Background

The Council of State Governments (CSG) and Elsevier are proud to partner on this report to analyze the research strengths of the United States. Using a variety of data sources, including Scopus—Elsevier’s proprietary abstract and citation database of peer-reviewed research literature—this report assesses where states have a comparative advantage in research and how they can capitalize on those advantages to drive innovation, attract jobs, and foster economic growth.

As the only organization that serves all three branches of state government, CSG plays a unique role in informing and bringing together state decision-makers. A key focus of CSG’s policy work in 2015 is the “State Pathways to Prosperity” initiative, designed to assist states in growing their economies through workforce and economic development strategies based on nonpartisan, evidence-based research. By providing its members and the broader public with comparative state information—particularly which research fields states specialize in and how researchers collaborate across states lines and internationally—CSG aims to spur and inform discussions about research funding and prioritization and how the policy goals of a state align with the goals and expertise of its research institutions.

With more than a century’s experience in providing research information and tools, Elsevier works closely with the global science and health communities. Every day, Elsevier serves more than 30 million scientists, students, and health and information professionals in over 180 countries by delivering journals, books and research databases. Through its unique vantage point on the world of research, Elsevier can help leaders in the world of research shape and implement larger research strategies.

This report combines CSG’s strong state- and national-level policy expertise with Elsevier’s experience in quantitative research performance evaluation to offer state decision-makers a new, data-driven perspective on the strengths of their research institutions and the national and international connections among those institutions.

Executive Summary

Research and development is a critical contributor to innovation and long-term economic growth, and the United States has a long history of being a global leader.

As the United States’ economy gains momentum, everyone—from legislators and regional planners
to corporations and everyday workers—is focused on answering a few key questions. How can the U.S. sustain that momentum? Where should states and institutions place their bets and invest their resources to create long-term pathways to prosperity?

To help answer these questions, The Council of State Governments—in partnership with Elsevier—is proud to offer “America’s Knowledge Economy: A State-by-State Review.”

This report explores the comparative research strengths of states. CSG hopes this report will spur and inform discussions about higher education research funding and prioritization, and how the policy goals of states align with the goals and expertise of its research institutions.

Analysis throughout this report pulls from a variety of measures and data sources, particularly Elsevier’s proprietary abstract and citation database of peer-reviewed research literature that includes 56 million documents published in more than 22,000 journals, book series and conference proceedings by some 5,000 publishers.

Previous studies have touted both the short- and long-term benefits of increasing investments in research and development. In an environment in which all stakeholders increasingly demand more accountability for the risks they take, particularly when it comes to public dollars, states and universities do not want simply to invest more money. State leaders are adopting strategies to identify in which areas to invest their limited resources most effectively.

Moreover, while public officials should not be dissuaded from investing in moon shots—areas with long-time horizons for maturity—policymakers need to be sure they are choosing the right moon shots, those that build on a state’s existing strengths and critical mass of expertise.

Once states’ comparative research advantages have been identified, it is imperative that policymakers and stakeholders around the country receive that information. It is important that local universities, businesses, government agencies, not-for-profit incubators and economic development organizations recognize what they are doing best to collaborate and coordinate on maximizing those advantages.

Getting the word out to dynamic companies and talented workers about the research areas in which a state is a national or world leader helps link the economic development and policy goals of that state to its research institutions. To do this, however, those claims must be backed up with narratives and facts. That is where this report comes in.

This report outlines a process states can undertake to both identify and showcase their research strengths—those areas in which they have a comparative research advantage—and ties those strengths to economic development outcomes through four different perspectives: research output and impact, research focus, research and development inputs and knowledge transfer and collaboration.

**Research Output and Impact**

In 2013, the U.S. published more than 536,000 publications. California, New York, Massachusetts, Texas and Pennsylvania produced the largest absolute number of publications. To put this in perspective, the number of publications by California-based researchers in 2013 (almost 92,000) comprised 17.1 percent—more than one-sixth—of the total U.S. publication output and was higher than the entire output of Canada. The combined absolute outputs of the top five states comprised more than 50 percent of the total U.S. output.

In assessing a state’s research performance, it is important to take into account not just the volume
of research produced, but the quality of that research as well. One way to evaluate this is to look at citations, which are widely recognized as a proxy for quality.

This report uses a measure called field-weighted citation impact, also known as FWCI, which offers a more nuanced and useful measure than simply comparing absolute counts of citations across years and states. For example, different states have different research strengths and citations in research from one field may accumulate faster than others because that field simply produces more publications. Field-weighted citation impact analysis takes this into account.

Massachusetts and California achieved the highest field-weighted citation impacts among all states from 2004 to 2013. Other states with high field-weighted citation impacts for their respective region include Washington (second among all states in the West), Minnesota (first among all states in the Midwest), North Carolina (first among all states in the South), and Maryland (second among all states in the East and third among all states overall).

**Research Focus**

In order to identify the fields in which a state has a comparative advantage in research, this report looks at two indicators—relative volume and relative impact—along two dimensions. First, a state’s performance in a given research field was compared to its own performance in other research fields. For example, how does Colorado’s research in environmental science compare to its research in medicine? Second, a state’s performance in a given research field was compared to other states’ performances in the same research field. For instance, how is Colorado’s research in environmental science relative to Maryland’s research in environmental science?

From 2004–2013, 28.7 percent of the country’s total research output—or about 1.4 million publications—was in medicine. Engineering and biochemistry, and genetics & molecular biology were the two fields with the next highest levels of research output at 17.4 percent and 15.4 percent, respectively.

Within medicine, the top 3 states in terms of relative volume were Minnesota, Rhode Island and North Carolina. Within engineering, the top 3 states in terms of relative volume were New Mexico, Idaho and Virginia. Within biochemistry, genetics & molecular biology, the top 3 states in terms of relative volume were Maryland, North Carolina and Nebraska.

**Research and Development Inputs**

According to the National Science Foundation’s Higher Education Research and Development Survey, U.S. higher education institutions spent $67 billion on research and development in 2013. When adjusted for inflation and accounting for the American Recovery and Reinvestment Act of 2009, increases in R&D expenditures have slowed in the most recent years, and the percentage of expenditures from federal funding agencies actually has declined. Moreover, as the National Institutes of Health’s Data Book details, the average success rate for National Institutes of Health grants continues to fall.

The top five states in terms of growth in R&D expenditures were Rhode Island (6.90 percent), South Dakota (5.42 percent), North Carolina (4.53 percent), Washington (3.71 percent) and Delaware (3.61 percent).

The distribution of the sources of a state’s R&D funding is another important consideration, affecting how exposed or insulated that state’s research ecosystem is to federal or state funding pressures. For the U.S. in 2013, about 58.9 percent of total research and development expenditures
came from federal funding agencies. The top five states in terms of federal funding as a percentage of their total R&D expenditures were Wyoming (82.4 percent), Maryland (79.0 percent), Colorado (74.5 percent), New Hampshire (73.8 percent) and Vermont (73.6 percent).

**Knowledge Transfer and Collaboration**

Although universities produce the majority of research output, the larger research ecosystem spans government labs, corporations, hospitals, not-for-profit think tanks and other institutions. When researchers and knowledge workers can easily collaborate with and move across different sectors, all stakeholders benefit from the exchange of ideas and talent.

It is therefore important to understand the distribution of a state’s research output across different sectors. For example, about 8.5 percent of all published U.S. research is conducted by corporate institutions, but this percentage varies significantly across states. From 2004 to 2013, 20.8 percent of New Jersey’s total output (33,504 publications) was from corporate researchers, the highest among all states in the country and more than twice the rate of the entire country. The states with the next highest relative levels of corporate output were Delaware (13.9 percent), California (13.2 percent) and New York (10.9 percent).

In addition to understanding where a state’s research is produced, there is increasing interest in creating more and better indicators of the commercialization of research to assess how results of research are transferred from the academic sector to the corporate or government sectors.

Academic patent citations provide one way of understanding corporate usage of academic research, and they can be used as a proxy for measuring how much academic research contributes to innovation. These are defined as formal citations of academic publications in industry patents.

From 2004 to 2013, 959,172 patents were granted to U.S. inventors. California, with 25.1 percent of all patents granted to U.S. inventors, had a national patent share more than three times the level of the next closest state, Texas (7.1 percent). The rest of the top five states in terms of patents granted were New York (6.4 percent), Massachusetts (4.5 percent) and Washington (4.2 percent).

---


---

**America's Knowledge Economy** [7]

**Tags:**
- Policy Area
- Economics and Finance
- Economic Development and Trade
- Education
- Workforce Development
- Publications