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 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.

We suggest that the university's increasing role in the innovation process and in 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, which harnesses knowledge and creativity as sources of innovation and productivity growth (see Florida 2002, 2004a, 2004b, 2005). For that reason, we argue that the university plays a role not just in technology, but in all three Ts of economic development: technology, talent, and tolerance. This article provides a data-driven, empirical analysis of the university's role in the "3T's" of economic development, looking in detail at the effects of university R&D, technology transfer, students and faculty on regional technology, talent, and tolerance for all 331 U.S. metropolitan regions.

The findings show that the university plays an important role across all 3T's. First, 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.

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

The findings further suggest that 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.

We conclude that the university comprises a powerful *creative hub* in regional development. Alone, though, the university can be 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.

Theory and Concepts

Universities have long played an important role in research, development, and technology generation. Recently, they have been said to play a key role in 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 and more recently around Austin, Texas, and the North Carolina Research Triangle. (The literature here is vast, but see in particular: Geiger 1986, 1993; Leslie 1990, 1993). From these cases, many have concluded that the university serves as an innovative engine of economic development. Etzkowitz (1989, 2000) argues that the traditional university whose primary missions are research and teaching has been supplanted by an increasingly "entrepreneurial university" which generates revenue and enhances its political viability through technology transfer, the commercial transfer of innovation, the generation of spinoff companies, and direct engagement in regional development. One Silicon Valley entrepreneur, when asked yet again for "the secret of Silicon Valley's success," summed up this perspective by simply responding: "Take one great research university. Add venture capital. Shake vigorously."

There is a broader theoretical underpinning for the view of the university as an "engine of innovation." According to the "linear model of innovation," innovations flow from university science to commercial technology. This model informs the view that new and better mechanisms can be deployed to make the transfer and commercialization more effective and efficient, increasing the output of university "products" that are of commercial value to the economy.

Solow (1957) 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. More recent studies suggest that universities have significant effects on both corporate innovation and regional economic development. Mansfield (1991) later found that investments in academic research yield significant returns to the economy and society.

University research has also been found to make corporate innovation more efficient. Jaffe (1989) found that businesses located in close proximity to university research generate greater numbers of patents. Anselin, Vargas, and Acs (1997) found that university research tends to attract corporate research labs. Goldstein and Drucker (2005) examined the contribution of universities to economic development across US regions, finding that universities tend to increase average annual earnings, with the most substantial effects occurring in small and medium-size regions.

The university as engine of innovation has been criticized as oversimplified for assuming a one-way path from university-based science and R&D, to commercial innovation and also for seeing the steps in the innovation process as discrete (see Florida and Cohen 1999). It has also been criticized for distorting the mission of the university. Robert Merton (1973) 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. Dasgupta and David (1994) have argued strongly for keeping academic science separate from industry. 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, Rosenberg and Nelson (1994) argue 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.

As noted earlier, we argue that the university's increasing role in the innovation process and in 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, which harnesses knowledge and creativity as sources of innovation and productivity growth (see Florida 2002, 2004a, 2004b, 2005). For that reason, we argue that the university plays a role not just in technology, but in all three Ts of economic development: technology, talent, and tolerance.

Since Schumpeter (1962, 1982), economists have noted the role of the first T, technology, in economic growth (Romer 1986, 1990). More recently, there has been increased interest in the role of the 2nd T, talent or human capital in economic growth (Lucas 1988). 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 catalyze talent from within and attract 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 Cohen and Levinthal (1990), regions require an "absorptive capacity" – to effectively absorb and utilize the scientific and technological capabilities coming out of the university.

Fogarty and Sinha (1999) have 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. Although new knowledge is generated in many places, relatively few actually absorb and apply those ideas.

We thus argue that the university is 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.

Data and Methods

To explore these issues, we conducted an empirical analysis of the university's role in the 3T's of economic development for all 331 US metropolitan regions. Our university indicators include measures of students, faculty, research and development, technological innovation, and commercialization. The measures of students and faculty are from Integrated Post-Secondary Education Dataset (IPEDS) from the Department of Education; measures of research are from the National Science Foundation's Science and Engineering data series; and measures of technology transfer (such as license income and startups) are from the annual survey of the Association of University Technology Managers (AUTM) and indicators.

The technology measures include indicators of high-tech industry from the Milken Institute and from the patent database of the US Patent and Trademark Office. Talent measures include conventional measures of human capital based on educational attainment and measures of the creative class based on Florida (2002) and from the Bureau of Labor Statistics occupational data files. Tolerance measures are from the US Census and include specific measures of integration (Integration Index), foreign-born people (Melting Pot Index), artistic communities (Bohemian Index), and the gay and lesbian population (Gay/Lesbian 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 shed additional light on the university's role in the 3T's of economic development.

Technology

Technology is the first T. As noted above, various studies have found that universities play a significant role in regional technology. We begin with a listing of the top 25 regions in

R&D intensity (measured as R&D spending per capita). One can already see a limit to the university as engine of innovation perspective. 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 (Oregon State University); 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 Raleigh-Durham-Chapel Hill (15th) and Boston (19th) make the top twenty. Silicon Valley is conspicuously absent from the list.

<Table 1 here>

Table 2 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. These are also not regions that top the list of high-tech industrial centers. Two others, Santa Cruz and Santa Barbara, CA, generate more than $20,000, while 7 others generate more than $10,000 in licensing income. San Jose, Boston and Seattle, three noted high-tech industry centers, make this list, though a wide variety of other types of regions are on it, including a lot of classic college towns.

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. When considering number of startup companies per faculty member Rochester MN ranks first. This is followed by Galveston TX, Charlottesville VA, Birmingham AL, and Salt Lake City. None of these cities is known as being a hotbed of entrepreneurial activity.

However, the top ten is rounded out with Boston, the Research Triangle area, Madison WI, Athens GA, and Mobile AL. Again, major state university centers also do rather well.

<Table 2 here>

We conducted a variety of statistical analyses to better gauge the relationship between university technology and regional high-technology. 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 3 here>

The relationship between university technology and regional innovation is complex however. There are some regions where university technology has a strong effect on regional innovation and high-tech industry, and others where it does not. Figure 1 is a two-by-two matrix that we use to illustrate the pattern of relationships between university technology to regional innovation. It compares regions with high and low scores on the Mllken 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.

<Figure 1 here>

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 can be and 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. Lucas (1988) long ago argued that economic growth stems from clusters of talented people and high human capital. Glaeser (2000a, 2000b, Berry and Glaeser 2005) 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. Glendon (1998) 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. In their study of the economic effects of universities, Goldstein and Drucker (2006: 34-5) found that universities effect economic growth more through the production of human capital than from research and development.

Universities are themselves generators of 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.

Table 4 lists the top 25 regions by student and faculty concentration. The list here is dominated by college towns. The top 5 large regions in terms of student concentration are Austin, the Research Triangle, San Francisco, San Diego, and San Jose, but that none of these regions ranks higher than 50th in terms of student concentration.

<Table 4 here>

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 5 shows the correlations between university strength and talent.

<Table 5 here>

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. Students are significantly associated with the regions' patents per capita (0.490), patent growth (0.473), and high-technology industry (using the Milken Institute Tech-Pole Measure, 0.431)

Brain Drain or Gain

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. 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.

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.[1] We consider the BDGI to be the best available indicator of a region's combined talent attraction and retention capability. Table 6 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.

The most striking 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 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). We should also note that 6 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 6 here>

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 (see Table 7). 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 7 here>

In our view, 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 Joel Mokyr (1990) and Simonton (1999) have found that societies through history tend to flourish when they are open and eclectic but stagnate during periods of insularity and orthodoxy. Florida and Gates (2001) find that openness and tolerance are associated with differential rates of regional innovation and high-tech industry in the United States. Florida (2002) has argued 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. 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 (Black, Gates, Sanders and Taylor 2000). 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.

We conducted statistical analyses to gauge the relationship between the university and regional tolerance. 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/Lesbian 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 8 here>

Each of the tolerance measures was regressed against the logs of total population, total students and total faculty for all 331 metro regions. As Table 9 shows, students appear to play the key role here. 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.

<Table 9 here>

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 10 shows regions on the University-Creativity Index for four regional size classes.

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 suggest that there are may 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 10 here>

Conclusion

This study has examined the role of the university in the 3T's 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. We also 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 3T's 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 policy-makers have somewhat neglected the university's even more powerful roles in the two other Ts—in generating, attracting and mobilizing talent and in establishing a tolerant and diverse 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.

First, in terms of 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 many region's universities are at the cutting edge of technology, but their universities' technology does not develop into local 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.

Second, 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.

Third, universities and colleges have a significant effect on the third T, tolerance, shaping regional environments that are 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 3T's of economic development. The regions and universities that are able to synergistically and 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 all their people.

References

Anselin, L., Vargas, A., and Acs, Z. 1997. “Local Geographic Spillovers between University Research and High Technology Innovations.” *Journal of Urban Economics* 42:3, 422-48.

Berry, C., and Glaeser, E. 2005. “The Divergence of Human Capital across Cities.” *Harvard Institute of Economic Research*.

Black, D., Gates, G., Sanders, S., and Taylor, L. 2000. “Demographics of the Gay and Lesbian Population in the United States: Evidence from Available Systematic Data Sources.” *Demography* 37:2, 139-154.

Cohen, W., and Levinthal, D. 1990. “Absorptive Capacity: A New Perspective on Learning and Innovation.” *Administrative Science Quarterly* 35:1, 128-152.

Dasgupta, P., and David, P. 1994. "Toward a New Economics of Science." *Research Policy* 23:3, 487-521.

Etzkowitz, H. 1989. "Entrepreneurial Science in the Academy: A Case for the Transformation of Norms." *Social Problems* 36:1, 14-29.

Etzkowitz, H., Webster, A., Gebhardt, C., Terra, B. 2000. “The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm.” *Research Policy* 29, 313-330.

Florida, R. 2002. *The Rise of the Creative Class*. New York: Basic Books.

Florida, R. 2004a. *The Rise of the Creative Class,* updated paperback edition. New York: Basic Books.

Florida, R. 2004b. *Cities and the Creative Class*. New York: Routledge.

Florida, R. 2005. *The Flight of the Creative Class*. New York: Harper Business.

Florida, R., and Cohen, W. 1999. “Engine or Infrastructure? The University Role in Economic Development.” Pp. 589-610 in *Industrializing Knowledge: University – Industry Linkages in Japan and the United States*, edited by Lewis M. Branscomb, Fumio Kodama, and Richard Florida. Cambridge, MA: MIT Press.

Florida, R., and Gates, G. 2001. “Technology and Tolerance: The Importance of Diversity to High-Technology Growth.” Brookings Institute, Center on Urban and Metropolitan Policy.

Fogarty, M., and Sinha, A. 1999. "University-Industry Relationships and Regional Innovation Systems—Why Older Industrial Regions Can’t Generalize From Route 128 and Silicon Valley." Pp. 473-509 in *Industrializing Knowledge: University-Industry Linkages in Japan and the United States*, edited by Lewis M. Branscomb, Fumio Kodama, and Richard Florida. Cambridge, MA: MIT Press.

Geiger, R. 1986. *To Advance Knowledge: The Growth of American Research Universities, 1900-1940*. New York: Oxford University Press.

Geiger, R. 1993. *Research and Relevant Knowledge*. New York: Oxford University Press.

Glaeser, E. 2000a. “The New Economics of Urban and Regional Growth.” Pp. 83-98 in *The Oxford Handbook of Economic Geography*, edited by Gordon Clark, Meric Gertler, and Maryann Feldman. New York: Oxford University Press.

Glaeser, E., 2000b. “The Future of Urban Reseach: Non-Market Interactions.” Pp. 101-149 in *Brookings – Wharton Papers on Urban Affairs*, edited by William G. Gale and Janet Rothenberg Pack.

Glendon, S. 1998. “Urban Life Cycles.” Harvard University, Department of Economics, unpublished working paper.

Goldstein, H., and Drucker, J. 2006. " The Economic Development Impacts of Universities on Regions: Do Size and Distance Matter?" *Economic Development Quarterly* 20:1, 22-43.

Hall, B., Jaffe, A., and Tratjenberg, M. 2000. "The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools." NBER Working Paper 8498.

Jaffe, A. 1989. "Real Effects of Academic Research." *American Economic Review* 76:5, 984-1001.

Leslie, S. 1990. "Profit and Loss: The Military and MIT in the Postwar Era." *Historical Studies in The Physical and Biological Sciences* 21:1, 59-86.

Leslie, S. 1993. *The Cold War and American Science*. New York: Columbia University Press.

Lucas, R. 1988. "The Mechanics of Economic Development." *Journal of Monetary Economics* 22:1, 3-42.

Mansfield, E. "Academic Research and Industrial Innovation." *Research Policy* 20:1, 1-12.

Merton, R. 1973. *The Sociology of Science*. Chicago: University of Chicago Press.

Mokyr, J. 1990. *The Lever of Riches: Technological Creativity and Economic Progress*. New York: Oxford University Press.

Romer, P. 1986. "Increasing Returns and Long-Run Growth." *Journal of Political Economy* 94:5, 1002-1037.

Romer, P. 1990. "Endogenous Technological Change." *Journal of Political Economy* 98:5, S72-S102.

Rosenberg, N., and Nelson, R. 1994. "American Universities and Technical Advance in Industry." *Research Policy* 23:3, 323-348.

Schumpeter, J. 1962. *Capitalism Socialism and Democracy* New York: Harper Perennial.

Schumpeter, J. 1982. *The Theory of Economic Development*. Somerset, NJ: Transaction.

Simonton, D. 1999. *Origins of Genius: Darwinian Perspectives on Creativity*. New York: Oxford University Press.

Solow, R. 1957. "Technical Change and the Aggregate Production Function." R*eview of Economics and Statistics* 39:3, 312-320.

Tables and Figures

Table 1
University R&D, Inventions and Patent Applications

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

N = 107 MSAs for which AUTM data is available

Table 2
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 3
Correlations between University and Regional Technology Measures

	Invention Disclosures	Patent Applications	License Income	Startups
Regional Patents	0.344	0.390	0.376	0.291
	0.376	0.342	0.687	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

Figure 1
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

Table 4
Student and Faculty Concentration: Top 25 Regions

Rank	Region	College Students per 10,000	Total College Students	Faculty per 10,000	Total 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

Table 5
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

Table 6
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 7
Correlations among BGDI, 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

Table 8
Correlations between University Strength and Tolerance

	N	Tolerance Index	Melting Pot Index	Gay/Lesbian 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

Table 9
Regression Results for Diversity

	Dependent Variable			
	Tolerance Index	**Melting Pot Index**	**Gay/Lesbian 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 R^2	0.33	0.28	0.273	0.341

n/s = not significant

Table 10
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

Appendix:

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 (IPEDS) 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 who 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 Measures

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 De Vol and colleagues at the Milken Institute.

Patents: There are two measures 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 (Hall, Jaffe, and Tratjenberg 2000).

Talent Measures

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 (Florida 2002; 2005).

Tolerance Measures

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

Gay/Lesbian Index: Originally calculated by Black et al (2000) for Gay men only, 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 2000 Census.

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/Lesbian Index.[2]

Endnotes

[1] 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.

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