# From Insights to Impact

## Fostering Innovation Through Texas Higher Education

TECHNICAL APPENDIX

Texas Higher Education Coordinating Board

www.highered.texas.gov

# Acknowledgments

TIP Strategies, Inc., would like to acknowledge the contributions made by the seven-member Steering Committee that guided the project planning process. Additionally, the 18 members of the Technology Transfer Advisory Council shared their time and expertise. TIP would also like to thank the following team members at the Texas Higher Education Coordinating Board who contributed to the planning process.

## Project Advisors

Harrison Keller, Ph.D.
*Commissioner of Higher Education*
Texas Higher Education Coordinating Board

Lee Rector
*Associate Commissioner for Workforce Education*
Texas Higher Education Coordinating Board

Jaclyn Le
*Senior Director, Strategic Initiatives and Engagement*
Texas Higher Education Coordinating Board

Melissa Henderson
*Chief of Staff & Executive Director*
Texas Higher Education Coordinating Board & Texas Higher Education Foundation

Matt Parson
*Assistant Commissioner for Workforce Strategy*
Texas Higher Education Coordinating Board

Texas Higher Education
COORDINATING BOARD

# Consulting Team

TIP Strategies, Inc., is a privately held Austin-based firm providing consulting and advisory services to public and private sector clients. Established in 1995, the firm's core competencies are strategic planning for economic development, talent strategies, organizational development, resiliency planning, and equity initiatives.

## Project Contributors

Jon Roberts
*Managing Partner*

Brent McElreath
*SVP, Research & Development*

John Karras
*VP, Business Development*

Katrina Parkey
*Consultant*

Luke Shuffield
*Consultant*

Erica Colston
*Associate Consultant*

Evan Johnston
*Senior Analyst*

Ajay Kasturirangan
*Analyst*

Meredith Eberle
*Senior Graphic Designer*

## Contact

TIP Strategies
13492 N Hwy 183, Suite 120-254, Austin, TX 78750
PH: +1 512 3439113
www.tipstrategies.com

Research Bridge Partners bridges the gap between university labs in thin translational markets, where two-thirds of National Institutes of Health-funded research happens, and the California and Massachusetts biotech hubs, where two-thirds of biotech dollars are invested. Organized as a 501(c)(3), Research Bridge Partners manages an innovative, mission-focused venture capital fund to support this work.

## Project Contributors

Isaac Barchas
*CEO*

Jim Graham
*Managing Director of Investments*

## Contact

www.researchbridgepartners.org

# Letter from the Commissioner

Higher education institutions are essential engines for our state's economic growth and development. Colleges and universities educate, reskill, and upskill our workforce to produce the talent Texas businesses and economies rely on.

Texas higher education also drives our state's ability to compete through research, development, and innovation. Groundbreaking work across Texas campuses expands the frontiers of human knowledge and transforms our world.

Translating cutting-edge discoveries and innovations from our research laboratories and classrooms to the marketplace must be a top priority for Texas to compete into the future. Over the past two decades, policy decisions and state investments have laid the groundwork for extraordinary growth, and it is critical we strategically bolster and leverage our state's higher education research and development infrastructure.

Making Texas the best place for new startups to thrive, investments to flow, and talent to grow is crucial to our state's future in the innovation economy.

This is why our state strategic plan for higher education, *Building a Talent Strong Texas*, includes bold goals for increasing educational attainment, awarding credentials of value, and strengthening research and development. This year, the 88th Texas Legislature committed billions of dollars to help advance these goals and provide a path forward.

However, increased funding is only one piece of this equation. To sustain our state's global competitiveness, we must work together, fostering greater collaboration across higher education institutions, industry experts, investors, and community leaders. In particular, accelerating the translation of research discoveries from university laboratories to the marketplace is one of the most important ways we can generate more value and support our state's continued economic growth.

This report examines the current national landscape of higher education research and development to help gauge our state's current position and identify opportunities to drive further innovations into the future. I want to thank the hundreds of people across Texas who participated in this review and planning process. Their time, contributions, and insights were invaluable to this project.

Respectfully,
**Harrison Keller, Ph.D.**
Commissioner of Higher Education

# Contents

# Maintaining Texas' Edge

# Maximizing the Benefits of Academic Research and Technology

Higher education institutions play an essential role in Texas' global economic competitiveness. They provide the talent and innovation that give the state its competitive edge. The COVID-19 vaccine, ethernet, plasma screens, and e-readers are just a few of the thousands of ideas that were born at U.S. universities. These innovations have fundamentally changed the way people live. It is increasingly clear, however, that these breakthroughs cannot happen without robust supports designed to grow, advance, and translate ideas into successful commercial products.

Strong innovation ecosystems allow new ideas—and new companies—to flourish. Texas has the ingredients to compete with world-renowned innovation ecosystems like Silicon Valley and Boston's Route 128: top-tier research universities; science, technology, engineering, and math (STEM) talent; cutting-edge companies; and diversified funding streams relative to peer states. With these building blocks, the Lone Star State is well positioned to become one of the nation's leading states for innovation and technology transfer. But translating academic research into commercially viable products and companies is an ongoing challenge.

> *...the Lone Star State is well positioned to become one of the nation's leading states for innovation and technology transfer.*

While Texas has the necessary elements, there is an opportunity to develop more robust, regionally focused innovation ecosystems that leverage higher education institutions to create economic benefit. A more consistent and coordinated approach to support commercialization across its many research institutions would enable Texas to better tap the full potential of its higher education research and technology. Navigating the size of the state and its vast network of higher education institutions can be a challenge for investors, industry partners, and others seeking to support innovation in Texas. The scale of statewide infrastructure investments needed for these ecosystems to thrive—access to risk capital, highly skilled workers, and reliable broadband—is another.

## What is technology transfer?

Technology transfer moves innovative academic research into commercial products. When researchers develop a new technology, they can work with their university to safeguard their findings. That process relies on disclosures that protect the intellectual property (IP), typically through patents. Once the IP is protected, the university can license the IP through an agreement with a business or with a newly formed startup. This licensing agreement may include one-time licensing fees or a provision for a portion of revenues to come to the university. This process allows companies to develop and market products using the IP. Ideally, the resulting products and the technology behind them are successful in the market. Successful commercialization not only generates revenue for the company but can also result in an income stream that returns to the university, and that can provide jobs and an increased tax base for the state.

A more strategic and coordinated approach will be needed to address these challenges. To ensure Texas' continued competitiveness, state leaders must continue to evolve their understanding of innovation ecosystems. Creative collaborations that foster successful commercialization are a means to that end. Doing so will require ongoing support for research and development (R&D) and commercialization efforts at Texas higher education institutions. Broader adoption of promising practices from leading institutions and economies across the world can also foster stronger innovation and commercialization efforts at Texas colleges and universities.

The Texas Higher Education Coordinating Board (Coordinating Board) is committed to working with higher education institutions to advance the vision of Texas as a leader in translating basic and applied research into innovations that benefit individual Texans' lives and drive economic growth.

Generating knowledge and driving discovery are core tenets of *Building a Talent Strong Texas*, the state's strategic plan for higher education. In addition to bold goals for increasing educational attainment and awarding credentials of value, the plan recognizes that the state's future competitiveness requires a much stronger R&D infrastructure.

*Building a Talent Strong Texas* creates ambitious milestones for R&D and innovation. It aims to increase annual private and federal sponsored research by $1 billion by 2030 and to increase annual research doctorate awards to 7,500. Attracting major investments of private capital and federal grants to more colleges and universities will be essential. With that investment, Texas can be a stronger leader at the frontiers of knowledge, technology, and discovery.

**Figure 1. Primary Indicators for Research, Development, & Innovation**

| BASELINE | TARGET | |
|---|---|---|
| 2020: $3.5B | GOAL: + $1B | increase in annual private and federal R&D expenditures |
| 2020: 5,458 | GOAL: 7,500 | research doctorates awarded annually by Texas institutions of higher education |

Increased research funding and more doctorates are just the beginning. Strengthening higher education's role in creating a thriving ecosystem for research, development, and innovation requires a broader effort, one that makes an explicit link to economic competitiveness. With support from the Texas Higher Education Foundation and funding from the U.S. Economic Development Administration, the Coordinating Board engaged TIP Strategies, an economic development consulting firm, to assist with preparing a statewide plan focused on technology innovation and commercialization at Texas higher education institutions.

*Strengthening higher education's role in creating a thriving ecosystem for research, development, and innovation requires a broader effort, one that makes an explicit link to economic competitiveness.*

Identifying opportunities to improve the technology transfer process was a central aspect of this work: how university technology transfer offices (TTOs) can learn from each other and how they can better ensure that new ideas and new companies are anchored in the state. To make this possible, increased investment is also required to strengthen innovation ecosystem assets and put in place foundational supports that address corporate partnerships, capital access, and workforce development. *From Insights to Impact: Fostering Innovation Through Texas Higher Education* provides a roadmap for achieving those objectives, closing gaps in regional ecosystems across the state, and maximizing the return on investment in the state's academic research and technology development. This *Technical Appendix* provides further details and lays out a plan for how leaders across the state can collectively strengthen innovation and commercialization within Texas higher education.

# From Roadmap to Reality

# Raising the Bar: Strategic Focus on Innovation and Commercialization

Strengthening technology transfer support structures and processes at higher education institutions, bolstering regional innovation ecosystems across the state, and addressing the foundational supports needed for success cannot be achieved by any one entity alone. A wide range of stakeholders have a role in implementing this plan, from leaders at institutions of higher education to leaders in the Texas business community. With more than 400 individuals engaged in the planning process, Texas has the champions needed to bring *From Insights to Impact: Fostering Innovation Through Texas Higher Education* from roadmap to reality.

Extensive stakeholder engagement across the state and the country informed the development of this plan.

**400+**

### Stakeholders

Engaged individuals across the state and the nation in the planning process

**120+**

### Survey Responses

Surveyed stakeholders to prioritize and refine strategies

**50+**

### Interviews

Facilitated one-on-one interviews with experts in technology transfer, higher education, venture capital, and industry

**18**

### Council Members

Convened a Technology Transfer Advisory Council quarterly with leaders from higher education, state government, research organizations, the private sector, and philanthropic organizations

**10**

### Roundtables

Co-hosted roundtables with regional partners and economic development organizations statewide

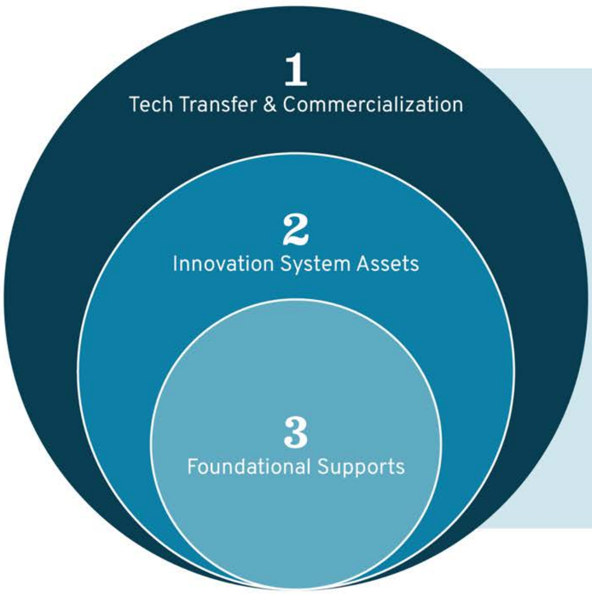
**7**

### Committee Members

Established a steering committee made up of leaders from higher education, investment firms, and businesses to guide the project planning process

In addition to the robust stakeholder engagement, the project team analyzed data to understand Texas' performance across a variety of innovation measures and reviewed promising practices from technology transfer offices and statewide innovation networks. Altogether, *From Insights to Impact: Fostering Innovation Through Texas Higher Education* provides targeted strategies aimed at easing the translation between academic research and commercial products, strengthening regional innovation ecosystems, and building a strong talent base for the innovation economy. **Figure 2** displays the plan's three-tiered framework: technology transfer and commercialization, innovation ecosystem assets, and foundational supports. These overarching goals represent spheres of influence for higher education institutions to effect change in R&D and innovation. Each goal lays out a clear vision for generating knowledge through basic and applied research and for translating discoveries into commercially viable products that will benefit Texans and drive economic development for decades to come.

Figure 2. Three-Tiered Framework




Texas higher education institutions **lead the nation** in translating academic research into commercialized products, serving as economic engines to benefit the state's economy and society overall.

Texas is home to thriving ecosystems of strong innovation assets that serve as **catalysts for bringing transformative ideas to life** and creating dynamic environments for **cross-sector partnerships**.

Texas invests in the **talent, infrastructure, and supports** needed for success in the innovation economy.

Source(s): TIP Strategies, Inc.

## Implementation Roles

The actions required for successful strategy execution are organized in the following pages by level of implementation: state, regional, or at institutions of higher education (see **Figure 3**). At the state level, some items may require action from statewide entities and agencies. At the regional level, business leaders, investors, or entrepreneurial support organizations in the community may have a role to play. Meanwhile, each institution of higher education operates under procedures unique to their institution or their system, so there are items best suited for institutions to implement if they choose to do so. Each action item that follows includes a colored indicator illustrating the proposed implementation level needed for success.

Figure 3. Implementation Role Levels

- S State
- R Regional
- I Institutions of Higher Ed.
- Limited Role

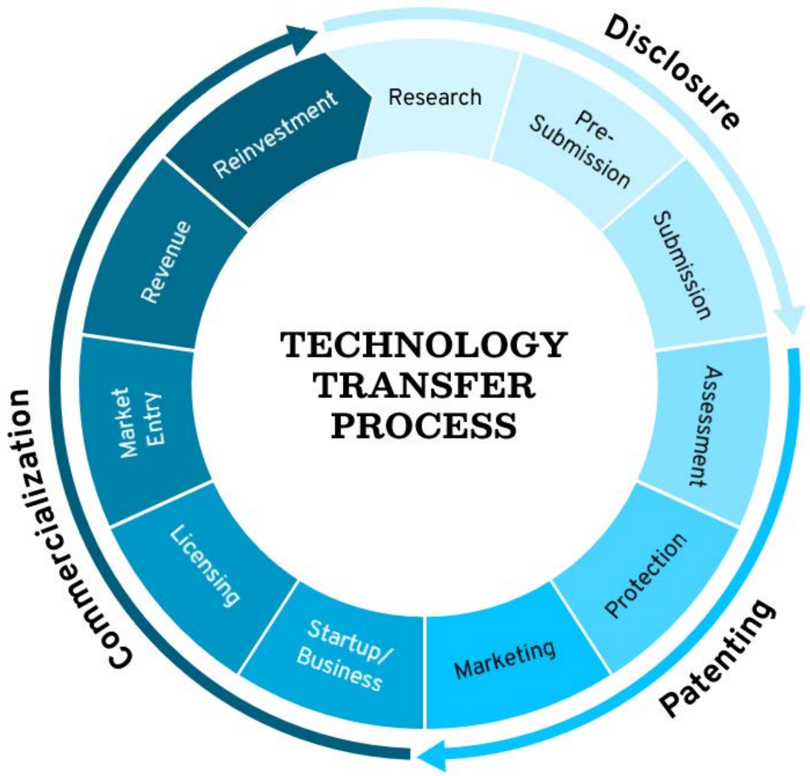
Source(s): TIP Strategies, Inc.

# GOAL 1. TECH TRANSFER AND COMMERCIALIZATION

## Vision: Texas higher education institutions lead the nation in translating academic research into commercialized products, serving as economic engines to benefit the state's economy and society overall.

Institutions of higher education are engines for economic growth and development. In addition to strengthening the talent pipeline, higher education is a major driver of research, development, and innovation, largely through the technology transfer process (see **Figure 4**). Researchers generate knowledge through basic and applied research, develop cutting-edge innovations, and work with industry to translate discoveries into new inventions or treatments that change lives. The role of higher education in fostering innovation is critical for Texas' long-term economic prosperity and the opportunities it offers to Texans.

Figure 4. Technology Transfer Process




Source(s): TIP Strategies, Inc.
Note(s): Graphic adapted from MIT's Technology Licensing Office.

However, a significant portion of research conducted at higher education institutions never reaches the market. Research universities across the state prioritize commercialization outcomes to different degrees and quantify success in different ways. This means Texas is not fully leveraging the potential of academic research for the state's economic benefit. The research and development function of higher education can often be overlooked; however, it is imperative to our society and economy.

To maintain and advance Texas' economic competitiveness, the state must continue to invest in the infrastructure, capacities, and resources needed to translate academic research into commercialized products. This goes beyond R&D funding alone. There must be intentional focus and resources devoted to support technology transfer and commercialization. All institutions have a role to play in driving research and innovation in Texas—accelerating the process between idea and market entry, creating new businesses, and promoting technological development in leading fields and sectors. This will ensure that Texas shares cutting-edge technologies developed within its universities with the world, growing the state's competitive advantage that generates high-skill, high-value jobs and supports the state's major industries in upstream operations.

## Strategies and Actions

Texas has a wide range of higher education institutions and systems. Increased coordination and sharing of promising practices across the state will strengthen Texas' competitive position. In addition, dedicated resources are needed if Texas is to lead the nation in technology transfer and commercialization. The following strategies outline how the state can raise the bar in applied research, technology development, and commercialization to foster innovation through Texas colleges and universities.

**1.1. COMMERCIAL VALIDATION.** Support institutions with dedicated resources like proof-of-concept funding to build capacity for market validation of commercially viable inventions and technologies.

**1.1.1.** Consider increasing statewide investments in research and innovation, such as enhanced proof of concept funding and other dedicated funds for commercialization activities available to higher education institutions in Texas. S R I

**1.1.2.** Explore opportunities to bolster other research and innovation resources, such as a statewide board of industry advisors and investors. While some institutions convene their own advisory boards, this board could serve as a supplemental resource that researchers and TTO staff access for specialized expertise, technical assistance, market validation, and review of applications for any statewide funding available in the future. S R I

- Consider segmenting industry leaders and investors by area of expertise to ease access for researchers and TTO staff.

**1.1.3.** Offer a roster of trusted commercial services for institutions to access if needed. These services could increase the efficiency of standard processes such as: securing legal counsel to assist with company formation filings, contracting accountants for outsourced financials when forming spin-outs, and leveraging regulatory consultants for specialized expertise in approval processes of federal agencies. S R I

**1.1.4.** Support institutions in establishing entrepreneurs-in-residence programs to advise their faculty, students, and technology transfer offices about startup formation, business management, and IP commercialization. S R I

### Penn Health-Tech

Launched in 2017, the Penn Health-Tech Center for Health, Devices and Technology (PHT) is a collaboration between the Perelman School of Medicine, the School of Engineering and Applied Science, and the Office of the Vice Provost of Research that facilitates the development of novel medical devices and healthcare technologies. Sponsored in part by an alumni donation, PHT trains and connects innovators to regional partners like the University of Pennsylvania health system and The Children's Hospital of Philadelphia. Through its Health Tech Accelerator, PHT provides proof of concept funding, where funding is issued subject to the achievement of agreed-upon milestones. After supporting 60 teams and providing $2 million in funding, in addition to hands-on project management, development expertise, and other critical resources, alumni of PHT have secured $50 million in follow-on funding from sources that range from government grants to corporate investment.

**1.2. PROCESS IMPROVEMENT.** Remove friction within the technology transfer process, especially to help applied research efforts respond to market needs in an efficient and effective manner.

**1.2.1.** Explore implementation of licensing processes that are more efficient and flexible. Reducing barriers to market entry is a high priority. S R I

- Specific examples include streamlined license agreements, expedited licensing processes for deals meeting certain criteria, and summary sheets for deals requiring custom terms.
- Post standard license agreements or pre-prepared license agreements online, where applicable, to facilitate interactions with external customers. For example, some licenses for software technologies rarely change, so a "ready to sign" agreement can facilitate expedited licensing processes.

**1.2.2.** Consider creative and flexible terms, such as anti-dilution protection within predefined boundaries, that facilitate the future commercial success of IP and spin-outs. S R I

- Negotiate terms that facilitate the future commercial success of the IP (see **Removing Frictions**). For example, if the university is seeking a nondilutive equity stake in a university spin-out, consider applying anti-dilution protection through a predefined boundary, like through a specified amount of funds raised.

**1.2.3.** Increase transparency of institutional technology transfer processes and IP portfolios for external stakeholders to better navigate differences across institutions. S R I

- Actively promote university technologies by sending abstracts to industry contacts segmented by market space, posting technologies online, creating a searchable database, and facilitating industry collaboration meetings with researchers.
- Pool patents, where appropriate, across institutions to make the collection of IP more appealing to external investors. For example, rather than each institution housing an individual searchable database, aggregate technologies available for licensing through higher education systems and organize related technologies based on their application use.

**1.2.4.** Develop scalable educational materials that raise awareness among faculty and graduate students about the commercialization process, including ways to protect their intellectual property (e.g., patents, copyrights, and other forms of legal protection). S R I

- Create inventor's guides for faculty that succinctly introduce inventors to common technology transfer topics. Content on common topics can be generated centrally by higher education systems. Institution-specific policies and resources can be added to customize the guides for processes that inventors may encounter through their institution's technology transfer process.

### Colorado State University (CSU) STRATA

Founded in 1941, CSU STRATA is a private, not-for-profit corporation (legally separate from the CSU System) that supports CSU entities through strategic real estate management, project development services, special project oversight, intellectual property management, and technology transfer services, as well as operational management of regional, state, national, and international assets. CSU STRATA administers the Advanced Industries Proof of Concept Grant Program, providing up to $120,000 in grants (with a required 1:3 cash match) to CSU faculty employees. The program targets projects in industries crucial to Colorado's growth including aerospace, advanced manufacturing, bioscience, electronics, energy and natural resources, infrastructure engineering, and technology and information.

1.3. **R&D RESOURCES.** Bolster higher education institutions by securing additional resources like R&D funding and specialized research talent to support technology transfer.

1.3.1. Support institutions in becoming more competitive for federal R&D funding by providing letters of support, increasing awareness of funding opportunities from federal agencies, and providing coordination support for applications involving multiple institutions. S R I

1.3.2. Inform considerations about sustained and expanded state funding, like the Texas University Fund for other public universities, for research and development focused on commercialization efforts at higher education institutions. S R I

1.3.3. Raise awareness of existing research talent recruitment tools like the Governor's University Research Initiative (GURI) and support higher education in accessing GURI to attract distinguished researchers to Texas. S R I

1.3.4. Develop and mentor doctoral students through education about industry collaboration, entrepreneurship, and commercialization to build a robust pipeline of world-class future faculty for Texas institutions. S R I

1.4. **STATEWIDE RESOURCE CENTER.** Establish a statewide resource center that provides information about grant funding and state programs to support research, development, and innovation; supports institutional training about technology transfer; and fosters opportunities for collaborative partnerships among multiple institutions.

1.4.1. Explore the benefits of a statewide conference that brings together researchers from different institutions working on similar research topics with industry experts and investors to support further development of IP for commercial viability. S R I

- Bring together researchers working on similar topics from different universities to facilitate a collaborative approach to R&D.

1.4.2. Amplify existing industry-specific innovation summits with higher education participation. S R I

1.4.3. Encourage the ongoing sharing of resources and ideas across technology transfer offices from multiple university systems through avenues like peer learning sessions or industry-specific workshops. S R I

- Facilitate peer learning opportunities bringing together technology transfer office staff from across the state to share challenges and best practices.
- Host industry-specific workshops for faculty, principal investigators, and technology transfer staff to learn from industry experts about specific pathways or roadblocks to commercialization relevant to that industry.

**1.4.4.** Share federal R&D funding opportunities with higher education institutions across the state and coordinate the pursuit of funding by providing grant-writing support and partner collaboration. S R I

**1.5. DATA INFRASTRUCTURE.** Expand statewide data infrastructure to collect R&D and technology transfer information from institutions of higher education and pinpoint opportunities for accelerated commercialization.

**1.5.1.** Consider collecting additional primary data from Texas higher education institutions, ideally around the time of the National Science Foundation's Higher Education Research and Development (HERD) Survey or other existing surveys to limit barriers to survey completion, to better understand targeted opportunities for successful commercialization outcomes. S R I

- Explore developing a survey in collaboration with technology transfer leaders across the state to collect additional primary data related to the technology transfer process.
- Collect detailed information on R&D funding by fields of study. For example, gather details like research conducted to further medical devices or drug discovery, to help identify commercial sponsors or investors. Include other measures like invention disclosures, patent applications filed, patents issued, licenses and options executed, startup companies formed to license university-generated IP, and gross revenue from IP.
- Pilot an annual technology transfer landscape survey of institutions of higher education.

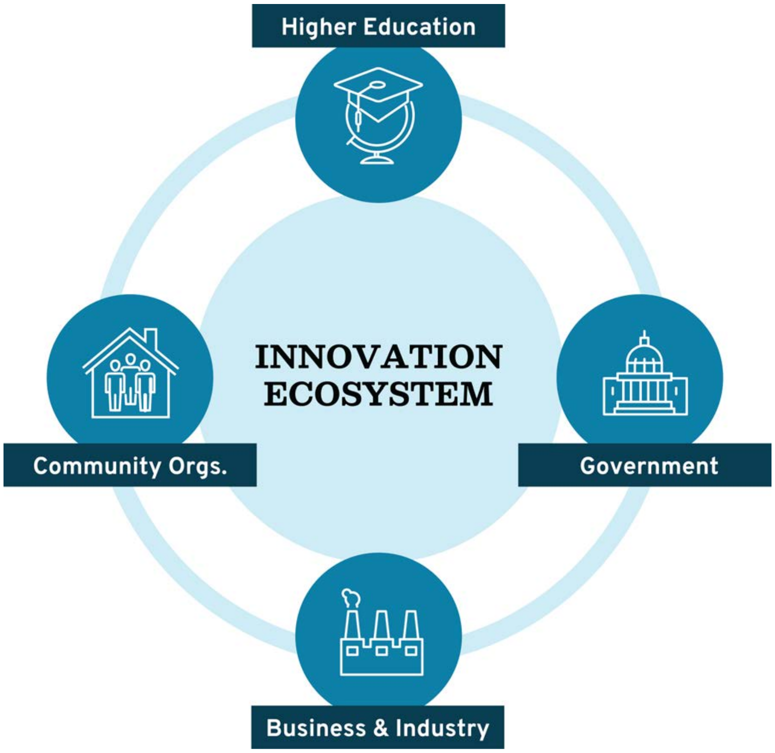
**1.5.2.** Support institutions of higher education in making data-driven decisions about commercialization efforts by publishing aggregated statewide data to create a holistic picture of the technology transfer landscape in Texas and creating privileged institution-specific data dashboards focused on research, innovation, and commercialization. S R I

# GOAL 2. INNOVATION ECOSYSTEM ASSETS

## Vision: Texas is home to thriving ecosystems with strong innovation assets that serve as catalysts for bringing transformative ideas to life and creating dynamic environments for cross-sector partnerships.

Successful translation of academic research into commercialized products does not happen in a vacuum. While improving processes and practices is important, commercialization requires strong partnerships and robust, regionally focused innovation ecosystems that go beyond the boundaries of higher education. A strong innovation ecosystem is comprised of collaborations among higher education, government, business and industry, and community organizations (see **Figure 5**).

Figure 5. Innovation Ecosystems




Source(s): TIP Strategies, Inc.

Beyond that, successful ecosystems rely on proximity and accessibility of various innovation assets—including risk capital, incubation spaces, accelerator programs, entrepreneurial support programs, and more. Texas is home to strong innovation assets, and more can be done to strengthen the collaboration between higher education and their regional innovation ecosystems. By bridging geographic disparities and improving partnerships, different areas within Texas can contribute to the broader innovation efforts in the state and make Texas more competitive for funding and industry innovation hubs.

The path between academic research and commercial products involves more than the efforts of the higher education institutions alone. It requires creative, cross-sector collaboration to capitalize on the strengths of Texas' innovation ecosystem assets. By strengthening the links between higher education institutions and their regional ecosystems, Texas can improve the pipeline from academic research to licensing deals, startup formation, and industry innovation.

## Strategies and Actions

More can be done to strengthen the innovation ecosystem assets in Texas—from facilitating strong partnerships between corporations and academia to increasing access to risk capital. By implementing these strategies, Texas can reinforce collaboration between higher education and broader innovation ecosystem partners.

**2.1. RISK CAPITAL.** Increase access to risk capital for Texas companies by matching existing federal grant programs and private investments to make Texas the most attractive environment to grow new businesses.

**2.1.1.** Consider matching Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants awarded to Texas companies licensing IP from Texas higher education institutions. S R I

**2.1.2.** Explore opportunities to match private investments made in Texas companies licensing IP from Texas higher education institutions. For example, use state funds to replicate other states' low-rate loans to venture funds to stimulate investments in state-based companies (see **Ohio Third Frontier Programs**). S R I

**2.2. CORPORATE AND ACADEMIC PARTNERSHIPS.** Encourage more robust partnerships between businesses and higher education institutions by increasing industry-sponsored research and strengthening their roles as anchors in regional economies across Texas.

**2.2.1.** Offer creative avenues for more robust corporate partnerships. For example, offering corporate membership models or simple master collaboration agreements with confidentiality clauses that can later be customized may lead to increased industry-sponsored research (see **Collaborating on Technology Development**). S R I

**2.2.2.** Explore ways to diversify R&D funding streams by increasing industry-sponsored research in fields of study that support Texas' target industries. In 2022, 7% of academic R&D expenditures were sourced from industry (see **Figure 10**). S R I

**2.2.3.** Organize reverse pitch competitions. S R I

- Recruit regional corporate leaders and higher education institutions to participate in reverse pitch competitions that give faculty and students the opportunity to solve problems that corporations are facing and respond to market needs.

**2.3. INNOVATION SUPPORT SYSTEMS.** Leverage the ongoing work of existing entrepreneurial support organizations and physical spaces like research parks and innovation districts to increase collaboration and facilitate cutting-edge innovation.

**2.3.1.** Raise awareness of and expand access to entrepreneurial learning programs like I-Corps (an experiential entrepreneurial training program for scientists and engineers operated by the National Science Foundation) that encourage faculty and researchers to pursue commercialization opportunities. S R I

**2.3.2.** Support institutions in developing and supporting real estate assets to meet the operational space demands of academic spin-outs. S R I

- Identify external startups operating in similar industries and address their space demands.

**2.3.3.** Encourage more robust collaboration between higher education institutions and external entrepreneurial support organizations to provide a stronger continuum of supports for entrepreneurs launching university spin-outs. S R I

**2.4. STORYTELLING.** Strengthen Texas' brand as a leader for innovation by sharing success stories about R&D conducted at Texas higher education institutions and university spin-outs.

**2.4.1.** Share a compelling vision of Texas being a national leader in technology transfer. S R I

- For gatherings among public and higher education leaders across the state, promote a market driven approach for academic R&D being conducted with the goal of developing commercial products.

**2.4.2.** Leverage networks within the state and across the nation to distribute news of higher education commercialization success to higher education leaders, economic developers, investors, and entrepreneurs. S R I

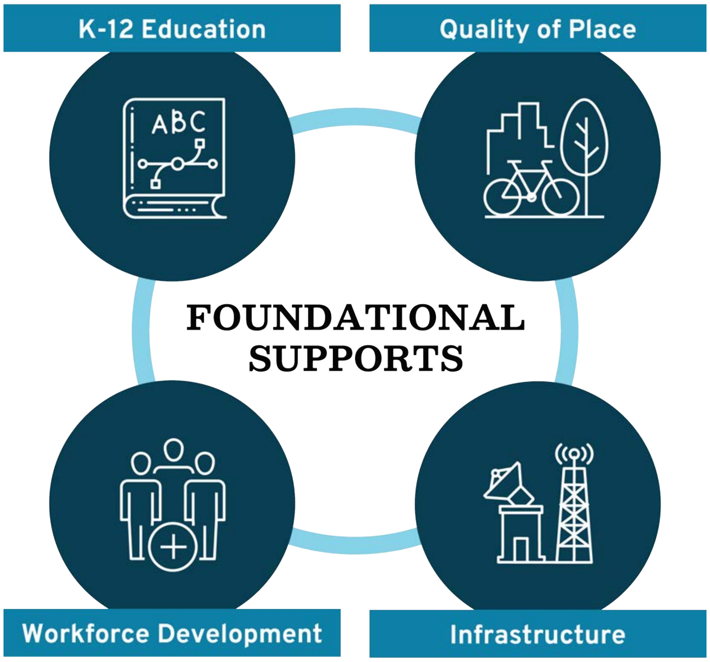
**2.4.3.** Share success stories at relevant conferences and gatherings like the Coordinating Board's annual Higher EDge conference, the State Science & Technology Institute (SSTI) Annual Conference, and Association of University Technology Managers (AUTM) events. S R I

# GOAL 3. FOUNDATIONAL SUPPORTS

## Vision: Texas invests in the talent, infrastructure, and supports needed for success in the innovation economy.

A thriving innovation ecosystem requires foundational supports, including a strong talent pipeline and reliable infrastructure. Texas' competitiveness and prosperity increasingly depend on an educated workforce, which the goals of *Building a Talent Strong Texas* elevate as a priority for the state. While the strategies outlined in this section focus on talent recommendations, other factors like broadband, housing, and placemaking are also necessary components for successful innovation (see **Figure 6**).

Figure 6. Foundational Supports




Source(s): TIP Strategies, Inc.

Higher education institutions are well known for the role they play in strengthening talent pipelines. Education and training programs—from short-term trainings at community colleges to multiyear doctorate programs at universities—have a pivotal role to play in preparing the future workforce. With Texas' recent move toward funding community colleges for outcomes focusing on credentials of value in high-demand fields, every institution, colleges and universities alike, has a role to play in fostering a dynamic talent pool capable of supporting and driving innovation in the state's core industries.

The state needs a wide range of talent, from faculty and principal investigators to conduct research, to entrepreneurs to run businesses that license university-generated IP, to skilled workers to manufacture the products.

The state's long-term competitiveness depends not only on its ability to create jobs but also on its ability to develop, attract, and retain skilled workers. Attracting and retaining top-tier talent, including faculty and principal investigators, depends on both the education and training landscape as well as the attractiveness of Texas communities as places to live, work, and thrive. Increased alignment between the state's higher education goals and its economic growth is vital to ensuring a prosperous future for all Texans.

## Strategies and Actions

By focusing on these necessary building blocks, Texas can reinforce regional innovation ecosystems to support thriving environments for research, technology development, and commercialization.

3.1. **WORKFORCE DEVELOPMENT.** Strengthen workforce education programs at higher education institutions that train students to meet the skilled talent needs of target industries, particularly for STEM careers.

3.1.1. Support the development and expansion of credentials of value that prepare learners for employment in the state's core industries, such as life sciences, advanced manufacturing, energy, aerospace, and semiconductors. S R I

3.1.2. Consider providing technical assistance to institutions launching or collaborating on sector partnerships that address workforce challenges of specific industries. S R I

- For example, assist community colleges in developing short-term training programs to train middle-skill workers needed for the downstream operations related to university-generated IP.

3.1.3. Help raise awareness of STEM career pathways within colleges and universities in collaboration with related industry associations, community organizations, and other higher education partners. S R I

3.2. **WORK-BASED LEARNING.** Expand efforts to provide students with high-quality experiential learning opportunities that equip them with knowledge and skills in demand by employers in core industries.

3.2.1. Expand efforts to provide students with paid, hands-on experiential learning opportunities for in-demand industries and sectors across different regions of the state. S R I

3.2.2. Continue support for initiatives that incentivize Texas companies to provide Texas students with internship opportunities and create more targeted links between existing initiatives and employers in Texas' core industries. S R I

3.2.3. Explore ways to establish work-based learning programs that provide Texas students with applied research experience to help them learn about the commercialization process, product development from research discoveries, along with licensing and startups. S R I

3.2.4. Offer technology transfer office internships to existing students and leverage the student population to mature ideas, including business students to conduct market analysis or engineering students to create physical prototypes of discoveries. S R I

3.3. **TEXAS TALENT RETENTION.** Add incentives and benefits to programs for Texas higher education students to support graduate retention.

3.3.1. Identify ways to increase data about where Texas higher education graduates go post-graduation and to what extent talent from Texas higher education institutions stay in their regions and the state. S R I

3.3.2. Explore adding talent retention considerations to existing state financial aid programs. S R I

3.3.3. Support existing talent retention programs operated by economic development partners. S R I

# Texas' Competitive Position

# How Does Texas Compare?

As part of the strategic planning process, TIP conducted an analysis of Texas' competitive position. Initial data collection began in May 2023 and the work extended over the next nine months. An in-depth analysis was delivered as an interactive data visualization. The key findings of this analysis, summarized below, informed and guided the direction of the strategic plan. It also laid the foundation for the best practices research comparing Texas' programs and performance to other geographies.

By several measures, Texas has seen tremendous growth in R&D activity, supported by significant investments by the Legislature. An in-depth data analysis benchmarked Texas' performance relative to peers with measures of higher education research activity, technology transfer outputs, and innovation investment impacts. These measures, however, are not perfect. R&D, technology transfer, and innovation are long-term processes, and the measures highlighted provide only a limited snapshot of Texas' performance. To truly bolster the state's economic competitiveness in these areas, state and institutional leaders will need to allocate resources and track the progress of these efforts for years to come.

For a quick snapshot of Texas' competitive position, see **Figure 8** on page 21. The **Technology Transfer Landscape** section compares Texas' performance to the states selected for in-depth case studies.

## Texas Public University Peer Groupings

In 2004, Texas developed a system for grouping higher education institutions to support performance benchmarking among universities. The groups, along with criteria for the groupings, are revised on a periodic basis by the Coordinating Board. Texas' system has five groups–research, emerging research, doctoral, comprehensive, and master's. The focus of this report is on the three groups that include criteria on R&D expenditures:

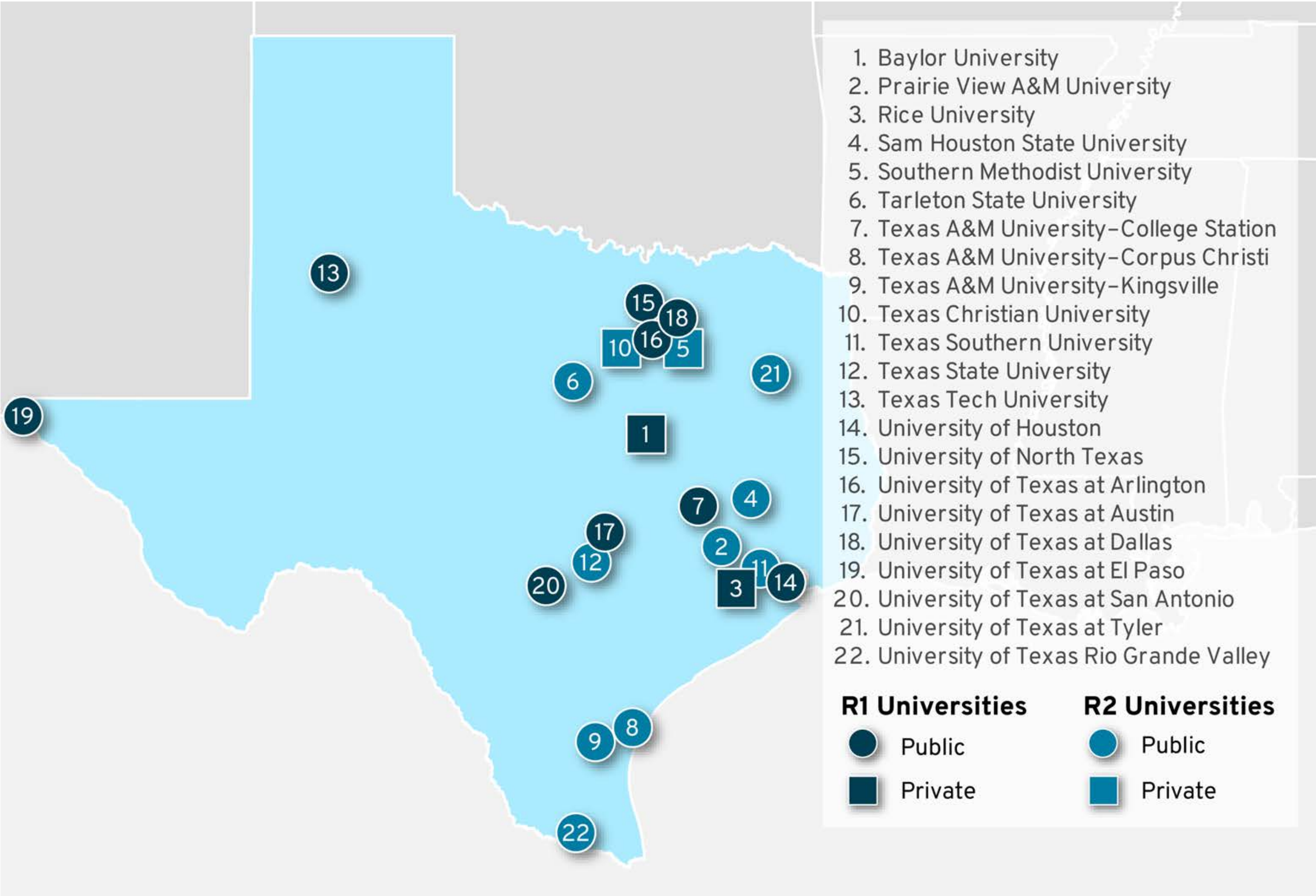
- Research universities award 200 or more PhD degrees annually and generate at least $150 million in restricted research expenditures, adjusted for inflation. As of September 2020, the adjusted threshold was approximately $193 million.
- Emerging research universities award at least 30 PhD degrees annually and generate at least 20% of the research universities' criteria for restricted research expenditures, which was approximately $38 million in 2020.
- Doctoral universities are expected to reach three of the following four criteria: award at least 10 PhD degrees annually, offer at least five doctoral research programs, enroll at least 150 doctoral students, or generate at least $2 million annually in restricted research expenditures.

### *Texas leads the nation with the most public R1 institutions.*

With thousands of colleges and universities in the U.S., the Carnegie Classification of Higher Education Institutions deemed only 146 as Research 1 (R1) institutions in 2023. This R1 designation, defined as an institution exhibiting "very high research activity," is based on measures like research spending, staff levels, and the number of doctorates awarded.[1] Achieving R1 status reinforces an institution's ability to attract top-tier faculty members and students in addition to strengthening its role as an economic driver.

A decade ago, Texas had only four R1 institutions. Today, Texas is home to 11 R1 universities and 11 Research 2 (R2) universities categorized as having "high research activity" (see **Figure 7**). That number ties Texas with California and New York for the highest number of R1 institutions. Nine of Texas' R1 designations are awarded to public institutions, the highest number among all 50 states. This report uses the Carnegie Classification to describe research universities because of its broader reach and applicability for national benchmarking. However, it is important to note that Texas has its own university grouping system, one commonly referenced by the Texas Legislature and the Coordinating Board (see **Texas Public University Peer Groupings**).

Figure 7. R1 and R2 Universities: Texas




Source(s): Carnegie Classification of Institutions of Higher Education; Integrated Postsecondary Education Data System; TIP Strategies, Inc.

[1] The Carnegie Classification of Higher Education Institutions is currently under review. The American Council on Education, which helps manage the classifications, is developing significant revisions that will be made effective in 2025.

Figure 8. State Comparison Indicators: Texas (TX)

| 2022 INDICATORS | TX | MEDIAN FOR ALL STATES | TEXAS' RANK: LOW OUTLIER | TEXAS' RANK: NORMAL RANGE | TEXAS' RANK: HIGH OUTLIER |
|---|---|---|---|---|---|
| **HIGHER EDUCATION RESEARCH ACTIVITY** | | | | | |
| Higher Education R&D Expenditures[1] | $7.44B | $1.03B | | | 3 |
| Academic R&D per $1THS GDP[2] | $3.16 | $3.82 | | 34 | |
| Research Doctorate Recipients[3] | 4,381 | 686 | | | 2 |
| Research Doctorate Recipients per 1M Residents[3, 4] | 146 | 149 | | 27 | |
| **TECHNOLOGY TRANSFER OUTPUTS AT IN-STATE UNIVERSITIES** | | | | | |
| Disclosures Received[5] | 1,209 | 349 | | | 7 |
| Disclosures Received per $1B Academic R&D Performed[5,1] | 162 | 220 | 36 | | |
| Patent Applications Newly Filed[5] | 806 | 197 | | | 5 |
| Patent Applications Newly Filed per $1B Academic R&D Performed[5,1] | 108 | 128 | | 26 | |
| US Patents Issued[5] | 298 | 87 | | | 7 |
| US Patents Issued per $1B Academic R&D Performed[5,1] | 40 | 60 | 38 | | |
| **INNOVATION INVESTMENT IMPACTS** | | | | | |
| Licenses/Options with Income[5] | 1,270 | 258 | | | 6 |
| Licenses/Options with Income per $1B Academic R&D Performed[5,1] | 171 | 164 | | 22 | |
| Gross License Income at In-State Universities[5] | $190M | $13M | | | 6 |
| Gross License Income at In-State Universities per $1B Academic R&D Performed[2] | $25.60 | $10.00 | | | 10 |
| Number of Operational Associated Startups[5] | 477 | 98 | | | 3 |
| Number of Operational Associated Startups per $1M Academic R&D Performed[2] | 64 | 67 | | 24 | |
| Number of Associated Startups in State[5] | 52 | 6 | | | 3 |
| Number of Associated Startups in State per $1B Academic R&D Performed[2] | 7 | 5 | | | 14 |
| Total Venture Capital Funding Disbursed[2] | $11.2B | $1.0B | | | 4 |
| Total Venture Capital Funding Disbursed per $1B GDP[2] | $4.66 | $3.41 | | 20 | |
| Venture Capital Deals[2] | 1,449 | 221 | | | 4 |

Source(s): 1. National Science Foundation, Higher Education Research and Development Survey; 2. National Science Foundation, National Science Board Science and Engineering Indicators; 3. National Science Foundation, Survey of Earned Doctorates; 4. US Census Bureau, Population Estimates Program; 5. Association of University Technology Managers (AUTM) Statistics Access for Technology Transfer Database; TIP Strategies, Inc.
Note(s): States in a "normal range" fall one median absolute deviation from the median of all states. States outside this range are categorized as "high outlier" and "low outlier." AUTM data represent an aggregation of self-reporting by universities in those states.

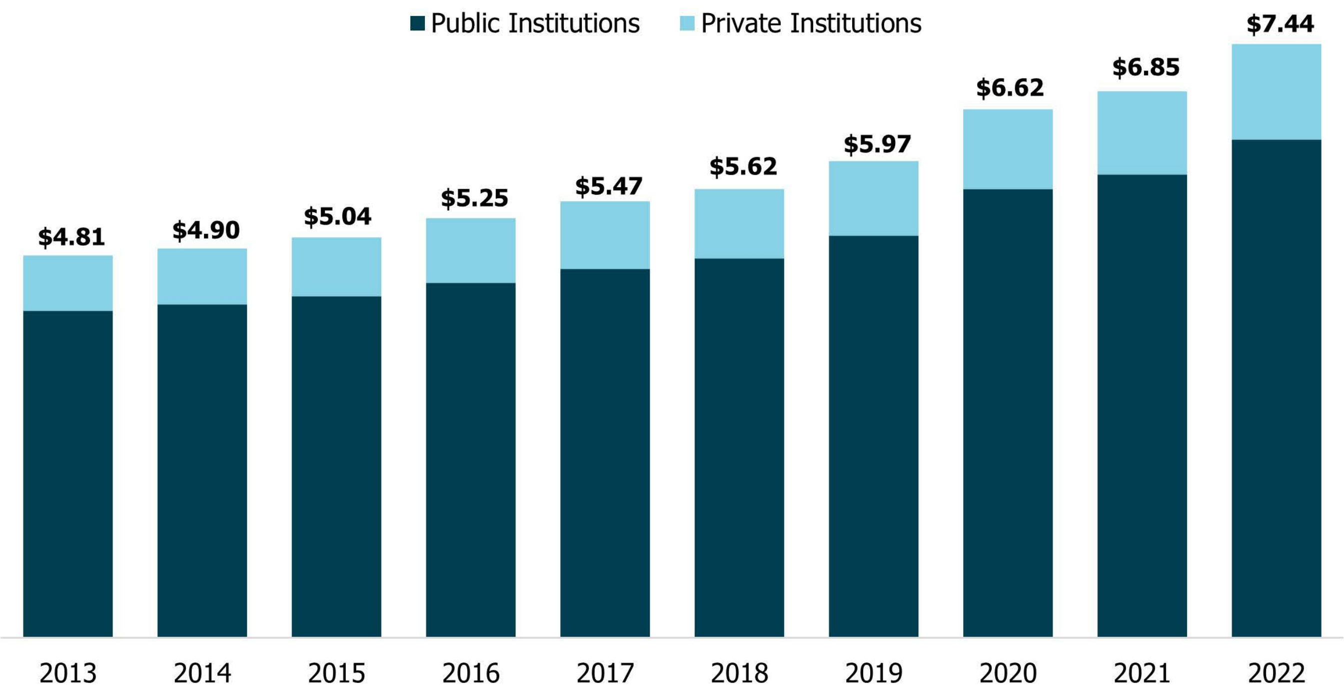
## *The number of doctorates awarded is moving in a positive direction.*

Along with an increase in R1 institutions, the number of research doctorates awarded by Texas institutions of higher education is also on the rise. With over 5,200 doctorates awarded in 2022, the state is on its way to reaching its goal of awarding 7,500 research doctorates annually.[2] These doctorates are essential to developing and mentoring graduates who have learned to work at the frontiers of their disciplines and world-class future faculty for Texas institutions.

## *Texas has seen a steady increase in higher education R&D expenditures.*

Data from the National Science Foundation shows that Texas' academic R&D expenditures (including both public and private universities) have increased at a steady rate between 2013 and 2022. In 2022, Texas higher education institutions generated over $7.44 billion in academic R&D expenditures, with $6.24 billion of that at public institutions (see **Figure 9**). Recent news of significant federal dollars available for research and innovation, coupled with the major investments made by the 88th Texas Legislature, suggests academic R&D funding is likely to see even more growth over the coming years.

**Figure 9: Higher Education R&D Expenditures (in $Billions) in Texas**
By Institutional Control




Sources: National Science Foundation, National Center for Science and Engineering Statics, Higher Education Research and Development Survey 2022; TIP Strategies, Inc.

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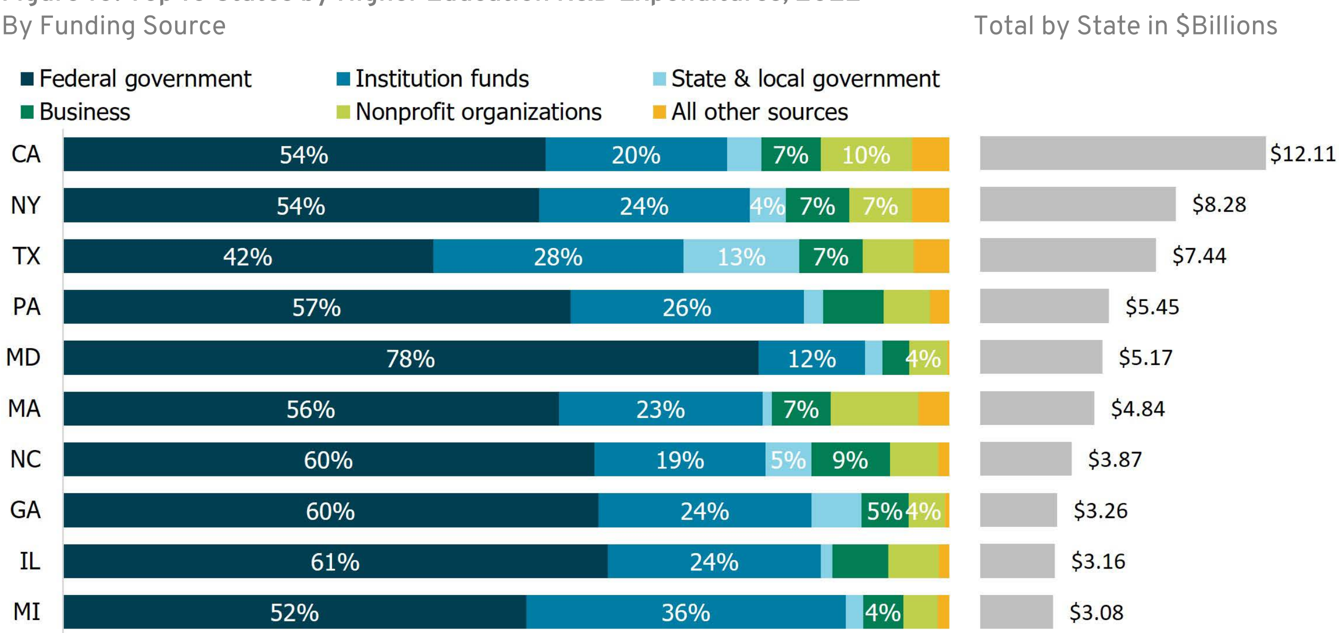
[2] Texas Higher Education Coordinating Board, "Shaping the Future with Research and Innovation," May 1, 2023. Figures may not align with other sources due to differences in reporting periods and methodologies.

## *Texas is ranked third in the nation with over $7 billion academic R&D expenditures in 2022.*

Comparing Texas' R&D expenditures to that of other states, Texas does quite well. Texas is ranked third in the nation on the amount of academic R&D expenditure generated in 2022. Only California ($12.12 billion) and New York ($8.28 billion) have more R&D expenditures from their universities. Overall, Texas has a more diversified mix of R&D funding sources compared to other states (see **Figure 10**). While federal funds make up the largest share of Texas' research expenditures, just 42% of Texas' funding— roughly 2 out of every 5 dollars—came from the federal government in 2022. Unlike states such as Maryland (78%), Illinois (61%), North Carolina (60%), and Georgia (60%), Texas' share of funding from the federal government is the lowest share among the top 10 states by higher education R&D expenditures.

Institutional funds comprised the next largest source, representing 28% of total R&D funding in 2022, well above states such as Maryland (12%) and North Carolina (19%). One of the most striking differences among the peers is the share of R&D funding Texas institutions receive from state and local government, which at 13% was the highest among the peers. Funding from businesses (7%), nonprofits (6%), and other sources (4%) rounded out the total for Texas.

**Figure 10: Top 10 States by Higher Education R&D Expenditures, 2022**
By Funding Source




Sources: National Science Foundation, National Center for Science and Engineering Statics, Higher Education Research and Development Survey 2022; TIP Strategies, Inc.

## *Business supplied 7% of 2022 R&D funding for Texas higher education institutions.*

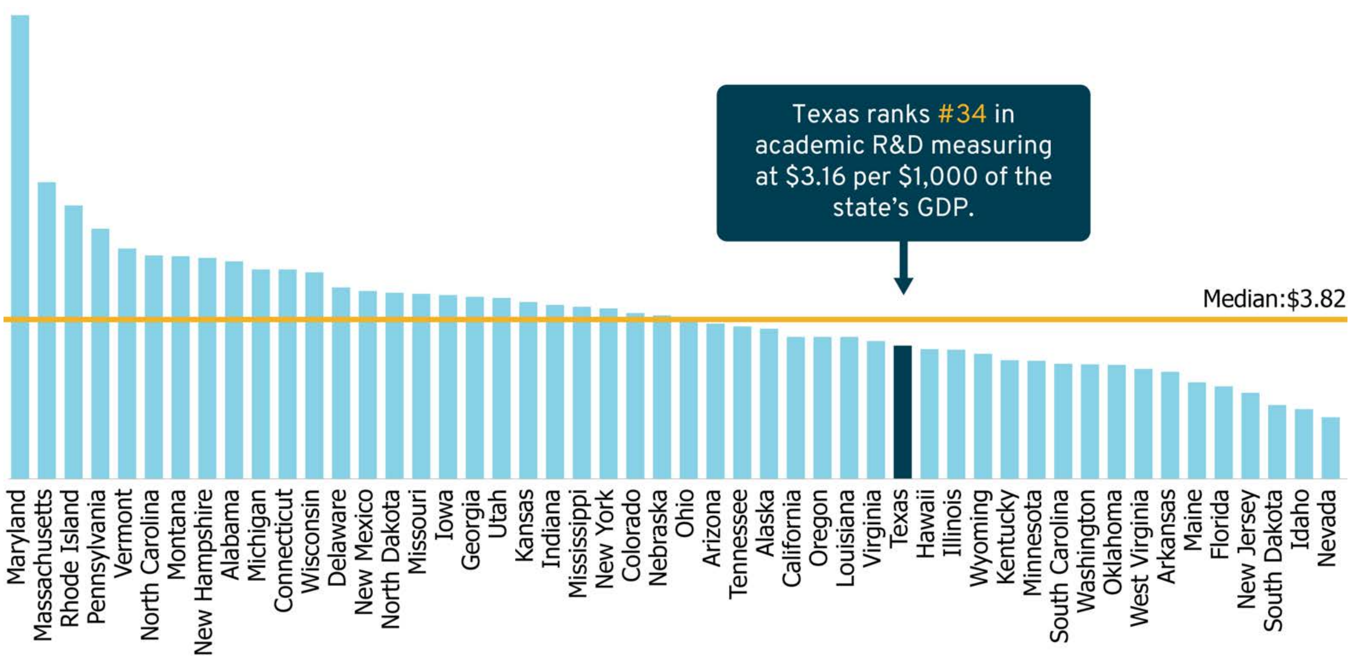
Despite Texas' relatively diversified funding streams, the data suggest considerable untapped potential. This includes aligning institutional commercialization efforts with industry needs. The state's broad range of major industries can certainly make this easier. For example, states like North Carolina are focusing their academic R&D funding toward industries vital to their economy. In 2022, 73% of North Carolina's R&D funding was focused on life sciences, and North Carolina is one of the top states in the nation for share of academic R&D funding sourced from industry. North Carolina remains a top competitor to Texas for business attraction and expansion in biosciences. To accelerate the state's economic growth and global competitiveness, academic research with commercialization potential can be linked more directly to regional industry needs and to the needs of the state's economy today and over the next decade.

Academic R&D funding information is sourced from the National Science Foundation's HERD Survey, which does not collect further details on the characteristics of the businesses supplying R&D funding to institutions. Some stakeholders hypothesized that most of the private industry research funding originates from small to mid-size companies lacking internal research capabilities. To validate or deny that theory, statewide entities can supplement the HERD Survey with further primary data collection. This would give Texas institutions the insights needed to target additional R&D funding for industry-sponsored research.

## *Economic growth outpaces increases in R&D funding.*

For a holistic understanding of Texas' competitive position, context is key. As discussed previously, Texas compares favorably to other states, ranking third in the nation for academic R&D expenditures generated in 2022, behind California and New York. Looking at academic R&D expenditures in the context of the state's overall economy, however, Texas is below the median. Even with Texas' gross domestic product (GDP) putting the state as one of the top 10 economies in the world, Texas ranks 34th in the nation for the amount of academic R&D generated relative to its GDP. Texas spent just $3.16 per $1,000 of the state's GDP in 2022 on academic R&D (see **Figure 11**). Interestingly, other large states like California and New York are also in the middle of the pack when the data is contextualized this way. Maryland and Massachusetts invest significantly more in academic R&D than might be expected given the sizes of those states. Given the seismic impact of the state's economy and the large number of research institutions in Texas, a renewed focus on research, development, and innovation in Texas is warranted.

Figure 11: States by Academic R&D per State GDP, 2022

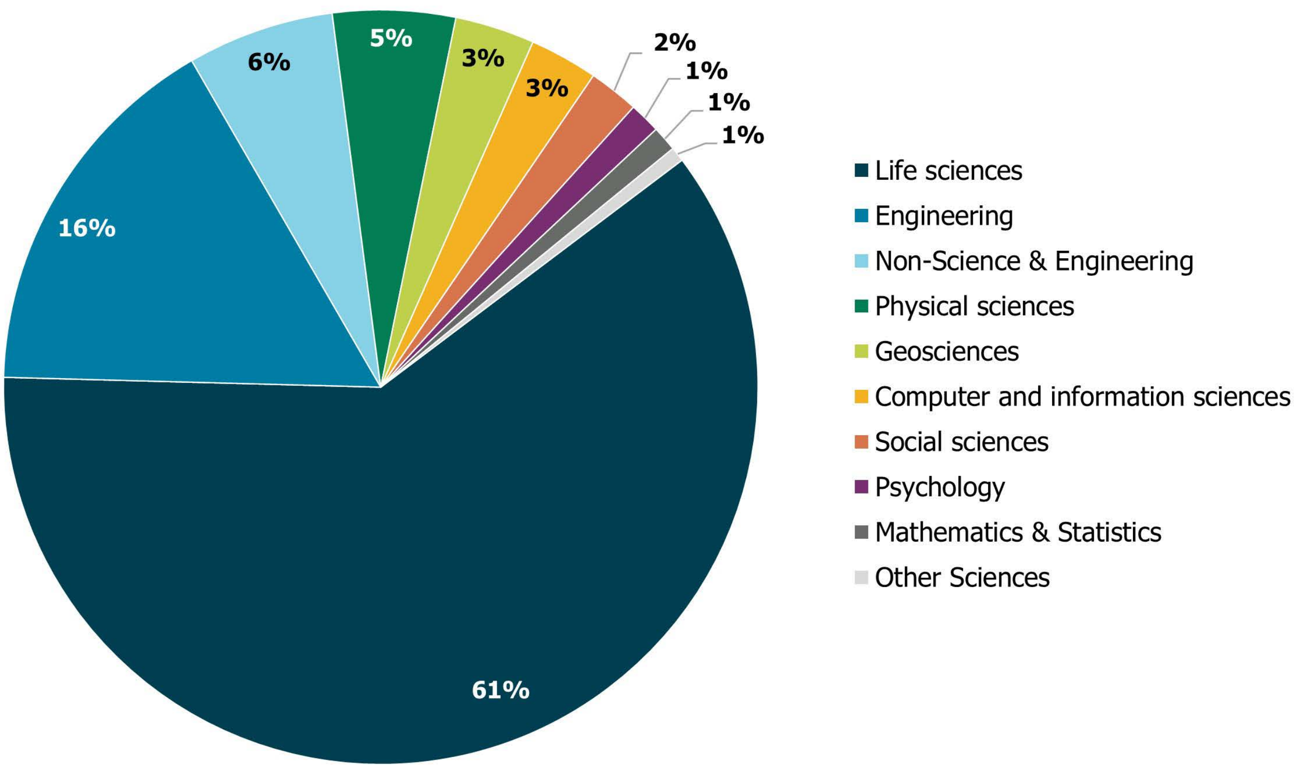



Sources: National Science Foundation, National Center for Science and Engineering Statics, Higher Education Research and Development Survey 2022; TIP Strategies, Inc.

## *Life sciences and engineering make up the top two fields of study for 2022 R&D funding at Texas higher education institutions.*

Life sciences leads in R&D funding with 61% ($4.52 billion) of all 2022 R&D funding at Texas higher education institutions (see **Figure 12**). Engineering follows with 16% ($1.21 billion). This data is sourced from the National Science Foundation's HERD Survey and can be broken down into further detail–to an extent. For example, within the life sciences field of study, R&D funding includes several subcategories: (1) agricultural sciences, (2) biological and biomedical sciences, (3) health sciences, (4) natural resources and conservation, or (5) other life sciences. But again, stakeholders expressed a desire for more detailed data to target resources. Stakeholders want to understand funding for research on drug discovery, biomedical devices, or preventive screening, for example, to pinpoint opportunities for accelerated commercialization and quick-win innovation. The same can be said for Texas' other target industries, including but not limited to, advanced manufacturing, aerospace, and energy. This warrants the state continuing to increase funding tied to major industries (similar to the Texas Space Commission and the Texas Semiconductor Innovation Consortium established by the 88th Texas Legislature) as important drivers for continued growth and competitiveness.

Figure 12. 2022 Share of R&D Funding by Field of Study




Sources: National Science Foundation, National Center for Science and Engineering Statics, Higher Education Research and Development Survey 2022; TIP Strategies, Inc.

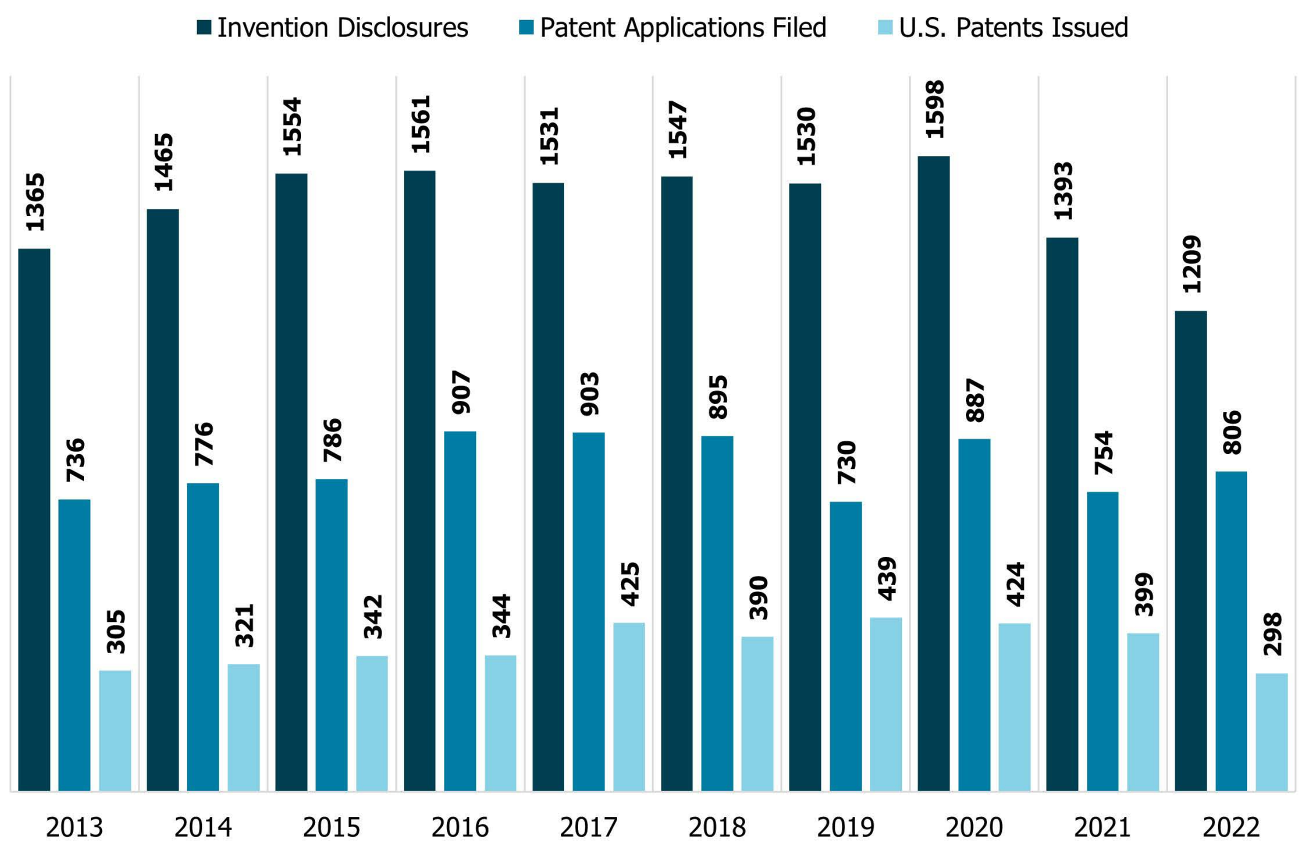
## *Texas ranks high in basic outputs of the technology transfer process.*

While boosting research doctorate completions and R&D funding enhances research activities, it does not guarantee a proportional increase in the successful commercialization of university-generated IP.

Invention disclosures are a common activity measure in the technology transfer process. Over the last 10 years, the number of invention disclosures received at Texas universities has held relatively steady, with a dip in 2021 and 2022 (see **Figure 13**). The competitive landscape, however, presents a different picture.

By sheer volume and scale, Texas' technology transfer outputs exceed those of many states. For example, in 2022, Texas ranked seventh, with 1,209 disclosures received at Texas universities–falling behind California, Massachusetts, New York, Pennsylvania, Ohio, and Maryland. When these outputs are normalized by the amount of academic R&D funding at higher education institutions, Texas falls below the national median on output measures. Texas' ranking plummets when comparing the number of disclosures received relative to academic R&D performed. In 2022, Texas ranked 36th in that normalized measure, trailing behind states like Vermont (ranked 34th) and New Mexico (ranked 35th).

**Figure 13. Number of Invention Disclosures Received, Newly Filed Patent Applications, and U.S. Patents Issued at Texas Institutions of Higher Education, 2013-2022**




Source(s): AUTM Statistics Access for Technology Transfer Database; TIP Strategies, Inc.

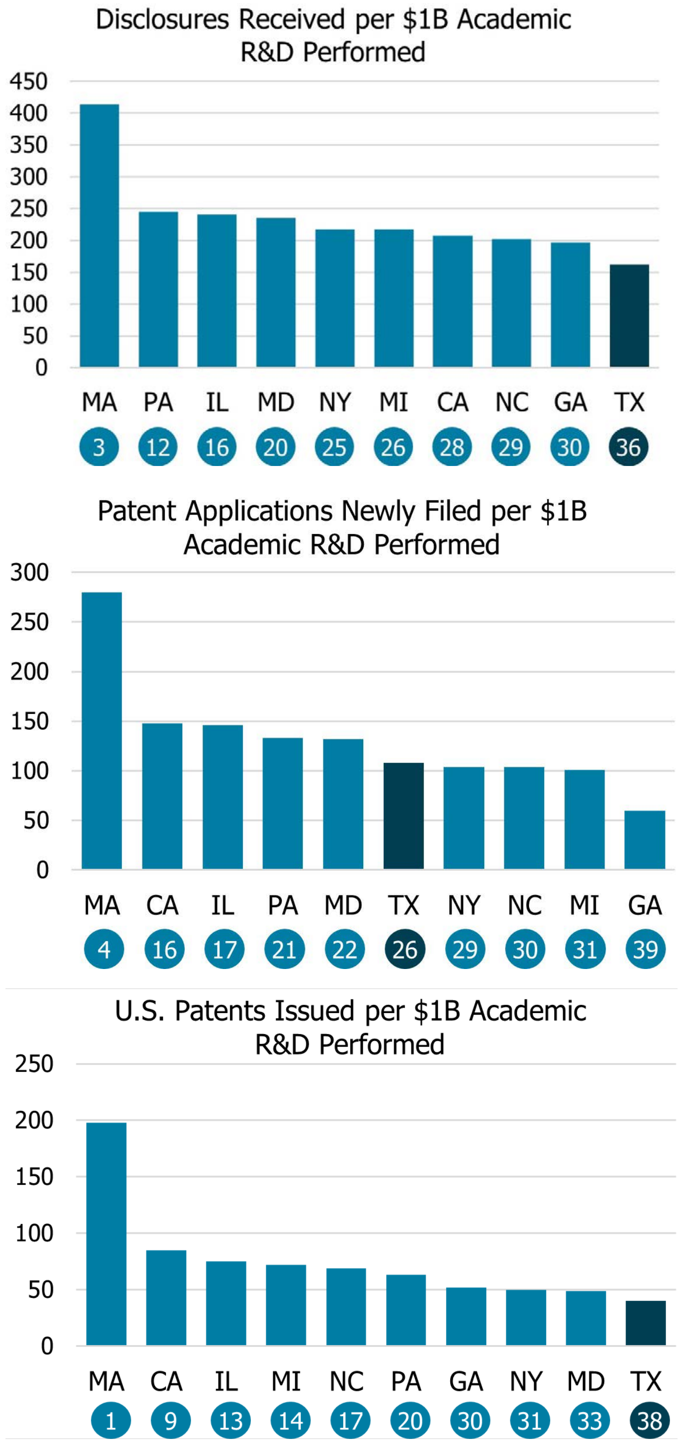
Patents are another key measure of the technology transfer process. Over a 10-year period at Texas higher education institutions, patent applications newly filed increased 10% and the number of U.S. patents issued held relatively steady (see **Figure 13**). In 2022, Texas ranked fifth for the number of patent applications filed from universities and seventh for U.S. patents issued to in-state higher education institutions. Contextualizing these outputs relative to academic R&D performed paints a different picture. Texas ranks 26th among the states for patent applications and 38th for U.S. patents issued, both relative to academic R&D performed.

As indicated previously, the data reveal that Texas has room for growth in technology transfer outputs in the context of academic R&D expenditures. For every billion dollars of academic R&D funding spent in 2022, Texas higher education institutions received 162 invention disclosures, filed 108 new patent applications, and had 40 U.S. patents issued. By those measures, Texas ranks below the median seen across states in the U.S. (see **Figure 8**). While these basic output measures do not necessarily indicate the effectiveness of a university's research or the potential commercial success of its intellectual property, they do serve as helpful measures to gauge the health of the technology transfer process.

## *Texas is a high performer in license income generation.*

Falling behind California, Massachusetts, New York, Oregon, and Washington, Texas ranked sixth with 1,270 licenses and income-generating options held by in-state institutions in 2022. However, for every billion dollars of academic R&D funding spent in 2022, Texas higher education institutions held 171 licenses (or other income-generating options), pushing Texas to the 22nd ranking (see **Figure 15**). Analyzing license revenue at Texas universities, Texas witnessed a general increase in license income year over year, with some unique outliers in 2016 and 2020 (see **Figure 15**).

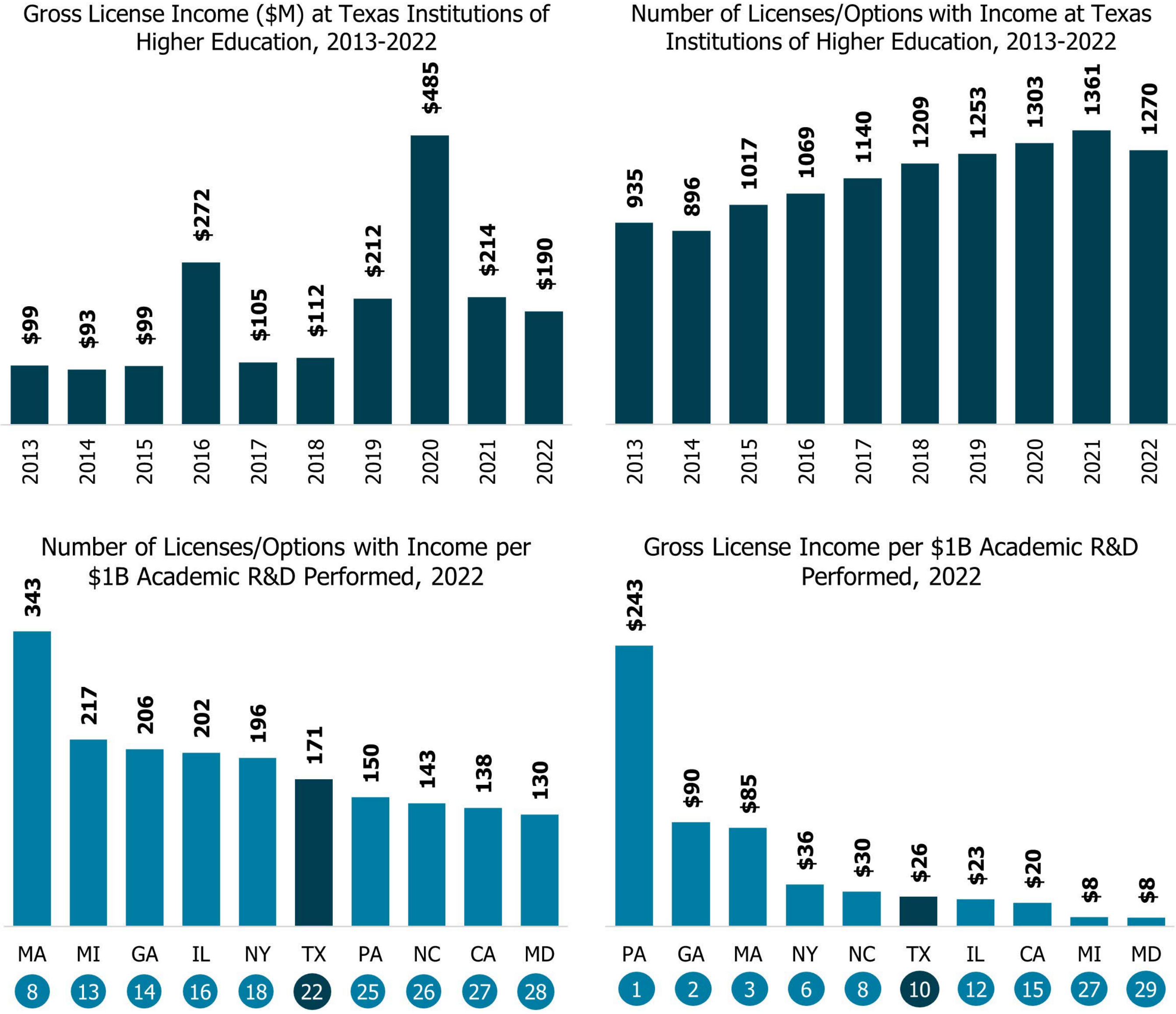
Figure 14. Selected Technology Transfer Outputs at Higher Education Institutions, 2022




Source(s): AUTM Statistics Access for Technology Transfer Database; TIP Strategies, Inc.
Note(s): States included represent the top 10 by higher education R&D expenditures in 2022. Rankings among the 50 states appear in circles.

While the data do not pinpoint the exact cause of these outliers, it may be due to a few wildly successful licenses from medical and health science institutions. Texas' ranking compared to other states has remained in the top 10 since 2009, most recently ranking sixth in 2022 with $190.45 million in gross license income. The states that outranked Texas in 2022 include: Pennsylvania ($1,325.29 million in gross license income), Massachusetts ($412.56 million), New York ($300.79 million), Georgia ($293.91 million), and California ($247.89 million). This time, contextualizing license income against academic R&D performed does not hurt Texas' ranking as severely. Instead, Texas ranked 10th in the nation for gross license income per $1 billion academic R&D performed in 2022.

Figure 15. Selected License Measures



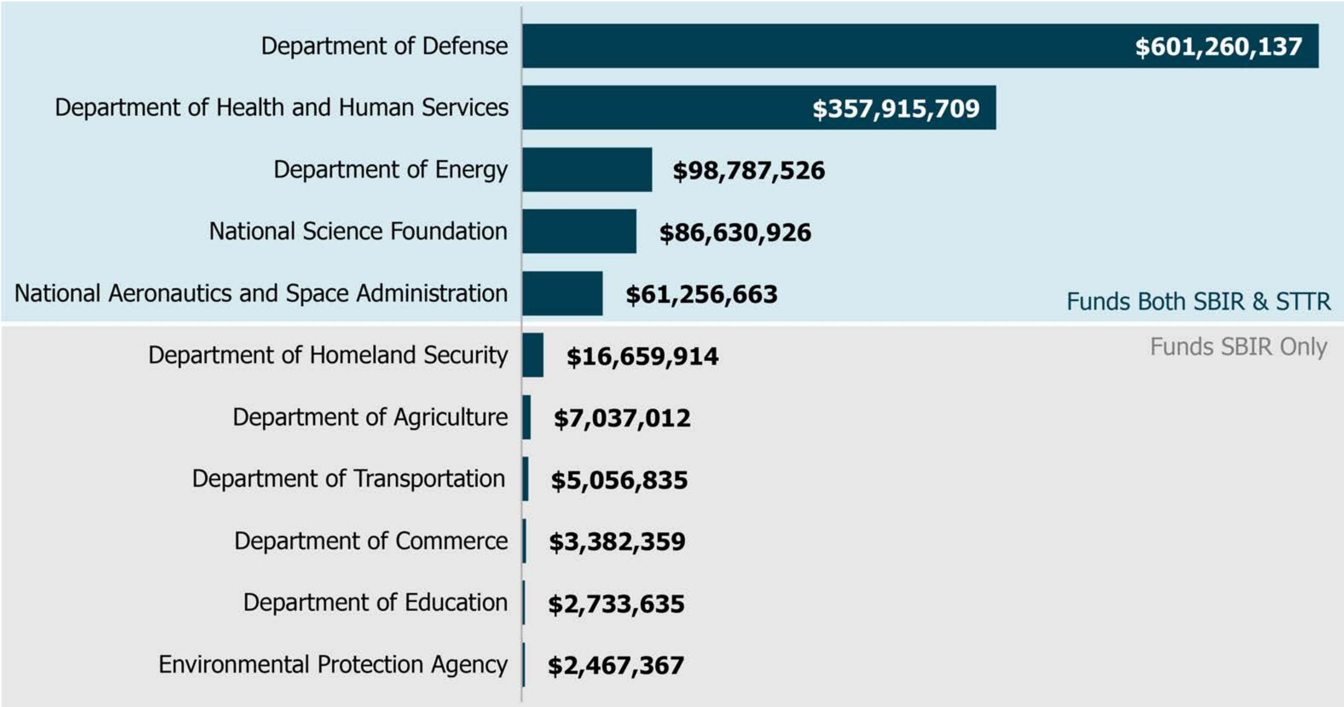

Source(s): AUTM Statistics Access for Technology Transfer Database; TIP Strategies, Inc.
Note(s): License income received includes license issue fees, payments under options, annual minimums, and running license income paid to other institutions. States included represent the top 10 by higher education R&D expenditures in 2022. Rankings among the 50 states appear in circles.

## *Over the last 10 years, the Department of Defense awarded over 48% of the total SBIR & STTR funding to Texas companies.*

The federal Small Business Innovation Research and Small Business Technology Transfer programs offer competitive awards to encourage small businesses to engage in R&D activities with potential for commercialization. Federal agencies that fund organizations outside the federal sector (known as extramural performers), allocate a percentage of that funding to the SBIR and STTR programs.[3] SBIR/STTR awards to Texas companies typically follow the pattern of agencies with the highest budget (see **Figure 16**), and it is worth noting that funding varies from year to year and from agency to agency.

The Department of Defense awarded 48% ($601.26 million of $1,243.19 million) of SBIR/STTR funding to Texas companies from 2013 to 2022. The trend follows with the Department of Health and Human Services awarding $357.92 million (29% of total SBIR/STTR awards to Texas companies over the last 10 years), the Department of Energy awarding $98.79 million (8%), the National Science Foundation awarding $86.63 million (7%), and NASA awarding $61.26 million (5%). That leaves just 3% ($37.34 million) of funding awards to Texas companies from the remaining federal agencies. With the likelihood of federal agency's R&D budgets increasing over time, SBIR/STTR funds offer Texas small businesses a strong opportunity to pursue nondilutive capital and support services.

Figure 16. SBIR & STTR Awards to Texas Small Businesses by Federal Agency, 2013-2022




Source(s): US Small Business Administration; TIP Strategies, Inc.
Note(s): The Small Business Innovation Research and Small Business Technology Transfer programs encourage domestic small businesses to engage in research and development activities with potential for commercialization.

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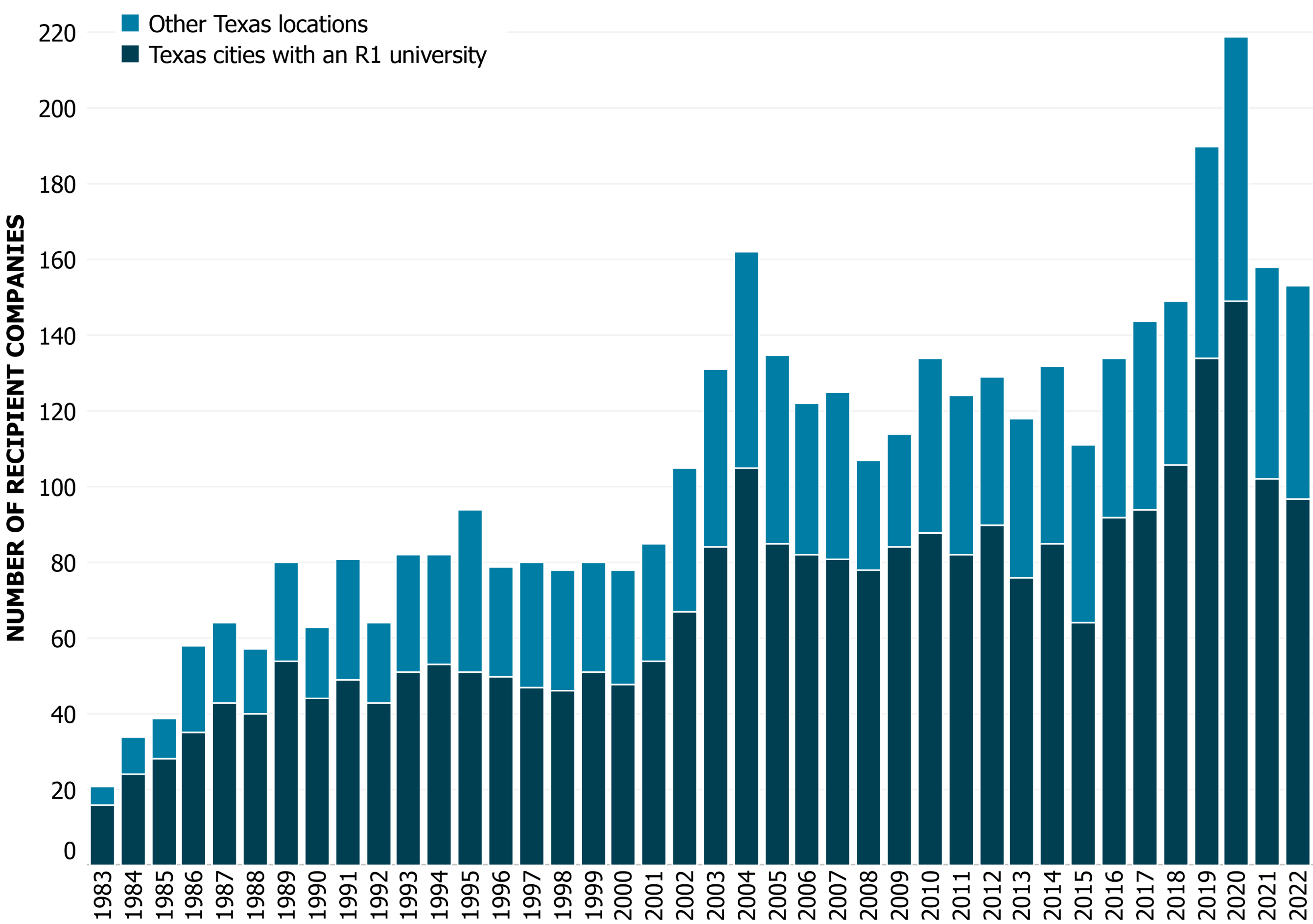
[3] US Small Business Administration, "About The SBIR and STTR Programs." For extramural R&D budgets that exceed $100 million, 3.2% is allocated to SBIR. For STTR, this figure is 0.45% of extramural R&D budgets that exceed $1 billion.

## *Texas SBIR & STTR awards tend to concentrate in cities with an R1 institution.*

Despite limited formal statewide support systems to assist companies with the SBIR/STTR application process, Texas has shown a promising growth trend in the number of SBIR/STTR awards. Since the inception of these funding opportunities, the number of awards to companies located in Texas cities with an R1 university (today represented by Arlington, Austin, College Station, Dallas, Denton, El Paso, Houston, Lubbock, San Antonio, and Waco) has consistently outpaced the number of awards to companies in other Texas locations (see **Figure 17**). This may be related to the technology transfer offices, the more general spillover benefits of the R1 institutions, or the pattern of R1s being located in larger cities with more vibrant economies. It also suggests that a strong innovation ecosystem is dependent on a major research university. Nonetheless, there are untapped opportunities to improve statewide support systems for Texas companies pursuing nondilutive funding like SBIR and STTR awards.

**Figure 17. SBIR & STTR Awards from All Funding Agencies by Recipient Location, 1983-2022**
The dark blue bar represents the number of recipient companies from Texas cities with an R1 university. The blue bar represents the number of recipient companies from other Texas locations.




Source(s): US Small Business Administration; TIP Strategies, Inc.
Note(s): The Small Business Innovation Research and Small Business Technology Transfer programs encourage domestic small businesses to engage in research and development activities with potential for commercialization.

## *Though Texas may be creating companies intellectual property from universities, it is not keeping most of those companies in the state.*

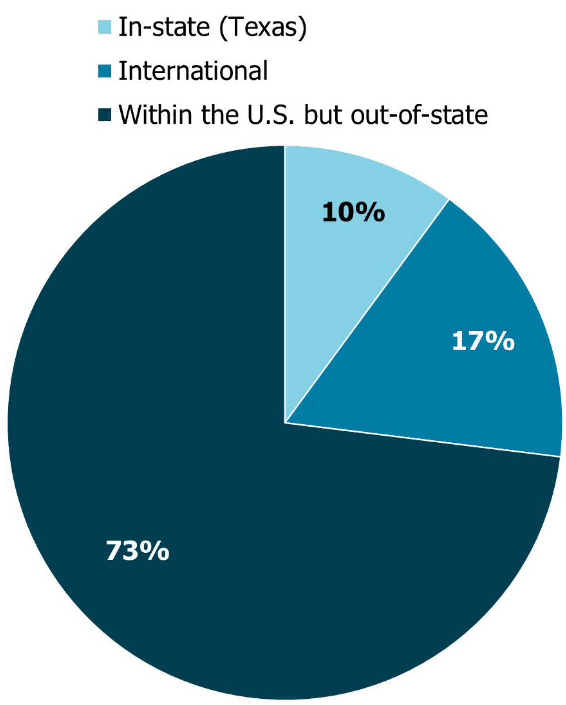
Data from the Association of University Technology Managers (AUTM) places Texas in third place with 477 associated operational startups in 2022. A company is considered an associated startup company if it was formed dependent on licensing the institution's technology. The "operational" definition includes companies that have been acquired, so long as the university intellectual property being licensed is still active and in compliance. Yet in the same year, Texas universities indicated that only 52 associated startup companies formed in prior years remained in the state. Instead, companies are being acquired by firms outside of Texas—which is considered a successful outcome for the startup—or the companies are relocating out of state. In other words, even though Texas may be creating many startups with IP from its higher education institutions, it is not retaining those companies in the state. As a result, the full economic benefits of those companies are not being returned to the local and state economies where they were formed. The situation may be in part due to the need for companies to relocate to regions with access to capital, talent, networks, and other supports that major venture capital firms provide.

## *Since 2018, 90% of venture capital invested in Texas companies originated outside of the state.*

A promising risk capital trend is the overall growth in venture capital investments in Texas. Between 2013 and 2017, venture capital investments in Texas totaled $4,063.21 million. From 2018 to 2022, venture capital investment in Texas more than quadrupled, totaling $18,324.08 million. Nearly three-fourths of venture capital funding between 2018 and 2022 (73% or $13,384.25 million) originated from within the U.S. but outside of Texas. An additional 17% ($3,094.15 million) originated internationally. Just 10% ($1,845.68 million) of recent venture capital investments in Texas companies originated within the state. Even investments from California and New York outpaced in-state investments, with $5,796.12 million and $3,845.85 million venture capital investments in Texas companies, respectively.

That fact, coupled with Texas' 20th-place ranking in total venture capital disbursed relative to the state's GDP, means that more can be done to ensure that university-generated IP stays in Texas. Access to risk capital within the state is a fundamental component of a strong innovation ecosystem. Moreover, having access to nearby funding may incentivize Texas companies to stay and grow within the state. Increasing access to risk capital could boost retention of university-generated IP in Texas and maximize the state's return on investment (ROI).

**Figure 18. Origin of Venture Capital Investments in Texas, 2018-2022**




Source(s): Crunchbase; TIP Strategies, Inc.
Note(s): Data are incomplete and represent only funding rounds in which investors and their funding levels have been disclosed. Data include all types of venture equity. All debt funding is excluded. Non-venture equity funding such as private equity and IPO-related funding are also excluded. Totals exclude any individual funding rounds under $100,000.

# Insights Heard

Through a robust stakeholder engagement process, a wide range of individuals shaped the direction of this work.

## Lessons from the Field

While data tell part of the innovation story in Texas, the individuals who have devoted their lives to R&D and innovation provide invaluable insights and additional context to add depth to the data. To support this work, the Texas Higher Education Coordinating Board engaged over 400 individuals ranging from investors, industry representatives, TTO staff, and higher education leadership, in the development of this plan. Their experience-based insights highlighted challenges and opportunities to strengthen R&D and innovation in the state. The stories shared during this process, along with key findings from data analysis, informed and guided the direction of the recommendations in *From Insights to Impact: Fostering Innovation at Texas Colleges and Universities*.

### *#1: Demand-driven innovation can lead to greater commercial success.*

Not all R&D is viable for commercialization, nor does it need to be. For IP where market entry is the goal, higher education's approach to R&D for successful commercialization can be reframed. Instead of looking for end users of a technology or discovery after it has been developed, better commercialization outcomes would be achieved through a more demand-driven approach. This shift from a "push" model to a "market pull" mindset requires supporting faculty interested in commercialization with more engagement with industry, investors, and other business partners earlier in the R&D process. Starting with an industry problem or a specific market demand can lead to more practical pathways for successful commercialization.

### *#2: Higher education needs resources and support to strengthen its capacity to respond to industry needs.*

To find a stronger balance between the "push" model and "market pull" mindset, it is crucial to test ideas for technological feasibility and alignment with market needs. Higher education institutions need to build their capacity for commercial validation. This may require additional resources, such as proof of concept funding to test and evaluate IP. Additional support could include tapping into industry expert panels for due diligence. Institutions can also work to expedite licensing, adopt business-friendly contract terms, and maintain transparent procedures to help investors better navigate their technology transfer processes.

### *#3: Successful technology transfer can benefit from regional flexibility and additional statewide supports.*

Texas is home to a large number of higher education institutions and systems. The diversity of institutions in the state is a major advantage, and each institution has a unique role to play in supporting their local innovation ecosystems. Technology transfer can balance the need to adapt processes to address different situations and opportunities with the larger need to provide campus and industry constituencies with clear, transparent, and efficient technology transfer processes. In addition, broader support and coordination across multiple institutions, within regions and across the state, can improve Texas' competitive position.

## #4: The pipeline for STEM and entrepreneurial talent needs reinforcement.

Developing and retaining a robust pipeline of STEM and entrepreneurial talent is foundational to commercializing university IP. In addition to increasing the number of research doctorates, Texas also needs talent to test and evaluate IP, pitch ideas to investors, and run startups. Faculty and researchers at Texas universities would benefit from stronger connections with serial entrepreneurs and executive talent who can help turn their innovative ideas into successful business operations.

## #5: Research commercialization can be better aligned with the needs of the state's major industries.

Finally, an overarching theme of this work was the universal need for stronger alignment between research commercialization efforts and the needs of the state’s major industries. The Texas Legislature recently made significant investments to support R&D in the semiconductor and aerospace industries. By strengthening the links between academic research and the industries fueling the state's economy, Texas can encourage research, talent, and companies to stay and create more opportunities for economic growth within the state. Connecting research and development activities with industry needs helps ensure Texas is the best place for higher education ideas and inventions to grow and thrive.

# Technology Transfer Landscape

# Examining Principles and Practices

To guide the strategic planning process, TIP conducted a comparative, qualitative research analysis of state and institutional approaches to technology transfer and commercialization in benchmark geographies. This analysis aims to understand use cases across the national landscape and, within them, identify applicable elements that may be replicated at colleges and universities in Texas. There are a wide variety of approaches to technology transfer and commercialization across the United States. Higher education governance varies across states, and many states fold technology transfer into their economic development portfolio. While no one-size-fits-all approach exists to prescribe a checklist for technology transfer success, advancing universities' research capacity, bolstering technology transfer offices, and strengthening ties between universities and innovation ecosystems are key.

## A Case Study Approach

This qualitative analysis examined California, Georgia, Massachusetts, Michigan, North Carolina, and Ohio through a case study approach. These states were chosen for a variety of reasons, leveraging an understanding of Texas' competitive position regarding its research and innovation assets. Quantitative metrics related to research and innovation, such as the number of R1 institutions, R&D expenditures, doctoral awards, invention disclosures, and licenses, supported benchmark selection (see **Figure 19**).

Each state case study includes one to two profiles within the benchmark geography. Some profiles, like for California and Massachusetts, examine university-level initiatives called out by stakeholders as gold standards of technology transfer. While the profiled institutions—Stanford University and the Massachusetts Institute of Technology (MIT), respectively—are private entities benefitting from significant historical, industrial, and financial advantages, they provide important insights into principles common to successful commercial outcomes. Other case studies, like Michigan and Ohio, summarize state-level, knowledge-based economic development policies that strengthen each geography's economic competitiveness.

Successful technology transfer principles and practices vary in rationale, form, and function. These principles and practices demonstrate distinct competitive advantages and variations in policy approach across benchmark geographies. Lessons learned from the case studies are reflected in the strategies within each goal area: technology transfer and commercialization, innovation ecosystem assets, and foundational supports (see From Roadmap to Reality).

- **California: Invention of the Modern TTO.** Through quantitative analysis, California became a clear benchmark for planning Texas' technology transfer and commercialization strategies. Still, through the stakeholder engagement process, identifying a use case from the state of California led to a singular, model institution—Stanford University. A private institution which has catalyzed and evolved with Silicon Valley, Stanford's differences from Texas public research institutions limit exact replication of its practices. Yet, a profile of Stanford provides insight into important qualities driving successful technology transfer and commercialization efforts.
- **Georgia: Betting on Scholars.** Stakeholder input identified the Georgia Research Alliance (GRA) as a useful profile. Created by an industry-research coalition, GRA recruits star research talent to Georgia universities and the GRA Venture Fund invests in university-affiliated startups in priority industries. With public and private funding, GRA's nonprofit status and its nonpartisan nature facilitates continued success over decades.

- **Massachusetts: Defense Engine.** Like California, stakeholder input identified a singular private institution as a leading institution in technology transfer and commercialization—MIT. MIT's relationship with industry has changed over the course of the institution's history as a land-grant university. Its emphasis on scientific and engineering research did not emerge until the early 20th century, and defense research funding during World War II radically transformed the institution. Yet, the principles driving MIT university leaders in the wartime and post-war eras laid important foundations for MIT's entrepreneurial research culture and for Boston's innovation ecosystem.
- **Michigan: State Innovation Networks.** Michigan's strategic state investments were identified through the stakeholder engagement process for profiles. These programs support different stakeholders within Michigan's innovation ecosystems. Some programs support university technology transfer and commercialization processes specifically, while others support startup development and in-state capital availability. Michigan deploys funding to leverage existing strengths and address gaps in technology transfer and entrepreneurial supports, creating a distributed innovation network with multiple entry points and resources.
- **North Carolina: Biotech Powerhouse.** The Research Triangle has long been synonymous with innovation and was a frequently cited benchmark among stakeholders. Creation of the Research Triangle Park (RTP) in the late 1950s represented a collaborative effort between business and academia to retain STEM graduates and promote high technology industry recruitment. Over time, the park became a convener for the three R1s to collaborate on technology transfer and industry-relevant research initiatives. RTP and North Carolina's biotech and innovation programs offer lessons for Texas because they weave university research commercialization programs into statewide industry supports.
- **Ohio: Venture Capital Recruitment.** Like Michigan, Ohio was identified by stakeholders because of its robust state-funded innovation and entrepreneurship programs. Ohio differs from Michigan in that less state supports exist for the technology transfer process itself; instead, Ohio heavily supports specific elements of innovation ecosystems—especially entrepreneurial supports and the risk capital landscape.

## Lessons Learned: Operating Principles from Leading Institutions

While technology transfer differs across higher education institutions, colleges, and universities with a track record of success have a common set of enabling conditions and cultures. These leading institutions set the standard for effective technology development by prioritizing entrepreneurship, deep connections with industry, and responsiveness to the needs of their local innovation ecosystems. Broader adoption of these principles across Texas higher education institutions would foster more substantial innovation and commercialization outcomes across the state. The following operating principles enable technology transfer practices at leading institutions to be more effective.

- **Prioritization of Technology Transfer.** A strong culture is reflected by institutional leaders prioritizing innovation and research commercialization. Adopting this approach is an avenue for institutions to have greater impact on their communities, society, and the world. Where the technology transfer team is housed in an institution signals the importance of commercialization. Leading institutions that prioritize commercialization tend to locate technology transfer in parts of the institution with high visibility, access to institutional leadership, reach across schools and departments, and proximity to external industry and investor networks.

- **A Broader View of ROI.** Technology transfer professionals across the country and around the world recognize that successful technology transfer is a long-term process with varying levels of risk and reward. Higher education leaders often make tradeoffs between generating revenue for their institutions, making strategic bets for future success, and serving the needs of a broad range of internal and external stakeholders. There are times when the best course of action is to take a less risky approach, such as licensing IP to existing businesses, while other opportunities call for a long-term investment in creating spin-outs, supporting entrepreneurs, or developing time-intensive technologies. Leaders of leading institutions adopt the long view, understanding that success can be rare and is seldom immediate. They also recognize that return on investment can come in many forms, including revenue returned to their institutions, career development for faculty and students, increased alumni engagement, the bolstering of the institution's reputation, and broader contribution to the economy and society.
- **Entrepreneurship Pathways.** Leading institutions encourage entrepreneurial endeavors among faculty, students, and staff. These institutions create opportunities for more researchers to consider commercialization as a pathway for success, allowing researchers to continue using university labs to launch commercial products or faculty to serve in advisory roles in a company licensing university-generated IP. Entrepreneurship is also fostered among undergraduate and graduate students by creating pathways for cross-discipline collaboration and opportunities to develop business plans and practice pitches. Leading institutions also view entrepreneurship as a central tenet of higher education's contribution to the world alongside teaching, research, and service.
- **Internal and External "Customers."** Institutions effective in technology transfer take a collaborative approach to developing technologies with researchers and businesses. While technology transfer at higher education institutions historically focused on serving internal stakeholders (e.g., faculty and students), a shift among leading institutions elevates external stakeholders, like investors and industry partners as key customers of technology transfer. Top institutions strike a balance between providing services and value to both internal and external stakeholders, recognizing successful technology transfer requires collaboration within and beyond their college or university.

## Lessons Learned: Promising Practices from Leading Institutions

In addition to enabling conditions for success, promising practices from leading institutions in technology transfer shed light on common, scalable, and tactical approaches that can lead to success. Strengthening adoption of these promising practices across Texas higher education institutions can facilitate more efficient and effective technology transfer. The following takeaways are based on research of leading institutions with demonstrated success in technology transfer.

### Supporting Researchers and Entrepreneurs

- **Inventor Awareness.** Leading institutions offer programs and tools that help faculty understand how to commercialize their research along with intensive support throughout the process. Inventors' guides succinctly introduce inventors to the common topics, paths, and policies they may encounter through the technology transfer process. Faculty at leading institutions can access this information at any time to learn more about resources and preferred internal processes within a specific institution. Beyond information guides, facilitating internal peer-to-peer relationships between faculty who have commercialized IP and faculty who are new to the commercialization process helps, as well.

- **Vetted Business Services.** Researchers often need access to business providers that can supply technical and legal guidance about IP protection, company formation, and business operations. Leading institutions often provide researchers with a trusted repository of startup-friendly service providers. For example, a list of attorneys to complete company formation filings or accountants to outsource financials can help when forming university spin-outs that are focused on commercializing IP from the institution.
- **Talent Development.** Successful technology transfer practices include developing opportunities to engage a broader pool of talent, including undergraduate and graduate students, to participate in technology transfer and commercialization processes. Some technology transfer offices offer internships and other programs for students to not only participate in research but also in commercialization and startup formation. This engages students from many disciplines and fields of study to develop research, conduct market due diligence, or create physical prototypes of discoveries.

## Collaborating on Technology Development

- **Relationship Building.** Successful technology transfer requires active relationship building. It is important to maintain strong relationships early in the research process with principal investigators and the companies that may eventually license university-generated IP or support commercialization in other ways. Leading institutions actively engage researchers by going to their labs and maintaining relationships with the companies that license the IP, both of which may lead to follow-on industry-sponsored research as the companies continue to develop the IP.
- **Advisory Boards.** A widespread practice among leading institutions is to explore the commercial viability of inventions and engage external stakeholders early, even before invention disclosures are filed. To help, some institutions convene advisory boards with industry executives, venture capitalists, and other faculty with expertise in the field of study to identify the most commercially competitive technologies. Advisory boards help explore the patentability of the invention, determine the size and growth potential of the relevant market, and make connections needed to further develop IP.
- **Corporate Partnerships.** Another way that leading institutions foster collaborative technology development is by forming corporate partnerships that explore industry innovation beyond one-time research projects. For example, some institutions offer corporate membership models that allow industry to access institutional research without entering a formal research contract and allow the institution to understand industry demand signals. Others may use a simple master collaboration agreement with confidentiality clauses that can later be customized to allow more specific industry-sponsored research under the master agreement.

## Removing Frictions

- **Business Development.** A common challenge for external stakeholders, such as investors, is understanding the breadth of research and technologies available from higher education institutions. A frequent practice among leading institutions is to develop tools and relationships that provide greater line of sight into their IP portfolio. This may include sending abstracts to industry contacts segmented by market space; posting technologies on an online, searchable database; or facilitating collaboration meetings between researchers and companies.

- **License Agreements.** Navigating differences in terms and agreements across higher education institutions is a common obstacle for investors, industry collaborators, and other external stakeholders. Where applicable, leading institutions increase transparency by posting standard license agreements or pre-prepared license agreements online, which can simplify internal processes for staff and create greater predictability for investors. For example, some licenses for software technologies rarely change, so a “ready to sign” agreement can facilitate expedited licensing processes. For deals requiring custom terms, a brief summary sheet allows both parties to quickly review all key negotiated terms. The summary sheet can then be used to generate the full agreement.
- **Term Negotiation.** Taking research at higher education institutions from the lab to the marketplace is just the start for viable technologies and spin-outs. The inventions created, companies launched, and entrepreneurs developed still have a long road ahead to realize commercial success. Leading institutions recognize that they can set their inventors and spin-outs up for favorable outcomes by negotiating terms to facilitate the future commercial success of the IP. For example, institutions can take a certain level of equity early in the life of a spin-out and then dilute their stake after a spin-out reaches certain milestones. This allows opportunities for further growth and investment from other sources, which can help take the spin-out to the next stage of growth.

**Figure 19. State Comparison Indicators for Benchmark States and Texas**
California (CA), Georgia (GA), Massachusetts (MA), Michigan (MI), North Carolina (NC), and Ohio (OH)

| 2022 INDICATORS | CA | GA | MA | MI | NC | OH | TEXAS |
|---|---|---|---|---|---|---|---|
| **HIGHER EDUCATION RESEARCH ACTIVITY** | | | | | | | |
| Higher Education R&D Expenditures[1] | $12.1B | $3.3B | $4.8B | $3.1B | $3.9B | $3.1B | $7.4B |
| Academic R&D per $1THS GDP[2] | $3.37 | $4.32 | $7.04 | $4.97 | $5.30 | $3.75 | $3.16 |
| Research Doctorate Recipients[3] | 6,817 | 1,600 | 3,254 | 1,930 | 1,866 | 1,935 | 4,381 |
| Research Doctorate Recipients per 1M Residents[3, 4] | 175 | 147 | 466 | 192 | 174 | 165 | 146 |
| **TECHNOLOGY TRANSFER OUTPUTS AT IN-STATE UNIVERSITIES** | | | | | | | |
| Number of Disclosures Received[5] | 2,513 | 642 | 2,003 | 668 | 782 | 1,331 | 1,209 |
| Number of Disclosures Received per $1B Academic R&D Performed[2] | 208 | 197 | 414 | 217 | 202 | 432 | 162 |
| Number of Patent Applications Newly Filed[5] | 1,796 | 197 | 1,354 | 311 | 402 | 681 | 806 |
| Number of Patent Applications Newly Filed per $1B Academic R&D Performed[2] | 148 | 60 | 280 | 101 | 104 | 221 | 108 |
| US Patents Issued[5] | 1,030 | 170 | 960 | 223 | 266 | 374 | 298 |
| US Patents Issued per $1B Academic R&D Performed[5,1] | 85 | 52 | 198 | 72 | 69 | 121 | 40 |
| **INNOVATION INVESTMENT IMPACTS** | | | | | | | |
| Licenses/Options with Income[5] | 1,674 | 670 | 1,657 | 669 | 555 | 570 | 1,270 |
| Licenses/Options with Income per $1B Academic R&D Performed[5,1] | 138 | 206 | 343 | 217 | 143 | 185 | 171 |
| Gross License Income[5] | $248M | $294M | $413M | $47M | $116M | $65M | $190M |
| Gross License Income per $1M Academic R&D Performed[2] | $20.47 | $90.15 | $85.29 | $7.93 | $30.01 | $21.26 | $25.60 |
| Number of Operational Associated Startups[5] | 278 | 221 | 603 | 311 | 417 | 231 | 477 |
| Number of Operational Associated Startups per $1B Academic R&D Performed[2] | 23 | 68 | 125 | 101 | 108 | 75 | 64 |
| Number of Associated Startups in State[5] | 101 | 14 | 61 | 15 | 30 | 24 | 52 |
| Number of Associated Startups in State per $1B Academic R&D Performed[2] | 8 | 4 | 13 | 5 | 8 | 8 | 7 |
| Total Venture Capital Funding Disbursed[2] | $102.8B | $2.3B | $22.7B | $1.3B | $4.9B | $3.6B | $11.2B |
| Total Venture Capital Funding Disbursed per $1B GDP[2] | $28.23 | $2.97 | $32.80 | $2.12 | $6.89 | $4.32 | $4.66 |
| Venture Capital Deals[2] | 7,169 | 484 | 1,468 | 327 | 536 | 366 | 1,449 |

Source(s): 1. National Science Foundation, Higher Education Research and Development Survey; 2. National Science Foundation, National Science Board Science and Engineering Indicators; 3. National Science Foundation, Survey of Earned Doctorates; 4. US Census Bureau, Population Estimates Program; 5. AUTM Statistics Access for Technology Transfer Database; TIP Strategies, Inc.
Note(s): AUTM data represent an aggregation of self-reporting by universities in those states.

# California: Invention of the Modern TTO

### Takeaways

- An academic mission ingrained in relationship-building with industry leaders and entrepreneurs leads to mutually beneficial collaborations between industry and academia.
- Establishing a research park should be a response to a documented need; therefore, a clear understanding of innovation assets and gaps should be the starting point.
- A research park can be a university-generated innovation asset serving the university's research mission through public-private collaborations.

## Technology Transfer at Stanford University

Founded as a private research institution in 1885, Stanford University (Stanford) is one of the world's most prestigious universities. Stanford created one of the nation's first technology transfer offices in 1970. The founder of Stanford's Office of Technology Licensing (OTL), Neils Reimers, is credited with operationalizing the technology transfer model within a dedicated, marketing-focused university office. Reimers advocated for the Bayh-Dole Act passed in 1980, and OTL is among the minority of TTOs created before the 1980s. In Fiscal Year 2022, OTL received 510 invention disclosures, filed 350 new patent applications, and had 188 U.S. patents issued.[4] Each of these measures from Stanford account for roughly 20% of the state's totals (see Figure 21). Stanford's academic R&D expenditures exceeded $1.38 billion in Fiscal Year 2022 (over 11% of the state's total).[5]

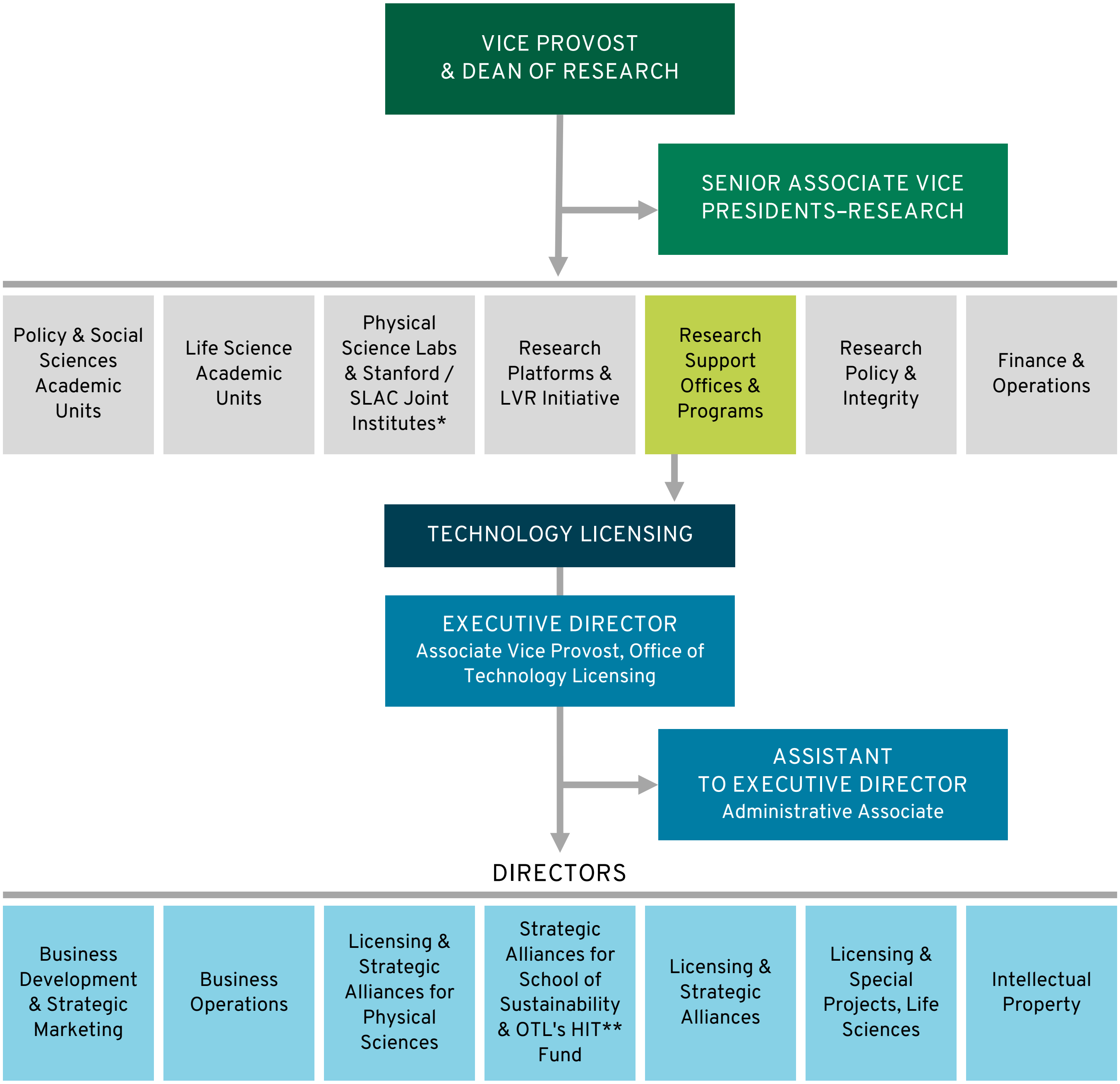
OTL is run by an Associate Vice Provost reporting to the Vice Provost and Dean of Research, who oversees Stanford's 15 labs and institutes, in addition to the university's overall research enterprise. The OTL is comprised of over 50 staff members, including an executive committee and seven teams covering licensing, fund management and advisory support, intellectual property, industrial contracts, business development and strategic marketing, business operations, and an internship program (see **Figure 20**).

The licensing process at Stanford's OTL is comprised of six stages: technology marketing, business development planning, term sheet negotiating, license negotiation, progress monitoring, and license amending. OTL's business development and strategic marketing team actively promotes Stanford technologies to external investors and industry contacts. The team sends out abstracts to industry contacts segmented by industry sector; posts technologies on an online, searchable database; and arranges company meetings with principal investigators.

In addition to managing corporate-sponsored research contracts, the Industrial Contracts Office within OTL operates the Industrial Affiliates Program (IAP). The IAP allows companies to tap into Stanford research through a fee-based corporate membership model, facilitating exchanges between researchers and IAP members on research topics without committing to a specific contract. These fees are governed as gifts and provide unrestricted financial support for IAP activities while retaining faculty research freedom since there are no research commitments. Likewise, the IAP expands awareness among faculty and students about industry challenges and potential areas for research collaborations.

[4] AUTM Statistics Access for Technology Transfer Database; TIP Strategies, Inc.
[5] National Science Foundation, Higher Education Research and Development Survey; TIP Strategies, Inc.

Figure 20. Stanford Research and Technology Licensing Organizational Structure




*In joint research centers and facilities, the SLAC National Accelerator Laboratory (SLAC) and Stanford partner to address important scientific problems and train the next generation of scientists.
**The OTL's High Impact Technology (HIT) Fund provides seed funding and advisory services to accelerate the commercialization of Stanford-based innovations.
Source(s): Stanford University, Office of the Vice Provost and Dean of Research; Stanford University, Office of Technology Licensing; TIP Strategies, Inc.

Notably, Stanford's TTO piloted a unique patent marketing model that did not exist before the 1970s. This model succeeded and differentiated Stanford from its peers because OTL did not wait for companies to discover licensing opportunities. Instead, OTL actively sought out researchers and companies to participate in technology transfer. However, Stanford's pilot also succeeded because of the strong innovation foundations established decades earlier. Stanford University's Provost and Dean of Engineering, Frederick Terman, shaped the institution's priorities in the 1940s by recruiting and retaining outstanding faculty in the core sciences and emergent engineering fields, like electronics. Terman introduced Stanford's institutional friendliness toward forging government and industry partnerships. Like MIT (see **MIT and the Boston Innovation Ecosystem**), Stanford's co-evolution with emergent industries occurred because of increased partnership between government, industry, and academia after World War II.

> *Before 2000, electronics inventions comprised Stanford's highest average net licensing income earners … [s]ince 2000, life sciences and chemistry inventions have surpassed electronics as the leading driver of Stanford's licensing income.*

Before 2000, electronics inventions comprised Stanford's highest average net licensing income earners, reflecting Silicon Valley's reputation as the birthplace of the modern electronics and computer industries. Since 2000, life sciences and chemistry inventions have surpassed electronics as the leading driver of Stanford's licensing income. At Stanford, all inventions earning more than $10 million net income and 59% of inventions earning more than $1 million net income are self-licensed by inventors' own startups.[6] Stanford's royalty-sharing policy splits net royalties equally between the inventor, the inventor's department, and the inventor's school, after 15% is reserved for OTL operations.

In 2022, OTL set aside $17 million to create the competitive High Impact Technology (HIT) Fund, designed to explore market applications of invention disclosures at the earliest stage of commercialization. The HIT Fund allows Stanford to fill gaps in access to seed funding, industry and patent expertise, venture capital, and other advisory support to researchers commercializing Stanford intellectual property, irrespective of department or field of study. An advisory board of industry executives, venture capitalists, and faculty reviews applications from researchers to identify the most commercially competitive technologies to invest in and de-risk. Researchers receive entrepreneurial support specific to their needs—not all require monies—in addition to staff support from MBA student interns.

## The Lesson

Stanford's technology transfer activities benefit from the entrepreneurial research culture that the institution has encouraged for decades, allowing for mutually beneficial collaborations between industry and academia. Research inquiries relevant to industry become valid pursuits in the eyes of the university because excellence in industry-relevant research enhances Stanford's overall reputation. As a result, Stanford's academic mission is not separated from its entrepreneurial and industrial relationship-building but instead is integrated and mutually strengthening.

[6] Weixin Liang, Scott Elrod, Daniel A. McFarland, and James Zou, "Systematic Analysis of 50 Years of Stanford University Technology Transfer and Commercialization." *Patterns* 3, 9, 100584: (September 9, 2022).

## Stanford Research Park

Established in 1951, Stanford Research Park (SRP) was the world's first research park, created to collocate R&D-focused technology firms near a research university. Today, SRP is home to over 150 companies across 700 acres, contributing $770 million annually to the Palo Alto economy and generous tax revenue for local governments. SRP was not Silicon Valley's only strategic asset in birthing the high-tech industry, but the park's historical roots in faculty-industry cross-pollinations and its focus on expanding R&D capacity for the university served as critical components to the development of the region's innovation ecosystem.

Frederick Terman pioneered the original Stanford Industrial Park as a creative fiscal solution to the university's budget troubles. University enrollment grew faster than funding. Though wealthy in land in the 1940s, the university could not sell land per endowment requirements. Simultaneously, the region lacked light industrial sites for new employers wanting to stay near the university, and Stanford graduated more students in the sciences and engineering than local employers could hire. Meanwhile, faculty were eager to collaborate with the rapidly growly electronics industry. As an advocate for faculty entrepreneurship and graduate retention, Terman extended the purpose of the park beyond revenue generation. Under his vision, Stanford developed and leased land to cultivate industry partnerships, which expressly added R&D capacity, developed Stanford talent, and served the university's scientific mission.

Stanford began by developing infrastructure for 209 acres zoned for light industry. Its first tenant, Varian Associates, was founded by Stanford researchers commercializing two university-patented technologies. Stanford capitalized on its entrepreneurial culture and continued adding tenants with close relationships to the university, including Hewlett-Packard, among other household names. As demand increased, Stanford's Lands Management Department incrementally developed more land to lease to R&D firms, adapting lease requirements to the site's organic growth pattern. SRP grew as a collaboration with the City of Palo Alto; by petitioning annexation, Stanford offered tax revenue collection in exchange for maintenance responsibility. City code and the SRP's university administration contributed to its campus-like features, consistent with creative environments.

Like the revolving door phenomenon between the public and private sectors in Washington D.C., Silicon Valley culture intentionally and proudly blurs the line between academia and industry. Stanford's irreplicable advantage was the culture of independent entrepreneurial ambitions prevalent through all levels of university leadership. This culture existed before SRP, and Stanford chose to activate a world-changing opportunity at a critical juncture. Through demand-driven economic development, Stanford accelerated and densified connections between cutting-edge research, university-affiliated job creators, industrial site needs, and talent supply.

### The Lesson

The success of Stanford Research Park is due to the critical roles that leadership, flexibility, and timing play in activating opportunity for innovation ecosystems. Stanford recognized the opportunity within what began as a fiscal challenge. As a result, university administrators created an asset serving its research mission through public-private collaborations. To foster innovation ecosystems, strong industry connections are crucial to retaining talent, creating high-tech job opportunities, and developing highly skilled STEM and entrepreneurial leaders. SRP was a method to meet these outcomes, but it cannot be replicated exactly given the historical moment leveraged by way of the rise of the electronics industry. Instead, SRP demonstrates the character of creative university leaders who invest in university-business collaborations.

# State Comparison Indicators: California

Figure 21. State Comparison Indicators: California (CA)

| 2022 INDICATORS | CA | MEDIAN FOR ALL STATES | CALIFORNIA'S RANK: LOW OUTLIER | CALIFORNIA'S RANK: NORMAL RANGE | CALIFORNIA'S RANK: HIGH OUTLIER |
|---|---|---|---|---|---|
| **HIGHER EDUCATION RESEARCH ACTIVITY** | | | | | |
| Higher Education R&D Expenditures[1] | $12.1B | $1.03B | | | 1 |
| Academic R&D per $1THS GDP[2] | $3.37 | $3.82 | | 30 | |
| Research Doctorate Recipients[3] | 6,817 | 686 | | | 1 |
| Research Doctorate Recipients per 1M Residents[3, 4] | 175 | 149 | | 18 | |
| **TECHNOLOGY TRANSFER OUTPUTS AT IN-STATE UNIVERSITIES** | | | | | |
| Disclosures Received[5] | 2,513 | 349 | | | 1 |
| Disclosures Received per $1B Academic R&D Performed[5,1] | 208 | 220 | | 28 | |
| Patent Applications Newly Filed[5] | 1,796 | 197 | | | 1 |
| Patent Applications Newly Filed per $1B Academic R&D Performed[5,1] | 148 | 128 | | 16 | |
| US Patents Issued[5] | 1,030 | 87 | | | 1 |
| US Patents Issued per $1B Academic R&D Performed[5,1] | 85 | 60 | | | 9 |
| **INNOVATION INVESTMENT IMPACTS** | | | | | |
| Licenses/Options with Income[5] | 1,674 | 258 | | | 1 |
| Licenses/Options with Income per $1B Academic R&D Performed[5,1] | 138 | 164 | | 27 | |
| Gross License Income at In-State Universities[5] | $248M | $13M | | | 5 |
| Gross License Income at In-State Universities per $1B Academic R&D Performed[2] | $20.47 | $10.00 | | | 15 |
| Number of Operational Associated Startups[5] | 278 | 98 | | | 9 |
| Number of Operational Associated Startups per $1M Academic R&D Performed[2] | 23 | 67 | 23 | | |
| Number of Associated Startups in State[5] | 101 | 6 | | | 1 |
| Number of Associated Startups in State per $1B Academic R&D Performed[2] | 8 | 5 | | | 10 |
| Total Venture Capital Funding Disbursed[2] | $102.8B | $1.0B | | | 1 |
| Total Venture Capital Funding Disbursed per $1B GDP[2] | $28.23 | $3.41 | | | 2 |
| Venture Capital Deals[2] | 7,169 | 221 | | | 1 |

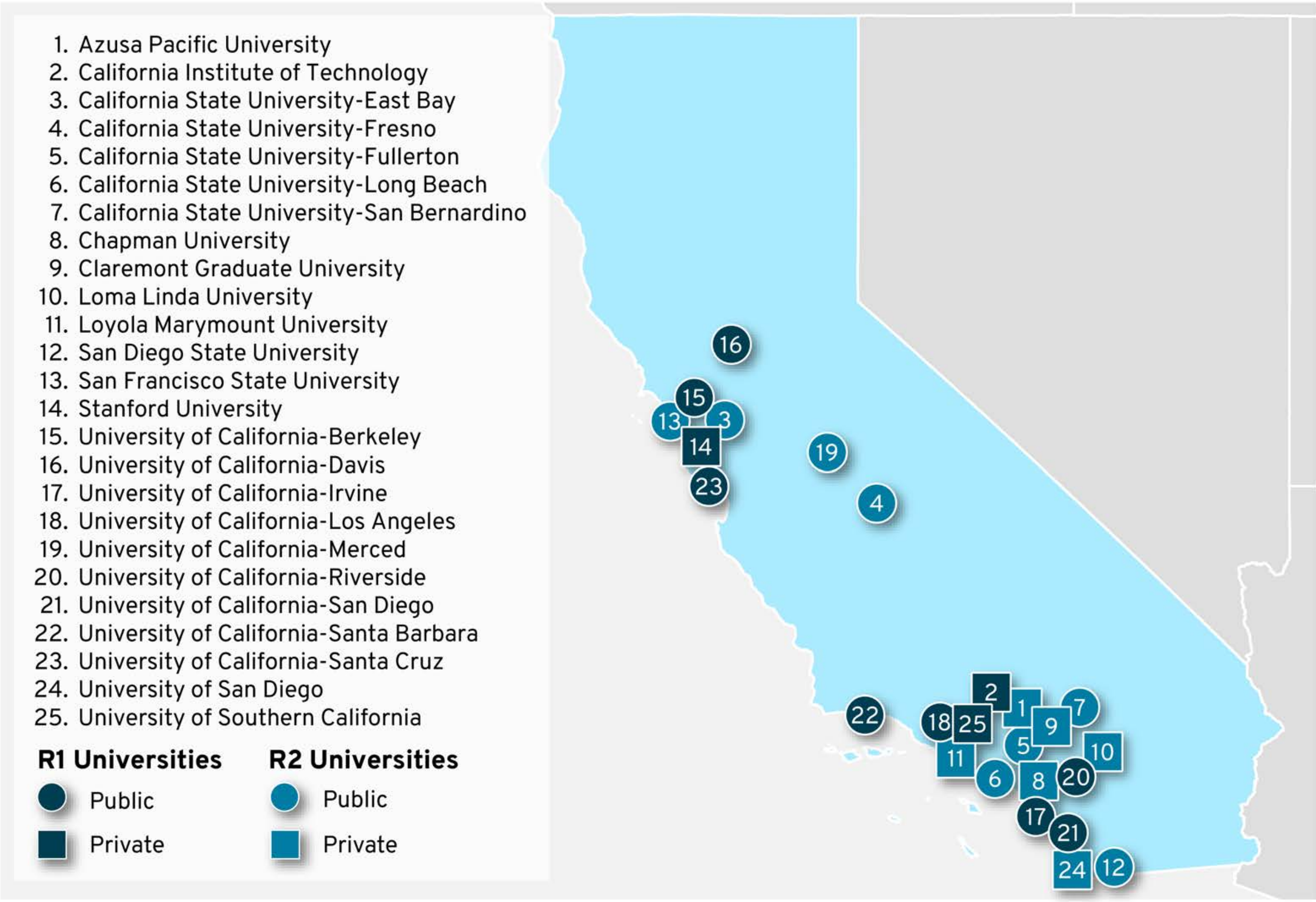
Source(s): 1. National Science Foundation, Higher Education Research and Development Survey; 2. National Science Foundation, National Science Board Science and Engineering Indicators; 3. National Science Foundation, Survey of Earned Doctorates; 4. US Census Bureau, Population Estimates Program; 5. Association of University Technology Managers (AUTM) Statistics Access for Technology Transfer Database; TIP Strategies, Inc.

Note(s): States in a "normal range" fall one median absolute deviation from the median of all states. States outside this range are categorized as "high outlier" and "low outlier." AUTM data represent an aggregation of self-reporting by universities in those states.

# R1 and R2 Universities: California

**Figure 22. R1 and R2 Universities: California**

California is tied with Texas and New York for the highest number of R1 institutions, with 11 each.




Source(s): **Carnegie Classification of Institutions of Higher Education; Integrated Postsecondary Education Data System; TIP Strategies, Inc.**

# Georgia: Betting on Scholars

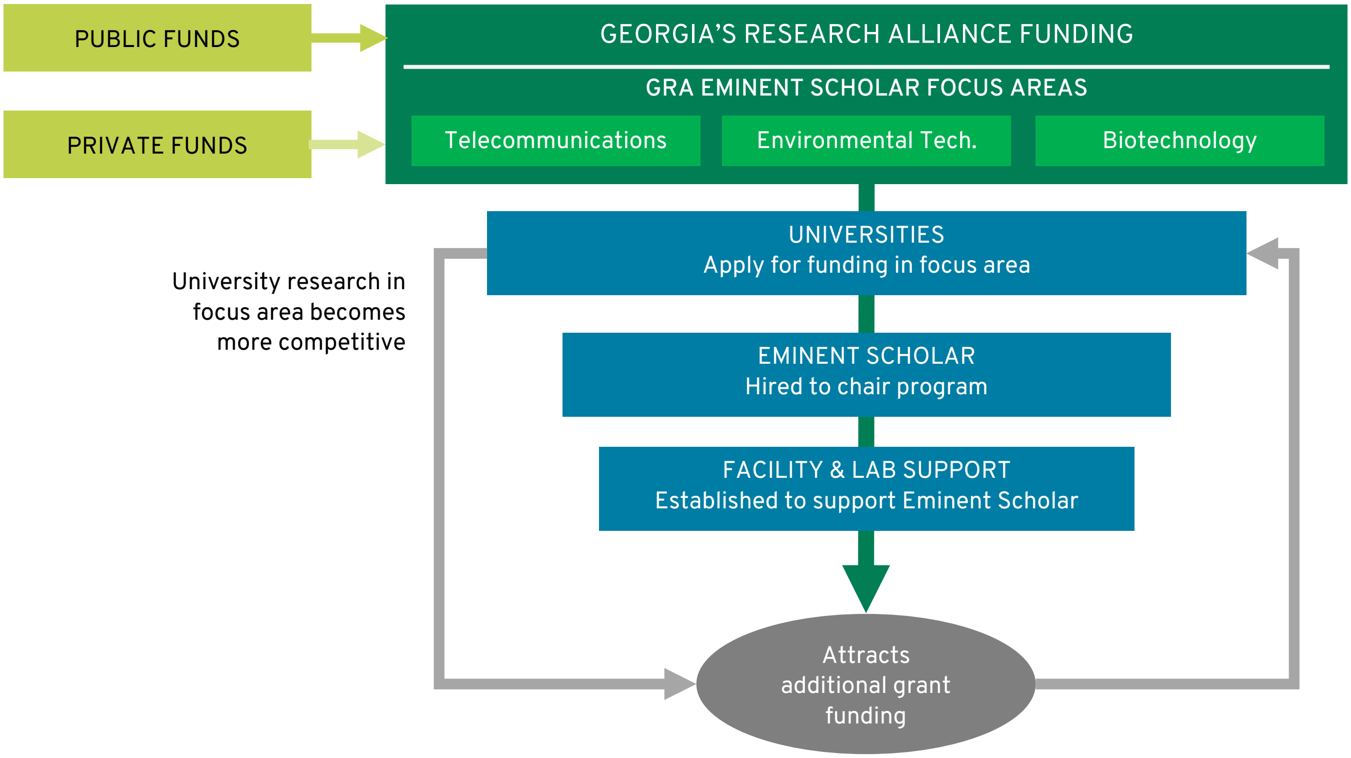
### Takeaways

- Encouraging university collaboration via a nonprofit organization, rather than a state agency or a higher education system, allows for a nonpartisan, strategic, and long-term operation.
- Prioritizing faculty recruitment and development can bolster an institution's reputation, lead to follow-on grant funding, and create additional research jobs.

## Georgia Research Alliance

The Georgia Research Alliance, founded in 1990, is a nonprofit university alliance created by business, academic, and government leaders to improve the state's high-tech industry competitiveness. GRA's flagship initiative is the Eminent Scholar Program (ESP), which recruits leading researchers to serve as faculty at Georgia research institutions. GRA augments the ESP with aligned research capital investments and, most recently, a venture fund focused exclusively on research commercialization projects. Private donors fund GRA operations while state allocations fund researcher incentives. The state's total investment of $702 million in GRA programs is estimated to have generated $13.2 billion in additional funding through research grants, venture capital, and matching funds over GRA's lifetime.[7]

Figure 23. Faculty Recruitment through the Eminent Scholars Program




Source(s): W. Henry Lambright, "Catalyzing Research Competitiveness: The Georgia Research Alliance" *Prometheus* 18, no. 4 (2000): 364; Georgia Research Alliance, "Who We Are"; TIP Strategies, Inc.

[7]Georgia Research Alliance, "Who We Are."

In the mid-1980s, Georgia was unsuccessful in recruiting a national high-tech R&D consortium. In response, business leaders advocated for state government support for a nonprofit to coordinate strategic collaborations among Georgia's universities. Governed by a board of 12 business and six university leaders, GRA was created as a nonprofit rather than as a state agency to retain autonomy. While GRA was not a state-initiated effort, Governor Zell Miller championed the initiative over the course of his administration.

GRA began by centering faculty recruitment on three competitive technology industries for Georgia: telecommunications, biotechnology, and environmental technology. Georgia's leading research institutions each specialized to concentrate research assets according to their existing industrial advantages: the University of Georgia with environment technology, the Georgia Institute of Technology with telecommunications, and Emory University with biotechnology. Today, universities identify scholars to recruit (see **Figure 23**). If GRA approves, the ESP recruits those researchers for state-funded chairs in addition to faculty appointments. Funding for research equipment and lab space supporting the chair's field of study is included in the recruitment incentive.

In addition to augmenting university research, Eminent Scholars support a university's ability to leverage federal grant funding. GRA's status as a nonprofit allows it to act as a fundraising vehicle to support required matching grants. Combined state and private funding for Eminent Scholars has resulted in over $600 million in additional federal funding.[8] Since 1990, GRA has supported the recruitment of 72 Eminent Scholars. In 2023, those researchers expended $857 million in R&D funding and created 2,484 research jobs in university labs.[9]

Along with faculty recruitment, GRA provides proof of concept and early-stage company formation funding exclusive to Georgia-university affiliated startups. GRA Phase I grants provide researchers with up to $50,000 at the conceptual stage, while Phase II grants provide up to $100,000 for research advancing to company formation, contingent upon a one-to-one government or private match. Low-interest Phase III loans support formed companies and finance future loans. Over 260 industry advisors help evaluate GRA's grantmaking and lending activities. In 2023, GRA-backed university startups attracted $148 million in outside capital invested, created 1,977 jobs, and generated $246 million in revenue and grants.

A separate organization, the GRA Venture Fund combines public investment with funding from 64 private investors. The GRA Venture Fund exclusively invests in university-affiliated startups advancing innovations in life sciences, manufacturing, agriculture, or information technologies. GRA Venture Fund portfolio companies must commit to having their principal place of business in Georgia and accepting a board appointment nominated by the fund's managing director. Across GRA grantmaking and venture capital activities, GRA-backed research commercialization projects have attracted $2.1 billion in outside investment as of 2022.

[8]W. Henry Lambright, "Catalyzing Research Competitiveness: The Georgia Research Alliance." *Prometheus* 18, no. 4, (2000): 367.
[9]Remaining figures in this section are from Georgia Research Alliance, "GRA 2023 Highlights."

## The Lesson

The Georgia Research Alliance was an industry response to Georgia's loss of a nationally competitive R&D consortium. As a neighbor to North Carolina, Georgia learned from the model of the Research Triangle Park (see **Research Triangle Park**). In particular, GRA's and Research Triangle Park's nonprofit status enables them to operate in a strategic role, led by business and government partnership, to unite universities in applied research collaboration. In both instances, the nonprofit model and its nonpartisan, research-based mission created cultures of university collaboration where none existed before. GRA focused on developing the core asset of research universities: exceptionally talented faculty. Investing in faculty developed the reputation of Georgia's universities, creating opportunities for additional capital investments and research jobs.

# State Comparison Indicators: Georgia

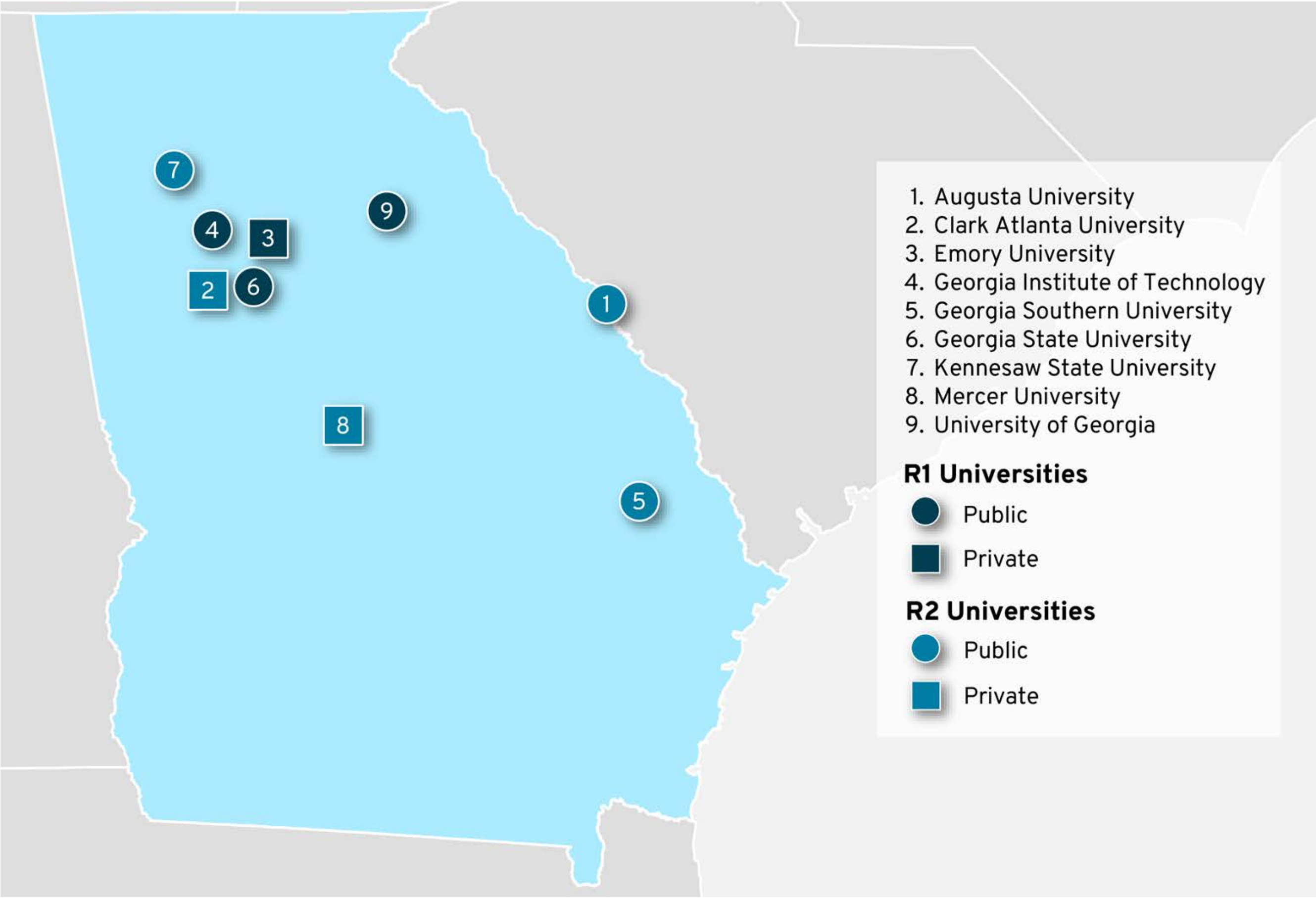
Figure 24. State Comparison Indicators: Georgia (GA)

| 2022 INDICATORS | GA | MEDIAN FOR ALL STATES | GEORGIA'S RANK: LOW OUTLIER | GEORGIA'S RANK: NORMAL RANGE | GEORGIA'S RANK: HIGH OUTLIER |
|---|---|---|---|---|---|
| **HIGHER EDUCATION RESEARCH ACTIVITY** | | | | | |
| Higher Education R&D Expenditures[1] | $3.3B | $1.03B | | | 8 |
| Academic R&D per $1THS GDP[2] | $4.32 | $3.82 | | 18 | |
| Research Doctorate Recipients[3] | 1,600 | 686 | | | 12 |
| Research Doctorate Recipients per 1M Residents[3, 4] | 147 | 149 | | 26 | |
| **TECHNOLOGY TRANSFER OUTPUTS AT IN-STATE UNIVERSITIES** | | | | | |
| Disclosures Received[5] | 642 | 349 | | | 14 |
| Disclosures Received per $1B Academic R&D Performed[5,1] | 197 | 220 | | 30 | |
| Patent Applications Newly Filed[5] | 197 | 197 | | 23 | |
| Patent Applications Newly Filed per $1B Academic R&D Performed[5,1] | 60 | 128 | 39 | | |
| US Patents Issued[5] | 170 | 87 | | | 16 |
| US Patents Issued per $1B Academic R&D Performed[5,1] | 52 | 60 | | 30 | |
| **INNOVATION INVESTMENT IMPACTS** | | | | | |
| Licenses/Options with Income[5] | 670 | 258 | | | 12 |
| Licenses/Options with Income per $1B Academic R&D Performed[5,1] | 206 | 164 | | 14 | |
| Gross License Income at In-State Universities[5] | $294M | $13M | | | 4 |
| Gross License Income at In-State Universities per $1B Academic R&D Performed[2] | $90.15 | $10.00 | | | 2 |
| Number of Operational Associated Startups[5] | 221 | 98 | | | 12 |
| Number of Operational Associated Startups per $1M Academic R&D Performed[2] | 68 | 67 | | 20 | |
| Number of Associated Startups in State[5] | 14 | 6 | | | 16 |
| Number of Associated Startups in State per $1B Academic R&D Performed[2] | 4 | 5 | | 25 | |
| Total Venture Capital Funding Disbursed[2] | $2.3B | $1.0B | | | 17 |
| Total Venture Capital Funding Disbursed per $1B GDP[2] | $2.97 | $3.41 | | 29 | |
| Venture Capital Deals[2] | 484 | 221 | | | 12 |

Source(s): 1. National Science Foundation, Higher Education Research and Development Survey; 2. National Science Foundation, National Science Board Science and Engineering Indicators; 3. National Science Foundation, Survey of Earned Doctorates; 4. US Census Bureau, Population Estimates Program; 5. Association of University Technology Managers (AUTM) Statistics Access for Technology Transfer Database; TIP Strategies, Inc.
Note(s): States in a "normal range" fall one median absolute deviation from the median of all states. States outside this range are categorized as "high outlier" and "low outlier." AUTM data represent an aggregation of self-reporting by universities in those states.

# R1 and R2 Universities: Georgia

**Figure 25. R1 and R2 Universities: Georgia**
Georgia is home to four R1 institutions and five R2 institutions.




Source(s): **Carnegie Classification of Institutions of Higher Education; Integrated Postsecondary Education Data System; TIP Strategies, Inc.**

# Massachusetts: Defense Engine

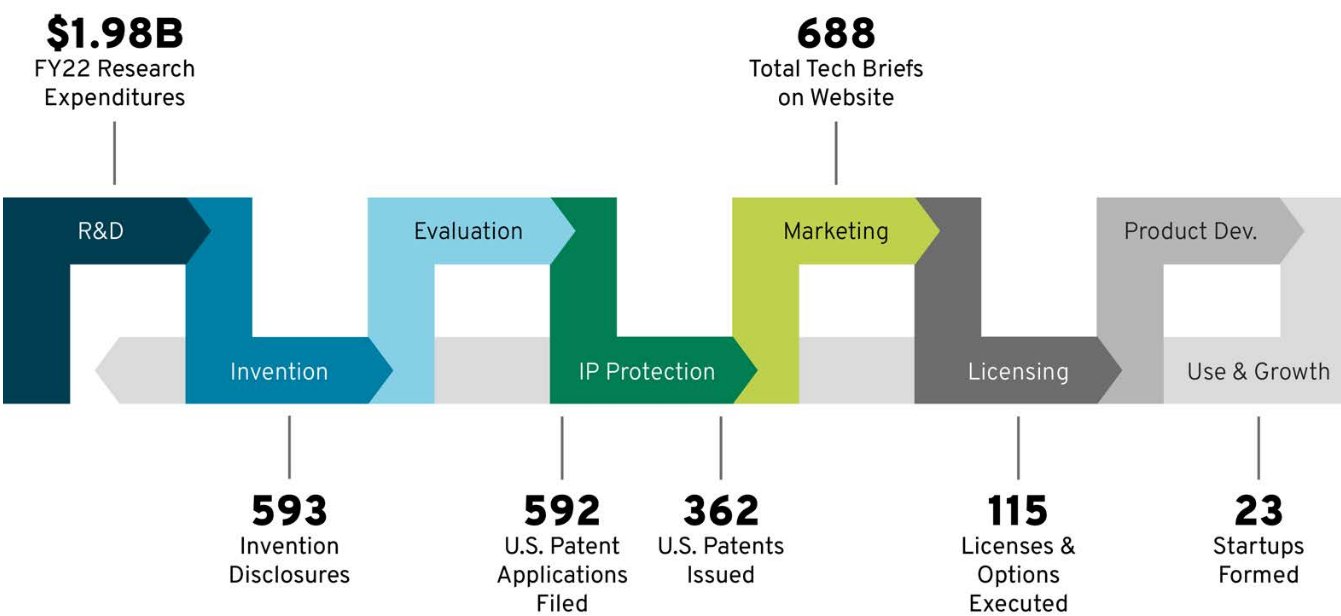
## Takeaways

- While a thriving, regional innovation ecosystem is important, a technology transfer office must actively engage external customers to realize successful technology transfer outcomes.
- A high concentration of STEM, entrepreneurial, and finance talent is key to driving a successful innovation economy.
- Invest in the building blocks necessary to be ready for an influx of federal R&D funding opportunities.

## Technology Transfer at MIT

The Massachusetts Institute of Technology (MIT) is one of the world's leading research institutions, known for its contributions to scientific and technological progress. Founded in 1862, MIT established an official patent policy in 1932 during MIT President Karl Compton's administration. MIT renewed its goal to commercialize university IP in 1985 by hiring Niels Reimers from Stanford's TTO to reorganize the Patent Office into the present Technology Licensing Office (TLO).[10] Reimers developed a model that envisioned technology transfer offices as marketer and matchmaker between research and industry, not solely as a patent office. In Fiscal Year 2023, TLO reported 593 invention disclosures, 362 issued patents, and 23 formed startups (see **Figure 26**).

Figure 26. MIT Fiscal Year 2023 Technology Transfer Lifecycle




Source(s): Massachusetts Institute of Technology, "TLO FY2023 Tech Transfer LifeCycle."

[10]John A. Eberlein, "Technology Transfer at MIT: An Analysis of the Technology Transfer Licensing Office." Unpublished thesis, Massachusetts Institute of Technology, Sloan School of Management, (1989): 46.

Robust research funding gave MIT one of its historically compounding competitive advantages. As a result of dramatically increased wartime spending in the 1940s, R&D funding at universities across the country shifted from majority corporate to federal sponsorship. MIT benefited greatly from the appointment of its Vice President and Dean of Engineering, Vannevar Bush, to lead the nation's scientific defense research. Bush's role allowed MIT to be among the few universities chosen during this immense pivot to a federally sponsored university R&D model. Bush was also a key leader in the development of MIT's first patent policies and industry partnerships and was one of the cofounders of Raytheon. MIT and its various federal research laboratories, including Lincoln Laboratory, received an outsized share of defense and military research spending through the World War II and Cold War eras.[11] At present, MIT spends nearly $1 billion on R&D annually ($989 million in 2022).[12] Though no longer a leading institution by sheer R&D expenditures, MIT alone accounts for about one-fifth of total R&D expenditures in Massachusetts (see Figure 27).

Today, TLO is a component of the Office of Strategic Alliances and Technology Transfer (OSATT), which provides guidance on industry-sponsored research and faculty-industry relations and reports to the Vice Provost and Associate Vice President for Research Administration. TLO has 52 full-time employees, divided into five teams: operations, physical sciences licensing, life sciences licensing, patent administration, and communications and marketing. TLO hires marketing interns with life sciences, physical sciences, or business backgrounds at all degree levels. OSATT's Corporate Relations office runs two programs with which TLO coordinates:

> *A "ready to sign license" reduces staff time spent on non-exclusive licenses for technologies where agreements rarely change.*

- Founded in 1948, the Industrial Liaison Program (ILP) provides a membership pathway for strategic corporate partnership. As opposed to executing research agreements, the ILP allows MIT to prioritize research with industry demand signals.
- The MIT Startup Exchange, a subprogram of ILP, promotes a database of over 1,400 MIT startups (commercializing university IP or otherwise) to over 260 ILP members. ILP program directors manage portfolios of corporate members, which they match to relevant startups.

For software technologies where license agreements rarely change, TLO created "ready to sign licenses" to reduce staff time spent on non-exclusive licenses. Interested licensees can download a prepared license agreement online and submit payment, whereupon the licensee receives the technology after final TLO review.

The Deshpande Center for Technological Innovation, a philanthropic initiative at MIT, provides resources to bridge the gap between applied research and venture capital funding when commercializing university research. The center provides grants to principal investigators for research that addresses market problems, helping grantees explore commercial applications, providing researchers entrepreneurship education, and facilitating industry and venture capital introductions. Grants at varying levels target proof of concept development and commercialization activities to attract follow-on venture capital investment. The center coordinates a volunteer group of business and entrepreneurship mentors, manages student teams designing go-to-market strategies, and hosts innovation related events in the community.

[11] Stuart W. Leslie, "Profit and Loss: The Military and MIT in the Postwar Era." *Historical Studies in the Physical and Biological Sciences* 21, no. 1 (1990): 60.
[12] National Science Foundation, Higher Education Research and Development Survey; TIP Strategies, Inc.

### The Lesson

Though MIT's innovation reputation enjoyed great heights throughout most of the 20th century, its TTO experienced ups and downs as it evolved. MIT's strong innovation ecosystem—which carried the momentum of accelerated scientific and technological progress of the wartime era into a post-war, commercial atmosphere—provided its TTO incredible assets to leverage. The leadership of Compton and Bush advanced MIT's place in the defense research enterprise, as well as founded the first non-family backed venture capital firm, unleashing tremendous capital at a time when innovators at MIT were actively encouraged to commercialize research. Experiencing a lull in outcomes due to narrowing the scope of the technology transfer office to focus more on the patenting process, MIT's innovation status reignited after hiring Reimers from Stanford to prioritize the active marketing of university technologies. The lesson to be learned from MIT's experience is that while a thriving regional innovation ecosystem is important, the university's TTO must be an active agent to realize technology transfer outcomes.

## MIT and the Boston Innovation Ecosystem

MIT's capacity to conduct research and translate it to industry benefited greatly from the interaction of three factors: MIT's positioning as a key national research asset during World War II, its interaction with the early venture capital industry, and university leadership institutionalizing MIT's interactions with entrepreneurs and industry. Specifically, MIT's leaders unlocked the deployment of risk capital for university-affiliated innovators. MIT succeeded in creating one of the first innovation ecosystems by fostering a post-war, entrepreneurial community.

Unlike most other higher education institutions at the time, MIT's institutional values and administration elevated the relationship between academia and industry—even before the major wars of the 20th century. Yet, the surge in federal R&D funding to meet military research needs during World War II certified the practical purpose of research with global relevancy. Within a short but critical period, MIT was charged with leading applied research on behalf of the nation. The federal government infused funding into MIT to create labs to produce wartime applications, and the national wartime research enterprise demanded collaboration between academia, industry, and government to achieve results. After the war, MIT emerged with greater scientific research assets than it had before, as well as a clear understanding of what can be accomplished through focused academic partnerships with industry.

The Boston-area innovators of this era wanted to continue accelerating scientific and technological progress through applied research. In the post-war era, that meant investigating commercial opportunity, though the Cold War would reinvigorate demand for defense research. Vannevar Bush, once the Dean of Engineering at MIT, wrote that "in 1939 millions of people were employed in industries which did not even exist at the close of the last war—radio, air conditioning, rayon and other synthetic fibers, and plastics are examples of the products of these industries" in a famous report requested by President Roosevelt on how to translate wartime scientific breakthroughs to society.[13] This same report proposed the creation of an early version of the National Science Foundation. MIT's leadership strongly believed in the impact that science could continue to make on the national economy.

Karl Compton, while president of MIT, contributed to a regional economic development organization called the New England Council (NEC). The NEC throughout the Great Depression and war years became increasingly interested in the role small businesses could play in strengthening local economies. But financing entrepreneurship and early-stage ventures was difficult from the 1930s until the creation of small business investment companies, as

[13] Vannevar Bush, "Science: The Endless Frontier."

Depression-era New Deal policies constricted the deployment of risk capital.[14] This restrictive policy environment, combined with the technological optimism of the time, resulted in high demand for risk capital. Compton and Bush, with other prominent New England economic and academic leaders, founded the first venture capital firm not backed by family wealth: the American Research and Development Corporation (ARDC). ARDC raised money from mutual funds, insurance firms, and, at first, MIT itself. The firm did not invest in the traditional sense; it took long-term risks and played an active managerial role. ARDC created a technical advisory board composed of MIT and Harvard professors, and MIT-affiliated companies were among its initial investments.

MIT became the one of the first examples of cultivating and attracting the talent needed for an innovation ecosystem. The university had focused on excellence in scientific and technological talent, but it also uniquely embraced industry through strategic partnership and faculty policy. With the addition of risk capital, ARDC created a specialized talent pool for a new financial industry. ARDC launched several successful businesses, sourcing many investments from MIT and concentrating senior entrepreneurs in the area. ARDC's first president, Georges Doriot, was a Harvard business professor who inspired a generation of graduate students to pursue venture capital. Several senior executives from ARDC went on to launch their own venture capital firms in the Boston area and in Silicon Valley. Because of Compton and Bush's vision, faculty participation in the entrepreneurial ecosystem was encouraged by both their leaders' example as well as policy. Faculty members were permitted to consult and to work toward the launch of their own enterprises outside of their regular faculty duties. Part-time entrepreneurship was especially helpful for faculty-initiated companies because they could engage in low-risk business development activities, rather than commit to full-time leave.

These interactions between the university, entrepreneurs, and investors compounded and strengthened each other over time. As new technology companies expanded, they found industrial space along the newly constructed Route 128, mirroring post-war suburban migrations. When Silicon Valley began to outcompete the Route 128 technology business center, MIT-owned real estate in Kendall Square became a redevelopment opportunity to house biotechnology firms. Today, MIT's InnovationHQ collocates the university's student entrepreneurship assets in a coworking and event space within Kendall Square. The hub houses the Deshpande Center, New England I-Corps, and the MIT Venture Mentoring Service (VMS). The VMS partners with I-Corps to serve all MIT-affiliated entrepreneurs with no-cost volunteer mentorship. MIT VMS disseminates the model for their program to universities, economic developers, accelerators, incubators, and other organizations around the world through an outreach training program.[15] MIT has made entrepreneurship a core aspect of its brand to attract students, causing prospective students to increasingly self-select for entrepreneurial ambition.

## The Lesson

The role of MIT administrators in supporting the venture capital industry ultimately transformed their region, the nation, and the world. Uniquely, the Boston-area innovation ecosystem excelled because it was the right institution with the right mission to secure and leverage wartime defense spending on research. Because of the value placed on industry, MIT faculty have always been encouraged to look beyond the ivory tower. This mindset became a competitive advantage when the institution elevated excellence in research as a fundamental goal. MIT's policies help sustain its innovative culture by encouraging faculty and students to capitalize on the commercial opportunities of breakthrough technologies. MIT concentrated senior entrepreneurial and financial talent near their affiliated institution, a talent base that strengthened itself over time.

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[14] Martin Kenney, "How Venture Capital Became a Component of the US National System of Innovation." *Industrial and Corporate Change*, 20, no. 6 (2011): 1685.
[15] Massachusetts Institute of Technology, "Outreach Training Program."

# State Comparison Indicators: Massachusetts

Figure 27. State Comparison Indicators: Massachusetts (MA)

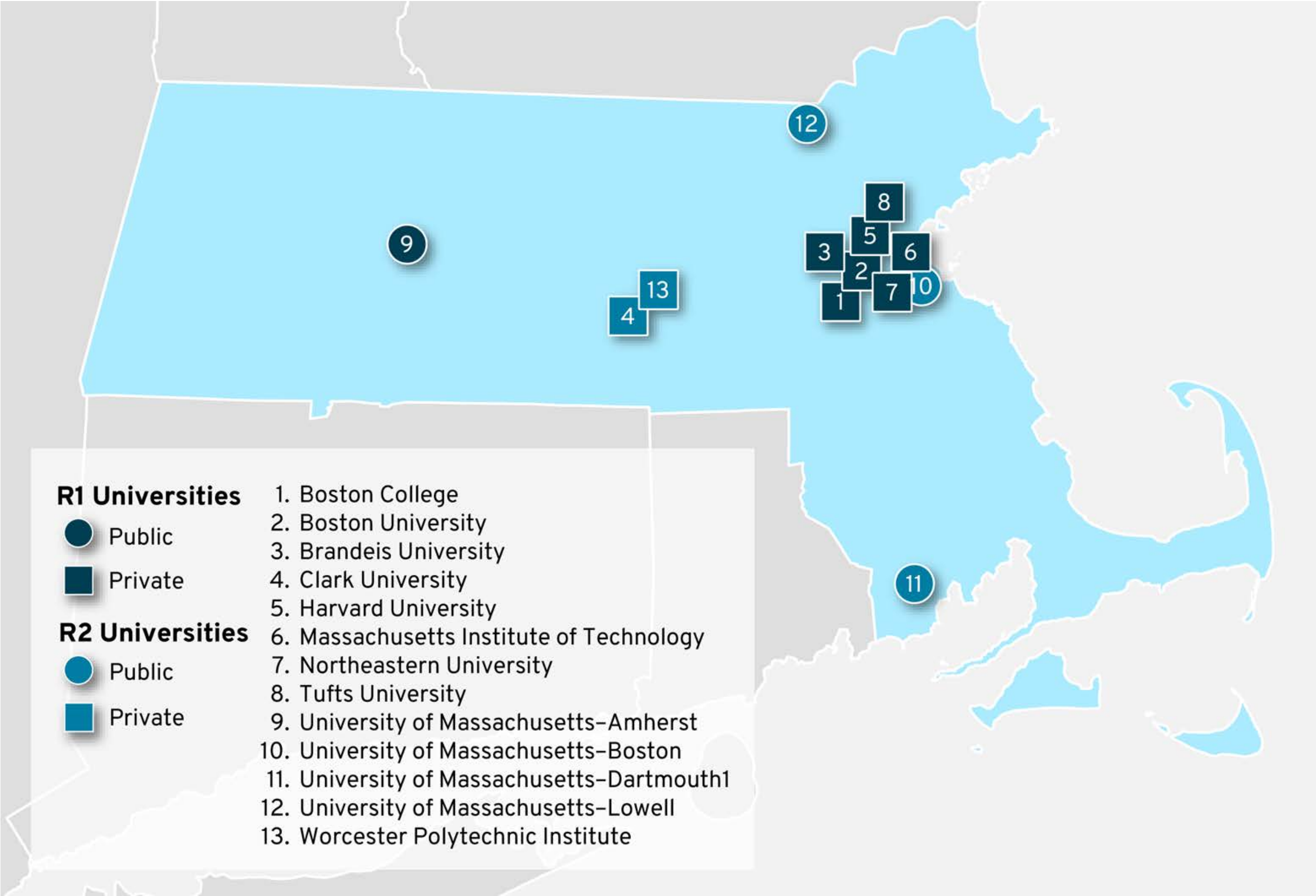
| 2022 INDICATORS | MA | MEDIAN FOR ALL STATES | MASSACHUSETTS'S RANK: LOW OUTLIER | MASSACHUSETTS'S RANK: NORMAL RANGE | MASSACHUSETTS'S RANK: HIGH OUTLIER |
|---|---|---|---|---|---|
| **HIGHER EDUCATION RESEARCH ACTIVITY** | | | | | |
| Higher Education R&D Expenditures[1] | $4.8B | $1.03B | | | 6 |
| Academic R&D per $1THS GDP[2] | $7.04 | $3.82 | | | 2 |
| Research Doctorate Recipients[3] | 3,254 | 686 | | | 4 |
| Research Doctorate Recipients per 1M Residents[3, 4] | 466 | 149 | | | 1 |
| **TECHNOLOGY TRANSFER OUTPUTS AT IN-STATE UNIVERSITIES** | | | | | |
| Disclosures Received[5] | 2,003 | 349 | | | 2 |
| Disclosures Received per $1B Academic R&D Performed[5,1] | 414 | 220 | | | 3 |
| Patent Applications Newly Filed[5] | 1,354 | 197 | | | 2 |
| Patent Applications Newly Filed per $1B Academic R&D Performed[5,1] | 280 | 128 | | | 4 |
| US Patents Issued[5] | 960 | 87 | | | 2 |
| US Patents Issued per $1B Academic R&D Performed[5,1] | 198 | 60 | | | 1 |
| **INNOVATION INVESTMENT IMPACTS** | | | | | |
| Licenses/Options with Income[5] | 1,657 | 258 | | | 2 |
| Licenses/Options with Income per $1B Academic R&D Performed[5,1] | 343 | 164 | | | 8 |
| Gross License Income at In-State Universities[5] | $413M | $13M | | | 2 |
| Gross License Income at In-State Universities per $1B Academic R&D Performed[2] | $85.29 | $10.00 | | | 3 |
| Number of Operational Associated Startups[5] | 603 | 98 | | | 1 |
| Number of Operational Associated Startups per $1M Academic R&D Performed[2] | 125 | 67 | | | 6 |
| Number of Associated Startups in State[5] | 61 | 6 | | | 2 |
| Number of Associated Startups in State per $1B Academic R&D Performed[2] | 13 | 5 | | | 13 |
| Total Venture Capital Funding Disbursed[2] | $22.7B | $1.0B | | | 3 |
| Total Venture Capital Funding Disbursed per $1B GDP[2] | $32.80 | $3.41 | | | 1 |
| Venture Capital Deals[2] | 1,468 | 221 | | | 3 |

Source(s): 1. National Science Foundation, Higher Education Research and Development Survey; 2. National Science Foundation, National Science Board Science and Engineering Indicators; 3. National Science Foundation, Survey of Earned Doctorates; 4. US Census Bureau, Population Estimates Program; 5. Association of University Technology Managers (AUTM) Statistics Access for Technology Transfer Database; TIP Strategies, Inc.

Note(s): States in a "normal range" fall one median absolute deviation from the median of all states. States outside this range are categorized as "high outlier" and "low outlier." AUTM data represent an aggregation of self-reporting by universities in those states.

# R1 and R1 Universities: Massachusetts

**Figure 28. R1 and R2 Universities: Massachusetts**
The state of Massachusetts is home to eight R1 institutions and five R2 institutions. Of the eight R1s, only one is a public institution.




Source(s): **Carnegie Classification of Institutions of Higher Education; Integrated Postsecondary Education Data System; TIP Strategies, Inc.**

# Michigan: State Innovation Networks

### Takeaways

- Interconnected programs allow Michigan's universities to share strengths and pool resources, linking the state's economic development priorities with higher education assets and bolstering the state's economic competitiveness.
- Statewide mentoring networks help retain and concentrate specialized talent in Michigan.
- Michigan Economic Development Corporation's investment strategy is designed to create landing points and connect entrepreneurs with existing assets and services rather than trying to become a provider.

## State Technology Transfer and Commercialization Programs

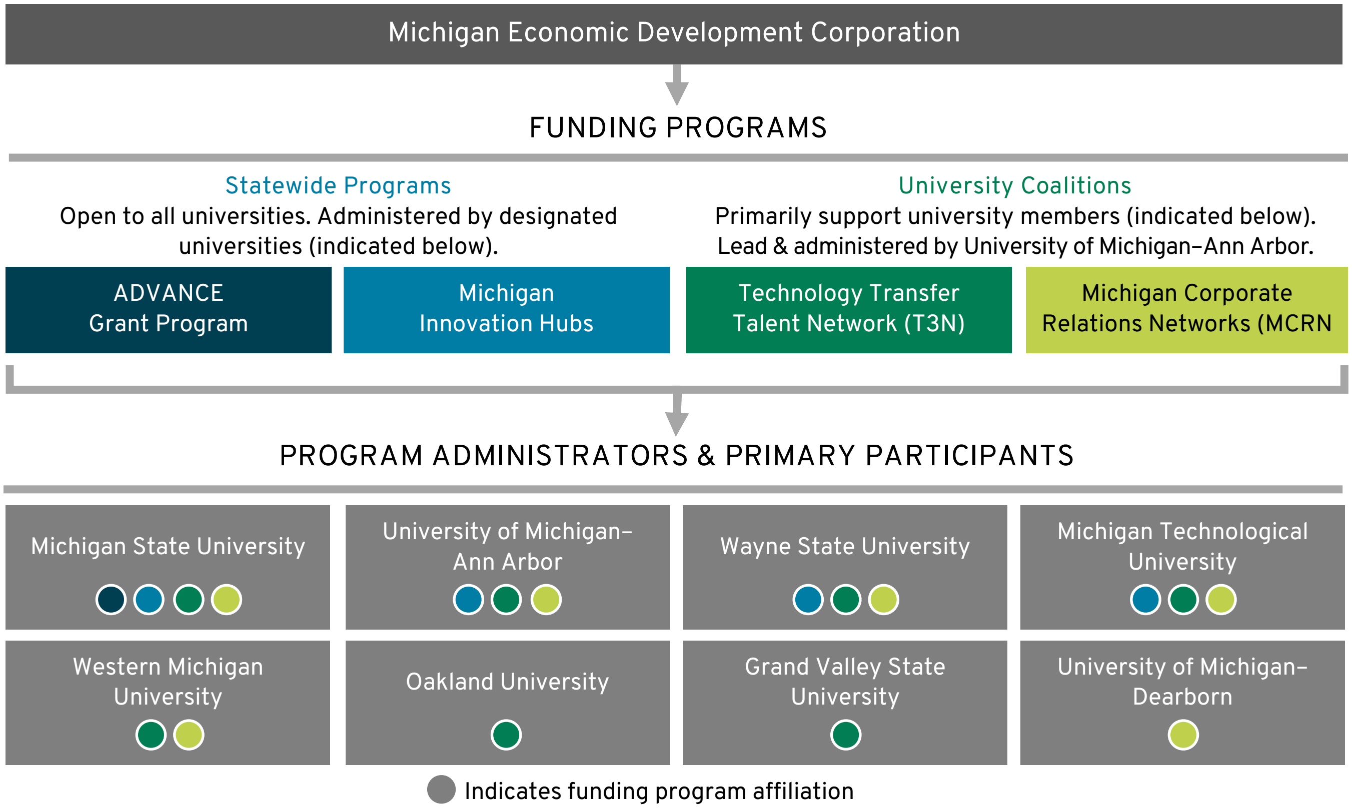
In Michigan, the state agency broadly investing in economic growth and university research commercialization is the Michigan Strategic Fund (MSF). The MSF finances and governs the Michigan Economic Development Corporation's (MEDC) technology transfer and innovation programs. Funded by a state allocation of $14-16 million per year, MEDC's innovation programs interconnect and offer multiple entry points addressing innovator needs. Three programs focus on university innovation, including the ADVANCE Grant Program, the Technology Transfer Network, and Michigan Innovation Hubs program, also known as the Michigan Translational Research and Commercialization Program. The Michigan Corporate Relations Network also supports industry connections to TTOs across the state (see **Figure 29**). These programs fill gaps in funding, mentorship, and support service access at the earliest stages of research commercialization.

### ADVANCE Grant Program

The ADVANCE Grant Program (also known as the University Early-Stage Proof of Concept Fund) is administered by the Michigan State University Innovation Center on behalf of Michigan public universities. The program's goal is to de-risk activities after invention disclosure and incentivize faculty to commercialize their inventions in high-value sectors. University TTOs apply on behalf of faculty, and funds may be used for activities like prototyping, customer discovery, market application research, animal studies, and detailed IP analysis.[16] State funding must be matched dollar-for-dollar by the applicant university. Grant proposals are evaluated against their fulfillment of program objectives, their technical and commercial feasibility, and their ability to advance meaningfully toward commercial outcomes measured by licensing or startup formation. Since 2021, most awards result in a $40,000 combined state and university grant.

[16] Michigan State University Innovation Center, "ADVANCE Grant Proof-of-Concept Fund."

Figure 29. Michigan Economic Development Corporation University Innovation Programs




Source(s): Michigan State University, "ADVANCE Grant Proof of Concept Fund"; Michigan Corporate Relations Network, "What is MCRN?"; Michigan Economic Development Corporation, "University Programs"; University of Michigan at Ann Arbor, "How T3N Helps Make Commercialization at Michigan Universities Possible," January 31, 2023; TIP Strategies, Inc.

## Michigan Innovation Hubs

*Michigan is now home to five innovation hubs accelerating technologies in agricultural biotechnology, life sciences, advanced transportation, advanced materials, and advanced computing.*

The Michigan Innovation Hubs Program, also known as the Michigan Translational Research and Commercialization (MTRAC) program, incentivizes universities to commercialize research, bundle inventions into packages, form university-affiliated startups, encourage their own faculty to commercialize technology, and connect applied research experts at universities to industry leaders. MTRAC is the state grant program that funds Michigan universities to launch and operate designated, sector-specific innovation hubs for up to six years. The state is now home to five innovation hubs accelerating technologies in agricultural biotechnology, life sciences, advanced transportation, advanced materials, and advanced computing. Though designated universities administer specific hubs, researchers from any state research organization may leverage the resources of any hub, provided the hub sector aligns with the given project. This approach allows a researcher working in a key technology area at one university to leverage the technology transfer resources of another university through their hub, facilitating cross-institutional technology transfer collaborations.

## Technology Transfer Talent Network

The University of Michigan at Ann Arbor administers the Technology Transfer Talent Network (T3N), a partnership between seven Michigan universities that provides statewide entrepreneurship mentoring and technology transfer talent support for TTOs. T3N provides four talent programs:

- Mentors-in-residence are seasoned investors and business professionals that support commercialization projects with "sector-specific knowledge, hands on experience, and…extensive networks within designated focus areas including life sciences, physical sciences, automotive/mobility, and digital/software."[17]
- The Technology Assessment Fellows Program trains graduate students in technology assessment to work part-time at TTOs.
- The Technology Transfer Shared Services Program supports universities without TTOs or those lacking sector-specific expertise for a commercialization opportunity.
- A Postdoctoral Commercialization Fellowship is available to provide salary support for postdoctoral researchers commercializing their research.

T3N also holds quarterly roundtables with major and smaller research institutions to share best practices. Since 2014, $10 million invested in T3N has resulted in "175 university startups launched that have created 850+ jobs and attracted over $1.2 billion in follow-on VC and angel investments."[18] The International Economic Development Council recognized T3N for its collaborative partnership in 2020.

## Michigan Corporate Relations Network

The Michigan Corporate Relations Network (MCRN) is another statewide, university-focused program funded by MEDC to advance technology transfer. Though MCRN is not an entrepreneurship program, MCRN complements the T3N as a statewide innovation network supporting TTOs. MCRN is a partnership between the industry engagement centers of six Michigan public research universities. The network administers the online University Experts Portal to help businesses understand and search for research expertise at MCRN universities. MCRN also administers two programs to help small business engagement with partner universities:

- The Small Company Innovation Program/Technology and Commercialization Assistance program provides project matching funds for small businesses collaborating with universities on R&D product development.
- The Small Company Internship Award provides small businesses matching funds for hiring students for 12-week internships or co-op positions.

[17] Tech Transfer Talent Network, "Mentors-in-Residence Program."
[18] University of Michigan at Ann Arbor, "How T3N Helps Make Commercialization at Michigan Universities Possible," January 31, 2023.

### The Lesson

These state-funded, university research commercialization programs provide appropriate incentives through access to funding and expertise to de-risk early university research commercialization activities. Most importantly, these programs interconnect to share each university's strengths and pool informational resources throughout Michigan. As an example, innovation hub grant funding to researchers is paired with a T3N mentor-in-residence. The T3N mentor network itself creates a capture point for new mentors as the Michigan innovation ecosystem develops, retaining and concentrating specialized talent proficient in technology transfer and innovation ecosystems. These programs incentivize universities to better align to their innovation ecosystems and support retention of the technology transfer talent required to evaluate research for its commercial potential. As a result, Michigan university commercialization projects benefit from transparent information and resources for researchers unfamiliar with entrepreneurship. Moreover, these programs are not the only state-funded innovation programs—additional state resources are available further along the commercialization process.

# State Innovation Ecosystem Supports

The other innovation programs administered by MEDC support startup growth after company formation, regardless of university affiliation. Some facilitate regional and statewide entrepreneurship support networks, two provide SBIR/STTR grant related assistance, and one funds nonprofit, pre-seed funds to help formed companies attract angel investments and venture capital.

## Michigan SmartZones

The Michigan SmartZones program provides grants to business incubators and accelerators to support regional entrepreneurship services. SmartZone grant recipients become designated Gateway Representatives for their government service region and track outcomes against state innovation priorities. SmartZones pool public and private innovation ecosystem resources to grow Michigan startups through programs, networking opportunities, consulting services, technical assistance, and SBIR/STTR training and funding matches. Grant amounts vary, though the program has disbursed $31.8 million and leveraged $30.7 million through matching funds since 2011. The 20 SmartZones managed by incubators and accelerators have led to the creation of 1,262 new companies, 9,234 jobs created, and $2.89 billion of new capital received by the companies supported by SmartZones.[19]

## Michigan Small Business Development Center

The Michigan Small Business Development Center (SBDC), a U.S. Small Business Administration-supported initiative, provides free consulting services to all types of small businesses, including startups. The Michigan SBDC is headquartered at Grand Valley State University and operates 11 regional offices and 20 satellite offices. For advanced technology companies, MEDC funds no-cost access to a specialized "Tech Team" of 10 business development consultants at the SBDC. The Tech Team provides sector-specific expertise as well as SBIR/STTR proposal review, investor meeting preparation, business model development, strategic marketing planning, and other financial and business services specific to startup needs. The Michigan SBDC also administers the MEDC-supported Business Accelerator Fund (BAF). BAF grants, available to applicants through their SmartZone, help companies purchase otherwise unavailable technical assistance. Individual awards to companies range between $7,000-$15,000.

[19] Michigan Strategic Fund, "MSF/MEDC Annual Report to the Legislature, FY 2021."

## SBIR/STTR Support

MEDC funds the Michigan SBIR/STTR Assistance Program to provide Michigan-based startups low-cost access to a proposal drafting consultant, BBC Entrepreneurial Training & Consulting LLC (BBCetc). Qualifying companies can pay $500 to access 10 hours of training, one-on-one proposal preparation assistance, BBCetc tools and templates, and reduced rates for additional training sessions. Separate from the SBIR/STTR Assistance Program, MEDC funds SBIR/STTR matching grants through the Michigan Emerging Technologies Fund (ETF). The ETF matches SBIR/STTR Phase 1 awards up to $25,000 and Phase 2 awards up to $125,000. ETF funds must advance technologies in state priority sectors, including automotive, manufacturing, materials, information technology, agricultural processing, energy, homeland security and defense, and life sciences. The ETF has disbursed $7.28 million since 2008.

## State Pre-Seed Fund Support

MEDC funds two nonprofit-managed pre-seed funds to close the gap between company formation and venture capital investment for qualifying companies aligned to state priority industry sectors.

- The First Capital Fund, administered by Invest Detroit, provides up to $150,000 to companies to secure follow-on funding within 12 months.
- The Pre-Seed Fund III, administered by the Michigan State University Research Foundation through Michigan Rise, provides funding between $100,000-$250,000 in addition to mentoring and grant assistance.

MEDC has an open request for proposals (RFP) for a nonprofit organization to administer a third pre-seed fund, the Michigan Innovate Capital Fund Program.[20]

### The Lesson

While these programs support entrepreneurs broadly, they provide important landing pads as technologies transfer out of universities. The university technology transfer support programs inject business acumen and incentives into universities, but these innovation ecosystem programs address company growth through regional and statewide networks. An important theme to MEDC's investment strategy is leveraging existing, high-performing innovation ecosystem assets. This helps entrepreneurs discover and engage with resources through established providers. Given the number of state-supported programs, MEDC's support also helps guide prospective grantees to appropriate resources. For example, MEDC has a blog section dedicated to video tours of each SmartZone facility, an interactive web map, and a holistic resource guide.[21] As a result, MEDC leverages its statewide branding and marketing reach to funnel clients to each program without attempting to become a provider itself.

[20] Michigan Economic Development Corporation, "Michigan Innovate Capital Fund Program."
[21] Michigan Economic Development Corporation, "Michigan SmartZones."

# State Comparison Indicators: Michigan

Figure 30. State Comparison Indicators: Michigan (MI)

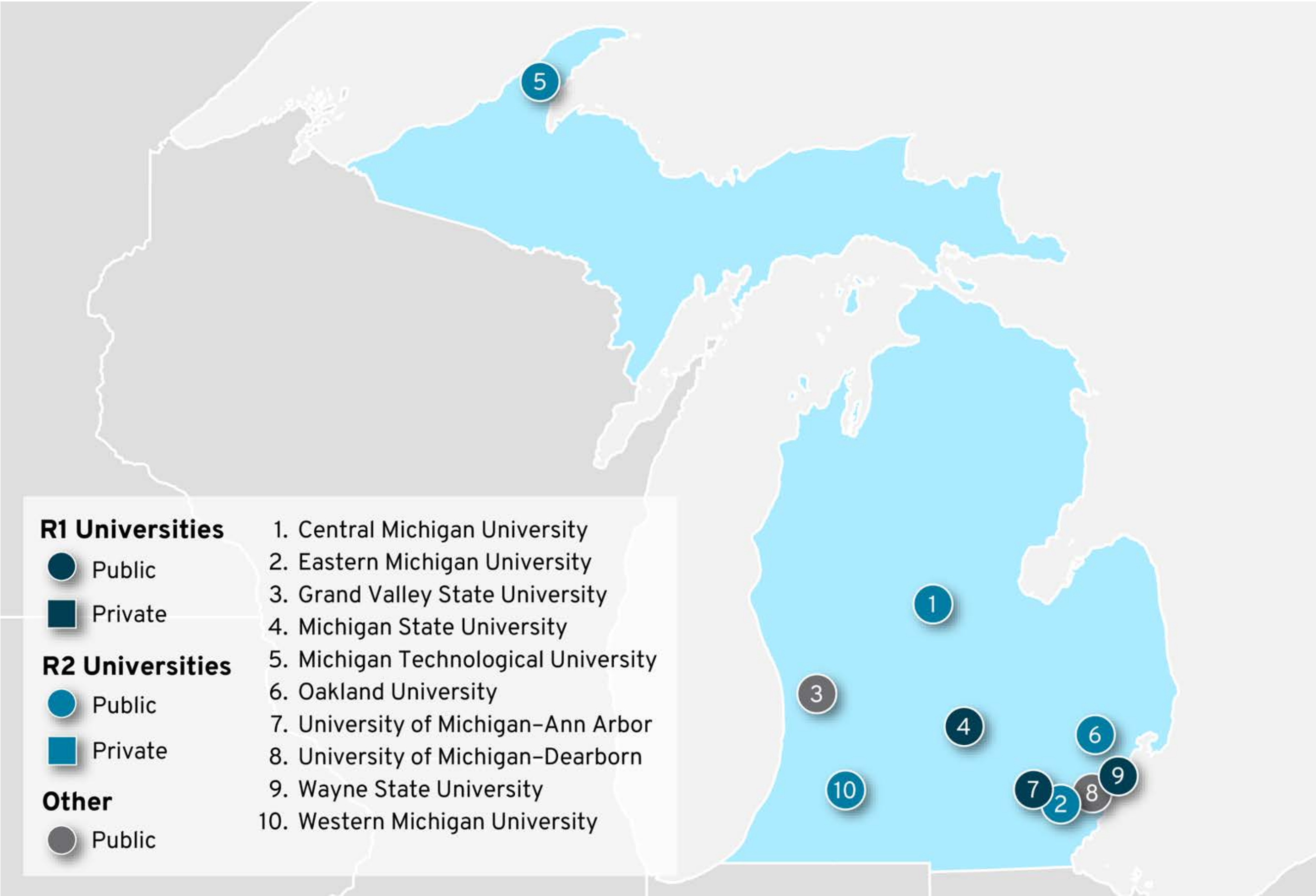
| 2022 INDICATORS | MI | MEDIAN FOR ALL STATES | MICHIGAN'S RANK: LOW OUTLIER | MICHIGAN'S RANK: NORMAL RANGE | MICHIGAN'S RANK: HIGH OUTLIER |
|---|---|---|---|---|---|
| **HIGHER EDUCATION RESEARCH ACTIVITY** | | | | | |
| Higher Education R&D Expenditures[1] | $3.1B | $1.03B | | | **10** |
| Academic R&D per $1THS GDP[2] | $4.97 | $3.82 | | | **10** |
| Research Doctorate Recipients[3] | 1,930 | 686 | | | **9** |
| Research Doctorate Recipients per 1M Residents[3, 4] | 192 | 149 | | | **16** |
| **TECHNOLOGY TRANSFER OUTPUTS AT IN-STATE UNIVERSITIES** | | | | | |
| Disclosures Received[5] | 668 | 349 | | | **12** |
| Disclosures Received per $1B Academic R&D Performed[5,1] | 217 | 220 | | **26** | |
| Patent Applications Newly Filed[5] | 311 | 197 | | **17** | |
| Patent Applications Newly Filed per $1B Academic R&D Performed[5,1] | 101 | 128 | | **31** | |
| US Patents Issued[5] | 223 | 87 | | | **13** |
| US Patents Issued per $1B Academic R&D Performed[5,1] | 72 | 60 | | **14** | |
| **INNOVATION INVESTMENT IMPACTS** | | | | | |
| Licenses/Options with Income[5] | 669 | 258 | | | **13** |
| Licenses/Options with Income per $1B Academic R&D Performed[5,1] | 217 | 164 | | **13** | |
| Gross License Income at In-State Universities[5] | $47M | $13M | | **17** | |
| Gross License Income at In-State Universities per $1B Academic R&D Performed[2] | $7.93 | $10.00 | | **27** | |
| Number of Operational Associated Startups[5] | 311 | 98 | | | **7** |
| Number of Operational Associated Startups per $1M Academic R&D Performed[2] | 101 | 67 | | | **12** |
| Number of Associated Startups in State[5] | 15 | 6 | | | **14** |
| Number of Associated Startups in State per $1B Academic R&D Performed[2] | 5 | 5 | | **23** | |
| Total Venture Capital Funding Disbursed[2] | $1.3B | $1.0B | | **21** | |
| Total Venture Capital Funding Disbursed per $1B GDP[2] | $2.12 | $3.41 | | **36** | |
| Venture Capital Deals[2] | 327 | 221 | | **18** | |

Source(s): 1. National Science Foundation, Higher Education Research and Development Survey; 2. National Science Foundation, National Science Board Science and Engineering Indicators; 3. National Science Foundation, Survey of Earned Doctorates; 4. US Census Bureau, Population Estimates Program; 5. Association of University Technology Managers (AUTM) Statistics Access for Technology Transfer Database; TIP Strategies, Inc.
Note(s): States in a "normal range" fall one median absolute deviation from the median of all states. States outside this range are categorized as "high outlier" and "low outlier." AUTM data represent an aggregation of self-reporting by universities in those states.

# R1 and R1 Universities: Michigan

**Figure 31. R1 and R2 Universities: Michigan**

Michigan is home to three R1 institutions and five R2s, all of which are public institutions.




**Source(s): Carnegie Classification of Institutions of Higher Education; Integrated Postsecondary Education Data System; TIP Strategies, Inc.**

Note(s): The other category includes institutions that do not have R1 nor R2 designation, but that participate in some of Michigan's programs profiled.

# North Carolina: Biotech Powerhouse

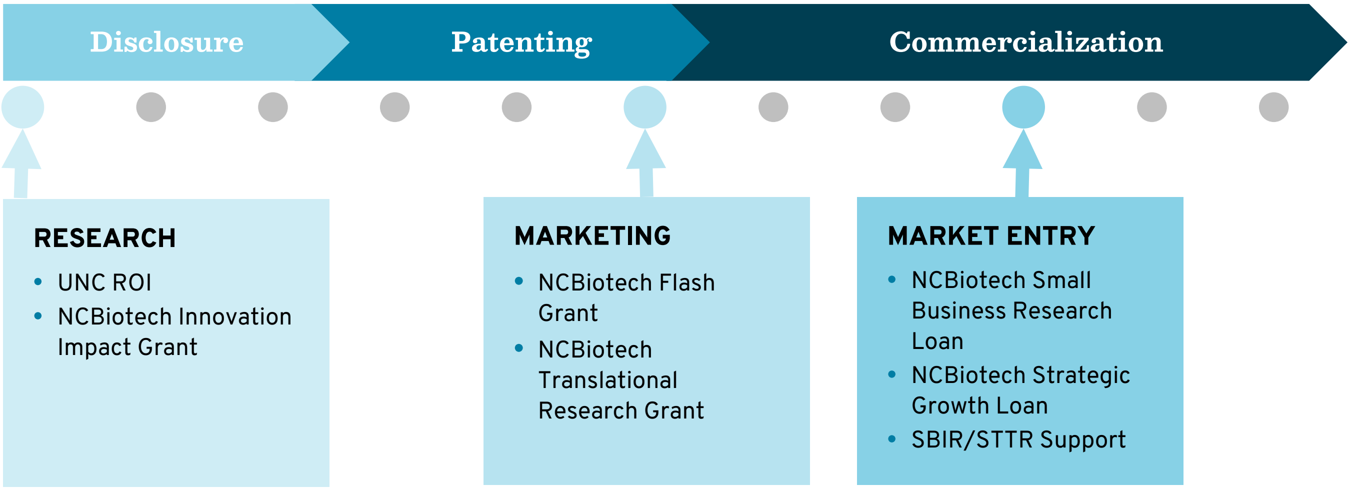
## Takeaways

- Strategic integration of university research commercialization programs with statewide supports focused on a single industry has propelled North Carolina's competitive edge in the life sciences.
- Supporting research that incorporates industry application and cross-sector partnership into the research process primes the eventual technology for commercial success.
- Facing scarce technology transfer supports, interinstitutional partnerships help pool TTO staffing resources.
- Rather than simply increasing R&D appropriations to institutions outside of the Research Triangle, NCInnovation is building a stronger infrastructure and filling gaps to equalize access to innovation resources across the state.

## State Technology Transfer and Commercialization Programs

The North Carolina General Assembly funds several programs through different organizations that support innovative research and facilitate technology transfer, including the North Carolina Biotechnology Center (NCBiotech), the University of North Carolina (UNC) System Research Opportunities Initiative program, and most recently NCInnovation (see **Figure 32**). Innovation and technology transfer activities in North Carolina are typically concentrated in the Research Triangle Park, leveraging the resources of Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University. These three universities account for 87% of R&D expenditures in the state.[22] Recently, the North Carolina General Assembly appropriated a new $500 million endowment for NCInnovation to foster innovation activities outside of the Research Triangle.

Figure 32. North Carolina Programs Visualized Within The Technology Transfer and Commercialization Process




Source(s): The University of North Carolina System, "UNC Research Opportunities Initiative"; North Carolina Biotechnology Center, "University Research Funding"; North Carolina Biotechnology Center, "Life Sciences Start Up Business Funding"; North Carolina Department of Commerce, "One North Carolina Small Business Program"; TIP Strategies, Inc.

[22] NCInnovation, "By the Numbers."

## NCBiotech

In 1984, the state of North Carolina invested in life sciences as a state priority sector by creating the first state-funded biotechnology center, NCBiotech. Dedicated to the growth of the biotech and life sciences industries, NCBiotech supports business recruitment, retention, and expansion activities, in addition to administering university research commercialization support. Program areas include technology transfer and early-stage company support, talent development initiatives and career networking, gap-filling investor and industry connections, office space supporting company growth, and information resources.[23] NCBiotech is strategically located within the Research Triangle Park, with regional offices in Wilmington, Greenville, Winston-Salem, Charlotte, and Asheville. Throughout its history, NCBiotech has distributed 3,206 grants totaling $160 million. NCBiotech also provides loans to early-stage life sciences firms. The revenue generated for the state through active loans is around $77 million—compared to its Fiscal Year 2022 state allocation of $17 million, which is most of NCBiotech's funding. Today, North Carolina ranks third among U.S. states in life sciences industry growth and eighth in life sciences employment.[24]

NCBiotech helps researchers commercialize biotechnology through three grant programs:

- The Flash Grant program provides no more than $20,000 in proof-of-concept development or experimental research funding to advance a project into translational research status.
- The Translational Research Grant program funds research teams with milestone-based project plans by providing up to $100,000 to mature research that show commercial promise. The applicant must identify team roles: the principal investigator; a project manager with product development experience; a TTO representative; an end-user representative who validates the technology's market need; and an optional business case advisor, such as an entrepreneur in residence, who provides industry insight.
- The Innovation Impact Grant funds researchers with up to $150,000 to purchase shared-use, state-of-the-art life sciences facilities and equipment. Innovation Impact Grants require a match from the applicant's institution. Proposals must demonstrate how the purchase provides a competitive advantage to the state's overall life sciences academic enterprise and value proposition for faculty recruitment.

NCBiotech helps biotechnology companies grow at every fundraising stage:

- The **Small Business Research Loan** program provides loans of between $100,000 and $250,000 to companies advancing life sciences or agricultural technology with commercial applications.
- The **Strategic Growth Loan** program provides loans of up to $250,000, which must be matched in equal or greater amount by a venture capital or angel investor. If the matching commitment is greater than $250,000, NCBiotech may award a loan up to $500,000.

Both loan programs require awardees to maintain a significant operating presence in North Carolina. According to a 2022 life sciences industry report for North Carolina, NCBiotech has made loans to 246 companies, of which 126 were in operation and employed a total of roughly 3,800 employees at the time of analysis. The impact of these loans included $5 billion in state economic activity, 12,484 total jobs, and $124 million in state and local tax revenues.[25]

[23] North Carolina Biotechnology Center, "2022 Evidence & Opportunity: Impact of Life Sciences in North Carolina," November 2022, vii.
[24] North Carolina Biotechnology Center, iii.
[25] North Carolina Biotechnology Center, ix.

## SBIR/STTR Supports

Beyond state support for life sciences startups, North Carolina also provides funds aligned with SBIR and STTR grant programs. The state's Department of Commerce manages the One North Carolina Small Business Program, delivering two types of funding: (1) incentives via reimbursement of Phase I proposal costs, and (2) matching grants for Phase I awardees to increase their competitiveness for Phase II applications. Since the program's inception in 2006, it has awarded $35 million in incentives and grants to 434 companies employing over 4,000 people. According to the latest fiscal report to the North Carolina General Assembly, over 70% of companies remain in operation and over 60% of matching-grant recipients advance to Phase II—a figure 6% above the national rate for Phase I awardees. Program awardees attracted over $8 billion in follow-on private and public funding.[26]

## UNC Research Opportunities Initiative

State funding also supports innovative research across additional state priority sectors: advanced manufacturing, data sciences, defense, military and security, energy, marine and coastal science, and pharmacoengineering. UNC Research Opportunities Initiative (UNC ROI) invests in high-impact projects at UNC institutions advancing research in the state's other priority sectors. Projects can be team-based, multi-institutional, and interdisciplinary. Applicants identify how projects will provide the state with a competitive academic advantage, leverage follow-on funding, demonstrate commercial promise, and enhance institutional collaboration. The UNC ROI program invests $1-2 million per award into only a few highly competitive applied research projects. Funding may be used for proof-of-concept development. UNC ROI affirms the state's commitment to priority research areas and amplifies projects likely to impact the North Carolina economy.

## NCInnovation

The North Carolina General Assembly, in its most recent legislative session, approved a new $500 million endowment to support technology transfer and commercialization activities. In 2018, North Carolina business leaders created a nonprofit, NCInnovation (NCI), to address the state's shortcomings on innovation metrics. NCI initially raised $23 million from corporate partners to address gaps, like uneven access to entrepreneurial mentorship and risk capital, across the state and underdeveloped regional partnerships between academia, industry, and government, as well as across institutions. With the state endowment, NCI intends to support regional innovation networks in four initial hubs at East Carolina University, North Carolina A&T, UNC-Charlotte, and Western Carolina University. The legislature charged NCI with choosing universities to foster collaboration in areas "at or below average in comparison to the rest of the State."[27] One of NCI's major goals is to spur rural economic development by supporting technology transfer at universities outside of the Research Triangle in response to population and job loss in parts of the state.

> *In response to population and job loss in parts of the state, one of NCI's major goals is to spur rural economic development by supporting technology transfer at universities outside of the Research Triangle.*

The North Carolina Department of Commerce manages the appropriation for NCI's endowment. State funding for NCI is contingent upon the organization establishing the four networks, completing studies on each network's regional impact, developing a statewide innovation plan, and following budget and performance management

[26] One North Carolina Small Business Program, "Fiscal Year 2023 Report of the Commitment, Disbursement, and Use of Funds."
[27] General Assembly of North Carolina 2023-2024 Regular Session, "Current Operations Appropriations Act of 2023," 339.

plans. NCI must also secure $25 million in corporate funding commitments within the next four years and reorganize its board as a 13-member body, including four appointees from each legislative chamber leader. Chancellors and presidents from leading institutions serve on an advisory committee. The endowment will fund proof of concept grants to researchers and other technology transfer supports, such as industry mentorship and legal services. NCI will require grantees to locate most of their employees and leadership in the state and enforce claw-back provisions for noncompliance. NCI plans to enter grantmaking in 2024.

# Research Triangle Park

The Research Triangle Park (RTP) is the largest research park in the country, connecting talent from Duke University, North Carolina State University (NCSU), and the University of North Carolina at Chapel Hill (UNC) with industry. Founded after Stanford's research park, RTP today spans 7,000 acres across Durham and Wake Counties and is home to over 60,000 employees working at more than 375 companies. RTP was originally conceived in the 1950s as a state economic development strategy. State government, industry, and university leaders co-created a nonprofit, the Research Triangle Foundation, to fundraise capital, purchase undeveloped land, and recruit the R&D branches of corporations. Over the decades since, RTP became a state asset for technology transfer and innovation ecosystem supports, including early-stage company grants and loans.

Like peer ecosystems at Stanford and in Boston, one of the main goals of RTP was to retain university graduates. North Carolina ranked among the lowest states in per capita income with an overdependence on the tobacco, textiles, and furniture industries. Graduates of North Carolina's leading science and engineering programs had no job prospects in-state. Governor Luther Hodges convened a committee of business and university leaders to determine how to diversify North Carolina's economy by employing high-skill talent. As a result, the committee designed RTP as an economic initiative serving the state of North Carolina via its strongest universities, in contrast to other organically developed research parks. A master-planned effort, RTP targeted R&D branches of firms recruited from out of state, as opposed to fostering student and faculty spin-outs.

> *Research Triangle Park began as a solution to improve the state's economy by stopping the leakage of STEM graduates.*

The creation of a nonprofit to manage the effort enabled the park's conceptual success. The universities could support RTP without concerns about diverting from knowledge-creating missions to serve industrial ends. The government could de-risk private investment with commitments to support infrastructure serving the universities, without direct subsidy. RTP supported its first tenant, a nonprofit contract research organization called the Research Triangle Institute, through a $500,000 and 157-acre donation.[28] RTP grew slowly until IBM's 1965 site purchase, which radically improved the park's renown. By the end of the 1970s, 38 firms located their R&D facilities in the RTP, including federal government laboratories. In 1984, the state legislature created a special district preventing city annexation of the park, reducing companies' taxes.[29]

Zoning requirements and the land-development pattern of RTP favored park creators' intended clientele–the R&D branches of large firms that valued independent research facilities. The concentration of R&D industry activity increased the visibility and capacity of the universities, positively influencing faculty recruitment.

[28] Michael I. Luger and Harvey A. Goldstein, *Technology in the Garden*. University of North Carolina Press. 1991. 78.
[29] Luger and Goldstein, 82.

Compared to Stanford Research Park or Route 128, RTP did not value capturing spinoff companies from either the university or larger firms until recent years.

The park as originally created did not reduce universities' technology transfer challenges, but it did lay foundations for additional solutions by facilitating collaboration between the three universities. Each of the Triangle universities created their technology transfer offices in the mid-1980s, but resources constrained TTO hiring to one full-time individual at each university. A report commissioned by the UNC system in 1984 identified barriers to commercialization within the Triangle universities. These barriers included "a lack of effective marketing resources or capabilities within the institutions, an absence of… relationships between academic researchers and industry…, an absence of a clear link to the missions of the universities, and no incentives for faculty participation."[30] While TTO officers could manage IP administration, the TTOs lacked industry, marketing, and licensing resources to carry commercialization agreements to fruition.

Duke, NCSU, and UNC created the Triangle University Licensing Consortium (TULCO) in 1986 to expand their respective technology transfer marketing and licensing capabilities. Hiring three licensing staff, TULCO leveraged funds from the Triangle Universities Center for Advanced Studies, a nonprofit created by the Research Triangle Foundation to anchor the universities' presence and collaboration within the park. TULCO staff split their time between developing industry and academic relationships, including educational seminars for faculty. Each university retained its respective patent rights and IP policies. Triangle TTOs kept their staff to manage IP and research agreement administration, signal the institutions' commercialization commitments, and maintain faculty relationships.

Over its eight-year lifetime, TULCO improved the visibility of technology transfer within each university. By the 1990s, TULCO maintained contacts with over 700 businesses, including an extensive international network. Supporting licensing strategies specific to three different universities, however, became increasingly untenable for TULCO without additional resources. Differences between the public and private universities, research areas, and institutional culture were challenges throughout TULCO's lifetime, but became impediments to growth in later years. The universities gradually exited the consortium in the late 1990s to staff internal, full-service TTOs accommodating each university's respective needs and priorities. Yet, TULCO successfully provided a short-term staffing solution that fostered entrepreneurial cultures at the Triangle universities. TULCO positively influenced technology transfer successes even after its dissolution by kickstarting previously impossible licensing activities.

## The Lesson

The evolution of the Research Triangle Park demonstrates the influence of state government on innovation ecosystems as drivers of innovation change over time. RTP's greatest success lies in reversing the state's downward economic trend by increasing high-tech employment. RTP catered to large-firm recruitment as part of a strategic economic development initiative, but on its own did not spur technology transfer across the state. Rather, RTP as a multiuniversity asset created foundations for technology transfer partnerships and innovation programs to ignite economic growth in competitive industries. The development of an entrepreneurship-based innovation ecosystem, throughout RTP's lifetime, has been constrained by the comparative lack of risk capital compared to leading venture capital communities. The park was also not designed as a collegial environment encouraging cross-pollination of ideas, talent, and entrepreneurial resources between organizations. As such, state funding efforts must carefully consider the incentives and patterns driving today's growth in innovation ecosystems and the additional efforts that were required to activate RTP's technology transfer potential.

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[30] Lisa. A Goble, "Evaluating The Influence of University Organizational Characteristics And Attributes on Technology Commercialization." Unpublished dissertation, UNC Chapel Hill, Department of Public Policy, (2013): 87-88.

# State Comparison Indicators: North Carolina

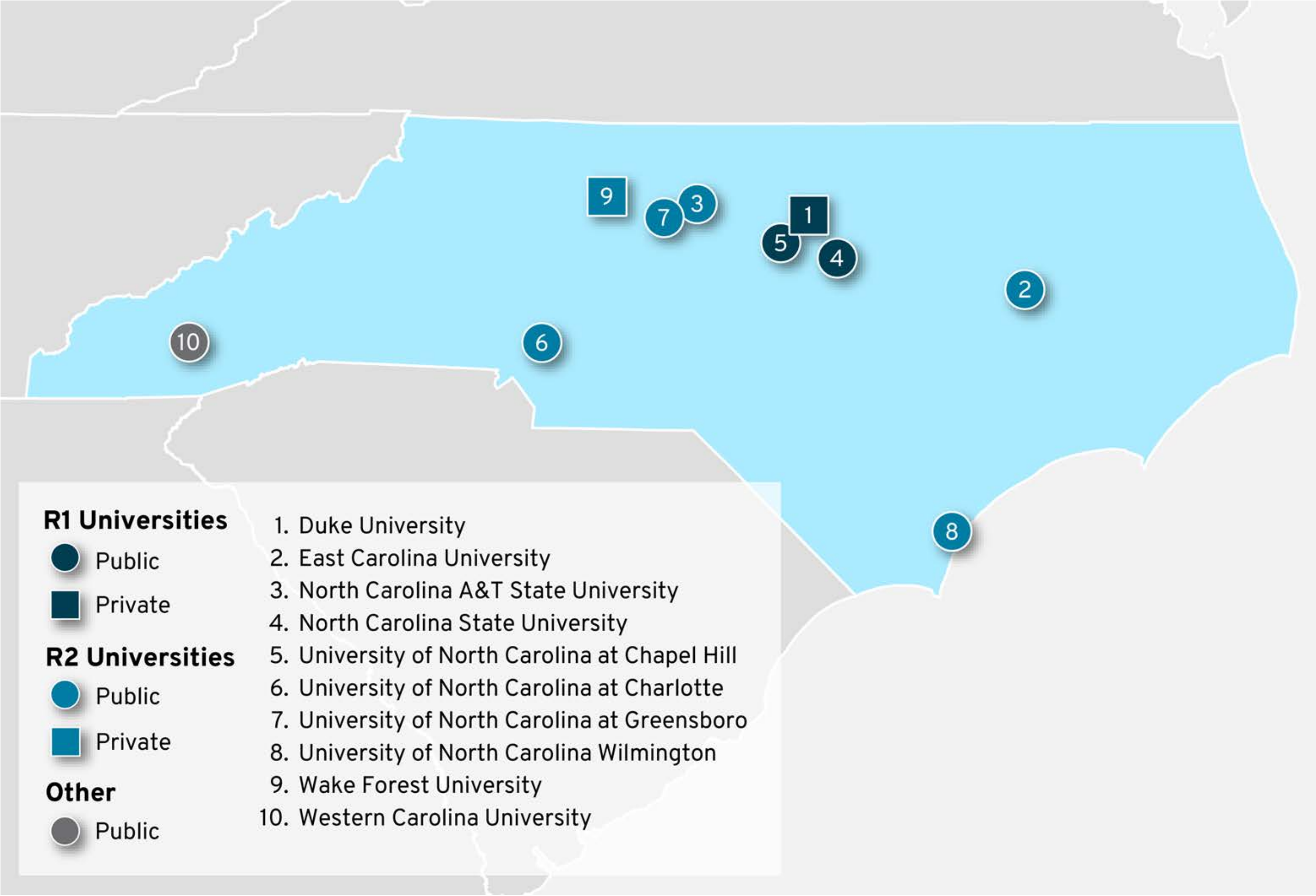
Figure 33. State Comparison Indicators: North Carolina (NC)

| 2022 INDICATORS | NC | MEDIAN FOR ALL STATES | NORTH CAROLINA'S RANK: LOW OUTLIER | NORTH CAROLINA'S RANK: NORMAL RANGE | NORTH CAROLINA'S RANK: HIGH OUTLIER |
|---|---|---|---|---|---|
| **HIGHER EDUCATION RESEARCH ACTIVITY** | | | | | |
| Higher Education R&D Expenditures[1] | $3.9B | $1.03B | | | 7 |
| Academic R&D per $1THS GDP[2] | $5.30 | $3.82 | | | 6 |
| Research Doctorate Recipients[3] | 1,866 | 686 | | | 10 |
| Research Doctorate Recipients per 1M Residents[3, 4] | 174 | 149 | | 19 | |
| **TECHNOLOGY TRANSFER OUTPUTS AT IN-STATE UNIVERSITIES** | | | | | |
| Disclosures Received[5] | 782 | 349 | | | 9 |
| Disclosures Received per $1B Academic R&D Performed[5,1] | 202 | 220 | | 29 | |
| Patent Applications Newly Filed[5] | 402 | 197 | | | 12 |
| Patent Applications Newly Filed per $1B Academic R&D Performed[5,1] | 104 | 128 | | 30 | |
| US Patents Issued[5] | 266 | 87 | | | 9 |
| US Patents Issued per $1B Academic R&D Performed[5,1] | 69 | 60 | | 17 | |
| **INNOVATION INVESTMENT IMPACTS** | | | | | |
| Licenses/Options with Income[5] | 555 | 258 | | | 17 |
| Licenses/Options with Income per $1B Academic R&D Performed[5,1] | 143 | 164 | | 26 | |
| Gross License Income at In-State Universities[5] | $116M | $13M | | | 8 |
| Gross License Income at In-State Universities per $1B Academic R&D Performed[2] | $30.01 | $10.00 | | | 8 |
| Number of Operational Associated Startups[5] | 417 | 98 | | | 5 |
| Number of Operational Associated Startups per $1M Academic R&D Performed[2] | 108 | 67 | | | 9 |
| Number of Associated Startups in State[5] | 30 | 6 | | | 6 |
| Number of Associated Startups in State per $1B Academic R&D Performed[2] | 8 | 5 | | | 12 |
| Total Venture Capital Funding Disbursed[2] | $4.9B | $1.0B | | | 10 |
| Total Venture Capital Funding Disbursed per $1B GDP[2] | $6.89 | $3.41 | | | 12 |
| Venture Capital Deals[2] | 536 | 221 | | | 11 |

Source(s): 1. National Science Foundation, Higher Education Research and Development Survey; 2. National Science Foundation, National Science Board Science and Engineering Indicators; 3. National Science Foundation, Survey of Earned Doctorates; 4. US Census Bureau, Population Estimates Program; 5. Association of University Technology Managers (AUTM) Statistics Access for Technology Transfer Database; TIP Strategies, Inc.
Note(s): States in a "normal range" fall one median absolute deviation from the median of all states. States outside this range are categorized as "high outlier" and "low outlier." AUTM data represent an aggregation of self-reporting by universities in those states.

# R1 and R2 Universities: North Carolina

**Figure 34. R1 and R2 Universities: North Carolina**
North Carolina is home to three R1s and six R2 institutions of higher education.




**Source(s): Carnegie Classification of Institutions of Higher Education; Integrated Postsecondary Education Data System; TIP Strategies, Inc.**
Note(s): The other category includes institutions that do not have R1 nor R2 designation, but that participate in some of North Carolina's programs profiled.

# Ohio: Venture Capital Recruitment

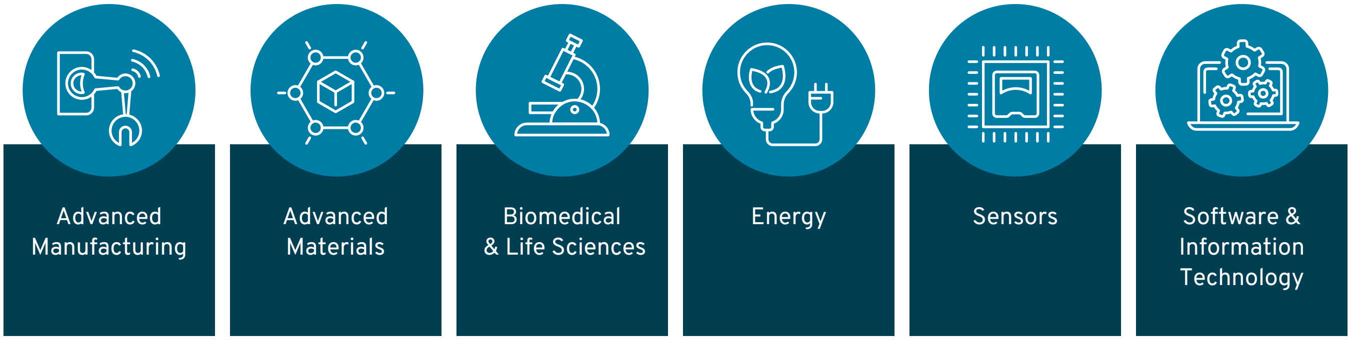
## Takeaways

- Ohio's competitive advantage relies on its creativity to strengthen the risk capital landscape in an attempt to attract and retain innovative startups in the state.
- By incentivizing the licensing of intellectual property with grant funding, Ohio facilitates the transition of technology from Ohio research institutions to the marketplace.

## Ohio Third Frontier Programs

The Ohio Third Frontier (OTF) initiative, created in 2002, comprises state programs supporting university technology transfer, entrepreneurial ecosystems, and Ohio-based venture capital firms. Most OTF programs receive state funding through the OTF Commission, an 11-member body of state government, research, and business leader appointees. The commission allocates state revenue appropriated by the Ohio General Assembly toward OTF programs administered by the Ohio Department of Development. Profiled programs include the Ohio Entrepreneurial Services Provider Program, the Third Frontier Technology Validation and Startup Fund, the Pre-Seed/Seed Plus Fund Capitalization Program, and the Ohio Capital Fund. In the initiative's 20-year plus history, Ohio voters authorized state funding for OTF multiple times. OTF supports innovation in the advanced manufacturing, advanced materials, biomedical and life sciences, energy, sensor, and software and information technology industries, though individual programs may emphasize certain sectors (see **Figure 35**).

Figure 35. Ohio Third Frontier Priority Industries




Source(s): Ohio Department of Development, "Ohio Third Frontier Technology Validation and Start-up Fund: Phase 1 – Technology Validation"; TIP Strategies, Inc.

### Entrepreneurial Services Provider Program

The Entrepreneurial Services Provider (ESP) Program awards grant funding to existing startup incubators and accelerators to serve as regional entrepreneurial hubs. ESP grants are awarded on a regional basis, dividing the state of Ohio into six subgeographies. ESP awardees commit to supporting early-stage startup companies by improving access to entrepreneurial talent, venture capital, specialized services, mentors, and customers. To receive funding, providers must cost share dollar-for-dollar with the state investment, though 25% of the providers' cost share may include donated services. Providers must commit to supporting only Ohio-based startups or startups committed to relocating to Ohio, as well as administering university and high school level entrepreneurial workforce development programs. The state considers improving the maturity of Ohio's startups, regardless of university affiliation, as a strategy to improve Ohio's competitiveness within target industry sectors and attract venture capital to Ohio. Ohio's five ESP providers are Jumpstart, CincyTech, Rev1Ventures, TechGROWTH Ohio, and Entrepreneurs' Center, which support 4,261 jobs.[31]

As an example, TechGROWTH Ohio (TGO) is based at Ohio University and serves a rural, 19-county region in southeastern Ohio. TGO is a public-private partnership between OTF, the Ohio University Voinovich School of Leadership and Public Affairs, and the private investment community. TGO organized three angel investor funds, created an entrepreneur-in-residence (EIR) team, and built relationships with funds.[32] TGO fosters an entrepreneurial talent network by providing access to one-on-one mentoring from EIRs, venture development courses, startup networking events, and shared services. With OTF and Ohio University financial support, TGO administers the TechGROWTH Ohio Fund, a pre-seed and seed-stage venture fund. TGO also provides deal flow for the Ohio Innovation Fund, an Ohio University- and Ohio State University-sponsored fund supporting startups across the ESP network. Both funds have invested $67 million, creating an estimated $1 billion in related economic activity and 854 jobs with an average salary of $50,000 since 2007. In the past five years, TGO clients have received over $315 million in services, as well as seed and angel funding.[33]

## Technology Validation and Start-up Fund

As part of the OTF statewide innovation ecosystem, the Technology Validation and Start-up Fund (TVSF) helps transition technology from Ohio research institutions into the marketplace. Ohio research institutions with technology transfer offices can apply to the Phase I grant program, while startups can apply to the Phase II grant program. As part of the programs' competitive RFP processes, the Ohio Development Department favors applications that demonstrate collaborations with other OTF programs.

Phase I grants help TTOs conduct due diligence for unlicensed university technologies to identify potential customers. Phase I grants may be requested in the amounts of $100,000, between $200,000-$500,000, and $1 million, where dollar-for-dollar cost share requirements exist for awards above $100,000. TVSF grants may fund staff, specialized services, and equipment related to university research commercialization activities, such as prototyping and technical testing. As part of the grant application, TTOs submit proposals and identify members of a project-selection committee, which decides the allocation of TVSF grant funding to specific technology transfer projects within the TTO's institution. Committees must have representation from external partners, including at least one local ESP and one venture capital representative. For TVSF-funded projects, the TTO must have already disclosed the technology to the U.S. Patent and Trademark Office (USPTO).

Phase II grants help startups license technologies from IP owned by universities or research organizations. The goal of the program is to commercialize technology through startups that have identified a plan to achieve follow-on funding. As part of the proposal process, prospective applicants must meet with their local ESP to discuss their proposal. Proposals must also demonstrate how the commercialization of the technology will benefit the state of Ohio. Funding may be awarded in amounts up to $200,000. Eligible use of funds includes purchasing services, supplies, and equipment, and up to 20% of the budget may be used to pay staff.

[31] Ohio Department of Development, "FY2023 Annual Report."
[32] G. Jason Jolley, Ikenna Uzuegbunam, John Glazer, "TechGROWTH Ohio: Public Venture Capital and Rural Entrepreneurship." *Journal of Regional Analysis and Policy* 48, no. 2, (July 2017): 17.
[33] TechGROWTH Ohio, "Impact (graphic)."

## Pre-Seed/Seed Plus Fund Capitalization Program

Other OTF programs focus on improving the risk capital landscape in Ohio. The Pre-Seed/Seed Plus Fund Capitalization Program (PFCP) supports Ohio-based venture funds with state loans. The program prioritizes supporting venture funds that invest in biomedical and software companies. On a secondary basis, the program also supports venture funds that invest in companies within the advanced materials, aero propulsion, fuel cells, sensors, and automation industries. If loans are used for company investments, the investment money must go to Ohio-based companies. Pre-seed loans may additionally use funds for conducting due diligence, providing management services for companies, or paying fund management expenses. Seed Plus loans may additionally be used to support due diligence and fund management activities. Both types of loans require cost sharing: Pre-seed loans must cost share dollar-for-dollar, while Seed Plus loans must cost share $3 to each loan dollar. Eleven venture funds participate in the PFCP network.

## Ohio Capital Fund

In 2003, the Ohio General Assembly instituted Chapter 150 of the state code (the "Ohio VC Statue") to increase the amount of venture capital (VC) in Ohio, supporting startup innovation as a driver of the state's economic competitiveness. Chapter 150 created the Ohio Venture Capital Authority (OVCA) as the state authority to administer and create a fund of funds, the Ohio Capital Fund (OCF), attracting venture capital to Ohio.[34] Through an RFP process, OVCA contracted a private fund manager, Buckeye Venture Partners LLC, to manage the OCF.[35] The OCF raises money through state-backed bonds, whereby if the fund cannot meet loan repayments, lenders receive state tax credits. The OCF may commit up to $10 million to any individual fund. The OCF must invest 75% of its funding in Ohio-based VC funds, while the remainder may be invested in VC funds outside Ohio. Meanwhile, all funds receiving OCF investments must use at least half of those investments to fund Ohio-based startups.

In practice, OCF and its portfolio of investments ("underlying funds") exceed these requirements with 88% of OCF capital committed to Ohio-based underlying funds. OCF's portfolio of funds has exceeded the investment requirement to fund Ohio-based companies by a factor of 5.5. As of 2023, the OCF has committed $140 million to underlying funds, which have invested $341 million into 107 Ohio-based startups. When accounting for co-investor funding, total private investment in these companies totals $1.41 billion, multiplying the OCF's investment by a factor of 10.

### The Lesson

Compared to other state innovation policies, Ohio places the greatest emphasis on increasing private investment available to Ohio-based startups—especially at the earliest stages of venture development. The Entrepreneurial Services Provider network (ESP), the Pre-Seed/Seed Plus Fund Capitalization program (PFCP), and the Ohio Capital Fund (OCF) each increase the amount of risk capital in Ohio. While the ESP helps startup founders prepare to pitch to venture capitalists, the PFCP provides loans for Ohio-based fundraising, and the OCF encourages venture capital firms to expand in Ohio. The Tech Validation/Startup Fund creates incentive-based linkages between technology transfer offices and the broader Ohio innovation ecosystem. Ohio's strength lies in its creativity to strengthen the risk capital landscape in the state and maximize the state's return on investment.

[34] Ohio Revised Code, "Chapter 150 - Venture Capital Program."
[35] Ohio Capital Fund, "Background."

# State Comparison Indicators: Ohio

Figure 36. State Comparison Indicators: Ohio (OH)

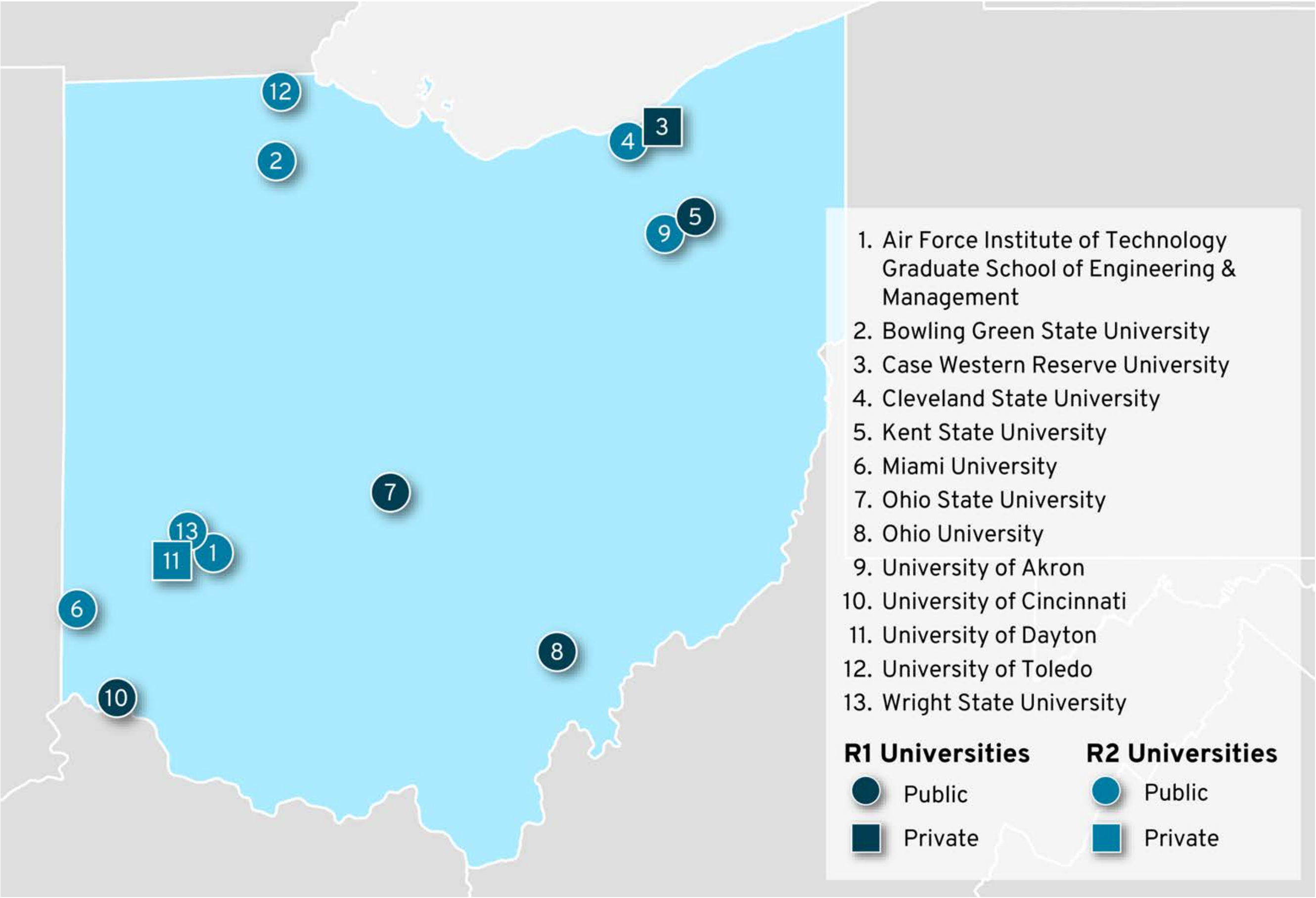
| 2022 INDICATORS | OH | MEDIAN FOR ALL STATES | OHIO'S RANK: LOW OUTLIER | OHIO'S RANK: NORMAL RANGE | OHIO'S RANK: HIGH OUTLIER |
|---|---|---|---|---|---|
| **HIGHER EDUCATION RESEARCH ACTIVITY** | | | | | |
| Higher Education R&D Expenditures[1] | $3.1B | $1.03B | | | 11 |
| Academic R&D per $1THS GDP[2] | $3.75 | $3.82 | | 26 | |
| Research Doctorate Recipients[3] | 1,935 | 686 | | | 8 |
| Research Doctorate Recipients per 1M Residents[3, 4] | 165 | 149 | | 22 | |
| **TECHNOLOGY TRANSFER OUTPUTS AT IN-STATE UNIVERSITIES** | | | | | |
| Disclosures Received[5] | 1,331 | 349 | | | 5 |
| Disclosures Received per $1B Academic R&D Performed[5,1] | 432 | 220 | | | 2 |
| Patent Applications Newly Filed[5] | 681 | 197 | | | 7 |
| Patent Applications Newly Filed per $1B Academic R&D Performed[5,1] | 221 | 128 | | | 9 |
| US Patents Issued[5] | 374 | 87 | | | 4 |
| US Patents Issued per $1B Academic R&D Performed[5,1] | 121 | 60 | | | 4 |
| **INNOVATION INVESTMENT IMPACTS** | | | | | |
| Licenses/Options with Income[5] | 570 | 258 | | | 16 |
| Licenses/Options with Income per $1B Academic R&D Performed[5,1] | 185 | 164 | | 20 | |
| Gross License Income at In-State Universities[5] | $65M | $13M | | | 12 |
| Gross License Income at In-State Universities per $1B Academic R&D Performed[2] | $21.26 | $10.00 | | | 13 |
| Number of Operational Associated Startups[5] | 231 | 98 | | | 10 |
| Number of Operational Associated Startups per $1M Academic R&D Performed[2] | 75 | 67 | | 17 | |
| Number of Associated Startups in State[5] | 24 | 6 | | | 9 |
| Number of Associated Startups in State per $1B Academic R&D Performed[2] | 8 | 5 | | | 8 |
| Total Venture Capital Funding Disbursed[2] | $3.6B | $1.0B | | | 11 |
| Total Venture Capital Funding Disbursed per $1B GDP[2] | $4.32 | $3.41 | | 22 | |
| Venture Capital Deals[2] | 366 | 221 | | 16 | |

Source(s): 1. National Science Foundation, Higher Education Research and Development Survey; 2. National Science Foundation, National Science Board Science and Engineering Indicators; 3. National Science Foundation, Survey of Earned Doctorates; 4. US Census Bureau, Population Estimates Program; 5. Association of University Technology Managers (AUTM) Statistics Access for Technology Transfer Database; TIP Strategies, Inc.

Note(s): States in a "normal range" fall one median absolute deviation from the median of all states. States outside this range are categorized as "high outlier" and "low outlier." AUTM data represent an aggregation of self-reporting by universities in those states.

# R1 and R2 Universities: Ohio

**Figure 37. R1 and R2 Universities: Ohio**
Ohio is home to five R1s and eight R2 institutions of higher education.




Source(s): **Carnegie Classification of Institutions of Higher Education; Integrated Postsecondary Education Data System; TIP Strategies, Inc.**

# Amplifying the Impact

# The Future of Higher Education in Texas' Innovation Economy

The path forward is clear. The strategies in *From Insights to Impact: Fostering Innovation Through Texas Higher Education* will strengthen higher education's role in shaping the future of Texas' innovation economy.

State leaders have made significant commitments to accelerate research and innovation opportunities across Texas. During the 88th Texas Legislature, lawmakers made sizable investments: $400 million to increase community college financing with a focus on credentials of value in high-demand fields, a nearly $4 billion endowment to expand research activities at qualifying universities, and nearly $700 million to invest in university facilities for semiconductor research. State funding will also be essential to ensure all colleges and universities have resources for commercialization efforts, strengthening the link between academic research and economic impact.

*To realize the state's full potential, leaders at both the state and institutional levels will need to accelerate progress and commit to strengthening Texas' innovation ecosystem.*

Coupled with the state's steady investments, a renewed focus on Texas higher education's contribution to the state's global competitiveness sets the stage for a bright future. There are many opportunities ahead for the Texas innovation economy. With additional details on implementation steps in this *Technical Appendix*, Texas higher education can strengthen its role as a global leader in innovation and commercialization of research. To realize the state's full potential, leaders at both the state and institutional levels will need to accelerate progress and commit to strengthening Texas' innovation ecosystem.

*As key sources of invention, colleges and universities generate knowledge, spur innovation, drive technology, and foster entrepreneurship, making them engines of the economy.*

State leaders can amplify the importance of supporting technology transfer and communicating its benefits to the future of Texas' innovation economy. In addition, increased resources for commercialization efforts within higher education will be required to take the state's R&D infrastructure into the future. The Coordinating Board is dedicated to serving as a resource, advocate, and partner to higher education institutions, working together to collectively realize the vision of Texas as a leader in translating research into innovations that enhance the lives of Texans and drive economic growth.

Higher education systems and institutions can optimize use of transformational investments from the Texas Legislature to continue advancing R&D while also increasing efforts targeted toward innovation and commercialization. Looking to promising practices from leading institutions with demonstrated success in technology transfer can help Texas higher education institutions strengthen their role in powering Texas' innovation economy.

Almost every notable innovation hub in the U.S. is anchored by one or more institution of higher education. As key sources of invention, colleges and universities generate knowledge, spur innovation, drive technology, and foster entrepreneurship, making them engines of the economy. The strategies within this plan are designed to better support higher education institutions in serving their researchers, regional innovation leaders, and commercial partners.

Higher education's role in fostering a thriving ecosystem for research, development, and innovation is crucial. Strengthening this ecosystem requires a comprehensive effort that explicitly links to economic competitiveness. Strategic investments, collaboration among higher education institutions, and statewide coordination will secure Texas' performance and improve commercialization outcomes. With these factors in place, leaders across the state can help Texas compete at the forefront of knowledge, technology, and discovery. Texas has the talent and assets to create the innovation economy of tomorrow. The state's long-term prosperity and global competitiveness depend on it.

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