

An aerial photograph of a university campus, likely the University of North Carolina at Chapel Hill, showing various buildings, green spaces, and a large parking lot. The image is framed by a thin black border.

THE UNIVERSITY AND THE **CREATIVE** ECONOMY

2006

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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 estab-

lishing 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 univer-

sity 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 growth⁸

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

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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 uni-

versities 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.

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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

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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.

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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

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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

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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.

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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

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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

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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

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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.

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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

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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 which AUTUM data is available.

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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.

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- 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 0.376	0.390 0.342	0.376 0.687	0.291 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 Milken 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 identify 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.

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Table 8:
University Patenting versus Regional High-Technology

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

gued, 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 fac-

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ulty 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

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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

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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, Alabama	9	8	8
10	Athens, Georgia	10	4	4

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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.

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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 Table 11 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.

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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 be-

hind. 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 reten-

tion 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.

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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

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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

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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

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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%

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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

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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 psychol-

ogist 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 examples²¹. 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.

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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

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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.

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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

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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

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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, at-

tracting 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.

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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 area, 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 Em-

ployment 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

Appendix Two

Regional Rankings on the University–Creativity Index by Size

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
12	Minneapolis	45	0.770
13	Washington DC	46	0.766
14	Raleigh-Durham	47	0.763
15	Oklahoma City	63	0.719
16	Rochester NY	66	0.713
17	Hartford	70	0.702
18	Orange County	75	0.686
19	St. Louis	76	0.684
20	New York	82	0.675
21	Baltimore	84	0.672
22	Philadelphia	86	0.666
23	Phoenix	92	0.645
24	Middlesex	94	0.644
25	Columbus OH	97	0.636

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1 million and above (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
26	Pittsburgh	99	0.634
27	Kansas City	107	0.616
28	Cleveland	115	0.595
29	Milwaukee	119	0.589
30	Newark	122	0.585
31	Houston	124	0.583
32	Tampa	129	0.579
32	Providence	129	0.579
34	Salt Lake City	136	0.556
35	Dallas	138	0.551
36	Miami	140	0.550
36	Detroit	140	0.550
38	Buffalo	142	0.548
39	Atlanta	143	0.545
40	San Antonio	145	0.544
41	Portland OR	148	0.542
42	West Palm Beach	151	0.538
42	Norfolk	151	0.538
44	Monmouth	156	0.532
45	Fort Lauderdale	167	0.512
46	Nassau	173	0.494
47	Nashville	174	0.492
48	Orlando	181	0.479
49	New Orleans	186	0.464
50	Cincinnati	187	0.462

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1 million and above (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
51	Charlotte	188	0.458
52	Riverside	197	0.441
53	Jacksonville FL	202	0.437
54	Greensboro	219	0.402
55	Louisville	231	0.391
56	Bergen	239	0.381
56	Indianapolis	239	0.381
58	Fort Worth	252	0.340
59	Memphis	256	0.310
60	Grand Rapids	263	0.293
61	Las Vegas	301	0.168

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

THE UNIVERSITY AND THE CREATIVE ECONOMY

500,000 and 1,000,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
11	Tucson	81	0.677
12	Charleston SC	85	0.668
13	Worcester	87	0.662
14	Scranton	95	0.64
15	Akron	96	0.637
16	Richmond	100	0.631
17	Jersey City	103	0.624
18	Ventura	103	0.624
19	Wilmington DE	112	0.603
20	Bakersfield	113	0.598
21	Wichita	125	0.582
21	Honolulu	125	0.582
23	Colorado Springs	132	0.565
24	Birmingham	134	0.559
25	El Paso	138	0.551
26	Harrisburg	150	0.541
27	Toledo	158	0.529
28	Tacoma	161	0.526
29	Little Rock	162	0.523
30	Allentown	180	0.483
31	Tulsa	197	0.441
31	Knoxville	197	0.441
33	Mobile	214	0.411
34	Greenville SC	219	0.402
35	McAllen	224	0.397

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500,000 and 1,000,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
36	Fresno	225	0.396
37	Fort Wayne	258	0.307
38	Stockton	263	0.293
39	Vallejo	277	0.251
40	Youngstown	292	0.204
41	Gary	294	0.195
42	Sarasota	296	0.189

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
11	Santa Rose	49	0.758
12	Melbourne	54	0.748
13	Santa Barbara	60	0.742
14	Santa Cruz	62	0.73
15	Fort Collins	63	0.719

THE UNIVERSITY AND THE CREATIVE ECONOMY

250,000 and 500,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
16	Pensacola	65	0.715
17	Brockton	66	0.713
18	South Bend	69	0.704
19	Dutchess County	71	0.701
20	Binghamton	73	0.698
21	Daytona Beach	74	0.692
22	Eugene	76	0.684
23	Lexington	82	0.675
24	Huntington	88	0.659
25	Jackson MS	91	0.653
26	Springfield MO	97	0.636
27	Anchorage	100	0.631
28	Lowell	106	0.618
29	Lawrence MA-NH	110	0.609
30	Killeen	111	0.607
31	Kalamazoo	114	0.597
32	Macon	118	0.592
33	Corpus Christi	120	0.588
34	Boulder	143	0.545
35	Erie	145	0.544
36	Salem	159	0.527
37	Fayetteville NC	163	0.521
38	Stamford	165	0.517
39	Peoria	174	0.492
40	Boise City	177	0.488

THE UNIVERSITY AND THE CREATIVE ECONOMY

250,000 and 500,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
41	Utica	185	0.467
42	Quad Cities	188	0.458
43	Salinas	190	0.453
44	Flint	194	0.444
45	Appleton	195	0.443
46	Bridgeport	200	0.44
47	Charleston WV	205	0.435
48	Fort Pierce	208	0.427
49	Brownsville	209	0.426
50	Beaumont	213	0.417
51	Augusta	217	0.405
52	Chattanooga	222	0.4
53	Hamilton	229	0.393
54	Fayetteville AR	231	0.391
55	Johnson City	234	0.387
56	Saginaw	239	0.381
57	Reno	244	0.376
58	Savannah	246	0.364
59	Evansville	248	0.36
60	Rockford	249	0.352
61	New London	253	0.335
62	Lafayette LA	260	0.295
63	Biloxi	272	0.273
64	Fort Myers	273	0.267
65	Modesto	282	0.236
66	Newburgh	283	0.234
67	Canton	286	0.225

THE UNIVERSITY AND THE CREATIVE ECONOMY

250,000 and 500,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
68	Visalia	289	0.218
69	Columbus GA	297	
		0.187	
70	Reading	302	0.15
71	Shreveport	303	0.147
72	Lakeland	303	0.147
73	Lancaster	305	0.142
74	Naples	311	0.119
75	Hickory	313	0.118
76	York	315	0.109
77	Atlantic City	316	0.106
78	Galveston	320	0.095
79	Ocala	327	0.057

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

THE UNIVERSITY AND THE CREATIVE ECONOMY

250,000 and 500,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
11	Las Cruces	24	0.841
12	Bangor	27	0.832
13	Manchester	29	0.814
13	La Crosse	29	0.814
15	Monroe	32	0.808
16	Kankakee	33	0.804
17	Springfield IL	39	0.779
18	Iowa City	40	0.778
18	Lawrence KS	40	0.778
20	State College	50	0.755
21	Duluth	52	0.751
22	Redding	53	0.749
23	Cedar Rapids	54	0.748
24	Columbia MO	57	0.746
24	Dover	57	0.746
26	Eau Claire	72	0.699
27	Tyler	78	0.681
27	Tuscaloosa	78	0.681
29	Pocatello	80	0.678
30	Fitchburg	88	0.659
31	Champaign-Urbana	90	0.656
32	Auburn	92	0.645
33	Wilmington NC	102	0.628
34	Portsmouth	105	0.619
35	Chico	108	0.615
36	Burlington	109	0.61
37	Parkersburg	115	0.595
38	Longview	117	0.594

THE UNIVERSITY AND THE CREATIVE ECONOMY

250,000 and 500,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
39	San Luis Obispo	120	0.588
40	Janesville	122	0.585
41	San Angelo	125	0.582
42	Amarillo	128	0.58
43	Gadsden	131	0.577
44	Bellingham	133	0.563
45	Yuba City	134	0.559
46	Waterloo	137	0.553
47	Brazoria	145	0.544
48	Fort Walton	148	0.542
49	Abilene	153	0.533
49	Waco	153	0.533
51	Terre Haute	153	0.533
52	Athens	157	0.53
53	Williamsport	159	0.527
54	Nashua	163	0.521
55	Mansfield	166	0.514
56	Jonesboro	167	0.512
57	Bloomington IN	169	0.509
58	Florence SC	170	0.506
59	Grand Forks	171	0.502
60	Fargo	172	0.497
61	Dothan	176	0.489
62	Florence AL	177	0.488
63	Roanoke	179	0.485
64	Asheville	182	0.474
65	Cheyenne	183	0.471
66	Jackson MI	184	0.468

THE UNIVERSITY AND THE CREATIVE ECONOMY

250,000 and 500,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
67	Sumter	191	0.45
67	Pueblo	191	0.45
69	Topeka	193	0.449
70	Albany GA	195	0.443
71	Cumberland	200	0.44
72	Richland	202	0.437
72	Lubbock	202	0.437
74	Odessa	205	0.435
75	Sherman	207	0.429
76	Billings	210	0.424
77	Danbury	211	0.421
78	Wheeling	212	0.42
79	Jackson TN	215	0.409
80	Altoona	216	0.406
81	Casper	218	0.403
82	Lewiston	219	0.402
83	Great Falls	222	0.4
84	Lynchburg	225	0.396
84	Pine Bluff	225	0.396
86	Green Bay	228	0.394
87	Kenosha	229	0.393
88	Anniston	233	0.39
89	Hattiesburg	234	0.387
90	Clarksville	236	0.385
91	Lima	237	0.384
91	Olympia	237	0.384
93	New Bedford	242	0.379
94	Fort Smith	243	0.378

THE UNIVERSITY AND THE CREATIVE ECONOMY

250,000 and 500,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
95	Bismarck	245	0.367
96	Kokomo	247	0.361
97	Victoria	249	0.352
98	Danville	251	0.343
99	Waterbury	254	0.32
100	Sioux City	255	0.313
101	Wichita Falls	257	0.308
102	Greeley	259	0.299
103	Rochester MN	260	0.295
103	Joplin	260	0.295
105	Rocky Mount	265	0.292
106	Grand Junction	266	0.289
107	Yuma	267	0.285
108	Jamestown	268	0.282
109	Lawton	269	0.279
109	Benton Harbor	269	0.279
111	Vineland	271	0.278
112	Lake Charles	274	0.264
113	St. Joseph	275	0.26
114	Decatur IL	276	0.257
115	Rapid City	278	0.249
116	Laredo	279	0.248
117	Pittsfield	280	0.243
118	Hagerstown	281	0.242
119	Dubuque	284	0.233
120	Sharon	285	0.231
121	Johnstown	287	0.224
122	Wausau	288	0.222

THE UNIVERSITY AND THE CREATIVE ECONOMY

250,000 and 500,000 (cont.)

Rank	Region	Overall Rank	University/Creativity Interaction
123	Yakima	290	0.207
124	Sioux Falls	291	0.205
125	Texarkana	293	0.198
126	Alexandria	295	0.193
127	Steubenville	298	0.184
128	Panama City	299	0.18
129	Elmira	300	0.175
130	Decatur AL	306	0.139
131	Punta Gorda	307	0.133
132	Goldsboro	308	0.131
133	Flagstaff	309	0.13
134	Barnstable	310	0.122
135	Glens Falls	311	0.119
136	St. Cloud	314	0.112
137	Bremerton	317	0.103
138	Merced	318	0.1
139	Sheboygan	318	0.1
140	Medford	321	0.082
141	Greenville NC	322	0.074
142	Enid	323	0.073
142	Myrtle Beach	323	0.073
144	Owensboro	325	0.069
145	Racine	326	0.063
146	Yolo	328	0.036
147	Elkhart	329	0.021
147	Jacksonville NC	329	0.021
149	Houma	331	0.02

Endnotes

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- ⁷ Harvey Goldstein and Joshua Drucker, "The Economic Development Impacts of Universities on Regions: Do Size and Distance Matter?," *Economic Development Quarterly*, 20, 1, (2006), pp. 22-43.
- ⁸ See for example, Richard Florida and Wesley Cohen, "Engine or Infrastructure? The University Role in Economic Development. in Lewis M. Branscomb, Fumio Kodama, and Richard Florida (Eds.), *Industrializing Knowledge: University – Industry Linkages in Japan and the United States*. (Cambridge, MA: MIT Press, 1999), pp. 589-610.
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¹⁵ Michael Fogarty and Amit Sinha, "University-Industry Relationships and Regional Innovation Systems—Why Older Industrial Regions Can't Generalize From Route 128 and Silicon Valley," in Lewis M. Branscomb, Fumio Kodama, and Richard Florida (Eds.), *Industrializing Knowledge: University-Industry Linkages in Japan and the United States*. (MIT Press, 1999).

¹⁶ See Robert Lucas, "On the Mechanics of Economic Development," *Journal of Monetary Economics*, (1998), pp. 38-9.

¹⁷ See for example, Edward Glaeser, "The New Economics of Urban and Regional Growth." In Gordon Clark, Meric Gertler, and Maryann Feldmen (eds.), *The Oxford Handbook of Economic Geography*. (Oxford University Press, 2000), pp. 83-98. Glaeser, "The Future of Urban Research: Non-Market Interactions". In William G. Gale and Janet Rothenberg Pack (eds.), *Brookings – Wharton Papers on Urban Affairs*, (2000), pp. 101-149. Christopher

Berry and Edward Glaeser, "The Divergence of Human Capital across Cities," (Harvard Institute of Economic Research, September 2005).

¹⁸ See, Spencer Glendon, "Urban Life Cycles," (Harvard University, Department of Economics, unpublished working paper, 1998).

¹⁹ See Goldstein and Drucker (2005), pp. 34-5.

²⁰ It is important to point out that the numerator does not count people under 25 who already have a degree and are working, while it does count those who have a degree but are not working. These however should tend to balance out in comparison among regions. Another caveat is that regions with more university students actually tend to score lower on the BDGI because the denominator (percent of younger people currently in school) is so large.

²¹ See for example, Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress*. New York: Oxford University Press, 1990; Dean Keith Simonton, *Origins of Genius: Darwinian Perspectives on Creativity*. (Oxford University Press, 1999).

²² See, Richard Florida, *The Flight of the Creative Class; The Global Competition for Talent*, (Harper Business, 2005).

²³ See, Dan Black, Gary Gates, Seth Sanders, and Lowell Taylor, "Demographics of the Gay and Lesbian Population in the United States: Evidence from Available Systematic Data Sources," *Demography* 37, 2, (May 2000), pp. 139-154.

²⁴ See especially, Florida, *The Rise of the Creative Class*, (2002).

²⁵ See for example, B.H. Hall, Adam Jaffe, and Manuel Trajtenberg, "The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools." NBER Working Paper 8498, (2000).

²⁶ See Florida (2002, 2005).

²⁷ See, Black, et al, "Demographics of the Gay and Lesbian Population in the United States," (May 2000).

²⁸ See the paperback edition of *The Rise of the Creative Class* (Basic Books, 2004) for further definition of the Integration and Tolerance indices.