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# Selected Measures of Iowa's Research and Development Performance

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## **Introduction**

Iowa is the home to some of the nation's most advanced manufacturers, global leaders in plant and animal genetics, sophisticated financial services firms, emerging renewable energy industries, and universities that are nationally ranked in scientific scholarship. At first blush, the presence of these firms and institutions would suggest that Iowa must be a leading state for research and development (hereafter R&D) activity.

In an effort to preserve and promote its technological competitiveness, Iowa subsidizes private R&D activity with tax credits that offset a portion of firms' qualified R&D costs. In addition, Iowa's official economic development policies specifically target growth in many R&D-intensive industries such as advanced manufacturing, life sciences, and information systems. Iowa's focus on producing jobs in these industries presupposes the need to induce high-technology firm growth, stimulate and consolidate demand for high-tech occupations, and create greater opportunities for the state to retain its highly trained college graduates.

This report examines several measures of state R&D performance in order to assess whether Iowa does, indeed, demonstrate prominence in R&D activity. In light of recent attention on Iowa's Research Activities Credit program, this report also looks for evidence that the state's active involvement in R&D promotion during the last two decades has coincided with material improvement in R&D-related indicators.

## **Growth in Research Activities Tax Credits**

In Iowa and other states trying to foster growth and innovation within their traditional and emerging industries, R&D tax credits have become a popular tool. Such programs supplement federal R&D tax credits, and they are intended, on a theoretical basis, to induce a greater level of research activity among firms than would normally occur. As scientific ideas and applications cannot be completely patented and contained, the credits are intended to compensate firms for the inevitable knowledge

spillovers that occur. The argument for the credits is that R&D related knowledge spillovers benefit society materially, so society has an interest in compensating those spillovers to assure that they continue to occur.

In recent years, though, such arguments are rarely articulated, and they have proven very hard to quantify historically. Instead state R&D support activities are viewed primarily as outright economic development incentives designed to either retain existing firms or attract new R&D oriented activities. Accordingly, the default measures of success of state R&D programs are the number of R&D conducting firms created, the number of high tech jobs boosted, and the value of capital investment linked to the state's R&D activities.

Iowa has a very generous R&D tax credit program called the Research Activities Credit (RAC). It is fully refundable, which means that even if a qualifying firm did not pay state taxes, the state nonetheless pays the full value of the credits back to the firm. A recently released state compilation of Iowa's tax credits reported that RAC claims in 2007 totaled \$48.1 million,<sup>1</sup> and RAC claims for 2008 were recently estimated at \$70.9 million.<sup>2</sup>

Iowa's major corporations receive the vast majority of credits under the RAC program. It is therefore very popular in business circles, and it is aggressively protected when it is subject to scrutiny by the Iowa General Assembly. Over the 2002 through 2006 period, for example, corporations received 95 percent of the value of credits with individual filers receiving the remainder.<sup>3</sup>

The value of the RAC to Iowa corporations is aptly demonstrated in Figure 1, which shows the dollar amount of RAC claims expressed as a percentage of net state corporate income taxes on an annual basis.<sup>4</sup> During much the 1990s, RAC claims ranged from the equivalent of 2.5 percent to as high as 7.5 percent of the amount of corporation income taxes paid in Iowa.

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<sup>1</sup> State of Iowa Agency Reports on Tax Credits, 2009. Obtained from:  
[http://www.governor.iowa.gov/files/state\\_of\\_iowa\\_agency\\_reports\\_on\\_tax\\_credits\\_final.pdf](http://www.governor.iowa.gov/files/state_of_iowa_agency_reports_on_tax_credits_final.pdf)

<sup>2</sup>Rood, Lee, 5 Tax Credits Top Film Program, Des Moines Register, 29 December 2009, Page A1. Obtained from:  
<http://www.desmoinesregister.com/article/20091229/NEWS10/912290369/1001/NEWS/5-tax-credits-top-film-program>

<sup>3</sup> Corporate and total RAC claims data for 1986-2006 were obtained from a 2008 evaluation study authored by Angela Gullickson and Amy Rehder Harris, Tax Research and Program Analysis Section, Iowa Department of Revenue. Corporate RAC claims data for 2007 and 2008 were estimated based on a Tax Credit Contingent Liabilities Brief prepared by the Iowa Department of Revenue and dated March 17, 2009.

<sup>4</sup> Given the vagaries of government revenue definitions using state of Iowa definitions over time, this research utilizes U.S. Census of Government declarations of corporation income taxes for the 1986 through the 2008 fiscal periods owing to a general alignment at the federal level with Generally Accepted Accounting Principles for governmental finance accounting. Fiscal 2009 corporate tax estimates were provided by the Fiscal Division of the Iowa Legislative Services Bureau.

During this decade, however, the value of those credits shot up sharply. The lowest value was 13 percent in 2000, and the highest value was over 28 percent in 2003. Stated differently, the credits for research activities that are paid to Iowa corporations have offset the equivalent of one seventh to one quarter of the taxes paid by all corporations to the state of Iowa this decade. Most significantly, the amount of offset is much higher for those corporations receiving credits than Figure 1 would suggest, because relatively few Iowa corporations actually claim the credits.

**Iowa Corporate Research Activities Credit Claims Expressed as a Percentage of State Corporate Taxes, 1986 to 2008**

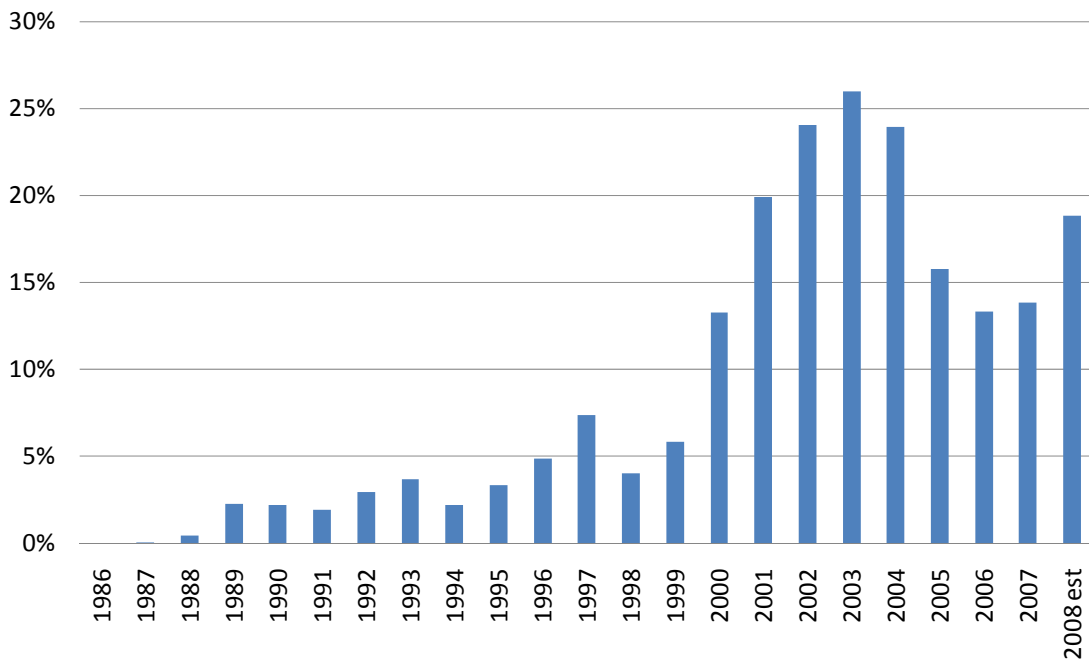


Figure 1

The growing value of the RAC as compared to corporation tax payments in Iowa raises an important point regarding the promotion of R&D in Iowa through the RAC. Does the RAC truly boost the state’s competitive position in terms of technical innovation, technology related jobs, and overall higher productivity? Or, is the RAC as it has evolved primarily a very valuable tax offset to the corporations that can claim credits? This report highlights sets of R&D related outcomes and indicators to evaluate Iowa’s past R&D performance and its near term prospects.

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As tax credits are claimed on calendar or a tax year basis, state fiscal year values were converted to annual, calendar year values to align with the credits by computing a two-year moving average. For example, the average of fiscal 1986 and 1987 Iowa corporation taxes constitute calendar year 1986 corporation taxes.

## Research and Development as a Fraction of the Economy

Table 1 relies on National Science Foundation (NSF) compilations from various years to give a sense of Iowa R&D activity as a fraction of the state's Gross Domestic Product (GDP).<sup>5</sup> GDP is the standard manner in which the value of production across states and nations is gauged. Notwithstanding the sharp rise in RAC payment levels in Iowa, overall R&D as a percentage of state GDP remained relatively flat across the available measurement points. The state's R&D effort was 1.4 percent of GDP in 1991 and 1.5 percent in 2004, the latest year for which data are available. Referring back to Figure 1, in 1991, the RAC value amounted 2 percent of the corporation taxes paid in Iowa; whereas in 2004 the RAC value as a percentage of Iowa corporation taxes was well above 20 percent. The value of the credit to corporations increased ten-fold, but the value of R&D as a fraction of the economy remained almost unchanged. Notably, over the intervening years, Iowa's national R&D ranking plummeted. In 1995 it ranked 21<sup>st</sup> nationally, by 2004 it had fallen to 33<sup>rd</sup>.

Table 1

Year	R& D as a Percentage of GDP	State Ranking
1991	1.4	24
1995	1.9	21
1998	1.4	30
2000	1.3	31
2002	1.4	32
2004	1.5	33

Figure 2 compares the state to the nation on the same indicator shown in Table 1. Where Iowa R&D has mostly remained pegged near the 1.5 percent of GDP range, the U.S. average R&D effort has been consistently just shy of 2.5 percent of GDP. On a comparative shares basis, then, Iowa's R&D effort as a fraction of GDP is about 40 percent lower than the national average.

The value of that difference in performance can be approximated. In 2004, Iowa R&D activity was \$1.446 billion, according to NSF estimates. Had the state performed R&D at the same intensity as the national average, it would have engaged in \$2.413 billion in total R&D activity. The R&D spending gap between Iowa's actual R&D performance and the national norm was \$967 million in 2004 alone.

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<sup>5</sup> National Science Foundation, Science and Engineering Indicators, various years.

## R&D as a Percentage of State and National GDP

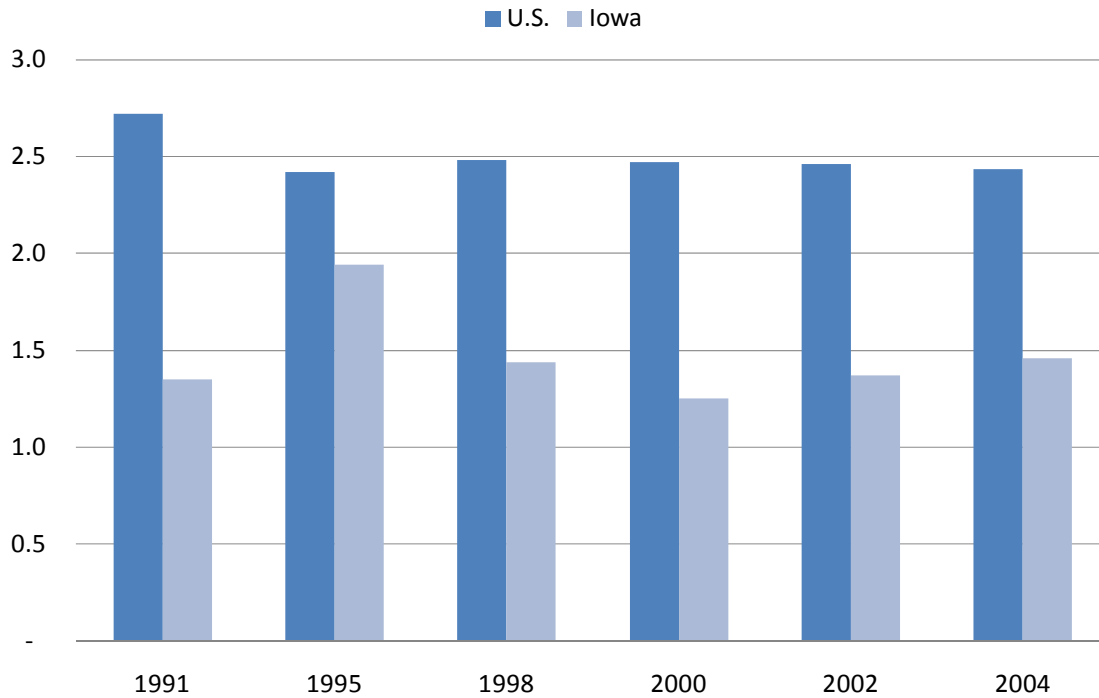


Figure 2

The overall pattern of change in RAC spending in Iowa and the pace of change in GDP are displayed in stark terms in Figure 3. In this graph, both GDP and RAC spending are measured in real terms; meaning that the effects of inflation have been removed so that the values can be compared on a year to year basis. Next, the values are indexed so that 1996 = 100 (or 100%) so that the 10 years previous and after can be compared. From 1996 to 2006, real Iowa GDP grew by 26 percent. Real RAC payments increased by 271 percent – more than 10 times the rate of GDP growth. That effort notwithstanding, the pace of real GDP growth in Iowa lagged the national average during the same period. As yet, there is no clear evidence that the state's competitive position in terms of overall R&D activity or total productivity growth as measured by GDP have improved during the two decades of the RAC program's existence.

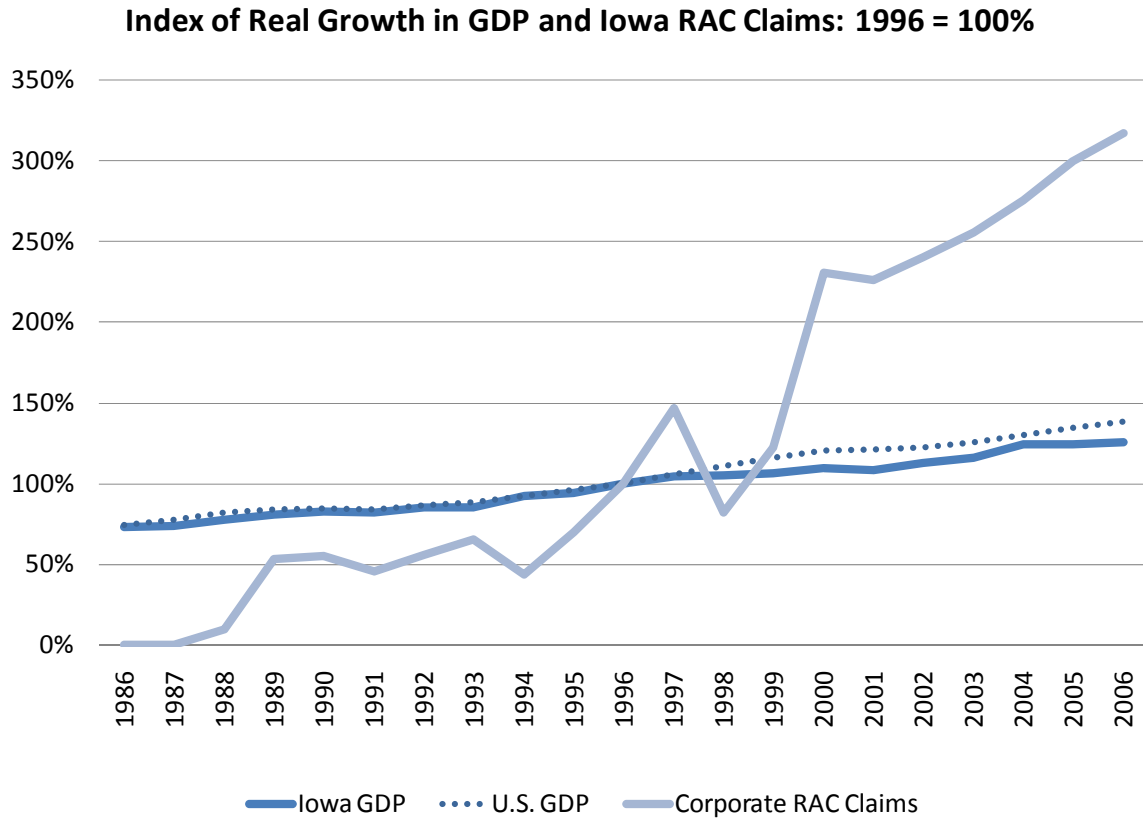


Figure 3

### Actual and Expected R&D Spending in the Private Sector

Iowa has a strong competitive advantage in manufacturing. This would suggest the state might demonstrate R&D leadership in that sector. However, as some manufacturing industries engage in much higher levels of R&D activity than others, it is important to consider the mix of manufacturing industries when assessing Iowa’s overall propensity for R&D spending. For example, Iowa has led the nation in chemical industry job growth owing to the boom in ethanol plant growth over the past six years. This industry typically has high levels of R&D effort. Iowa also has a strong competitive advantage in food manufacturing, where average R&D performance tends to be lower.<sup>6</sup>

Based on national R&D spending patterns by industry, we can gauge the overall R&D performance of Iowa’s companies. NSF survey data measure the amounts of non-federally funded company R&D spending by specific industry in the United States. These values can be standardized by industry employment to measure the average R&D spending per job by industry. Applying those national

<sup>6</sup> Data from the NSF Survey of Industrial R&D show that among R&D-performing firms in the U.S., the chemical manufacturing industry averaged about \$50,000 in R&D spending per employee in 2007. R&D-performing firms in U.S. food manufacturing industries averaged only \$2,800 in spending per employee in 2007.

averages to Iowa's industrial portfolio allows us to estimate the amount of R&D spending that would be expected from Iowa firms, assuming they were spending at levels similar to their national counterparts.

Figure 4 demonstrates the expected amount of spending for Iowa, were it to spend at the national rate for its industrial mix, versus the actual amount of R&D spending for the state.<sup>7</sup> Iowa's manufacturing firms would have been expected to spend \$1.58 billion on R&D. All other Iowa non-manufacturing firms would have been expected to spend \$627 million. The expected value for all firms was \$2.21 billion.

Actual R&D expenditures by Iowa's firms suggest a much lower level of R&D spending in the state. The NSF estimated that combined the state's companies spent \$1.187 billion in R&D in 2007, or just over 46 percent less than would have been expected if they had matched the national per worker averages. Some, but not all, of this gap may be explained by Iowa's relatively lower wage structure, as the average Iowa worker earns just 85 percent of the national norm. Still, these data suggest that the overall mix of firms in Iowa have a significantly lower likelihood to engage in R&D than national averages would have suggested.

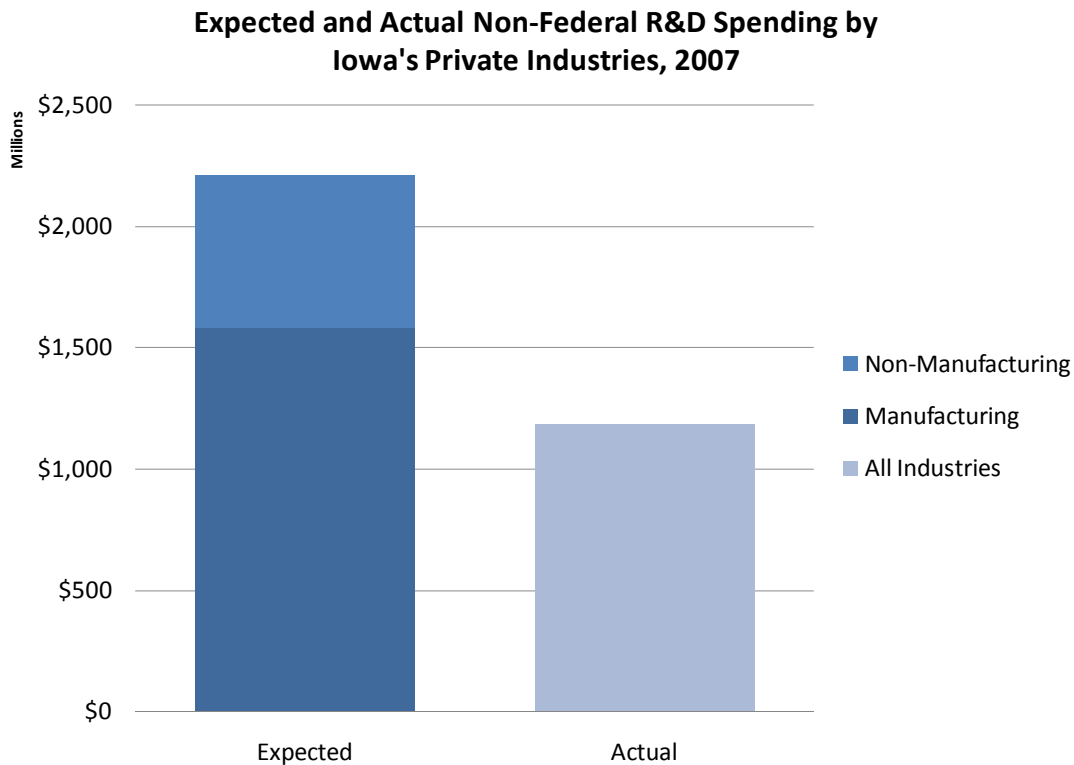


Figure 4

<sup>7</sup> National Science Foundation/Division of Science Resources Statistics, Survey of Industrial Research and Development: 2007.

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## Actual and Expected High-Technology Employment Levels

Given Iowa's high level of state support for R&D activity at primarily the corporate level, we might also compare the state's overall mix of technology-related occupations to national averages to look for evidence of emerging technological specialization in the workforce. One way to do this is to compute the state's occupational location quotient for high-technology occupations.<sup>8</sup> The location quotient is the fraction of high-tech jobs in the Iowa economy divided by the same fraction nationally. If we were at the national average in our mix of high-technology jobs, our expected value would be 1 (or 100 percent).

Figure 5 gives a sense of Iowa's high technology occupation location quotients for 1998 and for 2008 as compared to surrounding states. Remembering that the expected value is 100 percent, Iowa scored at 74 percent and 75 percent on this measure for 1998 and 2008 respectively. Among our neighbors, only Minnesota scored above the national average in 2008. Both North Dakota and South Dakota score lower than the Iowa value. Over the measurement period, Illinois, Nebraska, and North Dakota high tech occupation local quotients deteriorated. Minnesota, Missouri, Kansas, South Dakota, and Wisconsin posted improvements.

On a national ranking basis, Iowa ranked 37<sup>th</sup> nationally on the high technology employment specialization measure in 1998 and 36<sup>th</sup> in 2008. Iowa had 57,310 jobs in high-technology occupations in 2008, accounting for 3.8 percent of total employment. The same high-technology occupations accounted for 5.2 percent of total employment in the United States.<sup>9</sup> On a jobs basis, Iowa's comparative deficit translates to about 20,200 high-technology jobs.

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<sup>8</sup> High-technology occupations include workers in scientific, engineering, technical, and managerial occupations requiring in-depth knowledge of the theories and principles of science, engineering, and mathematics. Some of these workers are engaged in R&D, others apply technology in the design of equipment, processes, structures, and computer applications, and others manage these activities. See Hecker, Daniel E., "High-technology employment: a NAICS-based update." *Monthly Labor Review*. s.l. : Bureau of Labor Statistics, U.S. Department of Labor, July 2005.

<sup>9</sup> 2008 Occupational Employment Survey, U.S. Bureau of Labor Statistics



**Location Quotients for High-Technology Occupations, 1998 and 2008  
(U.S. Average Value = 100%)**

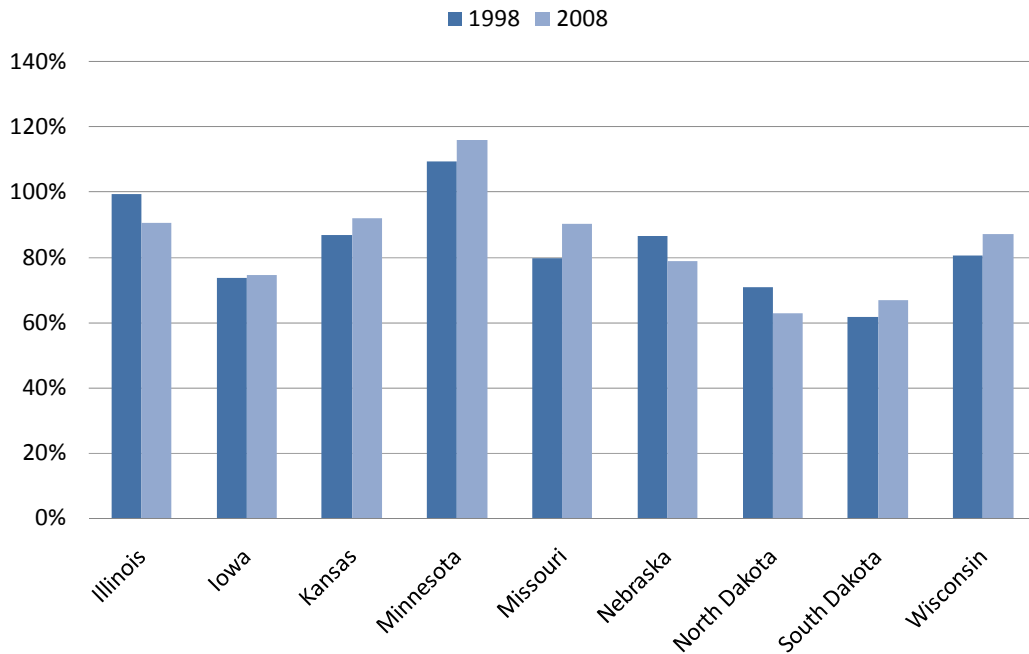


Figure 5

Given the configuration of industries in Iowa and their typical staffing patterns, the state’s slightly lower fraction of high-technology workers compared to the U.S. average is not surprising. This is mostly because Iowa has large production agriculture and commodity processing components to its economy that have limited demand for high numbers of high-technology jobs. On a proportionate basis, then, the state’s remaining firms and the high tech workers that they demand represent smaller fractions of the state’s overall economy.

Even after adjusting for the state’s industrial mix, however, Iowa still has lower-than-expected employment levels in overall high-technology employment and in many specific high-technology occupations.<sup>10</sup> These outcomes are displayed in Figure 6.

<sup>10</sup> For this comparison, actual employment levels obtained from 2007 Occupational Employment Survey data from the U.S. Bureau of Labor Statistics (BLS) were compared to expected employment levels developed at Iowa State University. The expected levels were derived by applying national occupation by industry employment ratios from the BLS Occupational employment survey to state employment by industry data from the BLS 2007 Quarterly Census of Employment and Wages.

Overall, the state has only 85 percent of the high-tech occupations that would be expected given our adjustment for the state’s industrial structure. The strongest deficits are among physical scientists and technical engineering and drafting jobs. The state also posts a surprisingly strong deficit in the expected number of engineers given Iowa’s prominence in manufacturing.

Iowa scores below expected in computer specialists, but it has strong rankings for life scientists, technicians working in life, physical, or social sciences, and mathematical science occupations. The strong showing in mathematical sciences is driven in part by actuarial science employment, which may be linked to the state’s large insurance sector.

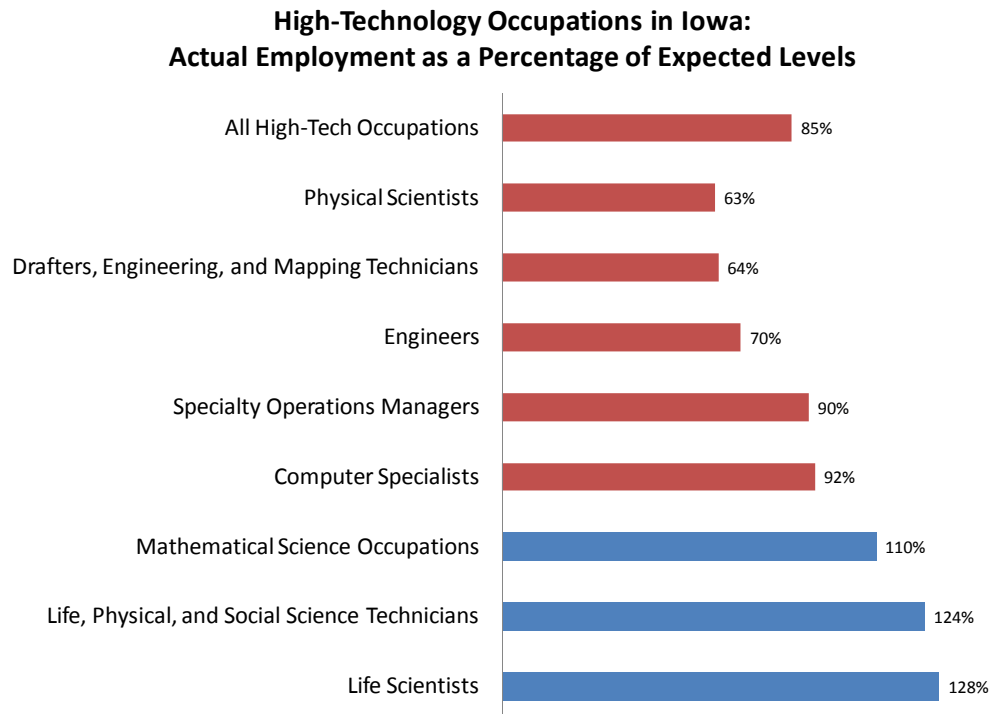


Figure 6

## Additional R&D Indicators

### Iowa's High Tech Business Formation Lags Other States

Iowa has consistently ranked near the bottom nationally in the number of business starts. Compared to the rest of the states, entrepreneurship in Iowa is at a very low level. While overall business starts tend to lag the nation, Iowa's RAC assistance program has been promoted as a means to help reduce barriers to entry for high-technology startup firms. Recent data from the 2008 Science & Engineering Indicators report by the National Science Foundation suggest those barriers must still be very high.

- ▶ Iowa is creating new high-technology business establishments at 1/10<sup>th</sup> the pace we would expect based on national averages.
- ▶ In 2004, for example, 12 net, new high-technology firms were created in Iowa.
- ▶ Given the total number of firms in Iowa, the state should have expected 128 net, new high-technology firm formations in that year.

Public support via incentives and state economic development programming notwithstanding, Iowa's ability to produce high tech firms severely lags national patterns of growth. Figure 7 shows previous NSF compilations of the high-technology firm-formation measure. Given Iowa's total number of firms, the overall pattern of change has resulted in a general reduction in actual high technology firm development versus what would have been expected given national growth rates applied to Iowa.

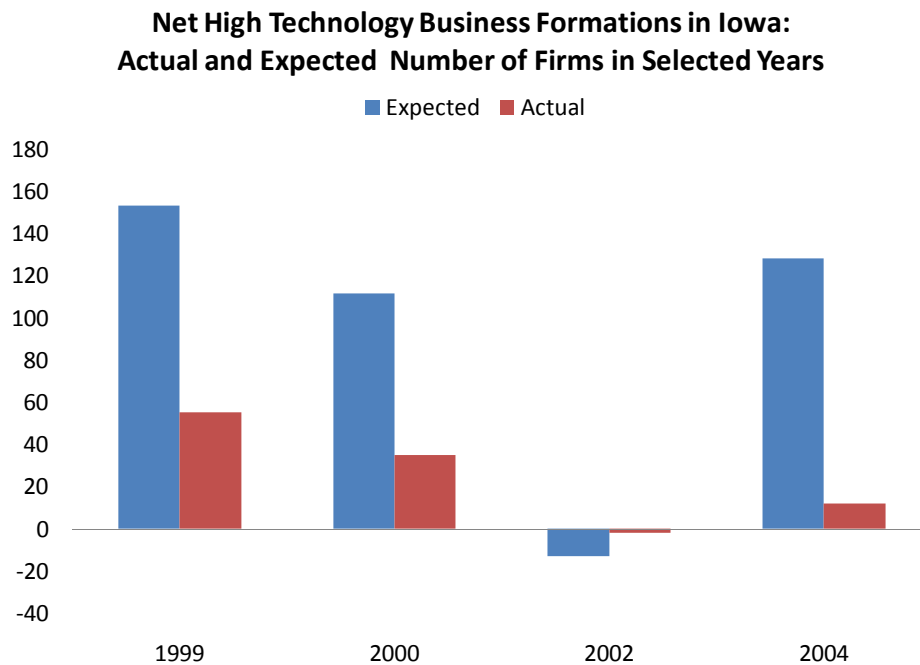


Figure 7

## Iowa's Ability to Produce Highly Trained Scientists Outpaces the State's Demand

Iowa has consistently lost its young people to other states. The state does an excellent job of educating its young adults, but the Iowa economy's ability to absorb that talent is limited; hence, there is a persistent outmigration pattern resulting in both a brain and skilled talent drain in human capital. These losses are quite pronounced in the state's most highly educated science and engineering graduates. NSF data show that in 2006, Iowa's incidence of science and engineering (S&E) doctorates was about 80 percent of the per capita average for all states.

Oddly, in the same year, Iowa's educational institutions conferred 60 percent more S&E doctoral degrees than would have been required to replace the normal annual turnover in the state's own pool of S&E doctorates. Iowa has consistently ranked first among states in this ratio of new degrees conferred per resident doctoral degree-holders. Iowa's universities are therefore serving a global demand for S&E doctorates, as the state's economy is limited in its ability to absorb these highly trained scientists and its utilization of this talent is not appreciably improving over time.

Lest anyone suggest that valuable resources are being wasted in the education of these surplus scientists and engineers, it is important to note their contributions to the state's economy during their tenure in Iowa. Their graduate assistantships, fellowships, and post-doctoral appointments constitute jobs, albeit temporary, in the Iowa economy. In addition, they and their supervising faculty members attract millions of research dollars to the state from federal and other external sources. NSF survey data from 2007 suggest that about 65 percent of the state's S&E graduate research assistants, trainees, and fellows are supported by federal or other non-state or foreign sources.<sup>11</sup>

Indeed, Iowa's academic institutions have shown impressive growth in their ability to generate external support for their R&D activity over the last two decades, with most of the growth coming from federal funding sources. In 2008 alone, Iowa's colleges and universities attracted \$340 million in federal support for their R&D efforts.

Figure 8 illustrates the growth in the amount of R&D spending by Iowa's academic institutions during the time frame covered by this report. Between 1986 and 2008, R&D spending by Iowa's colleges and universities increased in real terms by \$275 million. Iowa state and local government spending accounted for 11 percent of this increase. Industry-financed support for academic R&D efforts accounted for 4 percent of the growth, while institutional and other sources financed 6 percent of the

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<sup>11</sup> NSF-NIH Survey of Graduate Students and Post-Doctorates in S&E, National Science Foundation, obtained from: <http://webcaspar.nsf.gov>

spending growth. Federal government sources accounted for 78 percent of the real change in academic R&D spending in Iowa.<sup>12</sup>

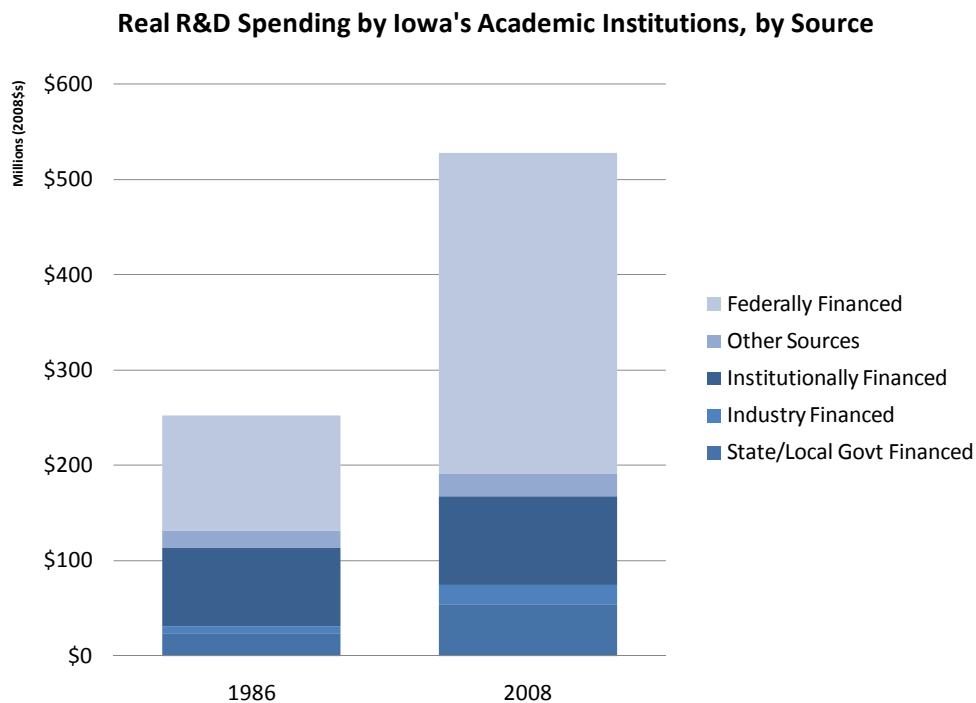


Figure 8

### Iowa Has Comparatively Lower Pay in Many High Technology Occupations

For Iowa to attract and retain high technology workers, it must compete with all other states for workers. Wages are the most important indicator of regional demand for occupations. Employers that are profitable and segments of the economy that are expanding will offer higher wages, salaries, and benefit levels to attract the top talent.

The average annual wage for jobs across all occupations in Iowa was 85 percent of the U.S. average in 2008. This average is the expected wage ratio for any particular occupation. Occupations with comparative wage ratios below 85 percent of the national average may be considered lower-value jobs. Occupations with a wage ratio above 100% of the national average are high-value jobs indicating industries in which Iowa has a strong competitive advantage.

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<sup>12</sup> NSF Survey of R&D Expenditures at Universities and Colleges, National Science Foundation, obtained from: <http://webcaspar.nsf.gov/>

The following high technology occupations have average compensation levels in excess of the U.S. average for occupations in those categories. They constitute, however, only 3 percent of all high technology jobs in Iowa.

Animal scientists	Environmental science and protection technicians
Biological scientists, misc.	Health technicians
Life scientists, misc.	Forest and conservation technicians
Social science research assistants	Surveying and mapping technicians

The following high technology occupations have average compensation levels less than 85 percent of the U.S. average. As Iowans earn on average 85 percent of the national average in wage and salary, pay in these occupations would be considered substandard nationally – Iowa would not be expected to be nationally competitive in these occupations at all. These occupations constitute a full third of Iowa’s high-tech jobs. These jobs represent the categories where the state would have the most difficulty recruiting and retaining skilled occupations.

Atmospheric and space scientists	Conservation scientists
Biomedical engineers	Electronics engineers, except computer
Computer and information systems managers	Engineering managers
Computer hardware engineers	Geoscientists, except hydrologists and geographers
Computer programmers	Materials engineers
Computer software engineers, applications	Medical scientists, except epidemiologists
Computer software engineers	Operations research analysts
Computer specialists, all other	Physical scientists, miscellaneous

Iowa’s remaining high technology occupations, which are 64 percent of high tech jobs, provide average compensations at levels between 85 percent and 100 percent of the national average for the same occupations. For the following occupations, Iowa is holding its own on pay and compensation.

Actuaries	Environmental scientists and specialists
Agricultural and food science technicians	Food scientists and technologists
Agricultural engineers	Foresters
Chemical engineers	Health and safety engineers
Chemical technicians	Industrial engineering technicians
Chemists	Industrial engineers
Civil engineering technicians	Life, physical, and social science technicians
Civil engineers	Mechanical engineering technicians
Computer support specialists	Mechanical engineers
Computer systems analysts	Microbiologists
Database administrators	Natural sciences managers
Electrical and electronic engineering technicians	Network and computer systems administrators
Electrical engineers	Network systems and data communications analysts
Electro-mechanical technicians	Soil and plant scientists
Engineering technicians, except drafters	Statisticians
Environmental engineering technicians	Zoologists and wildlife biologists
Environmental engineers	

## Conclusions

Using several indirect measures of state R&D performance over time, this study indicates the state's overall competitive position vis-à-vis R&D activity lags national average levels substantially. The state's universities produce a surplus of highly trained scientists, engineers, and technicians, but the state's overall rate of high technology firm growth as well as its existing industrial structure are not sufficient to effectively utilize that talent and it must, therefore, outmigrate to jobs in other states.

R&D related payments under the state's Research Activities Credit program have grown exponentially this decade, which would suggest the state should be achieving improvements in its national competitive position in high tech job growth, levels of R&D activity, and high tech firm start ups. This study indicates that the state performs much worse than would be expected in all categories.

Nationally, two thirds of R&D tax credit claims go to qualifying wages and salaries. The rapid growth in RAC claims in Iowa would likely be driven primarily by rapid growth in R&D jobs in the state, which would logically presume growth in high-technology occupational competitiveness. After 20 years of subsidies to R&D, improvements in the state's occupational competitiveness are still not evident.

The growth in RAC claims has been used by industry as evidence of the program's value to the state of Iowa. This research suggests that claim may be something of a red herring. The primary value of the RAC in Iowa appears to be its ability to offset corporation income tax payments more so than any direct or indirect Iowa economic performance gains or improved national R&D competitiveness.

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