

COMMONWEALTH OF INNOVATION:

A POLICY AGENDA FOR
REVITALIZING PENNSYLVANIA'S
ECONOMIC DYNAMISM

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Executive Summary

Few states possess as many of the assets needed for innovation-driven growth as Pennsylvania. Powerhouse research universities are working on the most critical issues of the day in life sciences, artificial intelligence, robotics, transportation, and energy. Breakout companies are making headlines and garnering major investments. And the diversity of talent in the state's cities and rural areas is contributing to a rich capacity for community-based innovation at a time when creativity and inclusion matter more and more.

In short, Pennsylvania has much of what it takes to be a winner on a national economic map characterized by a short list of "superstars" and a longer one of "left-behind" places.

And yet, for all that, Pennsylvania has not been able

to convert its assets into abundant, high-quality economic growth. Specifically, leadership in some of the most prized factors for innovation-driven growth (e.g., research and development, patents, tech transfer) has failed to translate into the capstone indicator of innovation success: broad-based employment across an array of high-tech, high-pay advanced industries.

Given that, Pennsylvania needs to unlock its innovation potential, which will require catalytic steps on the part of state government. To assist with that, this report reviews the state's major innovation trends and challenges, and suggests a set of state-level policy recommendations with an eye toward helping the new governor energize the state's innovation sector. Overall, the report draws several key conclusions:

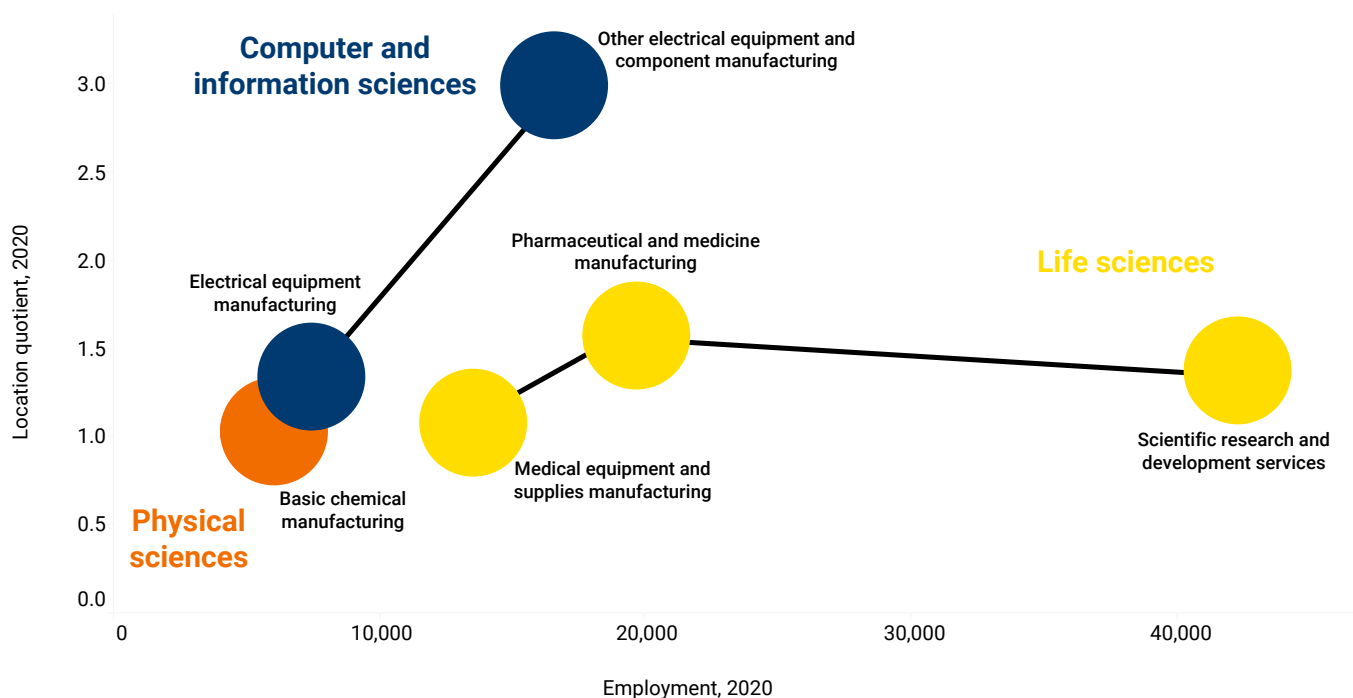
PENNSYLVANIA EXCELS AT UNIVERSITY-BASED R&D BUT LAGS IN HIGH-VALUE, HIGH-PAY JOB CREATION

Pennsylvania is emerging from the COVID-19 pandemic with a set of middling trend lines that include a relatively slow employment recovery and fairly solid income growth. At the same time, the state's innovation metrics are polarized.

On the one hand, Pennsylvania has a rich innovation history, with strong research universities and several groundbreaking innovation programs. The state's \$4.8 billion higher education R&D enterprise ranked fourth-

largest in the nation in 2020, with a top 10 R&D growth rate and strong patenting. At the same time, the state has begun to develop a set of nationally competitive innovation clusters, mostly centered in Philadelphia and Pittsburgh but extending into other regions as well. These clusters encompass above-average concentrations of research and industry activity in multiple areas, including the life sciences, computer and information services, robotics, chemicals, and plastics and rubber products.

EMPLOYMENT AND LOCATION QUOTIENTS FOR SELECTED ADVANCED INDUSTRIES IN PENNSYLVANIA, 2020



NOTE: Figure 12 in the full report

SOURCE: Brookings analysis of Lightcast data

On the other hand, the state's accumulation of advanced industry jobs has been lagging. From 2010 to 2019, Pennsylvania saw its advanced industry jobs grow by an aggregate 10.9%, trailing the national sector by 8 percentage points. Overall, Pennsylvania ranked sixth out of nine peer states in terms of advanced industry job growth, lagging

Indiana and Massachusetts by 9 percentage points and Michigan by 23. From 2015 to 2021, employment the Pennsylvania advanced industry sector grew by just 3%. Scientific research, software, and pharmaceuticals/medicine activities surged, but dozens of advanced manufacturing categories went sideways or shed jobs.

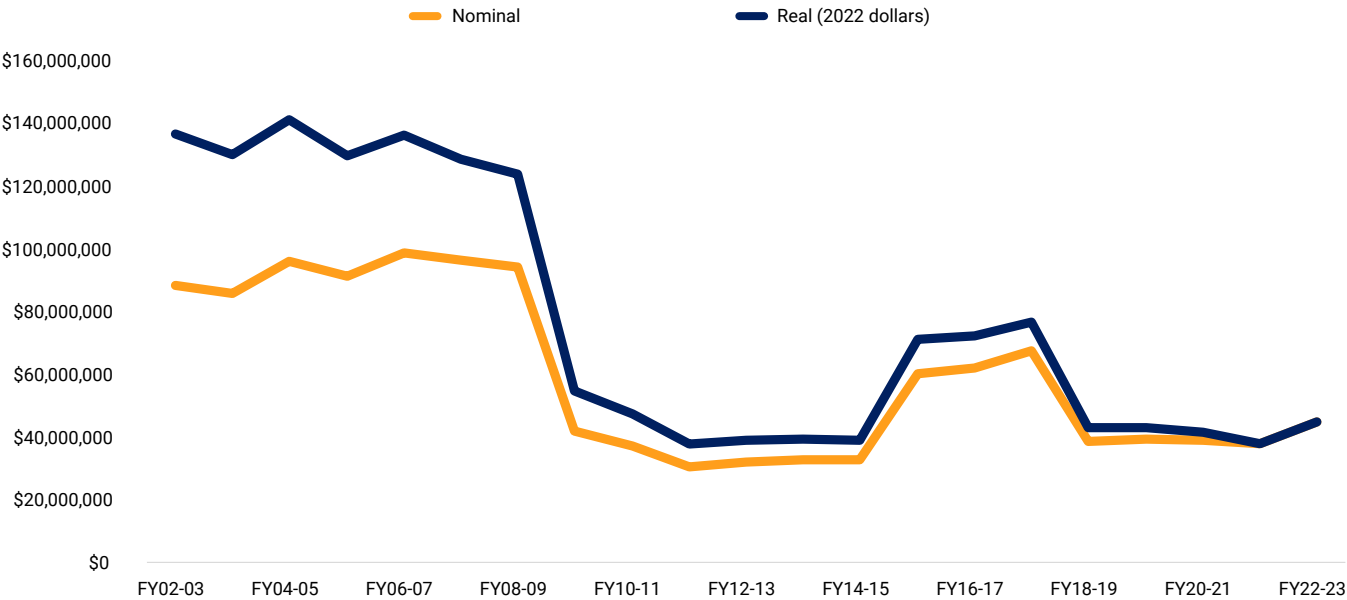
UNDERLYING PENNSYLVANIA’S INNOVATION DRIFT LIE FOUR CHALLENGES THAT ARE HOLDING THE STATE BACK

Brookings’ 2019 Pennsylvania innovation report, “Ideas for Pennsylvania’s innovation policy: Examining efforts by competitor states and national leaders,” underscored just how much effort peer states are investing in fostering innovation-based growth. This report, conversely, reveals numerous innovation-system gaps in Pennsylvania that are depressing innovation-based growth and require attention.

Four issues in particular warrant notice, beginning with a question of commitment:

- 1. **State government has seemed to lack a clear commitment to innovation and has let its core innovation programs languish.** Pennsylvania lacks a high-profile innovation vision and messaging framework that a growing number of competitor states have. No well-researched strategy document appears regularly, nor does the state invest much in promoting its innovation economy. Since 2010, governors have kept a low profile on the topic of innovation, and years of disinvestment have eroded the size and relevance of the state’s innovation efforts. Most starkly, Pennsylvania reduced its investments in innovation programs by nearly two-thirds during the Great Recession, and has failed to rebuild in subsequent years.

CORE INNOVATION FUNDING IN PENNSYLVANIA, FY 2003 – FY 2023



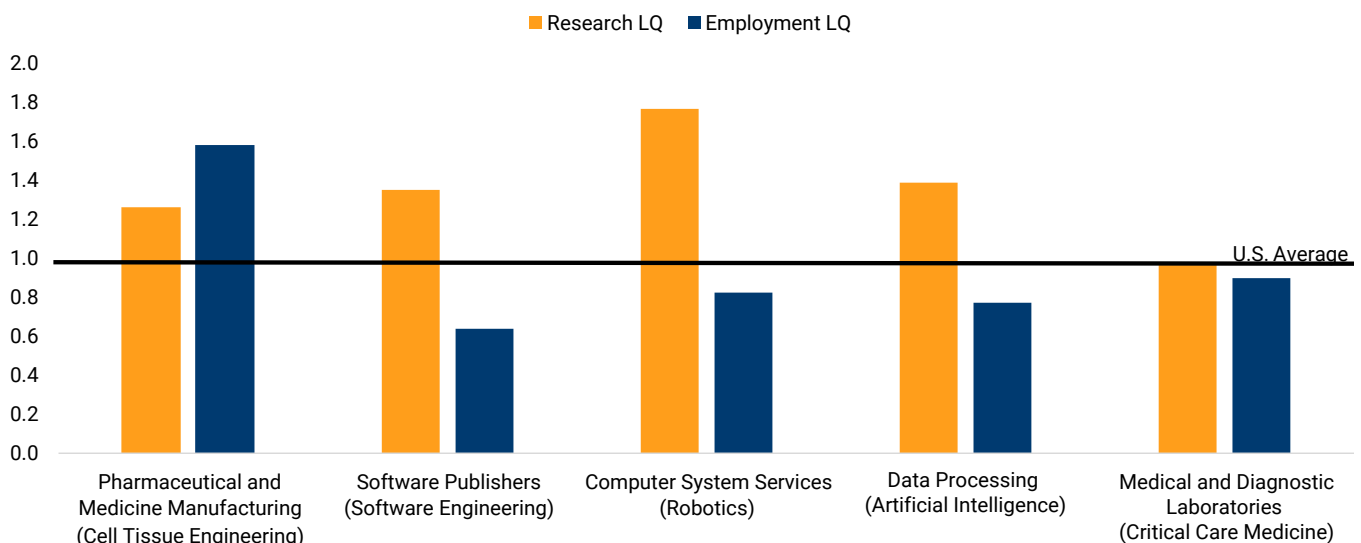
NOTE: Figure 15 in the full report

SOURCE: Brookings analysis of Pennsylvania Department of Community and Economic Development data

2. The state lags on converting top-quality research into growth firms and broader employment growth. The growth of commercial clusters depends on the presence of supportive tech “ecosystems” built out of local intermediaries, investor groups, and entrepreneurship networks. However, shortcomings in Pennsylvania’s entrepreneurial ecosystems are likely impeding new-firm creation and scale-up in advanced industries. Specifically, the state’s above-average concentrations of academic research in fields such as IT are so far failing to translate into above-average employment concentrations in pertinent advanced industries. Only in the pharmaceutical and life sciences realm has Pennsylvania’s above-average research concentration and strong tech transfer generated above-average employment commensurate with the state’s scientific leadership. Also depressing innovation-related employment growth is thin startup formation and hiring.

Contributing to the problem is reduced state investment, which has weakened efforts to bolster entrepreneurial ecosystems, support new-firm formation, and help companies scale. State policy is important in ecosystem-building, yet Pennsylvania drastically reduced its investments in innovation inputs and ecosystem-building during the 2008-2009 budget cycle amid the Great Recession, and never restored those investments to pre-recession levels. The results are severe budget reductions for key ecosystem supports such as the Pennsylvania Life Sciences Greenhouse initiative and the Ben Franklin Technology Development Authority. Other innovation-oriented programs were zeroed out. Increases for innovation programs requested by Governor Tom Wolf in the FY 2023 budget have only modestly restored some of the reductions.

PENNSYLVANIA’S RESEARCH ACTIVITY AND INDUSTRY EMPLOYMENT; LOCATION QUOTIENTS IN SELECT FIELDS, 2020



NOTE: Figure 18 in the full report

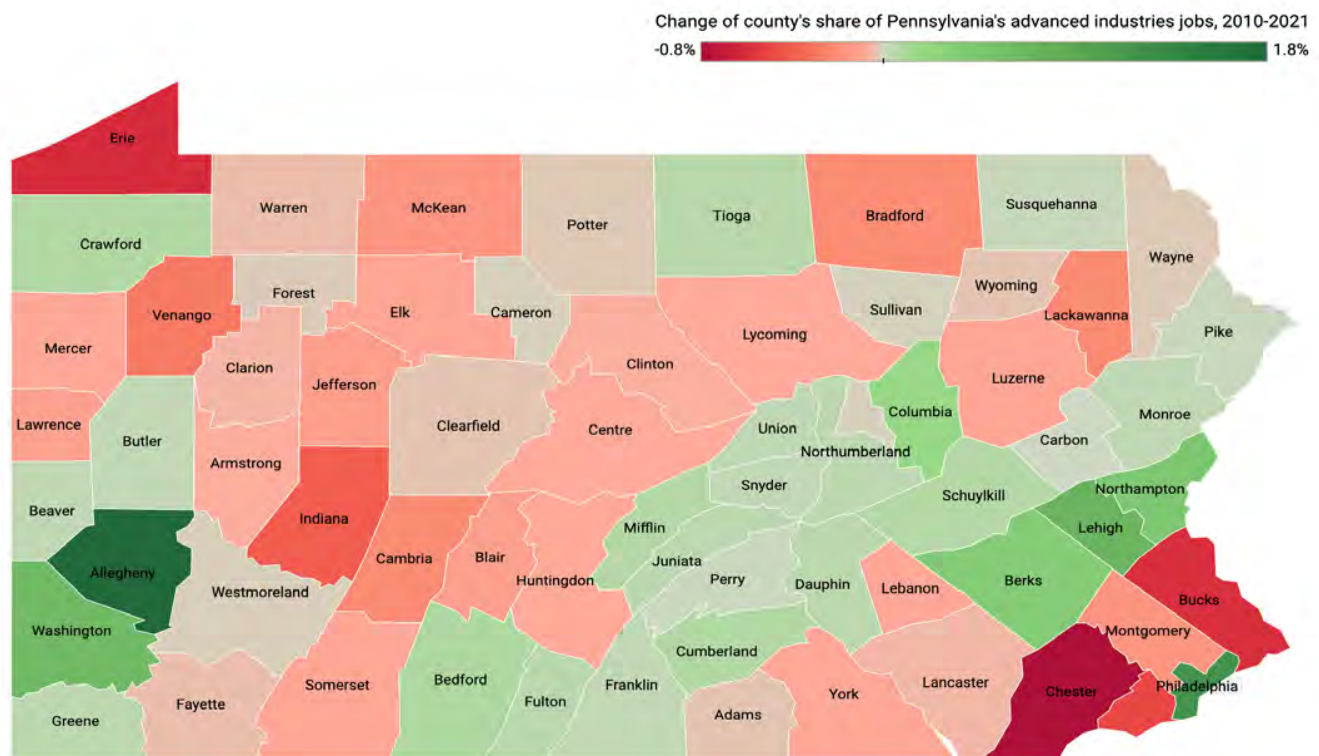
SOURCE: Brookings analysis of data from Lightcast, TEconomy Partners, and World of Science

3. Meanwhile, innovation is struggling outside of the state's largest cities. Crucial university innovation activity remains sparse outside the state's major academic metro areas of Philadelphia, Pittsburgh, and State College. Specifically, only about 1% of Pennsylvania's university-based R&D activity takes place beyond the confines of the major university hubs.

Advanced industry employment and vibrancy also lag outside these hubs. Advanced sector employment—though present in every county—is thinly distributed across most of the state, with

local clusters remaining sparse outside the major metro areas. In fact, regions outside the three major metro areas have seen their share of the state's advanced industry employment decline through the last decade to 42% of the state total. Data from Crunchbase shows that just 27% of the state's advanced sector new-firm starts were formed outside of the major university metro areas. Overall, the past decade of Pennsylvania's advanced industry growth reflects a broader pattern seen nationwide, with the largest cities pulling away from the rest of the state, and many of the most rural counties lagging.

CHANGE OF COUNTY'S SHARE OF PENNSYLVANIA'S ADVANCED INDUSTRIES JOBS, 2010-2021



NOTE: Map 2 in the full report

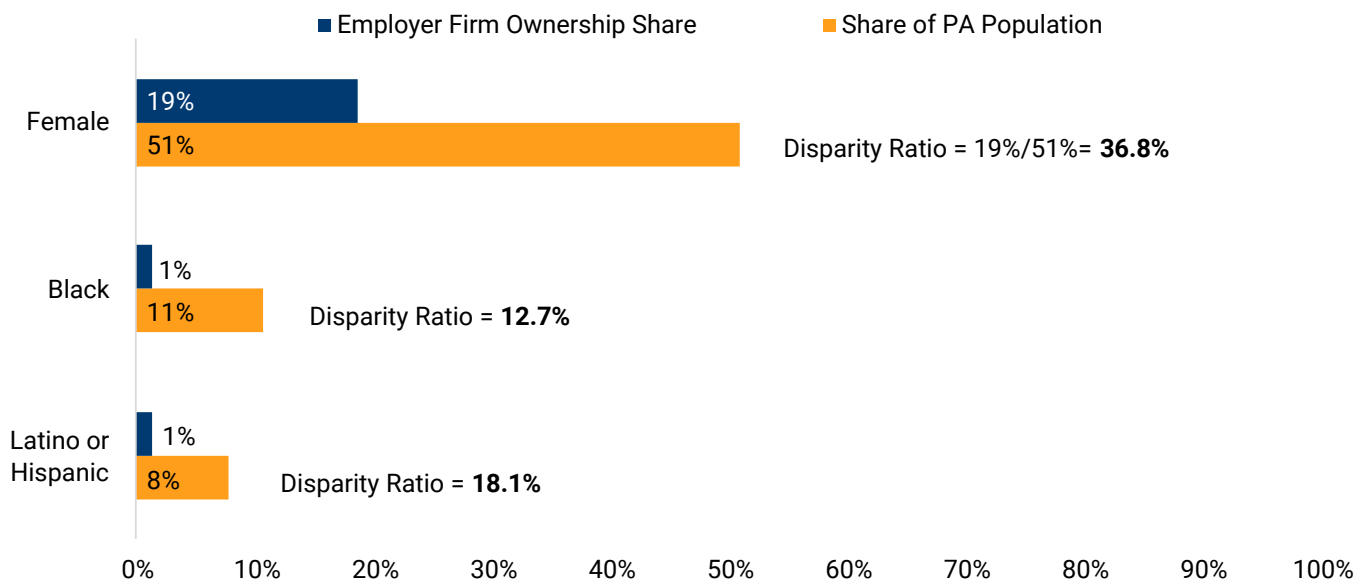
SOURCE: Brookings analysis of Lightcast data

4. Throughout the state, access to the innovation economy is unequal by race and gender. To start, K-12 STEM education remains significantly unequal by race in Pennsylvania. Underserved Pennsylvania students attend schools with fewer resources for STEM learning. This feeds into higher education, with female, Black, Latino or Hispanic, and Indigenous Pennsylvanians underrepresented among STEM degree graduates in the state. Black, Latino or Hispanic, and Indigenous people account for nearly 19% of Pennsylvania's population, but less than 10% of STEM degrees, and just 5% of STEM Ph.Ds. Women account for less than 40% of STEM degrees in Pennsylvania, and just one-third of STEM Ph.Ds.

With less access to STEM education, female, Black, and Latino or Hispanic Pennsylvanians are also underrepresented in the state's advanced industry jobs. Women hold just one-third of all advanced industry jobs, while Black workers hold advanced industry jobs at a rate half their share of the state population.

Finally, significant inequalities exist across race and gender when it comes to entrepreneurship and firm ownership. Just 1% of firms with employees in Pennsylvania have majority-Black ownership, and just 1% have majority-Latino or -Hispanic ownership. Meanwhile, only 19% of firms with employees in the state have majority female ownership.

WOMEN, LATINO OR HISPANIC, AND BLACK PENNSYLVANIANS ARE OWNERS OF FIRMS WITH EMPLOYEES AT DISPROPORTIONATELY LOW RATES



NOTE: Figure 32 in the full report. Business ownership is defined as having 51% or more of the stock or equity in the business; only businesses classifiable by owner or demographic group are included in the calculations. Calculations based on unrounded numbers; ownership share may not sum to 100% due to co-ownership.

SOURCE: Brookings analysis of Bureau of Labor Statistics and Census Bureau data

THE COMMONWEALTH NEEDS TO RENEW ITS COMMITMENT TO INNOVATION AS A FUNDAMENTAL DRIVER OF HIGH-QUALITY, BROAD-BASED PROSPERITY

Having lost its focus on innovation in the last 15 years, the commonwealth needs to refocus on innovation as the best way to unlock its economic possibilities. Given its world-class anchor institutions, promising urban ecosystems, and diverse talent, the state possesses vast potential to invent, grow, and participate in the next crucial technology platforms. However, if it is to meet that potential, Pennsylvania must reclaim its history of supportive policy innovation. Such assistance remains a crucial aspect of the kind of ecosystem-building critical for the state's innovation enterprise.

What follows, then, is a finite set of priority themes and recommendations through which state government can catalyze Pennsylvania's vast innovation potential and reinvigorate its entrepreneurial dynamism. Specifically, the state now has a critical opportunity to:

1. **Commit to innovation.** Today, Pennsylvania's main innovation programs are mostly adrift, without either adequate funding or high-level advocates in government. The next administration's top leaders should move urgently to elevate the importance of innovation. Along these lines, the next administration should:

- **Embrace the cause of innovation** and articulate a strong vision.
- **Center innovation in economic development** activities.
- **Rebuild the innovation budget.**

2. **Accelerate commercialization and growth in the state's major innovation metro areas.** Pennsylvania lags in translating its top-quality R&D into growth firms and advanced industry employment. At the same time, reduced state investment has undercut efforts to bolster the vital tech ecosystems that help companies grow, particularly near research universities. The state therefore needs to enact a bold initiative aimed at assisting its major innovation regions scale up transformative strategies to convert startups into growth. Accordingly, the next administration in Harrisburg should:

- Design and **support a Pennsylvania Innovation Hubs program** as a sizable challenge grant to help regional innovation clusters in key university-based innovation hubs promote tech-based economic growth and job creation.
 - Aggressively **leverage parallel federal cluster programs** such as the Advanced Research Projects Agency for Health (ARPA-H) and the regional technology hubs programs in the CHIPS and Science Act for further impact.
 - **Expand the state matching fund for federal Small Business Innovation Research (SBIR)/ Small Business Tech Transfer (STTR) awards**—programs that provide funding to small businesses engaged in federal-agency-relevant R&D that has potential for commercialization—with an emphasis on support for underrepresented groups.
3. **Foster innovation and entrepreneurship outside of major metro areas.** Pennsylvania's stark regional divides divorce hundreds of thousands of Pennsylvanians from opportunities in big-city innovation centers. Today, whole portions of the state threaten to become traps of underdevelopment that undercut economic connection and may fuel "backlash" political dynamics. To help more of the state's smaller cities, towns, and rural areas tap into the benefits of the innovation economy, the next administration should:
- Design and **fund a competitive challenge grant** to catalyze innovation and entrepreneurship in 20 regions outside Pennsylvania's major metro areas.
 - **Establish an advanced industries innovation voucher** program to help firms across the state access cutting-edge research from Pennsylvania universities.
 - Continue to **strengthen the Penn State LaunchBox and Innovation Network** and expand university engagement in local regions more broadly.

4. **Insist on inclusion.** Investing in Pennsylvania communities of all sizes will be critical for bolstering Pennsylvania's innovation economy. However, without a specific effort to build a more inclusive innovation economy, Pennsylvania risks perpetuating the same inequalities that it has faced for years. Given that, the state should focus on enhancing inclusion in its innovation economy across three themes:

- **Grow a more inclusive entrepreneurial ecosystem** through steps such as providing additional, state-level funding for the SSBCI Diverse Leaders Venture Program; establishing a state CDFI fund; and better leveraging public procurement to support entrepreneurship and business development among underrepresented groups.
- **Expand access to advanced industry careers** through efforts such as developing a set of state-supported communities of practice for organizations focused on connecting workers to advanced industry jobs; providing competitive funding to programs that aim to bolster engagement of underrepresented groups in the advanced industry workforce; and leveraging funding from recent federal legislation to connect underrepresented workers to innovation jobs.

- **Make STEM education more equitable** through policy actions such as creating a new program to attract diverse STEM professors and Ph.D. candidates to Pennsylvania higher education institutions; bolstering the Pennsylvania Department of Education's PAsmart grants program for schools; and providing competitive funding to programs that aim to bolster racial, gender, and other types of inclusion in STEM education.

Reenergizing Pennsylvania's stagnant innovation economy will take more than a one-off investment. To generate sustained and consistent investment over time, the state can explore a variety of revenue options. One would be to channel a portion of the growth in personal income tax receipts received by the state from advanced industry workers into a new "Keystone Advanced Industries Growth Fund," to be used to finance future investments in innovation and advanced industry growth without raising taxes. Other options could include tapping the state's sizeable budget surplus or taxing transactions tied to legal marijuana to fund an inclusive innovation agenda.

In order to build a more competitive and inclusive economy in the coming years, the commonwealth must act now to reclaim its former position as an innovation leader.





Introduction

Few states possess as many of the assets needed for innovation-driven growth as Pennsylvania.

Powerhouse research universities are working on the most critical issues of the day in life sciences, artificial intelligence, robotics, transportation, and energy. Breakout companies are making headlines and garnering major investments. And the diversity of talent in the state's cities and rural areas is contributing to a rich capacity for community-based innovation at a time when creativity matters more and more.

In short, Pennsylvania has much of what it takes to be a winner on a national economic map characterized by a short list of “superstars” and a longer one of “left-behind” places.

And yet, for all that, Pennsylvania has not been able to convert its assets into abundant, high-quality economic growth in recent years. Even though the state's \$4.8 billion higher education R&D enterprise ranked fourth-largest in the nation in 2020, Pennsylvania ranks seventh out of nine peer states and last among eight

high-growth states on its formation of new tech firms. Meanwhile, the share of the state's employment in good-paying advanced industry jobs—a capstone indicator of innovation success—lingers at around 27th place among states. More broadly, overall job growth in the state has been nearly nonexistent through the last decade—low even on a list of relatively slow-growing Northeastern and Midwestern peer states.

In short, Pennsylvania needs to unlock its innovation potential. To assist with that, this report probes the state's current trends to assess the strengths and weaknesses of its innovation systems. After that, the report proposes a state policy agenda aimed at addressing some of the core issues at this critical moment of opportunity.

Timed to coincide with an important gubernatorial election, the analysis here builds on Brookings' 2019 report "Ideas for Pennsylvania's Innovation Policy: Examining efforts by competitor states and national leaders." That report highlighted the actions numerous peer states were taking to accelerate innovation in the years before the pandemic.¹ Going beyond that inventory, this new report lays out a manageable set of recommendations for helping the new governor energize the state's innovation sector.

This agenda presumes that while the state has in

hand much of what it needs to excel at the innovation game, what is missing involves a lack of urgency, vision, and investment on the part of state government. Accordingly, the policy agenda begins with the suggestion that the new governor set out a bold vision and plan for how the state should leverage its incredible assets—its world-class institutions, vibrant regions, high-potential ecosystems, philanthropies, human potential, and diversity. After that, the report suggests a set of robust investments aimed at supporting "bottom-up" actions to enhance the major metro areas' core innovation ecosystems and ensure that all of the state's places and people participate in the needed innovation surge.

In that vein, the report commences with two sections that review why innovation matters for Pennsylvanians, and the status of the state's innovation discussion. Following those sections, two more sections review the state's broad economic and innovation trends, as well as the main challenges embedded within them. After those sections, the report lays out a four-part policy agenda, followed by notes on funding.

In sum, the present report calls out an incredible opportunity for Pennsylvania to seize a critical economic moment. Now is the time for state leaders to convert rich innovation potential into a more inventive, entrepreneurial economy.





Why innovation matters for Pennsylvanians

Innovation might seem a remote concern for the average Pennsylvanian. Especially during the last decade, “innovation” has come to seem an elite activity concentrated in distant “superstar” tech hubs, such as the Bay Area.

In truth, though, innovation also can lead to compelling local benefits for diverse people in widely distributed places—including in Pennsylvania.

In recent decades, an increasing number of economists have concluded that innovation—the creation and adoption of new products, services, and business models—is the key to improved standards of living.² That’s because innovation helps workers and firms create new products and processes, which drive resilience and growth. Think, for example, of life and work during at the beginning of the COVID-19 pandemic, when hundreds of Pennsylvania restaurants and stores overhauled their businesses to embrace online ordering and drive-by pickups. In those

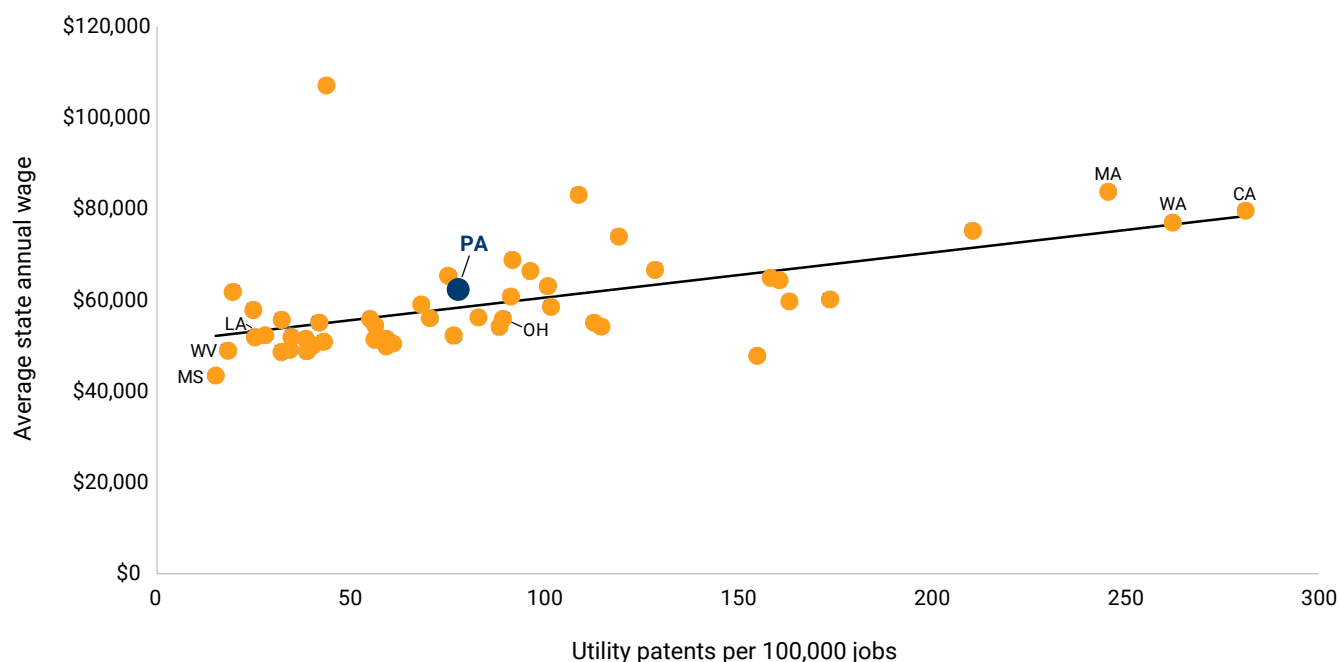
instances, innovative tools, processes, and services enabled many of the state’s businesses to survive the pandemic shock and bounce back stronger than ever (though of course not all did).

Yet beyond those benefits of growth and resiliency, innovation is essential because it yields solutions that increase the productivity of people, firms, and communities. Productivity in the economy reflects the amount of output added per unit of labor.³ For that reason, productivity gains are essential to producing higher standards of living in Pennsylvania because they allow workers to produce more for the same amount of work.

Nor are these benefits merely anecdotal or theoretical. Statistics confirm persistent links between innovation and positive economic outcomes. Higher innovation rates in states (measured by patents per 100,000 jobs) correlate with higher standards of living (measured by average annual wages).

FIGURE 1

Average state annual wage, given utility patents per 100,000 jobs, 2020



SOURCE: Brookings analysis of U.S. Patent and Trademark Office and Bureau of Labor Statistics data

So, the more innovative a place is, the more prosperous it is. However, it's important to note the tendency for demographic and income divides, given the low representation of women and BIPOC workers in the tech and innovation sectors.

Pennsylvania ranks far from the bottom of all states in innovation, and slightly overperforms its expected wage level given its level of patenting. Still, the state sits far from a position of national leadership on both innovation and wages. Pennsylvanians, in this regard, should be concerned about their state's lag in comparison to leading states.

But they should also be up for the challenge of improvement—and the task of ensuring innovation is inclusive. After all, raising a state's innovation rate by 10 utility patents per 100,000 jobs correlates with a

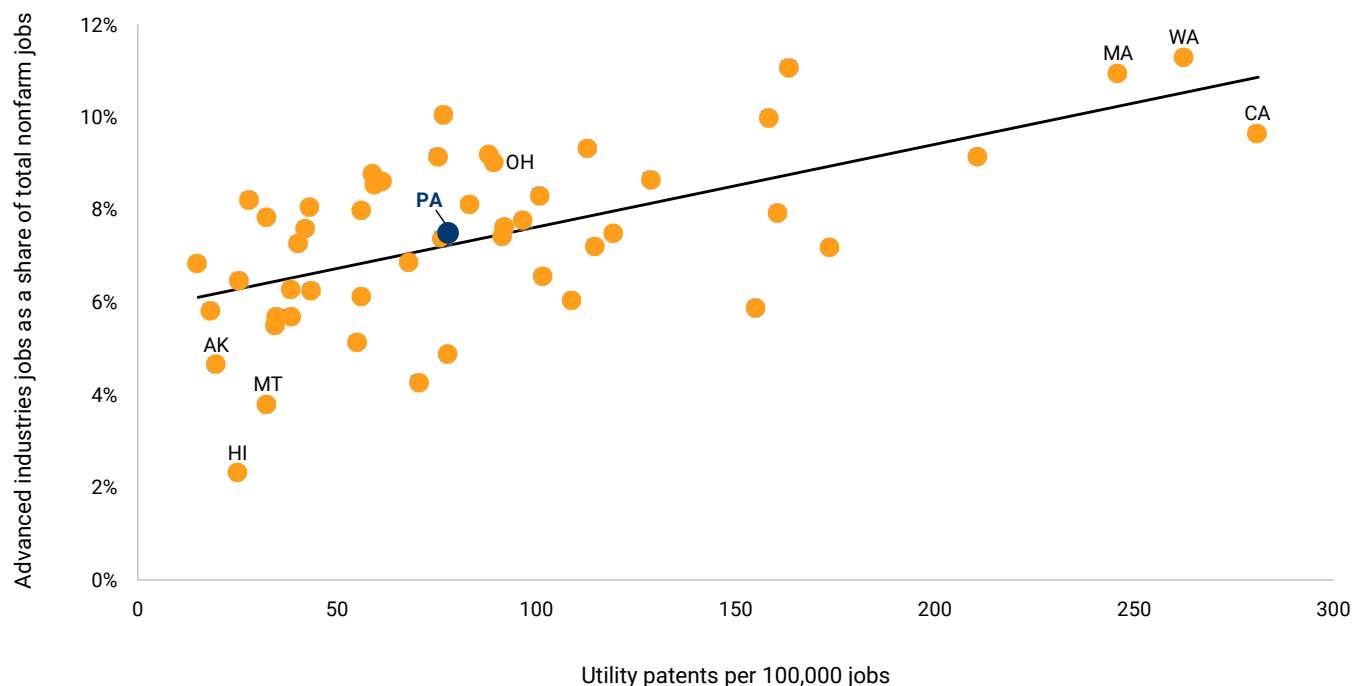
\$1,000 increase in annual wages, on average.

Likewise, innovation rates in science and engineering forecast participation in what Brookings calls “advanced industries”: industries with high levels of R&D spending and STEM workers, which are important engines of high-quality output.⁴

Advanced industries—whether they are engaged in precision manufacturing, vehicle automation, software development, or pharmaceutical production and energy—stand out as critical sources of radiating benefits for a state or region's economy. Overall, these industries pack a massive economic punch that ranges from good-paying jobs and inordinate output to long supply chains and substantial “multiplier effects.” Yet here again, higher local innovation rates predict higher state concentrations of advanced industries.

FIGURE 2

State advanced industries jobs share, given utility patents per 100,000 jobs, 2020



SOURCE: Brookings analysis of Bureau of Labor Statistics, Lightcast, and U.S. Patent and Trademark Office data

Given this link between R&D, patenting, and advanced industries, it is critical that states and regions boost their innovation rates if they want to capture more of the massive economic benefits of these industries.

Advanced industries anchor Pennsylvania's prosperity. But to retain and grow these "crown jewel" clusters—and the high standard of living they bring Pennsylvanians—the state will need to expand its innovation capacity significantly. All of these, then, are reasons innovation matters for Pennsylvania.



Recapping recent innovation discussions in Pennsylvania

Pennsylvania has a rich innovation history. From the Ben Franklin Technology Partners (a statewide early-stage investor dating to 1982) to the launch of Philadelphia's University City Science Center (one of the country's first innovation districts), Pennsylvania's innovation institutions have been models for technology-based economic development. More recently, stakeholders in Pennsylvania's government, business, higher education, and nonprofit sectors have put a renewed focus on innovation, with the aim of bolstering the state's long-term growth.

In 2019, Brookings released "Ideas for Pennsylvania Innovation: Examining efforts by competitor states and national leaders."⁵ That report was not a traditional policy report, but instead identified a set of discrete

challenges facing Pennsylvania's innovation economy, and highlighted policies other states had adopted in recent years to solve for similar challenges. The four primary challenges the 2019 report identified were:

- The absence of a comprehensive state innovation strategy grounded in an evidence-based understanding of the state's industries and innovation status.
- Below average and stagnating industry R&D.
- Reduced state investment for early-stage companies, combined with declining venture capital.
- Significant spatial divergence between the largest innovation centers (Philadelphia, Pittsburgh, and State College) and the rest of the state.

Even though that report did not provide specific policy recommendations, its release sparked a robust bipartisan discussion centered on how innovation can be leveraged to support Pennsylvanians across the state.

In January 2020, Governor Tom Wolf announced the Pennsylvania Innovation Plan, aimed at addressing several of the issues identified in the 2019 Brookings report.⁶ The plan contained a variety of investments aimed at bolstering innovation across Pennsylvania, including increased funding for statewide programs such as the Ben Franklin Technology Development Authority and the Partnerships for Regional Economic Performance (PREP) network; greater funding for the state's Industrial Resource Centers, which serve small- and medium-sized manufacturers; and dedicated state resources for the Invent Penn State network. The plan also proposed the creation of a comprehensive statewide innovation strategy to support innovation in communities of all sizes.

The 2019 Brookings report and the governor's 2020 innovation plan both garnered strong bipartisan interest. In March 2020, the four policy committees of the Pennsylvania General Assembly agreed to hold—for the first time in recent history—a bipartisan, bicameral public hearing on advancing economic growth in the state, with innovation as the agenda's centerpiece.⁷

However, the onset of the COVID-19 pandemic brought these discussions to a halt, as the state (rightly) shifted its priorities to respond to what would become a historic public health and economic emergency.

And yet, even amid the pandemic's economic fallout, discussion about innovation in Pennsylvania did not end. For one, the state's existing innovation structure continued operating throughout the downturn. For example, the Ben Franklin Technology Development Authority awarded \$4 million to the Ben Franklin Technology Partners, which then matched that funding with an additional \$4 million to support companies affected by the pandemic.⁸

Then, in May 2021, a group of Carnegie Mellon University graduate researchers engaged with Pennsylvania's Department of Community and Economic Development (DCED) to publish "Pennsylvania's Innovation

Economy"—the first state-backed annual report in over 15 years to catalog the state's innovation economy.⁹ Along with the report, the research team published a wide-ranging set of policy recommendations for both the executive and legislative branch. And to monitor progress on innovation over time, the research team and DCED published a dashboard covering a set of innovation-related metrics ranging from traditional measures on entrepreneurship, firm growth, and venture capital to broader investments in areas such as workforce, infrastructure, and innovation governance.¹⁰

Elsewhere around the state, complementary efforts were underway that, while not directly focused on innovation, were nonetheless relevant for the state's innovation economy. In January 2020, just days before Governor Wolf announced his plan, Team Pennsylvania—a nonpartisan 501(c)(3) nonprofit led by government and private sector leaders and co-chaired by the governor—released the Pennsylvania Economic Competitiveness Dashboard.¹¹ The dashboard, created in partnership with Philadelphia-based economic consulting firm Econsult Solutions, Inc., compared Pennsylvania against its neighboring states, a set of peer states, and a set of high-growth states on an array of economic indicators. While the dashboard was focused on the state's workforce and economic development, it also contained innovation-relevant metrics related to firm starts and closures, talent development and brain drain, and population attainment and migration, among others.

Meanwhile, regional business and economic development groups throughout the state have continued to push both local and statewide innovation efforts. The Chamber of Commerce for Greater Philadelphia, through its Grow PA initiative and network, held statewide virtual convenings on innovation policy and worked to encourage a statewide innovation strategy in the Pennsylvania General Assembly.¹²

These efforts have maintained momentum around in the state, even as the state's leaders prioritized emergency response to the pandemic. Now, though, it's time to convert these discussions into real-world responses. As the state looks to continue its economic recovery, innovation will play a central role.

Governor Wolf's FY 2023 budget is an important start. It recognizes the role that innovation will play in Pennsylvania's recovery, and proposes several innovation-relevant investments. After negotiations with the legislature, the final budget includes:¹³

- A \$2.5 million increase to the Ben Franklin Technology Development Authority and the Ben Franklin Technology Partners.
- An additional \$1 million in funding to the PREP network for competitive grants for partnerships with higher educational institutions
- An additional \$1.5 million in funding to the Manufacturing PA program to provide grants to the state's Industrial Resource Centers to foster innovative service delivery.
- \$2.35 million in state funding for Invent Penn State, providing state funding to the program for the first time.
- A \$5 million increase in the cap on the state's R&D tax credit.

Beyond these commonwealth investments, the record influx of federal funding in the last two years

has included funding for state innovation initiatives. These federal programs include the \$10 billion State Small Business Credit Initiative (SSBCI), which could provide as much as \$268 million in federal funding to Pennsylvania over the next decade. The state is using this funding to increase capital access for firms, including equity funding for innovation-oriented companies.¹⁴ Also important have been metro Philadelphia and Pittsburgh's successful applications for major funding from, respectively, the Economic Development Administration's Good Jobs Challenge (GJC) and the Build Back Better Regional Challenge (BBBRC). Together, these wins have secured more than \$85 million for innovation-related workforce and cluster development in Pennsylvania.

In the short run, then, Governor Wolf's FY 2023 budget items are common-sense investments. In the longer term, though, more will need to be done to ensure that Pennsylvania can regain its place as a national innovation leader. In this regard, it's time for policymakers from both parties to embrace an innovation-oriented growth agenda that supports all Pennsylvania residents, from the largest metro areas to the smallest townships.





Trends in Pennsylvania's innovation economy, from the Great Recession to the pandemic

The growing urgency about Pennsylvania's innovation sector owes to the many links between innovation and broader economic vitality—and the state's mixed performance on both. Overall, Pennsylvania's middling innovation performance is likely contributing to its middling economic performance.

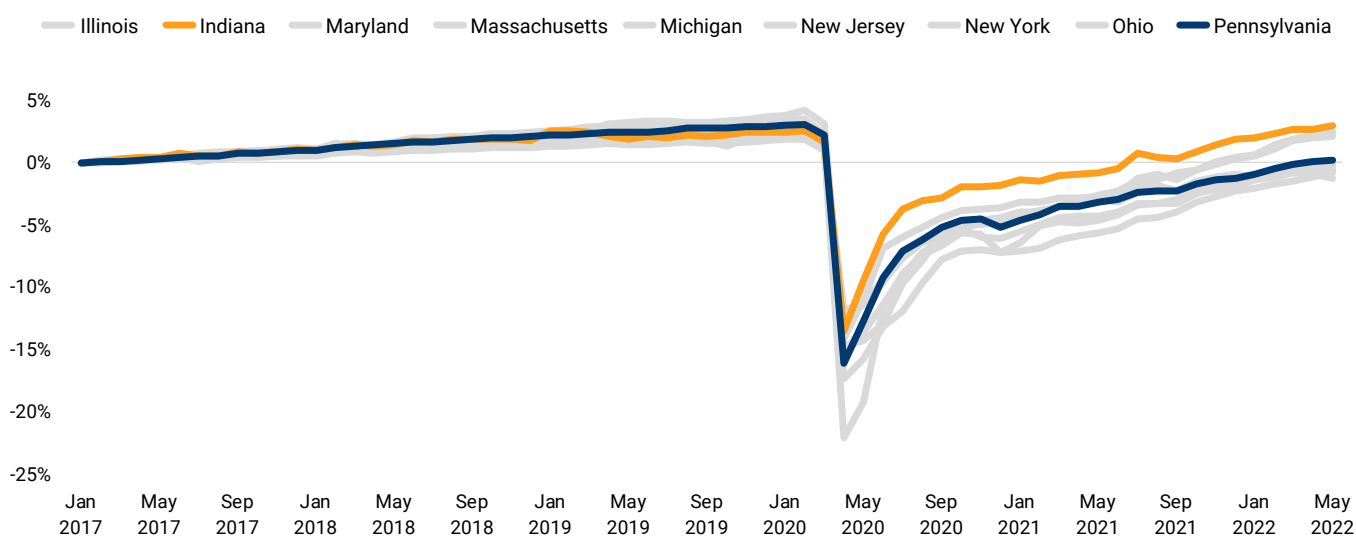
PENNSYLVANIA WEATHERED THE PANDEMIC WITH A MIXED ECONOMIC PERFORMANCE

To be sure, Pennsylvania proved relatively resistant to the initial COVID-19 employment downturn, including in comparison to many of its peer states. Overall, it saw a 15.3% contraction in employment between February 2020 and May 2020. While that was historically

severe, it ranked in the middle among peer states, and may have reflected the state's large manufacturing sector, which in general proved more resistant to early pandemic layoffs.

FIGURE 3

Change in total nonfarm employment in Pennsylvania and selected peer states, seasonally adjusted, January 2017 – May 2022



NOTE: May 2022 data is a preliminary estimate

SOURCE: Brookings analysis of Bureau of Labor Statistics data

With that said, Pennsylvania's employment recovery has been relatively slow—a signal of deeper sluggishness almost certainly linked to lackluster innovation trends.

As of May 2022, Pennsylvania's employment remained 2.8% below where it was in February 2020, before the full onset of the pandemic's economic effects. Compared to employment across nation as a whole—which as of May 2022 is just 0.6% below its February

2020—Pennsylvania has experienced a slower economic recovery. What's more, Pennsylvania's employment recovery has flatlined since late 2020, compared to both peer and high-growth states.

At the same time, the state has experienced middling trends when it comes to both productivity growth and income growth as it has emerged from the pandemic. Each of these measures is linked to innovation, and each has been spotty in Pennsylvania.

Pennsylvania's peer states and high-growth states

This report compares Pennsylvania to two distinct sets of states: peer states and high-growth states.

Brookings has designated eight states as “peer states” for Pennsylvania: **Illinois, Indiana, Maryland, Massachusetts, Michigan, New Jersey, New York, and Ohio**. These states allow comparison between Pennsylvania's topline economic performance and a group of Northeastern and Midwestern states with similar demographic trends, as well as advanced industry sectors of comparable sizes. Each of these states was also identified in a previous report as a peer state of Pennsylvania.¹⁵

“High-growth states,” meanwhile, are a set of Sun Belt and West Coast states that have seen rapid population growth in recent years. Because of Pennsylvania's demographic challenges, it is likely to lag these states on many indicators. However, it is still worthwhile to benchmark against states that are seeing significant population inflows as an aspirational analysis. Brookings identified seven high-growth states: **Arizona, California, Florida, Georgia, North Carolina, Texas, and Washington**.

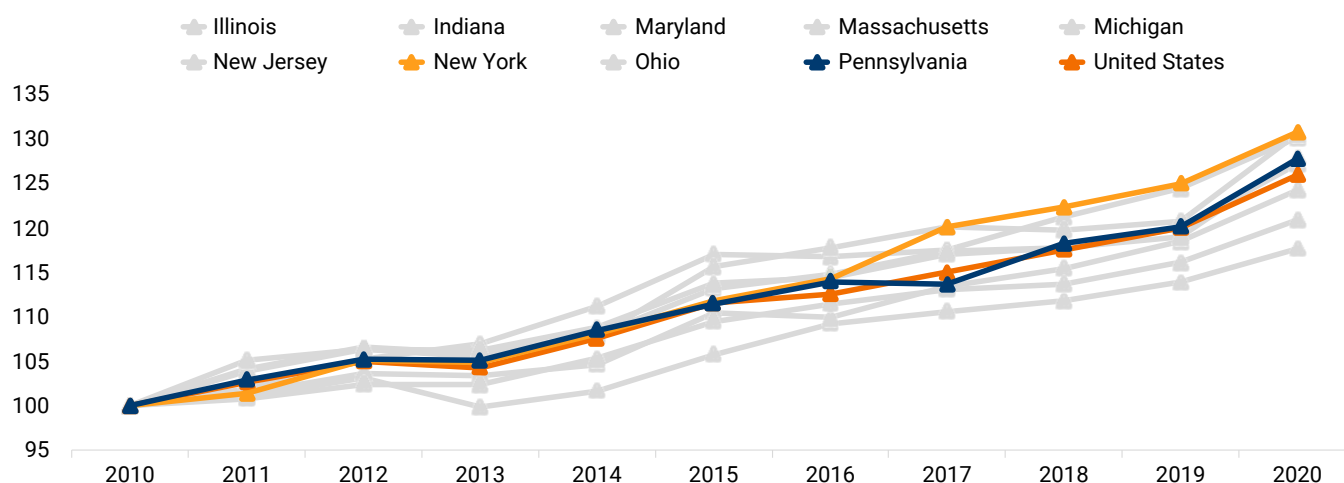
To be sure, negative labor productivity growth in 2017-2018 gave way to a tentative uptick in 2019 and 2020, even as several peer states converged on and ultimately surpassed Pennsylvania's productivity growth.

With that said, Pennsylvania's middle-of-the-pack productivity growth has contributed to middle-of-the-road income growth in the pandemic period.

The good news is that, as of the end of 2020, both Pennsylvania's per capita income and its income growth over the last decade exceeded the U.S. average. For example, the state's 2020 per capita income of \$57,000 a year exceeded the national average of \$53,500. However, that difference was entirely accounted for by income changes that occurred in the pandemic year of 2020. Overall, the state's income performance—while better than its employment performance—still trails national leaders significantly.

FIGURE 4

Indexed real per capita personal income in Pennsylvania, selected peer states, and US, 2010-2020 (2010=100)



SOURCE: Brookings analysis of Bureau of Economic Analysis data

PENNSYLVANIA'S MIXED RECOVERY FOLLOWS A DECADE OF ANEMIC GROWTH.

Looking at the recovery period alone masks deeper challenges: Pennsylvania has been struggling with both lagging job growth and inconsistent productivity and income growth for more than a decade.

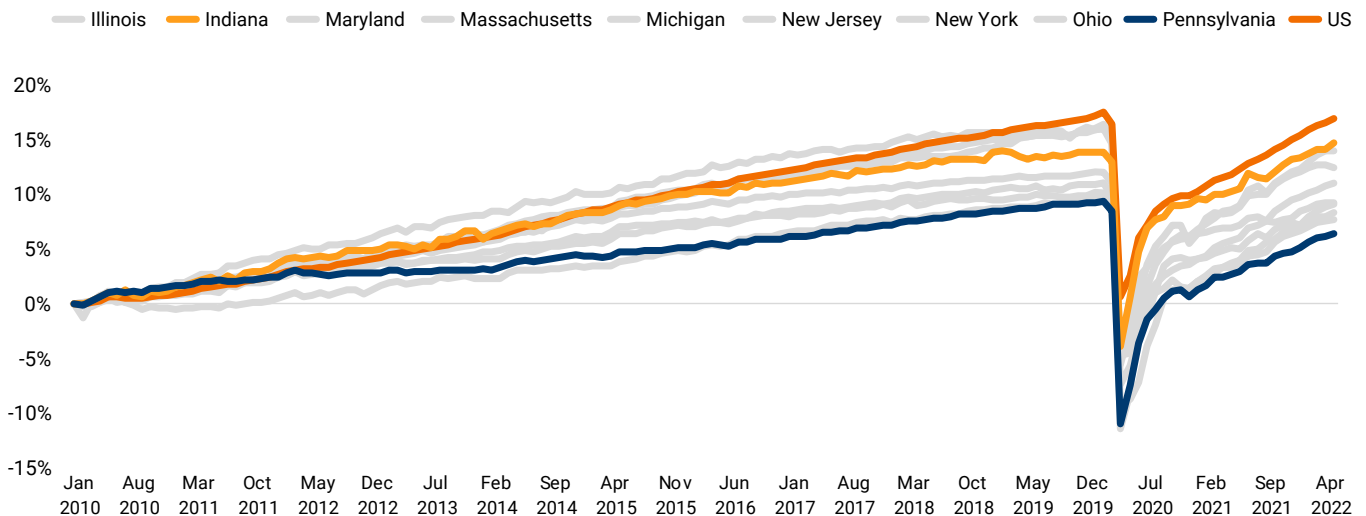
Pennsylvania job growth lagged throughout the 2010s. So while the state's employment rate may have dropped less than some peer states during the pandemic shock, that owes partially to the fact that it created fewer jobs before the downturn. Specifically, Pennsylvania's job base grew by just 9.3% during the

pre-pandemic expansion from January 2010 until February 2020, whereas the nation as a whole saw its job rolls grow almost twice as fast, by 17.5%.

In that sense, Pennsylvania is a historically slow-growing state with a sizable manufacturing sector and an aging population. Even so, its slow growth remains disconcerting, given that its employment growth in recent years ranked last during among the group of nine peer states.

FIGURE 5

Change in employment in Pennsylvania, selected peer states, and US, seasonally adjusted, January 2010 – May 2022



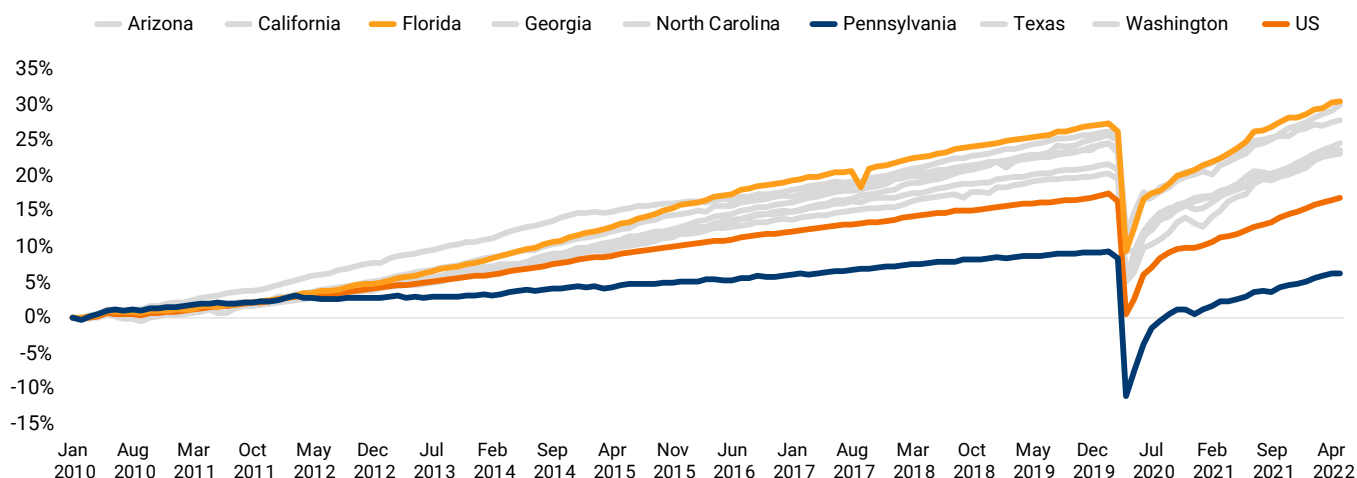
NOTE: May 2022 data is a preliminary estimate

SOURCE: Brookings analysis of Bureau of Labor Statistics data

Pennsylvania's lag looks even more substantial when compared to a group of fast-growing Sun Belt and Western states.

FIGURE 6

Change in employment in Pennsylvania, selected high-growth states, and US, seasonally adjusted, January 2010 – May 2022



NOTE: May 2022 data is a preliminary estimate

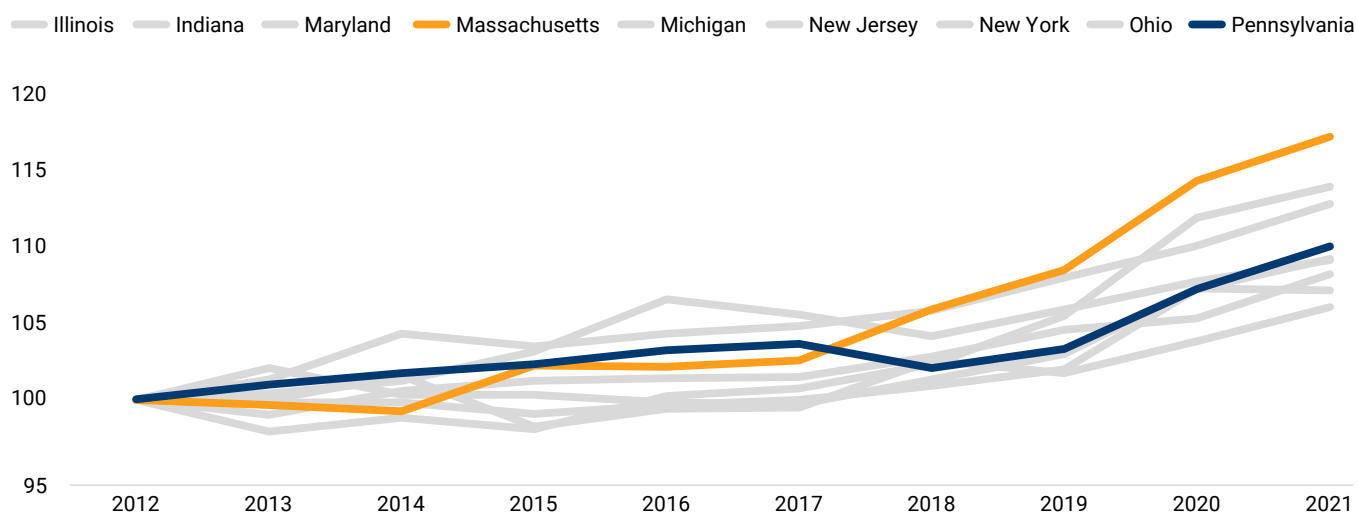
SOURCE: Brookings analysis of Bureau of Labor Statistics data

Turning to the state's productivity and income trends, the story remains mixed. Bright spots in Pennsylvania's early-2010s productivity look less impressive in the context of other states, especially later in the decade. Not only did some peer states see faster productivity growth late in the decade, but Pennsylvania

significantly trailed the performance of top high-growth states. Indeed, Washington and California's productivity growth was more than double Pennsylvania's during this period, underscoring that while Pennsylvania has seen some gains, it still remains significantly behind the pace of national leaders.

FIGURE 7

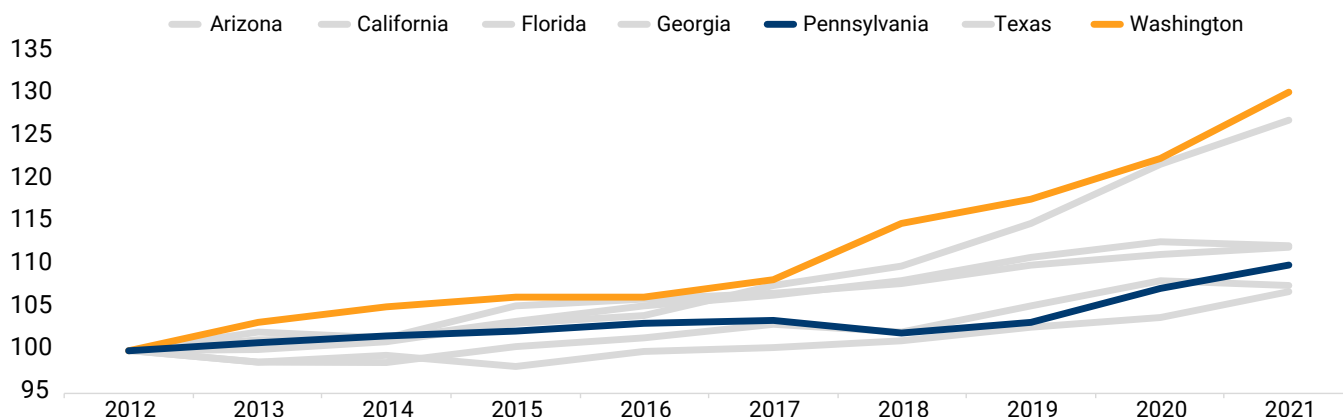
Indexed labor productivity for private nonfarm in Pennsylvania and selected peer states, 2012-2021, (2012=100)



SOURCE: Brookings analysis of Bureau of Labor Statistics data

FIGURE 8

Indexed labor productivity for private nonfarm in Pennsylvania and selected high-growth states, 2012-2021, (2012=100)



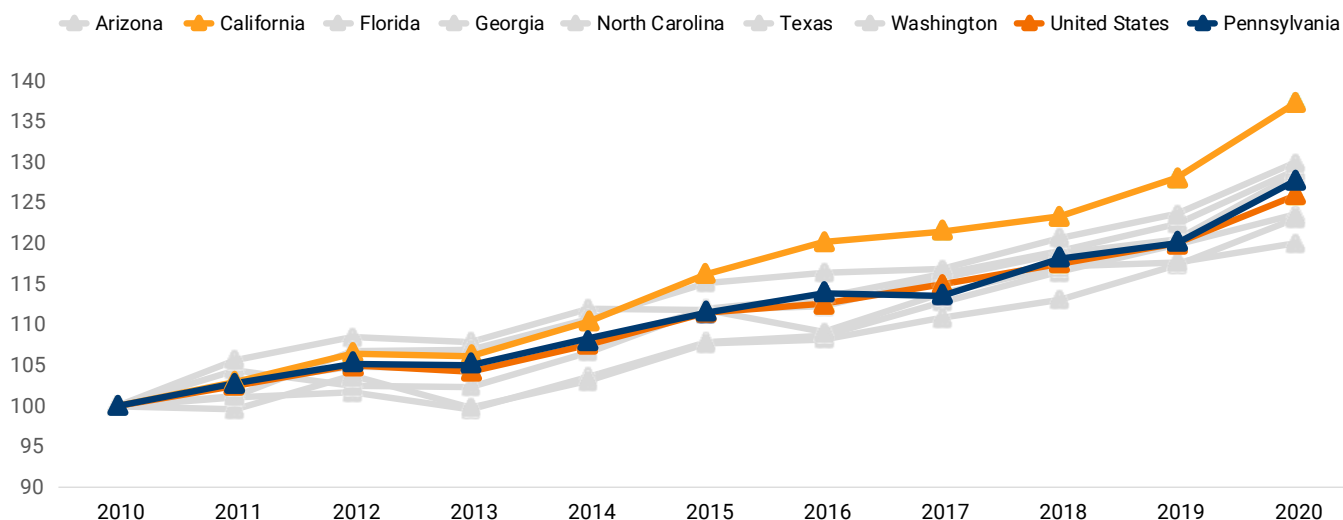
SOURCE: Brookings analysis of Bureau of Labor Statistics data

Pennsylvania's income growth has likewise been middling when compared to the seven high-growth states. Pennsylvania ranked fifth out of eight when included in this high-growth group, although it

substantially lagged the leader, California, which started the decade with lower per capita income than Pennsylvania, but surpassed it by the end of the decade.

FIGURE 9

Indexed real per capita personal income in Pennsylvania, selected high-growth states, and US, 2010-2020 (2010=100)



SOURCE: Brookings analysis of Bureau of Economic Analysis data

Overall, the state's current mediocre economic performance as it moves beyond the pandemic appears very much a continuation of the economic patterns of the last decade. Breaking the cycle of

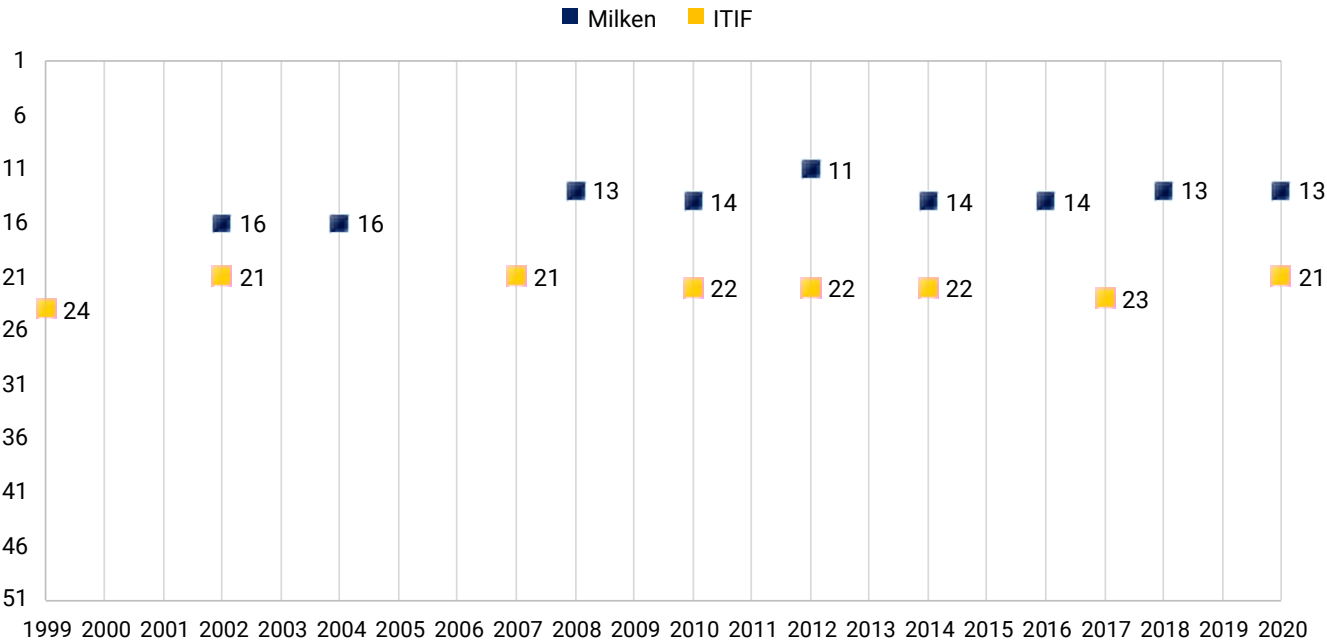
anemic growth and limited vitality should be a priority for policymakers as they consider how to navigate the next phase of the state's recovery.

MIDDLING PERFORMANCE ON MAJOR INNOVATION INDICES OVER TWO DECADES IS CONTRIBUTING TO PENNSYLVANIA’S ECONOMIC DRIFT

Innovation is a critical and pervasive contributor to growth and vitality—for nations, states, and communities. However, despite Pennsylvania possessing numerous innovation assets and programs, major innovation rankings have consistently ranked the state as above average but outside the top tier.

Specifically, two widely cited state innovation rankings—the Information Technology and Innovation Foundation’s (ITIF) State New Economy Index and the Milken Institute’s State Science and Technology Index—track only sideways progress in Pennsylvania’s innovation power over the past two decades, based on dozens of metrics.

FIGURE 10
Pennsylvania ranking over time in major state innovation indices



SOURCE: Brookings analysis of Milken Institute and Information Technology and Innovation Foundation data

In 2020, for example, ITIF ranked Pennsylvania 21st among all states. That tied for the highest the state has ever received, yet it also reflected no advancement in relation to other states since 2002. Pennsylvania has fared better in Milken’s rankings, but only somewhat, placing 13th among the 50 states in 2020. That ranking kept the state in the same position it held in 2018—and for that matter, as far back as 2011. Only once has Pennsylvania ranked higher than that in Milken’s rankings, when it placed 11th in 2012.

Across the two rankings, Pennsylvania has never placed in the top 10 of all states, signaling its inability to break into the top tier of innovation despite its many strengths.

PENNSYLVANIA STILL RETAINS SUBSTANTIAL RESEARCH STRENGTHS

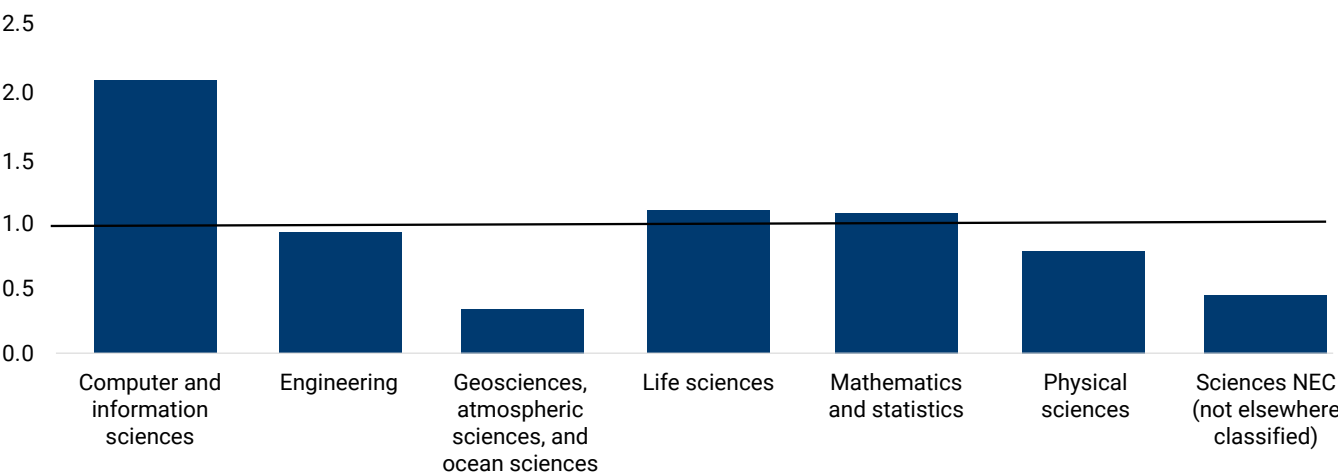
Mediocre rankings aside, Pennsylvania possesses enviable innovation assets—most notably in its major universities. These institutions are core drivers of innovation in the state.¹⁶

Pennsylvania’s higher education research ecosystems are anchored by six Research 1, or “R1,” universities (defined as institutions with the highest level of research activity) situated primarily in its two largest cities, Philadelphia and Pittsburgh.¹⁷ A mix of public and private institutions, the state’s R1 universities are the University of Pennsylvania, Drexel University, and Temple University in Philadelphia; Carnegie Mellon University and the University of Pittsburgh in Pittsburgh; and Pennsylvania State University, which has campuses statewide but consolidates most of its research activity at its main University Park campus in Centre County. Beyond these are a half-dozen smaller “R2” research institutions spread throughout the state, including both private institutions and public institutions in the Pennsylvania State System of Higher Education (PASSHE).¹⁸

Combined, these research universities—along with smaller contributions from other regional public universities and private institutions in the state—form the basis of Pennsylvania’s massive research strength. To be specific, the state’s \$4.8 billion higher education R&D enterprise was the fourth-largest in the nation in 2020, and smaller than only the R&D concentrations of California, New York, and Texas. Pennsylvania ranked 10th among states for the growth of its higher education R&D expenditures, behind just Massachusetts among its peers and behind only Georgia and Arizona among high-growth states.

When it comes to innovation-relevant fields, Pennsylvania universities excel in computer and information sciences in particular, with above-average contributions in the life sciences, mathematics, and statistics as well.

FIGURE 11
Location quotients for higher education expenditures in Pennsylvania, sorted by topic area, FY 2020



SOURCE: Brookings analysis of National Science Foundation data

Anchored by Carnegie Mellon University and Penn State, Pennsylvania's universities are powerhouses in computer and information sciences, producing research in those fields at over twice the rate of universities nationwide. Carnegie Mellon, in particular, is a national leader in computer and information sciences, producing research at over 14 times the national average. Penn State, for its part, produces computer and information sciences research at over 2.7 times the national average. Several of Penn State's Commonwealth Campuses also have strong concentrations in computer and information sciences, including Penn State Harrisburg and Penn State Behrend in Erie, both of which boast concentrations of computer sciences research at twice the national average. Finally, Lafayette College in the Lehigh Valley also conducts computer and information sciences research at over twice the national rate.

Pennsylvania also has several other innovation-relevant higher education research strengths. The state ranks above the national average in both life sciences research and mathematics and statistics research.

Life sciences is a significant innovation focus across Pennsylvania, with the strongest concentration in Philadelphia. The Philadelphia metro area has become a global leader in cell and gene therapy in recent years, due in no small part to research being done at universities in the region. Thomas Jefferson University, the University of Pennsylvania, and Temple University all have life sciences research concentrations that are 25% or more above the national average. These are rounded out by additional research conducted by the Philadelphia College of Osteopathic Medicine and the University of the Sciences in Philadelphia (now part of Saint Joseph's University), which have research concentrations that are 74% and 47% above the national average, respectively. This research strength isn't limited to just Philadelphia, with the University of Pittsburgh having a life sciences research concentration 50% above the national average, and Mercyhurst University in Erie being 27% above the national average.

In this regard, university research both shapes and reflects Pennsylvania's innovation strengths.



PENNSYLVANIA IS DEVELOPING A NUMBER OF NATIONALLY COMPETITIVE INNOVATION CLUSTERS

On the business side, Pennsylvania has in recent years begun to develop a set of nationally competitive innovation clusters, centered particularly on Philadelphia and Pittsburgh and often in relation to its university research strengths. These strengths are reflected in the state's business R&D concentrations, as

well as in its concentrations of employment in high-R&D, high-STEM, high-value advanced industries. The presence of such industries is both a critical feature of state and regional innovation activity and an end goal of such development.

America's—and Pennsylvania's—advanced industries

"Advanced industries" are the 46 manufacturing, services, and energy industries that form the basis of America's innovation economy. An industry is characterized as an "advanced industry" when its R&D spending per worker falls in the 80th percentile of industries or higher and it has a STEM workforce share of over 20%. Examples of advanced industries include medical device and electronics manufacturing, energy and chemicals production, and high-tech services such as computer systems design and software publishing.

Advanced industries matter for innovation because these industries perform 90% of the nation's private sector R&D and generate 85% of its patents. These industries also generate long supply chains, with an average of 2.2 other jobs being created for every advanced industry job (including an average of 0.8 local jobs), compared to an average of just 0.8 additional jobs (just 0.4 of which are local) created by non-advanced industries. As a result, the linkages between research by companies in advanced industry fields and employment in those fields are strong. Places with a critical mass of business R&D in advanced industries typically also have significant employment in those industries. In other words, advanced industries form the backbone of the nation's—and Pennsylvania's—innovation system. What's more, their presence is a desirable end result of a dynamic innovation ecosystem.

SOURCE: Mark Muro and others, *America's Advanced Industries: What They Are, Where They Are, and Why They Matter.* (Washington: Brookings Institution, 2015).

Pennsylvania, in any event, has built up several significant innovation clusters over time, each characterized by above-average concentrations of both university and private sector R&D as well as employment in specific advanced industries. In these domains, significant business sector research strengths are dovetailing with the state's notable academic strengths to propel emerging advanced industry concentrations.

To assess the convergence of business and academic research with advanced industry employment in key innovation clusters, this analysis uses location quotients to measure the state's concentrations of advanced industry employment activity compared to the national norm. In doing so, a set of promising advanced industry clusters emerges that reflects the interplay between academia, business, government, and communities. These include:

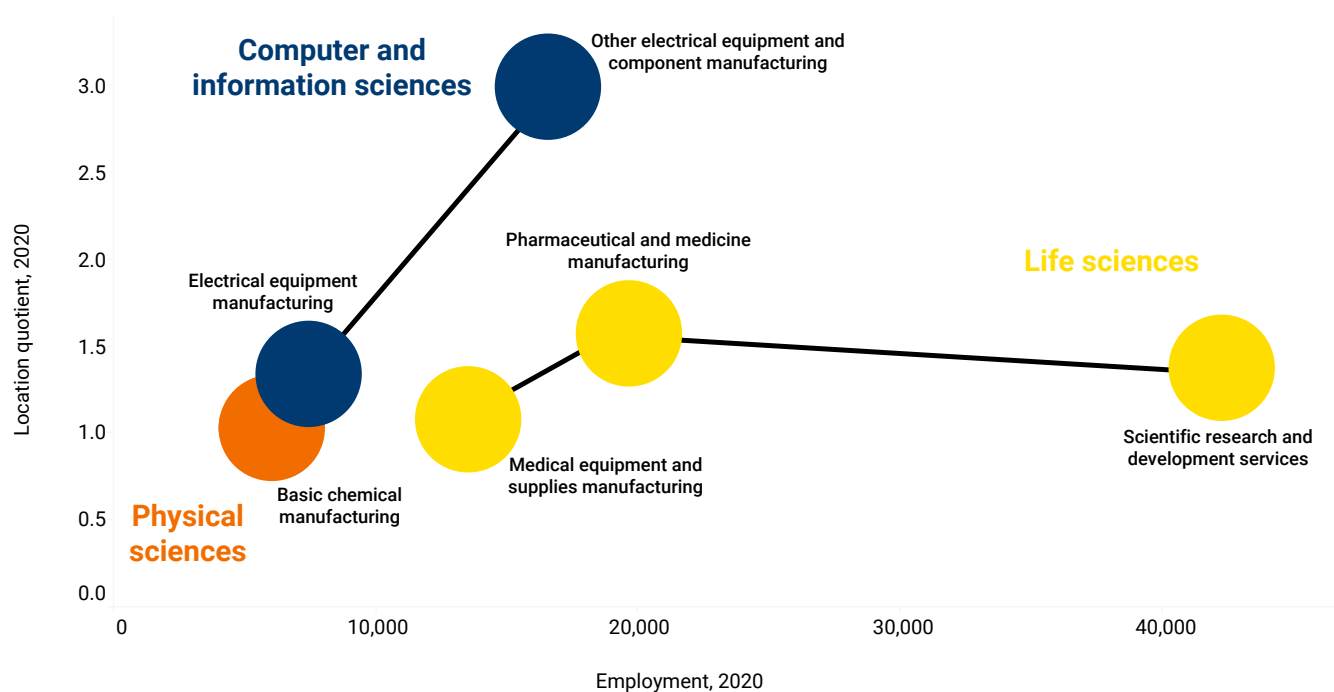
- **Life sciences.** Pharmaceuticals and medicines make up one of the most substantial industry concentrations in the state—an outgrowth of the strong life sciences presence in its higher education

institutions. In tandem with that presence, by 2020, pharmaceutical and medicine manufacturing employment was 58% more concentrated in Pennsylvania than in the U.S., according to data from Lightcast. Overall, seven counties accounted for 80% of Pennsylvania life sciences jobs in 2020, with more than 60% of the jobs concentrated in Southeast Pennsylvania and about 18% in Southwestern Pennsylvania.

The state's life sciences clusters don't stop at pharmaceutical and medicine manufacturing. Pennsylvania businesses also excel in R&D related to scientific research and development services, with a concentration that is almost 50% higher than that of the nation as a whole. Pennsylvania's business R&D in pharmaceuticals and medicines, engineering, and life sciences other than biotechnology stand out. Here too, the state's substantial research strengths have generated a significant cluster of economic activity, with employment in scientific research and development services 40% more concentrated in Pennsylvania than the U.S. overall.

FIGURE 12

Employment and location quotients for selected advanced industries in Pennsylvania, 2020



SOURCE: Brookings analysis of Lightcast data

- **Computer/information services and robotics.**

Likewise, a strong academic R&D enterprise in computer and information services (centered on Pittsburgh) has generated an extensive robotics and autonomy industry most visible in the electrical equipment, appliances, and components industry. Businesses conduct research in this field at a rate 2.2 times the national average. This research has spillover effects into other industries, with the state's employment concentration in several electrical equipment manufacturing industries ranging from between 1.3 and 3 times larger than the national average in electrical equipment manufacturing and other electrical equipment and component manufacturing, respectively.

- **Chemicals.** Pennsylvania businesses—especially in Southeastern Pennsylvania and the Allentown area—are also a hub for R&D and employment related to chemicals. Businesses in the state conducted R&D in the basic chemicals sector at 2.7 times the national level in 2020. R&D on resin, synthetic rubber, and artificial synthetic fibers and filaments was 3.4 times the national average in 2020, while it was 3.3 times higher for paint, coating, adhesive, and other chemicals. Demonstrating the linkages

to the state's agriculture industry, business R&D on pesticide, fertilizer, and other agricultural chemicals was 2.1 times the national average. Unfortunately, these strong business R&D outputs have not always translated into strong employment concentrations. Only two chemical industries had substantially above-average employment concentrations in Pennsylvania: Other Chemical Product and Preparation Manufacturing and Soap, Cleaning Compound, and Toilet Preparation Manufacturing. Basic chemical manufacturing—with about 6,000 jobs in 2020—had an about average employment concentration in 2020.

- **Plastics and rubber products.** The state's abundant hydrocarbon resources have helped generate above-average levels of R&D in plastics and rubber products, with a business R&D concentration 30% above the national average. Unsurprisingly, the state's concentration of 34,000 plastics product manufacturing jobs remains 52% denser than the national average. The state also possesses a 12% higher presence of petroleum and coal product manufacturing jobs. Metro area Erie and Scranton as well as Lancaster County and Southeastern Pennsylvania maintain the strongest concentrations of plastics activity.



HOWEVER, THE STATE'S ADVANCED INDUSTRIES HAVE SEEN ONLY MODEST EMPLOYMENT GROWTH

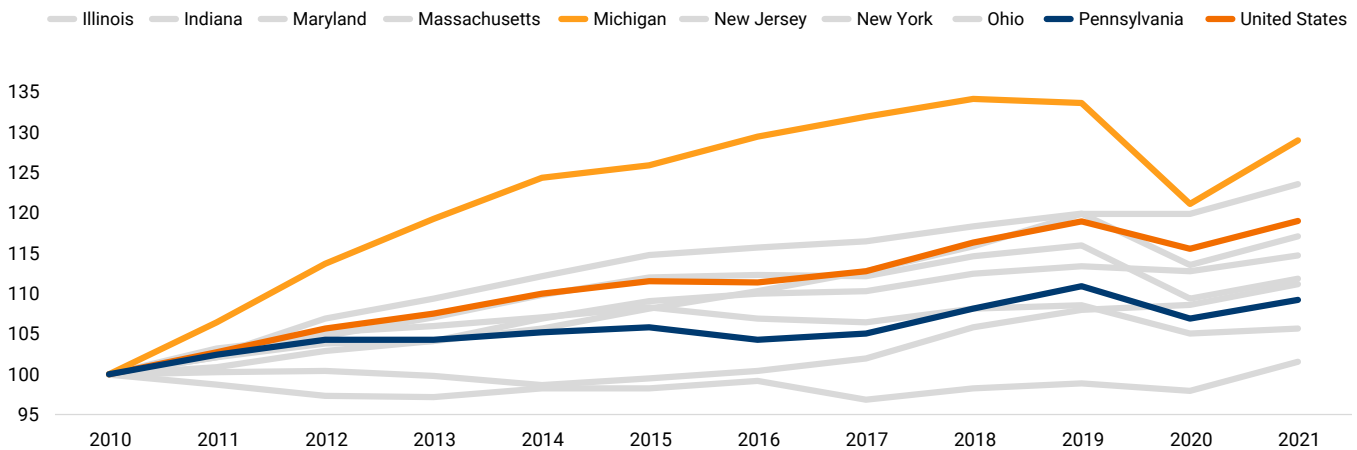
The emergence of compelling, research-driven innovation clusters holds out a major opportunity for Pennsylvania. Such clusters represent the possible starting point for dynamic advanced industry employment growth—a top goal of modern economic development.

And yet, for all of the potential of its clusters, Pennsylvania has had to make do with lagging growth in innovation-rich advanced industry jobs.

From 2010 to 2019, just before the onset of the COVID-19 recession, Pennsylvania saw its advanced industry jobs grow by an aggregate 10.9%. That lagged the nation as a whole by 8 percentage points. Overall, Pennsylvania ranked sixth out of nine peer states in terms of advanced industry job growth, lagging Indiana and Massachusetts by 9 percentage points, and Michigan by 23. During the pandemic years of 2020 and 2021, advanced industry employment in Pennsylvania shrank by 1.5 percentage points. This was in the mid-range of losses among peer states.

FIGURE 13

Indexed advanced industries employment growth in Pennsylvania, selected peer states, and US, 2010-2021 (2010=100)



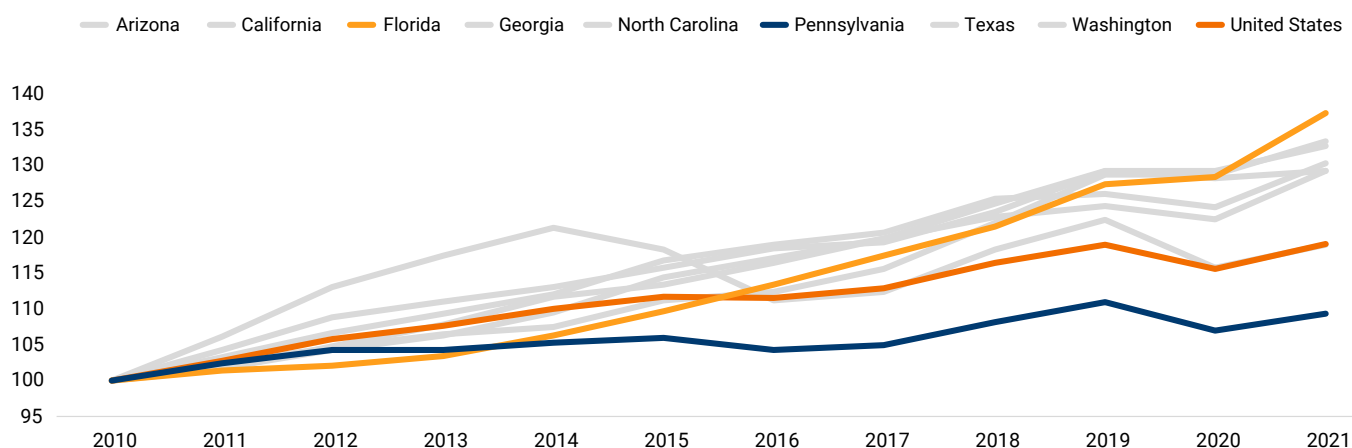
SOURCE: Brookings analysis of Lightcast data

As for comparisons with the selected high-growth states (with which Pennsylvania compares favorably on academic research), the lag in Pennsylvania's advanced industry employment growth looks even more severe. The state's advanced industry growth from 2010 to 2019 lagged each of the high-growth

states by at least 11 percentage points. While that gap closed somewhat in 2020 and 2021 as the pandemic took hold, Pennsylvania's growth from 2010 to 2021 was still nearly 10 percentage points behind the next closest state, Texas.

FIGURE 14

Indexed advanced industries employment growth in Pennsylvania, selected high-growth states, and US, 2010-2021 (2010=100)



SOURCE: Brookings analysis of Lightcast data

A closer look at individual advanced industries makes clear that these industries—the state’s highest-potential sources of high-quality, innovation-driven employment—have been growing at variable, often anemic, rates.

To be sure, Pennsylvania’s sizable scientific research industry added 14,500 jobs between 2015 and 2021—a 49% growth rate. The smaller software publishing industry added 8,600 jobs during that period, expanding its employment base by 153%. And the pharmaceutical and medicine manufacturing industry grew by 15%.

With that said, the aggregate advanced industry sector barely grew at all from 2015 to 2021. Medical equipment and supplies manufacturing grew only modestly, by 3%. Aerospace products went sideways. And for that matter numerous manufacturing, machinery, communications, and technology segments actually shed jobs.

In short, most of the state’s “crown jewel” advanced industries—the best reflection of its status as an innovation state delivering employment gains to its people—are moving sideways. More than half of these industries shed jobs across the last decade.

TABLE 1

Selected advanced industries employment in Pennsylvania, 2015-2021

Industry	2021 Jobs	2015 - 2021 Change	2015 - 2021 % Change
Software Publishers	14,248	8,617	153%
Scientific Research and Development Services	44,079	14,480	49%
Data Processing, Hosting, and Related Services	12,198	3,238	36%
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	7,291	1,037	17%
Pharmaceutical and Medicine Manufacturing	20,324	2,618	15%
Plastics Product Manufacturing	34,942	3,105	10%
Computer Systems Design and Related Services	74,980	6,034	9%
Other Information Services	9,195	725	9%
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	14,842	834	6%
Basic Chemical Manufacturing	6,059	190	3%
Industrial Machinery Manufacturing	5,322	161	3%
Medical Equipment and Supplies Manufacturing	13,575	409	3%
Other General Purpose Machinery Manufacturing	11,812	267	2%
Aerospace Product and Parts Manufacturing	10,292	159	2%
Other Electrical Equipment and Component Manufacturing	16,225	165	1%
Electrical Equipment Manufacturing	7,146	-30	0%
Other Miscellaneous Manufacturing	11,563	-424	-4%
Wired and Wireless Telecommunications Carriers	25,006	-984	-4%
Medical and Diagnostic Laboratories	10,550	-538	-5%
Metalworking Machinery Manufacturing	9,365	-1,340	-13%
Semiconductor and Other Electronic Component Manufacturing	8,872	-1,665	-16%
Agriculture, Construction, and Mining Machinery Manufacturing	7,035	-2,205	-24%
Motor Vehicle Parts Manufacturing	6,546	-2,119	-24%
Support Activities for Mining	8,467	-6,961	-45%
Advanced Industries (all)	442,157	13,853	3%

NOTE: Industries with less than 5,000 workers are excluded from the list

SOURCE: Brookings analysis of Lightcast data



Behind the trends: Four challenges for Pennsylvania innovation

Behind Pennsylvania's mixed innovation performance lie a number of challenges that represent urgent economic problems. These challenges are almost certainly limiting the state's full realization of its innovation sector's potential.

Accordingly, this section details four particular challenges that continue to hold the state back, despite its many assets. Along these lines this report notes that:

- The commonwealth lacks a clear commitment to supporting statewide innovation programs and has let its core innovation programs languish.
- The state economy lags on converting top-quality research into new firms and employment growth.
- Innovation is in decline outside of the state's larger metro areas.
- The innovation economy is unequal by race and gender.

CHALLENGE #1: THE COMMONWEALTH LACKS A CLEAR COMMITMENT TO INNOVATION AND HAS LET ITS CORE INNOVATION PROGRAMS LANGUISH

The first problem the commonwealth faces is that its earlier innovation stance has blurred in the last decade. At a moment of heightened inter-state competition, peer states such as Massachusetts and New Jersey have assembled sharp strategy reports, aggressive marketing campaigns, and high-profile new programs to secure the benefits of innovation.¹⁹ (As noted earlier, Brookings previously inventoried some of these state efforts in a 2019 report.) By contrast, Pennsylvania state government has gone adrift on the work of shaping a compelling, forceful vision of innovation's importance; communicating that; and using it to marshal its assets.

In this vein, two particular problems stand out:

- The state lacks a high-profile vision and messaging on innovation
- Years of disinvestment have eroded the size and relevance of the state's innovation efforts

The state lacks a high-profile vision and messaging on innovation

Dynamic state performance depends on the articulation of a strong vision that can drive high-level unity and organizing. For that reason, multiple states have moved in recent years to raise the prominence of innovation among their citizens, whether via the governor's bully pulpit or through the publication of glossy, high-visibility vision and progress reports.²⁰

In Pennsylvania, however, less of that has occurred. To its credit, the Wolf administration announced a meaningful budget proposal to fuel innovation across the state in 2020 and then moved to establish an evidence-based statewide annual innovation report. Even so, these gestures have remained relatively low-profile—and insufficient for mobilizing the state after more than a decade of neglecting the topic. One signal of that is the fact that Pennsylvania's last major effort to assess its innovation economy and make recommendations—the TechFormation report—dated to 2005.²¹ That means Pennsylvania lacked a statewide innovation strategy and reference for nearly 15 years.

Nor does Pennsylvania's current highlighting of innovation seem equal to the moment. The Department of Community and Economic Development (DCED) deserves credit for enlisting a volunteer team of graduate students from Carnegie Mellon University to develop its 2021 Pennsylvania's Innovation Economy annual report. And the Carnegie Mellon team's work is excellent.²² However, state government's overall articulation of the importance of innovation has remained makeshift and low-profile. For example, the state's Pennsylvania Innovation Economy Dashboard—which assembles metrics from the Carnegie Mellon report—remains unreachable from the DCED homepage. Relatedly, the state has neglected to actively promote the strengths of its innovation economy, either within the state or externally. For example, DCED's budget for marketing to attract business (used for all kinds of business attraction opportunities, not just ones related to innovation firms) has hovered in the vicinity of just \$2 million a year for most of the last decade—down from \$4 million to \$5 million before 2010.²³

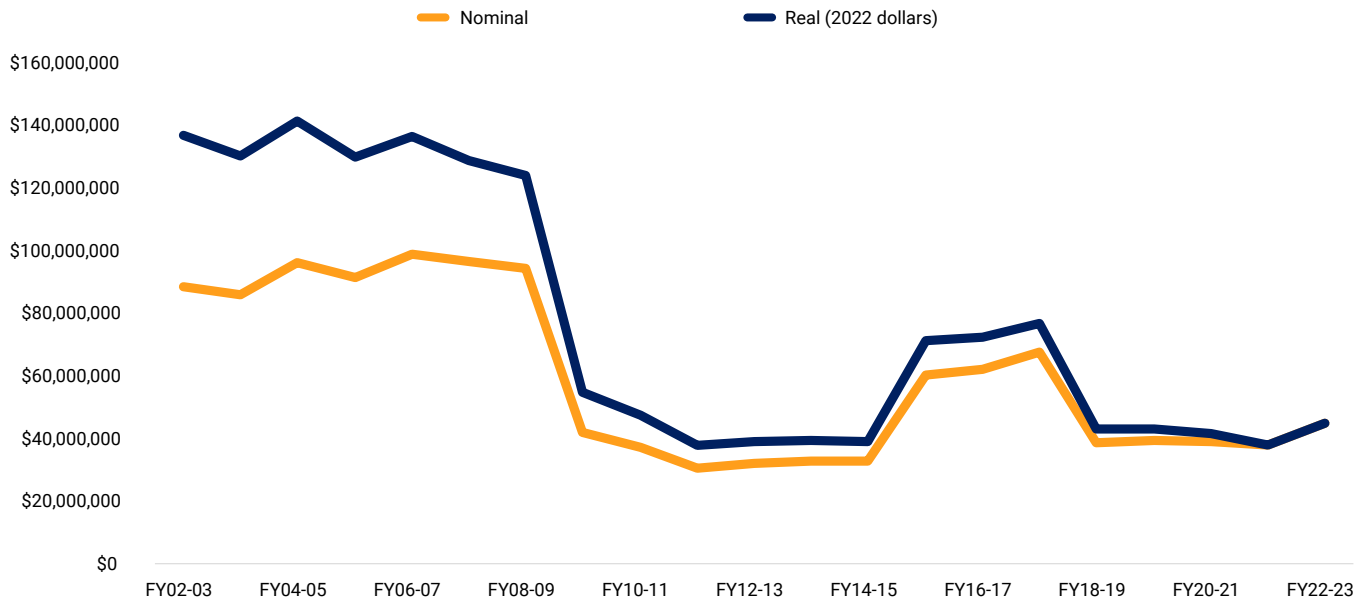
Years of disinvestment have eroded the size and relevance of the state's innovation efforts

More fundamentally, years of budget-cutting, legislative gridlock, and neglect have left the commonwealth's innovation programs and platforms in a state of decline. And while the Wolf administration has proposed greater investments in the state's innovation ecosystem in recent years (some of which were adopted by the General Assembly), overall real investment remains far below where it was 15 years ago.

Most starkly, Pennsylvania massively reduced its investments in innovation during the Great Recession and has failed to rebuild its initiatives in subsequent years.²⁴ Overall, these reductions saw the state's aggregate innovation expenditures in DCED and other programs plunge from an annual \$90 million or so during the 2000s to \$42 million in FY 2010 and \$45 million in FY 2022. (All of these are nominal numbers; in real 2022 terms, the innovation budget has plummeted from around \$130 million in the 2000s to \$55 million in FY 2010 to \$45 million now).

FIGURE 15

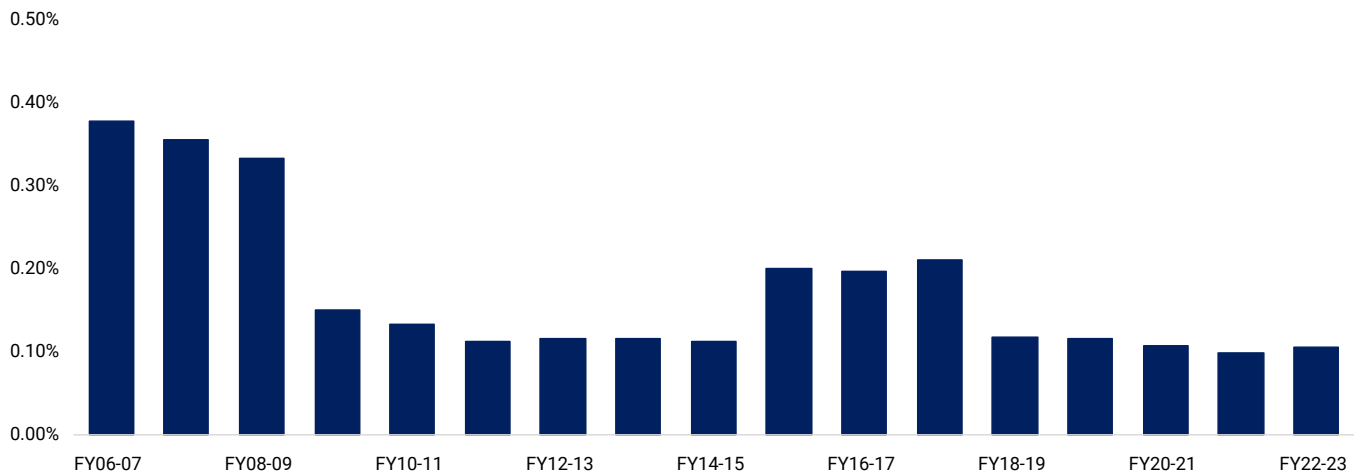
Core innovation funding in Pennsylvania, FY 2003 – FY 2023



SOURCE: Brookings analysis of Pennsylvania Department of Community and Economic Development data

FIGURE 16

Core innovation funding as a percentage of state budget in Pennsylvania, FY 2006 – FY 2023



SOURCE: Brookings analysis of Pennsylvania Department of Community and Economic Development and Office of the Budget data

In the mid-2010s, this deterioration was partially mitigated through the sale of \$100 million of insurance premium tax credits.²⁵ Since then, however, the tax

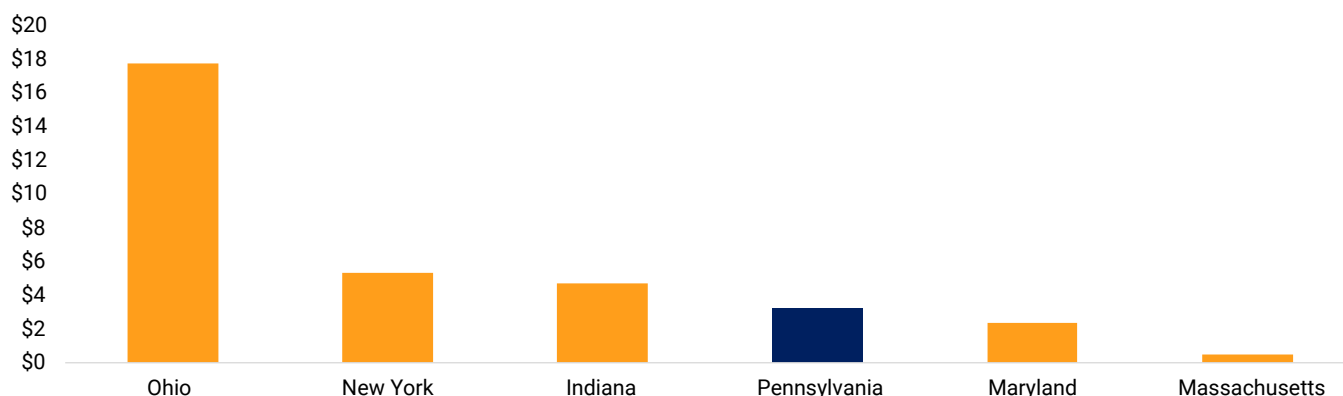
credit sale funding has expired, leaving innovation investment levels in the area of \$38 million to \$39 million in recent years.²⁶

To its credit, the Wolf administration took steps to halt this disinvestment by proposing significant new investments into key innovation programs in its most recent budget proposals.²⁷ As mentioned earlier, some of those proposals were included in the budget the state legislature passed, albeit at lower levels of funding.²⁸ Still, even with these new investments, overall innovation funding in the state remains below where it was from FY 2015-2018, and well below its pre-2008 levels.

As to how this stacks up against benchmark states, data from the Council for Community and Economic Research (C2ER) shows Pennsylvania trails top peer states in its per capita state expenditure on tech transfer activities (“tech transfer” in C2ER’s data refers to various programs aimed at supporting the development and adoption of new ideas in business).²⁹ Specifically, Pennsylvania ranks just fourth out of six among the peer states for which C2ER has data, with its expenditure level on tech transfer just one-fifth that of Ohio (\$3.20 per person versus \$17.80).

FIGURE 17

Average per capita state expenditure for tech transfer in Pennsylvania and selected peer states, FY 2020 – FY 2022



SOURCE: Brookings analysis of data from Council for Community and Economic Research and Census Bureau

And while C2ER shows its tech transfer investments as minimal over the past three years, Massachusetts has invested over \$1.6 billion in its life sciences industry since 2008 through its Massachusetts Life Sciences Initiative.³⁰ Meanwhile, Maryland is exploring the creation of a \$500 million Maryland Equitech Growth Fund within TEDCO, the state’s technology-based economic development entity.³¹ So even though those states rank behind Pennsylvania in terms of tech transfer investment in the last three years, they are nonetheless making sizeable investments in innovation that aren’t reflected in Figure 17.

These lower funding levels, in any event, have left Pennsylvania’s innovation offerings small and behind the curve. For their part, the Life Sciences

Greenhouse Initiative and the Ben Franklin Technology Partners network remain meritorious, but are in many cases underfunded renditions of 20- or 30-year-old departures. In other cases, programs are too small to make a difference. And more broadly, the absence of substantial new investments or programs means the state’s offerings fail to support modern priorities such as regional cluster-building, bottom-up ecosystem strategies, or strategic sector initiatives. Ultimately, the state’s inability to coalesce around innovation support has left it watching competitor states stand up programs such as the \$2.3 billion, 20-year-old Ohio Third Frontier in the last decade.³² In sum, the combination of a vision gap and a funding gap has gutted the state’s ability to stay at the forefront of efforts to leverage innovation for economic growth.

CHALLENGE #2: THE STATE LAGS ON CONVERTING TOP-QUALITY RESEARCH INTO GROWTH FIRMS AND BROADER EMPLOYMENT GROWTH

Pennsylvania universities are powerhouses, with many boasting top-echelon strengths in scientific research. Only a few states' institutions conduct more such research. Yet for all that, the conversion of leading-edge science and technology into business expansions and employment growth in Pennsylvania remains spotty and insufficient.

This matters because new businesses account for nearly all net job growth in the U.S., with innovative startups and growth companies having the potential to crack global markets and achieve high rates of growth.

Unfortunately, the state's high concentration of university research in commercially relevant fields is still not resulting in prolific new-firm creation, rapid scale-ups, or broad-based advanced industry sector growth.³³

What has resulted is a state economy over-indexed toward scientific potential and under-indexed toward broad-based industry growth. Underlying this disconnect are several addressable issues:

- Shortcomings in the state's entrepreneurial ecosystems are likely impeding new-firm creation and scale-up in advanced industries
- Reduced state investment has weakened efforts to bolster tech ecosystems and help companies scale up

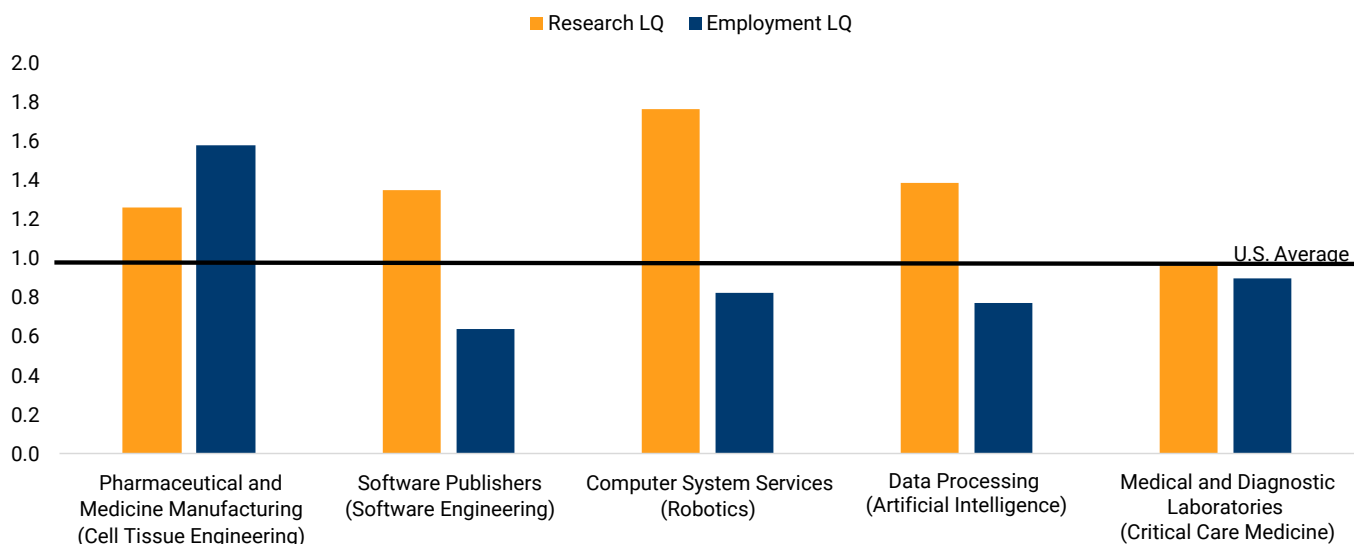
Shortcomings in the state's entrepreneurial ecosystems are likely impeding new-firm creation and scale-up in advanced industries.

Building on previous work by Brookings in Pittsburgh, this report documents uneven links between Pennsylvania's academic research strengths and its ability to generate advanced industry employment gains.³⁴ Most notably, wide gaps persist between the strong academic prowess of Pennsylvania anchor institutions and the modest employment growth of several pertinent advanced industries.

To be sure, the state's strong research presence in the pharmaceutical and medicine field has yielded above-average employment concentrations. However, employment levels have otherwise lagged the national level in an array of technology domains—ranging from software engineering and robotics to AI—in which the state's universities maintain strong scientific expertise. Only in the pharmaceutical and the life sciences realm has Pennsylvania's research generated large-scale employment commensurate with its scientific leadership.

FIGURE 18

Pennsylvania's research activity and industry employment; location quotients in select fields, 2020



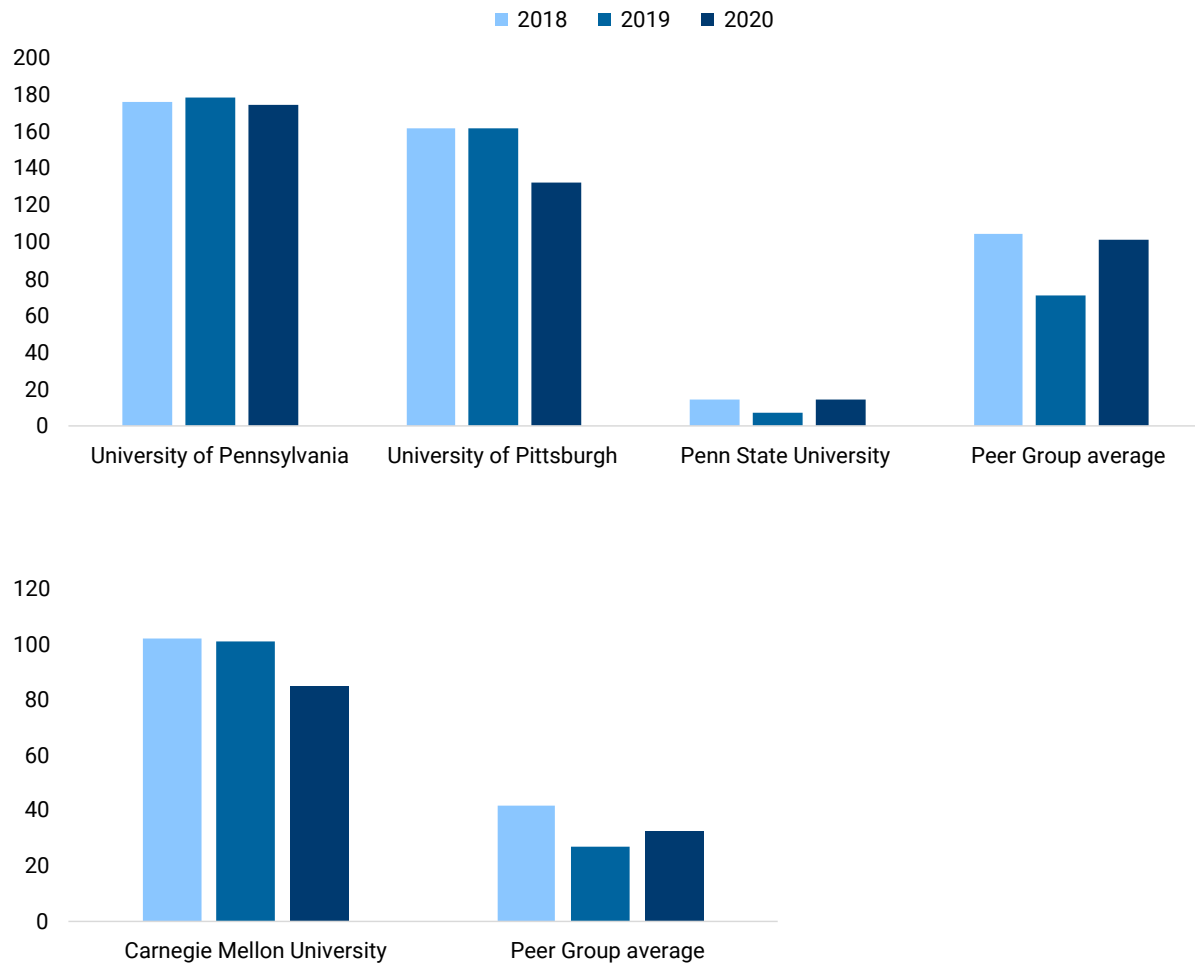
SOURCE: Brookings analysis of data from Lightcast, TEconomy, and World of Science

To explain such variability, discussion often raises questions about lethargic tech transfer activities within the state's anchor institutions. And it's true that Pennsylvania universities' tech transfer activities vary in outcome. Yet data from the Association of University Technology Managers show that Pennsylvania universities perform very to quite well on measures of technology transfer. The University of Pennsylvania and the University of Pittsburgh both far exceed tech transfer norms for U.S. universities conducting large amounts of research and transfer activities. For its

part, Carnegie Mellon also far exceeds its cohort of universities with middle-sized tech-transfer activities, while Drexel and Temple universities perform near the norm for their set of similarly active schools. Only Penn State performs far below the (large-school) norm on measures of intellectual property licensing and start-up formation, though this may in part owe to the university's sizable involvement in military and space activities for which traditional licensing opportunities may be limited).³⁵

FIGURE 19

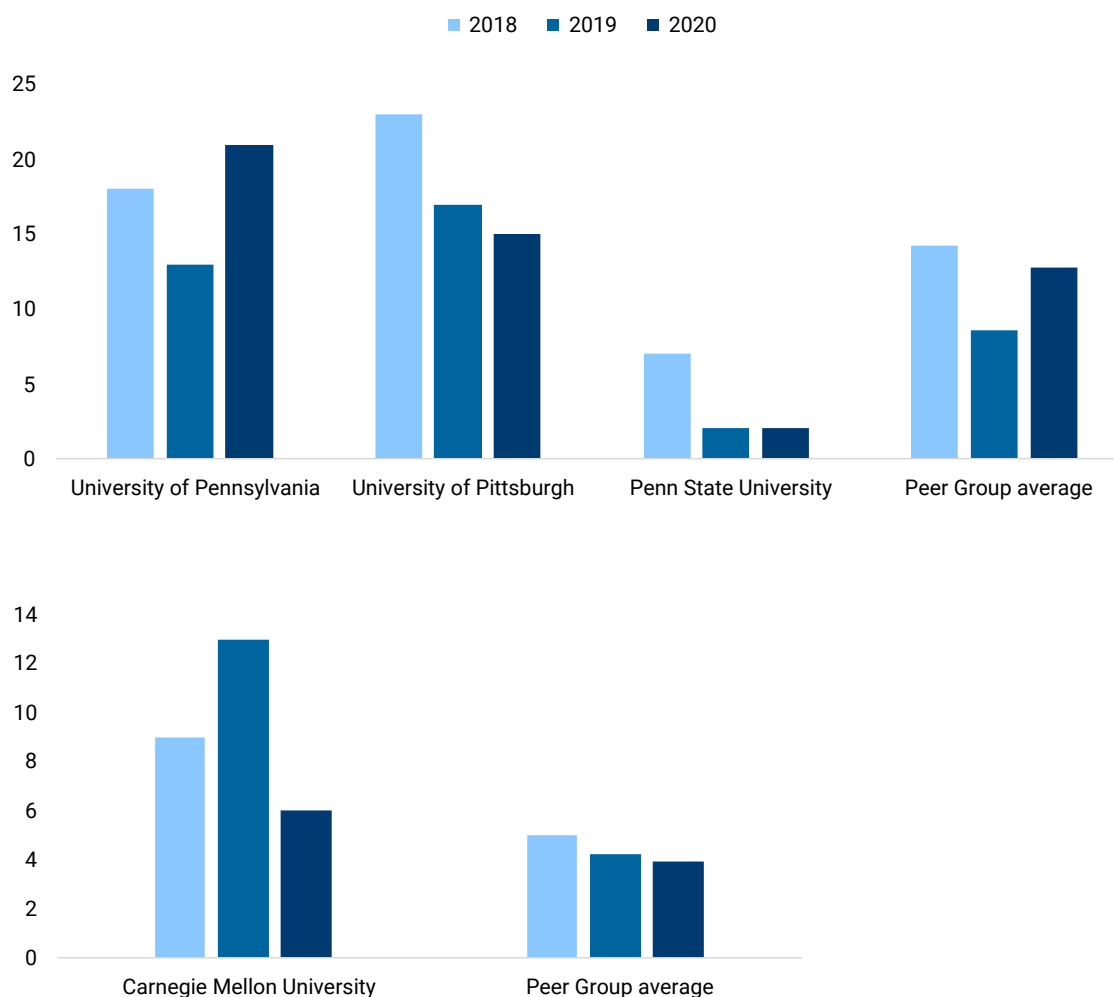
Licenses and options executed in selected research institutions in Pennsylvania, 2018-2020



SOURCE: Association of University Technology Managers data

FIGURE 20

Startups formed in selected research institutions in Pennsylvania, 2018-2020



SOURCE: Association of University Technology Managers data

Given that, inattentive anchor institutions do not appear to be the main limit on innovation sector commercial development in the state. In fact, Pennsylvania anchor institutions are frequently doing a *better* job than their peers in executing licenses for commercial development of university research and seeing the formation of spinoff firms around university licenses.

What looks more concerning for the Pennsylvania innovation scene appears to be problems outside the universities' gates: shortcomings of the state's wider ecosystem for fostering the creation and growth of innovative firms.

Innovation often begins with cutting-edge technical work inside an institutional anchor, but it almost always depends on an array of external assets, resources, services, programs, and spaces across a supportive region. Great anchor institutions provide critical technology inputs, but a supportive surrounding region is needed to provide a nurturing local environment conducive to firms' successful growth. Such supports may include people and programming to provide advice, skills, and financing; networks to supply community and information; or physical spaces for convening and offices. In short, innovation depends on the emergence of supportive regional ecosystems that provide a nurturing habitat for new firms.

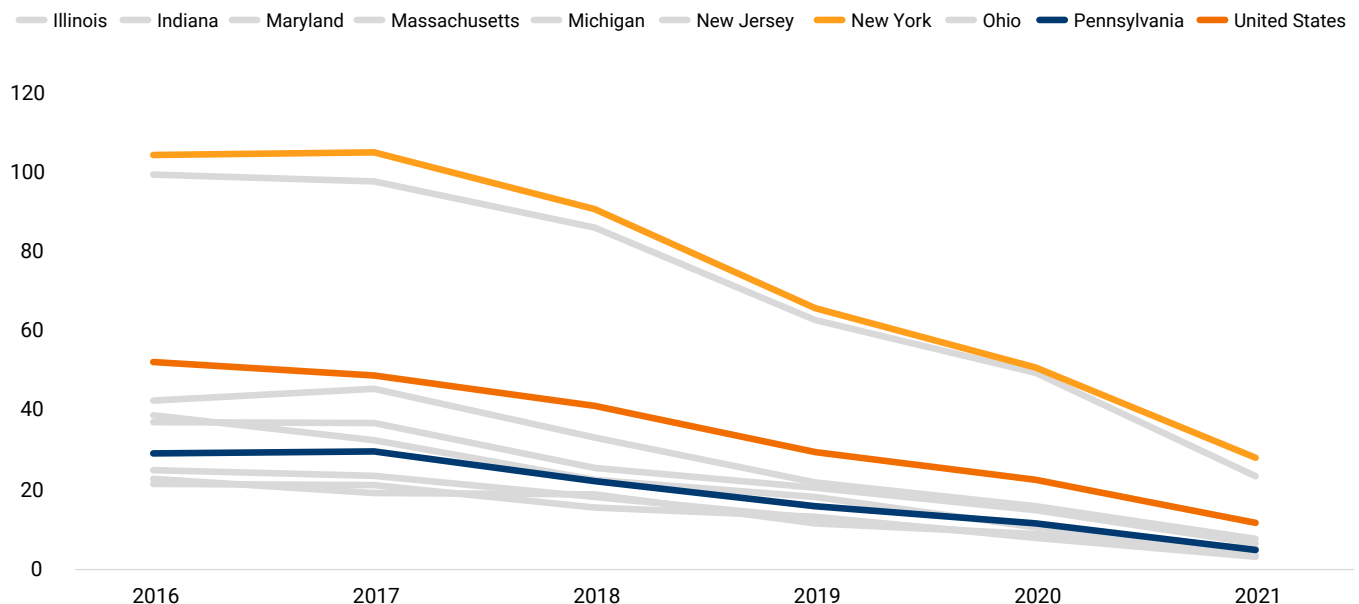
Unfortunately, several strands of evidence raise doubts about whether Pennsylvania is providing a truly nurturing ecosystem for the creation, survival, and dynamic growth of new advanced industry firms and employment.

Disappointing new-firm start rates in tech segments—consistent with the state’s slow advanced industry employment growth—reinforce the impression of

deficiencies in the state’s innovation ecosystem. To be sure, tech firm starts in advanced industries have been slowing in all states in recent years, as measured by Crunchbase. Even so, the state’s low level of startups—just 4.9 per 1 million population—ranks last among high-growth states, and trails all but two peers; it also runs at less than half the national average of 11.8 startups per 1 million residents.

FIGURE 21

New tech firms in advanced industries per million people in Pennsylvania, selected peer states, and US, 2016-2021

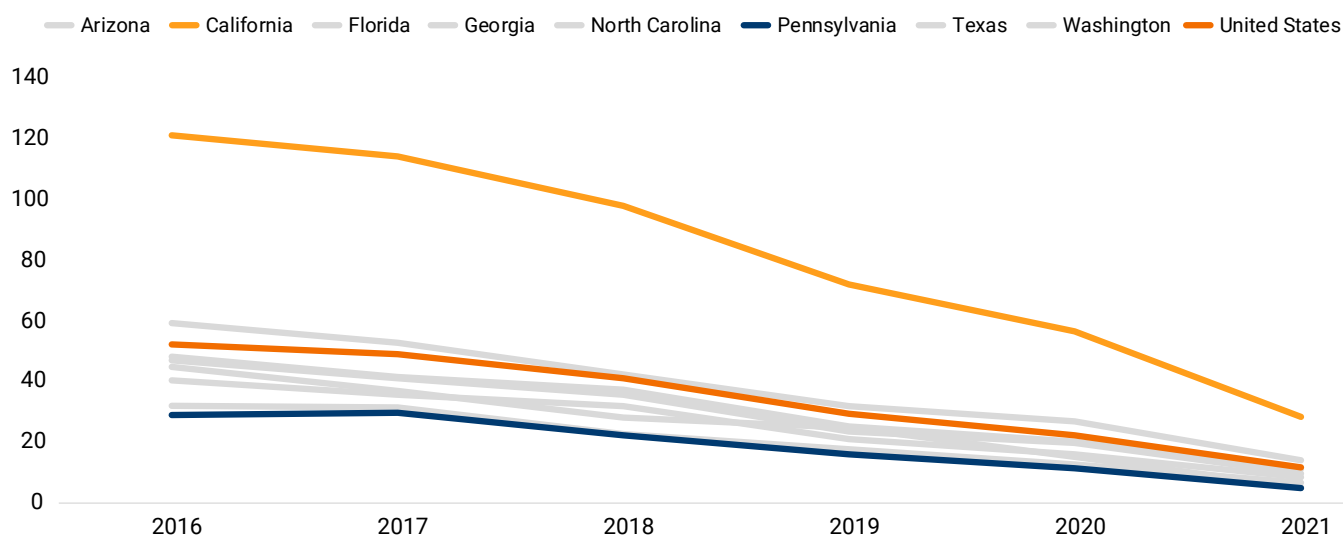


NOTE: Industry groups included in this analysis are: Apps, Artificial Intelligence, Biotechnology, Commerce and Shopping, Consumer Electronics, Content and Publishing, Data and Analytics, Design, Energy, Financial Services, Gaming, Hardware, Information Technology, Internet Services, Manufacturing, Messaging and Telecommunications, Mobile, Natural Resources, Navigation and Mapping, Payments, Platforms, Privacy and Security, Professional Services, Sales and Marketing, Science and Engineering, Software, Sustainability, and Transportation. Data was last updated in May 2022.

SOURCE: Brookings analysis of Crunchbase and Census Bureau data

FIGURE 22

New tech firms in advanced industries per million people in Pennsylvania, selected high-growth states, and US, 2016-2021



NOTE: Industry groups included in this analysis are: Apps, Artificial Intelligence, Biotechnology, Commerce and Shopping, Consumer Electronics, Content and Publishing, Data and Analytics, Design, Energy, Financial Services, Gaming, Hardware, Information Technology, Internet Services, Manufacturing, Messaging and Telecommunications, Mobile, Natural Resources, Navigation and Mapping, Payments, Platforms, Privacy and Security, Professional Services, Sales and Marketing, Science and Engineering, Software, Sustainability, and Transportation. Data was last updated in May 2022.

SOURCE: Brookings analysis of Crunchbase and Census Bureau data

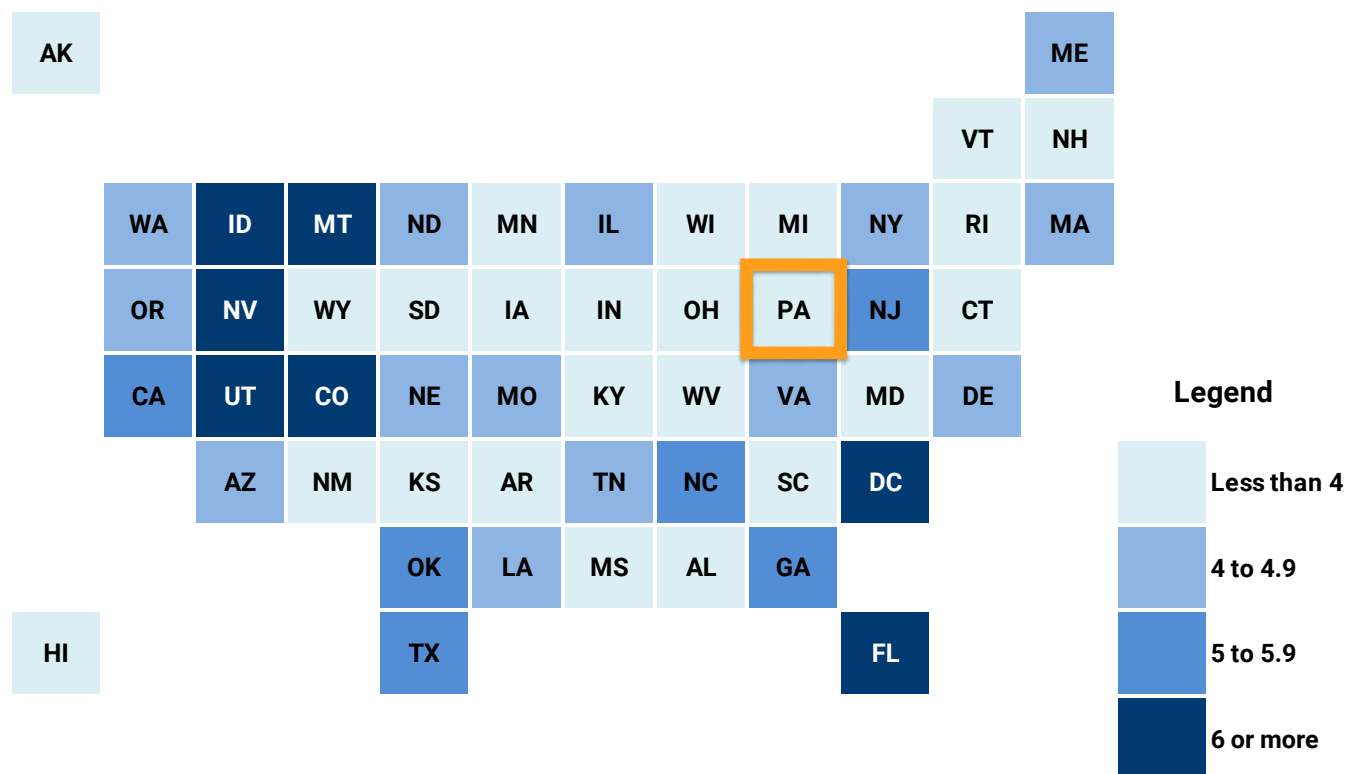
To be sure, new-firm start rates in tech exceed the state average in Philadelphia and Pittsburgh (where they reach 7.2 and 5.9 starts per 1 million people). Yet even those rates trail not just those of growth state metro areas such as Atlanta and Charlotte, N.C., but also the startup rates notched by the most innovative of slow-growing peer state metro areas such as Boston, Chicago, and New York. Similarly, the state's standing on new-firm starts and growth in all sectors remains

middling—another signal of shortcomings in its growth ecosystem.

For one, an unusually small share of Pennsylvanians start new businesses, according to a measure from the Ewing Marion Kauffman Foundation.³⁶ For another, Pennsylvania startups of all kinds tend to be extremely slow to add jobs in their first year of operation.³⁷

FIGURE 23

Average number of jobs created by startups in their first year (normalized by population), 2021



SOURCE: Ewing Marion Kauffman Foundation data

According to the Kauffman data, Pennsylvania startups create only 3.43 jobs in their first year on average—a growth level that trails not only the U.S. average of 4.74 jobs per startup but all of the state’s peers except Maryland. This data suggests Pennsylvania may not be a particularly supportive environment for launching and growing a new firm.

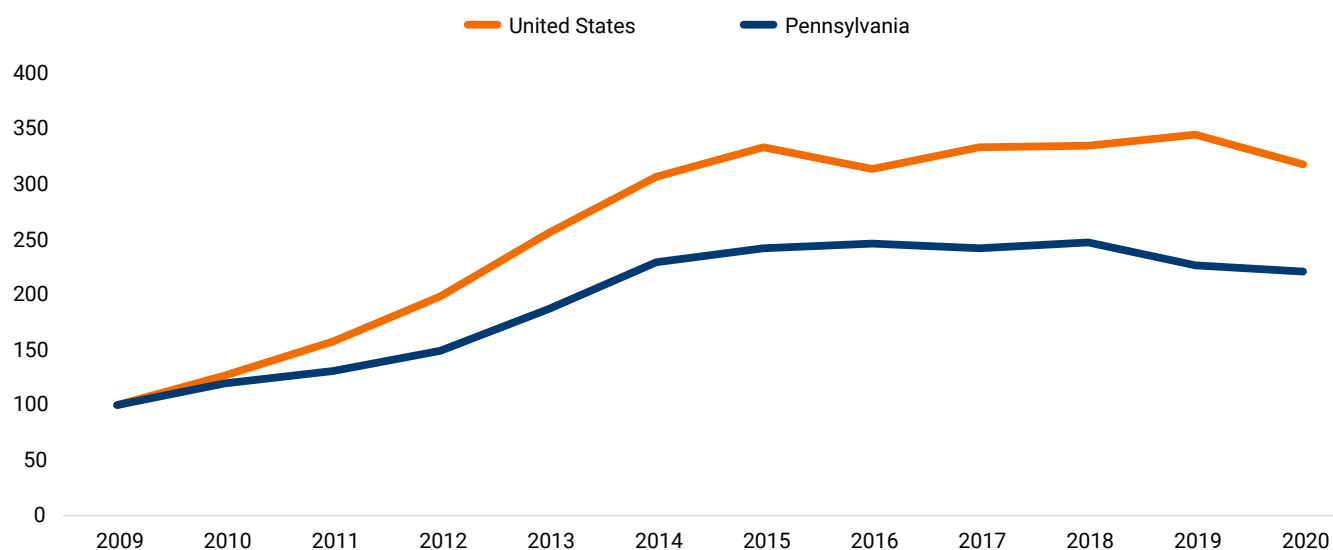
Adding to the picture of ecosystem thinness are gaps in the state’s innovation finance scene. Pre-seed and other startup support activities remain thin even in Pennsylvania’s innovation hubs. Award funding from the highly selective federal Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) assistance programs remains below where it could be given the size of the state’s overall economy and its level of higher education

research, while support from DCED programs remains insufficient.

At the same time, the publicity around a number of blockbuster Philadelphia and Pittsburgh venture capital (VC) deals in recent years should not divert attention from the only modest increases in deal flow. To be sure, total Pennsylvania VC disbursements reached decade highs in the most recent three-year period, in keeping with a national surge in VC deals.³⁸ However, while national VC deal flow more than doubled in the last decade, it grew by much less in Pennsylvania, even despite the bright spots in Philadelphia and Pittsburgh. To be specific, Pennsylvania VC deals rose by just 98% between 2009-11 and 2018-20, compared to 160% nationally. This reflects more shortcomings in the state’s innovation and entrepreneurship habitats.

FIGURE 24

Indexed venture capital deal growth in Pennsylvania and US, 2009-2020 (2009=100)



SOURCE: Brookings analysis of National Science Foundation data

Overall, slow population growth is surely part of the state's lag in vibrancy lag. But deficiencies in its innovation ecosystems are also likely part of the story. In this regard, statistics are only suggestive; equally informative are the gaps the local participants and reports frequently highlight.

In Philadelphia, participants in the region's breakout cell and gene therapy cluster worry about inadequate links to the community in expanding efforts to produce needed lab technicians and service providers. The same participants as well as those in other fields also point to early-stage capital shortages and siloed organizations.

In Pittsburgh, a strategy report produced for the region's high-potential autonomous systems sector detailed numerous gaps in the local ecosystem: the lack of a central convening organization; a shortage of entrepreneurial support activities; a need for more social and promotional events; and a variety of risk-capital gaps, including a lack of locally based venture funds for early-stage investments.³⁹ Similarly, an unpublished white paper prepared by a participant in the region's life sciences sector described a series of rifts in that sector's ecosystem, including the absence

of a core regional life sciences convenor; a lack of affordable space for new companies; a lack of firm-support services; a need for more corporate guidance experts; and a need for more experienced advisory services.⁴⁰

And in other regions, entrepreneurs complain about the thinness of available ecosystem services and supports, such as spotty signposting of resources, the absence in some communities of centrally located incubation or accelerator facilities, and a lack of entrepreneur support organizations (ESOs) and expert advice.⁴¹ Given that support services and organizations such as the Small Business Development Centers, Industrial Resource Centers, and Ben Franklin Technology Partners all operate in those regions, Pennsylvania likely needs to do a better job of enabling those organizations to support the communities they serve, including by providing more resources and greater visibility.

In sum, a variety of signals suggest Pennsylvania has much more of an ecosystem problem than a tech transfer one. Pennsylvania anchor institutions are as efficient as those anywhere in converting innovative technology into new private firms. However, the state's

local and statewide innovation ecosystems are in many cases not providing the full complement of items—ranging from physical space to entrepreneurship services to capital—needed to support broad, high-gain commercialization and in-state job creation.

Reduced state investment has weakened efforts to bolster entrepreneurial ecosystems and help companies scale up

State policy is important in ecosystem-building. Certainly, much ecosystem activity happens organically, though private sector action alone. Even so, state and other public sector actors almost always play an important supportive role in filling the gaps in the local support system.

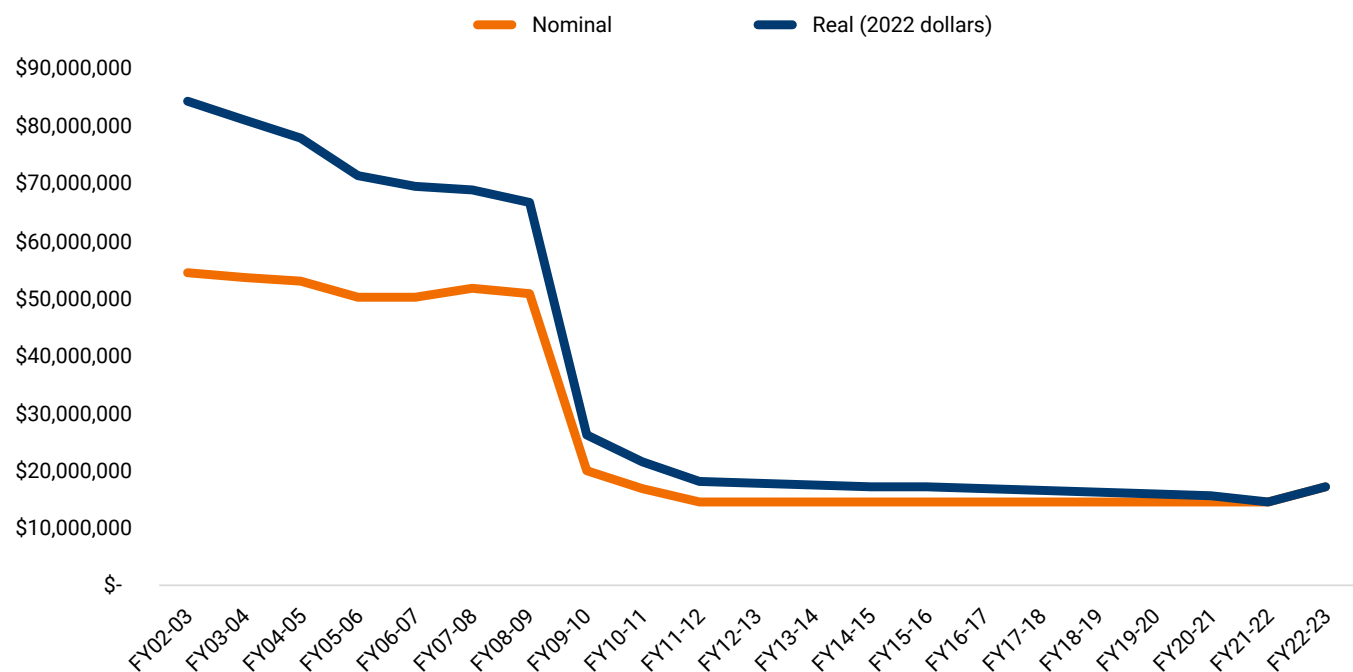
And yet, during the 2008-09 budget cycle, Pennsylvania significantly scaled back its pathbreaking earlier

investments in innovation inputs and ecosystem-building, and then never restored those investments to pre-Great Recession levels. To be sure, the new FY 2022-23 budget takes steps to replace some of the lost support. But a close look at the previous funding declines confirms that some of the most disruptive cuts have hit the programs most involved in on-the-ground ecosystem-building, including:

- Cuts to the Pennsylvania Life Sciences Greenhouse Initiative, which have hurt its ability to provide critical early-stage funding and sector-specific business advice out of locations in Harrisburg, Pittsburgh, and Philadelphia.
- Major reductions to the Ben Franklin Technology Development Authority (the state's main technology development entity), which have led to cutbacks in key innovation and entrepreneurship offerings.

FIGURE 25

Ben Franklin Technology Development transfer funding, FY 2003 – FY 2023



SOURCE: Brookings analysis of Pennsylvania Department of Community and Economic Development data

Most notably, cuts to the signature Ben Franklin Technology Partners network have reduced its ability to provide seed capital and expert advice to early-stage and other companies out of its regional hubs in the Lehigh Valley, Pittsburgh, Philadelphia, and State College.

At the same time, broader reductions in funding around that time forced the Ben Franklin Technology Development Authority to zero-out support for a variety of innovation-oriented programs.⁴² These included:

- The Keystone Innovation Zone (KIZ) grant program, which provided operational grants for the state's 29 designated KIZs, with the goal of supporting R&D, tech commercialization, and entrepreneurship within designated geographic areas.
- Technology Development Grants, which sought to advance technology adoption and the creation of high-wage jobs.
- University Research Grants, which sought to foster stronger synergies between university-based R&D and state economic development and workforce development.
- The Pennsylvania Angel Network, which has supported angel investing around the state.

Beyond these reductions are several missed opportunities to improve the state's offerings for fostering small-business commercialization. One is the state's lack of a matching grant for firms that win awards from the federal government's highly competitive SBIR and STTR programs for research and product development with the goal of commercialization. At least 26 states use such matching grants to provide additional commercialization funds to highly promising innovation businesses, but Pennsylvania does not.⁴³

At the same time, the state's Research and Development Tax Credit Program (with \$11 million of its recent \$55 million award pool reserved for small businesses) provides a critical support for hundreds of small innovation companies and has been heavily oversubscribed every year since its creation in 1997.⁴⁴ That the \$55 million statewide cap was increased this summer by \$5 million in the FY 2022-23 budget after a decade of stagnation is a welcome—though modest—adjustment.

In short, notwithstanding its incredible promise, Pennsylvania has not been providing the full complement of investments necessary to produce a truly supportive set of regional innovation and commercialization ecosystems.



CHALLENGE #3: INNOVATION IS IN DECLINE OUTSIDE OF THE STATE'S LARGER METRO AREAS

To be sure, innovation is taking place in every region of Pennsylvania. Whether it's patenting activities or advanced industry enterprise, the Pennsylvania innovation economy supports productive work across the entire state. With that said, the state's innovation economy is unevenly distributed and struggling with stark regional divides and spatial divergence.

And while it's not realistic to expect innovation to be at the same level in the state's smaller communities as it is in larger innovation hubs, it's nonetheless problematic when smaller places are losing ground or even seeing outright declines in their innovation activity, as is the case in many regions across Pennsylvania.

These divides are important because they depress the state's innovation activity, leave ideas on the table, and separate many Pennsylvanians from the state's best opportunities. Along these lines, the state increasingly contends with two serious geographic challenges that are impeding the state's innovation economy:

- University-based innovation activity remains sparse in areas far from the state's three major academic hubs
- Advanced industry employment and vibrancy lag in the state's smaller places

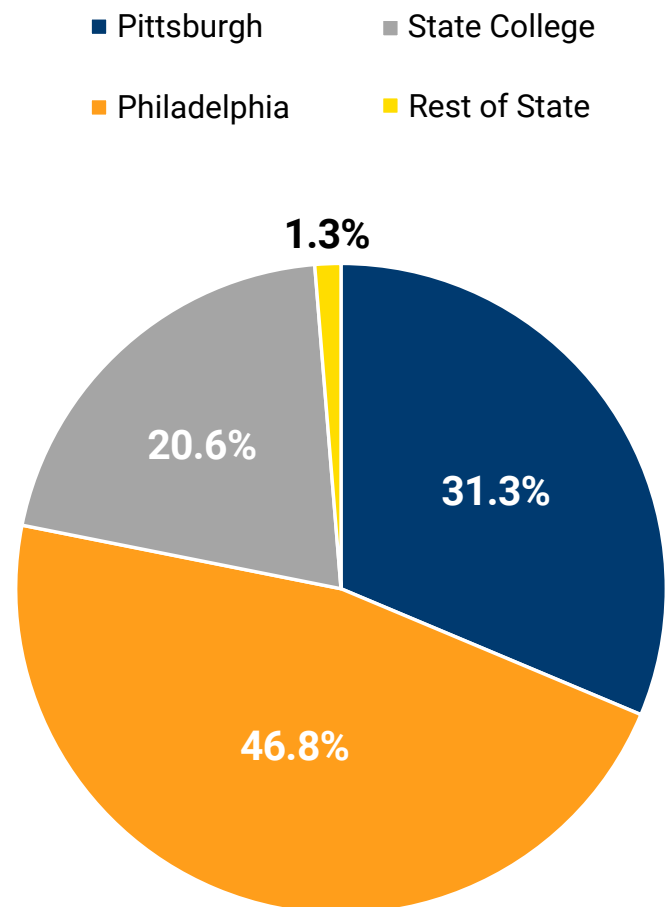
University-based innovation activity remains sparse in areas far from the state's three major academic hubs

Wide swaths of Pennsylvania lag on measures of innovation because few of them participate in the state's main university-based research and technology activity. In fact, most counties are experiencing low and falling participation in university R&D and patenting activities—key bases of innovation.

Overall, roughly 99% of the state's higher education R&D takes place in the state's three major university hub metro areas: Philadelphia, Pittsburgh, and State College.

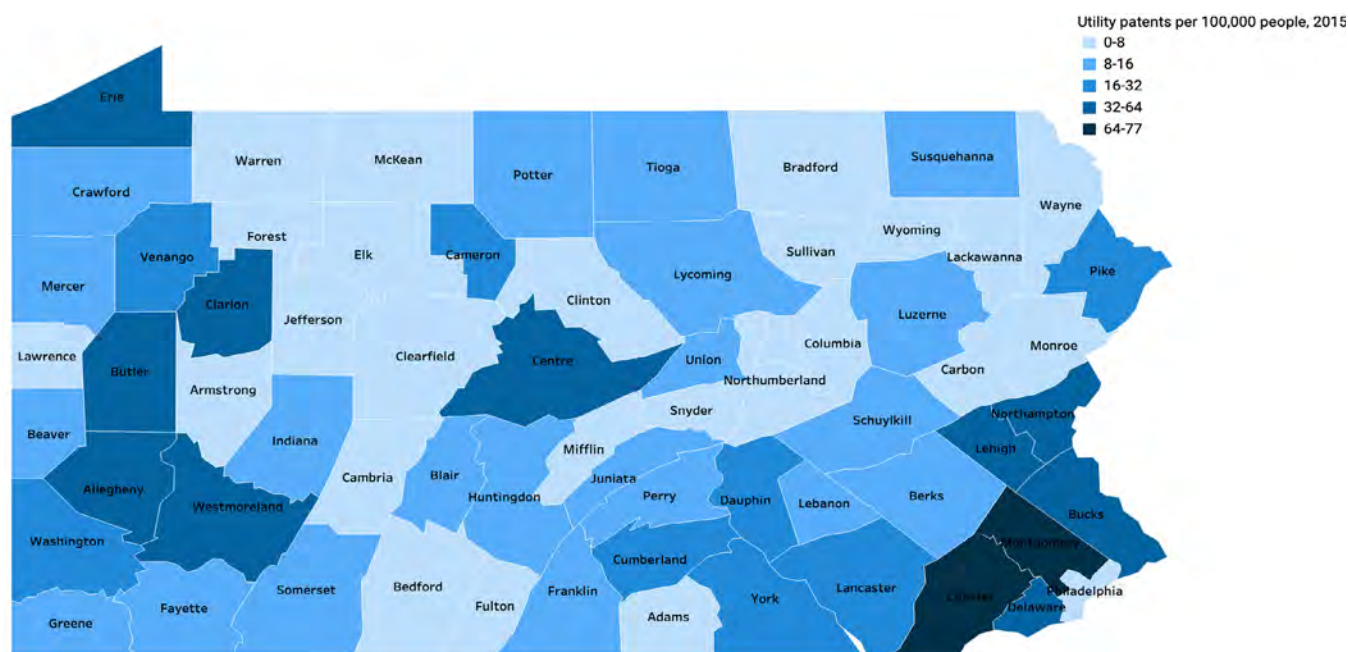
FIGURE 26

Percentage of higher education R&D expenditures by metropolitan statistical area in Pennsylvania, FY 2020



SOURCE: Brookings analysis of National Science Foundation data

Per capita utility patents by county in Pennsylvania, 2015



SOURCE: Brookings analysis of Census Bureau and U.S. Patent and Trademark Office data

What's more, Philadelphia, State College, and Pittsburgh's combined share of such patents *increased* by 5% between 2001 and 2015, while that of the rest of the state declined. That likely foreshadows additional innovation deficits across the rest of the state. That the university campuses that do serve more rural or small-town regions do not carry out large amounts of in-depth scientific research underscores that forecast.

With that said, Penn State's Invent Penn State initiative—with its 21 LaunchBox and Innovation accelerators—explicitly seeks to redefine the university's land grant mission and distribute entrepreneurship and innovation programs widely across its 24 campuses.⁴⁵ Given that, would-be entrepreneurs in numerous communities now enjoy free access to modern accelerator programs, coworking space, legal and IP advice, mentorship, rapid prototyping, pitch competitions, and funding. Scaling the program up could be helpful, but it remains mostly a self-funded university effort, although the recent FY 2022-23 budget includes \$2.35 million to support the initiative, including the accelerator network.

Advanced industry employment and vibrancy lag in the state's smaller places

Equally concerning are the spotty growth and lagging entrepreneurial vitality of the state's advanced industries outside the larger metropolitan areas. This spottiness is disappointing because access to advanced industry work embodies the most tangible benefit of the innovation economy: good-paying employment for workers with a variety of skills and credentials.

However, trends outside of Pennsylvania's major innovation hubs are moving in the wrong direction. Advanced industry employment—though present in every county—remains thinly distributed across most of the state, with local clusters remaining quite sparse.

More than 40% of the state's 400,000-plus advanced industry jobs lie outside of Philadelphia, Pittsburgh, and State College. And yet, that share of the state's advanced industry employment has been declining through the last decade, ensuring that large areas have

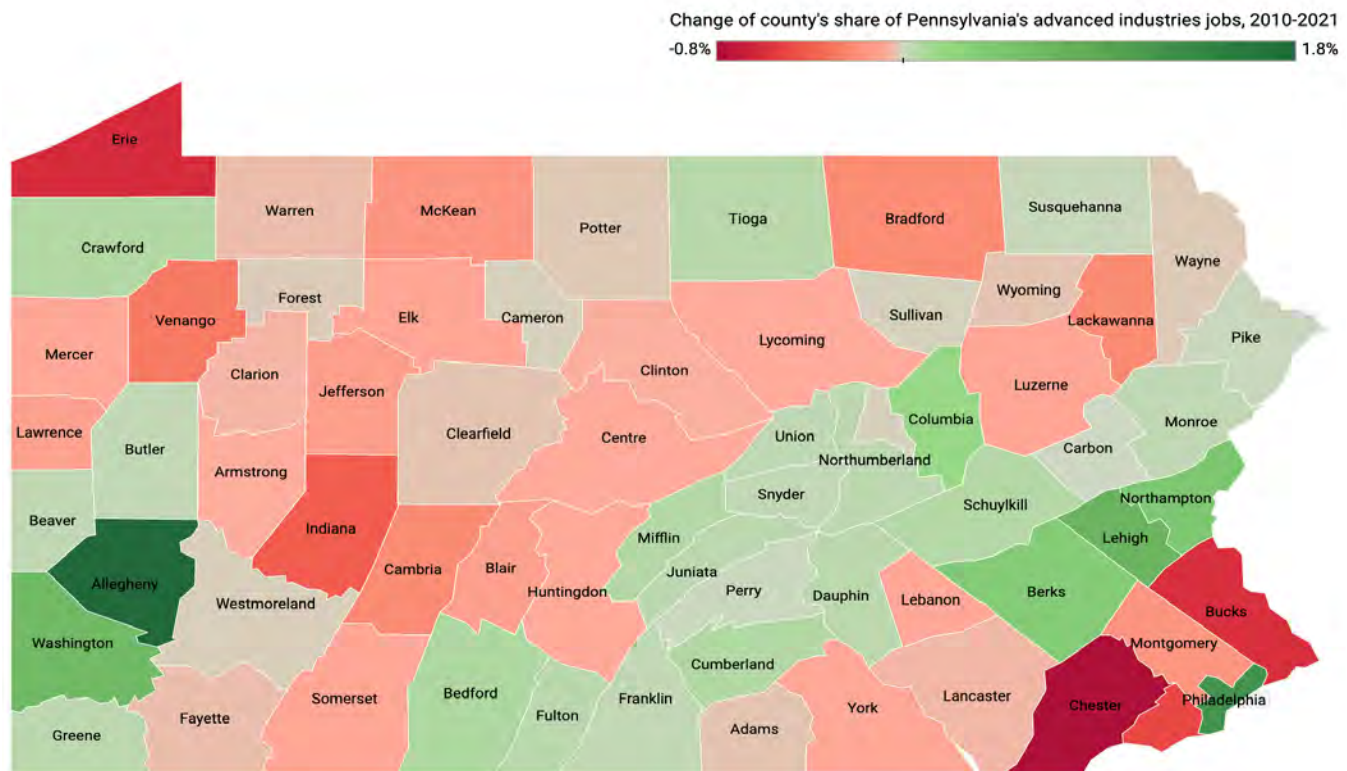
been seeing flat to negative growth of advanced sector employment. As result, the past decade of advanced industry growth reflects a broader pattern seen nationwide, with the state's largest cities pulling away from the rest of the state, and many of its most rural counties lagging.

In absolute terms, advanced industry employment change during the last decade has been strongly

concentrated in the Philadelphia and Pittsburgh regions. Other regions showing positive change included the Lehigh Valley region and parts of south-central Pennsylvania, and the western portion of greater Pittsburgh. However, large portions of central and northern Pennsylvania, ranging from Centre County to Erie, saw declines in their advanced industry employment.

MAP 2

Change of county's share of Pennsylvania's advanced industries jobs, 2010-2021



NOTE: This graph includes employment in actual counties only and excludes jobs whose specific location within Pennsylvania is unknown or undefined

SOURCE: Brookings analysis of Lightcast data

Further underscoring the innovation challenge much of the state faces is a widespread deficit of entrepreneurship, as reflected in advanced sector new-firm starts. Most notably, 2021 Crunchbase data depicts a significant gap between the major metro areas and the rest of the state in tech-oriented new-firm formation. This data reports that just 27% of the advanced sector new-firm starts were formed in counties outside the Philadelphia, Pittsburgh, and State College areas. Those areas encompass 48% of the state's population, meaning they are significantly thinner in tech startup density. Leave out starts in the

Lehigh Valley, Harrisburg, and Lancaster areas, and just 17% of the state's most innovative startups occurred in areas housing one-third of the population.

Overall, these statistics suggest the thinness of many areas' advanced industry sectors outside the major metropolitan areas. Pairing these figures with most counties' lack of research and patenting activities underscores the challenges many regions are facing in building truly competitive local advanced industry clusters.

CHALLENGE #4: THE INNOVATION ECONOMY IS UNEQUAL BY RACE AND GENDER

Innovation in Pennsylvania isn't just unequal by place. Even in the state's largest and most productive hubs, large portions of the state's population remain excluded from the innovation system.

Female, Black, Latino or Hispanic, and Indigenous Pennsylvania residents are all underrepresented in innovation occupations and as entrepreneurs, reflecting centuries of structural inequality. Beginning to fix it matters both from a moral perspective and because—as with fixing the state's significant spatial inequality—a more equitable innovation sector will help bolster economic growth in Pennsylvania.

This section should not be taken to suggest that the groups listed above are the only ones that face challenges in accessing innovation jobs. As others have noted, many marginalized groups, including LGBTQ+ workers, disabled workers, and others, face barriers to jobs in innovation fields. However, given the availability of data, this analysis focuses primarily on exclusion by gender and race/ethnicity.

With that in mind, this report identifies four significant racial and gender inequalities that Pennsylvania's innovation system is facing:

- K-12 STEM education remains significantly unequal by race

- Female, Black, Latino or Hispanic, and Indigenous Pennsylvanians are underrepresented among STEM degree graduates
- Female, Black, and Latino or Hispanic Pennsylvanians are underrepresented in advanced industry jobs
- Significant inequalities exist across race and gender when it comes to entrepreneurship and firm ownership

K-12 STEM education remains significantly unequal by race

Inequalities across Pennsylvania's innovation ecosystem don't begin during workers' careers. Rather, inequality in access to, and quality of, STEM education early in life has lingering effects. These inequalities in educational quality, coupled with the stereotypes that women and people of color often face in STEM education, plant the seeds for the inequality seen across Pennsylvania's innovation ecosystem today. And while these issues are not unique to Pennsylvania, they are nonetheless present in the state, and policy interventions that do nothing to address these early-life inequalities will be insufficient for addressing the full scope of inequality in Pennsylvania's innovation ecosystem.

The economic conditions that students grow up in affect STEM performance. For example, a study of the School District of Philadelphia found that students who grow up in neighborhoods with high unemployment levels tend to have lower math scores, while students in neighborhoods with high median household incomes have higher math scores.⁴⁶ In the U.S., economic factors such as unemployment and income tend to break down along racial lines, with areas that have higher populations of Black, Latino or Hispanic, and Indigenous residents tending to have higher unemployment rates and lower median household incomes. Pennsylvania is no exception to this trend. As a result, these place-based inequalities effectively become racial inequalities.

Meanwhile, a 2020 study by the Pennsylvania Department of Education found that high school STEM enrollment—specifically, enrollment in STEM AP classes—varies greatly by race and gender.⁴⁷ White students enroll in STEM AP courses at over twice the rate (37%) as Black or Latino or Hispanic students (16%). A significant factor contributing to this disparity comes from Black and Latino or Hispanic students having less access to STEM coursework—over half of Black students involved in the study were enrolled in schools with low STEM availability. The study also found that girls tended to enroll at lower rates in so-called “strict” STEM fields, such as mathematics and physics; however, they did take AP classes in fields such as health sciences at rates more comparable to boys. The study noted that access isn’t the only factor affecting STEM enrollment, and increasing access alone isn’t sufficient. Rather, a series of complex factors, outlined below, prevent underrepresented students from enrolling in STEM coursework.

These findings are complemented by a 2016 ACT report, which found that underserved learners in Pennsylvania meet fewer STEM and college readiness benchmarks, even when they have an expressed and measured interest in STEM fields.⁴⁸ The report defines “underserved learners” across three characteristics: minority, low-income (parental income is less than \$36,000), and first-generation. The report finds that Black, Latino or Hispanic, and Pacific Islander students

in Pennsylvania had lower STEM benchmarks across multiple measurements than white or Asian American students, with Native American students also having lower STEM benchmarks in certain cases. Moreover, the study found that, unsurprisingly, the more “underserved” characteristics a student has, the lower their STEM benchmark attainment tended to be.

When it comes to opportunities to succeed in STEM, underserved Pennsylvania students face many of the same challenges that underserved students face nationally. They tend to go to schools with fewer resources, which exacerbates the challenges they face in engaging with STEM fields.⁴⁹ Fewer resources mean that schools cannot spend as much on computing equipment or extracurricular activities, which evidence shows can help direct kids into technology- and innovation-related fields.⁵⁰ Moreover, schools that are under-resourced also have fewer resources to hire qualified STEM teachers, meaning lower-income children tend to also be taught by the least experienced teachers.⁵¹

The underrepresentation of girls and certain students of color in STEM is not only linked to unequal access to resources, but also to cultural perceptions of students. Low-income students, particularly low-income Black and Latino or Hispanic students, are saddled with negative stereotypes, including that they “can’t do math” or that they are “troublemakers.”⁵² Girls, meanwhile, are less likely to be seen as having the “innate brilliance” that is often perceived (wrongly) as being necessary to succeed in STEM fields.⁵³

These stereotypes are reinforced by imbalanced racial and gender makeups in STEM classrooms, as well as the overall lack of STEM role models for girls and students of color. The constant exposure to these stereotypes often forces girls and students of color to manage “stereotype threat”: the risk of confirming negative stereotypes that others hold about one’s race, ethnicity, gender, or another group that one belongs to. Evidence has demonstrated that stereotype threat and the efforts needed to manage it have negative effects on students’ trajectories.⁵⁴

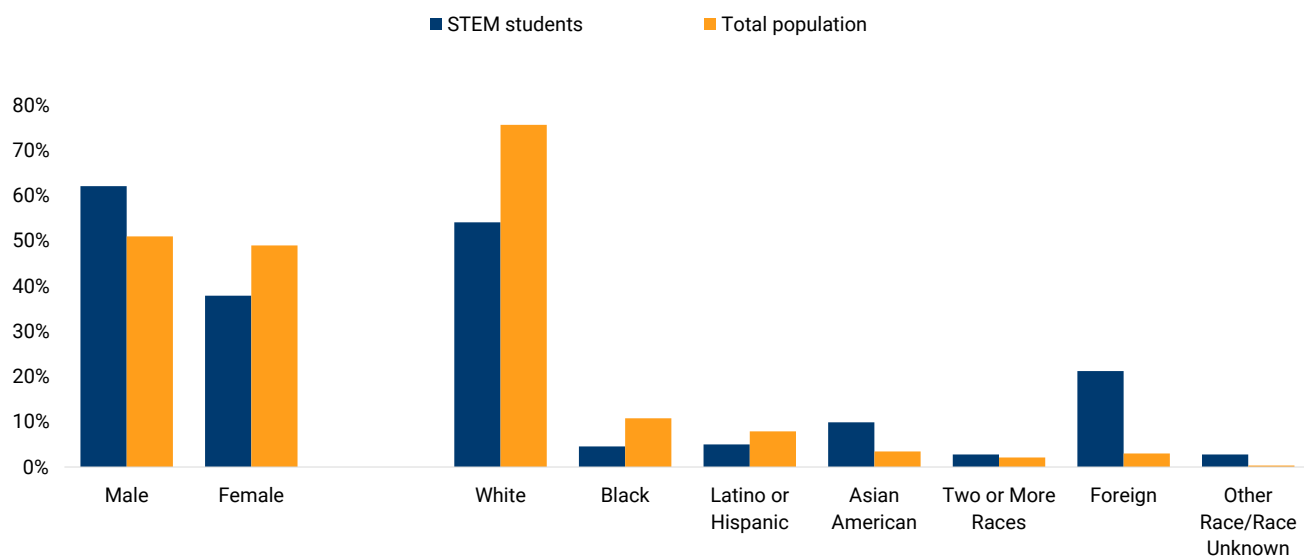
Female, Black, Latino or Hispanic, and Indigenous Pennsylvanians are underrepresented among STEM degree graduates

When it comes to accessing both careers and firm ownership in innovation fields, higher education is a critical component. STEM academic programs serve not only as a source of critical skill development for individuals, but also networks for would-be innovation employees and entrepreneurs.

However, like K-12 education, STEM degrees are not equitably distributed in Pennsylvania. Reflecting a broader national trend, female, Black, Latino or Hispanic, and Indigenous individuals are underrepresented among STEM graduates in Pennsylvania.

FIGURE 27

STEM degree share by race and gender in Pennsylvania, all institutions, 2019-2020



NOTE: STEM students consist of all graduates awarded associate, bachelor's, master's, or doctorate degrees in STEM fields during the 2019-2020 academic year. Population data uses 2019 ACS 1-year estimates. Calculation based on unrounded numbers. Numbers may not sum to total due to rounding. Other Race/Race Unknown" category includes American Indian, Alaska Native, and Native Hawaiian and Other Pacific Islander STEM degree graduates, as well as those who did not report their racial category.

SOURCE: Brookings analysis of data from Census Bureau and Integrated Postsecondary Education Data System

Across all degree levels—associate, bachelor's, master's, and doctorate—men are awarded more than three out of every five STEM degrees in Pennsylvania.⁵⁵ Black, Latino or Hispanic, and Indigenous STEM graduates are also underrepresented compared to their share of the state's population. While Black Pennsylvanians account for 10.7% of the state's population, they receive just 4.4% of STEM degrees in the state. Latino or Hispanic individuals account for 7.8% of the state's population but only 4.9% of its STEM degrees. White students are also underrepresented relative to their share of the population, however they

still account for a majority of STEM degrees awarded in the state.

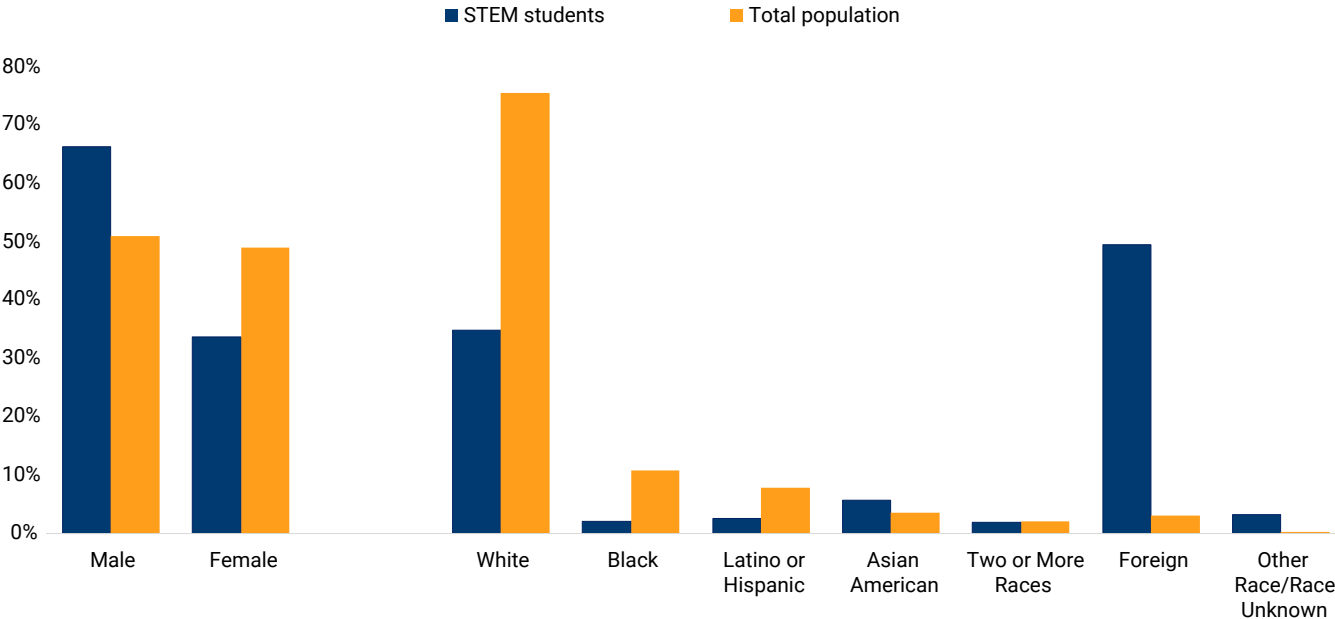
Native Americans and Native Hawaiians are a small share of Pennsylvania's overall population; however just 37 Native American students and 23 Native Hawaiian students received STEM degrees there in 2019-20, out of a total of over 35,000 STEM degrees awarded in the state that year.⁵⁶ So even given their small share of the population, Pennsylvania is still underperforming in terms of STEM higher educational attainment for Indigenous students.

Conversely, Asian American account for 3.5% of the state's population, but 9.9% of all STEM degrees. Foreign-born students were even more overrepresented, accounting for just 3.1% of the population but over 21% of STEM degrees. These foreign-born students present an opportunity for Pennsylvania to retain talent and grow its economy at a time when the state's population as a whole is stagnating.

Focusing now on doctorate degrees in STEM fields, the racial and gender disparities are even more stark. STEM doctorate degrees among underrepresented

groups matter because STEM doctorate graduates are best positioned to become scientists and researchers working with emerging technologies. Those scientists and researchers, in turn, are often the individuals who find commercial applications for those technologies and spin out startup firms. In other words, to give underrepresented groups the best opportunities to become founders of high-growth startups, they must first be in the lab—and doing so requires a STEM doctorate.

FIGURE 28
STEM Ph.D. degree share by race and gender in Pennsylvania, all institutions, 2019-2020



NOTE: STEM Ph.D. degrees consist of all graduates awarded doctorate degrees in STEM fields during the 2019-2020 academic year. Population data uses 2019 ACS 1-year estimates. Calculation based on unrounded numbers. Numbers may not sum to total due to rounding. Other Race/Race Unknown" category includes American Indian, Alaska Native, and Native Hawaiian and Other Pacific Islander STEM degree graduates, as well as those who did not report their racial category.

SOURCE: Brookings analysis of data from Census Bureau and Integrated Postsecondary Education Data System

The disparities observed in STEM higher education generally are more acute among STEM Ph.D. graduates. Two-thirds of STEM doctorate degrees in Pennsylvania were awarded to men. Meanwhile, Black and Latino or Hispanic graduates were severely underrepresented, accounting for just under 19% of Pennsylvania's population but less than 5%

of STEM Ph.D.s. Indigenous representation was nearly non-existent among STEM Ph.D.s: Just one Native Hawaiian student received a STEM Ph.D. in Pennsylvania during the 2019-2020 academic year, and no American Indian or Alaska Native students did.

Conversely, half of all STEM Ph.D.s in Pennsylvania were awarded to foreign-born students. That these students account for such a significant source of the state’s STEM talent underscores the central role that Pennsylvania’s universities play in talent attraction for the state, and serves as a reminder of how critical it is for Pennsylvania to retain these graduates if it wants to become a national innovation leader.

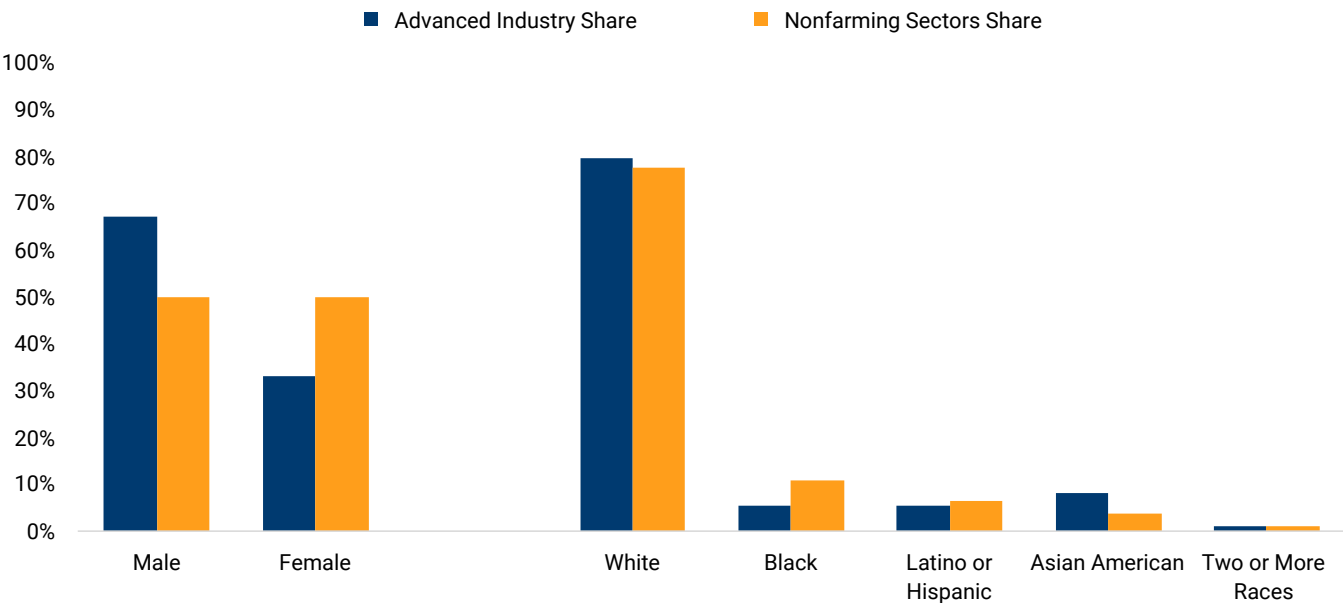
A variety of factors make it more difficult for underrepresented students who enroll in STEM fields to persevere to completion. These factors include stereotypes that make STEM feel inaccessible; harassment, ranging from “casual” racist and sexist comments up to more targeted verbal and sexual harassment; the risk of “stereotype threat”; and curricula that are Eurocentric, making it difficult for students of color to connect to; among others.⁵⁷

This inequality matters because it begets further inequality. Evidence shows that when individuals don’t have mentors and role models that share common characteristics with them, they are less likely to pursue academic careers in STEM.⁵⁸ This in turn perpetuates the cycle of certain groups remaining underrepresented.

Female, Black, and Latino or Hispanic Pennsylvanians are underrepresented in advanced industry jobs

Given the state’s shortage of job growth over the last decade, growing the number of good-paying, accessible advanced industry jobs is one of the major reasons to focus on bolstering innovation in Pennsylvania. However, as with Pennsylvania’s STEM education system, advanced industry sector employment is also skewed by both gender and race.

FIGURE 29
Share of advanced industries workers by demographic group in Pennsylvania, 2020



NOTE: Calculation based on unrounded numbers. Numbers may not sum to total due to rounding. Data on American Indian, Alaska Native, and Native Hawaiian and Other Pacific Islander workers not displayed due to small sample size

SOURCE: Brookings analysis of Census Bureau data

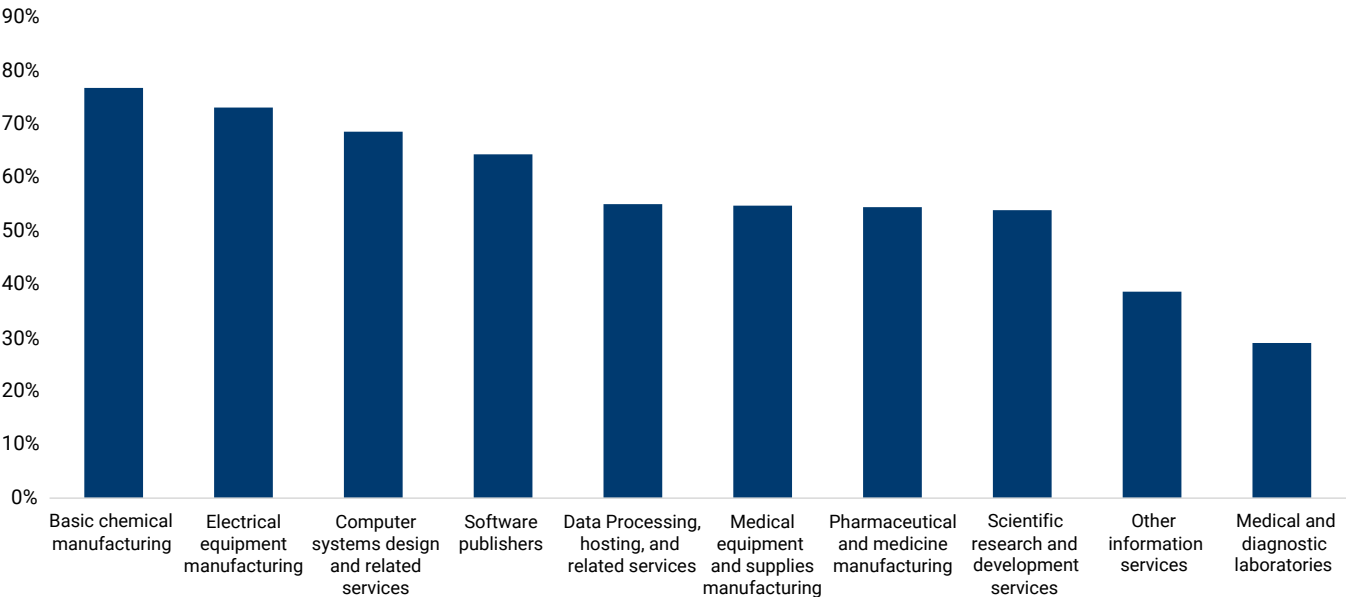
Black workers are the most underrepresented racial group in Pennsylvania’s advanced industries. While Black workers account for 11% of the state’s nonfarm workforce, they are just 6% of workers in advanced industry jobs.

Latino or Hispanic workers, while not as underrepresented as Black workers, still account for a lower share of the advanced industry workforce than their share of the Pennsylvania workforce as a whole. While Latino or Hispanic workers are 7% of the state’s workforce, they account for only 5% of

advanced industry jobs. Indigenous workers—American Indian, Alaska Native, and Native Hawaiian and Other Pacific Islander workers—account for less than 1% of Pennsylvania’s advanced industry workforce.

Conversely, Asian American workers are overrepresented in Pennsylvania’s advanced industry sector, accounting for 8% of the that workforce compared to 4% of Pennsylvania’s overall workforce. White workers, meanwhile, account for 78% of Pennsylvania’s workforce but 80% of Pennsylvania’s advanced industry workers.

FIGURE 30
Percent of workforce that is male in selected advanced industries in Pennsylvania, 2020



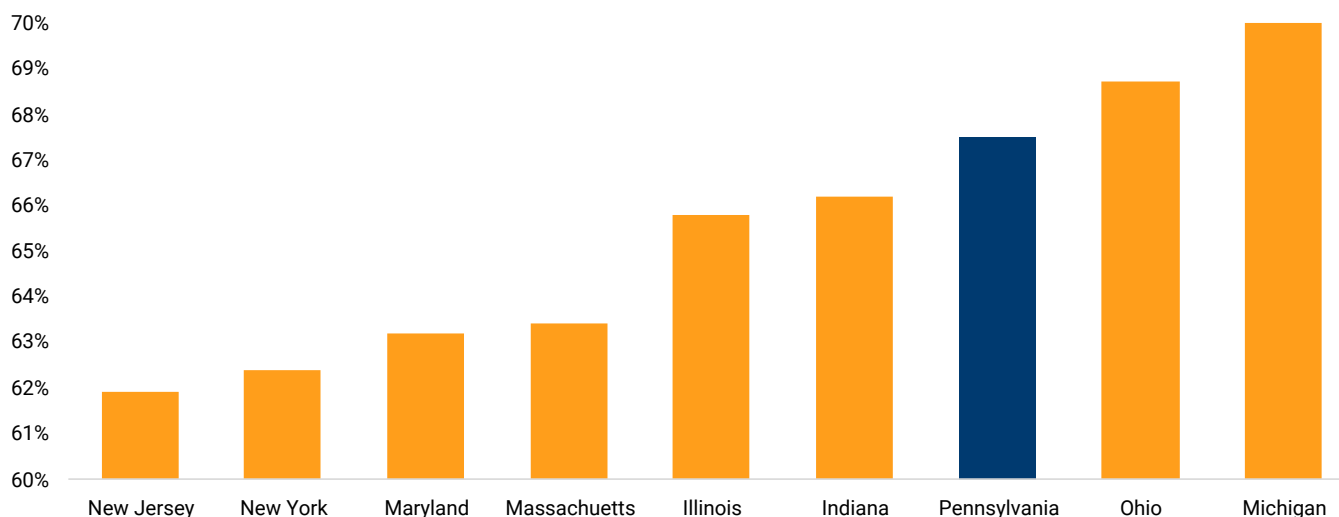
NOTE: Calculation based on unrounded numbers
SOURCE: Brookings analysis of Census Bureau data

Meanwhile, men account for 50% of Pennsylvania’s overall workforce, but hold two-thirds of all advanced industry jobs. One explanation for Pennsylvania’s gender gap may be that the advanced industry sector has a heavy tilt toward advanced manufacturing and advanced energy, both of which tend to be significantly skewed toward men. However, further analysis shows that the state’s gender gap exists across nearly every advanced industry in the state.

Of the 46 advanced industries that have a presence in Pennsylvania, just two have a workforce that is at least 50% female, and only eight have a workforce that is at least 40% female. In short, the inequality challenges in Pennsylvania’s advanced industry sector go beyond just manufacturing and energy; women are underrepresented across the entirety of the state’s innovation workforce.

FIGURE 31

Share of advanced industry jobs held by men in Pennsylvania and selected peer states, 2020



NOTE: Calculation based on unrounded numbers

SOURCE: Brookings analysis of Census Bureau data

Comparing Pennsylvania to its peer states underscores the national challenge that not only it, but every state, faces when it comes to inclusion in the innovation economy. Not one of Pennsylvania's peer states had advanced industry employment that was less than 61% male. In this regard, Pennsylvania reflects national trends—but again is far from a position of leadership. Given that, there is ample policy opportunity for Pennsylvania to become a leader among peer states—and nationally—in advanced industry inclusion by gender and by race.

Pennsylvania's advanced industry sector—which not only forms the backbone of its innovation economy, but is also a significant source of high-paying jobs—remains out of reach for many women and workers of color. In this regard, bolstering innovation while also making the innovation system more inclusive can grow the number of good-paying, accessible advanced industry jobs in Pennsylvania. Doing so creates the opportunity both to enhance Pennsylvania's growth and competitiveness while also improving the quality of life for residents of all backgrounds.

However, to do so, the state must not only retain the firms it already has, but also do more to create new

firms. Unfortunately, Pennsylvania's firm creation not only lags, but is itself highly unequal by race and gender.

Significant inequalities exist across race and gender when it comes to entrepreneurship and firm ownership

The disparities by race and gender that exist in both STEM higher education and advanced industry employment in Pennsylvania are even more stark when it comes to firm ownership. The barriers to access and opportunity that individuals from underrepresented groups face throughout their education and careers make it harder for them to start or own their own firms. And additional barriers in the entrepreneurship ecosystem further limit opportunities for firm ownership by individuals from underrepresented groups.

Firm ownership matters for several reasons. On a statewide level, new-firm starts are needed to ensure a state's economy remains dynamic by creating new jobs for residents to retain population and promoting economic growth.⁵⁹ On the regional and local level, new firms keep regional economies healthy by growing the

number of jobs for residents and supporting the health of downtowns and commercial corridors.⁶⁰ Finally, on an individual level, firm ownership can provide a variety of opportunities, ranging from creating livelihoods for workers who may not otherwise be able to find employment to, in some cases, generating significant wealth for owners of high-growth firms.⁶¹ Research has likewise found entrepreneurship to be particularly important for economic growth and resiliency in minority communities.⁶²

Due to data limitations, this section necessarily combines data on both “growth” entrepreneurship, centered on the Pennsylvania’s advanced industries, as well as “Main Street” entrepreneurship, centered on other industries. That should not be taken to mean that Main Street entrepreneurship is a substitute for supporting more robust entrepreneurship by underrepresented groups in innovation-intensive industries. Rather, both types of entrepreneurship play distinct economic roles, and racial and gender underrepresentation is prevalent across all forms of entrepreneurship in Pennsylvania.

Main Street firm ownership such as retail or food service businesses can help sustain or revitalize downtown areas, while growth entrepreneurship in advanced industries can help establish new regional clusters. And because many communities remain segregated by racial and income lines, when certain groups are excluded from firm ownership, it exacerbates both interpersonal and spatial inequality.

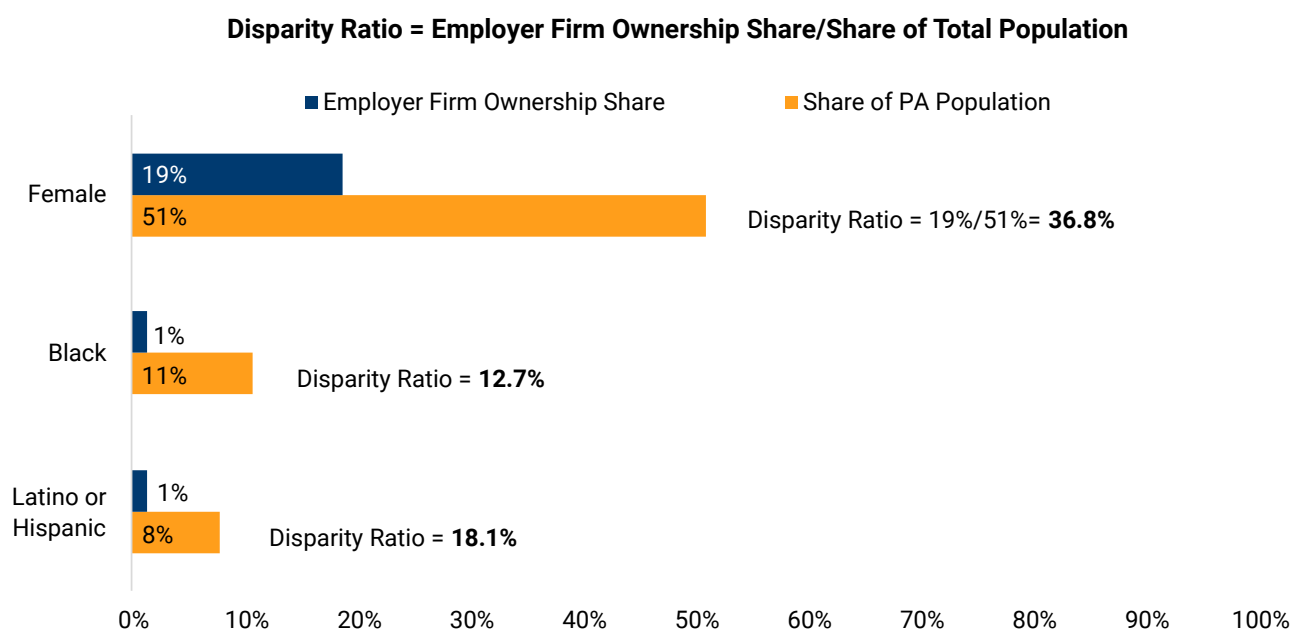
However, it’s possible that the pandemic brought an inflection point when it comes to firm ownership among underrepresented groups. The pandemic recession brought with it a record number of new-firm starts; some of these were by so-called “opportunity” entrepreneurs, or individuals who chose to leave employment in order to begin a career as an entrepreneur. However, many other starts—particularly at the height of the pandemic recession—were by “necessity” entrepreneurs, or individuals who start a business because they cannot find adequate employment. A significant number of necessity entrepreneurs are women and entrepreneurs of color—and many did not have access to the types of capital and business services support that well-resourced (and often white and male) opportunity entrepreneurs have. Now that the economy has moved from recession to recovery, it’s time for Pennsylvania to take proactive steps to make entrepreneurship more equitable.

Firms can be divided into non-employer firms (those without any employees, e.g., sole proprietorships), and employer firms (those with at least one employee who isn’t the owner). This distinction matters because non-employer firms are typically limited in how large they can grow to be, which restricts wealth creation. So, while non-employer firms can certainly sustain a comfortable lifestyle for their owners (and at times do bring in significant revenue), it is employer firms that drive the largest wealth creation, particularly in high-growth industries focused on innovation.

FIGURE 32

Women, Latino or Hispanic, and Black Pennsylvanians are owners of firms with employees at disproportionately low rates

Employer firm ownership disparity by race and gender in Pennsylvania



NOTE: Business ownership is defined as having 51% or more of the stock or equity in the business; only businesses classifiable by owner or demographic group are included in the calculations. Calculations based on unrounded numbers; ownership share may not sum to 100% due to co-ownership. Data on American Indian, Alaska Native, and Native Hawaiian and Other Pacific Islander firm owners suppressed due to small sample size

SOURCE: Brookings analysis of Bureau of Labor Statistics and Census Bureau data

It's a problem, then, that female, Latino or Hispanic, and Black entrepreneurs own firms at significantly lower rates than their share of Pennsylvania's population as a whole. To demonstrate this, this analysis calculates the "disparity ratio" of firm ownership for underrepresented groups. The disparity ratio shows a group's firm-ownership share relative to its share of the total population, illustrating the disparity between the rate that the group actually owns firms and the rate that they would do so if they owned firms at a rate equal to their total share of the population.

In 2019, women accounted for a majority (51%) of Pennsylvania's population, but were majority owners of just 19% of employer firms in the state. Their disparity ratio then, was just over 36%—in other words, women were majority owners of firms at just over one-third of the rate that they would be if they owned firms in

proportion to their share of the population.

Latino or Hispanic and Black Pennsylvanians accounted for 8% and 11% of Pennsylvania's population, respectively. However, each accounted for just 1% of employer-firm ownership. The disparity ratio for Black owners was 12.7%, and for Latino or Hispanic owners, it was 18.1%. So, if firm ownership was more racially equitable in Pennsylvania, Black entrepreneurs would have owned employer firms at nearly eight times the rate they actually did, and Latino or Hispanic entrepreneurs would have owned employer firms at over five times the rate they actually did. Indigenous ownership of employer firms in Pennsylvania, including firms owned by American Indian, Alaska Native, and Native Hawaiian and Other Pacific Islander entrepreneurs, was so low that the data was suppressed by the Bureau of Labor Statistics.

Conversely, entrepreneurs who were male, white, or Asian American were overrepresented relative to their share of Pennsylvania's population. Men accounted for 49% of the population, but were majority owners of 65% of employer firms (17% of employer firms were owned equally by men and women). White Pennsylvanians accounted for 76% of the population, but owned 84% of employer firms, while Asian Americans accounted for 4% of the population, but owned 7% of employer firms. In short, the same demographic inequalities that play

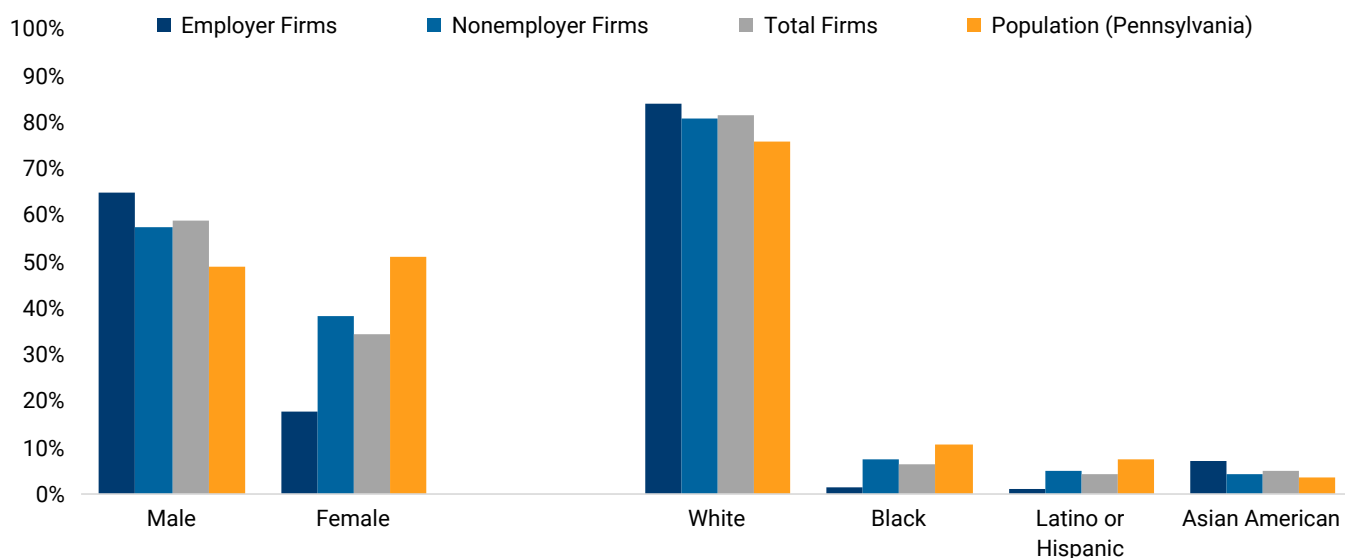
out elsewhere in the state's innovation system exist in firm ownership as well.

While the disparities in employer firms are particularly stark, they don't account for the entirety of Pennsylvania's entrepreneurship picture. As Figure 33 shows, women and entrepreneurs of color account for a significantly larger share of non-employer-firm ownership than they do employer-firm ownership.

FIGURE 33

Women and people of color own non-employer firms at higher rates than employer firms, but are still underrepresented

Share of firms in Pennsylvania owned by demographic group, 2018



NOTE: Ownership may not sum to 100% due to firm co-ownership, owners who decline to report gender, missing data, and other factors. Asian American employer firm ownership is imputed from Asian American total firm ownership and Asian American nonemployer firm ownership. At the time of publishing, 2018 was the latest year available for nonemployer firm demographic data. Data on American Indian, Alaska Native, and Native Hawaiian and Other Pacific Islander firm owners suppressed due to small sample size.

SOURCE: Brookings analysis of Census Bureau data

This matters because non-employer-firm ownership is not only a source of income and wealth-building for individuals, but also can ultimately lead to employer-firm ownership if sufficiently supported. In this regard, just looking at employer-firm numbers doesn't paint the full picture of entrepreneurship in Pennsylvania.

When non-employer firms are included, the data shows that female, Latino or Hispanic, and Black entrepreneurs own a larger share of firms in the state

than when just employer firms are used. Nonetheless, even when including non-employer firms, none of these groups have firm-ownership levels that equal their share of the overall state population.

And an important caveat must be attached to the non-employer-firm data: A significant share of non-employer firms in certain industries—particularly transportation and accommodation and food service—are not actually firm owners, but rather “gig workers”

that are classified as independent contractors.⁶³ These workers are not necessarily firm owners with opportunities for future growth, but rather more akin to employees working for a large company (albeit without the typical wage and worker protection laws offered to employees). As a result, the non-employer-firm numbers may overestimate the levels of firm ownership for underrepresented groups in Pennsylvania.

As of 2018, underrepresented groups own non-employer firms at disproportionately higher rates than they own employer firms in Pennsylvania. Statewide, just over 80% of firms are non-employer firms. About 90% of firms owned by women in Pennsylvania are non-employer firms, compared to 78% of firms owned by men. Similarly, 96% of Black-owned firms, and 94% of Latino- or Hispanic-owned firms, are non-employer firms in Pennsylvania, compared to 80% of white-owned firms and 71% of Asian American-owned firms.

FIGURE 34

Firm ownership by race and gender in Pennsylvania, 2018



NOTE: Ownership may not sum to 100% due to firm co-ownership, owners who decline to report gender, missing data, and other factors. Asian American employer-firm ownership is imputed from Asian American total firm ownership and Asian American non-employer-firm ownership. At the time of publishing, 2018 was the latest year available for non-employer-firm demographic data. Data on American Indian, Alaska Native, and Native Hawaiian and Other Pacific Islander firm owners suppressed due to small sample size.

SOURCE: Brookings analysis of Census Bureau data

A variety of factors are driving this inequality in entrepreneurship across different demographic groups. One of the most significant is the lack of access to capital for entrepreneurs from underrepresented groups.

Capital remains inaccessible to underrepresented entrepreneurs for multiple reasons. One of the most basic forms of capital for entrepreneurs is debt financing, such as a bank loan. However, a disproportionate share of entrepreneurs of color lack

the resources needed to access bank loans. They may not have an existing relationship with a bank, or they may lack the credit history needed for a loan, among other barriers. At the same time, these entrepreneurs may not have access to the “friends and family” financing that is common for many founders.

In other cases, would-be entrepreneurs may be physically cut off from accessing financing due to where they live or where they want to open their business.

For example, a study by Next Street in conjunction with Urbane, Econsult Solutions, and SourceLink found that business lending to Black and Latino or Hispanic communities in North and West Philadelphia was significantly lower than business lending in City Center areas with the highest concentrations of white residents.⁶⁴

Even when underrepresented entrepreneurs are able to access initial amounts of capital, they often run into challenges with scaling and expanding their business. For example, some entrepreneurs may make use of microloans or microgrants to get their company started, but run into obstacles with accessing larger loans or equity investments needed for expanding their company due to the reasons mentioned above.

Community development financial institutions (CDFIs), which are financial institutions with a mission to lend to individuals in under-resourced communities that mainstream finance traditionally doesn't reach, help fill that gap for some entrepreneurs. While they generally (though not exclusively) support Main Street entrepreneurship and tend to work less with innovation-intensive businesses, CDFIs are deeply embedded in many underserved communities. However, CDFIs are often undercapitalized, unable to fully meet demand in underserved communities, and don't have sufficient resources to scale their impact.⁶⁵

The challenges that underrepresented entrepreneurs face in accessing equity investments such as angel investment and venture capital are even more significant. Equity investment matters in innovation because it tends to fund the fastest-growing companies, particularly in innovation-intensive sectors like tech. While only 1% of U.S. businesses received venture capital funding, over 60% of companies that go public received venture capital.⁶⁶

Inequality in equity investment is due to multiple intersecting factors. The first is that equity investors tend to focus on specific, high-growth sectors such as tech and health care, in order to maximize their chances of getting the significant returns they need to repay their limited partners.⁶⁷ Entrepreneurs of color tend to be underrepresented in these fields due to the significant startup costs required.

Relationships are important for accessing loans, but they are critical to accessing equity investment. Equity investment is dominated by a concept called "homophily," or the tendency of people to bond with others who have similar characteristics to themselves.⁶⁸ For example, equity investors often rely on referrals from within their network, or "warm introductions," to begin the investment process.⁶⁹ Entrepreneurs who cannot access these referrals start at a disadvantage. And these networks aren't equal along racial or gender lines: 97% of VC professionals are white or Asian American, and 79% are men.⁷⁰ Meanwhile, over 40% of VC professionals attended just five schools: Harvard, Stanford, the University of Pennsylvania, Duke, and the Massachusetts Institute of Technology.⁷¹ Because VC investors tend to connect with and invest in entrepreneurs that come from a similar background as them, entrepreneurs that don't share these characteristics are at a disadvantage.

The federal State Small Business Credit Initiative (SSBCI) aims to respond to some of these capital access challenges. As part of the American Rescue Plan Act of 2021, federal policymakers created the \$10 billion SSBCI program, which provides dedicated funding to states to enhance capital access for small businesses. SSBCI dedicates 20% of its funding to support disadvantaged groups who have been historically underrepresented as business owners. Pennsylvania is receiving as much as \$268 million in SSBCI funding, slated to arrive in three tranches over the next six years. This funding provides an unprecedented opportunity for the state to begin to rectify some of the entrepreneurship inequalities it faces.

Pennsylvania has allocated \$125 million toward a loan participation program that will extend loans to small business borrowers through certified economic development organizations (CEDOs) and CDFIs.⁷² These loans will need to be matched on a 1:1 basis by private funding—in other words, SSBCI funding cannot account for more than 50% of the loan's total financing. Another \$125 million will be leveraged for equity investments into seed and early-stage companies through the Ben Franklin Technology Partners and Life Sciences Greenhouses. Finally, the state's \$17 million Diverse Leaders Venture Program will provide loans to VC firms with diverse owners, with the aim of diversifying capital investors themselves.⁷³



Reinventing Pennsylvania innovation: Four initiatives

Pennsylvania possesses significant assets that could power its emergence as a world-class innovation economy, with substantial benefits for millions of Pennsylvanians. Few states have so much potential.

And yet, the fact remains that the state's innovation enterprise—especially its history of supportive policy innovation—needs renewal to better assist unlocking the state's vast potential.

In the broadest sense, Pennsylvania state government has lost focus on innovation in the last decade. Most notably, the commonwealth has allowed once pathbreaking innovation programs such as the Ben Franklin Technology Partners to languish, just as other state governments have been redoubling their innovation focus.⁷⁴

At the same time, this drift has allowed troubling fissures to open in the state's innovation enterprise, which now require a response. The commonwealth needs to do more to help university communities convert top-quality academic science into growth companies that deliver employment growth, and unleash the ideas of entrepreneurs working outside of the state's larger metro areas. And state government has a role to play in ensuring women and people of

color can contribute to the innovation sector and benefit from it.

What will this restoration of effort look like? Pennsylvania leaders should take actions that respond to the challenges highlighted in the previous section—and do so in ways that would support the bottom-up efforts of Pennsylvania entrepreneurs and regional innovation clusters, rather than steering too much from the top. Specifically, the state needs to create new, interconnected policies and programs that better support innovation, business creation, and growth.

Given that, the sections that follow suggest a finite set of policy themes through which state government can play a catalytic role in unlocking Pennsylvania's boundless innovation potential and accelerating company creation and advanced industry employment growth. These themes are:

- Commit to innovation
- Accelerate commercialization and growth in the state's major metro areas
- Foster innovation and entrepreneurship in smaller cities and rural areas
- Insist on inclusion

RECOMMENDATION #1: COMMIT TO INNOVATION

Above all, Pennsylvania needs to recommit itself to innovation. Currently, the commonwealth lacks a forceful and unified strategy to accelerate innovation and entrepreneurship. For the most part, the state's main innovation programs are adrift without either adequate funding or high-level government advocates. So, in the next administration, the governor, assembly, and business leaders should come together to elevate the importance of innovation; center innovation in economic development activities; and rebuild depleted innovation programs and budgets.

Along these lines, the next administration—working with the General Assembly—should:

- Set a bold vision
- Center innovation in economic development activities
- Rebuild the state's innovation budget

Set a bold vision

To start with, the next governor and his team need to **enthusiastically embrace the cause of innovation** as an economic driver and articulate a strong vision that can motivate action. Such a vision will be a crucial starting point for recommitting the state to innovation. For that reason, Pennsylvania's next governor should move decisively to both promote innovation as a priority and make available high-quality information about its characteristics, clusters, and benefits. Also essential is the need to explain why the state is losing dynamic entrepreneurs and firms to neighboring or competing states and how it can produce a more fertile ground for innovators and businesses at home.

To start this work, the next governor should champion innovation and entrepreneurship from the outset and, in doing so, **deploy the bully pulpit** energetically. Specifically, the new governor and his team should actively and personally explain the importance of innovation for all communities—and tell the story widely. In doing so, the governor and other top officials should work intently to capture the state's attention by communicating an exciting, forward-looking vision

of the innovation economy and the opportunities it holds. Critical here will be an ongoing effort to make innovation accessible and compelling by highlighting exciting inventions, enterprises, and entrepreneurs. Cheerleading for local successes during travel around the state or at local town halls will go a long way to counter drift with enthusiasm and attention. Such showcasing will help Pennsylvanians better understand the full continuum of innovation and entrepreneurship and why it matters for everyone in the state.

Yet the governor's bully pulpit and barnstorming are only a start at reasserting a dynamic pro-innovation vision. Also critical is the need to back up enthusiasm with gravitas, insight, data, and strategy. Unfortunately, for more than a decade Pennsylvania has lacked the capacity to set and promote an innovation agenda based on objective measures and analysis, even as other states have produced bold visions, glossy framing documents, and ambitious agendas.⁷⁵ Given that, Pennsylvania needs to build up a solid capacity to track and report trends; analyze issues and weigh strategy; and advance a data-informed innovation strategy. Then, with the requisite insight and data in hand, the state needs to establish a strong approach to thought leadership that engages industry and entrepreneurs as sources of expert advice.

With that in mind, the next governor should **engage key business leaders, entrepreneurs, scientists, and philanthropic executives to participate in a high-level new strategy commission** to provide the kind of trend assessments and industry-grounded guidance that will be needed to shape and execute a top-quality innovation strategy. Representation would reflect the most vital elements of the state's innovation base, including its universities, technology sectors, entrepreneurs, investors, and underrepresented communities, as well as the state's varied regions. From the outset, the new board would play a critical role in informing and affirming the state's new direction, including through direct dialogue with the governor and dynamic sessions around the state. In time, this non-statutory body could play a role in executing any new strategy; improving coordination

across the state's regions and sectors; validating assets in investment conversations; and mobilizing private and philanthropic resources for key initiatives.

Behind this strategy engagement, meanwhile, Pennsylvania will need to build up real data and benchmarking capabilities to sharpen its new focus. This means the state should **establish a rigorous innovation strategy development center to monitor progress and provide input into the governor's strategy-setting**. Such a center would collect and assess consistent national, state, and regional metrics useful to setting and updating strategy as well as informing the government and innovation sector. The center could also anchor both the governor's thought leadership and the creation of a world-class marketing campaign built around quality research facts. In these ways, then, the governor's office—with its new strategy-setting capacity—can and should provide important thought leadership for the state, its regions, and its industry. This agenda-setting work can be achieved cost-effectively: The capacity of several full-time equivalent staff and a modest additional budget could supplement contributions from DCED's small but capable Office of Strategic Information Services to deliver the needed trend and strategy agenda.

Center innovation in economic development activities

Turning to administrative refocusing, the arrival of a new administration holds the opportunity to center innovation in the state's economic development activities. To begin with, it goes without saying that the new governor should **appoint committed innovation champions to key positions** such as DCED secretary and the deputy secretary role at the Office of Technology and Entrepreneurship. Such appointments—reflecting real-world knowledge and diverse perspectives—will extend the reach of the new innovation priority on a day-to-day basis.

Beyond that, the new administration could take other steps to elevate and center innovation as a core priority of the state's economic development approach. To begin with, the governor could **move the Governor's Action Team into the governor's office** and focus it on aggressively building the innovation sector.

Likewise, the governor could **update the DCED's mission (and perhaps name)** to feature innovation and entrepreneurship as key sources of prosperity.⁷⁶ Likewise, the governor could formally **elevate the Office of Technology and Entrepreneurship** by enhancing its role as the state's main coordinator of state-government activity on innovation.

Relatedly, the governor could further center innovation and entrepreneurship in Pennsylvania development activities by moving to **create a cross-agency, cross-sector innovation hub** in either the governor's office, DCED, or the Office of Technology and Entrepreneurship. Reflecting the new cross-government focus on innovation, the new hub would build on recent efforts such as the Wolf administration's Workforce Command Center to create a new focal point for active problem-solving and coordination. In this vein, the hub would at once expand the interaction now occurring between state agencies and forge new interaction between the administration, regional innovation initiatives, and the private sector. Through this exchange, the hub would seek to troubleshoot and optimize state innovation programming, identify successful models, track progress, and monitor the implementation of new or expanded policies and initiatives. Members of a presiding executive committee, meanwhile, would consist of relevant representatives of key innovation-relevant agencies such as DCED, the Department of Labor and Industry, and relevant private sector or academic stakeholders.

Rebuild the state's innovation budget

Beyond these adjustments, though, there remains the continued need to address the long-standing crisis of the state's depleted innovation budget. Currently, Pennsylvania is likely missing out on significant present and future job creation and tax collections associated with innovation supports' return on investment.

Pennsylvania successes such as Spark Therapeutics, Centocor, Duolingo, Argo AI, and Aurora all suggest the potential. Yet, as the previous section reported, the commonwealth's innovation investments have not only not kept pace with past levels, but have slipped in relation to competitors like Ohio.

Last summer's flush 2022-23 state budget saw only modest increases in innovation programs and the aggregate innovation budget. Consequently, continued underfunding (following the massive cuts during the Great Recession) leaves the overall innovation budget of \$45 million about one-third the size of its budget in 2007, with effort levels (measured in per capita expenditures) in recent years only one-fifth of those in Ohio. And so, the time has come for the governor and legislative leaders to come to grips with the reality of Pennsylvania's drift and move to rebuild the state's basic innovation budget to support a brighter future.

To be sure, few lawmakers will likely warm to restoring DCED's base innovation budget to its pre-Great Recession level of \$130 million a year in real 2022 dollars. With that said, the governor and legislators need to bear in mind how far the budget has slipped. This is true even after factoring in the recent budget's modest increases and an infusion of

federal SSBCI funds into the Ben Franklin Technology Partners and Life Sciences Greenhouses. Even then, the state's innovation budget remains on a sideways trajectory that has left it far behind peer states such as Massachusetts or Ohio, with their 10-year, \$1 billion and 20-year, two-billion innovation investments.

Given that, meaningful infusions are needed to—at minimum—**restore the funding, business advice, and support programs of the Ben Franklin centers and the Life Sciences Greenhouses.** That it would take about \$50 million a year to bring the two programs to their pre-Great Recession size gives a sense of scale to the needed funding infusion. Such additional funding will be necessary to support meaningful new activities across this report's major recommendations to accelerate commercialization in the state's major hubs, foster innovation and entrepreneurship elsewhere, and insist on inclusion.

Supporting recovery in communities of all sizes: Indiana's READI program

Over the past year, Indiana's state government has boldly leveraged federal funds (and its standing concern for regional equity) to bolster growth and accelerate innovation in communities of all sizes across the state.

As part of its 2021 budget, Indiana's General Assembly appropriated \$500 million of federal American Rescue Plan Act funding to create the Regional Economic Acceleration and Development Initiative (READI). Beginning in May 2021, communities across Indiana arranged themselves into 17 self-defined regions. From there, the Indiana Economic Development Corporation (IEDC) provided each region with \$50,000 in planning grants to defray the cost of developing a strategic plan. As part of this process, regions convened important stakeholders such as major employers, anchor institutions, educational institutions, economic development organizations, philanthropy, and government officials to create a plan that outlined a vision for the region's future and leveraged state funding to implement that vision.⁷⁷ Regions were assessed on how well their plans bolstered the local quality of place, quality of life, innovation and entrepreneurship, and talent development and attraction.⁷⁸

In December 2021, IEDC awarded each of the 17 regions a READI grant, ranging from \$5 million to \$50 million. These grants are being matched at a 1:1 rate from local government and a 3:1 rate from private and philanthropic sources, resulting in a total statewide investment of \$2 billion.⁷⁹

Indiana's regions are now implementing their plans. Due to the Treasury Department's guidance on how American Rescue Plan funds can and cannot be used, some regions have had to recalibrate their plans or drop certain projects in recent months.⁸⁰ To help those regions implement as much of their plans as possible and sustain investment there, Indiana Governor Eric Holcomb has said he will ask the Assembly for additional funding for READI in the next budget cycle.⁸¹

RECOMMENDATION #2: ACCELERATE COMMERCIALIZATION AND GROWTH IN THE STATE'S MAJOR METRO AREAS

This report shows that Pennsylvania lags in translating top-quality R&D into growth firms and advanced industry employment. The analysis also suggests that reduced state investment has undercut efforts to bolster the vital innovation ecosystems that help companies grow, particularly near research universities.

And so, the commonwealth needs to do much more to support innovation-firm growth by bolstering the multidimensional ecosystems that surround great academic institutions and business concentrations and foster critical cluster expansion.

Important help with this could result from restoring the capacity of the Ben Franklin Technology Partners and Life Sciences Greenhouses, each of which provide early-stage and growing companies with funding, business and technical expertise, and access to their regional networks of ecosystem resources. Already in place, meanwhile, is modest help through the FY 2022-23 state budget and an infusion of federal SSBCI funding.⁸²

However, given their current diminished size, these worthy programs remain too small to serve as the state's primary tech ecosystem programs. This is why the state needs to launch a bold initiative aimed at assisting the state's major innovation regions in their ability to scale up transformative strategies that convert startups into economic growth, especially in the state's largest university-anchored metro areas.

Neither solely "top-down" nor "bottom-up" in its operation, the new initiative should build on the latest practices of "place-based" ecosystem-building—which is gaining prominence in federal policy—to help regional coalitions establish dynamic hubs of activity by which to seed and sustain tangible new growth in the state's major innovation centers.⁸³

Accordingly, the next administration in Harrisburg should:

- Design and support a "Pennsylvania Innovation Hubs" program to accelerate growth in the state's major innovation hubs
- Aggressively leverage parallel federal cluster programs for further impact
- Expand the state matching funds program for SBIR/STTR awards

Design and support a 'Pennsylvania Innovation Hubs' program to accelerate growth in the state's major innovation metro areas

To generate more jobs from its innovation, Pennsylvania needs to bolster the regional innovation ecosystems surrounding the world-class anchor institutions in its major innovation centers—whether that is scaling up Pittsburgh's autonomy cluster or Philadelphia's cell and gene therapies concentration. This matters because supportive ecosystems can accelerate firm and cluster growth by surrounding promising new firms with an array of convenors, entrepreneur supports, finance options, commercialization programming, talent, and space. What's more, focused leaders in each of the state's major innovation metro areas stand ready with compelling agendas and plans.⁸⁴

Yet the fact remains that in recent years, neither the state nor its regions have been able to provide the full complement of items needed to surround powerhouse universities with truly supportive growth ecosystems. Instead, local organizing challenges and funding gaps have often precluded concentrated action to unlock regions' potential.

So, what needs to happen? The commonwealth should **launch a major “Pennsylvania Innovation Hubs” initiative** in the next budget cycle to call forth and help fund ambitious, locally designed ecosystem-building initiatives to boost growth in the state’s key innovation centers. Such initiatives would be required to organize around a singular vision for delivering accelerated growth in promising local clusters that are currently underinvested. Likewise, they would be expected to deliver not just growth but also inclusion—meaning widely shared participation and benefits, including for historically excluded populations and neighborhoods.

What would this look like? Think, for example, of the investments being made by Carnegie Mellon University and the Richard King Mellon Foundation in technology activities and placemaking to spur a more vibrant future for Hazelwood Green in Pittsburgh.⁸⁵ Or look at the Southwestern Pennsylvania New Economy Collaborative, which recently received \$62.7 million from the federal government’s Build Back Better Regional Challenge to accelerate its world-class robotics and autonomy cluster and ensure the benefits reach rural and coal-impacted communities in the broader region.⁸⁶

In each case, transformational funding will be deployed to boost a region’s innovation and social inclusion simultaneously—the goal of this new Innovation Hubs initiative. Aimed at unlocking missing growth, a sizable challenge grant would allow key hubs to compete for major investments in support of new ecosystem strategies to scale up local advanced industry growth. Ultimately, regional leadership coalitions would obtain

sizable financial support from the state to help them launch transformative strategies of their own design for creating startups, growing new businesses, and promoting employment growth.

To launch the new initiative the commonwealth will first need to identify an appropriate revenue source to support the hub effort (and other programs) that is sizable enough to make a difference. One potential source in the near term might include the state’s current budget surplus. Alternatively, could examine a form of “tax increment financing” that has been used elsewhere in the country to capture and reinvest the incremental increase in state revenue generated by the growth of key industry sectors, for the purpose of enabling the state and its regions to invest in regions’ innovation plans.

In any event, policymakers have an opportunity to build on solid precedents in several states and from several recent federal innovations to:⁸⁷

- Establish the Pennsylvania Innovation Hubs program as a sizable challenge grant to help regional innovation clusters in key university-based innovation hubs promote tech-based economic growth and job creation.
- Call out regional coalitions to organize compelling initiatives to that end.
- Put in place a high-quality merit review process to ensure awardees are selected and evaluated in a fair, competitive, transparent, and in-depth manner. The same rigor should be employed to evaluate outcomes to help the state learn what works.

Along these lines, the next administration and Assembly should:

1. *Announce a competition to award three Phase 1 \$500,000 development awards and three Phase 2 \$50 million to \$75 million implementation awards to help local coalitions develop compelling hub strategies—and fund them.* The 18-month, two-tier competition would allow for both careful preparation and bold implementation (though some consortia with ready-to-go proposals could move directly to the implementation stage). Awards would be available on a competitive basis to consortia from the state's four large university-based metro areas (Philadelphia, Pittsburgh, State College, and the Lehigh Valley). The overarching goal would be to aggressively scale up industry expansion and job creation by deepening emerging clusters and collaborations around the state. Strong emphasis would be placed on initiatives that expand economic inclusion for underrepresented founders and leaders and for left-behind nearby or adjacent places. In this vein, the awards could favor applications that involve minority or female stakeholders and/or create new linkages between established large metro clusters, R1 universities, and surrounding exurban or rural areas.
2. *Structure the competition to mobilize intentional partnerships and diverse stakeholders to carry out the interventions.* Central to the challenge should be provisions that require a single lead institution to manage the partnership and name a single regional economic competitiveness officer (or other point person) to drive success and accountability. Also important will be criteria that prioritize collaboration and coordination as well as local, private sector, or philanthropic funding matches demonstrating regions' existing traction in the endeavor. Working cohesively, local consortia would design bottom-up proposals and execute them if they win funding. Eligible activities, meanwhile, should include a wide range of innovation and scale-up supports dependent on local needs. These might include startup supports, technical assistance, finance, new-firm incubation, market feasibility studies, or capital

for revolving loan funds. Alternatively, initiative undertakings might entail university-based centers of excellence, accelerators, cluster hubs, branding and marketing initiatives, near-proximity wet and dry lab facilities, supply chain development projects, or education and workforce initiatives. In terms of their geography, initiatives should correspond with the four regions' metropolitan areas, though existing industry and supply chain dispersion could warrant "hub-and-spoke" arrangements or other urban-rural links.

3. *Ensure the strategies, selection, and performance management deliver excellence, inclusion, and independence.* Winning proposals will deliver compelling, well-documented strategies for scaling up promising existing innovation clusters by transforming the surrounding ecosystem that nurtures them. Winning strategies will also include strong industry leadership, including as expressed by sizable matching funds or in-kind participation from businesses. Also required should be a vision and reality of inclusivity and broadly shared benefits. Finally, the mechanics and culture of the hub program should promote a culture of rigor and innovation. Flexibility in the design of initiatives should be paired with stringent independence on award decisions and initiative selection. A National Science Foundation-style selection process insulated from state, local, or corporate partiality should be paired with sound evaluation plans to track progress. For example, hubs should report out on their progress annually to allow the sharing of practices as well as assessment of what worked well enough to be worth repeating. Finally, throughout the project, each initiative should promote a culture of trust, transparency, knowledge-sharing, and collaboration.

In sum, the state should launch a bold initiative focused on its core innovation challenge: the need to accelerate high-quality growth by deepening the ecosystems surrounding the tech clusters near its major universities. Through such a surge, Pennsylvania can and will unlock more of its untapped potential.

Designing top-quality innovation strategies from bottom-up: The Southwestern Pennsylvania New Economy Collaborative

The concept of major state funding of locally devised innovation strategies will prompt skepticism in some quarters about regional capacity. However, Southwestern Pennsylvania's \$62.7 million award from the federal government's highly competitive Build Back Better Regional Challenge (BBBRC) shows there is top-flight capacity to spearhead major innovation projects in Pennsylvania's university-based metro areas.

In September 2022, the Southwestern Pennsylvania New Economy Collaborative was announced as one of just 21 winners out of 529 BBBRC applicants. Pittsburgh and its surrounding communities in Allegheny County are home to a globally recognized robotics and autonomy cluster. However, women and workers of color have been underrepresented in the cluster, and relatively few of its benefits have diffused to other counties in Southwestern Pennsylvania.

The collaborative's strategy is to further expand Pittsburgh's robotics and autonomy industry presence while making it more inclusive and strengthening the economic links between Pittsburgh and the broader region.

The collaborative also aims to make the region's robotics and autonomy workforce more inclusive through a project focused on expanding opportunities for individuals of diverse backgrounds to start firms in the robotics and autonomy space. Growing the number of diverse firm owners is critical both to diversifying the industry as a whole and ensuring that the wealth benefits that accrue from this cluster are distributed more equally. At the same time, a parallel project will aim to expand pathways for underrepresented workers to access careers in the robotics and autonomy sector.

Complementary projects will focus on increasing the level of robotics adoption for small- and medium-sized enterprises (SMEs) across the region. This effort has the goal of making manufacturers in both in Allegheny County and its surrounding counties more globally competitive. Finally, the collaborative will work to connect robotics and autonomy startups with manufacturers throughout the region, in order to both develop stronger regional supply chains and ensure that firms in all of the region's counties benefit from the cluster.

In any event, Southwestern Pennsylvania's BBBRC award shows that the state's major tech centers are more than ready to put state investment to work. In addition, the win confirms that the state's communities can compete successfully for federal funding opportunities, underscoring that the Pennsylvania should support such opportunities with state resources to take advantage of the continued pipeline of federal funding. Coming soon are compelling innovation competitions, such as those through the Advanced Research Projects Agency for Health (ARPA-H), the National Science Foundation's Regional Innovation Engines program, and the Department of Energy's Regional Clean Hydrogen Hubs program.

SOURCE: Southwestern Pennsylvania New Economy Collaborative, "Coalition Overarching Narrative" (Washington: Department of Commerce, 2022)

Aggressively leverage parallel federal cluster programs for further impact

In addition to shaping its own innovation competitions, the state should also do more to **leverage relevant federal opportunities**. As it happens, right now is a moment of unprecedented opportunity to leverage federal funds to advance regional innovation, given the recent passage of watershed bills containing highly relevant programs.

Southwestern Pennsylvania has already secured a \$63 million grant from Economic Development Administration's Build Back Better Regional Challenge (BBBBRC) to supercharge the region's globally recognized robotics and autonomy cluster and ensure that its economic benefits equitably reach rural and coal-impacted communities in the 11-county region. Yet there are many other potential awards to be won, including the National Science Foundation's Regional Innovation Engines competition and the Commerce Department's Regional Technology and Innovation Hubs program in the CHIPS and Science Act—each of which contain major funding and leveraging opportunities for local ecosystem-building initiatives. Other opportunities reside in pending innovation investments, such as the Department of Energy's \$8 billion H2Hubs competition to support at least four regional clean hydrogen hubs, and the Department of Transportation's \$100 million Strengthening Mobility and Revolutionizing Transportation (SMART) grants. On all of these fronts, having a strong statewide innovation vision and strategy will give Pennsylvania proposals a leg up—but so will direct engagement.

The commonwealth should pile onto these opportunities aggressively, whether to support its regions in winning them or to multiply their impacts with complementary investment. Participation in these initiatives is ripe for enhancement and expansion, win or lose. A case in point is the state's BBBRC win, where the state should actively explore “sidecar” initiatives related to the main proposal. Since the Southwestern Pennsylvania robotics award came in tens of millions of dollars less than the original request, for example, the state could consider funding elements that were omitted from the funded award. Or it could support complementary investments. Likewise, although the

impressive Pennsylvania Wild rural development proposal faltered after gaining finalist status, the state should view the proposal as an opportunity vetted through a vigorous competition and help fund it.

Pending programs from newer legislation—such as the \$280 billion CHIPS and Science Act and the general appropriations process—hold out additional opportunities. For example, the state should get in front of the competition to host the planned Advanced Research Projects Agency for Health (ARPA-H)—a \$6.5 billion opportunity to accelerate the state's and nation's life sciences growth.⁸⁸ Likewise, the commonwealth should engage with its regional partners to convene and support consortia, assist early planning with technical assistance funds, and make available matching funds in order to maximize its regions' chances to win future energy, transportation, and tech innovation challenge grants. For that matter, the regional tech hubs cry out for state engagement given that the CHIPS and Science Act authorizes a \$10 billion program to launch 20 geographically distributed regional hubs focused on expanding innovation capacity, technology inclusion, and job creation. Though final appropriations have yet to be secured, the hubs represent another major opportunity. In that vein, the possibility of a Pennsylvania region winning a five-year, half-billion-dollar grant oriented to exactly the kind of place-based acceleration it needs calls for urgent engagement (at the earliest moment) to ensure the state puts its best foot forward. Large, flexible, and involved, the new generation of transformative place-based challenge grants are inherently more complicated than other federal grants, meaning that responses will require careful thought and design. Given that, the state should play an early convening and planning role—and invest. At the earliest moments—even now, prior to the federal appropriations process—the state could issue a modest challenge grant to its key regions to brainstorm proposal ideas. This would serve as a pre-application “Phase Zero” exercise that would incentivize regions to begin honing concepts for their tech hubs even before any formal notice of a funding opportunity. Later, the state will need to engage more directly with letters of support tied to sizable funding contributions. In these ways, Pennsylvania could invest effectively to help its regions plan ahead and improve their chances of winning

transformative federal funds that ideally suited to addressing the state's innovation needs. Having a strong state innovation strategy would also help; in that way, the state could reemerge as an active supporter of its regions' "bottom-up" venturing.

Expand the state matching funds program for SBIR/STTR awards

In addition to federal place-based investments, the commonwealth should leverage two other federal programs to support growth among its many science-based startups. The Small Business Innovation Research program (SBIR) and the Small Business Technology Transfer program (STTR) are federal grant programs designed to encourage tech development and commercialization by small businesses, with a particular focus on supporting minority and female entrepreneurs, while meeting federal research needs.

Through the SBIR and STTR programs, federal agencies reserve a portion of their R&D funding to support small businesses. The small businesses, in turn, conduct R&D and design a product or process innovation to bring to market, which will be generally aligned with the mission of the federal agency providing the funding. While the two programs have some distinctions, they are generally talked about as a single entity and will hereafter be referred to as SBIR/STTR.⁸⁹

Pennsylvania should invest in firms receiving SBIR/STTR funding and help them attract more funding. SBIR/STTR matters for Pennsylvania firms because it is a substantial source of no-strings-attached funding designed explicitly for the purposes of technology innovation and commercialization. Companies that receive SBIR/STTR funding do not give up intellectual property rights or an equity stake in their company, and the funding isn't a loan.⁹⁰ In this regard, the funding has the potential to help address one of Pennsylvania's most crucial challenges: the need to convert more of its tech transfer activity into startup growth and scale-up activity. In particular, the STTR program—which focuses on tech transfers from nonprofit research institutions like universities—is especially well designed to boost the growth of new firms emerging from one of Pennsylvania's greatest strengths: its research universities.

Given that, Pennsylvania should make a concerted effort to boost SBIR/STTR firms and secure more SBIR/STTR funding for such firms and the state. One way to do so would be to **expand the state matching funds program for SBIR/STTR awards**.

SBIR/STTR leverages a three-phase process. Phase I is a concept development phase, and typically lasts between six months and a year. Phase II is for prototype development, and lasts up to two years. Both Phase I and Phase II are funded by the SBIR/STTR programs. Phase III is the commercialization phase, and isn't funded by SBIR/STTR.⁹¹

Currently, 33 states offer some sort of SBIR/STTR match. Some states offer what are referred to as "Phase Zero" grants, which help new applicants in their pursuit of Phase I (concept development) grants.⁹² Other states offer matching grants for companies that have been awarded Phase I or Phase II (prototype development) grants. Pennsylvania has a "Phase Zero" grant program, but no support for Phase I or II grants. That gap represents a glaring missed opportunity to further support—or create—a significant stream of high-potential startups.

The opportunity here stems from the fact that significant research shows that SBIR/STTR can help firms secure private venture capital and lead to greater levels of patenting—essential ingredients for growing the innovation economy.⁹³ SBIR/STTR grants are powerful catalysts for supporting innovative young firms, in particular.⁹⁴ Moreover, research shows that SBIR/STTR state matching programs can help firms secure federal SBIR/STTR awards, and ultimately advance ideas toward commercialization. In particular, literature has shown that state matches for Phase I grants can increase the success of securing a Phase II award by over 6 percentage points, and that grants are particularly useful for companies that haven't previously won SBIR grants.⁹⁵ Beyond that, state matching funds can help increase an SBIR/STTR-funded firm's ability to secure subsequent funding from the private sector.⁹⁶ Furthermore, the SBIR/STTR program maintains as one of its goals fostering and encouraging participation in innovation and entrepreneurship by women and individuals from socially or economically disadvantaged groups.⁹⁷

This makes SBIR/STTR a powerful potential tool for not just countering Pennsylvania's overall underperformance in innovation-oriented entrepreneurship, but also taking on its glaring inequalities in entrepreneurship by race and gender.

In this regard, targeting state support to winners of Phase I SBIR/STTR grants—particularly young firms who haven't previously won an award—can create significant value for Pennsylvania's innovation ecosystem and overall economy. It can increase the flow of federal funding into the state, create more equal entrepreneurship opportunities for underrepresented groups, grow the overall level of firm creation, and create new products and companies that otherwise may not happen in Pennsylvania.

The opportunity for progress is sizable. In 2020, Pennsylvania was awarded \$33 million in Phase I SBIR/STTR grants, and \$129 million in Phase II grants.⁹⁸ All told, Pennsylvania's \$165 million in SBIR/STTR awards ranks seventh nationally—about on par with what one would expect given its status as the sixth-largest state economy. However, that ranking actually underperforms given that Pennsylvania has the fourth-highest level of higher education research.⁹⁹ What's more, four of the states ranked ahead of Pennsylvania on SBIR award dollars—Massachusetts (second), Virginia (third), Maryland (fourth), and Colorado (sixth)—all have smaller economies, and significantly overperform in SBIR/STTR awards given their size. Massachusetts, in particular, received over 2.5 times more in SBIR/STTR awards than Pennsylvania, despite

having both an economy and population that are substantially smaller. In other words, Pennsylvania is leaving money on the table. With additional investment, the state could secure even more federal funding to support innovation-oriented firm creation and scale-up.

In addition to its Phase Zero program, then, Pennsylvania should also enact a Phase I matching grant program targeting companies that evidence shows would benefit the most. Grants should be oriented toward young companies—perhaps those five years old or younger—that haven't previously been awarded Phase II SBIR/STTR grants. That will ensure the funds widen the circle of innovation and firm growth. The state should also enact provisions to support companies owned or led by historically underrepresented groups, who are also less likely to have previously won a Phase II SBIR/STTR award. For example, the state could allow women- or minority-owned or -led firms that are older than five years old apply for a Phase I grant, or provide a higher matching limit for those firms. Such a focus would not only reflect the state's interest in supporting socially disadvantaged and women entrepreneurs, but also help address its serious inclusion problems.

Beyond that, Pennsylvania could consider creating a Phase II matching program to bolster capital to companies receiving SBIR/STTR grants and incentivize keeping them in the state. However, such a step would not directly bring new federal investment into the state in the same way that a Phase I grant would.

RECOMMENDATION #3: FOSTER INNOVATION AND ENTREPRENEURSHIP IN SMALLER CITIES AND RURAL AREAS

The state's four largest metro areas represent its strongest footholds in the global innovation economy and require urgent development. However, more than one-third of Pennsylvanians live and work outside of those major hubs, in smaller communities often remote from the state's core advanced industry concentrations.

This innovation divide, which disconnects scores of communities from the industry clusters that make up the state's big-city innovation economy, is a grave problem that cries out for action.

These gaps deprive scores of Pennsylvania communities of needed concentrations of talent, ideas, and entrepreneurship. Likewise, they deprive the whole state of needed inventions, productivity gains, and high-quality job creation. As such, whole portions of the state—thin on advanced industry growth and short on high-value entrepreneurial gains—are not gaining their share of the family-sustaining jobs of the present and future.

Given that, the state can ill-afford to continue delaying action to counter the trends reported here. And so, the time has come for the commonwealth to launch a broad, state-spanning initiative aimed at helping more of the state's population tap into the benefits of the innovation economy.

In this fashion, the next administration should:

- Design and fund a competitive challenge grant to catalyze innovation and entrepreneurship in 20 regions outside Pennsylvania's major metro areas
- Establish an advanced industries innovation voucher program to help companies throughout the state access cutting-edge research from Pennsylvania universities
- Continue to strengthen the LaunchBox and Innovation Network and expand links to universities

Design and fund a competitive challenge grant to catalyze innovation and entrepreneurship in 20 regions outside Pennsylvania's major metro areas

To fully catalyze innovation in more communities around the state, the commonwealth needs to promote ecosystem vitality in its numerous smaller cities and towns, which are often struggling with their own challenges that are different from those of the university-based tech hubs.

In the big hubs, the main ecosystem priority reflects the need to nurture and scale-up tech-based ideas and new firms. Ecosystem-building there is a matter of enhancing the array of resources that surround universities and local clusters to foster growth. In contrast, in smaller communities across the rest of the state, the work of ecosystem-building is much more about initiating and expanding ecosystems in less dense, smaller-scale regions where they now remain thin or nonexistent.

On this front, the need in much of the state—away from the major metro areas and top research universities—is to build up the often-missing infrastructure of entrepreneurship support. As such, an acute need exists to support the development of more local coalitions and actors engaged with fostering innovation, new-firm formation, and growth in these communities. Such work might entail funding local ecosystem-building initiatives and entities. It might involve the creation of dedicated entrepreneur support organizations (ESOs). Or it might entail establishing funding structures to seed local investment mechanisms, setting up industry-serving research institutes or partnerships between local manufacturers and universities or community colleges.

And so the state should pair its ecosystem-building surge in major hubs with an equally ambitious challenge grant—call it the “Innovation Communities Challenge”—to call forth and **support “place-based” ecosystem-building in 20 or more smaller regions.**

Once again, a new initiative would leverage an appropriate revenue source to support a competitive grant program (such as the advanced sector tax increment mechanism) to assist 20 communities in promoting innovation—though in this case, the initiative would be more broadly distributed. In this vein, the new ecosystem-building challenge would:

- Establish the sizable challenge grant program to help smaller market Pennsylvania regions develop, launch, or strengthen local ecosystem-support programs to nurture local innovation, entrepreneurship, and cluster growth.
- Call out regional coalitions to propose, organize, and implement such ecosystem-building initiatives.
- Organize an insulated, expert process for selecting proposals.

In basic structure, the statewide ecosystem program would repeat some—but not all—aspects of the big-city innovation surge. As another place-focused challenge grant, the program would select among regional partnerships anchored by multiple local institutions; prioritize collaboration on transformative, “bottom-up” projects; and call for local funding matches. As with the larger surge awards, the program would hold out both Phase 1 development awards and Phase 2 implementation ones. Consortia seeking larger awards would name a regional economic competitiveness officer to serve as the point person and provide accountability.

With that said, the scale and purpose of these grants would differ somewhat from the larger Innovation Hub grants. They would focus exclusively on regions beyond the extent of the four large university-based metro areas. They would stress capacity-building, technical assistance, and strategy development relatively more than the larger program—reflecting the needs of smaller communities. And the ecosystem program’s awards mix would tilt more toward development awards to support capacity-building. Along those lines, the award mix might include:

20 \$250,000 Phase 1 development awards for technical assistance funds to develop partnerships and plans for stimulating and nurturing local innovation; and **10 \$2 million to \$4 million Phase 2 implementation awards** to put the best plans in motion. A one-quarter local match would be encouraged, as would emphasis on linkages to rural communities and underrepresented groups, including women and veterans. Out of this will come unique, locally designed and tailored efforts that will build new capacity, forge multistakeholder partnerships, nurture emerging clusters, advance worker training for in-demand roles, convene links between businesses and universities, and design new financing tools to help startups grow.

An example of the kind of locally created initiative that the Innovation Communities Challenge might support is the Northwest Pennsylvania Innovation Beehive Network, through which four higher education institutions and the library system in and around Erie created a pool of resources for early-stage entrepreneurs in that region, including support for ideation, market analysis, branding assistance, business design, and rapid prototyping.¹⁰⁰ Another example the Grotto, a nascent entrepreneur support organization in York that began as a nonprofit coworking space focused on artists, freelancers, and small businesses.¹⁰¹ And still another example is the Pennsylvania Wild Center’s proposal to scale up the Pennsylvania Wilds Outdoor Recreation Cluster—one of 62 BBBRC finalists selected out of 500-plus applications from around the country.¹⁰²

With an Innovation Communities Challenge in place, Pennsylvania could prioritize stirring up valuable new innovation and entrepreneurship activity in parts of the state without well-established existing ecosystems. In doing so, it would add enhance prosperity for dozens of smaller Pennsylvania communities and the state as a whole.

Developing a multi-university innovation cluster: The Northwest Pennsylvania Innovation Beehive Network

Pennsylvania's Erie region lacks a large Research 1 university that produces research in the highest tier nationally. Nonetheless, it has a rich stock of higher education institutions and a knack for creative innovation initiatives—including as a manufacturing region.

In 2013, the Erie County Gaming Revenue Authority and a collection of the region's leading innovation agencies hosted Ignite Erie: A Day of Innovation. From that one-day event grew the broader Ignite Erie initiative, a multiyear initiative to grow the region's innovation economy and promote economic revitalization for both the city of Erie and the broader Northwest Pennsylvania region.¹⁰³

One of Ignite Erie's central efforts has been growing innovation-rich partnerships between the region's universities, small businesses, and neighborhoods to promote economic development. Recognizing that the region did not have a single university that could on its own match the research and innovation prowess of Pennsylvania's largest regions, in 2014, five of the region's higher education institutions as well as the Erie County Public Library formed the Northwest Pennsylvania Innovation Beehive Network—a coalition of smaller institutions that, when working together, can provide the full array of research and business support services needed to grow the region's innovation economy.

Each institution in the Beehive has a specialization, and as a whole, the network offers assistance across an array of business services. Across the different universities, Penn State Behrend's Innovation Commons focuses on engineering, product design, and prototyping; the Erie County Public Library's Idea Lab provides a maker-space with access to high-tech equipment such as 3D printing and classes on new equipment and technology; Edinboro University's Center for Branding and Strategic Communication focuses on design and product promotion to increase brand awareness; Gannon University's Center for Business Ingenuity provides business consulting; and Mercyhurst University's Innovation Entente Lab produces market analysis and business intelligence services.¹⁰⁴

The Beehive Network's staying power was further underscored in August 2022, when Allegheny College announced that they would be joining the network and launching a Center for Sustainable Development to provide sustainability research and consulting services to regional businesses.¹⁰⁵

Promoting entrepreneurship in rural Pennsylvania: Pennsylvania Wilds

Innovation and entrepreneurship—and smart planning work—exist all over Pennsylvania, including in rural Pennsylvania. The Pennsylvania Wilds project shows that clearly.

When rural firms adopt new products and processes, it enhances their competitiveness and can bolster homegrown supply chains. At the same time, many rural areas have significant industry clusters, ranging from agriculture and natural resource management to manufacturing, and can leverage this knowledge to make unique contributions to product and process development throughout the state and nation.

One of those clusters is outdoor recreation. Hoping to take advantage of both the booming interest in outdoor recreation and significant inflow of federal funding, the Pennsylvania Wilds Outdoor Recreation Cluster (PA Wilds) applied for a \$73 million Build Back Better Regional Challenge (BBBRC) grant. PA Wilds is a 13-county region in North Central and Northwest Pennsylvania that is home to about 500,000 residents and over 2 million acres of public land. The primary focus of the application is a set of six construction projects to grow the size of the overall cluster. Meanwhile, over a third of proposed funding would go toward supporting entrepreneurial ecosystem expansion and workforce development in the region, through activities such as bringing regional manufacturers closer to the cluster.

The PA Wilds Center for Entrepreneurship, Ben Franklin Technology Partners, and other partners are also implementing a complementary \$1.5 million project funded by the Appalachian Regional Commission's Partnerships for Opportunity and Workforce and Economic Revitalization (POWER) grant to support technology-based entrepreneurship in the region. The project, called Igniting Innovation in the PA Wilds Region, includes entrepreneurial competitions, assessments of existing manufacturers, microfinancing for new product development, and planning for high-return placemaking.¹⁰⁶ For example, the initiative is offering three "BIG IDEA" prizes of up to \$50,000 to rural entrepreneurs developing products or processes related to the region's industry specialties.¹⁰⁷

The PA Wilds BBBRC grant application was selected as one of 60 finalists out of 529 applicants, though it was not ultimately selected as a winner. Nonetheless, the application serves as an example of the type of high-quality regional thinking that is beginning to surface in rural Pennsylvania, and would be well suited for a small, community-focused state-level innovation grant.

SOURCE: Pennsylvania Wilds Center for Entrepreneurship, "Coalition Overarching Narrative" (Washington: Economic Development Administration, 2022).

Establish an advanced industries innovation voucher program to help companies throughout the state access cutting-edge research from Pennsylvania universities

While innovation is scarcer in smaller places, that doesn't mean it isn't happening at all. Many advanced industries firms (particularly, advanced manufacturing and advanced energy firms) are present throughout Pennsylvania's smaller communities. These companies help form the basis of innovation ecosystems in communities throughout the state, not just through their own R&D, but through expertise-sharing with partners in their community and statewide. But while those firms are often sources of innovation for smaller places, they have limited access to the state's most effective innovation ecosystem-building resources—its universities.

And while larger firms throughout the state can, and often do, conduct their own R&D, or have the market power and financial resources to collaborate with universities, many smaller firms do not have the same opportunities.

This matters not just for individual companies, but for the communities and regions they are situated in. When firms are unable to adopt innovative products and processes, it reduces their competitiveness. In some cases, that can reduce firm growth, meaning less job growth for regions. In some cases, firms that fail to adapt may even go out of businesses, with negative regional employment effects.

To boost the diffusion of innovation throughout the state, Pennsylvania should **establish an advanced industries innovation voucher program to help companies access cutting-edge research from universities in the state**. This program would allow Pennsylvania advanced industries firms with fewer than 500 workers apply for a voucher to defray the costs of working with a Pennsylvania four-year college or university, community college, or research institution on innovation-related issues.

Vouchers could be worth between \$5,000 and \$50,000, depending on the size and scope of the project. The money could be used to pay for R&D assistance, technology feasibility studies, tech transfer analysis, analysis of the innovation potential of a new technology, process innovation support, or other uses as designated by the state.¹⁰⁸ Companies would be able to apply on a rolling basis, and the state should take care to create a simple application that minimizes barriers to application.

An innovation voucher program could strengthen innovation ecosystems in smaller communities across the state by growing the connections between Pennsylvania's higher-education-based research apparatus (which is overwhelmingly concentrated in the Philadelphia, Pittsburgh, and State College metro areas) and firms in smaller communities. To ensure this program reaches those communities, policymakers should require that a substantial share of innovation voucher awards and funding go to smaller places. For example, policymakers could require that at least half of awards and half of all funding go to companies outside of the state's largest innovation hubs. Small firms headquartered outside of Pennsylvania could be considered as well, but they would need to have a significant Pennsylvania employment presence and demonstrate that the project would materially benefit their Pennsylvania-based operations.

Continue to strengthen the LaunchBox and Innovation network and expand links to universities

Finally, Pennsylvania should further support entrepreneurship in the state's smaller areas by further **bolstering the Penn State system's Invent Penn State initiative** and its 21 LaunchBox and Innovation Network accelerators and innovation spaces. To its credit, the Assembly invested for the first time this summer in what has been a self-funded Penn State initiative, with a \$2.3 infusion in its recent FY 2022-23 budget. That funding affirmed the potential of the initiative as a promising way for the state to leverage one of its most important existing networks (the Penn State campus

system) as a platform for decentralized ecosystem-building. Looking forward, the network seems well positioned—with modest but consistent support—to participate in multiple regional ecosystems around the state by providing local entrepreneurs needed work rooms, communities, and specialized programs to help with launching startup companies. The state should continue nurturing this network as an additional contributor to its Innovation Communities Challenge. For their part, the Invent Penn State nodes should seek to identify emerging local ecosystem needs—and help fill them.

More broadly, the state should encourage and incentivize increased engagement on the part of Pennsylvania universities in local innovation ecosystems, regional workforce collaborations, and efforts to connect students with firms. The state's

dependence on its universities for economic growth underscores this. Now more than ever, Pennsylvania institutions need to create new programmatic thrusts to leverage their invaluable reservoirs of talent, research, and skill-building to do more. Pennsylvania universities need to be willing to aggressively extend the reach of their research and education impacts, especially to smaller, rural, and underrepresented communities. They need to engage with small manufacturers as well as with the Googles and Pfizers of the world. And beyond that, they need to help attract companies to the state and ask how even highly regarded commercialization programs can be more effective for both major metro area and smaller-town communities. In short, Pennsylvania's world-class universities and expansive higher education sector need to become more active stakeholders in revitalizing innovation—for everyone.



RECOMMENDATION #4: INSIST ON INCLUSION

Investing in Pennsylvania's communities—from its existing innovation hubs to its smaller towns and rural areas—will be critical for bolstering the innovation economy. However, investing by place without a specific effort to build a more inclusive innovation economy risks perpetuating the same inequalities that the state has been facing for years.

Given that, in addition to its investments in large and small communities, the state should enact an innovation agenda focused on enhancing inclusion in the innovation economy, focused on three themes:

- Grow a more inclusive entrepreneurial ecosystem
- Expand access to advanced industry careers
- Make STEM education more equitable

Grow a more inclusive entrepreneurial ecosystem

Supporting inclusive entrepreneurship is the place to start. Entrepreneurship is central to growing Pennsylvania's innovation ecosystem and its economy as a whole. However, the high levels of inequality in entrepreneurship and firm ownership by race and gender in Pennsylvania not only reduce economic opportunity for individuals from those groups, but also suppress overall growth.¹⁰⁹

Given that, the state can and should enact a variety of policies to create more entrepreneurial opportunities for Pennsylvania residents from underrepresented groups. Along these lines, the state should:

- Expand access to capital:
 - Center inclusion in investments using SSBCI funding
 - Provide additional, state-level funding for the Diverse Leaders Venture Program
 - Establish a state CDFI fund
 - Increase the funding cap on the Pennsylvania Minority Business Development Authority loan program

- Foster critical connections and business supports for underrepresented groups:
 - Strengthen the connections between private lenders, mission lenders, and entrepreneurs from underrepresented backgrounds
 - Enable business development supports for entrepreneurs looking to receive equity funding
 - Increase funding for incubators and accelerators focused on underrepresented groups
 - Leverage public procurement to support entrepreneurship and business development by underrepresented groups

To start, the state has a signal opportunity now to expand access to capital for entrepreneurs. The federal SSBCI program, which is providing \$268 million to Pennsylvania over the next 10 years to bolster lending and equity investment, has the potential to jump-start entrepreneurship across the state, including within communities that have been historically excluded from firm ownership. To maximize the program's impact, particularly for underrepresented groups, the state should consider a variety of complementary investments in the coming years.

First, it should ensure that lenders and equity investors **center inclusion in investments using SSBCI funding.** Fifteen percent of Pennsylvania's SSBCI allocation is set aside to support business enterprises owned and controlled by socially and economically disadvantaged individuals ("SEDI-owned businesses").¹¹⁰ In addition, the state can unlock an additional \$21 million if it ensures that at least 31.29% of its SSBCI allocation goes to SEDI-owned businesses.¹¹¹ For its part, DCED has included the amount of funding that must be expended on SEDI-owned businesses in its suballocation agreements with lenders and investors.¹¹² Lenders and equity investors should aim to go above-and-beyond these thresholds. It will take years of deliberate and sustained investment to reverse the significant entrepreneurial disparities for underrepresented groups in Pennsylvania, and the SSBCI provides an opportunity to begin doing so.

One of the most innovative aspects of Pennsylvania's SSBCI program, meanwhile, is the state's Diverse Leaders Venture Program. The program provides loans to venture funds owned and controlled by diverse general partners that are investing in businesses owned and controlled by diverse populations.¹¹³ This program matters because investors from diverse backgrounds are more likely to invest in entrepreneurs and businesses from diverse backgrounds, so growing the number of diverse investors can help grow the number of diverse firms. However, while important, the Diverse Leaders Venture Program is relatively small in the overall scale of the venture capital space. The estimated total state funding for the program (\$17 million) is roughly the size of one large venture capital

deal. And given that that funding will be spread across three tranches issued over six years, the initial size of the program will be just a fraction of that.

To bolster the program's impact, the state should **provide additional, state-level funding for the Diverse Leaders Venture Program**. Doing so can magnify its impact by allowing more diverse venture organizations to participate and increasing the overall resources that each participating fund has to deploy to entrepreneurs and startups. While federal SSBCI funding will bolster a set of diverse venture funds in Pennsylvania, additional resources beyond the federal funding will be needed to close the entrepreneurship inequalities that exist in Pennsylvania.

Growing capital access for diverse and underinvested firms: Black Tech Nation Ventures

Black entrepreneurs can be found throughout Pittsburgh and the surrounding region, but their underrepresentation makes it difficult for them to connect with one another. Kelauni Jasmyn has been working to change that by creating a more robust community for Pittsburgh's Black entrepreneurs.

In 2017, Jasmyn founded Black Tech Nation, a nonprofit organization dedicated to connecting Black tech professionals in the Pittsburgh area. Since its founding, Black Tech Nation has promoted ecosystem activities by organizing local meetups, partnering with firms to shape their policies around diversity and inclusion, and leading coding classes for Black students.

In 2021, Pittsburgh-based Birchmere Ventures partnered with Black Tech Nation to found Black Tech Nation Ventures, a venture capital firm focused on investing in founders with diverse backgrounds that have historically been overlooked by venture capital. Black Tech Nation Ventures' goal is to advance diverse innovation, and it's currently focusing investments in software and tech-enabled solutions.¹¹⁴ While the fund isn't investing solely in Pennsylvania companies, it is based in Pittsburgh, and the firm's partners and leadership are all currently Pittsburgh-based.

Black Tech Nation Ventures has set a goal of raising \$50 million for investment in 20 to 30 companies over the next five to 10 years.¹¹⁵ In December 2021, the company announced that it had reached \$25 million in funding and had made its first investment.¹¹⁶ In September, Google's parent company Alphabet invested an undisclosed amount in Black Tech Nation Ventures via its CapitalG fund.¹¹⁷

Black Tech Nation Ventures is one of a small but growing number of venture firms run by individuals of diverse backgrounds. Supporting and growing these types of firms is the core focus of the Diverse Leaders Venture Program that Pennsylvania is creating with its SSBCI funding.

Another way to support the state's loan participation program would be to **establish a state CDFI fund**. The federal government's CDFI fund, managed by the Department of the Treasury, provides capital grants, equity investments, and technical assistance and capacity-building for CDFIs nationwide. A state-level fund could provide similar forms of assistance to CDFIs in Pennsylvania. In 2020, for example, New York became the first state to create a state-level CDFI fund.¹¹⁸ While such a fund may not be able to directly support SSBCI-financed lending (as SSBCI matching funds need to come from private sources), it would be able to further expand CDFI-based lending to small businesses and disadvantaged groups beyond what the SSBCI program alone could support. This fund could also be leveraged to establish pre-seed and early-stage funds focused on "growth" entrepreneurship at more institutions in the Pennsylvania CDFI network, with the goal of broadening the number of avenues that underrepresented entrepreneurs have available to access equity investment.

In addition to greater capital to start companies, underrepresented entrepreneurs need greater resources to scale them. One state tool to help grow businesses owned by individuals with diverse backgrounds is the Minority Business Development Authority loan program. This program provides low-interest loans to businesses owned and operated by ethnic minorities in Pennsylvania. It finances up to 90% of eligible projects up to a limit of \$250,000, at a fixed rate of 2%.¹¹⁹ However, for some companies, the \$250,000 cap can be too low to be useful, as the various eligible uses—which include land costs, building costs, machinery costs, and working capital—often require more than \$250,000 in investment.

Policymakers should therefore **increase the funding cap on the Minority Business Development Authority loan program** to make it useable for more companies. This has precedent in Pennsylvania. The Pennsylvania Industrial Development Authority (PIDA) loan program can be used for many of the same types of projects as the Minority Business Development Authority loan program, but the former can be worth up to \$2.25 million rather than just \$250,000 (albeit with a much higher cost share of 25% to 50% rather than 10%).¹²⁰

However, PIDA loans aren't specifically designed for minority business owners, and so those owners may face challenges in accessing PIDA loans that they wouldn't face if the state created a more robust Minority Business Development Authority loan program.

Pennsylvania can take further steps to fill in some of the barriers that exist in the federal SSBCI program by **fostering critical connections and business supports for underrepresented groups**. One barrier, for example, is that SSBCI funding can only support 50% of total loan financing. This requirement exists to ensure that SSBCI funding spurs private investment into entrepreneurs and firms. While securing 50% of financing from private sources may not be a challenge for some companies and lenders, this requirement could be barrier for some entrepreneurs from underrepresented backgrounds.

Given that, Pennsylvania should **strengthen the connections between private lenders, mission lenders, and entrepreneurs from underrepresented backgrounds**. To do so, the state could convene mission lenders and traditional financial institutions and encourage them to develop strategies to co-invest. It could also provide greater funding to organizations supporting entrepreneurs in areas such as developing a business plan, identifying a market, and improving their financial and management structures—each of which make entrepreneurs more likely to be able to access private lending.

When it comes to venture capital and equity investment, the state can take several steps to bolster the effectiveness of its SSBCI funding into the Ben Franklin Technology Partners and Life Sciences Greenhouses. First, the state can provide funding to **enable business development supports for entrepreneurs looking to receive equity funding**. Like CEDOs and CDFIs, the Ben Franklin Technology Partners and Life Sciences Greenhouses don't just provide funding, but also a variety of other services for entrepreneurs and communities. These include mentoring and training, ecosystem development, and support for intermediaries such as centers of excellence, incubators, and accelerators. While SSBCI

will allow the Ben Franklin Technology Partners and Life Sciences Greenhouses to increase the amount they invest, they will be restricted in who they can invest in if they don't have a corresponding scale-up in funding to support these complementary, non-investment activities that ready entrepreneurs for receiving investment.

Pennsylvania policymakers can also go beyond the SSBCI program to increase the flow of capital to diverse entrepreneurs. For example, as part of any ecosystem-building efforts, the state could **increase funding for incubators and accelerators focused on underrepresented groups**. Pennsylvania possesses a robust network of incubators and accelerators, some supported by public entities such as the Ben Franklin Technology Partners or organizations working with the Pennsylvania Partnerships for Regional Economic Performance (PREP) network, and others managed by private organizations. The state could institute priorities in new ecosystem-building programs for both innovation hubs and smaller communities to support incubators and accelerators with a dedicated focus on underrepresented groups. As a complementary measure, the state could also consider requiring that incubators receiving public funding must enroll at least one cohort of individuals from underrepresented groups on a regular basis. The state could leverage the same definition of "SEDI-owned businesses" used by SSBCI as eligibility for which groups count as underrepresented.

Finally, the state can and should do more to **leverage public procurement to support entrepreneurship and business development by underrepresented groups**. The Pennsylvania state government has set an impressive aspirational target to have 26.3% of its contracting spending go to small and diverse businesses.¹²¹ However, in 2020-21, only 11.72% of the state's procurement spend went to those businesses.¹²² The next administration has an opportunity to build on previous efforts, and should prioritize meeting the state's 26.3% target.

One tool to do so is the 2018 Pennsylvania contracting disparity study, which inventoried the state's shortcomings when it came to contracting, and set a path forward. An updated disparity study was supposed to be published in 2022, though to date it has not been released.¹²³ Prioritizing a new disparity study early in the next administration and committing to updating it at regular intervals can help the state track its progress on diverse contracting and set goals and strategies reflecting progress over time.

Beyond that, the state can aim to more thoroughly integrate its investments into capital programs like SSBCI or company incubators and accelerators with its procurement efforts. For example, the state could proactively make firms receiving funding through Pennsylvania's SSBCI program, publicly funded incubators and accelerators, or the Minority Business Development Authority aware of public procurement opportunities. The state could also coordinate with funding intermediaries such as the Ben Franklin Technology Partners, Life Sciences Greenhouses, incubators and accelerators, and CDFIs to design technical assistance programs to better prepare companies in those institutions' portfolios to bid on and win state contracts. Finally, the state could do more to publicize its Small and Small Diverse Businesses directory, with the goal of addressing inequalities in marketing that these firms face.¹²⁴ One example of a local organization leveraging business accelerators to create procurement opportunities for diverse businesses' is the work being done by the Cincinnati Minority Business Accelerator.¹²⁵

Expand access to advanced industry careers

While expanding access to entrepreneurial activity is central to increasing inclusion in Pennsylvania's innovation economy, most workers will ultimately not be firm owners. For many, jobs in the advanced industries will be how they access the good pay associated with the Pennsylvania innovation economy.

To promote more equitable access to advanced industry employment, Pennsylvania policymakers should take the following steps:

- Develop a set of state-supported communities of practice for organizations focused on connecting workers to advanced industry jobs
- Provide competitive funding for both new and existing programs that aim to bolster engagement of underrepresented groups in the advanced industry workforce
- Encourage high-quality, non-degree workforce pathways in state-funded innovation programs
- Fund child care and other wraparound services to help workers enter or stay in advanced industry occupations
- Leverage Pennsylvania's significant new streams of federal funding to connect underrepresented workers to innovation jobs

Women and workers of color remain significantly underrepresented in advanced industry jobs. While many organizations are working on the local and regional levels to connect underrepresented workers to these jobs, they are often doing so without significant state support or visibility into efforts across the state. To amplify these organizations' efforts, share best practices, and bolster connections between industry and workforce efforts, the state should identify existing programs and organizations actively supporting advanced industry skill development and **develop a set of state-supported communities of practice for organizations focused on connecting workers to advanced industry jobs.** This effort could be operated as a joint effort among the Pennsylvania Department of Labor and Industry, the Department of Education, and the Department of Community and Economic Development, with a dedicated point person to identify organizations operating throughout the state. This effort would be particularly valuable because it would allow organizations and programs that are already established to share their knowledge and experience without having to create a stable of new initiatives that would duplicate existing efforts. The communities of practice could focus on key industry or topic verticals such as advanced manufacturing, life sciences, robotics, or broader STEM equity.

To complement this best-practice sharing effort, Pennsylvania's state government could **provide competitive funding to both new and existing programs that aim to bolster engagement of underrepresented groups in the advanced industry workforce.** Funded programs would be required to participate in the statewide community of practice, to ensure that the most effective processes of programs receiving public funding are diffused to organizations across the state. Doing so can ensure that even organizations not directly receiving state funding can benefit from this public investment. Pennsylvania policymakers have previously taken steps to support these types of organizations, such as through Governor Wolf's PAsmart initiative.¹²⁶ However, given the continued inequalities in access to advanced industry employment, the state needs a larger and more sustained effort focused on connecting workers from underrepresented groups to these jobs.

In addition to directly funding local and regional organizations connecting workers to advanced industry jobs, Pennsylvania policymakers should ensure that any broader investments they make into fostering innovation ecosystems—whether in larger innovation hubs or smaller communities—have an explicit inclusion dimension. One way to do so would be to **encourage high-quality, non-degree workforce pathways in state-funded innovation programs** like the Innovation Hubs and Innovation Communities challenge grants. While bolstering the number of diverse STEM doctoral graduates is critical to increasing Pennsylvania's innovation competitiveness (and more needs to be done to facilitate that), ultimately those graduates will only encompass a small portion of the state's innovation workforce. The state should instead encourage localities to expand the use of apprenticeships, in-demand certificates, and other non-degree programs that are widely accepted by regional firms and industries. In addition, the state should begin collecting data on student outcomes and career paths for non-degree programs that receive public funding, to ensure that students are receiving the skills they need to enter good-paying jobs that lead to viable career paths.¹²⁷ Doing so will maximize the opportunities for workers of all backgrounds to access the innovation economy.

While direct workforce and employment efforts are important, by themselves they are likely insufficient for closing the racial and gender workforce gaps in Pennsylvania's advanced industries. To complement workforce efforts, the state can consider a variety of investments to provide the necessary supports for workers to enter innovation-related and advanced industry careers.

One of the most significant barriers keeping some workers from accessing advanced industry jobs is limited access to child care. Evidence shows that labor market outcomes for women and workers of color are disproportionately affected by access to child care.¹²⁸ At the same time, some advanced manufacturing jobs—which are a disproportionate share of innovation jobs in smaller communities across Pennsylvania—may require off-peak shifts during early-morning or late-night hours.¹²⁹ The scarce availability of child care during those times limits who can take nonstandard shift work, with a disproportionately negative effect on single mothers.¹³⁰ Given these realities, the state, perhaps working in conjunction with industry, should establish a new program to **fund child care and other wraparound services to help workers enter or stay in advanced industry occupations**. Examples of other supports could include housing assistance, transportation stipends, financial literacy, support for purchasing industry-relevant attire, and dedicated case management. To start, the state could provide these supports to help workers access a selected set of in-demand, advanced industry occupations, with an emphasis on those that provide pathways for workers without a bachelor's degree. Importantly, these supports don't just matter for advanced industry workers in urban areas, but rather workers in communities of all sizes across the state.

In addition to limited access to child care, underrepresented workers—and, disproportionately, workers of color—tend to live in places that are physically separated from innovation districts, advanced manufacturing facilities, and other sources of advanced industry jobs. Over the past two years, the federal government has passed historic levels

of investment into states within laws such as the Infrastructure Investment and Jobs Act, the CHIPS and Science Act, and the Inflation Reduction Act. Some of this funding is already in motion, while other funding will continue to flow in the coming years, in the form of both guaranteed formula funds as well as competitive funding opportunities.

Policymakers should take care to **leverage Pennsylvania's significant new streams of federal funding to connect underrepresented workers to innovation jobs**. These new investments will touch nearly every part of the state economy, from the state's physical built environment to its workforce development system.

For example, the federal infrastructure bill is providing historic levels of funding to states to bolster roads, public transit, and other forms of transportation. Policymakers can take an inclusion lens while determining which backlogged physical reconstruction projects to prioritize in the state's capital budget. They may also want to support Pennsylvania communities applying for competitive funding such as the Department of Transportation's Rebuilding American Infrastructure with Sustainability and Equity (RAISE) program. Policymakers may even leverage federal funding to create state-level initiatives that parallel federal efforts such as the Reconnecting Communities program, by investing in projects with a dedicated focus on connecting neighborhoods with high proportions of residents of color to innovation districts, exurban manufacturing areas, and other areas with large shares of innovation employment.

Moreover, each of these federal laws contains significant workforce investments, ranging from physical construction to semiconductor manufacturing and advanced energy. In addition to physical investment, the state can promote inclusion by pushing workforce partners such as workforce development boards, economic development organizations, unions, community colleges, and companies themselves to prioritize inclusion in their workforce efforts.

Make STEM education more equitable

While entrepreneurship and workforce development policies are critical, interventions at the career level alone are insufficient to promote greater innovation equity in Pennsylvania. Indeed, if access to innovation-critical STEM education remains inequitable for women, students of color, and other underrepresented groups, it will continue to place individuals from those groups at a disadvantage when it comes to accessing innovation careers.

It is critical, then, that Pennsylvania take steps to promote a more equitable STEM education system, ranging from elementary education all the way to faculty and doctorate degrees. The following steps can help achieve that goal:

- In higher education:
 - Create a new program to attract diverse STEM professors and researchers to Pennsylvania higher education institutions
 - Establish a complementary program aimed at recruiting diverse Pennsylvania students to STEM doctorate programs
 - Create more research opportunities for undergraduates from underrepresented groups
 - Establish a program to create paid internships at STEM-focused organizations for underrepresented students
- In K-12 education:
 - Bolster the Pennsylvania Department of Education's PAsmart grants program
 - Provide resources to enhance entrepreneurship education at schools educating students from underrepresented groups
 - Elevate and expand STEM communities of practice like the PA STEM Coalition
 - Provide competitive funding to new and existing programs that aim to bolster racial, gender, and other types of inclusion in STEM education

Ensuring access to and participation in STEM higher education is important for skill development. But STEM higher education—and STEM Ph.D. programs specifically—are particularly important because they grant individuals the opportunity to become university STEM faculty. As STEM faculty, individuals have the opportunity to conduct research and, in some cases, ultimately commercialize that research—turning their findings into viable products and creating companies to sell those products. These university faculty “spin-off” companies are both an important source of innovation and job creation in Pennsylvania as well as a potential opportunity for wealth-building for their founders. Indeed, past work by scholars notes that employment in STEM fields alone isn't enough to shrink the wealth gaps that exist within the tech space and across the economy—greater entrepreneurship and firm ownership by underrepresented groups is central to closing those gaps.¹³¹ However, when women and individuals of color are shut out of STEM degrees—and, in particular, STEM Ph.D. programs—they are also shut out of the best-recognized pathway to creating high-growth, innovation-oriented university spin-off firms, and the wealth-building opportunities they come with.

While funding to get more Pennsylvania residents from underrepresented groups into Ph.D. programs will develop Pennsylvania's diverse innovation talent in the coming years, the state can take steps to bolster its diverse tech talent in the short run as well. To do so, it should **create a new program to attract diverse STEM professors and researchers to Pennsylvania higher education institutions**. This program would pay dividends for the state not just in the research and technology development that those scholars produce, but also because their presence would present more role models for underrepresented students looking to enter innovation-related fields.

This type of program has precedent in Pennsylvania. The state previously ran a faculty recruitment program as part of its Keystone Innovation Starter Kit (KISK) program. That effort recruited new, top-level research faculty to Pennsylvania to facilitate focused research in key Keystone Innovation Zone industry cluster areas.¹³² Another model the state could leverage would be the Georgia Research Alliance's Eminent Scholars

program, which recruits top national scientific talent to Georgia universities.¹³³ While neither the KISK faculty recruitment program nor the Eminent Scholars program specifically focused on scholars with diverse backgrounds, they could serve as templates for what type of benefits the state could provide to make Pennsylvania competitive for top research talent.

Beyond that, Pennsylvania should take steps to develop homegrown STEM Ph.D. talent. To do so, it should **establish a complementary program aimed at recruiting diverse Pennsylvania students to STEM doctorate programs** and providing funding and essential supports to them as they complete their degrees. Pennsylvania could leverage connections with its faculty recruitment program to make its Ph.D. student recruitment as competitive as possible. For example, the state could incorporate recruited faculty into the selection process and provide selected candidates with the opportunity to conduct research with faculty recruited through that program. Policymakers should take care to align these efforts with any entrepreneurship and advanced industry employment investments that are part of the state's broader ecosystem development efforts. Doing so will create opportunities for firm creation and employment by Ph.D. graduates and aid in talent retention.

Ultimately, however, most STEM higher education students will not pursue a Ph.D. Still, Pennsylvania can take several steps to bolster opportunities for undergraduate STEM students from underrepresented backgrounds. For example, the state can work to **create more research opportunities for undergraduates from underrepresented groups**. Here too, Georgia offers a similar template, with the Georgia Research Alliance's Student Scholars program connecting students from underrepresented backgrounds as researchers for faculty recruited through its Eminent Scholars program.¹³⁴ Pennsylvania could establish a similar program and prioritize giving students the opportunity to work with diverse faculty recruited to the state.

For students looking to enter STEM industries, the state could **establish a fund for paid internships at STEM-focused organizations for students from underrepresented backgrounds**. Internships are

critical to helping students access post-graduation employment. However, many internships, particularly at nonprofit organizations and government agencies, remain unpaid. Evidence shows that unpaid internships are disproportionately biased toward higher-income students, and put lower-income students—who tend to also come from racial and ethnic backgrounds that are underrepresented in STEM fields—at a competitive disadvantage in the job market.¹³⁵ Such a program could provide low-income students from underrepresented backgrounds with a stipend of up to \$8,000 for a three-month internship (equivalent to an hourly wage of just over \$15) at a STEM-related nonprofit or government agency.¹³⁶

Moving to K-12 education, early exposure to STEM education is critical to helping students access STEM higher education. And classroom funding is critical to ensuring that students develop the skills and interest in STEM that will ultimately lead to innovation careers. Pennsylvania's state government can and should take a more proactive role in ensuring schools have the resources they need to make STEM education as equitable as possible across Pennsylvania.

One way to do so could be to **bolster the Pennsylvania Department of Education's PAsmart grants program** to help schools train and hire qualified STEM teachers. Since 2018, the PAsmart program has secured \$60 million in investments for Pennsylvania schools.¹³⁷ It provides smaller targeted grants of up to \$35,000 to help local education agencies connect teachers with professional learning to expand access computer science and STEM in their schools, as well as larger "advancing grants" of up to \$500,000 to support expanding regional computer science and STEM ecosystems, enhancing access for underserved populations, and growing the number of computer science and STEM educators, among other uses.¹³⁸ Policymakers can take several steps to do more with this program. For example, at just \$35,000 per grant, the program's targeted grants are limited in the amount of support they can provide to schools. Moreover, given the PAsmart program's focus on teacher training and skill development, the state could consider establishing a parallel program to help schools purchase and utilize new STEM-related equipment.

Next, the state should work to link its investments in STEM education to innovation-related career opportunities. One way to do so is to **provide resources to enhance entrepreneurship education at schools educating students from underrepresented groups.** Here too, the state already has a baseline to build from. The Pennsylvania Career Education and Work Standards require all students be exposed to four areas of knowledge before graduating high school: career awareness and preparation, career acquisition, career retention and advancement, and entrepreneurship.¹³⁹ However, as evidenced by the significant disparities in entrepreneurship and firm ownership by race and gender in Pennsylvania, the state still has a long way to go in promoting equity in entrepreneurship.

To better support this effort, Pennsylvania could provide grants to schools serving a large proportion of students from underrepresented groups to bolster their Career Education and Work Standards offerings. As a complementary effort, the state could provide grants to schools to offer extracurricular programming for students from backgrounds underrepresented in entrepreneurship.

A number of local and regional efforts throughout the state are aiming to connect young people with STEM skills outside of the classroom. However, these programs are operating independently, without dedicated state support and with limited opportunities to collaborate and share best practices.

A cradle-to-career approach to STEM learning: The Philadelphia STEM Equity Collective

Philadelphia's STEM industries have long been unequal by race and gender, despite its position as one of the largest STEM industry hubs in the United States.¹⁴⁰

However, a variety of local governmental and nonprofit efforts have been working to change those trends. In 2015, the Philadelphia Education Fund, the 21st Century Partnership for STEM Education (21PSTEM), and the Philadelphia Mayor's Office of Education launched the Philadelphia STEM Ecosystem as part of the first cohort of over 100 STEM Learning Ecosystems nationwide.¹⁴¹

In January 2020, pharmaceutical company GSK committed \$10 million over 10 years to create the Philadelphia STEM Equity Collective in partnership with the Philadelphia Education Fund. The STEM Equity Collective has the goal of increasing the number of Black, Latino or Hispanic, and female Philadelphians in STEM industry jobs by 2030. It is working across four focus areas:

1. Improving home and community access by growing the number of high-quality and culturally responsive STEM out-of-school programs.
2. Formalizing pathways to recruit and inspire more underrepresented Philadelphia K-12 students to study STEM fields.
3. Connecting Philadelphia higher education students to careers in STEM industries.
4. Working with STEM industry employers to develop equitable policies and best practices to recruit hire, retain, and promote Black, Latino or Hispanic, and female employees.¹⁴²

GSK is offering backbone support for the STEM Equity Collective by providing dedicated management staff as well as pro bono volunteers. Initial efforts by the STEM Equity Collective have included growing the number of free resources for STEM in-home education, expanding wraparound and support services for students, integrating culturally competent content into K-12 STEM education, and improving alignment between both degree and non-degree postsecondary programs with STEM careers.¹⁴³

To the state's credit, efforts do exist in some regions to connect young people with STEM skills. One example is the various STEM Learning Ecosystems in communities across the state. This effort is a global community of practice aimed at delivering rigorous, effective pre-K-16 STEM instruction, both in and out of the classroom in after-school and summer programs, as well as in sciences centers, libraries, and other public and community spaces.¹⁴⁴ Pennsylvania has eight STEM Learning Ecosystems, tied with California and behind only New York for the most of any state.¹⁴⁵ And while the state has acknowledged these ecosystems via a dedicated government webpage, it's not clear how much support or coordination the state government has put into them.¹⁴⁶

STEM Learning Ecosystems are just one example of the many organizations that are doing local work to support STEM learning in Pennsylvania. With many smaller, distributed STEM learning efforts across the state, proactive state leadership should aim at connecting these organizations, facilitating best-practice sharing, and developing statewide scale that can attract more federal, state, and philanthropic funding. Luckily, the state already has a platform for taking on this work. The PA STEM Coalition is a statewide network of over 400 stakeholders focusing on equitable access to STEM, from childhood to higher education.¹⁴⁷ The next governor and state secretary

of education can aim to **elevate and expand STEM communities of practice like the PA STEM Coalition**, with the goal of sharing best practices across different regions, supporting greater corporate and philanthropic involvement to fund STEM education efforts, and creating further policy recommendations for engaging underrepresented students in STEM. The state could also provide funding to local and regional organizations to establish central online hubs for students and their families to learn about STEM resources in their area and how to access them.

As with efforts to support organizations focused on connecting individuals from underrepresented groups to advanced industry careers, Pennsylvania could also **provide competitive funding to new and existing programs that aim to bolster racial, gender, and other types of inclusion in STEM education**. In particular, the state should look to encourage best-practice sharing with these grants. One way to do so would be to provide incentives to partnerships of different organizations, funding both the group that developed the best practice, as well as the group or groups that are adopting the best practice. As with employment efforts, any organizations receiving public funding would be required to participate in a state-supported community of practice to spread programmatic best practices, including to organizations that aren't receiving direct public funding.



Revenue ideas to support a robust innovation economy

Reenergizing Pennsylvania's stagnant innovation economy will take more than a one-off investment. Rather, the state will need to generate sustained and consistent investment over time to accelerate expansion in a sector whose tepid growth reflects decades of disinvestment and disinterest.

To be sure, it's never easy to locate such investment resources. However, the commonwealth has several revenue options for funding a sustained, multi-year innovation campaign.

Most notably, Pennsylvania could leverage a creative finance strategy that has been used elsewhere in the country to capture and reinvest a portion of the

incremental growth of state revenue generated by innovation sector employment gains. Through this approach, the state would channel a portion of the growth in personal income tax receipts from workers in its advanced industries into a **"Keystone Advanced Industries Growth Fund,"** to be used to finance future investments in innovation and advanced industry growth. Importantly, this model would not in any way reduce revenue flows reserved for the Pennsylvania general fund. Nor would the approach raise taxes. Instead, it would channel future new funds toward investment—in sizable amounts. Using 2022 as a base year, for example, the program could yield as much as \$540 million over five years for investment in Pennsylvania's advanced industries.¹⁴⁸

Note, too, that this model has previously been used in other states. In 2004, Kansas established the Kansas Bioscience Authority, and in 2013, Colorado established an Advanced Industries Accelerator program.¹⁴⁹ Both made use of this funding model. Preliminary assessment suggests such a mechanism could in a few years become a valuable source of investment funding for Pennsylvania's efforts to rejuvenate its innovation sector.

With that said, one of the characteristics of the tax increment funding option is that it grows revenue over time, with a slow initial ramp-up. Given that, Pennsylvania will need to locate near-term resources to support its initial investments. Fortunately, it has options for doing that. Specifically, the state's share of federal pandemic relief funds combined with strong tax collections in recent years mean Pennsylvania has a multi-billion-dollar budget surplus. The state could **tap this sizable budget surplus** and make a one-time transfer from its general fund to seed the Keystone

Advanced Industries Growth Fund and secure funding over the first years of the program before letting it run on its own.

Finally, there is another funding option. Pennsylvania, like many states, is currently engaged in a debate about whether to legalize, regulate, and tax marijuana for recreational adult use. While estimates vary, **taxing transactions tied to legalizing marijuana** could potentially generate hundreds of millions of dollars in annual revenue.¹⁵⁰ If Pennsylvania decides to legalize marijuana, it could consider using this new tax revenue to fund an inclusive innovation agenda. Efforts to broaden STEM exposure for underrepresented students, connect workers from underrepresented groups to good-paying advanced industry jobs, and facilitate entrepreneurship and wealth-building for individuals from underrepresented backgrounds can all support the goal of ensuring marijuana legalization helps the communities that have borne the largest burdens from prohibition.



Conclusion

In sum, this report calls out an incredible opportunity for the state to seize a critical economic opportunity. At present, Pennsylvania has much of what it will take to compete for leadership amid the ebbs and flows of innovation's long waves. What it needs, though, is vision, urgency, and a willingness to invest in building up both its larger and smaller regional ecosystems and ensure that all places and people participate. This is the work at hand—and the work suggested in this agenda—for revitalizing Pennsylvania's promising innovation economy.

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