Beyond Tech Transfer: A More Comprehensive Approach to Measuring the Entrepreneurial University

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I. Introduction

Over the last 30 years, researchers across the country have been documenting the shifts in university policies and practices enabled in no small part by the Bayh-Dole[1] legislation of the mid-1980s, and the establishment and growth of the Small Business Innovation Research (SBIR) Program. These major shifts in national policy created an environment in which universities were free to manage their IP in ways that would support knowledge transfer as well as commercialization of new companies, along with an increased availability of private sector risk capital (Mowery et al., 2004; Siegel, 2006a) to support promising start ups. These dynamic changes in the 1980s created incentives for universities to become more entrepreneurial and opportunities for the private sector to engage in new ways with research universities. It was also during this period that the technology capabilities, particularly in countries such as Germany, Sweden and Japan began to catch up with those of the United States after years of rebuilding in the post WWII period. US domination in the innovation and entrepreneurship landscape in the 50s, 60s and 70s was unparalleled. By the 80s, that was changing. The creation of the US Council on Competitiveness in the late 1980s was in large part a response to the new threats from both Asia and Europe in technology global market share. As a result, since the early 1980s, US universities have greatly increased their entrepreneurial activities along many dimensions: patenting and licensing, creating incubators, science parks, and university spin-outs, and investing equity in start-ups, among other indicators (Mowery et al., 2004; Siegel, 2006a, Thursby and Thursby, 2002).

At the center of the larger innovation system lies what has become known as the "entrepreneurial university." It generates technology advances and facilitates the technology diffusion process through intermediaries such as technology transfer offices as well as the creation of incubators or science parks producing support R&D for existing companies or to help jump start new firms. Increasingly the university system has expanded to include activities outside the "ivory tower" with the goal of transforming inventions into innovations for the betterment of society and to enhance the university's revenues and philanthropic contributions. As the scope of the university has grown to include these functions, it often reorganizes in order to renew and transform its mission, and moves toward embracing an economic development mandate (Rothaermel, Agung, and Jiang 2007). In turn, interactions both within the university

[1] The US Bayh-Dole Act of 1980 and its European counterparts, which encouraged universities to patent inventions funded by federal agencies, marked the beginning of notably greater technology transfer from universities to industries and led to a corresponding rise in the growth of the scholarly literature on university entrepreneurship, especially in the United States and the United Kingdom.

system itself and between the university and industry continue to renew the role the university system plays in innovation and economic development.

The last decade has witnessed a growing concern about the more localized competitiveness of regions, not just nations. Leading thinkers on competitiveness, as well as national foundations making strategic investments in entrepreneurship and innovation are increasingly focused on the pivotal role regional economies play in the innovation and economic transformation process (Florida, 2008; Saxenian, 2000; Porter 2008; and Audretsch, 2001). Even though there has been this shift in the national conversation about entrepreneurship, jobs and wealth creation including new policy and funding incentives focused on creating more regional opportunity development, the predominant literature on the entrepreneurial university continues to be focused on activities which "push" technology out into industry regardless of locale rather than on the myriad ways in which universities can and do engage communities and industries in ways that are of value to regional entrepreneurship and innovation capacity.

Our team has been engaged in field research in multiple regions across the United States over the last two decades trying to understand the social and institutional dynamics that shape how regions respond to new economic imperatives. In particular, we have been concerned with how regions increase their ability to accelerate their entrepreneurial and business creation activities. What we have concluded from this work is that universities are in fact engaging communities in a myriad of ways, interacting in diverse activities related to research, teaching and technical assistance, little of which is being documented or measured by scholars interested in the entrepreneurial university. Researchers interested in the entrepreneurial university continue to focus primarily on a limited range of university outputs; technology transfer, licensing and spinout companies. These metrics have become the "proxy" for the entrepreneurial university. A number of additional practices need to be captured and broader metrics need to be developed by researchers in order to better characterize the 21st century entrepreneurial university. Such work would benefit from a more coherent framework to enable capturing not only the outputs but the more nuanced array of inputs that enable the entrepreneurial university's outputs.

In this article, we outline a framework that enables the development of research questions and metrics which may capture a more robust range of entrepreneurial and innovation activities within universities. However, many of them have yet to be quantified in ways that enable meaningful inter-institutional comparison. The predominant indicators of the entrepreneurial university over the last three decades have been based on more easily available quantitative indicators which capture the way in which universities push or sell what they already do; the incentives they create, the ways in which they organize themselves and the outputs they produce in the form of patents, licenses and spinouts. All of these are excellent metrics but only reveal part of the story. The piece in which we are interested is how universities actively engage and collaborate to serve the entrepreneurial needs of the community and regional industry. This component of the process involves the less studied and less understood inputs that universities engage in order to develop proactive, collaborative initiatives which connect with the needs of the regional economy in order to create new clusters, grow promising sectors, assure globally competitive companies, as well as a well prepared and a continuously updated pool of creative, managerial and technical talent.

The somewhat asymmetrical relationship between universities and their local communities represented by narrower measures of entrepreneurism can be rebalanced with a

framework that properly captures the multiple dimensions of engagement that are occurring in universities across America.

II. Current Research on the Entrepreneurial University

Rothaermel, Agung, and Jiang in their 2007 'University Entrepreneurship: A Taxonomy of the Literature' identify four major research streams addressing the entrepreneurial university: (i) Entrepreneurial Research University, (ii) The System of Innovation and Entrepreneurship, (iii) Productivity of Technology Transfer Offices, and (iv) University Spinoffs. Each one of these research streams has been critical to better understanding the entrepreneurial university. Our experience suggests a variety of other potential metrics that are barely touched upon that could yield a much more robust characterization.

The dominant literature relies decidedly on "output" metrics drawn from readily measureable factors such as patents and licenses. "Input" metrics, albeit less easy to capture, are less studied. Research capturing inputs typically involves descriptive accounts or close studies of the system of innovation and entrepreneurship both within the university and between the university and industry. These are primarily case studies which elucidate distinct organizational efforts usually at a single university.

The problem with technology transfer centric measures is that they miss much of the cultural complexity and embeddedness of the university within a region that enables researchers to truly understand the entirety of the entrepreneurial university including activities related to preparing students for an entrepreneurial economy; provision of advice and technical assistance to entrepreneurial enterprises; assisting the business and professional communities with formal and informal education that prepares them to support an entrepreneurial rather than a managerial economy (Audretch & Thurick 2000).

Single campus case studies elucidate how particular campuses organize and incentivize entrepreneurs but rarely allow for inter campus comparisons. A recent piece by Stephen Casper (2013) argues impressively for the power of community connections and networks of innovation which enable community and corporate "pull," what we call inputs, not just researcher "push," what we call outputs. Figure 1 summarizes a research project we did for the California Science and Technology Council evaluating the effects of a state funded seed fund, CalTIP. It reveals that nearly three times the number of research faculty were embedded in these networks of consulting, advising and directing entrepreneurial companies than had applied for a patent or license (Lee and Walshok 2000).

Figure 1: Summary of Links for CalTIP Applicant Companies (N=124)

Type of Academic Linkage	Total No. of Links	No. of Cos. Reporting Links	% of Total Cos.
A. Links with Area University/Research Institution			
Technology Links	20	18	15%
Direct Links	100	50	40%
Indirect Links	170	91	73%
Scientific/Technical Advisory Links	108	51	41%
B. Links with Area Firms			
Technology Links	14	14	11%
Direct Scientific/Engineering Links	148	75	60%
Direct Corporate Executive Links	31	29	23%
Scientific/Technical Advisory Links	23	10	8%
Investor/Board Member Links	35	15	12%
C. Local Risk Capital Investments			
Venture Capital	5	5	4%
Angel Investment	1	1	1%
Total:	**655**	**124**	**--**

Source: Lee and Walshok (2000)

A. A Taxonomy of the Literature on the Entrepreneurial University

(i). The entrepreneurial research university

The research stream on the entrepreneurial university suggests entrepreneurial activity is a step in the natural evolution of a university system that emphasizes economic development in addition to the more traditional university missions of education and research (Chesbrough 2003). Most of the articles in this research stream describe how the organizational design of specific universities inhibits or enhances the commercialization of university inventions (Rothaermel, Agung, and Jiang 2007). Such studies cover incentive systems, university status, location, culture, intermediary agents, focus, experience, and defined role and identity (Thursby and Thursby, 2002). In addition to organizational design, studies focus on the characteristics and roles of faculty and the nature of the technology to be commercialized (Darby and Zucker, 2006). Entrepreneurial activities are measured in various ways: existence of a formal program, cooperation agreements, research support, licensing, marketing activities, quality of commercial output (licenses, patents), existence of incubators and science parks (Rothaermel, Agung, and Jiang 2007).

Qualitative studies in this stream describe the drivers of entrepreneurial activity among individual faculty (Owen-Smith and Powell, 2001) or at the university level (Mowery et al., 2001; Laukkanen, 2003; Powers and McDougall 2005a). Discussions of how a traditional university transitions into a more entrepreneurial organization abound (Etzkowitz, 2003; Jacob et al., 2003) as do descriptions of the barriers to the university commercialization process (Argyres and Liebeskind, 1998; Collins and Wakoh, 2000; Henrekson and Rosenberg 2001; Feldman and Desrochers, 2003). Work on the factors that facilitate the technology transfer process, as well as attempts to identify ways to make universities more entrepreneurial are also informative (Henrekson and Rosenberg 2001; Saragossi and van Pottelsberghe de la Potterie, 2003; Siegel et

al., 2003a, 2004; Debackere and Veugelers, 2005). These qualitative studies also identify various commercialization options (Lee and Gaertner, 1994; Bains, 2005), explain why different stakeholders care about technology transfer from universities to industry (Bell, 1993), and discuss the consequences or effects of entrepreneurial activities at universities (Freier, 1986; Chrisman et al., 1995; Wallmark, 1997; Etzkowitz, 1998; Powell and Owen-Smith, 1998). Importantly, nearly all the work in this research stream is concerned with single case studies surrounding the organization and faculty inducements of a particular university. They are focused on factors which enable technology push from universities and are somewhat fragmented due to the lack of a common language and framework among these researchers.

(ii). The System of Innovation and Entrepreneurship

The research stream on the system of innovation and entrepreneurship emphasizes that university entrepreneurship is not simply a result of internal factors but also is heavily influenced by external factors (Etzkowitz, 2003), most notably federal laws and policies like the Bayh-Dole Act in the United States (Mowery et al., 2001; Jacob et al., 2003), the surrounding industry (Gulbrandsen and Smeby, 2005), and regional conditions (Friedman and Silberman, 2003). One of the main factors discussed in this literature is the importance of being embedded in networks of innovation, which in turn are influenced by the regional context (Rothaermel, Agung, and Jiang 2007) outside the university.

Research on innovation networks highlights the benefits of such networks to technology-based firms. Scholars have produced evidence that innovation networks are beneficial for overall firm productivity, R&D capability, and R&D output (Adams et al., 2001; Zucker and Darby, 2001; Zucker et al., 2002; Murray, 2004; Lofsten and Lindelof, 2005; Medda et al., 2005). In addition, involvement in innovation networks enhances a firm's embeddedness in social networks and increases its survival (Lockett et al., 2003; Murray, 2004). Scholars have also identified various means to develop innovation networks, ranging from informal to formal collaborations, from facility sharing to deep and reciprocal knowledge sharing (e.g., joint projects and recruitment of scientists) (Zucker and Darby, 2001; Zucker et al., 2002; Perez Perez and Sanchez, 2003; Murray, 2004; Lofsten and Lindelof, 2005). However, while extraordinarily important much of the literature in this space once again deals with single case studies. This line of inquiry has yet to lend itself to cross university comparisons, because it lacks a larger framework or typology of activities that allow for a more systematic approach to studying and comparing the entrepreneurial university. Nonetheless, we have found this sort of "input' literature highly useful to thinking about a more robust way of characterizing the entrepreneurial university.

(iii) Productivity of technology transfer offices

The great majority of the literature, in part because it represents readily available quantitative data coming directly from university Technology Transfer Offices (TTOs) is comparative analyses of patents, licenses and spinouts. With the increasing entrepreneurial activities at universities, TTOs have been in the spotlight of research, because they typically function as the key transactional gateway between the university and industry. This research stream suggests university entrepreneurship is a function of the productivity of their TTOs. Most measures of entrepreneurial activities are focused around commercial output, including university licensing (number of licenses, licensing revenue), equity positions, coordination capacity (number of shared clients), information processing capacity (invention disclosures, sponsored research), royalties, and patents (number of patents, efficiency in generating new patents) (Rothaermel, Agung, and Jiang 2007). Factors that have been identified to be important

in explaining the productivity of TTOs include technology transfer offices' systems, structure, and staffing, as well as the different mechanisms of technology transfer, nature and stage of technology, faculty, university system, and environmental factors.

In examining the implications of TTO structure, scholars have found that the choice of organizational structure influences TTO performance through the shaping of the flow of resources, reporting relationships, degree of autonomy, incentives, and commercialization strategy (e.g., Bercovitz et al., 2001; Feldman et al., 2002; Markman et al., 2005b). Besides the organization and management of TTOs, scholars have also explored external factors that contribute to relative TTO performance. For example, the stage of technology (e.g., embryonic) is related to the rate of invention disclosures and commercialization strategy (Thursby et al., 2001; Markman et al., 2005). Moreover, both tangible and intangible resources from the university and locality, such as research support and R&D activities, have been understood as input factors of TTO productivity (Jones-Evans and Klofsten, 1999; Siegel et al., 2003b; Chapple et al., 2005). The literature describing the TTO space does an excellent job of comparing metrics across universities and provides excellent quantitative data. It does not provide insight into the processes and complexity of a university's embeddedness in a regional context where capital, business and managerial know how, partnerships and global regulatory development, marketing and distribution of a technology make the difference to whether a patent "matters" to a regional economy. It provides a window into the output of the university without addressing whether that output travels through an entrepreneurial development process, which increases its probabilities of success. Multiple university mechanisms increasing are in place at universities to facilitate that, but output research rarely addresses them.

(iv). University Spinoffs

Another strong area of research focuses on entrepreneurial activity is new firm creation (e.g., university spin-offs). Indicators of university entrepreneurship revolve around the quantity of new firms created by the university, their performance (VC funding, IPO, survival/failure, revenues, growth), and their attributes (i.e., timing and location, rate of establishment, types, founding team characteristics) (Rothaermel, Agung, and Jiang 2007).

Research in this area has explored the various types of spin-outs. Based on the transferee, spin-offs are classified into "technology only," "technology and personnel," and "personnel only" (Carayannis et al., 1998; Nicolaou and Birley, 2003a,b). Based on their business activities and resource requirements, spin-offs are categorized as "consultancy," "intellectual property licensing," "software," "product," and "infrastructure creation" (Druilhe and Garnsey, 2004). Scholars have also sought to account for the variety of antecedents to spin-offs. For instance, some argue that a university spin-off is mainly the result of development-oriented technology and the personality of the scientists involved (Roberts, 1991). Others argue that the structure of spin-offs is determined by the scientist's business network. Other characteristics of university spin-offs concern the stage of their development (Nicolaou and Birley, 2003a,b). Development stages have been defined with reference to start-up date (Clarysse and Moray, 2004), main business activities (Ndonzuau et al., 2002), and critical resources needed (Sine et al., 2003; Wright et al., 2004b). Scholars find that the dynamics of development stages in a university spin-off is related to the dynamics of its founding team (Clarysse and Moray, 2004). This final category captures a disproportionate amount of attention very likely because the data is readily available. While university spinoffs represent an important metric in understanding university entrepreneurship it is again concerned with an institution's output and fails to recognize the importance of the numerous inputs that make successful spinoffs possible, much less the ways

universities support other start up enterprises which are *not* university spin outs. In a dynamic innovation region such as San Diego, university patenting and licensing represents less than 10% of the annual regional totals and spinouts less than 5% of the annual technology start ups in the region. Nonetheless, UC San Diego is perceived as the entrepreneurial hub in the region in no small part because of the diversity of its numerous collaborative basic research initiatives and its support of regional commercialization and entrepreneurship efforts.

Taken together, research on university entrepreneurship can clearly benefit from a more holistic systems perspective across different levels of analysis rather than its current focus on distinct subsystems in order to better represent which universities are truly entrepreneurial. According to Rothaermel, Agung, and Jiang (2007), current research lacks the complexity of models or richness in data to understand the interdependent processes across many different actors, agents, and institutions involved in university entrepreneurship. Our basic thrust throughout the remainder of this article will be to challenge what, among academics at least, are the conventional markers of an entrepreneurial university by presenting a framework for capturing the understudied metrics we keep referring to. Taken together, they might provide a more robust picture of the entrepreneurial ecosystem. We're especially interested in documenting through the work we have done, a framework of metrics that can be useful to comparisons across universities and regions.

III. Promising Metrics for Better Characterizing the Entrepreneurial University

As was discussed in the introduction and brief review of the current research relevant to entrepreneurial universities, our experience suggests that research moving forward should be designed to capture not only the "push" or output dimensions of university entrepreneurship, but the myriad inputs that characterize university/industry interactions which benefit communities directly. Campuses may need to incorporate the paradigm shift suggested by Miller and DeBoeuf (2009) by moving from a central focus on policies and activities which *promote technology transfer* to knowledge development and diffusion activities which are relevant to the entire *university innovation ecosystem*. The framework we are proposing promises to amplify the work that is currently being done by capturing a wider range of university technology and knowledge outputs. It also proposes ways to begin quantifying the "softer" activities related to partnerships, collaborations, networks and talent development. The framework we propose in addition to TTO Metrics, suggests four distinct additional groups of indicators of a) entrepreneurism as a key factor in university culture and identity; b) comprehensive campus based commercialization support; c) formal and informal talent development initiatives relevant to the innovation and entrepreneurship community and d) the diversity of university engagements with industry.

1. Campus Identity tied to Innovation and Entrepreneurship

1a. Organization and Staffing Investments

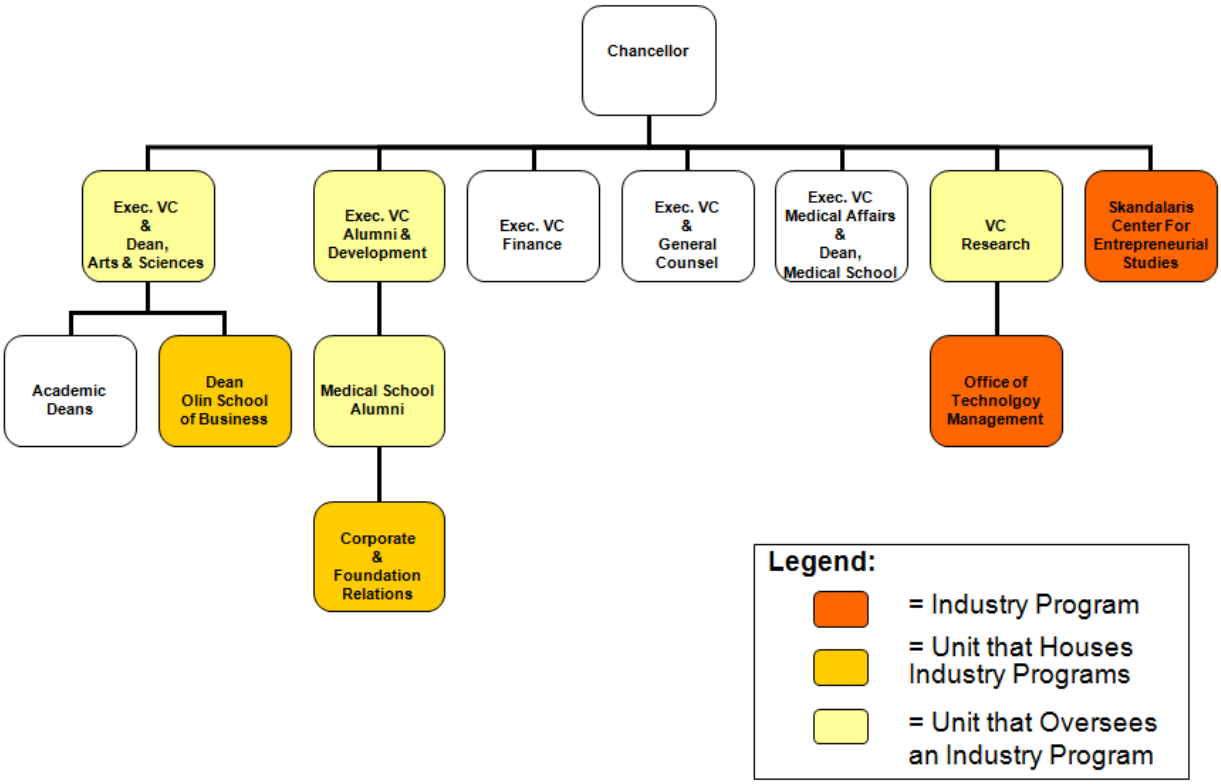
The level of investment in people and offices whose main responsibility is industry relations, innovation or entrepreneurship is one way to assess how important this factor is to a campus' identity. In addition, within the university, the extent to which an entrepreneurial culture is embraced by all levels of the organization, from the chancellor or president on down through deans and department heads, and up from the individual researchers and graduate students who perform collaborative work can be reflected in the range and amount of support for research and curricular activities of value to innovation and entrepreneurship.

Senior administrators set the tone by actively seeking research or programmatic goals that are of mutual interest to industry and the academic institution. This goes beyond just being open to industry funding. It means policies and practices which empower their staff and researchers to actively develop partnerships based on trust and exhibit flexibility when working with industry collaborators. Importantly, the extent to which a university displays an equal willingness to engage with small companies and not just large firms is critical. Stanford University represents the gold standard of a collaborative and entrepreneurial university culture that is ingrained in nearly every aspect of the university. The technology business community exhibits this culture through its willingness to treat the research community as a partner and invests in activities that support collaboration and integration. This includes contributing time (volunteering) and financial resources (program underwriting and philanthropy) both of which can be measured. Within the technology business community, trade associations work in concert towards mutual goals and advocate on policy and other issues on behalf of a community-wide constituency including the university. Serial entrepreneurs, a valuable community resource for collaboration, share their knowledge and experience within the university and in the technology community.

It is possible to measure such things as mentors used, entrepreneurs who teach on campus, internships in companies for undergraduate students, applied Master's degrees and dissertations relevant to technology or business development in the region. Walshok and West (2014--forthcoming) have documented such activities vis a vis the growth of the wireless sector in San Diego even though UCSD has been a minor source of few patents or spin outs. Lastly, government agencies can influence the community environment by creating incentives for collaboration, and through their programs and policy requirements, embrace shared risk. Typically these combined resources represent dozens of programs and hundreds of people all working together to support science-based company formation and growth. Some campuses have many more of these federally funded projects. Many secure fewer SBIR funds than they are eligible for, for example. While having such a culture is one of the most important elements to these systems, it is also one of the most difficult elements to document, much less measure. The examples that follow provide some clues to how a collaborative culture can be fostered and once in place, maintained and enhanced.

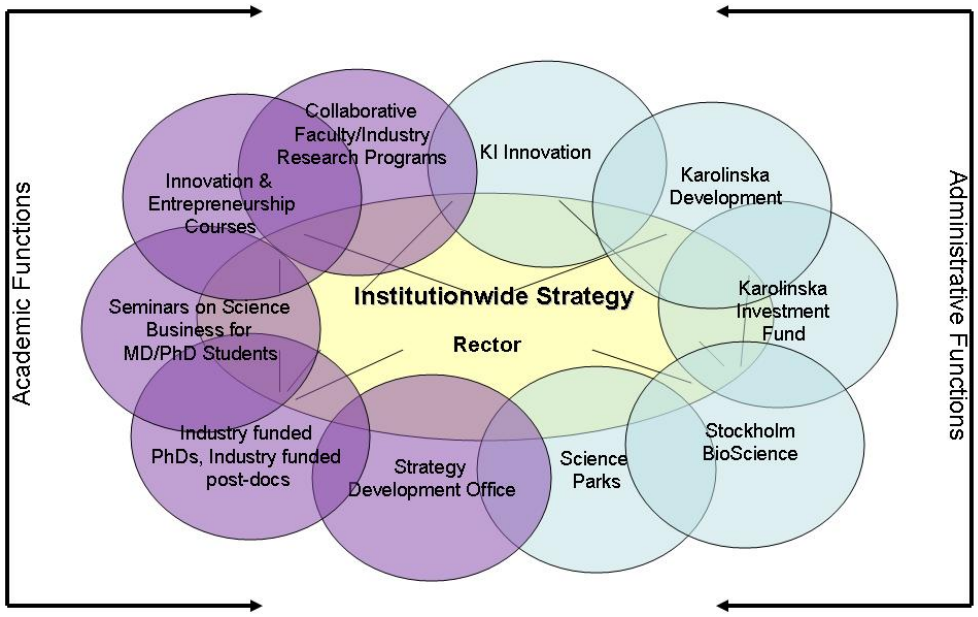
Comparative research we have done reveals a wide variation in how campuses structure and invest in these relationships. The charts we developed to characterize a comparative study of research universities done in 2007 resulted in the following graphic representation of how differently universities organize themselves. Washington University (Figure 2) looks like many universities around the country which have clear, hierarchical reporting relationships. The Karolinska Institute (Figure 3) in Stockholm has a uniquely consultative Swedish flavor to its organization and Stanford (Figure 4) has more than 100 dispersed offices and individuals (most of whom report eventually to the Provost) building relationships with the external community.

Figure 2: *Washington University's academic & administrative units that have staff that engage with industry*



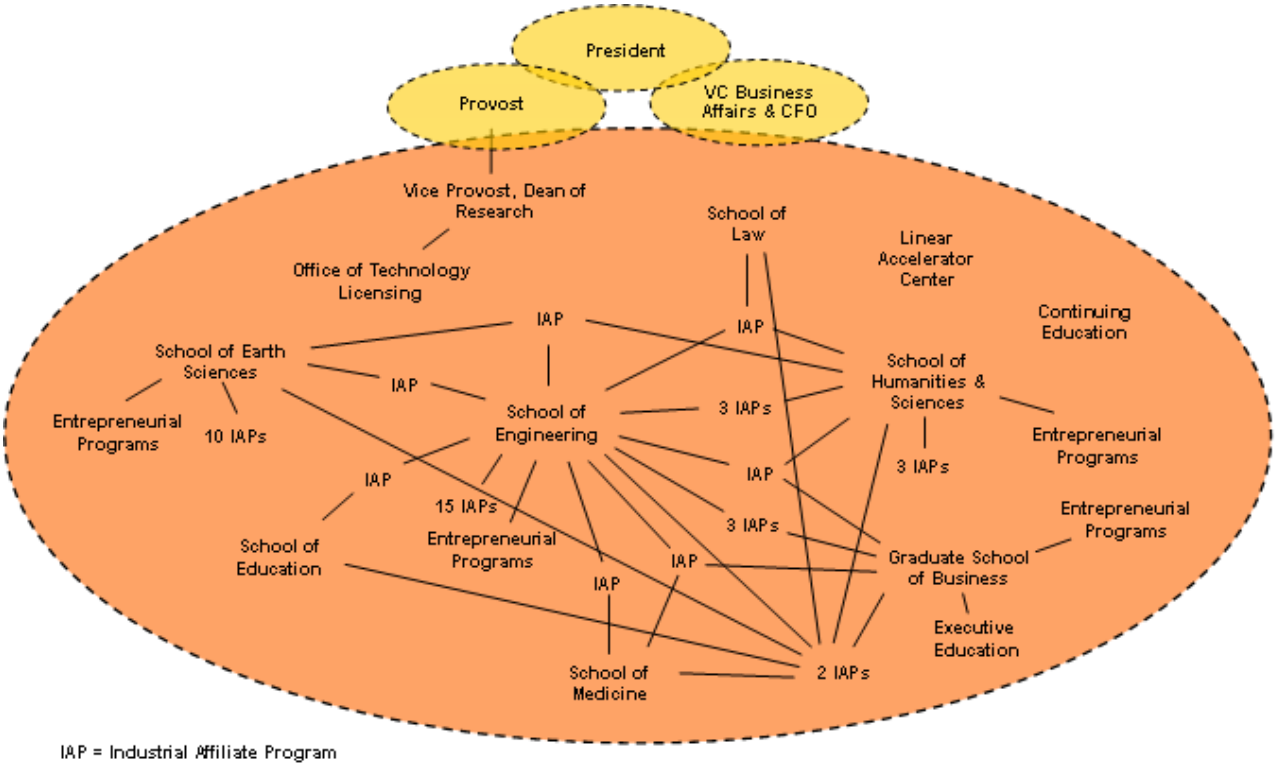
Source: Global Connect (2007)

Figure 3:



Source: Global Connect (2007)

Figure 4: Stanford University's permeable ecosystem of industry engagement



Source: Global Connect (2007)

1b. The leadership of the university is strongly supportive of technology commercialization and student/researcher entrepreneurship.

In addition to the willingness to embrace collaboration with industry at the chancellor or vice chancellor level, support for commercialization manifests itself in university policies that incentivize commercialization, allow for the appointment of senior administrators with a commercialization brief, and include entrepreneurship education programs that are pervasive throughout the university (not just in the business school). Leadership can put in place policies that encourage entrepreneurial activity, ranging from promotion and tenure policies that include the evaluation of economic or enterprise development, fellowships and scholarships in the entrepreneurship and innovation space, to the amount of time faculty are free to pursue outside activities and leaves of absence. How the IP ownership/royalty shares are divided is yet another indicator. At the Karolinska Institute in Sweden, administrative staff are empowered by the Rector to work with industry by making it part of the core mission of the Institute, along with a strong focus on education and research. Further, industry experience is viewed as essential for all staff appointments in tech transfer, science development, and business formation positions. As an example UC San Diego, which for years did not include an explicit commitment to industry partnerships, economic development or innovation in any of its job titles has recently made significant investments in expanding the role of the Vice Chancellor for Research to include economic development activities, innovation and business development, industry partnerships and technology based internships and research opportunities for UCSD students. These moves indicate a shift in campus culture vis a vis how it defines its entrepreneurial role. It is possible

from campus to campus to identify, categorize, and count senior administrators with similar titles or functions and compare across campuses the character and range of these positions.

1c. Commercialization

Universities have a number of places in which proof of concept work or translational research can occur. Such activities tend to be organized research units, multi-disciplinary centers and in some cases full-fledged divisions. Their purpose is to actively connect students and faculty with proof of concept or early applied research which can lead to a solution or product of value to the larger society. The UCSD campus provides an example. Like all campuses it has many organized research units (ORU's) but only some have in their stated purpose, moving ideas from the lab into application or practice. Illustrative examples include the San Diego Center for Algae Biotechnology (SDCAB) which is identifying innovative solutions that partner campus based algae research with private industry for commercial success. Through SD-CAB, science unites with industry to apply lab discoveries from biology, chemistry and engineering to real world solutions for sustainable energy and a revitalized economy. Another example is the Clinical and Translational Research Institute at UC San Diego which seeks to help researchers develop the know-how, resources, and collaborations necessary to translate discoveries into practice. The Institute is a partnership between the University of California, San Diego, and other local institutions dedicated to improving human health. To achieve this goal they support collaboration between many groups: academia, industry, non-profit agencies, government, and most importantly, the community.

In the last five years business planning, financing forums, and related education initiatives have proliferated on campuses across America. UC San Diego, for example has created workshops and seminars directed to faculty; commercialization showcasing opportunities for the private sector and private capital forums in the School of Pharmacy and The Rady School of Business and even among student venture capital associations. All of these campus based activities can be documented and counted as a way of assessing the extent to which a commitment to entrepreneurship has penetrated the entire campus. Once again, on campuses such as Stanford these activities occur even within the Arts and Humanities.

1d. Effective Lateral Communication "across silos" Within the University

Both formal and informal mechanisms that support lateral communication within the university are also needed, particularly in more decentralized structures at large research universities such as Stanford or UCSD, to minimize the inefficiencies which can be created by "siloed" departments. For instance, committee assignments or appointments within multidisciplinary research centers (formal mechanisms) or participating in outside activities such as public events (informal mechanisms) provide opportunities for lateral communication. The sharing of information can foster a collaborative atmosphere within the university and between the university and the outside community. Again, UC San Diego's increasing commitment to engagement with the entrepreneurial needs of the larger community has led to the creation of committees, task forces and new administration units from various parts of the university with the goal of effectively sharing new ideas and developing new collaborative models. At the Karolinska Institute, as the previous chart demonstrated, the strategy and development office was formed to provide university wide planning and initiatives related to commercialization and research partnerships with industry.

2. Commercialization Supports

2a. Business Planning and Financing Forums

University sponsored programs which provide an opportunity for student entrepreneurs as well as community entrepreneurs to pitch their companies in front of an audience of other entrepreneurs, investors, researchers, and service providers can also be tracked and measured. Financial Forum events include presentations made by companies at various angel network meetings, as well as to larger, more public audiences. They are focused on aggregating opportunities in a way that is more efficient for the entrepreneur and investor. Springboard, as offered by San Diego CONNECT and CONNECT Sweden, is a multi-week technical assistance program that puts entrepreneurs through a hands-on coaching and mentoring process to develop a 10 to 12-minute presentation of their business case. The culminating event is a critique of the presentation by a 10 to 12-member panel of volunteer domain experts from the community. Combined with CONNECT sponsored Meet the Researcher and Meet the Entrepreneur events, these programs deliver value in multiple ways – they create visibility for the region's science and technology-based businesses, assist the growth of companies, develop a community of competence, filter the better business opportunities, and actively engage community members in a meaningful task. Financing programs take longer to develop and implement and require cultivating the pool of domain experts to voluntarily serve on review and advisory panels. They also require more resources. However, community stakeholders in San Diego, for example, consider the Springboard programs to be among the most important offered by CONNECT as does the CONNECT Sweden network. And, such activities sponsored by universities or in partnership with universities can be documented and measured in a way that allows for cross university comparisons. CONNECT's recent internal statistics reported that there were over 150 Springboard Business Advisors (formerly called EIRs) and that there were over 340 Springboard Domain Experts (marketing, finance and industry domain experts) supporting these efforts.

2b. Technology Assessment and Entrepreneurship Centers

Mechanisms or centers which assess the technical and commercial viability of early ideas and solutions, conduct proof of concept work, or build industry partnerships represent an additional indicator. Such activities occur in translational medicine centers, in schools of engineering, in biological sciences and environmental sciences, as well as through entrepreneurship programs in business schools. A campus which regularly engages knowledgeable practitioners and entrepreneurs who can evaluate the market potential and assist in startup activity, aka commercialization of student, faculty and even community ventures is by our definition entrepreneurial. To this end, schools of medicine, engineering and business commercialization and entrepreneurship education programs may be as important as offices of technology transfer. This is where incubators, whether university anchored or private, and programs like Deshpande at MIT and the von Liebig Center at UC San Diego make an enormous contribution. They proactively connect students and scientists with ideas to a knowledgeable start up business community. They also keep data on enrollments, new projects evaluated and number of projects securing external funding annually, information more often found in center annual reports than in offices of technology transfer. The Von Liebig Center, a school of engineering based commercialization support program at UC San Diego, collects annual data on enrollments in entrepreneurship courses, number of ideas evaluated and advised upon as well as the number of plans they review annually for a competition which provides up to $25,000, along

with an entrepreneur in residence for a year to students and faculty with promising ideas. From 2001-2012 the Von Liebig center calculates they have trained more than 1,000 students through graduate level entrepreneurism courses and awarded $5 million in proof-of-concept grants and business mentoring to more than 110 innovator teams. They report contributing to the creation of 32 companies which have raised over $150 million in capital and created more than 200 jobs.

2c. The role of intermediary organizations in university-industry entrepreneurship

CONNECT in San Diego, the Council for Entrepreneurial Development in the Research Triangle Park in North Carolina, IC^2 in Austin Texas, Bio-crossroads in Indiana, and the Stanford Technology Ventures program are examples of effective intermediary organizations. Each is a collaborative organization, which provides a platform for communication, networking, and the development of shared goals among diverse community stakeholders, such as entrepreneurs, trade associations, university researchers and administrators, capital providers, and business support service providers. Their focus is to foster innovation and entrepreneurship across and within the private sector as well to facilitate greater university-industry engagement. Such organizations that sit at the interface of idea creation and business generation. While they may be heavily supported by the private sector, these organizations typically act as honest, neutral brokers that build and reinforce a culture of collaboration through their valuable technical assistance programs, services, and leadership. Additionally, they are peer driven and organizationally flexible enough to adapt to changing needs in their region. To catalyze innovation and collaboration, these organizations leverage existing regional assets and competencies to deliver resources to entrepreneurs when needed and create linkages between the various elements of the system working very closely with key academic leadership most often Deans of Engineering, Science, Medicine and Business and Directors of major research centers rather than technology transfer offices. The pooling of knowledge, experience, and access to capital they provide can be valuable for regions that lack critical mass in these areas or are heavily fragmented.

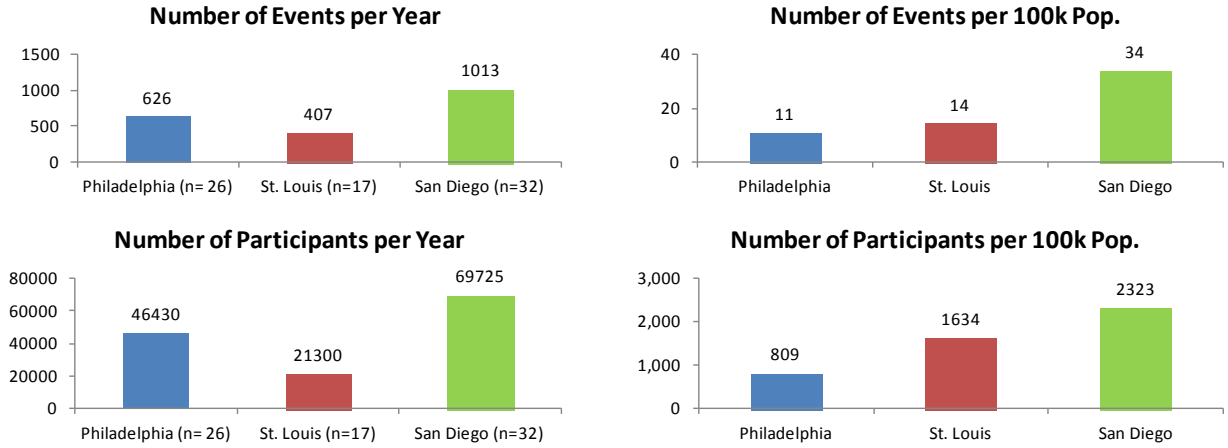
In terms of university-industry collaboration, these organizations utilize filtering mechanisms to efficiently and effectively provide resources and opportunities both for the university to access the market and vice versa. They also help create cross-professional knowledge, where researchers begin to understand business processes and priorities, and the business community becomes more sophisticated in its understanding of science and technology. In this way, these platforms have helped the university culture to become more open to entrepreneurship and commercialization of research outputs. However, these organizations also help the many entrepreneurs in their community that are not directly involved with research institutions. Such entrepreneurs or companies may in fact be the majority to whom these organizations provide assistance.

These sorts of “intermediary” organizations, to a higher degree than established trade groups in a region, support overlapping and recurrent communication among diverse stakeholders in the entrepreneurship community. They provide multiple opportunities to participate on boards along with membership status, as well as opportunities to organize events, initiate and sponsor programs, and facilitate access for members across institutional and functional boundaries. Through programs, events, and committees, intermediary organizations typically provide meaningful tasks for members in which to engage. People do not just attend meetings. They take an active role in serving their community. In this way, intermediary organizations move beyond networking and become genuine communities of practice.

Stakeholders are willing to take on these roles because they see a "return on involvement" rather just a return on their financial investment. Further, the activities, programs, and events serve as an effective means of lateral communication "across the silos" that tend to divide many industries and organizations in other regions. A University's active engagement in such intermediary organizations can be productive of research partnerships, private sector investments in major campus initiatives as well as accelerate technology commercialization all of which are measureable.

It is possible to quantify the variety, scope and outcomes of such intermediary activities as represented in Figure 5 below. In a recent comparative study of St. Louis, Philadelphia and San Diego intermediary organizations we were able to capture the following data:

Figure 5: Annual Number of Intermediary Events and Participants



Source: Walshok et al. (2013)

The San Diego based CONNECT Program reported in its 2012 annual report, 1,800 volunteers serving on advisory and review committees as well as speakers at events, and 18,200 registrants in various CONNECT events. As noted earlier, CONNECT's Springboard (business startup business evaluation and support activity) advisors (formerly called EIR's) involved over 150 volunteers and engaged 340 plus domain experts advising Springboard startup companies in areas such as marketing, finance and technology.

Were researchers to study intermediary organizations within communities and especially those organized by universities it would be possible to gather similar information and have a base for making comparisons vis a vis university anchored entrepreneurial activity.

3. Talent Development

3a. Competency and Business Service Infrastructure

A business services infrastructure that can help convert a promising idea or product into a viable and ultimately profitable business is critical to any regional entrepreneurship community. This is where law schools and business schools, for example, can make an enormous difference. One thinks of the Boalt Law School and Haas School of Business at Berkeley and the range of entrepreneurship/technology focused programs they have around IP, contracts, HR and marketing for entrepreneurial companies. Education and research programs of the faculty in multiple divisions, i.e. engineering or the arts which focus on elucidating entrepreneurship and innovation as well as building the knowledge, skills and networks that students need to become

successful entrepreneurs regardless of business sector merits description and measurement in terms of percentage of faculty involvement, enrollments and graduates earning degrees or certificates in these specialties available across disciplines. The Skandalaris Center at Washington University annually supports social entrepreneurship workshops, events and competitions as well as for-profit start up activities.

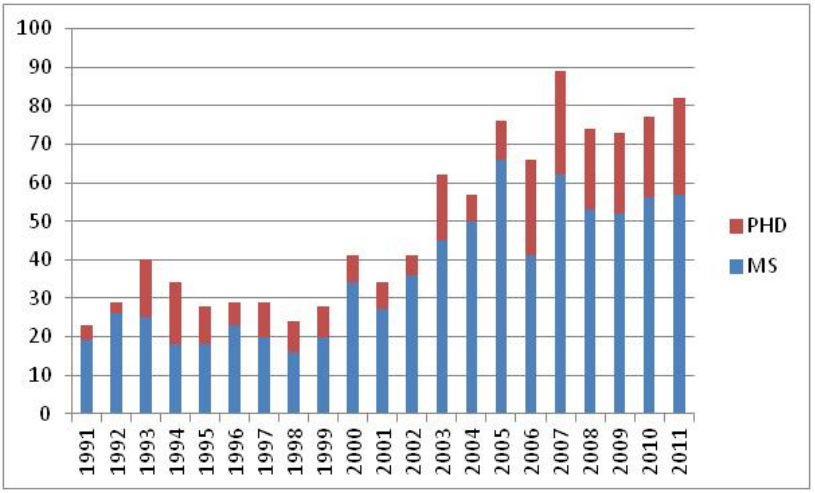
3b. Student internship, co-op, and job placement programs

There is little disagreement that people are the most important form of knowledge transfer. Leading regions have multiple methods to link their students to work experience and job opportunities in the private sector. These include mentorship programs, internships, co-ops, business plan competitions, and traditional career services. Financial support from these programs includes both public and private sector funding, but ranges in degree depending on the location. Stanford University has more than 10 different programs that seek to foster student entrepreneurship. UNC's Kenan-Flagler Business School has also developed a strong reputation for its student entrepreneurship training programs. At Washington University in St Louis the Skandalaris Center provides multiple activities and credit courses on entrepreneurship in multiple disciplines. Examples of student-driven efforts exist at multiple universities such as Cornell, MIT and include such things as the Student Biotechnology Network in British Columbia and VentureForth at UC San Diego. Most of these organizations keep track of student placements, events offered and the numbers of employers and mentors participating on an annual basis. These are also the sorts of relationship development activities which are responsive to community needs for talent and producing and growing the networks which Whittington and Powell (2009 and Casper (2013) have so well elucidated.

3c. Undergraduate and Graduate Research Activities

Undergraduate and Graduate Research Activities – Increasing numbers of campuses are creating opportunities for undergraduate students to participate in research programs that build their research skills through work in campus labs, internships in regional entrepreneurial companies and/or summer employment or internship opportunities relevant to innovation and entrepreneurship. Figure 6 presents data collected on the campus of UC San Diego for purposes of elucidating the ways in which the university contributed to the wireless cluster in San Diego. It provides stunning documentation of the extent to which Ph.D. dissertation topics relevant to this emerging cluster grew over a 15 year period, suggesting synergies between the academic work of graduate students and the technology growth of a whole industry. The UCSD experience suggests that it is not just research about entrepreneurship per se that matters, but research in the science and technology sectors that represent the building blocks of regional entrepreneurial companies, may be equally important. For example, wireless communication masters and PhD projects can potentially enhance the growth of the entrepreneurial wireless business sector by helping advance competitive technologies vital to the sector. Not to be overlooked is the extent to which advanced science and technology companies require research scientists and developmental engineers as employees.

Figure 6: Graduate Degrees in wireless related engineering fields, 1991-2011



Source: UCSD Office of Graduate Studies (OGS) Internal Data

Figure 7 presents data on alumni founded companies. Though not direct university spinoffs, such metrics are another indicator of potential value in characterizing the entrepreneurial university, as we discovered while doing research on the wireless cluster.

Figure 7: SD telecommunications companies founded by UCSD alumni, 1985-2001

Organization	**Date Founded**	**UCSD Alumnus**
Qualcomm¶	1985	Franklin Antonio†
ViaSat¶	1986	Steven Hart†, Mark Miller†
Primary Access	1988	Jim Dunn†
Tiernan Communications	1988	James Tiernan (PhD) †
Peregrine Semiconductor	1989	Ronald Reedy (PhD), Mark Burgener (PhD)
Broadband Innovations	1990	Ron Katznelson (PhD) †
CommQuest	1991	Mark Lindsey†
VIA Telecom	1995	Mark Davis (PhD) †
ComCore	1996	Sreen Raghavan (PhD)
Dot Wireless	1997	Rick Kornfeld†
Path1 Networks	1998	Doug Palmer†
AirFiber	1998	Jim Dunn†
RF Magic	2000	Dale Hancock†
La Jolla Networks	2001	James Tiernan (PhD) †
Entropic Communications¶	2001	Ladd Wardani†, Anton Monk (PhD)
Vativ Technologies	2001	Sreen Raghavan (PhD)

† Employee of Linkabit or M/A-Com Linkabit prior to 1985
¶ Went public via IPO
Source: Adapted from Simard (2004)

In addition to indicators such as graduate degree projects and alumni activity it is possible to survey campus units about the exact character of their internship and summer employment activities that connect to innovation and entrepreneurship. We have learned that the School of Engineering, the Division of Physical Sciences and the Division of Biological Sciences at UCSD have been accelerating such opportunities over the last few years. In addition, the Vice Chancellor for Research now has a full time Ph.D. on her staff facilitating both undergraduate and graduate opportunities to do research in companies as an intern or through summer employment. The level of participation in these sorts of programs can be counted and compared across the campuses.

3d. Continuing and Advanced Professional Education

For more than a decade the team at UC San Diego has been tracking data on where recent graduates needing skills to put their education to work and adults needing to upgrade their skills, (even though they have a Baccalaureate or Post Baccalaureate degree) find such education and training. Most large research universities such as Harvard, Chicago, Wisconsin and UC have large academic divisions called Extension Services or Schools of Continuing Education through which annually tens of thousands of regional professionals secure certification and skills needed to put their core education to work in technical and entrepreneurial startup companies. A vivid example from UC San Diego, again relates to the Wireless Cluster. Beginning in the 1990s, a small high growth company Qualcomm (today a Fortune 500 Company) turned to the Extension service to qualify the well-educated engineers they were hiring in the new technology platform their company was developing CDMA. UCSD through its Extension Division over two decades proved to be a primary education and training partner for this highly successful entrepreneurial company vis a vis the specific skills needed in their employees. Figure 8 below describes wireless related certificate enrollment over this period.

Figure 8: UCSD Extension certificate programs serving the local telecommunications industry

Certificate	Certificate Name	*First Course Offered	Total Enrollment	**Total Graduates
EMHA	Embedded Computer Hardware	1995	51	29
EMSE	Embedded Computer Systems Engineering	1995	22	6
EMSO	Embedded Computer Software	1995	224	105
MENG	Embedded Computer Engineering	1995	311	50
SYSE	Systems Engineering	1995	534	272
CPMA	CDMA/WCDMA Engineering	1998	378	218
VLSI	VLSI Digital Design	2002	23	4
BBMWE	Broadband Mobile Wireless Engineering	2003	8	4
CMENG	Communications Engineering	2003	37	19
DSPR	Digital Signal Processing	2003	42	21
RFENG	RF Engineering	2003	122	41
CDMA	CDMA Engineering Fund.	2004	0	0
ICDE	Integrated Circuit Design Engineering	2006	8	0
ICDSG	Integrated Circuit Design Engineering	2008	15	3
WLENG	Wireless Engineering	2009	35	8
MADVL	Mobile Applications Development	2011	11	0
MDPRG	Mobile Device Programming	2011	31	2
	Grand Total		**1,852**	**782**

Source: UCSD Extension Student Services Internal Data

In addition to the Extension Program, Qualcomm has endowed Chairs at UCSD in International Relations and the Business School, both of which provide meaningful internships and research opportunities for UCSD students. This sort of synergy between an entrepreneurial growth company and the university across a variety of education and training activities represents an essential part of what it means to be an entrepreneurial university. The kinds of data one can gather from continuing education and extension divisions, combined with the information available through offices of Graduate Studies can be organized and compared across campuses as part of an assessment of how entrepreneurial the curriculum and student experiences with industry are on any given campus.

4. Diversity of University Industry Engagements

A university potentially is a permeable system with multiple points of university-industry connection. However some campuses have offices which function more like “gatekeepers” than “gateways.” There may need to be many doors to the university through which potential university partners can enter in order to develop the variety of collaborative relationships essential to the entrepreneurial ecosystem. Both formal and informal mechanisms are needed, with the informal relationships often being established first through personal connections followed by more formal arrangements as the university-industry relationship becomes focused

and more complex. The broader regional eco-system thrives on collaborative programs and relationships. So too a university with multiple inward and outward-facing methods to support collaboration may be more entrepreneurial. What follows are examples and descriptions of ways universities can engage with industry.

4a. Corporate Affiliate Programs

Corporate affiliate programs represent formal, structured mechanisms which support collaborative relationships between the university and the participating corporate members. Such programs not only facilitate knowledge transfer but contribute to building greater trust between different communities of interest. They are found at the division, department, lab, or center levels. Membership dues are typically required, and can be very high i.e. $25,000 a year or fairly modest in order to engage smaller and startup enterprises. Stanford University has an impressive 150 distinct corporate affiliate programs spread throughout the entire university. Numerous affiliate programs are tied to multiple schools, often based in multidisciplinary research centers. UCSD's dozen plus affiliate programs are also found at the divisional and center level, with five of them based in the School of Engineering. Although a department or center may offer an affiliate program, those at the divisional level potentially provide a higher level of access and represent a deeper institutional commitment.

Affiliate programs can provide a) an industry voice in curriculum development, b) an opportunity to work with faculty and administration in shaping research agendas (often in applied areas); c) direct access to students for recruitment; and d) enhanced positioning at campus-related events. The interaction that takes place between affiliate program members and the campus staff can build trust and reinforce the collaborative culture, particularly when it involves arriving at mutually beneficial research agendas or projects. For some firms, membership in an affiliate program can lead to larger collaborative research projects. In such cases, the affiliate program acts as the "training wheels" for an even deeper relationship between the university and the company sponsor. Here again, the number, size and activities of such programs is a measureable and potentially powerful indicator of how entrepreneurial different university campuses are. Figure 9 demonstrates an example from Washington University of how to document the number and types of industry connections each academic department has with industry.

Figure 9: Industry Connections-Washington University in St. Louis

Department	# of S&T Industry Connections	# of Non S&T Industry Connections
Arts and Sciences	1	3
Brown School of Social Work	1	2
School of Engineering and Applied Science	13	0
School of Design & Visual Arts	0	1
School of Law	1	4
School of Medicine	13	2
Skandalaris Center	1	0
Olin School of Business	2	0
Total	**31**	**12**

Source: Walshok et al. (2013)

If the reader revisits the Stanford chart (Figure 3) previously presented the number of industry connections from all department totals close to 150; three times the number at Washington University.

4b. Meet the Researcher / Meet the Entrepreneur Events

These typically hour and a half-long events and/or lecture series sponsored by university departments and research centers encourage researchers and entrepreneurs to present their current research efforts or general business concepts to audiences of interested students, faculty and/or community members. British Columbia's IdeaLinxs programs offered by the regional science and technology councils are an example, as are Washington University in St Louis' Idea Bounce and CONNECT's Frontiers of Science Series for business professionals. The approximately 30-minute presentations during a Meet the Researcher / Meet the Entrepreneur events are typically preceded by networking and followed by informal, interactive question and answer periods. These sorts of events tend to only require a modest level of resources and support, can be implemented fairly quickly, and accomplish several things. For one, they help to create the cross-professional knowledge (i.e. business-savvy researchers and science-savvy entrepreneurs) that has been such an important element present in leading innovation systems. Further, these events provide a mechanism to begin bridging the university/technology business cultural divide by opening a window on each. Activities such as these can be described, attendance can be tracked, and numbers on industry sponsors and levels of investment can be measured.

4c. Industry Brokers

University-industry collaboration can be strongly enhanced by the presence of "brokers" or facilitators embedded within multiple levels of the university in many guises. Brokers or facilitators may fill a senior position within the office of the chancellor, a member of a dean's staff, the technology transfer office, or based at a research center or institute. They themselves represent multiple points of entry for collaboration by supporting research matchmaking, corporate philanthropy, business development, economic development goals, or serving as entrepreneurs-in-residence (EiRs). Private sector backgrounds or a strong understanding of how industry operates, combined with knowledge of the academic culture are common characteristics of these brokers which allow them to effectively align the interests and motivations of the parties involved. Given the very different cultures of the university and industry, the importance of aligning interests and expectations cannot be overstated when attempting to develop collaborative relationships. They must be trusted and credible, as well as entrepreneurial in how they operate in their role as facilitators and networkers. Examples of such brokers abound at places such as Stanford from the School of Engineering's Director of Corporate Relations who is responsible for promoting industry-sponsored research and corporate philanthropic gifts to the Division of Arts and Humanities. The University of California's Industry-University Collaborative Research Program for many years had a fellowship program to develop a professional cadre of facilitators with a mandate to promote greater university-industry collaboration at several campuses of the system. UNC-Chapel Hill enhanced its focus on the level of industry-sponsored research and the university's impact on the local economy created an Office of Economic and Business Development. Washington University in St. Louis has fewer such brokers across the campus. Once again, a typology of brokers, personnel dedicated to building entrepreneurial capacity could be developed and tabulated campus by campus for comparative purposes.

4d. Entrepreneurs in Residence

Having entrepreneurs-in-residence (EiR) to support students, faculty and often community members is an important component of many campus programs which is rarely used as an indicator of the entrepreneurial university by traditional researchers. EiRs are experienced business advisors from outside of the university who work with faculty and students interested in commercializing research. They provide valuable coaching and mentoring, help align the expectations vis a vis what can be realistically commercialized, have a good sense of entrepreneurial business culture, and can serve as vehicles for bridging the university- industry divide. The William J. von Liebig Center within the Jacobs School of Engineering at UC San Diego has seven part-time EiRs each with a specific area of focus. In fact, the Kaufmann Foundation cited von Liebig at UC San Diego and the Deshpande Center at MIT, which utilizes 40 business mentors annually, as best practices in undergraduate entrepreneurship support. The University of British Columbia, UNC-Chapel Hill, Washington University, St Louis and dozens more have implemented EiR programs in recent years. Based on the CONNECT data gathering process it is clearly possible to collect comparable data on these sorts of engagements from multiple campuses around the country.

4e. Multi-disciplinary Research Centers with Industry Buy In

Centers or institutes that have a mandate to perform collaborative research with industry and increasingly across two or more academic disciplines represent the high end of the collaboration value chain, particularly if they focus on a) research areas that have a significant level of academic exploration as well as b) represent a high probability of creating commercializable outcomes of value to the region or a specific industry sector. For this to happen, a high level of trust and alignment of interests must be established between the university and its industrial partners over a long period of time, aided by many of the mechanisms described above. The Qualcomm Calit2 Institute at UCSD provides a highly collaborative and entrepreneurial research environment that cuts across two dozen academic departments and has 30 corporate partners that have provided $78 million since the inception of the institute in 2001. This is in addition to the nearly $300 million raised to match the State of California $100 million commitment to get the center established. Similarly, the Renaissance Computing Institute links UNC-Chapel Hill, Duke University, North Carolina State University and industry through multidisciplinary research projects. Many of Stanford's corporate affiliate programs are tied to multidisciplinary research centers. As organized research units are expected to keep data of annual grants, contracts, corporate contributions as well as affiliated activities, these data can be tabulated, organized and used comparatively.

IV. A Road Map for Developing More Robust Metrics

As we underscored in the introduction, local citizens and politicians are increasingly preoccupied with how universities connect to community entrepreneurial needs, most significantly:

a) creating new companies and jobs to replace declining or departing industries
b) securing new and reliable tax revenues to fund schools, infrastructure, health and safety
c) creating new forms of wealth to assure regional prosperity and quality of life as traditional sources of wealth stagnate or decline.
d) Creating high value jobs and a workforce ready for new and emerging jobs

When viewed through this critical lens, the existing metrics of entrepreneurialism fall short of capturing a university's true value to its region. Patents and licenses can be negotiated

with companies that are headquartered anywhere in the world and don't necessarily benefit the local regions where the research was conducted. College graduates can pursue jobs anywhere in the country and don't necessarily enrich local economies with their new skills and advanced knowledge. Campus economic impact reports documenting how the university, as a regional employer and a direct consumer of goods and services, sustains suppliers, contractors and jobs are of value. However, all fall short of describing how universities and research institutions catalyze the creation of companies and jobs that form the basis of new industries in a region. Thus, developing new ways of documenting how research institutions yield outcomes which are integrated with their regional assets and embedded in local economies and communities has become a high priority.

We start from the premise that innovation is what drives the creation and growth of globally traded clusters in regional economies. As Porter (2001) notes, as much as one third of regional enterprises need to be in globally traded sectors. Regional competitiveness and quality of life are highly dependent on these globally traded clusters. Knowledge is what drives the innovation which nurtures these clusters and a research university is a community's key knowledge resource. The development of new knowledge, its translation into products and integration into practice represent the true marks of an entrepreneurial university.

The development of new knowledge can be documented in the amount of research dollars won, the numbers of PhD researchers in the workforce, quality of citations in peer reviewed publications and distinguished awards received by individual scholars and researchers. Such "indicators" can be used to describe and benchmark regional research capacity. The translation of research into products potentially beneficial to society and growth companies enriching regional economies can also be described and documented. Types and levels of public and private capital investments in developmental, "proof of concept" activities which lead to new, useful, and marketable products based on the fruits of university research can be tabulated. Personal interconnections between the investors, developers and operators of local knowledge based companies and university faculty, researchers and students can also be "mapped" and tabulated.

The integration of knowledge into practice occurs at all ages and stages of life. Undergraduate and graduate education is critical, particularly if it enlarges and diversifies the local talent pool for science based companies. However, post-doctoral training, executive programs, and advanced, post-baccalaureate continuing education also assure the continuous dissemination and integration of the newest knowledge and most advanced forms of practice to employees in the globally traded clusters of a region. This too can be documented and described by providing data on the varied forms of education and advanced training connecting new knowledge developments with local employees and policy makers.

None of the types of metrics we have been discussing are adequately or consistently tracked or presented by universities, much less scholars. They are typically buried in programmatic and public outreach activities, operating at the interface of the university and the regional community with few, if any, federal or state reporting requirements. Often self-supporting activities, they are not factored into the university's budgetary relationship with the state legislature. As a consequence, they are not documented and their regional economic impacts are not well understood, in part or in whole. Our research experience suggests there are ways to "capture" much of this kind of data within an analytical framework which allows for comparisons across universities. The analytical framework below suggests five distinct types of university activity

that can be measured to better capture the entrepreneurial university embedded in the larger community entrepreneurship ecosystem.

Figure 10: Framework for Measuring the Entrepreneurial University

Sample Measures of The Entrepreneurial University

Entrepreneurship Focused Culture	Commercial-ization Supports	Talent Development Contributions	Diversity of Industry Connections	Tech-Transfer Activities and Outputs
* Percent of leadership with industry knowledge and experience *Committees and initiatives focused on cross-disciplinary entrepreneurship * Campus identity tied to innovation and entrepreneurship * Number of offices and staff dedicated to industry relations * Leadership valuing & supportive of technology commercialization *Knowledge sharing and creating culture of risk tolerance * Content analysis of speeches, news releases, PR campaigns by university officials embracing economic development mandate	* Proof of concept centers (number, size, advisors, outputs) * Business planning and financing forums * Technology assessment groups/centers (activities on general campus, within TTO, and number of ideas evaluated annually) *Incubators and science parks (numbers and industry partners)	* Undergraduate internships in entrepreneurial companies * Continuing education certificates and seminars serving entrepreneurial companies *Entrepreneurship centers (curriculum, activities, number of participants, ideas/business plans vetted, outcomes) * Undergrad and grad job placements *Business service infrastructure *Number and types of student research and doctoral projects annually * Number of post-docs employed in the region	*Corporate affiliate programs (number of sectors served, company members, financial support) *Number of industry brokers in what department/ divisions * Size and industry of sponsored research *Advisory boards * Philanthropy (endowed chairs, faculty forums, private support, & fellowships) * Multi-disciplinary research centers * Number of research/outreach events annually & participation rates * Entrepreneur In Residence (EIR's), practitioners teaching	*Patent applications & awards *Licensing applications and awards *Spin-outs Annually *Equity positions taken in startups * Amount of Licensing Revenue * Number of Invention Disclosures * Amount of royalties * Number and revenues from Material Transfer Agreements (MTA's)

Studies on the character of the entrepreneurial university need to move beyond single case studies (Grigg, 1994; Rosenberg and Nelson 1994; Debackere and Veugelers, 2005) and over reliance on a narrow range of quantitative TTO metrics (Van Looy et al., 2004). By using a more comprehensive framework, which includes the understudied metrics we have been discussing, scholars, likely will provide a more robust analysis of what represents a truly entrepreneurial university. Current metrics strongly favor well funded research universities with large TTO functions. However, small liberal arts colleges and regional state universities can also play vital roles in helping to build entrepreneurial sectors as we have learned from out field research in big cities such as Philadelphia, in renewing economies such as St. Louis, Missouri and small towns such as Warsaw, Indiana and Grand Rapids, Michigan. Their contributions are lost in much of the scholarly research. The metrics and framework we propose broaden how we think about the character of research universities at the same time that they allow capturing the ways in which less research intensive campuses nonetheless can be highly entrepreneurial vis a vis their relationship to the entrepreneurial needs of their communities.

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