# THE UNIVERSITY AND THE CREATIVE ECONOMY

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# Introduction

Most who have commented on the university's role in the economy believe the key lies in increasing its ability to transfer research to industry, generate new inventions and patents, and spin-off its technology in the form of startup companies. As such, there has been a movement in the U.S. and around the world to make universities "engines of innovation," and to enhance their ability to commercialize their research.

Universities have largely bought into this view, both because it makes their work more economically relevant and as a way to bolster their budgets. Unfortunately, not only does this view oversell the immediately commercial function of the university; it also misses the deeper and more fundamental contributions made by the university to innovation, the larger economy, and society as a whole.

This report examines the university's role in the Creative Economy through the lens of the "3T's" of economic development: Technology, Talent, and Tolerance. To do so, it examines a wide range of data and trends on technology transfer, startup companies, talent, brain drain, tolerance, and creativity for U.S. metro regions.[1]

Its main findings show that the university plays an important role across all 3 T's.

• **Technology:** As major recipients of both public and private R&D funding, and as important hotbeds of invention and spin-off companies, universities are often at the cutting edge of technological innovation.

• **Talent:** Universities affect talent in both directly and indirectly. They directly attract faculty, researchers and students, while also acting as indirect magnets that encourage highly educated, talented and entrepreneurial people and firms to locate nearby, in part to draw on the universities' many resources.

• **Tolerance:** Large research universities help shape a regional environment open to new ideas and diversity. They attract students and faculty from a wide variety of racial and ethnic backgrounds, economic statuses, sexual orientations, and national origins. University communities are meritocratic and open to difference and eccentricity; they are places where talented people of all stripes interact in stimulating environments that encourage open thought, self-expression, new ideas, and experimentation.

Until now, the university's role in the first T, technology, while important, has been overstressed. Both experts and policymakers have neglected the university's even more powerful role across the two other axes of economic development—in generating, attracting, and mobilizing talent, and in establishing a tolerant social climate—that is open, diverse, meritocratic and proactively inclusive of new people and new ideas.

The university thus comprises a powerful *creative hub* in regional development. Alone, though, the university is a necessary but insufficient component of successful regional economic development. To harness the university's capability to generate innovation and prosperity, it must be integrated into the region's broader creative ecosystem.

## The University's Role in Economic Development

Universities have long played an important role in research, development, and technology generation. Recently, they have proven key contributors to regional development, too. Any discussion of the university's role in innovation and economic development quickly circles back to the now classic cases of Stanford University and MIT, which played critical roles in the development of Silicon Valley and the greater Boston area. Something similar has emerged in Austin, Texas, and the North Carolina Research Triangle. [2] From these cases, many have concluded that the university serves as an innovative en-

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gine of economic development. One entrepreneur, when asked yet again for "the secret of Silicon Valley's success," responded: "Take one great research university. Add venture capital. Shake vigorously."

But there is a broader theoretical underpinning for the view of the university as an "engine of innovation." It traces back to the Nobel prize-winning studies of MIT economist Robert Solow in the late 1950s. Solow argued that productivity growth was only partly attributable to the traditional explanatory factors, gains to capital and labor. The unexplained "residual" productivity growth, he surmised, must have been due to technological change, which he defined broadly.[3] More recent studies suggest that universities have significant effects on both corporate innovation and regional economic development. Investments in academic research yield significant returns to the economy and society, according to the studies of the economist, Edwin Mansfield.[4]

University research has also been found to make corporate innovation more efficient, according to Adam Jaffe; businesses that are located in close proximity to university research generate greater numbers of patents.[5] University research also tends to attract corporate research labs, according to other studies.[6] A 2005 study by the regional economists, Harvey Goldstein and Joshua Drucker examined the contribution of universities to economic development broadly across more than 300 metropolitan regions in the United States. They found that universities tend to increase average annual earnings, but that the biggest effects were in small and medium-size regions, those with less than 200,000 jobs.[7]

Many have argued that the university plays a key role at the front-end of the innovation process. According to the so-called "linear model of innovation" ideas flow naturally from university science and technology that can be commercially exploited and turned into economic growth. The key thus lies in developing new and better mechanisms to make this transfer of university science and technology to the commercial sector more effective and efficient, increasing the output of university "products" that are of commercial value to the economy.

The university as engine of innovation has been criticized as oversimplified because it sees the steps of innovation as distinct and occurring in discrete institutions. It assumes there is one-way path from university-based science and R&D, to commercial innovation (either within large companies or via spin-offs) and ultimately resulting in job generation and economic growth[8]

This perspective has been criticized by some as distorting the fundamental scientific mission of the university. The sociologist Robert Merton long ago contended that academic science should be an open project because it is firmly centered on the efficient creation of knowledge and movement of frontiers. Firms, on the other hand, seek scientific advance in order to increase profits and acquire intellectual property. [9]

The economists Partha Dasgupta and Paul David have argued strongly for keeping academic science separate from industry.[10] They feel that due to the inherently different motivations for undertaking university and industry science, that any intermixing of the two would negatively impact social welfare. Close ties between industry and university might, they argue, draw academic scientists toward research enterprises with immediate short-term benefits to industry, but away from research with broader and long-term impacts to society and the economy.

Conversely, Nathan Rosenberg and Richard Nelson, two leading students of the history of technology, argue forcefully that university and industry research, basic science and applied science have always been intertwined, and that it is difficult to even discern the divide between science and technology.[11] Wherever one falls between the two poles, the "engine of innovation" paradigm remains predominant, and continues to drive contemporary thinking about the university's role in economic development.

The university's increasing role in innovation and economic growth stems from deeper and more fundamental forces. The changing role of the university is bound up with the broader shift from an older industrial economy to an emerging Creative Economy. The past few decades have been one of profound economic transformation. In the past, natural resources and physical capital were the predominant drivers of economic growth. Now, human creativity is the driving force of economic growth. Innovation and economic growth accrue to those places that can best mobilize humans' innate creative capabilities from the broadest and most diverse segments of the population, harnessing indigenous talent and attracting it from outside.

The creative sector is the propulsive sector of economic growth. It has generated roughly 20 million new jobs between 1980 and 2000, and is projected to add another 10 million between 2004 and 2014. This creative sector currently employs some 40 million Americans, accounting for approximately one-third of total employment and more than $2 trillion dollars in wages and salaries – as much as the manufacturing and service sectors combined.

Economic growth in the Creative Economy is driven by 3 T's: Technology, Talent and Tolerance. Since the early writings of Joseph Schumpeter, economists have noted the role of the first T, technology, in economic growth.[12] More recently, there has been increased interest in the role of the 2nd T, talent or human capital in economic growth.[13] But technology and talent have been mainly seen as *stocks* that accumulate in regions or nations. In reality, both technology and talent are flows. The ability to capture these flows requires understanding the third T, tolerance, the openness of a place to new ideas and new people. Places increase their ability to capture these flows by being open to the widest range of people across categories of ethnicity, race, national origin, age, social class, and sexual orientation. The places that can attract the widest pool of creative talent--harnessing the creative contributions of the most diverse range of people--gain considerable economic advantage emerging as creativity magnets. They simultaneously mobilize talent from within and draw in talent from the outside environment. With the rise of the Creative Economy, the university – as a center for research and technology generation, a hub for talent production and attraction, and a catalyst for establishing an open and tolerant regional milieu—becomes increasingly essential to both innovation and economic growth.

We can think of the relationship between the university and regional economy in terms of a simple transmitter-receiver system, with the university transmitting a signal that the regional economy must be able to absorb. Increasing the volume of the signal will not necessarily result in effective absorption or transmission if the region's receivers are not on or functioning properly. To borrow from Wesley Cohen and Daniel Levinthal, regions require an "absorptive capacity" – to effectively absorb and utilize the scientific and technological capabilities coming out of the university.[14]

The economist Michael Fogarty has found a consistent pattern in the flow of patented information from universities. Intellectual property migrates from universities in older industrial regions such as Detroit and Cleveland to high-technology regions such as the greater Boston, San Francisco Bay, and New York metropolitan areas. Fogarty finds that, although new knowledge is generated in many places, relatively few actually absorb and apply those ideas.[15]

The university is thus a necessary but insufficient element of economic growth. The region must have the will and capacity to transform and capitalize on what the university produces. It requires a geographically defined ecosystem that can mobilize and harness creative energy. In order to be an effective contributor to regional creativity, innovation, and economic growth, the university must be seamlessly integrated into that broader creative ecosystem.

In this report, we examine the effects of the university on all 3Ts of economic development. We look at these university effects across all 331 metropolitan regions, analyzing its impacts on technology, talent, and tolerance. To do so, we utilize a variety of indicators of university strength, including measures of students, faculty, research and development, technological innovation, and commercialization.

Our measures of university technology outputs are from the annual survey of the Association of University Technology Managers (AUTM) and the National Science Foundation science and engineering indicators. Our measures of university talent (students and faculty) are from Integrated Post-Secondary Education Dataset (IPEDS) from the Department of Education. We use a variety of demographic measures for tolerance including indexes of integration (Integration Index), foreign-born people (Melting Pot Index), artistic communities (Bohemian Index), and the gay and lesbian population (Gay Index). (See Appendix A for a full description of all variables and data sources).

We introduce a new measure of talent, the *Brain Drain/Gain Index* – a measure of the extent to which a region is gaining or losing college educated talent. We also introduce a new comparative measure of the university in the Creative Economy, the *University-Creativity Index*, a combined ranking of a region's university strength *and* its creative class. We employ a variety of statistical methods and tests to further illuminate the university's role in the 3Ts of economic growth, and which we believe can help shed new light on the broad and fundamental role universities play in economic growth and development.

## Technology

Technology is the first T. As discussed, universities play a powerful role in conducting research and development and generating new scientific information, which can then lead to inventions, patents, or spin-off companies. Table 1 provides rankings for the university research intensity (measured as university R&D per capita).

- Among large regions, the leaders are several noted high—tech regions such as North Carolina's Research Triangle (Raleigh-Durham-Chapel Hill), Boston, San Jose, Seattle and Austin.

- Also notable here are older industrial regions which are home to significant research universities such as Baltimore, Pittsburgh and Rochester, NY.

- Classic college towns, particularly those that are home to large state research universities – Ann Arbor, MI (University of Michigan); Tucson, AZ (University of Arizona); Madison, WI (University of Wisconsin); Fort Collins, CO (Colorado State University); State College, PA (Penn State); Bryan-College Station, TX (Texas A&M); and Iowa City, IA (University of Iowa) – top the lists of small- and medium-size regions.

# Table 1:
## R&D per capita*

### 1 million people and above

| Rank, R&D per capita | Region | Overall R&D per capita Rank | Total R&D size class rank | Total R&D Overall Rank |
|---|---|---|---|---|
| 1 | Raleigh-Durham-Chapel Hill | 15 | 4 | 4 |
| 2 | Boston | 19 | 1 | 1 |
| 3 | Baltimore | 25 | 2 | 2 |
| 4 | Seattle | 36 | 9 | 9 |
| 5 | San Jose | 37 | 13 | 15 |
| 6 | Austin | 39 | 19 | 25 |
| 7 | Pittsburgh | 40 | 10 | 11 |
| 8 | Rochester, New York | 41 | 23 | 34 |
| 9 | Columbus, Ohio | 46 | 20 | 27 |
| 10 | Sacramento | 47 | 18 | 24 |

### 500,000 to 1,000,000 people

| Rank, R&D per capita | Region | Overall R&D per capita Rank | Total R&D size class rank | Total R&D Overall Rank |
|---|---|---|---|---|
| 1 | Ann Arbor | 14 | 1 | 13 |
| 2 | Tucson | 27 | 2 | 21 |
| 3 | Springfield, Massachusetts | 29 | 3 | 40 |
| 4 | Knoxville, Tennessee | 38 | 4 | 46 |
| 5 | Birmingham, Alabama | 44 | 5 | 47 |
| 6 | Albuquerque | 45 | 6 | 55 |
| 7 | Charleston, South Carolina | 50 | 11 | 70 |
| 8 | Baton Rouge | 52 | 10 | 66 |
| 9 | Columbia, South Carolina | 57 | 12 | 78 |
| 10 | Wilmington, Delaware | 61 | 13 | 79 |

## 250,000 to 500,000 people

| Rank, R&D per capita | Region | Overall R&D per capita Rank | Total R&D size class rank | Total R&D Overall Rank |
|---|---|---|---|---|
| 1 | Madison, Wisconsin | 13 | 1 | 10 |
| 2 | Fort Collins | 18 | 4 | 50 |
| 3 | Santa Barbara | 21 | 2 | 35 |
| 4 | Lincoln, Nebraska | 22 | 6 | 54 |
| 5 | Santa Cruz | 23 | 7 | 56 |
| 6 | Lansing | 24 | 3 | 36 |
| 7 | Tallahassee | 26 | 5 | 53 |
| 8 | Galveston | 30 | 10 | 74 |
| 9 | Trenton | 33 | 8 | 64 |
| 10 | Lexington | 42 | 9 | 67 |

## 250,000 and below

| Rank, R&D per capita | Region | Overall R&D per capita Rank | Total R&D size class rank | Total R&D Overall Rank |
|---|---|---|---|---|
| 1 | State College, Pennsylvania | 1 | 1 | 16 |
| 2 | Bryan-College Station, Texas | 2 | 2 | 18 |
| 3 | Iowa City | 3 | 8 | 33 |
| 4 | Rochester, Minnesota | 4 | 5 | 29 |
| 5 | Lawrence, Kansas | 5 | 11 | 42 |
| 6 | Champaign-Urbana, Illinois | 6 | 3 | 22 |
| 7 | Bloomington, Indiana | 7 | 9 | 38 |
| 8 | Corvallis, Oregon | 8 | 12 | 52 |
| 9 | Athens, Georgia | 9 | 7 | 31 |
| 10 | Lafayette, Indiana | 10 | 6 | 30 |

N = 107 MSAs for which AUTM data are available.

While research intensity can contribute to regional innovation and ultimately growth, the ability of universities to translate their research capabilities into commercial innovation varies significantly. Table 2 provides regional rankings for university-based patenting.

- The top 10 large regions include several noted technology centers like Boston, the Research Triangle, and San Jose; but regions like Baltimore, Salt Lake City, Los Angeles. Atlanta and Houston also number among the top 10.

- Among small and medium-size regions, state university centers again rank highly, but regions like Omaha, Akron, Galveston, also do well.

# Table 2:
## Patent Applications*

### 1 million and above

| Rank, Patent App. per faculty | Region | Overall Rank, Patent App. per faculty | Invention Disclosures, size class rank | Invention Disclosures, overall rank |
|---|---|---|---|---|
| 1 | Boston | 7 | 1 | 1 |
| 2 | Raleigh-Durham-Chapel Hill | 8 | 4 | 4 |
| 3 | Baltimore | 10 | 3 | 3 |
| 4 | San Jose | 14 | 9 | 10 |
| 5 | Salt Lake City | 15 | 14 | 16 |
| 6 | Middlesex-Somerset-Hunterdon, NJ | 17 | 17 | 23 |
| 7 | Los Angeles | 19 | 2 | 2 |
| 8 | Atlanta | 21 | 7 | 8 |
| 9 | Houston | 24 | 8 | 9 |
| 10 | Orange County, California | 28 | 24 | 39 |

## 500,000 to 1 million

| Rank, Patent App. per faculty | Region | Overall Rank, Patent App. per faculty | Invention Disclosures, size class rank | Invention Disclosures, overall rank |
|---|---|---|---|---|
| 1 | Birmingham, Alabama | 3 | 2 | 31 |
| 2 | Ann Arbor | 23 | 1 | 17 |
| 3 | Richmond | 27 | 5 | 42 |
| 4 | Albuquerque | 30 | 11 | 69 |
| 5 | Knoxville, Tennessee | 41 | 9 | 58 |
| 6 | Tucson | 43 | 4 | 40 |
| 7 | Charleston, South Carolina | 46 | 6 | 53 |
| 8 | Omaha | 51 | 13 | 77 |
| 9 | Wilmington, Delaware | 55 | 17 | 90 |
| 10 | Akron | 56 | 8 | 56 |

## 250,000 to 500,000

| Rank, Patent App. per faculty | Region | Overall Rank, Patent App. per faculty | Invention Disclosures, size class rank | Invention Disclosures, overall rank |
|---|---|---|---|---|
| 1 | Galveston | 2 | 6 | 49 |
| 2 | Madison | 6 | 1 | 7 |
| 3 | Santa Cruz | 11 | 8 | 54 |
| 4 | Santa Barbara | 16 | 3 | 36 |
| 5 | Trenton | 20 | 5 | 38 |
| 6 | Lansing | 34 | 4 | 37 |
| 7 | Fort Collins | 36 | 9 | 60 |
| 8 | Tallahassee | 47 | 10 | 80 |
| 9 | Reno | 49 | 12 | 92 |
| 10 | Provo | 59 | 2 | 20 |

## 250,000 and below

| Rank, Patent App. per faculty | Region | Overall Rank, Patent App. per faculty | Invention Disclosures, size class rank | Invention Disclosures, overall rank |
|---|---|---|---|---|
| 1 | Rochester, Minnesota | 1 | 3 | 21 |
| 2 | State College, Pennsylvania | 4 | 1 | 15 |
| 3 | Charlottesville, Virginia | 5 | 5 | 27 |
| 4 | Greenville, North Carolina | 9 | 19 | 100 |
| 5 | Iowa City | 12 | 8 | 43 |
| 6 | Gainesville | 13 | 2 | 19 |
| 7 | Bryan-College Station, Texas | 18 | 4 | 24 |
| 8 | Lafayette, Indiana | 22 | 6 | 28 |
| 9 | Bloomington, Indiana | 25 | 10 | 50 |
| 10 | Athens, Georgia | 26 | 9 | 47 |

N = 107 MSAs for which AUTM data are available.

# Table 3:
## University R&D, Inventions and Patent Applications

| Rank | Regions | R&D per Capita | Total R&D ($ M) | Invention Disclosures per Faculty | Patent Applications per Faculty |
|---|---|---|---|---|---|
| 1 | State College | 3242.97 | 440.26 | 0.104 | 0.149 |
| 2 | Bryan-College Station | 2606.49 | 397.27 | 0.085 | 0.057 |
| 3 | Iowa City | 2259.52 | 250.82 | 0.081 | 0.081 |
| 4 | Rochester MN | 2146.82 | 266.80 | 1.434 | 0.717 |
| 5 | Lawrence KS | 1932.31 | 193.16 | 0.054 | 0.012 |
| 6 | Champaign-Urbana | 1913.54 | 343.80 | 0.062 | 0.031 |
| 7 | Bloomington IN | 1858.77 | 224.10 | 0.047 | 0.042 |
| 8 | Corvallis | 1775.23 | 138.74 | 0.044 | 0.034 |
| 9 | Athens | 1684.50 | 258.48 | 0.041 | 0.041 |
| 10 | Lafayette IN | 1440.97 | 263.44 | 0.076 | 0.046 |
| 11 | Gainesville | 1352.11 | 294.70 | 0.099 | 0.080 |
| 12 | Charlottesville | 1312.92 | 209.51 | 0.116 | 0.137 |
| 13 | Madison | 1299.71 | 554.36 | 0.194 | 0.109 |
| 14 | Ann Arbor | 863.43 | 499.70 | 0.054 | 0.045 |
| 15 | Raleigh-Durham | 805.49 | 956.87 | 0.143 | 0.093 |
| 16 | Auburn | 769.90 | 88.61 | 0.020 | 0.019 |
| 17 | Columbia MO | 695.05 | 94.15 | 0.024 | 0.012 |
| 18 | Fort Collins | 609.12 | 153.19 | 0.049 | 0.029 |
| 19 | Boston | 591.68 | 2015.74 | 0.103 | 0.098 |
| 20 | Bangor | 583.29 | 53.00 | 0.005 | 0.003 |
| 21 | Santa Barbara | 582.07 | 232.45 | 0.079 | 0.069 |
| 22 | Lincoln | 543.46 | 136.02 | 0.013 | 0.016 |
| 23 | Santa Cruz | 510.79 | 130.56 | 0.095 | 0.083 |
| 24 | Lansing | 508.64 | 227.73 | 0.044 | 0.032 |
| 25 | Baltimore | 489.39 | 1249.40 | 0.096 | 0.089 |

N = 107 MSAs for which AUTM data is available

Table 3 ranks the top 25 regions overall in terms of university research intensity, along with providing their data on university invention disclosures and patent applications.

- The top 5 regions are State College, PA (Penn State); Bryan-College Station, TX (Texas A&M); Iowa City, IA (University of Iowa); Rochester, MN; and Lawrence, KS (University of Kansas). Rounding out the top 10 are Champaign-Urbana, IL (University of Illinois); Corvallis, OR (University of Oregon); Athens, GA (University of Georgia); and Lafayette, IN (Indiana University). In fact, the entire list is dominated by regions home to large state universities.

- Of leading high-tech centers, only Boston and Raleigh-Durham-Chapel Hill make the list. Baltimore is the only larger region that is not a noted high-tech center to rank among the top 25.

# Table 4:
## License Income*

### 1 million and above

| Rank, License Income per Faculty | Region | Overall rank, License Income per Faculty | Total License Income, size class rank | Total License Income, overall rank |
|---|---|---|---|---|
| 1 | Orange County, California | 7 | 10 | 12 |
| 2 | Sacramento, California | 8 | 5 | 6 |
| 3 | Oakland, California | 9 | 4 | 5 |
| 4 | San Jose, California | 11 | 6 | 7 |
| 5 | New York New York | 12 | 1 | 1 |
| 6 | Los Angeles | 13 | 2 | 2 |
| 7 | Seattle | 14 | 7 | 8 |
| 8 | Boston | 15 | 3 | 3 |
| 9 | San Diego | 16 | 9 | 11 |
| 10 | Rochester, New York | 17 | 17 | 23 |

## 500,000 to 1 million

| Rank, License Income per Faculty | Region | Overall rank, License Income per Faculty | Total License Income, size class rank | Total License Income, overall rank |
|---|---|---|---|---|
| 1 | Birmingham, Alabama | 18 | 4 | 44 |
| 2 | Springfield, Mass. | 23 | 1 | 25 |
| 3 | Greenville, SC | 38 | 2 | 39 |
| 4 | Ann Arbor | 50 | 3 | 42 |
| 5 | Knoxville | 51 | 6 | 57 |
| 6 | Albany | 61 | 5 | 54 |
| 7 | Richmond | 67 | 9 | 67 |
| 8 | Baton Rouge | 70 | 8 | 65 |
| 9 | Syracuse | 72 | 7 | 63 |
| 10 | Mobile | 75 | 13 | 83 |

## 250,000 to 500,000

| Rank, License Income per Faculty | Region | Overall rank, License Income per Faculty | Total License Income, size class rank | Total License Income, overall rank |
|---|---|---|---|---|
| 1 | Tallahassee | 2 | 1 | 4 |
| 2 | Santa Cruz | 3 | 5 | 19 |
| 3 | Santa Barbara | 4 | 2 | 10 |
| 4 | Madison | 5 | 4 | 17 |
| 5 | Lansing | 10 | 3 | 15 |
| 6 | Galveston | 20 | 11 | 71 |
| 7 | Provo | 30 | 6 | 37 |
| 8 | Binghamton, New York | 44 | 10 | 68 |
| 9 | Trenton | 47 | 8 | 52 |
| 10 | Lexington | 54 | 7 | 51 |

## 250,000 and below

| Rank, License Income per Faculty | Region | Overall rank, License Income per Faculty | Total License Income, size class rank | Total License Income, overall rank |
|---|---|---|---|---|
| 1 | Rochester, Minnesota | 1 | 3 | 33 |
| 2 | Gainesville | 6 | 1 | 14 |
| 3 | Iowa City | 19 | 4 | 38 |
| 4 | Charlottesville | 25 | 5 | 41 |
| 5 | Bryan-College Station, Texas | 26 | 2 | 29 |
| 6 | Athens | 40 | 6 | 43 |
| 7 | Fargo | 41 | 11 | 69 |
| 8 | Bloomington, Indiana | 43 | 8 | 49 |
| 9 | Champaign-Urbana, Illinois | 46 | 7 | 46 |
| 10 | Jamestown, New York | 48 | 15 | 82 |

N = 107 MSA for which AUTM data is available.

Table 4 ranks regions on university licensing income.

- The 5 leading large regions are Orange County, Sacramento, Oakland, San Jose, and New York. Los Angeles, Seattle, Boston, San Diego and Rochester, NY, round out the top 10.

- Again, major state university centers dominate the rankings for small and medium-size regions.

The ability of universities to generate new startup companies has frequently been noted as a key spur to regional growth of high-tech industry. The roles played by Stanford University in the Silicon Valley and of MIT in the growth of the greater Boston-Route 128 corridor are legendary. Table 5 provides regional rankings for university spin-offs.

- Silicon Valley (San Jose) and Boston are among the top 5 large regions in generating university spin-off companies. Salt Lake City is first, while the North Carolina Research Triangle area and Baltimore also make the top 5. Rounding out the top 10 are Los Angeles, Central New Jersey, Houston, Minneapolis and Providence, Rhode Island.

- Again, major state university centers lead the small- and medium-size regions.

# Table 5:

## Start-ups*

### 1 million and above

| Rank, Start-ups per faculty | Region | Overall Rank, Start-ups per faculty | Total Start-ups (2000), size class rank | Total Start-ups (2000), overall rank |
|---|---|---|---|---|
| 1 | Salt Lake City | 5 | 7 | 7 |
| 2 | Boston | 6 | 1 | 1 |
| 3 | Raleigh-Durham-Chapel Hill | 7 | 4 | 4 |
| 4 | San Jose | 16 | 10 | 11 |
| 5 | Baltimore | 19 | 5 | 5 |
| 6 | Los Angeles | 22 | 2 | 2 |
| 7 | Middlesex-Somerset-Hunterdon | 24 | 19 | 27 |
| 8 | Houston | 25 | 8 | 9 |
| 9 | Minneapolis | 27 | 5 | 5 |
| 10 | Providence | 29 | 15 | 21 |

### 500,000 to 1 million

| Rank, Start-ups per faculty | Region | Overall Rank, Start-ups per faculty | Total Start-ups (2000), size class rank | Total Start-ups (2000), overall rank |
|---|---|---|---|---|
| 1 | Birmingham | 4 | 2 | 21 |
| 2 | Mobile | 10 | 3 | 33 |
| 3 | Ann Arbor | 14 | 1 | 11 |
| 4 | Albuquerque | 18 | 3 | 33 |
| 5 | Akron | 28 | 3 | 33 |
| 6 | Knoxville | 36 | 6 | 43 |
| 7 | Tucson | 43 | 6 | 43 |
| 8 | Baton Rouge | 52 | 6 | 43 |
| 9 | Charleston | 55 | 10 | 59 |
| 10 | Springfield, Massachusetts | 56 | 6 | 43 |

## 250,000 to 500,000

| Rank, Start-ups per faculty | Region | Overall Rank, Start-ups per faculty | Total Start-ups (2000), size class rank | Total Start-ups (2000), overall rank |
|---|---|---|---|---|
| 1 | Galveston | 2 | 3 | 33 |
| 2 | Madison | 8 | 1 | 15 |
| 3 | Santa Cruz | 13 | 5 | 43 |
| 4 | Lexington | 15 | 1 | 15 |
| 5 | Santa Barbara | 20 | 3 | 33 |
| 6 | Fort Collins | 23 | 5 | 43 |
| 7 | Trenton | 34 | 5 | 43 |
| 8 | Tallahassee | 38 | 5 | 43 |
| 9 | Lincoln | 40 | 5 | 43 |
| 10 | Lansing | 67 | 10 | 59 |

## 250,000 and below

| Rank, Start-ups per faculty | Region | Overall Rank, Start-ups per faculty | Total Start-ups (2000), size class rank | Total Start-ups (2000), overall rank |
|---|---|---|---|---|
| 1 | Rochester, Minnesota | 1 | 8 | 43 |
| 2 | Charlottesville | 3 | 1 | 7 |
| 3 | Athens | 9 | 2 | 13 |
| 4 | Gainesville | 11 | 3 | 15 |
| 5 | Lafayette, Indiana | 12 | 4 | 21 |
| 6 | Bryan-College Station | 17 | 5 | 27 |
| 7 | Missoula | 21 | 9 | 59 |
| 8 | State College, Pennsylvania | 26 | 5 | 27 |
| 9 | Champaign-Urbana, Illinois | 31 | 7 | 33 |
| 10 | Bangor | 37 | 9 | 59 |

N = 107 MSAs for with AUTUM data is available.

# Table 6:
## University Licensing Income and Startups

| Rank | Regions | Licensing Income per Faculty | Total Licensing Income ($ M) | Startups per 1000 Faculty | Total Startups (still in business) |
|---|---|---|---|---|---|
| 1 | Rochester MN | 47,460 | 5.36 | 17.699 | 5 |
| 2 | Tallahassee | 43,603 | 67.50 | 1.292 | 6 |
| 3 | Santa Cruz | 29,318 | 16.77 | 2.847 | 0 |
| 4 | Santa Barbara | 24,514 | 29.86 | 2.380 | 0 |
| 5 | Madison | 16,028 | 22.94 | 4.193 | 32 |
| 6 | Gainesville | 15,621 | 26.27 | 3.567 | 33 |
| 7 | Orange County | 13,133 | 28.07 | 1.275 | 0 |
| 8 | Sacramento | 13,084 | 38.70 | 1.270 | 0 |
| 9 | Oakland | 11,982 | 47.75 | 1.163 | 0 |
| 10 | Lansing | 11,864 | 25.72 | 0.461 | 15 |
| 11 | San Jose | 11,516 | 36.94 | 2.494 | 88 |
| 12 | New York | 9,977 | 164.09 | 0.934 | 54 |
| 13 | Los Angeles | 9,078 | 108.52 | 2.212 | 82 |
| 14 | Seattle | 7,914 | 30.30 | 1.567 | 127 |
| 15 | Boston | 7,558 | 73.33 | 5.154 | 271 |
| 16 | San Diego | 7,223 | 29.51 | 1.188 | 5 |
| 17 | Rochester NY | 5,879 | 14.63 | 0.923 | 5 |
| 18 | Birmingham | 5,421 | 3.72 | 7.278 | 28 |
| 19 | Iowa City | 4,915 | 5.07 | 0.000 | 17 |
| 20 | Galveston | 4,446 | 0.96 | 13.953 | 4 |
| 21 | Houston | 4,344 | 18.45 | 2.119 | 33 |
| 22 | Minneapolis | 4,291 | 23.14 | 2.039 | 50 |
| 23 | Springfield MA | 3,911 | 9.05 | 0.864 | 8 |
| 24 | Riverside | 3,754 | 15.60 | 0.364 | 0 |
| 25 | Charlottesville | 3,752 | 4.02 | 9.346 | 29 |

N = 107 MSAs for which AUTM data is available.

Table 6 ranks the top 25 regions across the country in terms of licensing income per faculty and university-generated spin-off companies.

• Two regions generate more than $40,000 per faculty in licensing income – Rochester, MN, and Tallahassee, FL. Two others, Santa Cruz and Santa Barbara, CA, generate more than $20,000, while 7 others generate more than $10,000 in licensing income: Madison, WI; Gainesville, FL; Orange County, CA; Sacramento, CA; Oakland, CA; Lansing, MI; and San Jose, CA.

• Aside from some of these, New York, Los Angeles, Houston, San Diego, Seattle, and Minneapolis are the leading large regions on the list.

We conducted a variety of statistical analyses to better assess the relationship between university technology and the ability of a region to grow technology-based business. In particular, we looked at the relationship between university technology outputs and the Milken Institute's commonly used measures of high-technology industry. The main findings are as follows:

• There is a considerable overall relationship between university technology and regional high-technology industry.

• The correlations between university technology outcomes (invention disclosures, patent applications, licensing income, startups) and regional innovation and high-tech industry are consistently positive and significant.

• It should be noted that the correlations are considerably stronger for the 49 large regions (those with populations of more than one million) than for all 107 regions for which data are available.

## Table 7:
### Correlations between University and Regional Technology Measures

| | Invention Disclosures | Patent Applications | License Income | Startups |
|---|---|---|---|---|
| **Regional Patents** | 0.344<br>0.376 | 0.390<br>0.342 | 0.376<br>0.687 | 0.291<br>0.288 |
| **Tech-Pole** | 0.312 | 0.409 | 0.485 | 0.287 |
| | All insignificant | | | |

Note: First row for each indicator is for the 47 regions over 1 million; the second row is for all 107 regions for which university data are available

The relationship between university technology and regional innovation is more complex. There are some regions where university technology has a strong effect on regional innovation and high-tech industry, and others where it does not. Table 8 is a two-by-two matrix that we use to gauge the pattern of relationships between university technology to regional innovation. It compares regions with high and low scores on the Miliken Institute's Tech-Pole Index (a measure of high-tech industry concentration) to the level of university innovation (measured as university patenting in the region). Its quadrants identity four types of regions, as follows.

• **University-Technology Winners:** Los Angeles, Houston, Atlanta, Boston, and San Jose combine strong university invention with significant high-tech industry.

• **Strong Tech Industry/Weak University Innovation**: New York; Washington, DC; Nassau; Newark, NJ; and Portland, OR, have significant high-tech industry, and relatively low levels of university innovation.

• **Strong University Innovation/ Weak Tech Industry**: Regions such as Pittsburgh and Baltimore have high levels of university innovation but low levels of high-tech industry. The same is true of major state university centers—regions like Charlottesville, VA; State College, PA; Bryan-College Station, TX; and Athens, GA. Universities in these regions perform on par with, or in some cases even better than, their counterparts in leading high-tech regions, but their technological capability is not absorbed by their regions.

• **University-Technology Losers**: Regions like Detroit; Baton Rouge, LA; Springfield, MA; Mobile, AL; and Lexington, KY have low levels of both university innovation and regional high-tech industry.

# Table 8:

## University Patenting versus Regional High-Technology

| | Low Tech-Pole Index | High Tech-Pole Index |
|---|---|---|
| **High University Patenting** | Galveston<br>Charlottesville<br>Athens<br>Bryan-College Station<br>State College<br><br>N=8 | Los Angeles<br>Houston<br>Atlanta<br>Boston<br>San Jose<br><br>N=8 |
| **Low University Patenting** | Detroit<br>Baton Rouge<br>Springfield MA<br>Mobile<br>Lexington<br><br>N=13 | New York<br>Washington DC<br>Nassau<br>Newark<br>Portland OR<br><br>N=6 |

Strong university innovation does not necessarily translate into strong local high-tech industry. Again, an apt, if oversimplified, metaphor for this dynamic is the university as the transmitter and the region as the receiver. In a few, highly selective cases the university sends out a strong signal which is picked up well by the region. But this is far from the norm. In a large number of cases, the university may be sending out a strong signal—it is carrying out a lot of technical R&D and producing patents—but the region's receiver is switched off and unable to take in the signal the university sends out.

Interestingly, these signals are frequently picked up by other regions outside the place where the universities are located. This results in regions where the signal coming from local universities is weak, but the ability to pick up and absorb signals from outside is strong. The extent to which regions exhibit the capacity to absorb ideas and knowledge into their economies is indicative of the presence of a local ecosystem of creativity, places that, with their universities, create an environment amenable to the attraction of both new ideas and creative and knowledgeable people. We achieve a better understanding of this environment by looking at the next two T's, Talent and Tolerance.

### Talent

Talent is the second T. The Nobel prize-winning economist Robert Lucas long ago argued that economic growth stems from clusters of talented people and high human capital.[16] Harvard University's Edward Glaesar finds a close association between human capital and economic growth. He shows that firms locate not to gain advantages from linked networks of customers and suppliers, as many economists have argued, but to take advantage of common labor pools of talented workers.[17] Glaesar's student Spencer Glendon found that human capital levels in cities in the early 20th century provided a strong predictor for city growth over the course of the entire century.[18] In their study of the economic effects of universities, Harvey Goldstein and Joshua Drucker provide evidence which suggests universities effect economic growth more through the production of human capital than from research and development.[19]

Universities play a huge role in generating human capital. They attract and produce two primary types of talent—students and faculty. Regions that can retain these locally produced goods gain competitive advantage. Students represent the core production of universities. But faculty members are important talent in their own right. In addition to teaching students and doing research, star faculty attract other faculty who in turn attract students. Star faculty can and often do have a magnetic effect in the attraction of people and even companies.

To provide a first approximation of this issue, Tables 9 and 10 present some simple counts of talent production relative to the overall regional population.

- The top 5 large regions in terms of student concentration are Austin, the Research Triangle, San Francisco, San Diego, and San Jose. Rounding out the top 10 are Boston, Orange County, Oakland, Los Angeles and Columbus, OH. But it is important to note here that none of these large regions ranks higher than 50th in terms of student concentration.

- Major state university centers dominate the ranking of student concentration and the overall top 10 are all regions below 250,000: Bryan-College Station, TX; Bloomington, IN; State College, PA; Lawrence, KS; Gainesville, FL; Iowa City, IA; Champaign-Urbana, IL; Corvallis, OR; Auburn, AL; and Athens, GA.

# Table 9:

## Students Concentration

(Students per 10,000 Population)

### 1 million and above

| Rank, students per 10,000 | Region | Overall rank, Students per 10k | Faculty per 10k, size class rank | Overall rank, faculty per 10k |
|---|---|---|---|---|
| 1 | Austin | 50 | 2 | 61 |
| 2 | Raleigh-Durham-Chapel Hill | 52 | 3 | 66 |
| 3 | San Francisco | 55 | 14 | 133 |
| 4 | San Diego | 57 | 33 | 189 |
| 5 | San Jose | 61 | 13 | 123 |
| 6 | Boston | 64 | 1 | 58 |
| 7 | Orange County | 67 | 55 | 276 |
| 8 | Oakland | 69 | 20 | 157 |
| 9 | Los Angeles | 74 | 42 | 219 |
| 10 | Columbus, Ohio | 75 | 12 | 109 |

## 500,000 to 1 million

| Rank, students per 10,000 | Region | Overall rank, Students per 10k | Faculty per 10k, size class rank | Overall rank, faculty per 10k |
|---|---|---|---|---|
| 1 | Ann Arbor | 30 | 1 | 23 |
| 2 | Springfield, Mass. | 47 | 2 | 39 |
| 3 | Baton Rouge | 56 | 3 | 46 |
| 4 | Toledo | 63 | 28 | 188 |
| 5 | Tucson | 65 | 20 | 116 |
| 6 | New Haven, Conn. | 71 | 5 | 54 |
| 7 | Columbia, SC | 72 | 7 | 62 |
| 8 | Honolulu | 77 | 10 | 89 |
| 9 | Syracuse | 81 | 4 | 51 |
| 10 | Albuquerque | 83 | 22 | 143 |

## 250.000 to 500,000

| Rank, students per 10,000 | Region | Overall rank, Students per 10k | Faculty per 10k, size class rank | Overall rank, faculty per 10k |
|---|---|---|---|---|
| 1 | Tallahassee | 12 | 2 | 22 |
| 2 | Provo | 16 | 7 | 36 |
| 3 | Lansing | 21 | 5 | 28 |
| 4 | Madison | 26 | 3 | 24 |
| 5 | Fort Collins | 28 | 9 | 41 |
| 6 | Boulder | 33 | 62 | 267 |
| 7 | Lincoln | 35 | 1 | 18 |
| 8 | Santa Barbara | 37 | 13 | 56 |
| 9 | Santa Cruz | 41 | 23 | 87 |
| 10 | Lexington | 45 | 4 | 26 |

## 250,000 and below

| Rank, students per 10,000 | Region | Overall rank, Students per 10k | Faculty per 10k, size class rank | Overall rank, faculty per 10k |
|---|---|---|---|---|
| 1 | Bryan-College Station, Texas | 1 | 5 | 5 |
| 2 | Bloomington, Indiana | 2 | 3 | 3 |
| 3 | State College, Pennsylvania | 3 | 1 | 1 |
| 4 | Lawrence, Kansas | 4 | 6 | 6 |
| 5 | Gainesville, Florida | 5 | 12 | 12 |
| 6 | Iowa City, Iowa | 6 | 9 | 9 |
| 7 | Champaign-Urbana, Illinois | 7 | 7 | 7 |
| 8 | Corvallis, Oregon | 8 | 2 | 2 |
| 9 | Auburn-Opelika, Albama | 9 | 8 | 8 |
| 10 | Athens, Georgia | 10 | 4 | 4 |

# Table 10:
## Student and Faculty Concentration: Top 25 Regions

| Rank | Region | College Students per 10,000 | College Students | Faculty per 10,000 | Faculty |
|---|---|---|---|---|---|
| 1 | Bryan-College Station | 3,086 | 47,039 | 108.3 | 1,651 |
| 2 | Bloomington IN | 2,896 | 34,916 | 116.9 | 1,409 |
| 3 | State College | 2,678 | 36,356 | 144.4 | 1,961 |
| 4 | Lawrence KS | 2,565 | 25,640 | 104.5 | 1,045 |
| 5 | Gainesville | 2,449 | 53,371 | 77.2 | 1,682 |
| 6 | Iowa City | 2,422 | 26,885 | 92.9 | 1,031 |
| 7 | Champaign-Urbana | 2,377 | 42,713 | 104.2 | 1,873 |
| 8 | Corvallis | 2,153 | 16,823 | 119.3 | 932 |
| 9 | Auburn | 2,123 | 24,433 | 98.9 | 1,138 |
| 10 | Athens | 2,047 | 31,409 | 115.4 | 1,771 |
| 11 | Lafayette IN | 2,018 | 36,888 | 84.6 | 1,547 |
| 12 | Tallahassee | 1,845 | 52,485 | 54.4 | 1,548 |
| 13 | Columbia MO | 1,833 | 24,827 | 66.2 | 897 |
| 14 | Yolo | 1,785 | 30,104 | n/a | n/a |
| 15 | Bloomington IL | 1,633 | 24,570 | 67.7 | 1,019 |
| 16 | Provo | 1,547 | 57,002 | 43.1 | 1,589 |
| 17 | Greenville NC | 1,506 | 20,154 | 5.8 | 78 |
| 18 | Charlottesville | 1,391 | 22,199 | 67.1 | 1,070 |
| 19 | Muncie | 1,366 | 16,227 | 77.1 | 916 |
| 20 | Grand Forks | 1,339 | 13,051 | 48.6 | 474 |
| 21 | Lansing | 1,302 | 58,283 | 48.4 | 2,168 |
| 22 | Tuscaloosa | 1,282 | 21,141 | 60.8 | 1,003 |
| 23 | Lubbock | 1,271 | 30,844 | 40.4 | 981 |
| 24 | San Luis Obispo | 1,270 | 31,338 | 14.5 | 358 |
| 25 | Chico | 1,269 | 25,780 | 6.7 | 137 |

Production of students is only a small part of the overall regional talent story. It is important to examine the larger role of the university in the region's overall talent or human capital system. To get a first glimpse of this, we look at the correlations between the talent produced by the university and the region's overall talent base. Table 11 provides these correlations.

# Table 11:

## Correlation of University and Talent Measures (N=331)

| | Students per Capita | Faculty per Capita |
|---|---|---|
| **Human Capital (BA and above)** | 0.572 | 0.429 |
| **Super-Creative** | 0.251 | 0.134 |
| **Creative Class** | 0.208 | 0.150 |

- As Table11 shows, there is a positive and significant correlation between both students and faculty and regional talent, measured by the percentage of the working age population with a college degree.

- A positive but less strong relationship is also found between students and faculty and the creative and super-creative classes. Here, it is important to note that university faculty are members of both the creative and super-creative class and when faculty are removed from those categories the correlation disappears.

- While there is a strong tie between regional talent and technology outcomes, the relationships between university talent and regional technology outcomes are mixed. The relationship is much stronger for students than for faculty.

- As Table 12 shows, students are positively correlated with patents, patent growth, and high-technology industry (both the Tech-Pole and Tech-Share measures). Although faculty clearly play a role in generating new innovations within universities, the lack of a significant correlation shows that areas with higher per capita faculty levels do not necessarily gain technology or growth benefits.

## Table 12:
### Correlations between Talent and Technology/Growth

| | Human Capital | Creative Class | Super Creative | Students | Faculty |
|---|---|---|---|---|---|
| **Patents Per capita** | 0.540 | 0.536 | 0.733 | 0.490 | n/s |
| **Patent Growth** | 0.484 | 0.418 | 0.449 | 0.473 | n/s |
| **Tech-Pole** | 0.488 | 0.574 | 0.643 | 0.431 | n/s |
| **Tech-Share** | 0.510 | 0.644 | 0.545 | 0.299 | n/s |

### The Brain Drain/Gain Index

Ideally, we want to be able to look not just at a region's stock of talent, but to begin to understand the *flows* of talent from one region to another. Talented people are a very mobile means of production. Students often leave regions after their four years are up; and young, highly educated people are the most mobile of virtually any demographic group. Some regions produce talent and export it, while others are talent importers.

There has been mounting concern in the United States and elsewhere over the so-called *"brain drain"* – the movement of talented, high human capital people from one region to another, as seen from the losing region's perspective. Low retention rates of local graduates is troubling to parents and economic developers alike, and many regions are trying to figure out ways to keep graduates from leaving or to lure them back when they get older.

But focusing only on retention misses a crucial part of the picture. A region that retains many of its own graduates but fails to attract degree-holders from other regions will most likely fall behind. The availability of a strong pool of local talent can trump both physical resources and cost in attracting corporations and growing regional economies.

To get at this issue, we developed an index that quantifies the combined retention and attraction rates of university-educated talent. We call it the *Brain Drain/Gain Index* (BDGI). This measure makes no distinction between graduates retained and those drawn from other regions. It just computes the net result: the relative gain (or drain) of people progressing from students to degree-holding workers.

The BDGI for a region is calculated as the percent of the population age 25 and over with bachelor's degree or above, divided by the percent of the population ages 18-34 currently in college or university (post-secondary school). A region with a BDGI above 1.0 is a *brain gain* region, a net recipient of highly educated talent. A region with a BDGI below 1.0 is a *brain drain* region, a net *breeder* or *donor* of university talent. It retains proportionately fewer degree-holders than degree-earners.[20] We consider the BDGI to be the best available indicator of a region's combined talent attraction and retention capability.

- The most striking overall finding is that just 10 percent of all 331 U.S. metro regions are net attractors of talent.

- Of all regions, only 10 boast BDGI scores of 1.25 or above. Another 5 score over 1.20, and 8 more over 1.15. Only 23 regions nationwide do better than 1.15.

Table 13 shows the top 10 regions on the BDGI by size class.

- Among large regions, the top 5 are Atlanta, Denver, Dallas, Washington, DC, and San Francisco. Completing the top 10 are Seattle, Central New Jersey, Charlotte, Indianapolis, and Minneapolis.

- The leading regions overall are Stamford and Danbury, CT, and Naples, FL.

- Other regions with high BDGI scores include: Rochester, MN; Barnstable MA; Nashua, NH; Portland, ME; Santa Fe, NM; Elkhart, IN; Sioux Falls, SD; Springfield, IL; Des Moines, IA; and Boise, ID.

Table 14 shows the 25 regions on the BDGI along with the percentage of the total population in college, percentage of 18-34 year-olds in college and percentage of those 25 and above with a college degree or above.

- Especially notable here are San Francisco, San Jose, Washington, DC, and Santa Fe, which have very high college populations (more than 30 percent) and high levels of their workforce with college degree (more than 40 percent).

- As Table15 shows, six regions score high on both the BDGI and our overall measure of university strength: Austin, Boston, Raleigh-Durham, San Francisco, San Jose, and Portland, ME.

# Table 13:

## Brain Gain or Drain

### 1 million and above

| Rank | Region | BDGI | Overall rank BDGI |
|---|---|---|---|
| 1 | Atlanta | 1.45 | 4 |
| 2 | Denver | 1.38 | 6 |
| 3 | Dallas | 1.38 | 7 |
| 4 | Washington DC | 1.31 | 8 |
| 5 | San Francisco | 1.25 | 10 |
| 6 | Seattle | 1.24 | 11 |
| 7 | Middlesex-Somerset-Hunterdon | 1.22 | 13 |
| 8 | Charlotte | 1.22 | 14 |
| 9 | Indianapolis | 1.21 | 15 |
| 10 | Minneapolis | 1.19 | 16 |

## 500,000 to 1 million

| Rank | Region | BDGI | Overall rank BDGI |
|---|---|---|---|
| 1 | Colorado Springs | 1.09 | 36 |
| 2 | Sarasota | 1.09 | 37 |
| 3 | Richmond | 1.03 | 43 |
| 4 | Jersey City | 1.02 | 46 |
| 5 | Birmingham | 0.97 | 57 |
| 6 | Little Rock | 0.93 | 67 |
| 7 | Omaha | 0.91 | 75 |
| 8 | Tulsa | 0.90 | 79 |
| 9 | Harrisburg | 0.88 | 87 |
| 10 | Columbia, South Carolina | 0.87 | 100 |

## 250,000 to 500,000

| Rank | Region | BDGI | Overall rank BDGI |
|---|---|---|---|
| 1 | Stamford-Norwalk, Connecticut | 2.04 | 1 |
| 2 | Naples | 1.67 | 2 |
| 3 | Des Moines | 1.15 | 21 |
| 4 | Boise City | 1.12 | 29 |
| 5 | Anchorage | 1.10 | 31 |
| 6 | Fort Myers | 1.10 | 32 |
| 7 | Boulder | 1.09 | 35 |
| 8 | Lawrence, Mass. | 1.03 | 42 |
| 9 | Lowell, Massachusetts | 0.99 | 50 |
| 10 | York | 0.97 | 54 |

## 250,000 and below

| Rank | Region | BDGI | Overall rank BDGI |
|---|---|---|---|
| 1 | Danbury, Connecticut | 1.50 | 3 |
| 2 | Rochester, Minnesota | 1.41 | 5 |
| 3 | Barnstable-Yarmouth, Mass. | 1.25 | 9 |
| 4 | Nashua | 1.23 | 12 |
| 5 | Portland, Maine | 1.16 | 20 |
| 6 | Richland-Kennewick-Pasco, Washington | 1.15 | 22 |
| 7 | Santa Fe | 1.15 | 23 |
| 8 | Elkhart-Goshen, Indiana | 1.14 | 24 |
| 9 | Sioux Falls | 1.12 | 27 |
| 10 | Springfield, Illinois | 1.07 | 39 |

# Table 14:
## Leading Brain Drain/Gain Index Regions

| Rank | Region | BDGI | % of Entire Population in College | % 18-34 in College | % 25 and above with Degree |
|---|---|---|---|---|---|
| 1 | Stamford | 2.04 | 4.3% | 24.2% | 49.4% |
| 2 | Naples | 1.67 | 2.7% | 16.7% | 27.9% |
| 3 | Danbury | 1.50 | 4.7% | 26.3% | 39.4% |
| 4 | Atlanta | 1.45 | 5.4% | 22.0% | 32.1% |
| 5 | Rochester MN | 1.41 | 5.1% | 24.7% | 34.7% |
| 6 | Denver | 1.38 | 5.8% | 24.8% | 34.2% |
| 6 | Dallas | 1.38 | 5.4% | 21.7% | 30.0% |
| 8 | Washington DC | 1.31 | 7.1% | 31.9% | 41.8% |
| 9 | Barnstable | 1.25 | 3.4% | 26.8% | 33.5% |
| 9 | San Francisco | 1.25 | 8.7% | 35.0% | 43.6% |
| 11 | Seattle | 1.24 | 6.6% | 28.9% | 35.9% |
| 12 | Nashua | 1.23 | 5.0% | 26.9% | 33.2% |
| 13 | Middlesex | 1.22 | 6.4% | 30.8% | 37.4% |
| 13 | Charlotte | 1.22 | 5.1% | 21.8% | 26.5% |
| 15 | Indianapolis | 1.21 | 4.6% | 21.4% | 25.8% |
| 16 | Minneapolis | 1.19 | 6.1% | 28.0% | 33.3% |
| 16 | Houston | 1.19 | 5.3% | 22.9% | 27.2% |
| 18 | San Jose | 1.18 | 8.4% | 34.4% | 40.5% |
| 19 | Kansas City | 1.17 | 5.0% | 24.4% | 28.5% |
| 20 | Portland ME | 1.16 | 5.7% | 28.9% | 33.6% |
| 21 | Des Moines | 1.15 | 5.5% | 24.9% | 28.7% |
| 21 | Richland | 1.15 | 3.9% | 20.3% | 23.3% |
| 21 | Santa Fe | 1.15 | 6.3% | 34.8% | 39.9% |
| 24 | Elkhart | 1.14 | 2.9% | 13.6% | 15.5% |
| 24 | Newark | 1.14 | 5.5% | 27.7% | 31.5% |

## Table 15:
### Brain Gain and University Strength: Top 5 Regions

| Region | University Strength | BDGI |
|---|---|---|
| Austin | 517 | 1.10 |
| Boston | 509 | 1.07 |
| Portland ME | 550 | 1.16 |
| Raleigh-Durham | 448 | 1.12 |
| San Francisco | 472 | 1.25 |
| San Jose | 494 | 1.18 |

To get at the relationship between talent and regional growth, we ran correlations between the BDGI and a variety of regional outcome measures: patent growth, high-tech industry, population growth, job growth, and income growth. As Table 16 shows, the correlations are uniformly high. The BDGI is very strongly related to key regional outcomes, especially employment growth and high-technology industry, but also regional innovation, population growth and income growth.

## Table 16:
### Brain Gain and Regional Innovation and Growth

| Outcome | BDGI |
|---|---|
| Patent Growth | 0.395 |
| Tech-Pole | 0.361 |
| Tech Share | 0.434 |
| Tech Share Growth | 0.432 |
| Population Growth | 0.443 |
| Job Growth | 0.520 |
| Per Capita Income Growth | 0.320 |

As seen in Table 16, the BDGI is significantly and positively correlated with virtually all measures of regional growth. We suspect that the relationship between the BDGI and regional growth is a two-way street. High BDGI regions have thick and thriving labor markets that are able to capture and absorb growth. But high BDGI regions also have higher talent levels, which in turn is associated with higher technology levels.

In effect, the correlation results for the BDGI reflect a "virtuous circle" where higher levels of talent lead to more technology generation, innovation and entrepreneurship, leading over time to higher rates economic growth more job generation and in turn to higher rates of talent production, retention and attraction.

## Tolerance

Tolerance is the 3rd T. Major research universities can do much to "seed" tolerance and diversity in a region. Nationwide, university towns tend to be among most the diverse regions. Tolerance means being open to different kinds of people and ideas — ideally being *proactively inclusive* – not just "tolerating" their presence but welcoming diverse people as neighbors and entertaining their views as valid and worthwhile.

A key mechanism by which universities—both singularly and in partnership with communities—help build ecosystems of innovation and contribute to talent retention and attraction is through the promotion of tolerance and diversity, which have been shown to be important factors in individuals' location decisions.

Scholars such as the economic historian Joel Mokyr and the social psychologist Simonton have noted that entire societies, through history, tend to flourish when they are open and eclectic but stagnate during periods of insularity and orthodoxy: China, Japan and the Islamic Middle East at various times have been examples[21]. Our research suggests that the same phenomenon helps to explain differences among regions during the current epoch in the U.S.

A growing number of studies have shown that talented and creative people favor diversity and a wide variety of social and cultural options. Openness to ideas — to *creativity* — is paramount to both talent attraction and economic success. Talented and creative people vote with their feet—and they tend to move away from communities where their ideas and identities are not accepted. Indeed, regions with large numbers of high-tech engineers and entrepreneurs also tend to be havens for artists, musicians, and culturally creative people. Seattle, Austin, and Boston are cases in point.

The university has long functioned as a hub for diversity and tolerance. Some have called the universities the "Ellis Islands" of our time, noting their ability to attract large numbers of foreign-born students.[22] The Silicon Valley venture capitalist, John Doerr, has frequently remarked that the United States should "staple a green card" to the diplomas of foreign-born engineering and science students who contribute significantly to the nation's innovative capability.

Indeed, universities can serve as an incredibly productive refuge for minorities seeking education as a hedge against discrimination. Gay men and lesbians show higher than average education levels and are often disproportionately represented on college campuses and in college towns.[23] Lifelong learning provides older citizens with a way to actively engage in a community. In general, the universities and university communities have long been places that are open to free speech, self-expression, political activism and a broad diversity of ideas.

Until relatively recently, though, the university had been a very insular environment, often purposely and intentionally separating itself from the broader society. In a way, university communities provided a function sort of like the old bohemian communities of Greenwich Village where eccentricity and difference were readily accepted, even encouraged. With the rise of creativity as the primary driver of economic growth, the norms and values of these once limited and isolated "creative communities" become more widely generalized and diffused throughout greater segments of society.[24]

We conducted statistical analyses to gauge the relationship between the university and tolerance or diversity. We employ various measures of tolerance including an overall Tolerance Index, which is composed in turn of separate measures of racial integration (Integration Index), foreign born population (Melting Pot Index) artistic and bohemian communities (Bohemian Index), and the gay and lesbian population (Gay Index).

We found a considerable correlation between tolerance and the log of students and faculty, as Table 17 shows. Tolerance increases with both overall population and number of faculty, but the strongest relationships are almost always with the number of students. This is true in all but one case, the Melting Pot Index, which is roughly the same for total population and number of students.

# Table 17:
## Tolerance and University Size Correlations

| | N | Tolerance Index | Melting Pot Index | Gay Index | Bohemian Index | Integration Index |
|---|---|---|---|---|---|---|
| Log Total Students | 331 | 0.510 | 0.463 | 0.502 | 0.548 | -0.480 |
| Log Total Faculty | 324 | 0.427 | 0.322 | 0.420 | 0.478 | -0.351 |
| Log Total Population | 331 | 0.386 | 0.467 | 0.415 | 0.440 | -0.538 |

To get at the effects of tolerance, each of our tolerance measures was regressed against the logs of total population, total students and total faculty for all 331 metro regions. As Table 18 shows, students are the key factor. The correlations for the total number of students are positive and highly significant for the overall Tolerance Index and the separate Melting Pot, Gay, and Bohemian Indexes. The correlations for both population and faculty are generally negative and significant.

The negative coefficients for population suggest that the impact that the total number of students has on diversity declines with increasing population. In another words, the universities have a bigger and more pronounced effect on tolerance when they are located in smaller regions.

# Table18:
## Regression Results for Diversity

| | Dependent Variable | | | |
|---|---|---|---|---|
| | Tolerance Index | Melting Pot Index | Gay Index | Bohemian Index |
| Intercept | -0.004 n/s | -0.384 | -0.389 n/s | -0.176 n/s |
| Log Students | 0.541 | 0.136 | 0.757 | 0.834 |
| Log Faculty | -0.123 | -0.075 | -0.169 | -0.151 |
| Log Population | -0.272 | 0.012 n/s | -0.290 | -0.382 |
| Adjusted R2 | 0.33 | 0.28 | 0.273 | 0.341 |

n/s = not significant

Universities are institutions which value diversity and whose effects on diversity and tolerance extend far beyond their classrooms and laboratories. This is especially true in smaller regions where the universities play large and more significant roles in shaping regional norms and values. By creating social environments of openness, self-expression and meritocratic norms, universities help to establish the regional milieu required to attract and retain talent and spur growth in the Creative Economy.

## The University-Creativity Index

In order to get at the broader relationship between the university and regional creativity, we constructed a *University-Creativity Index* or UCI. The index combines a measure of student concentration with the percent of a region's work force in the creative class. We view this not as a measure of actual creative performance, but rather as a measure of how well a region's absorptive capacity is doing to capitalize on its university capabilities and combine them with other creative assets. In our view, a ranking in the top 50 means a region has considerable assets to work with and is well positioned to leverage those assets for improved innovative and economic performance. Table 19 provides the results. The full ranking is detailed in Appendix 2.

- The top 5 large regions are all noted high-tech regions: San Jose, San Francisco, San Diego, Austin and Boston. Rounding out the top 10 are Sacramento and Oakland (both in the San Francisco Bay Area), Seattle, Denver, Los Angeles, and Chicago.

- The rankings for small and medium-size regions, not surprisingly, are dominated by major state university centers, such as: Lansing, MI (Michigan State); Ann Arbor, MI (University of Michigan); Madison, WI (University of Wisconsin); Provo, UT (University of Utah); Gainesville, FL (University of Florida); Bryan-College Station, TX (Texas A&M); and Corvallis, OR (University of Oregon), among many others. These findings suggest there is tremendous potential for harnessing university assets for regional economic growth in these communities. This is already occurring in some of these places, notably Madison's recent ascendance as a center for high-technology industry and spin-off companies.

- A wide variety of regions that are not usually seen as topping the lists of high-technology centers also do well on the UCI. These include: Albany and Syracuse, NY; Omaha and Lincoln, NE; Dayton, OH; Trenton, NJ; Des Moines, IA; Spokane, WA; Muncie, IN; and Portland, ME. Our sense is that there is considerable unrealized creative potential in these regions.

- Of older Industrial regions, only Chicago places in the top 50. Other older industrial regions with superb universities and colleges – like St. Louis, Baltimore, Philadelphia, and Pittsburgh—rank only between 50 and 100. It is our view that these regions suffer from a significant absorptive capacity deficit. Alongside efforts to improve university research and technology transfer, these regions need to work on their ability to absorb the significant signals their universities are sending out.

- Our findings also suggest that there are likely to be considerable advantages for developing inter-regional partnerships between older industrial regions and their surrounding university centers. Two places that jump out from the data are Central Indiana and Greater Detroit. Indianapolis, for example, which ranks 239th on the UCI is flanked by Bloomington and Lafayette which rank 3rd and 10th respectively. Detroit which ranks 140th on the UCI is flanked by Lansing and Ann Arbor which rank 4th and 21st respectively.

- In our view, the economic future of these regions lies less in their older commercial centers and downtowns (which are in part legacies of the industrial age), and much more in the major university centers are on their peripheries. These places would benefit from broad inter-regional partnerships—and the development of "super-regional" strategies that combine the size and scale of their older centers with the considerable 3T capabilities of their major research university communities.

# Table 19:
## University-Creativity Index

### Regions with population 1 million and above

| Rank | Region | Overall Rank | University/ Creativity Interaction |
|---|---|---|---|
| 1 | San Jose | 6 | 0.924 |
| 2 | San Francisco | 11 | 0.896 |
| 3 | San Diego | 19 | 0.856 |
| 3 | Austin | 19 | 0.856 |
| 5 | Boston | 24 | 0.841 |
| 6 | Sacramento | 26 | 0.837 |
| 7 | Oakland | 29 | 0.814 |
| 8 | Seattle | 34 | 0.801 |
| 9 | Denver | 35 | 0.795 |
| 10 | Los Angeles | 42 | 0.772 |
| 10 | Chicago | 42 | 0.772 |

### Regions with population between 500,000 and 1,000,000

| Rank | Region | Overall Rank | University/ Creativity Interaction |
|---|---|---|---|
| 1 | Albany NY | 15 | 0.876 |
| 2 | Ann Arbor | 21 | 0.855 |
| 3 | Columbia SC | 37 | 0.789 |
| 4 | Omaha | 42 | 0.772 |
| 5 | Albuquerque | 48 | 0.761 |
| 6 | Springfield MA | 51 | 0.754 |
| 7 | Dayton | 54 | 0.748 |
| 8 | New Haven | 59 | 0.745 |
| 9 | Syracuse | 61 | 0.737 |
| 10 | Baton Rouge | 68 | 0.71 |

## Regions with population between 250,000 and 500,000

| Rank | Region | Overall Rank | University/ Creativity Interaction |
|---|---|---|---|
| 1 | Lansing | 4 | 0.926 |
| 2 | Madison | 8 | 0.917 |
| 3 | Montgomery | 9 | 0.914 |
| 4 | Provo | 11 | 0.896 |
| 5 | Trenton | 13 | 0.893 |
| 6 | Tallahassee | 14 | 0.891 |
| 7 | Huntsville | 22 | 0.853 |
| 8 | Lincoln | 28 | 0.828 |
| 9 | Des Moines | 36 | 0.79 |
| 10 | Spokane | 38 | 0.787 |

## Regions with population below 250,000

| Rank | Region | Overall Rank | University/ Creativity Interaction |
|---|---|---|---|
| 1 | Gainesville | 1 | 0.98 |
| 2 | Bryan-College Station | 2 | 0.976 |
| 3 | Bloomington IL | 3 | 0.965 |
| 4 | Corvallis | 4 | 0.926 |
| 5 | Missoula | 7 | 0.923 |
| 6 | Lafayette IN | 10 | 0.899 |
| 7 | Charlottesville | 15 | 0.876 |
| 8 | Muncie | 17 | 0.869 |
| 9 | Santa Fe | 18 | 0.861 |
| 10 | Portland ME | 23 | 0.849 |

# Conclusion

This study has examined the role of the university in the 3Ts of economic growth – Technology, Talent, and Tolerance – suggesting that the role of the university encompasses much more than the simple generation of technology. We examined these issues for all 331 metropolitan regions in the United States, analyzing the performance of universities in producing technology and talent and in shaping the tolerance of their regions.

We introduced a new indicator for talent flows, the *Brain Drain/Gain Index* (BDGI), a measure of the extent to which a region is attracting and retaining college educated talent. And we introduced a new comparative measure of the university in the Creative Economy, the *University-Creativity Index***,** a combined ranking of a region's university *and* its overall strength in the Creative Economy. We used statistical methods to further illuminate the university's role in the 3Ts of and hopefully to shed new light on its broad role in economic growth and development.

Our findings suggest that the role of the university goes far beyond the "engine of innovation" perspective. Universities contribute much more than simply pumping out commercial technology or generating startup companies. In fact, we believe that the university's role in the first T, technology, while important, has been overemphasized to date, and that experts and policymakers have somewhat neglected the university's even more powerful roles in the two other Ts—in generating, attracting and mobilizing talent and in establishing an tolerant social climate.

In short, the university comprises a potential – and, in some places, actual – *creative hub* that sits at the center of regional development. It is a catalyst for stimulating the spillover of technology, talent, and tolerance into the community.

**Technology:** As major recipients of both public and private research and development funding and as sources of innovations and spin-off companies, universities are often at the cutting edge of technological innovation. But university invention does not necessarily translate into regional high-tech industry and economic growth. In fact, we found that there are many regions whose universities are at the cutting edge of technology, but where that university technology does not turn into regional growth. While universities comprise an important precondition for regional innovations, to be effective they must be embedded in a broader regional ecosystem that can absorb their research and inventions and turn them into commercial innovations, industrial development, and long run growth.

**Talent:** Universities play a powerful role in generating, attracting, and retaining talent. On one hand, they directly attract top faculty, researchers and students. On the other hand, they can also act as magnets for other talent, attracting talented people, research laboratories and even companies to locate near them to access their research and amenities.

**Tolerance:** Universities and colleges help to shape a regional environment that is open to new ideas and diversity. Universities are the Ellis Islands of the creative age, attracting students and faculty from a wide variety of racial and ethnic backgrounds, income levels, sexual orientations, and national origins. University communities and college towns are places that are open to new ideas, cultivate freedom of expression, and are accepting of differences, eccentricity and diversity. These norms and values play an increasingly important role in attracting talent and in generating the new ideas, innovations and entrepreneurial enterprises that lead to economic growth.

In order to be an effective contributor to regional creativity, innovation and economic growth, the university must be integrated into the region's broader creative ecosystem. On their own, there is only a limited amount that universities can do. In this sense, universities are necessary but insufficient conditions for regional innovation and growth. To be successful and prosperous, regions need absorptive capacity—the ability to absorb the science, innovation, and technologies that universities create. Universities and regions need to work together to build greater connective tissue across all 3Ts of economic development.

The regions and universities that are able to simultaneously bolster their capabilities in technology, talent and tolerance will realize considerable advantage in generating innovations, attracting and retaining talent, and in creating sustained prosperity and rising living standards for their people.

# Appendix 1:

## Indicators and Data Sources

This appendix provides a brief description of the major variables and data sources used. The unit of analysis is the region or Metropolitan Statistical Area (MSA).

## University Measures

**University Technology:** Data for university technology outputs, including research and development, invention disclosures, patent applications, licensing Income, and startups are from the Association of University Technology Managers annual survey. The data are for the year 2000 and cover 107 metropolitan areas.

**University Strength:** This measure is the sum of inverse rankings of college students per capita and faculty members per capita, and it covers all 331 MSAs. The faculty data are from the Integrated Postsecondary Education (IPED) dataset and are for the year 2000. Students per capita come from the 2000 Census which counts students in the metropolitan region. IPEDS also has student numbers, but they are based on the number of students attend institutions within the metropolitan are, so those who attend the school and commute from outside the MSA are counted. The IPEDS and Census figures are closely correlated (0.98 correlation).

**University-Creativity Index:** This measure is the sum of inverse rankings of students per capita and percent Creative Class (see below), with that quantity divided by 662.

## Technology

**Tech-Pole Index:** This measures the prevalence or spatial concentration of high-tech industry in a metropolitan area and is based on two factors: (1) high-tech location quotient and (2) the metro area proportion of national high-tech output (referred to in the text as 'tech share'). It based on data provided by Ross DeVol and colleagues at the Milken Institute.

**Patents:** There are two measure of patents: patents per capita and patent growth This variable measures innovation by using simple utility patent count data available from the NBER Patent Citations Data File.[25]

## Talent

**Human Capital:** This is the standard human capital index which measures the percentage of residents 25 years of age and older with a bachelor's degree and above.

**Creative Class:** Percentage of the region's employees in the following categories:

- Super-Creative Core: Computer and mathematical occupations, architecture and engineering occupations; life, physical and social science occupations; education, training and library occupations; arts, design, entertainment, and media occupations
- Management occupations
- Business and financial operations occupations
- Legal occupations
- Healthcare practitioners and technical occupations (not including Healthcare support)
- High-end sales and sales management

These definitions are based on Florida, *The Rise of the Creative Class* and are from the 2000 Bureau of Labor Statistics Occupational Employment Statistics Survey.[26]

## Tolerance

Bohemian Index: A location quotient of the number of bohemians in an MSA. It includes authors, designers, musicians, composers, actors, directors, painters, sculptors, craft-artists, artist printmakers, photographers, dancers, artists, and performers.

**Gay Index:** Originally calculated by Black and his collaborators,[27] it is a location quotient measuring the over- or under-representation of coupled gays and lesbians in an MSA.

**Melting Pot Index**: This variable measures the percentage of foreign – born residents in an MSA. It is based on the Census Public Use Microdata Sample (PUMS).

**Integration Index:** The Integration Index measures how closely the racial percentages within each Census tract within a metropolitan area compare to the racial composition of the region as a whole. This measure takes into account six racial/ethnic groups: white, non-Hispanic; black, non-Hispanic; Asian/Pacific Islander, non-Hispanic; other races (including mixed races), non-Hispanic; white Hispanic; and nonwhite Hispanic.

**Tolerance Index:** Tolerance Index is a composite of four separate measures, each of which captures a different dimension of tolerance or diversity: the Integration Index, Melting Pot Index, the Bohemian Index, and the Gay Index.[28]