122	98	102	137	120
152	Duquesne University	25.66	152	90	158	158	160	164	117	12	153	124	158	126	150	151
153	Boise State University	25.08	141	85	64	6	144	139	146	146	145	134	136	163	155	162
154	University of Louisiana Lafayette	24.11	137	159	136	113	151	154	95	82	143	156	143	154	145	116
155	University of California, Merced	23.76	160	162	158	158	160	165	136	98	110	26	128	61	163	131
156	Catholic University of America	22.6	164	164	158	158	153	149	146	146	84	1	160	72	142	114
157	University of North Florida	22.4	152	25	148	112	158	157	146	146	151	40	123	131	157	157
158	University of Texas at Tyler	22.05	163	9	158	158	160	161	146	146	157	5	156	136	139	112
159	Illinois State University	20.7	158	126	148	100	155	155	146	146	149	105	102	130	132	100
160	North Carolina A&T State University	19.38	149	142	158	158	142	137	146	146	141	127	151	153	136	31
161	Bowling Green State University	17.6	157	94	156	154	156	156	146	146	157	143	148	159	112	46
162	University of Texas at Rio Grande	17.25	135	38	148	153	135	124	146	146	154	149	166	166	166	166
163	University of Alaska Anchorage	15.16	152	80	153	144	160	163	146	146	160	152	157	164	158	47
164	University of Memphis	15.08	132	92	158	158	160	166	146	146	125	114	144	160	135	145
165	University of West Florida	9.53	165	165	158	158	157	159	146	146	163	163	146	121	148	139
166	University of Texas at Permian Basin	7.4	165	165	158	158	160	160	146	146	163	163	161	117	164	159

Full Index Table with Component Scores

The following table includes all universities considered in the overall index creation. This table is equivalent to the full index table with component rankings, with the exception that indexed values (rather than ranks) are listed for each variable. Again, both the normalized and scaled, labeled as "raw," versions are included for reference.

RANK	INSTITUTION	INDEXED SCORE	FORMAL TECHNOLOGY TRANSFER								INFORMAL TECHNOLOGY TRANSFER					
			INVENTION DISCLOSURES		LICENSES AND OPTIONS		GROSS LICENSING INCOME		STARTUPS FORMED		CITATIONS OF PATENTS		STEM BACHELORS GRADUATES		STEM MASTERS GRADUATES	
			RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX
1	Carnegie Mellon University	100	31.53	44.08	10.82	1.74	100	100	37.21	9.17	9.6	26.58	17.7	65.91	63.56	84.3
2	University of Florida	98.72	43.28	23.6	28.83	3.38	92.37	95.76	52.33	5.03	17.11	18.47	74.36	51.76	44.78	26.42
3	Columbia University	98.37	51.39	22.5	9.08	0.9	91.17	94.96	87.21	6.73	21.22	18.39	26.42	79.2	100	43.17
4	Stanford University	95.5	66.24	18.1	17.35	1.33	90.87	94.04	86.05	4.15	55.44	29.99	20.76	73.14	36.07	35.29
5	Harvard University	94.96	58.83	24.05	13.29	1.15	92.54	95.31	58.14	4.19	100	80.91	29.85	73.12	34.25	15.91
6	University of Pennsylvania	93.88	45.22	16.56	20.02	2.25	93.23	95.35	56.98	3.68	36.35	26.36	26.22	54.43	40.24	27.26
7	North Carolina State University	92.79	35	24.62	19.01	2.75	79.59	91.86	65.12	8.08	8.67	12.08	54.39	51.61	43.85	42.57
8	University of California, San Diego	92.64	47.54	14.42	7.65	0.82	86.83	92.85	80.23	4.29	34.34	20.62	89.19	71.39	37.41	47.24
9	University of California, Los Angeles	91.47	41.27	12.54	6.26	0.77	92.65	94.83	69.77	3.74	34.42	20.7	100	78.13	35.03	27.39
10	University of Minnesota	91.01	49.52	18.18	25.7	2.63	86.65	93.12	58.14	3.76	25.86	18.79	73.54	51.54	31.51	19.55
11	Massachusetts Institute of Technology	90.81	100	20.46	17.66	0.9	90.44	93.39	100	3.61	45.95	18.62	16.76	91.16	27.12	38.91
11	Purdue University	90.81	44.02	24.28	15.34	1.77	80.54	91.76	73.26	7.12	12.93	14.12	63.84	45.48	30.12	27.71
13	Northwestern University	90.58	27.02	16.38	5.53	1.04	99.79	98.46	37.21	3.98	25.9	31.08	25.75	73.11	35.45	25.83
14	Cornell University	90.35	55.44	19.91	10.05	0.92	84.82	92.46	56.98	3.61	33.76	24	42.04	68.87	39.14	43.7
15	Duke University	88.29	40.46	14.43	13.49	1.69	91.51	94.72	50	3.14	25.55	18.04	26.03	96.5	26.09	26.08
16	University of Michigan	87.56	59.16	13.88	24.07	2.07	84.93	91.75	63.95	2.64	30.12	13.98	74.98	59.11	63.53	37.88
17	New York University	87.05	21.39	11.37	6.65	1.57	95.29	96.70	45.35	4.25	16.65	17.52	39.15	35.76	66.14	25.61
18	University of Washington	86.51	36.37	10.1	44.36	6.19	86.52	92.59	45.35	2.22	35.11	19.3	78.96	60.72	42.27	27.3
19	California Institute of Technology	86.36	31.82	31.12	7.88	1.26	81.8	93.19	58.14	10.03	12.78	24.74	3.33	87.62	3.54	27.3
20	University of Texas at Austin	85.97	19.9	10.71	11.48	2.92	84.64	93.11	43.02	4.08	17.19	18.31	75.99	46.63	28.25	25.93
21	University of Pittsburgh	85.78	43.81	19.66	18.16	2.1	78.81	90.81	63.95	5.06	22.96	20.39	45.91	48.38	21.44	23.12
22	Princeton University	85.62	13.12	15.98	3.44	1.32	88.75	95.94	23.26	4.99	11.27	27.17	15.14	68.84	13.46	45.04
23	Brigham Young University	84.5	9.02	100	4.91	2.73	75.72	95.38	51.16	100	1.47	32.29	41.12	32.39	6.54	21.66
24	University of Chicago	84.46	16.96	17.32	3.32	0.99	80.61	92.86	29.65	5.34	17.54	35.44	21.19	75.8	28.05	26.64
25	University of California, Berkeley	83.57	24.39	11.32	3.59	0.75	82.83	92.23	45.35	3.71	24.35	22.38	89.99	70.75	38.48	32.61
26	University of California, Davis	82.71	28.73	13.69	9.91	1.75	83.91	92.64	43.6	3.66	17.11	16.14	94.31	75.03	13.62	17.85
27	Johns Hopkins University	81.71	60.36	11.98	13.87	1.17	89.65	93.06	51.16	1.79	28.49	11.19	18.08	71.23	74.3	35.79

RANK	INSTITUTION	INDEXED SCORE	FORMAL TECHNOLOGY TRANSFER								INFORMAL TECHNOLOGY TRANSFER					
			INVENTION DISCLOSURES		LICENSES AND OPTIONS		GROSS LICENSING INCOME		STARTUPS FORMED		CITATIONS OF PATENTS		STEM BACHELORS GRADUATES		STEM MASTERS GRADUATES	
			RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX
28	Tufts University	81.12	7.28	14.05	1.74	1.19	80.75	94.02	16.28	5.54	7.82	29.86	18.14	75.69	21.88	36.75
29	University of California, Irvine	80.74	15.95	14.73	1.8	0.57	80.37	92.60	29.65	4.83	12.39	22.64	82.51	66.94	19.54	30.03
30	University of Miami	78.6	12.25	13.02	3.09	1.27	82.79	93.67	30.23	5.67	10.1	21.27	21.83	47.59	12.46	19.22
30	Washington State University	78.6	13.53	24.45	5.95	2.22	78.48	93.14	32.56	10.37	3.29	11.77	39.62	37.47	8.74	15.81
32	Ohio State University	78.41	54.9	22.44	7.81	0.72	81.02	91.40	47.67	3.43	19.01	15.38	81.76	43.04	25.26	17.39
33	Arizona State University	78.1	35.71	21.6	9.89	1.4	69.61	88.21	58.14	6.2	8.52	10.2	67.31	37.31	42.19	47.95
34	University of Arizona	77.98	33.93	18.13	12.09	1.81	78.68	91.07	48.84	4.6	9.79	10.36	54.92	39.21	19.14	19.08
35	Rutgers University New Brunswick	77.87	22.09	12.51	6.72	1.54	86.61	93.87	19.77	1.97	13.2	14.8	62.78	42.79	31.47	22.52
36	University of Houston	77.44	8.27	16.64	0.77	0.47	91.13	97.62	16.28	5.77	4.8	19.11	48.77	31.14	18.96	25.19
37	University of Utah	77.29	24.58	17.49	4.56	0.94	82.74	92.95	30.23	3.79	10.8	15.21	35.26	35.49	20.56	24.65
38	University of Wisconsin - Madison	77.21	45.97	13.56	8.54	0.94	86.29	92.62	36.05	1.87	19.36	11.3	73.97	56.27	28.05	23.72
39	Case Western Reserve University	75.54	28.8	32.21	7.23	1.27	72.94	90.41	29.07	5.73	12.35	27.34	14.41	65.97	12.47	19.27
40	University of South Florida	75.27	24.76	15.53	14.43	2.95	76.27	90.53	34.88	3.86	7.01	8.7	53.33	40.21	32.94	28.58
41	University of California, Santa Barbara	74.92	10.61	16.31	1.22	0.58	83.32	94.50	12.21	3.31	6.54	19.91	66.77	70.48	9.28	31.41
41	University of Kansas	74.92	8.4	12.23	6.45	3.85	83.3	94.39	17.44	4.48	7.74	22.31	24.48	30.68	11.5	14.64
43	Iowa State University	74.88	18.2	17.02	7.03	1.95	78.07	91.84	18.6	3.07	6.54	12.11	51.19	44.59	18.21	35.97
44	University of Southern California	74.84	29.09	12.37	5.72	1	80.79	91.39	34.88	2.62	16.8	14.15	34.04	41.22	84.48	30.3
45	University of Georgia	74.81	25.61	20.16	21.6	4.27	83.15	93.27	15.12	2.1	7.67	11.95	47.61	39.31	11.7	12.93
46	Northeastern University	74.69	13.03	29.64	1.51	0.58	68.63	90.19	19.19	7.69	6.23	28.07	29.26	50.77	45.04	56.43
47	Emory University	74.61	31.44	19.24	6.18	1	82.94	92.75	30.23	3.26	20.29	24.57	18.03	62.41	7.85	10.79
48	University of Oregon	74.42	4.96	22.24	100	100	82.74	96.17	6.98	5.51	0.54	4.81	38.07	49.67	9.06	25.04
49	University of New Mexico	71.9	14.27	21.12	6.3	2.23	72.88	90.88	39.53	10.31	3.52	10.32	25.2	35.84	11.36	21.11
50	Washington University in St. Louis	71.67	26.35	12.66	13.79	2.65	84.31	92.80	29.07	2.46	0.89	0.85	21.25	66.95	21.07	25.25
51	University of North Carolina at Chapel Hill	71.47	21.72	9.31	9.47	2.21	80.88	91.43	29.07	2.2	26.09	22.13	45.81	58.94	9.32	8.72
52	Rice University	71.28	10.88	29.85	1.24	0.57	70.67	91.21	15.12	7.31	8.67	47.09	12.37	76.45	9.95	30.3
53	Vanderbilt University	71.24	24.37	12.15	9.97	2.07	84.02	92.76	19.77	1.74	15.06	14.86	21.95	78.57	8.13	13.05
54	University of Virginia	70.81	27.22	18.17	9.12	1.7	77.03	90.90	20.93	2.46	9.1	12.02	40.29	58.38	16.02	20.08
55	Drexel University	70.08	13.9	42.46	2.67	0.97	65.77	89.74	19.77	10.64	4.72	28.56	23.34	37.32	20.54	23.43
56	Oregon State University	70	9.31	12.6	10.28	5.54	78.4	92.60	11.63	2.77	4.72	12.65	46.89	44.03	14.01	25.68

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			RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX
57	University of Texas at Dallas	69.3	7.61	23.52	1.2	0.79	78.03	93.92	3.49	1.9	5.34	32.68	30.12	35.35	47.96	56.28
58	University of Connecticut	68.29	9.18	15.49	2.13	1.16	70.9	90.44	13.95	4.15	5.61	18.74	45.61	59.65	22.98	27.33
59	Colorado State University	68.26	14.07	13.81	4.6	1.65	76.77	91.49	19.77	3.42	4.26	8.28	39.5	37.75	21.08	27.69
60	Georgia Institute of Technology	67.48	37.05	16.94	2.72	0.37	74.69	89.44	24.42	1.97	14.09	12.76	43.53	67.2	62.75	30.94
61	Worcester Polytechnic Institute	67.4	7.45	84.66	1.62	1.09	54.36	88.16	13.95	27.96	1.59	35.72	14.46	74.83	15.27	71.79
62	University of Massachusetts Boston	66.98	25.57	14.29	6.03	1.19	96.91	97.34	31.4	3.09	0.74	0.81	15.8	30.92	6.96	20.58
63	Indiana University	66.78	21.14	15.67	4.83	1.16	78.54	91.59	22.09	2.89	12.08	17.72	32.85	24.47	15.63	15.4
64	Virginia Commonwealth University	66.71	15.8	23.27	2.32	0.74	78.36	92.74	16.28	4.23	5.61	16.36	31.98	34.51	7.13	10.34
65	Brandeis University	65.66	6.91	42.63	0.62	0.45	77.53	94.96	3.49	3.79	1.12	13.71	14.96	100	13.46	63.16
66	Clemson University	65.54	7.36	19.97	1.43	0.97	67.29	90.05	13.95	6.67	2.59	13.92	35.52	43.34	17.24	30.72
67	Dartmouth College	65.16	7.49	14.25	1.31	0.88	78.67	93.29	10.47	3.51	5.88	22.17	14.56	80.49	5.41	25.29
68	Brown University	65.08	7.76	15.77	0.64	0.41	74.53	92.00	10.47	3.75	6.62	26.64	19.31	66.45	12.12	38.3
69	University of Arkansas Fayetteville	64.92	6.79	17.44	3.36	2.48	73.93	92.21	11.63	5.27	2.09	10.64	24.5	26.23	12.2	26.99
70	Kansas State University	64.69	9.76	16.82	3.67	1.89	77.76	92.81	10.47	3.18	2.56	8.72	27.55	39.45	11.09	24.66
71	University of Kentucky	63.64	10.72	12.47	2.16	1.02	76.98	91.85	20.93	4.29	6.43	14.8	29.24	32.4	8.88	12.43
72	University of North Carolina Charlotte	63.14	4.59	41.13	0.62	0.67	60.69	89.90	11.63	18.36	1.24	21.96	37.43	38.32	19.26	34.85
73	University of Akron	62.71	7.82	82.11	0.89	0.57	62.72	90.86	13.95	25.83	2.32	48.29	16.22	27.01	7.57	27.08
74	University of Louisville	61.55	10.47	21.65	1.97	0.95	72.7	91.41	15.12	5.51	4.37	17.91	16.35	25.41	9.11	15.72
75	University of Rochester	61.51	15.27	14.44	2.98	0.98	78.87	92.13	11.63	1.94	7.39	13.85	18.09	65.76	9.26	17.03
76	Rochester Institute Technology	61.43	2.69	18.27	0.73	1.33	62.4	89.99	12.79	15.32	0.89	11.97	23.52	43.54	19.62	66.93
76	Tulane University	61.43	4.43	11.08	0.7	0.78	74.04	92.20	11.63	5.13	3.1	15.34	14.71	45.43	17.15	34.81
76	University of Central Florida	61.43	13.9	22.51	3.71	1.35	74.85	91.71	6.98	1.99	5.27	16.87	59.38	24.65	14.87	14.86
79	University of Toledo	61.32	6.91	48.54	1.28	0.92	76.57	94.87	3.49	4.32	1.86	25.84	14.23	22.52	7.74	18.82
80	San Diego State University	61.24	3.97	28.09	10.66	13.25	69.76	92.56	1.16	1.45	1.66	23.31	40.41	32.29	13.76	29.39
81	University of California, Riverside	60.93	8.56	18.8	0.64	0.37	80.18	94.05	3.49	1.35	5.57	24.22	45.52	50.87	7.98	22.91
82	Michigan State U niversity	60.39	19.45	9.94	7.34	1.91	78.49	90.93	13.95	1.26	7.51	7.6	62.18	39.12	13.8	13.02
82	Oklahoma State University	60.39	5.09	11.69	1.39	1.36	76.56	92.91	10.47	4.24	0.58	2.64	26.76	32.91	13.2	32.78
84	Colorado School of Mines	59.92	6.21	34.09	1.62	1.3	57.16	87.84	9.3	9.01	1.59	17.26	14.96	71.53	9.14	62.29

RANK	INSTITUTION	INDEXED SCORE	FORMAL TECHNOLOGY TRANSFER								INFORMAL TECHNOLOGY TRANSFER					
			INVENTION DISCLOSURES		LICENSES AND OPTIONS		GROSS LICENSING INCOME		STARTUPS FORMED		CITATIONS OF PATENTS		STEM BACHELORS GRADUATES		STEM MASTERS GRADUATES	
			RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX
85	University of Cincinnati	59.84	15.1	21.58	2.2	0.74	68.06	89.19	13.95	3.52	4.92	13.91	30.42	26.42	32	29.48
86	University of Notre Dame	59.69	11.01	17.85	1.97	0.9	68.72	89.63	19.77	5.65	3.6	11.56	21.91	61.83	6.64	16.85
87	University of North Texas at Denton	58.45	5.3	66.29	0.85	0.8	60.52	90.42	9.3	20.53	1.24	30.7	30.62	23.46	11.76	16.43
88	Boston University	57.95	9.97	7.72	0.89	0.45	75.37	90.59	10.47	1.43	11.54	17.69	30.85	42.28	47.66	30.38
89	Stevens Institute of Technology	57.13	4.59	39.07	0.35	0.38	58.06	88.91	8.72	13.08	1.16	19.56	8.2	55.25	34.66	95.92
90	University of Texas at San Antonio	57.02	6.91	33.19	0.89	0.64	59.61	88.44	9.3	7.88	2.32	22.09	31.58	27.52	11.51	26.74
91	University of Alabama Birmingham	56.78	11.63	7.22	3.94	1.71	80.22	91.86	17.44	1.91	11.89	14.61	12.51	22.29	10.16	12.37
92	University of California, Santa Cruz	56.47	6.89	19.9	0.52	0.38	66.53	89.90	6.98	3.55	3.45	19.7	47.73	67.15	7.83	39.75
93	Ohio University	55.85	3.48	22.56	0.23	0.33	79.53	95.73	4.65	5.32	0.89	11.44	21.43	25.16	9.62	15.13
94	Temple University	55.81	10.26	17.85	1.39	0.68	67.74	89.42	16.28	4.99	5.23	18	27.57	23.66	12.6	12.56
95	Auburn University	55.54	8.69	14.94	1.97	1.14	72.61	91.05	9.3	2.82	2.28	7.77	33.58	33.65	14.34	24.52
96	George Washington University	55	8.03	11.29	0.77	0.48	70.41	89.96	10.47	2.59	4.37	12.18	25.84	51.01	49.3	32.26
97	Georgetown University	54.92	6.21	15.49	0.66	0.53	76.44	93.01	1.16	0.51	3.33	16.45	17.59	57.71	36.77	30.53
98	University of Tennessee Knoxville	54.42	21.47	19.57	2.43	0.57	75.33	90.87	10.47	1.68	4.84	8.73	30.38	32.14	11.87	19.3
99	Florida State University	54.22	6.95	13.27	1.85	1.33	68.87	89.97	8.14	2.74	2.83	10.68	63.11	46.75	16.76	18.31
100	University of Delaware	53.64	5.96	14.46	0.89	0.74	62.36	88.18	12.79	5.47	3.37	16.18	28.09	35.19	10.61	25.76
101	South Dakota State University	52.56	5.59	32.04	0.93	0.83	71.61	92.82	3.49	3.53	0.85	9.67	12.58	30.8	5.55	38.51
102	University of Texas at Arlington	52.4	6.37	21.32	0.77	0.61	62.61	88.82	8.14	4.8	2.01	13.34	25.28	17.89	38.34	27.84
103	University of Iowa	52.17	13.2	10.37	6.14	2.35	74.19	90.22	13.95	1.93	6.58	10.23	26.53	27.85	6.08	7.85
104	East Carolina University	51.05	2.79	30.78	0.64	1.11	61.58	90.56	5.23	10.17	1.47	32.1	21.25	22.69	5.19	9.34
105	Michigan Technological University	50.85	4.1	19.37	1.2	1.44	65.64	90.46	3.49	2.91	1.08	10.15	14.18	60.79	10.26	80.56
106	Penn State University	50.5	21.02	8.32	1.97	0.47	72.53	88.45	19.77	1.38	12.74	9.98	88.16	28.55	16.36	10.7
107	University of New Hampshire	48.88	6.54	19.85	15.69	11.99	71.21	91.57	1.16	0.62	0.54	3.26	21.35	42.99	5.45	21.42
108	James Madison University	48.72	0.74	75.64	0.23	1.36	53.46	91.69	3.49	62.46	0.15	31.14	20.13	24.94	1.79	9.34
109	University of Wisconsin - Milwaukee	48.33	6.41	43.12	0.97	0.75	52.47	86.60	6.98	8.27	1.2	15.98	21.76	25.41	9.6	20.83
110	West Virginia University	47.98	6.14	21.5	0.41	0.33	69.95	91.39	3.49	2.15	3.33	23.06	29.77	34.8	7.65	13.34
111	Marquette University	46.9	2.03	21.9	0.23	0.55	70.22	93.46	2.33	4.43	0.7	14.9	15.07	43.62	3.07	9.31

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112	University of Alabama Huntsville	46.16	5.88	24.9	0.35	0.29	60.48	88.51	5.81	4.34	2.44	20.46	9.56	29.49	7.04	35.32
113	University of Alabama	46.01	6.33	34.05	0.41	0.32	58.08	88.12	5.23	4.96	2.44	25.97	33.6	25.25	6.81	12.88
114	Portland State University	45.97	1.74	10.36	2.38	6.5	68.94	91.98	1.74	1.83	0.58	6.85	27.42	33.26	12.13	24.32
115	Southern Illinois University	45.89	2.3	22.56	0.35	0.73	71.71	93.80	0	0	0.62	12.05	19.01	55.33	7.44	23.11
116	Wayne State University	45.35	7.41	11.38	0.77	0.52	69.93	89.94	6.98	1.89	5.69	17.31	18.99	26.52	19.23	21.01
117	North Dakota State University	44.96	3.29	8.03	5.74	8.55	72.47	91.62	3.49	1.5	1.01	4.86	15.92	36.23	5.43	23.25
118	University of Vermont	44.46	5.15	14.47	0.58	0.56	65.97	89.66	8.72	4.32	1.74	9.69	19.93	42.93	4.33	20.64
119	Western Michigan University	43.88	1.12	23.99	0.12	0.48	57.39	90.31	6.98	26.41	0.31	13.17	14.59	21.09	9.63	21.85
120	Utah State University	42.29	4.1	5.25	3.36	4.05	74.71	91.25	0	0	1.63	4.12	21.91	21.89	8.08	25.8
121	Mississippi State University	41.94	4.26	6.2	0.89	1.03	62.05	87.18	11.63	2.98	1.32	3.79	24.75	32.46	9.4	27.46
122	University of North Carolina Wilmington	41.28	0.74	16.1	1	5.88	56.36	89.97	4.65	17.73	0.04	1.66	17.05	28.42	3.85	14.25
123	University of Nevada, Las Vegas	40.74	5.67	24.09	1.08	0.95	65.85	90.34	5.81	4.36	0.46	3.91	17.77	16.95	3.96	7.44
124	Montana State University	40.54	2.57	7.06	4.6	8.7	66.16	89.69	3.49	1.69	1.47	8.02	18.37	30.68	5.3	27.54
125	Ball State University	40.19	2.36	77.29	5.56	11.41	58.48	91.42	0	0	0.27	17.58	10.62	15.67	8.03	14.03
126	Loyola University Chicago	39.84	0.43	4.01	0	0	72.78	94.05	0	0	1.78	32.52	18.44	37.12	7.67	15.63
127	Rowan University	39.03	2.85	37.75	0.27	0.46	62.43	91.17	1.16	2.71	0.74	19.25	19.33	29.76	4.61	12.82
128	University of Idaho	38.6	2.81	9.19	0.58	1	74.21	92.72	0	0	0.77	5	12.43	32.61	6.74	26.67
129	Northern Illinois University	38.41	1.03	23.12	0.04	0.17	43.17	85.54	1.16	4.58	0.5	22.27	19.5	39.62	11.58	25.94
130	Augusta University	37.95	4.84	17.89	0.93	0.95	67.56	90.68	8.14	5.3	0	0	4.66	20.51	0.54	1.77
131	University of South Alabama	37.87	3.93	20.9	0.27	0.34	70.95	92.47	3.49	3.27	0.97	10.19	9.23	23.7	3.27	6.83
132	University of Nevada, Reno	37.33	2.77	10.14	0.7	1.22	65.72	90.03	3.49	2.25	1.24	8.97	25.77	36.72	4.58	12.44
133	Georgia State University	37.13	3.23	5.92	0.35	0.53	59.43	86.69	6.98	2.26	3.17	11.52	30.79	27.14	15.68	22.21
134	Northern Arizona University	36.47	6.04	41.71	0.35	0.29	52.61	86.69	3.49	4.25	0.85	11.64	29.17	27.12	4.68	11.11
135	University of Southern Mississippi	36.4	0.81	9.52	0.52	2.85	55.04	88.46	5.23	10.88	0.58	13.56	8.91	18.95	3.18	12.58
136	Cleveland State University	35.89	1.9	8.39	0.73	1.84	60.21	88.49	3.49	2.71	0.43	3.72	16.6	35.38	9.78	25.35
137	Morgan State University	35.58	2.77	65.32	0.23	0.41	48.97	87.60	6.98	28.98	0.15	7.22	6.09	23.22	2.28	17.56
138	University of Dayton	35.19	2.17	5.6	0.41	0.9	67.77	90.12	3.49	1.59	0.43	2.18	13.67	39.72	9.38	31.45
139	New Jersey Institute of Technology	34.34	5.65	13.5	0.17	0.15	55.31	85.75	0	0	1.55	7.33	19.98	55.99	27.16	100
140	Louisiana Tech University	33.8	1.32	18.95	0.23	0.81	61.98	91.15	1.16	2.93	0.39	10.97	9.55	22.88	3.15	25.88

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			RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX	RAW INDEX	NORMALIZED INDEX
141	University of Texas at El Paso	32.79	2.4	8.96	0.43	0.86	56.81	87.04	5.81	3.83	1.05	7.72	19.26	22.16	7.68	20.53
142	University of Hawaii	32.13	5.54	6.77	1.28	1.14	63.3	87.29	5.81	1.25	1.39	3.37	18.54	36.18	5.46	11.26
143	University of South Carolina	31.24	8.15	13.64	0.54	0.33	57.86	86.00	4.65	1.37	2.79	9.24	34.77	31.16	6.54	8.34
144	Wright State University	30.27	1.43	8.4	0.29	0.95	53.67	86.77	1.74	1.81	0.54	6.32	13.35	35.1	14.91	50.09
145	University of Denver	29.84	0.56	6.1	0.19	1.44	60.51	90.18	0	0	0	0	11.27	48.12	17.25	24.18
146	University of Alaska Fairbanks	28.14	3.1	9.56	0.35	0.55	52.21	85.14	10.47	5.69	0.08	0.47	3.89	15.46	1.9	19.61
147	Miami University	27.87	0.43	7.65	0.06	0.53	31.2	81.06	0	0	0.54	18.88	26.92	38.47	9.3	37.77
147	University of South Dakota	27.87	0.87	21.06	0.06	0.3	0	0.00	1.74	7.45	0.62	29.72	3.8	12.53	1.93	7.91
149	University of Northern Iowa	27.83	1.28	11.85	0.27	0.98	53.35	87.46	3.49	5.68	0.12	2.12	9.31	25.62	1.84	12.08
150	University of Mississippi	27.67	1.7	7.77	0.08	0.22	66.82	90.81	2.33	1.88	1.55	14.05	15.72	22.59	4.22	9.48
151	University of Rhode Island	27.56	3.23	10.95	0.35	0.53	61.75	88.56	0	0	1.51	10.15	19.35	32.78	4.72	16.22
152	Duquesne University	25.66	0.74	15.77	0	0	0	0.00	3.49	13.02	0.23	9.74	6.39	26.96	3.38	10.09
153	Boise State University	25.08	1.74	16.55	3.13	8.55	53.95	87.71	0	0	0.43	8.03	13.81	14.86	2.57	7.77
154	University of Louisiana Lafayette	24.11	2.23	5.64	0.31	0.67	51.77	84.64	8.14	3.62	0.46	2.32	12.27	20.71	4.01	17.28
155	University of California, Merced	23.76	0.5	4.93	0	0	0	0.00	1.74	3.05	1.32	25.86	14.71	44.49	0.95	13.65
156	Catholic University of America	22.6	0.19	3.16	0	0	47.17	86.42	0	0	2.98	100	5.36	40.27	4.34	17.47
157	University of North Florida	22.4	0.74	30.7	0.12	0.68	32.44	82.97	0	0	0.27	22.11	15.34	25.66	2.02	8.5
158	University of Texas at Tyler	22.05	0.25	47.3	0	0	0	0.00	0	0	0.12	43.81	7.16	25.24	4.65	17.79
159	Illinois State University	20.7	0.62	11.81	0.12	0.79	39.44	83.99	0	0	0.31	11.66	19.23	25.97	5.38	20.53
160	North Carolina A&T State University	19.38	0.99	9.47	0	0	54.61	87.94	0	0	0.5	9.5	9.32	20.8	5.02	33.19
161	Bowling Green State University	17.6	0.7	15.55	0.04	0.24	38.55	83.95	0	0	0.12	5.08	10.29	16.8	7.68	29.27
162	University of Texas at Rio Grande	17.25	2.32	23.27	0.12	0.24	57.65	89.06	0	0	0.19	3.85	0	0	0	0
163	University of Alaska Anchorage	15.16	0.74	17.02	0.06	0.34	0	0.00	0	0	0.08	3.5	6.41	13.04	1.93	29.16
164	University of Memphis	15.08	2.48	15.69	0	0	0	0.00	0	0	0.85	10.66	11.53	16.36	5.04	11.75
165	University of West Florida	9.53	0	0	0	0	33.31	80.89	0	0	0	0	10.73	27.78	3.8	12.57
166	University of Texas at Permian Basin	7.4	0	0	0	0	0	0.00	0	0	0	0	5.14	29.14	0.77	8.26

From Systems to Individual Institutions

There were 15 entities that reported to AUTM as systems: University System of Maryland, University of Colorado System, University of Missouri System, Texas Tech University System, State University of New York System, Louisiana State University System, Texas A&M University System, University of Nebraska System, University of Massachusetts System, University of Illinois System, University of Wisconsin System, University of Oklahoma System, City University of New York System, University of California System, and University of Texas System. In order to make similar and more comprehensive comparisons, we searched for data about the constituent universities for each system.

The University of California System's Knowledge Transfer Office, housed within the Office of the President, reported technology transfer activity by institution for fiscal years 2017 and 2018. These reports can be found at the following address: https://www.ucop.edu/knowledge-transfer-office/innovation/innovation-impact/technology-commercialization-report.html.

The University of Texas System has created a dashboard to allow the public to explore various reported figures by institution. This includes measures of technology transfer by fiscal year. We extracted values from this dashboard, which can be found at the following address: https://data.utsystem.edu/data-index/tech-transfer.

We were not able to locate sufficiently comprehensive data on individual institutions for the other systems and thus exclude them from our rankings.

Formal Technology Transfer Data Collection

Data for formal technology transfer was drawn from the Statistics Access for Technology Transfer (STATT) database created by AUTM, which includes data from AUTM's Licensing Activity Survey, which is conducted yearly among U.S. AUTM member institutions. We particularly focus on universities that reported to AUTM for at least one year in the range of 2017-2019.

AUTM's Licensing Activity Survey collects data on multiple dimensions of technology transfer. However, this index focuses primarily on key technology transfer variables that span from early stage to end-use outcomes. Below, we list each AUTM variable incorporated in this index and its definition (https://autm.net/AUTM/media/Surveys-Tools/Documents/Licensing-Survey-Definitions.pdf).

Total Research Expenditure: AUTM defines total research expenditures as including "expenditures (not new awards) made by the institution in support of its research activities that are funded by all sources including the federal government, local government, industry, foundations, voluntary health organizations (i.e., AHA, ACS, etc.), and other nonprofit organizations. Indirect costs should be included." Although total research expenditure is not a technology transfer outcome, we used it to scale technology transfer outcomes and to compare similar institutions.

Out of the institutions included in this study, only the University of Rhode Island, University of Memphis, and University of Texas institutions were missing all years within the range of 2017-2019 for reported total research expenditure. These values were inputted using NSF data, which is described in more detail below (see "Additional Data Collection").

Among all individual universities included in this index, the dollar values for total research expenditures ranged from 1,152,000 (University of Texas Permian Basin) to 1,833,162,126 (Johns Hopkins University) with an average of 319,201,726.

We used the NSF data as a supplementary source when AUTM institutions were missing values for research expenditure for all years within the range of 2017-2019. This included only University of Rhode Island, University of Memphis, and University of Texas institutions (note: UT institutions were not reported separately to AUTM, but rather were included based on UT Tech Transfer data, which was missing research expenditure values). For each of these institutions, the NSF reported values for the years 2017-2019 were averaged, and then multiplied by 1000 to match the magnitude of research expenditures as reported by AUTM. These values were then inputted in the Total Research Expenditure Mean column.

Invention Disclosures Received: Invention disclosures received is defined by AUTM as "the number of disclosures, no matter how comprehensive, that are submitted during the survey year requested and are counted as received by the institution." No institutions were missing for this variable for all years considered in this study. The average reported value was 59.83 for this variable.

Licenses and Options Issued: This variable was created by summing each respective year reported for the AUTM variables "Licenses Issued" and "Options Issued." AUTM defines these variables as the "number of license or option agreements that were executed in the year indicated for all technologies. Each agreement, exclusive or non-exclusive, should be counted separately. Licenses to software or biological material end-users of $1,000 or more may be counted per license, or as 1 license, or 1/each for each major software or biological material product (at manager's discretion) if the total number of end-user licenses would unreasonably skew the institution's data. Licenses for technology protected under U.S. plant patents (US PP) or plant variety protection certificates (US PVPC) may be counted in a similar manner to software or biological material products as described above, at manager's discretion. Material Transfer Agreements are not to be counted as Licenses/Options in this Survey."

University of Oregon reported the highest average of licenses and options issued. Among all institutions, the average reported value was 43.327.

The following six AUTM-member universities did not report for either licenses issued or options issued for any year considered in this index: Loyola University Chicago, North Carolina A&T State University, Catholic University of America, University of West Florida, University of Memphis, Duquesne University. Among added institutions, University of California Merced, University of Texas Tyler, and University of Texas Permian Basin had reported values of 0 for licenses and options issued.

Gross Licensing Income: AUTM defines gross licensing income as including "license issue fees, payments under options, annual minimums, and running license income paid to other institutions." As gross licensing income is an end-use outcome, it was weighted more heavily in our index (see "Index Calculation" for more detail).

This variable was not reported for any year considered for the following four AUTM institutions: University of Memphis, Duquesne University, University of Alaska Anchorage, and University of South Dakota. We inputted gross licensing income as 0 for these universities. In addition, gross licensing income was reported as 0 for the following three added institutions (as reported by their system Technology Transfer Office): University of California Merced, University Texas Tyler, and University of Texas Permian Basin.

The lowest reported value gross licensing income was Miami University, with a value of 425. The highest average gross licensing income was reported by Carnegie Mellon University. With the values of 0 included, the average reported gross licensing income by universities was 10,744,519.

Startups Formed: AUTM defines startup companies formed as "new companies that were dependent on licensing your institution's technology for their formation. If a technology was licensed to an existing startup company that was formed to develop a different technology, this company should be counted as a SMALL COMPANY when responding to Question 6C, not a STARTUP COMPANY. STARTUP COMPANIES, as used in this Survey, refer only to those companies that were formed specifically to develop the technology being licensed. A STARTUP COMPANY may be formed well in advance of when the actual license is signed, while the founders research and write the company's business plan and explore the feasibility of securing investors or grants. A company should be reported as a STARTUP COMPANY irrespective of whether the company was formed by the licensing institution OR by an entrepreneur, investor, the professor, a graduate student, or a post-doctoral fellow. The key question is: "Was the company that licensed a technology formed specifically to license and develop the technology being licensed."

This variable was not missing for any individual university. However, the following institutions reported values of 0 for this variable: New Jersey Institute of Technology, Utah State University, University of Rhode Island, University of Idaho, University of Memphis, Ball State University, University of Texas Rio Grande, Southern Illinois University, Boise State University, North Carolina A&T University, University of Alaska Anchorage, University of North Florida, Bowling Green State University, Illinois State University, University of Denver, Loyola University Chicago, Miami University, University of Texas Tyler, Catholic University of America, University of West Florida, and University of Texas Permian Basin. Overall, the mean reported value for average number of startups formed in the range of 2017-2019 was 5.279. The maximum reported value was Massachusetts Institute of Technology.

Informal Technology Transfer Data Collection

In addition to the data provided directly from AUTM, we incorporated outside data sources to fill data gaps, add university demographic data (such as state membership, student population, and public/private designation), and to incorporate measures of informal technology transfer such as STEM graduates and citation data. Below, we list each measure the source of data used.

Citations: Lens.org aggregates data on scholarly works and patent records from diverse data sources. By conducting a “structured search” on this platform, we obtained counts of scholarly works cited by patents granted between January 1, 2017 and December 31, 2019. Institution country/region was filtered to focus on only institutions within the United States. These data were collected on November 4, 2021 and were manually inputted into an excel spreadsheet based on individual searches of AUTM institutions.

Human Capital: JobsEQ for Education is a software tool provided by Chmura Economics, a market analysis software consultant. To get an estimate of human capital created by institutions, STEM (science, technology, engineering, and math) graduate values were procured from JobsEQ. Data was downloaded from the Education Data Explorer from 7/26/2021-7/27/2021.

The total number of STEM degrees awarded for each unique combination of year (2017, 2018, or 2019), institution, and award level (bachelor’s or master’s) were downloaded. A given award year considers all degrees awarded in the academic year listed, which would end in the spring semester of that given year.

JobsEQ uses the Census definition of STEM disciplines; the most recent list of U.S.-government designated STEM CIP (Classification of Instructional Programs) codes can be found in the following document: https://www.ice.gov/sites/default/files/documents/stem-list.pdf. STEM fields include mathematics, natural sciences, engineering, computer and information sciences, and the social and behavioral sciences – psychology, economics, sociology, and political science.

Both the average number of STEM master’s graduates and STEM bachelor’s graduates, respectively, were incorporated as variables in this index. Additionally, STEM masters graduates as a percentage of all graduate students, and STEM bachelors’ graduates as a percentage of all undergraduate students were included as variables in our index.

The total number of graduate students and undergraduate students were obtained from the Integrated Postsecondary Education Data System (IPEDS), housed by the National Center for Education Statistics (NCES). These data focus on post-secondary educational institutions and their characteristics. Using the “College Navigator” tool (https://nces.ed.gov/collegenavigator/), we extracted data on 7/14/2021 as a measure of student population (both undergraduate and graduate), public/private designation, and institution location (state). Data for all available public and private non-profit institutions in each U.S. state were downloaded. These data are representative of the student cohort which began their postsecondary education in the Fall 2014 semester, and thus would be on track to graduate in Spring 2018.

Index Calculation

Once each variable had been averaged over our 2017-2019 year period, we proceeded to create normalized and scaled versions of variables within each of the three respective institution groupings (non-system universities, university systems, and non-university institutions). Therefore, at each normalization, scaling, or ranking step, only like institutions are compared.

Licenses and Options: A "normalized" version of the licenses and options variable by dividing by the average number of the school's invention disclosures received (the value of 1 was added to each institution's average, due to some reported values of 0). Next, we create a "scaled" version of this normalized variable by dividing by the maximum value over all institutions in the given category.

$$LO_{normalized} = \frac{LicensesAndOptionsMean}{InventionDisclosuresMean + 1}$$

$$LO_{normalized,scaled} = \frac{LO_{normalized}}{max(LO_{normalized})}$$

A scaled version of the variable was also created for the raw mean of Licenses and Options issued.

$$LO_{scaled} = \frac{LicensesAndOptionsMean}{max(LicensesAndOptionsMean)}$$

Gross Licensing Income: First, we replaced any value of 0 for this variable with 0.001 in order to ensure that every value would be finite when taking the natural log of the value.

$$GLI_{normalized} = ln\left(\frac{GrossLicensingIncomeMean}{TotalResearchExpenditureMean}\right) + constant$$

$$GLI_{normalized,scaled} = \frac{GLI_{normalized}}{max(GLI_{normalized})}$$

We then created a "normalized" version of the variable by dividing the ratio of Gross Licensing income to Total Research Expenditures, and then taking the natural log of this ratio due to the skewed distribution of gross licensing income for all universities. Next, we created a "scaled" version of this normalized variable by dividing by the maximum value over all institutions in the given category.

$$GLI_{scaled} = \frac{ln(GrossLicensingIncomeMean)}{max(ln(GrossLicensingIncomeMean))}$$

A scaled version of the variable was also created for the natural log of the Gross Licensing income by dividing by the maximum value over all institutions in this category.

Invention Disclosures Received: We created a "normalized" version of average invention disclosures received by dividing by the total research expenditure of that institution. Next, we created a "scaled" version of this normalized variable by dividing by the maximum value over all institutions in the given category.

$$IDR_{normalized} = \frac{InventionDisclosuresRecievedMean}{TotalResearchExpenditureMean}$$

$$IDR_{normalized,scaled} = \frac{IDR_{normalized}}{max(IDR_{normalized})}$$

A scaled version of the variable was also created for the raw mean of Investment Disclosures received.

$$IDR_{scaled} = \frac{InventionDisclosuresRecievedMean}{max(InventionDisclosuresRecievedMean)}$$

Startups Formed: We created a "normalized" version of the average startups formed by dividing by the total research expenditure of that institution. Next, we create a "scaled" version of this normalized variable by dividing by the maximum value over all institutions in the given category.

$$SUF_{normalized} = \frac{StartUpsFormedMean}{TotalResearchExpenditureMean}$$

$$SUF_{normalized,scaled} = \frac{SUF_{normalized}}{max(SUF_{normalized})}$$

A scaled version of the variable was also created for the raw mean of Startups formed.

$$SUF_{scaled} = \frac{StartUpsFormedMean}{max(StartUpsFormedMean)}$$

Unique Citing Patents: We created a "normalized" version of average unique citing patents by dividing by the total research expenditure of that institution. Next, we created a "scaled" version of this normalized variable by dividing by the maximum value over all institutions in the given category.

$$UCP_{normalized} = \frac{UniqueCitingPatentsMean}{TotalResearchExpenditureMean}$$

$$UCP_{normalized,scaled} = \frac{UCP_{normalized}}{max(UCP_{normalized})}$$

A scaled version of the variable was also created for the raw mean of Unique Citing Patents.

$$UCP_{scaled} = \frac{UniqueCitingPatentsMean}{max(UniqueCitingPatentsMean)}$$

STEM graduates: STEM bachelors and masters graduates were considered separately. For the following protocol, STEM bachelors graduates are described, but we the same calculations were done for master's graduates.

We incorporated a ranking (again using R's "dense rank" command) of institutions based on the raw number of STEM bachelors graduates (averaged over the years 2017-2019) from each institution. Separately, we included a ranking where the number of graduates is "normalized" by the maximum number of STEM bachelors graduates in any university.

We additionally considered the number of STEM bachelors graduates divided by the total number of undergraduate students at that institution (when considering masters graduates, this is instead divided by the total number of graduate students at a given institution). We additionally included a ranking based on this raw fraction, as well as a ranking where the fraction of students graduating with STEM degrees is "normalized" by the institution with the largest fraction of students graduating with STEM degrees.

Overall ranking sum calculation: We ranked all standalone universities based on the "scaled" and the "normalized and scaled" versions, respectively, of each variable. This was done through the R command "min_rank," found within the dplyr package. This ranking schematic assigns duplicate values the minimum rank in the case of a tie. For example, if school A had the highest score in a category, schools B and C were tied, and school D had the lowest score, then A would earn rank 1, B and C would earn rank 2, and D would earn rank 4.

Both the scaled raw ranking and the scaled and normalized rankings were then included in the overall calculation for an institution's rank sum. The ranks (both the scaled version and normalized + scaled versions) of Gross Licensing Income and Startups Formed were double weighted, while all other ranks were incorporated only once in the sum. We include the equation for the rank sum below for clarity.

$$SumOfRanks = Rank(LO_{scaled}) + Rank(LO_{normalized,scaled}) + 2*Rank(GLI_{scaled}) + 2*Rank(GLI_{normalized,scaled}) + Rank(IDR_{scaled}) + Rank(IDR_{normalized\ scaled}) + 2*Rank(SUF_{scaled}) + 2*Rank(SUF_{normalized\ scaled}) + Rank(UCP_{scaled}), + Rank(UCP_{normalized,scaled}) + Rank(STEMBachelorsGraduates) + Rank(STEMBachelorsFraction) + Rank(STEMMastersFraction) + Rank(STEMMastersGraduates)$$

Finally, universities were ranked based on this overall sum of ranks. The institution with the lowest sum would thus be the institution ranked first in our index. Again, the overall rank was computed with the R command "min_rank." Additionally, overall indexed scores were created by comparing the overall sum of ranks to that of the best performer overall.

Name Normalization

AUTM member institutions do not always report consistently. For ease of interpretation, we have changed some names from the original name reported to AUTM. In addition, some institutions changed the name they reported under, which we have also normalized. Specific changes and discrepancies are noted below.

The Sanford-Burnham Medical Research Institute was reported under the name "Burnham Institute" prior to the year 2009.

Loyola University of Chicago has consistently reported under the name "Loyola University of Chicago," with the exception of 2001 and 2004, when it was reported under the name "Loyola University Medical Center."

The Tufts Medical Center was reported under the name "New England Medical Center" from 2002-2006.

Temple University: ID switch in 2016. Reported name as "Temple University" from 2001-2015 and 2018-2019, but reported as "Temple University System" in 2016 and 2017. However, values are on similar trajectory throughout. The University of Chicago was also reported as the name "Univ of Chicago/UCTech."

"University of Illinois Chicago/Urbana" was reported to AUTM. We changed this name to "University of Illinois System," as University of Illinois Chicago and University of Illinois Urbana-Champaign are the two flagship universities of the system.

The following institutions were commonly reported as the research foundation of the respective institution: Brown University, Cornell University, Indiana University, Kansas State University, Medical College of Wisconsin, National Jewish Health, Purdue University, State University of New York System, University of Alabama Birmingham, University of Dayton, University of Idaho, University of Iowa, University of Kentucky, University of West Florida, University of Wisconsin-Madison, University of Wisconsin-Milwaukee, Washington State University.

Augusta University was listed as "Georgia Regents University" from 2012-2014, and as "Medical College of Georgia Research Institution" from 2002-2010.

The University of Colorado reported as a system from 2001-2019. The name did change slightly throughout the years for the associated AUTM ID (95192)- it was typically reported as "University of Colorado", but was reported as "University of Colorado System" in 2019. However, in 2018, this AUTM ID was reported under the name "University of Colorado Boulder". "University of Colorado Anschutz" (medical) was reported individually under a different ID number, but only for the year 2018. The values reported were trending upward over the years under the ID number 95192, so we overrode names to consider this to be "University of Colorado System" for all years.

The University of Tennessee University of Tennessee Knoxville was reported as simply the "University of Tennessee."

Virginia Tech was reported under the name "Virginia Tech Intellectual Properties Inc."

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