Research Universities and the Knowledge Region

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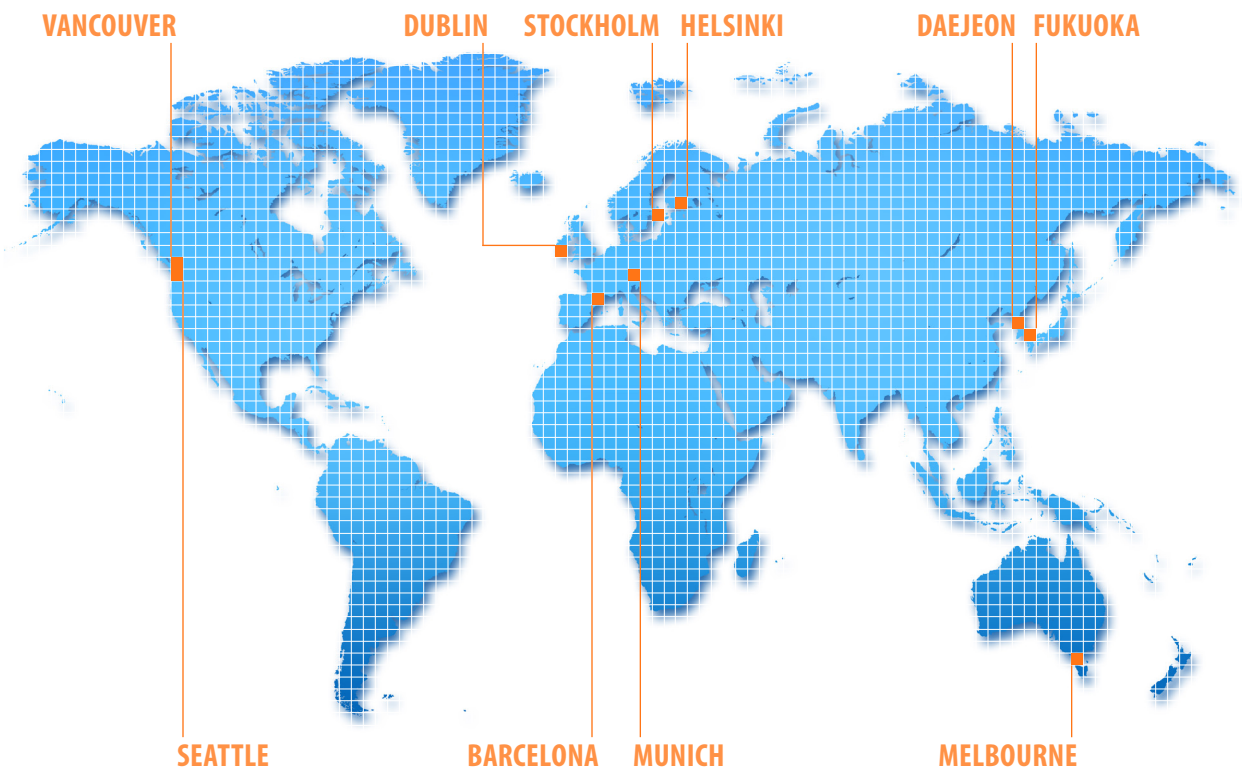

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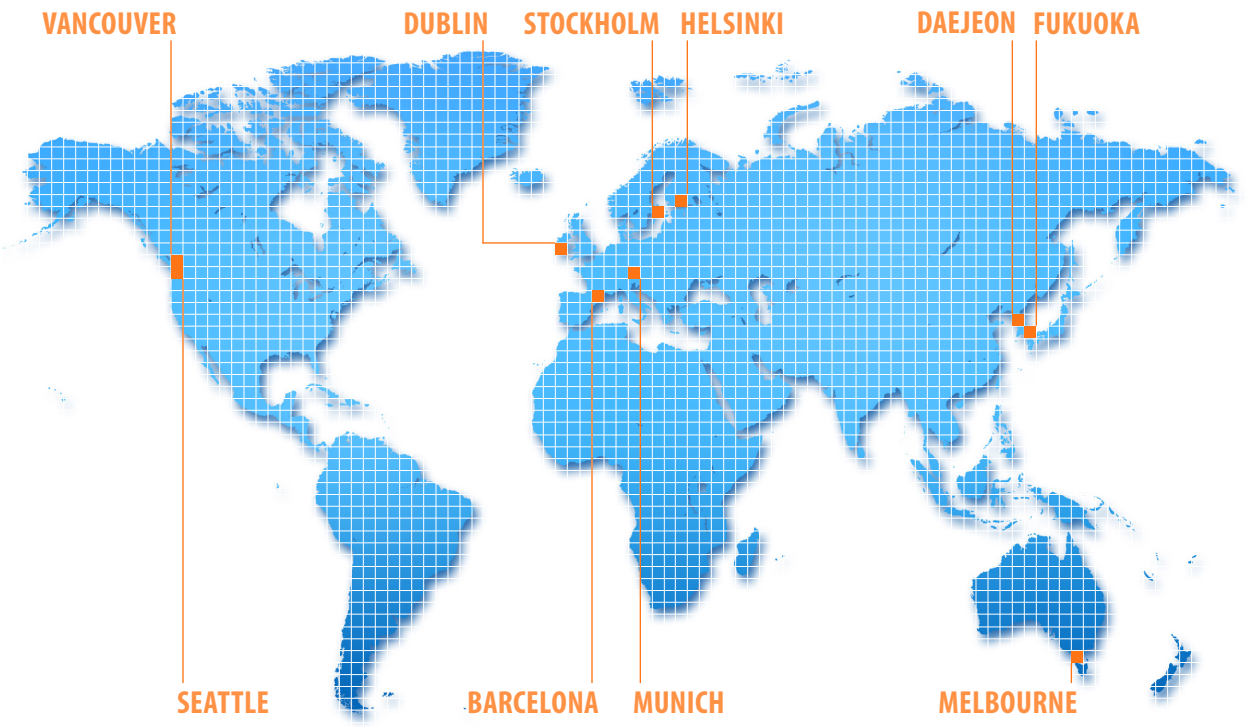


Introduction

The International Regions Benchmarking Consortium[1] (IRBC) is dedicated to expanding the prosperity of its member regions, and few things are as important as fostering the continued evolution of these areas into fully realized "knowledge regions." A consensus is emerging in economic geography that the two words in this term are central to the future of economic development around the world. "Knowledge" is the key to innovation, and innovation is the underlying phenomenon that allows per-capita economic growth. "Regions" have become the basic economic building block of the global economy. As the cost of transportation falls for products and ideas, and as national barriers drop away, the metropolitan economic region emerges as the indispensible and indivisible geographic unit for economic organization.

To a large extent, the members of the IRBC are already knowledge regions: a large part of their output concerns the production and use of ideas. The concept of the knowledge region is not, however, a static one, and regions need to continually adapt to the changing landscape of knowledge production and consumption. And, as will be discussed in this paper, many regions around the world underperform relative to their potential, especially in their efforts to harness the potential of their research universities.

This paper explores the ways that leaders can proactively move their economies increasingly toward a central focus on the knowledge economy. It is true that some of the most successful knowledge regions have grown in a purely organic fashion, with little assistance from the local government or civic sector. But it is also true that regions can fashion policies and undertake initiatives that result in "constructed advantage" in knowledge-based industries.

Although many have tried to find one, there is no exact recipe for creating the knowledge region, and this paper will not offer a formula for becoming the next Silicon Valley. As recently as 2009, an article in a prominent urban economics journal stated, "The precise linkages among educational investments, knowledge spillovers and regional output remain unclear." (Andersson et al, 2009) This paper will, however, offer a list of ingredients and suggest ways that those ingredients can best work together.

[1] *The IRBC member regions are Barcelona, Spain; Daejeon, S. Korea; Dublin, Ireland; Fukuoka, Japan; Helsinki, Finland; Melbourne, Australia; Munich, Germany; Seattle, United States; Stockholm, Sweden; and Vancouver, Canada.*

Knowledge and Its Flow

Varieties of Knowledge

There are many different kinds of knowledge, not all of which are germane to the growth of the knowledge region. Before we get too far into the process of creating a knowledge region, we need to understand what kinds of knowledge we are targeting. To illustrate these types of knowledge, we will use a very familiar, low-tech example: a restaurant.

First, we can identify two kinds of knowledge by the way that knowledge is held, stored and transmitted.

Tacit knowledge. Tacit knowledge exists mostly in the minds of people, in the form of know-how and institutional memory: how things work. Tacit knowledge comes from experience and is transmitted person-to-person. When a key employee leaves a workplace, productivity will be harmed by the loss of tacit knowledge. For example, a waiter in a restaurant will know how regular customers of the restaurant prefer to be served, and this tacit knowledge helps build regular business.

Codified, or explicit knowledge. As the name implies, codified knowledge can be written down and shared widely. This may be in the form of a design, formula, article, movie or other medium. Unlike tacit knowledge, codified knowledge can be shared instantly with millions of people, or held as protected intellectual property. The recipes used in the kitchen of a restaurant would be classified as codified knowledge.

Both types of knowledge play a central role in building the knowledge region. For example, an experienced entrepreneur (tacit knowledge of business creation) is needed to turn the results of university research (codified knowledge) into a business opportunity. The spatial dimension of this interaction of tacit and codified knowledge is among the most important issues in creating the knowledge region. The cost of transporting codified knowledge is now near zero, but tacit knowledge is still a function of place and the movement of individual people.

A second dimension to the definition of knowledge involves the context within which knowledge is created and used. Cooke, et al (2007) identified three types of knowledge by the use of it.

Synthetic knowledge. Synthetic knowledge is embedded in products and especially processes, and is connected to specific outcomes. A business or institution relies on a huge store of synthetic knowledge for its operations, and that knowledge can be very specific to that operation. Synthetic knowledge tends to be more practical than abstract, and is developed through a combination of experience and research. In our restaurant, the management and operation of the business consists mostly of synthetic knowledge specific to that restaurant, its style of food, its market and customer base.

Analytic knowledge. Unlike synthetic knowledge, analytic knowledge is not connected to any specific process or product, but exists, in some sense, as an end in itself. Analytic knowledge may, at some point, lead to a practical outcome, but the journey will be mostly in the abstract. Most research at universities and institutes results in analytic knowledge. Analytic knowledge will find its way into the restaurant through new research on flavorings, food safety or market trends.

Symbolic knowledge. We often do not think of books, movies, songs or poems as "knowledge" but in a real sense they represent the output of very knowledge-intensive processes. Symbolic knowledge encompasses this sphere of work, which relies on aesthetic rather than cognitive skills. The preparation and presentation of food in a fine restaurant is an artistic undertaking, the results of which can be classified as symbolic knowledge.

Combining these two approaches to defining knowledge, we can arrive at some useful categories of the sorts of knowledge that may or may not be part of our pursuit of the knowledge region.

Figure 1: Six Types of Knowledge

	TACIT	CODIFIED/EXPLICIT
Synthetic	"shop floor" sales and marketing techniques workforce motivation	product and formula modifications procedural manuals
Analytic	scientific expertise technical expertise long-term market trends	journal articles research results new products and processes
Symbolic	creative capacity cultural awareness	branding media output

For our purposes in this paper, we will be mostly concerned with the three areas shaded above. These represent the intersection points of the various players that will be discussed below, as we look at how the three components of the "Triple Helix" interact.

Ba, and the Interaction of Tacit and Codified Knowledge

A helpful construct for understanding how tacit and explicit knowledge interact within an organization setting has been developed by Japanese philosopher Kitaro Nishida. "*Ba*" refers to a space — physical or conceptual — within which learning advances through four stages, illustrated in Figure 2. (Nonaka & Konno, 1998)

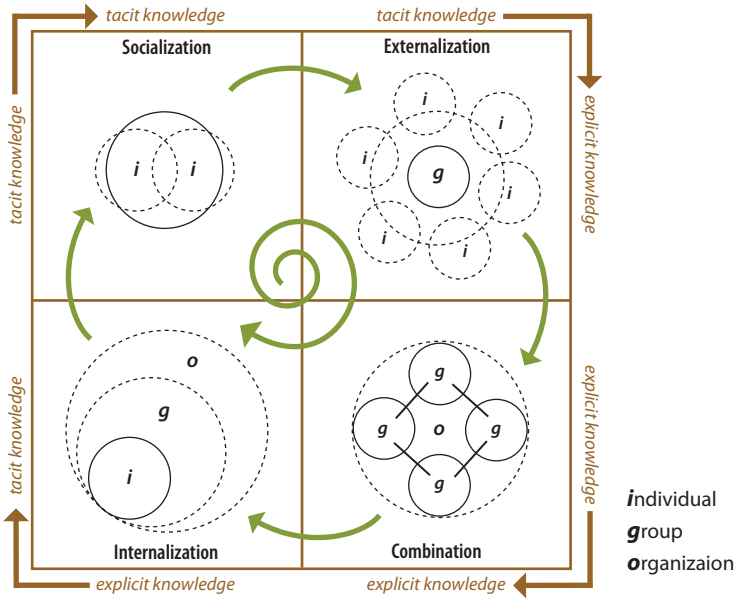
Socialization. In this phase, tacit, synthetic knowledge is developed by individuals within the organizational setting and shared among immediate coworkers.

Externalization. Individuals who now share this new, tacit knowledge begin to share it among larger groups, which translate this tacit knowledge into explicit knowledge that can be codified for wider use.

Combination. Here the new explicit knowledge is transformed into new procedures and designs that can now be embedded in the formal structures of the organization.

Internalization. The new codified knowledge becomes internalized within individuals throughout the organization, thereby becoming a new level of tacit knowledge. This new tacit knowledge regime, in turn becomes subject to re-thinking, and the process starts over again.

Figure 2: The Cycle of *Ba*



Source: Nonaka and Konno, 1998

We can go back to the restaurant for a very simple example of *Ba*. A waiter might notice that many customers have begun to complain about the quality of a certain dish. The waiter discusses this with other waiters and finds they have had the same experience (socialization). The waiters then bring this to the attention of the chef (externalization), who experiments with changes in the recipe to improve the dish (combination).

The cooks are taught this revised recipe (internalization) and the waiters begin to observe how customers are reacting to the new recipe (socialization begins again).

Ba can easily be envisioned as working within individual, formal organizations. But we can also apply *Ba* within the far less formal and structured environment of technology transfer that will be discussed below. In a sense, the idea of *Ba* should be an ultimate goal of the process of creating the knowledge region: a space, both physical and conceptual, to bring the assets of the region together to create new economic value and perpetuate a cycle of innovation.

Higher Education and the Knowledge Region

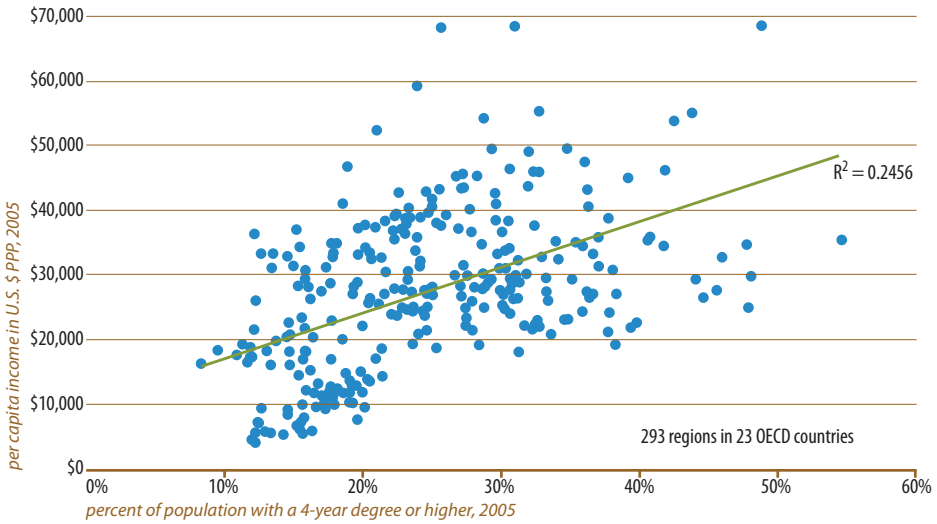
Economic Benefits of Universities

Although this paper mostly discusses the role that research universities play in creating new, codified knowledge that can be transferred to the private sector, it is worth beginning by discussing other roles that all universities play in the creation and growth of the knowledge economy.

Educating students for the workforce. In industrialized countries, between 20 percent and 40 percent of young people receive formal university degrees, and employers have come to expect they will have access to a highly educated workforce. Even when these university graduates do not have training in specific technical or business fields, they should, during their university years, have developed a set of more general skills — management, communications, interpersonal relations — that increase their productivity and value.

Figure 3 shows the correlation between tertiary education and productivity for regions in 23 OECD countries. While both tertiary education and GDP can be difficult to compare across countries, when the education-GDP relationship is examined within countries, the correlations tend to be quite high. So, whether measured domestically or internationally, the trend is clear: a more educated regional population is associated with a more productive region.

Figure 3. Higher Education and Productivity



Source: Organisation for Economic Co-operation and Development (OECD)

"Technology transfer on legs." Students leaving the university to enter the workforce, especially those with advanced degrees, bring with them the latest knowledge in their field. If university faculty have been updating their instruction, and if students have been participating in university research, knowledge will be transmitted to businesses through new employees. And this transfer can happen in reverse, as employees return to a university for an advanced degree, bringing their industry knowledge back to share at the university.

University-business interactions. Businesses and higher education institutions in a region interact in a wide variety of ways outside of formal technology transfer programs. University researchers can work with businesses on specific management or technical problems and are often members of professional societies. Personnel from business may return to the university for continuing education programs, and businesspeople may teach at universities on an adjunct basis, bringing a business perspective to students. Universities are part of the larger picture of knowledge exchange through formal and informal networks, contributing to the phenomenon noted by Alfred Marshall, in which knowledge of an industry is "in the air."

The university and its environment as a consumption amenity. Higher education institutions themselves, along with the other businesses and institutions that surround them, can be an attractive amenity for a community. Universities offer performances, lectures, exhibits and other events to the public, as well as continuing education opportunities. Campuses and university neighborhoods can be lively places that attract non-students from the region.

The university as an economic engine. Universities are often among the largest employers in a region, and since many students and most research funding comes from outside the region, they constitute an important part of the regional economic base. Large universities have thousands of faculty and staff members, and research universities employ graduate students and laboratory personnel. These institutions, while vulnerable to cuts in public funding, are relatively stable, and with students staying in school during economic downturns, they can be countercyclical.

The university's impact extends beyond campus, and includes the purchase of supplies and services (indirect economic impacts) and household spending by faculty, staff and students (induced impacts). Economic impact studies of universities arrive at economic multipliers mostly in the range of 1.5 to 2.0, meaning that every 100 Euros, dollars or yen spent on campus results in a total regional economic impact of 150 to 200.

Thus, universities can have large benefits to a region, even if direct technology transfer is weak.

Threats to the Benefits of Universities

These benefits to a community of the presence of a university can be limited in several ways.

Leakage of students. Regional businesses can only benefit from graduating students if those students choose to remain in the region. Many regions with historically excellent universities have seen their economies weaken, offering graduating students fewer opportunities. Many communities in this position offer internship programs and other ways to link students to regional employers while they are still in school, to increase the likelihood they will remain when they graduate.

"Town-gown" conflict. Universities are large institutions that can easily isolate themselves from their surrounding community. Cultural, educational and income gaps between university faculty and students and the residents of the surrounding communities can lead to tensions that inhibit healthy interactions. This is an age-old problem that will never entirely go away, but can be managed to minimize conflict and maximize beneficial interaction.

University-industry mismatch. This occurs when the strengths of the university do not match the technical skill needs of regional employers. Over time, universities will tend to build strengths based on predominant regional industries, but the regional industrial mix and the array of strong programs at regional universities can evolve at different paces, leaving students with fewer chances to use their skills locally, and industry with the need to recruit talent elsewhere. Path dependency can be overcome, but requires substantial work and political skill.

What is a "Research University"?

Nearly all universities in the world operate with the same two-part mission that has guided higher education for hundreds of years: advance knowledge and teach students. Most university faculty do some research as part of their regular work, so what makes a "research university" distinct from other institutions that also produce new knowledge? The distinction is one of scale, scope and constituency.

***Scale:** Research universities dedicate a far larger share of their resources to research than most universities. A large number of the faculty at a research university have only minimal teaching responsibilities, or none at all, and they will employ many staff and technical personnel that have no connection at all to teaching. This scale is possible because of outside funding of research. The table below shows the research budgets reported by individual universities and as a total for each region. Further descriptions of each university are contained in the appendix.*

***Scope:** Research universities have specialized expertise and facilities that allow them to engage in research at a depth and level of complexity that faculty at most universities cannot match.*

***Constituency:** Most scholars undertake research primarily to advance knowledge in their field, so their main constituency is other scholars. At a research university, a large share of research is sponsored by governments, businesses and other outside institutions who seek the expertise at the university to advance their own areas of interest.*

There are no exact metrics used to define research universities, but we can offer two useful sources of guidance. The criteria used for the Academic Ranking of World Universities, published by Shanghai Jiao Tong University (www.arwu.org) are entirely centered on research, so the score on that ranking will be an indication of a university's research prowess. The Association of American Universities, which admits only the largest research universities in the U.S., publishes its membership criteria, indicating the metrics viewed as most important for measuring the achievements of U.S. research universities (www.aau.edu)

	UNIVERSITY	RESEARCH BUDGET	REGIONAL TOTAL IN EUROS
Barcelona	Universitat de Barcelona Universitat Autonoma de Barcelona Universitat Politecnica de Catalunya	34.5 million euros 21 million euros 65.5 million euros	121 million euros
Dublin	University College Dublin National University of Ireland, Maynooth Dublin Institute of Technology	93 million euros 35 million euros 16 million euros	144 million
Fukuoka	Kyushu University Fukuoka University	18,000 million JPY 1,862 million JPY	176 million euros
Helsinki	University of Helsinki Aalto University	240 million euros 103 million euros	343 million euros
Melbourne	University of Melbourne LaTrobe University	765 million A$ 42 million A$	587 million
Seattle	University of Washington	1.07 billion USD	781 million euros
Stockholm	Karolinska Institute Uppsala University Stockholm University KTH Royal Institute of Technology Swedish University of Agricultural Society The Stockholm School of Economics Malardalen University Södertörns Högskola	3,600 million SEK 3,100 million SEK 2,100 million SEK 2,000 million SEK 1,800 million SEK 180 million SEK 200 million SEK 300 million SEK	1,426 million euros
Vancouver	University of British Columbia Simon Fraser University	475 million CDN 62 million CDN	391 million euros

Source: IRBC 2010 Questionnaire to Regions. Data from member regions Daejeon and Munich were not available.

UNIVERSITY OF BARCELONA, Barcelona

AALTO UNIVERSITY, Helsinki

KAIST (Korean Advanced Institute of Science and Technology)**, Daejeon**

KAROLINSKA INSTITUTE, Stockholm

Universities, especially those with strong research programs, can offer huge benefits to the economy of their region, but the region may not always be able to capture those benefits. The two traditional components of a university's mission — broad, liberal education for students and the pursuit of abstract knowledge — date back to the Middle Ages, and it is easy for a university to isolate itself and concentrate on that mission and ignore regional engagement. The traditional mission is still, of course, highly valued, both inside and outside universities, so the third mission component — regional economic development — may be slow to take root.

Universities and their surrounding communities need to work closely together to ensure that regions benefit from the economic advantages of universities while not endangering their core teaching and research mission.

The Research University: Necessary But Not Sufficient for Growing a "Knowledge Region"

We now turn to the more specific roles of research universities — those universities that have a substantial part of their activity taken up by research that is separate from their teaching mission. The work for this paper began with a central observation:

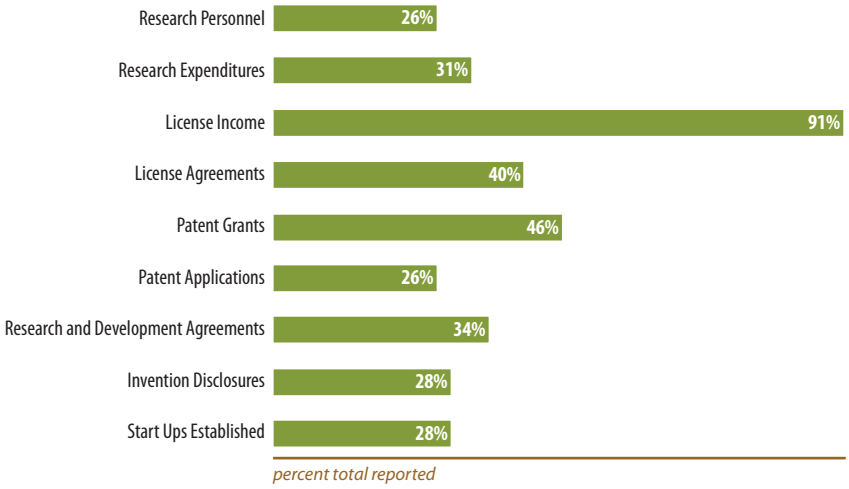
> *Every "knowledge region" has a prominent research university, but*
> *not every region with a prominent research university can be classified as a "knowledge region."*

We can observe that some regions with strong research universities have also developed robust technology-based business sectors that interact with those universities on a continual basis, spinning out new technologies, products and companies. At the same time, we can easily point to prominent research universities that see little spin-off activity and have few ties to regional businesses. It is clear that building a knowledge region requires much more than just a strong university, and identifying those needs will be the subject of the balance of this paper.

Figures 4 and 5 illustrate this observation, showing similar data for European and U.S. universities. Figure 4 shows the share of various outcomes that can be attributed to the top 5 institutions in a survey of 76 European universities and public research organizations. Figure 5, from a survey of the top 75 U.S. research universities shows outcomes attributable to the top five generators of licensing income. The top five European universities received 91 percent of the licensing income for the group of 76 universities, and the top five U.S. universities received 58 percent of the licensing income of the top 75 U.S. universities. The other outcomes are much more in line with what might be expected of top universities within a group of their peers. In other words, the top five universities had a much larger share of licensing income than the rest of their research activity would predict.

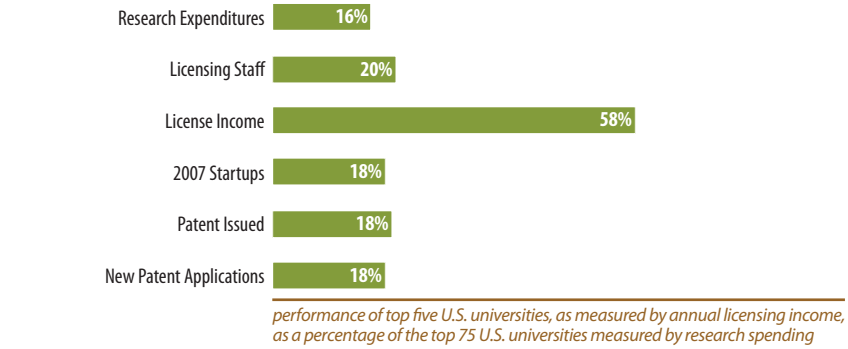
Figure 6 compares European and U.S. universities along several metrics of technology transfer performance. While European universities are more efficient at creating start-up businesses and obtaining licensing agreements, U.S. universities are more cost-effective in producing intellectual property. But what seems remarkable is that the figures are so similar, considering the significant differences in context within which these institutions operate. The challenge of extracting value from research conducted at universities and other public research institutions appears to be nearly universal.

Figure 4: Performance of Top Five Out of 76 European Universities



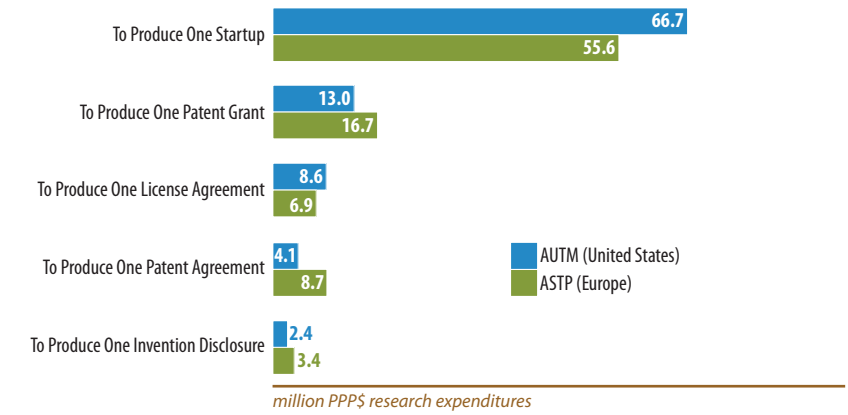
Source: Association of European Science and Technology Transfer Professionals (ASTP)

Figure 5: Performance of Top Five U.S. Research Universities Out of Top 75



Source: Association of University Technology Managers (AUTM)

Figure 6: Comparative Performance of European and U.S. Universities



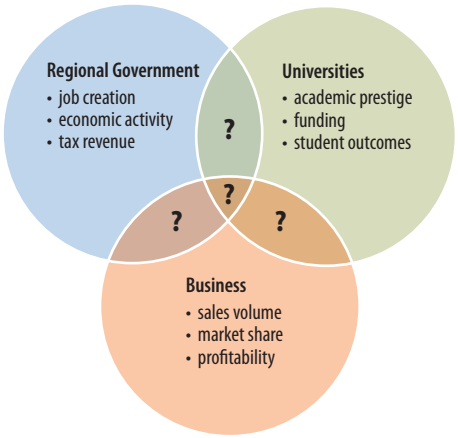
Source: Association of European Science and Technology Transfer Professionals (ASTP)

Connecting the Strands of the Triple Helix

The relationship between universities, governments and business, at the regional level, has come to be known as the Triple Helix. The image is of three independent, but interacting, forces working together and spiraling upward. This concept is easy to describe, but very difficult to bring into being. The problem is that the three strands have historically not had many things in common. Figure 7 provides a Venn diagram illustrating the three strands and their primary interests.

Governments, businesses and universities have primary interests that tend to drive their strategies and goals over time, and pursuing other interests can cause problems:

Figure 7: The Search for Common Interests in the Triple Helix



Local governments. The challenge for governments is that the economic benefits of innovation in the knowledge economy are not predictable, either in time or space. Having made investments — financial and/or political — governments expect a return, and if that return is slow, small or occurring elsewhere, governments can come under political pressure.

Universities. Universities have historically offered considerable academic freedom to their faculty, and have few internal incentives for entrepreneurial activity. Administrators often do not want to upset the longstanding culture of "research for its own sake." Pushing commercialization outcomes can be seen as violating longstanding university practice.

Business. The "traditional" business community of a region will consist mostly of businesses that have relatively conservative risk profiles and do not often become involved with brand new technologies and markets. Shareholders will not appreciate putting money at excessive risk in pursuit of new ventures.

Among these three strands there seem to be few primary interests that intersect with each other. Without some interests in the intersection points, we cannot assume that these institutions will find any reasons to work together and operationalize the Triple Helix. In other words, the strands of the helix may be spiraling upward, but not in any connection to each other, and producing no additional value for the regional economy. And while we can imagine some secondary interests filling in the intersection points, absent some exogenous forces, it is difficult to envision a scenario in which those secondary interests become primary ones, enabling the three strands to come together on their own.

The Core: Intermediaries Connecting the Strands of the Helix

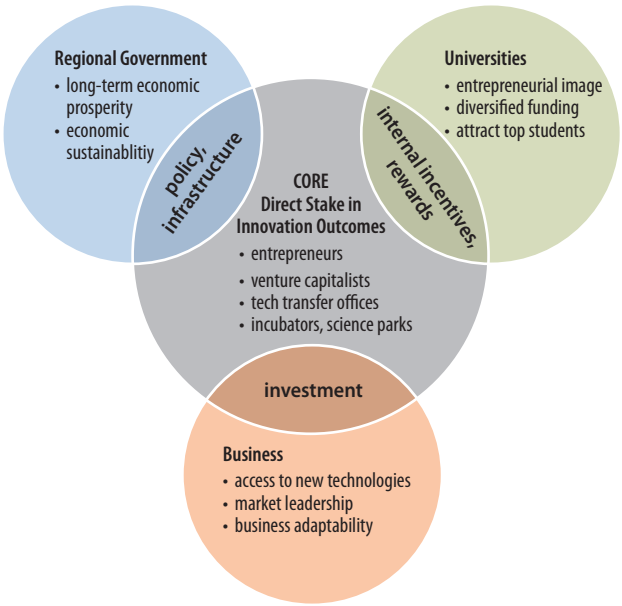
So, what might those exogenous forces be? In short, a set of individuals and institutions that have, as their *primary* mission, bringing the resources of universities and business together in a supportive local environment to create innovative businesses. In Figure 8, this is the "Core." The Core of the Triple Helix consists of a set of intermediaries who benefit directly by the success of the Triple Helix: if commercialization happens and businesses are created, they win, and if those interactions do not happen, they lose. With the Core driving innovation outcomes, the other three components of the Triple Helix can pursue secondary interests which are served by innovation outcomes.

If such stakeholders do not exist they can be created and recruited. Experience suggests that it is far easier to create this new stakeholder group than to transform the other three institutions in ways that would move their secondary interests up to a primary level. So, who are these intermediaries?

Entrepreneurs. These individuals and small firms are accustomed to the risk-reward profile of start-up business and new technology. They are well connected with the specialized financing and services needed by start-up businesses and are skilled at assessing the market potential of new technologies.

Venture capitalists, angels, investment bankers. This subset of the finance industry specializes in providing funding for start-up firms. "Angels" are generally wealthy individuals who can afford to risk money on good ideas that are in the earliest stages of development. Most venture capital funding is placed in firms that have proven their concept and are beginning to do real business. Investment bankers work with firms as they mature and exit the start-up phase.

Figure 8: Creating a Stake in Innovation



Technology transfer offices (TTOs). These offices usually reside within universities, but can be separate non-profit organizations owned by the university. Although they are part of the university structure, their sole mission is to move university-derived technology off campus and into businesses. This may involve working with new, start-up businesses or licensing technologies to existing businesses. Either way, they will be judged by the amount of technology they place and the revenue they gain for the university and researchers who have an ownership stake in the intellectual property that is for sale.

Incubators, science parks. These facilities are closely associated with universities, but may be owned by local governments or private investors. Their purpose is to provide physical space for researchers and entrepreneurs in a way that moves the work out of the university laboratories but keeps it close to the resources of the university. These facilities can also provide in-house expertise in a variety of business disciplines the entrepreneur will need. Like TTOs, the success of incubators and science parks will be determined by the amount of university-based technology that they nurture into successful business venture.

The intermediaries that make up the Core cannot create the new linkages and build a functional Triple Helix on their own, however. In this model, initiation of activity and responsibility for success lies with the Core, but organizations in the three strands need to be receptive and cooperative. Figure 8 suggests some benefits that the three strands will see from a functioning Triple Helix and ways that they can contribute to the success of the Core:

Local governments. In spite of the risks noted above, local governments need to keep a long-term perspective about their economies. Not every investment they make in innovation will pay off, but they can be certain that **not** investing will result in a stagnating economy at some point in the future. The safest way to invest in innovation is to avoid "picking winners and losers," and concentrate instead on ensuring that the region's infrastructure and regulatory environment are supportive of whatever sectors and technologies emerge as winners. Local governments play a large role in ensuring that local communities are attractive places for researchers and entrepreneurs to live.

Universities. Although a more entrepreneurial approach may be a departure from a university's traditional mission, it can have benefits in attracting a new type of faculty and student, and in diversifying the financial base. Academic excellence and entrepreneurism need not be mutually exclusive. The key is to create a set of internal rewards and incentives that foster entrepreneurism while not being perceived as "punishing" traditional academic pursuits.

Business. Traditional businesses may not want to be involved in the earliest stages of entrepreneurial activity, but they often want to buy into the results. At the end of every start-up process lies the possibility of selling the new enterprise to an established business. Businesses will be more aware of the opportunity to acquire promising new technologies and products if they maintain good relationships with the scientists, engineers and entrepreneurs who are getting those technologies and products past the earliest, riskiest stages.

The key to this model is that it does not require any radical transformation of the institutions that make up the three strands of the Triple Helix. As evidenced by Figure 4, there is a wide variation in the degree to which technology transfer and commercialization happen in very similar universities and communities, so expecting the initiative to come from these institutions is not realistic. The Triple Helix will become a reality only when there is an active, engaged and skillful Core of individuals and organizations who think of nothing other than creating new businesses and economic activity from the resources embedded in the three strands.

The Values of the Core: Patience and Risk Acceptance

The organizations and individuals who make up the Core operate differently from the institutions that make up the Triple Helix in two important, and inter-related ways. The Core is comfortable with the long, and often uncertain time horizons of innovation, and can remain patient as business processes mature. And the Core accepts the much higher level of risk associated with bringing new technologies to market. In other words, the Core can provide the stewardship necessary to create successful businesses out of the raw material of new ideas.

Figure 9 shows the three types of risk that any entrepreneur faces in bringing a new technology to market. To be successful, the technology first must perform as intended, reliably and safely. But a good idea is not enough, since it must meet an identified market need at a price users are willing to pay. And third, someone with money needs to appreciate the potential of the idea and be willing to fund the business until it matures.

Figure 9

Each of the three processes in Figure 9 can go wrong at any time, and the business will succeed only when all three questions are answered. Reaching the point where all three processes are complete can take a long time — new pharmaceutical products take many years to reach market — and often never happens at all.

The Core is far more comfortable with the uncertain timelines of the entrepreneurial process and the risk of total failure than are the members of the Triple Helix. In our new model for the knowledge region, the Core absorbs financial and time risk, allowing the other three strands of the Triple Helix to reap the benefits of participating in technology commercialization while staying within their established risk profile. Although the Core is entitled to the high financial rewards that accompany risk taking, the members of the Triple Helix will still gain ample benefits from their participation.

Leveraging University Assets with the Core: Role of Public Policy

We can assume that the strictly private sector elements of the Core — entrepreneurs, financiers, service providers — will find their own way to the opportunities presented by the growth of a knowledge region. Public policy does, however, have an important role in creating the infrastructure and environment that underpin the knowledge region. Some important considerations follow.

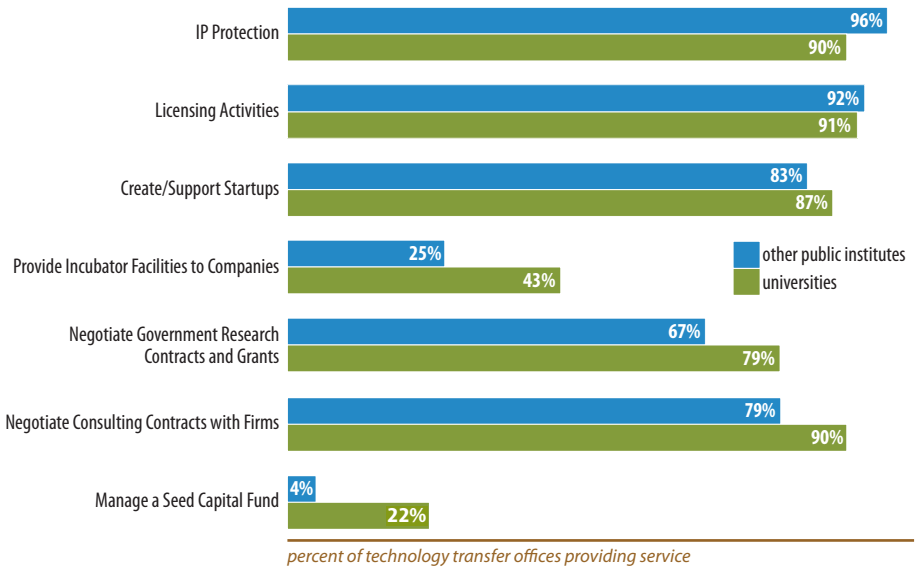
The Technology Transfer/Commercialization Function Within Universities

One of the consistent frustrations of those who have observed the knowledge economy is the generally poor entrepreneurial motivation, skill and performance of university researchers. Scientists and engineers in an academic setting struggle to identify a clear path that will send their discoveries into the marketplace. And even those who can see the path often lack the business skills needed to launch a successful venture. Recognizing this gap, universities around the world have opened technology transfer offices (TTOs) that serve as intermediaries between the university and its intellectual property and those who might use that intellectual property to launch new products and services. In a policy paper directed to the European Commission, Philip Cooke, at the University of Wales, observed that:

> *Universities alone will clearly be an insufficient base to make a substantial contribution to regional development beyond their current capabilities, but universities and, specifically their most accomplished research individuals, teams and centres working as hubs in a networked innovation system connecting research producers to resource-providers and users within and beyond any specific region constitute an untapped goldmine of potentially valuable knowledge. . . . If governments want more economic output from university research they will have to recognise the necessary activity as professionally distinct and supply the resources required to perform the function effectively.*

Cooke's point is that TTOs bring together a set of knowledge and skills that are simply not available in university settings and that would be unaffordable to individual researchers should they seek these services independently. These offices manage the patent and trademark process, as well as licensing agreements. They help researchers tailor their discoveries toward market considerations in order to increase the likelihood of attracting entrepreneurs and funding. They maintain contacts within the business community and work to generate interest in the university's portfolio of intellectual property among prospective buyers. Figure 10 taken from a 2006 survey of TTOs in 22 countries in Europe, shows the primary activities of TTOs associated with universities and independent research institutes.

Figure 10: Services Provided by European Technology Transfer Offices



Source: Association of European Science and Technology Transfer Professionals (ASTP)

TTOs are a critical part of the Core of the Triple Helix, and they tend to pay for themselves. O'Shea, et al (2005) found "convincing

evidence that the magnitude of resources invested in TTO personnel increases spinoff activity. . . Given the complex and time-intensive job of identifying, sourcing and exploiting university technologies for commercial exploitation, this finding highlights the greater the size of the TTO offices, the greater the likelihood of the university to produce spinoffs." In the survey of 76 European universities, the average TTO had 8.6 employees. The survey of 172 U.S. universities showed an average of five staff members per TTO. In the U.S. survey, the ten universities with the highest licensing income had a median income per TTO staff person of about $4 million.

TTOs vary widely in their effectiveness. According to Figure 4, there are 71 European universities producing only nine percent of the licensing income of the survey group, and if most of those universities have TTOs, the great majority of those TTOs must not be generating much income. In the survey of 176 U.S. universities, the median of licensing income per licensing staff person was $667,000, but income per staff person ranged all the way from over $17 million to under $1,000.

University Governance and Internal Influence

Appearances aside, universities are rarely monolithic institutions. Longstanding traditions of autonomy and academic freedom contribute to the fragmentation of authority within universities, making it very difficult to change the underlying culture. Given that most parts of a university will never see direct benefits from technology transfer and commercialization, resistance to change can be substantial. And yet some parts of the university must change in order to become more receptive to working with the other two strands of the Triple Helix, facilitated by the Core. Reichert (2006) has noted:

> *[U]niversities are confronted with a wide array of new demands which are associated with the enlarged realm of impact. Most of these require new ways of looking at university functions as well as new competences and additional resources. . . . [I]t is the politicians and businesses who stress the concerns of technology transfer and the commercialisation of knowledge, demanding increased attention to applied research and even commercialisation of research results. . . . [T]hese demands are often perceived with mixed feelings by university researchers since they go against the traditional grain and hierarchy of university values which sets basic purpose-free research as the highest pursuit of its members.*

Key to promoting change in universities, however limited, is understanding influences on university leadership. National universities presumably respond mostly to national governments who may have little interest in regional development, as such. And the trend in some countries of promoting "centers of excellence" by concentrating resources in just a few universities further complicates efforts to make resident universities part of regional economic strategies. Universities that fall under the jurisdiction of prefecture, state or provincial governments stand a better chance of responding to changes promoted in the name of regional development.

Path Dependency

Not surprisingly, universities that have a history of spinning off businesses and licensing technologies have a higher likelihood of doing so in the future. These universities have built up an internal culture that encourages entrepreneurship (or, at least, cooperation with entrepreneurs), have established capacity and procedures for handling intellectual property, and have gained a reputation among entrepreneurs as easy institutions with which to do business.

History, however, does not need to be destiny. Regions have, through intentional action, created "constructed advantage" around their research institutions and generated a substantial level of economic activity. One of the most famous examples of this is the Research Triangle Park area of North Carolina, in the U.S. In the 1950s, civic leaders of the region were looking for ways to diversify their economy out of agriculture and low-wage manufacturing. Seeing the presence of three research universities — University of North Carolina at Chapel Hill, Duke University, North Carolina State University — and a large tract of undeveloped land in

the triangle between them, local and state leaders created the Research Triangle Park (RTP). RTP excluded manufacturing and concentrated on attracting the research arms of large national and multi-national firms.

RTP is not the only case of locally-driven constructed advantage, but it does illustrate well one of the biggest challenges to such undertakings: the need for patience and a long-term view. The leaders who envisioned RTP knew that it would take decades for the park to take shape, and that investments in land and infrastructure would have a very long payback period. Such long timeframes and uncertainty, as noted above, present a major challenge for local governments as they contemplate investments in innovation infrastructure.

Bretnitz et al (2008) documented the process through which Yale University dramatically increased the formation of companies from life sciences technology developed on its campus. What was clear from this story is the substantial role played by government agencies in helping this process along. This study contrasts the Yale experience with that at the Massachusetts Institute of Technology (MIT) which has a long history of fostering spin off businesses, and, consequently, needs little government intervention in the commercialization process.

Who Leads?

One thing the model shown in Figure 8 lacks is a clear leader. Since technology transfer and commercialization are not part of the primary missions of the three strands of the Triple Helix, we cannot necessarily expect strong leadership from any of them. The components of the core, even though deeply interested in the process, might be viewed as too self-interested and, therefore, suspect. Moreover, the individuals and organizations in the Core may not be prominent enough in the community to take on a leading role.

Nonetheless, leadership is essential. There is nothing magic about creating regional economic advantage out of university research, but it happens far more often if the three parts of the Triple Helix are aligned with that objective, and are receptive to the intermediation of the Core. This alignment, which may entail some change of culture and institutional goals, requires strong leadership. In reviewing the development of several knowledge regions in Europe, Reichert (2006) notes:

> *Without such leadership, these cities would still have the same set of strengths and opportunities, all of which may make outsiders recognise them as knowledge intensive cities. However, they would not have been able to design and realise new major projects as easily. They would not have built common interests as actively and concertedly across different institutions in order to realise and expand this potential. They would have been unable to promote their strengths as explicitly to the outside world.*

Every region has its own leadership structures and traditions and will need to find its own solution to the leadership problem. But what must be recognized is that there is no really natural place within the Triple Helix model from which leaders will arise, and leadership must be constructed intentionally.

Spatial Issues: The Knowledge Region as a "Place"

The death of geography, as anticipated in the early days of mass computing and communications technologies, has been greatly exaggerated. While it may be theoretically possible for individuals and organizations to collaborate across distances in the creation of new businesses, this seems to be more the exception than the rule. Technology licensing and especially the spin off of businesses tends to have a strong regional component.

This can be explained largely through understanding the difference between, and the interaction of, tacit and codified/explicit knowledge (Audretsch et al, 2005). While a researcher may publish findings that the

whole world can access, that same researcher carries important tacit knowledge that remains stuck in his or her brain, and cannot be accessed easily. Electronic communications have their limitations, and people still seem to rely on face-to-face communication. The bigger pictures of clustering and agglomeration economics also suggest that groups of people with common interests and expertise will want to remain in close proximity to one another.

An excellent natural experiment in spatial relations of university spinoffs is found in Sweden, where universities were decentralized beginning in the late 1980s. Andersson et al (2009) found that for the new university campuses,

> *"between one third and one half of the total effect on productivity is registered within 5 km of the university . . . . There is strong evidence that an expansion of university presence in a community, measured by the number of university- based researchers, is associated with increased output per worker in that community and with increases in the patents awarded to inventors in that labor market area."*

In a study of technology-based start-up businesses in Germany, Audretsch et al (2005) found that firms tend to locate near universities when they rely on university graduates for their workforce and when the knowledge they are using is more tacit than codified. This suggests that for regions to capture the economic benefits of their universities they need to concentrate on creating interpersonal ties between participants in the Core and the university's researchers and students. Concentrating just on the technology may not create the regional benefits that are desired.

This is one point at which the interests of the university and the interests of the surrounding community may not coincide. The university is interested in generating income from licensing of intellectual property, no matter where the licensee may be located, whereas the region would like to maximize the use of intellectual property in the vicinity. Local governments and economic development agencies can promote local use of university research by building up the Core and fostering networks and linkages between university researchers and students and the local business community to increase the likelihood that tacit knowledge will be the focus of technology transfer efforts.

A common tool to address the spatial relationship of the university to business is the creation of science parks, incubators and other facilities that provide work space and services to start-up businesses, in a location convenient for university faculty and students. These tools have been used around the world, and are a straightforward way for local governments to become involved in the commercialization process. Research on the effectiveness of science parks and incubators is, however, mixed, and it is often difficult to know how to measure success (Phan et al, 2005; Clarysse et al 2005; Chan & Lau, 2005). A consistent theme in the literature on science parks and incubators is that facilities are far less important than the level and quality of assistance services provided.

As noted above, universities have a number of benefits — positive externalities — for a region beyond their impact on technology-based businesses. Universities, their faculty, staff and students spend money in the region, much of which comes from outside the region. Universities have amenities that can be shared by people outside the university community. Many universities become involved in solving specific local problems, using their expertise and the work of students.

To maximize these benefits, local governments and civic leaders need to ensure strong ties, both physical and interpersonal, between the university and its surrounding community. The university neighborhood should be an exciting and enjoyable place for local residents to go, and, conversely, university students and staff should have easy access to areas outside of the university neighborhood. It has been common practice in some areas to locate universities in isolated areas, presumably for the benefit of scholarship and to keep those rowdy students away from everyone else. In many, if not most cases this has proven to be a mistake.

Research Universities and the Knowledge Economy in the IRBC Regions

The ten IRBC regions can all be characterized as "Knowledge Regions" with a substantial and growing part of their economies based on knowledge industries. Furthermore, each of the regions has at least one major research university. But as discussed above, the presence of a research university does not automatically mean that it is a major contributor to the knowledge economy of the region. Our new model of the Triple Helix requires that there be a set of businesses, institutions and individuals that make up a "Core" that facilitates the interaction of the three strands of the Triple Helix. So, we now turn to a look at the strengths of the Cores that exist in each of the IRBC regions.

Staff contacts in each of the IRBC regions were sent a questionnaire that asked for information on the various intermediaries that make up the Core. The survey results show that the IRBC regions and the research universities in them have a wide range of models for institutions and organizations that make up their Core. This diversity of approaches allows for interesting comparisons. In the following section we look at the Core intermediary institutions that were subjects of the questionnaire and provide examples of how the IRBC regions are approaching these institutions. Complete responses to most of the questions are contained in the appendix.

Technology Transfer Offices

Technology transfer offices (TTOs) are almost always a formal part of the university structure, and perform various functions related to managing the intellectual property generated at the university. All of the research universities in the IRBC regions report having TTOs of some sort. There seem to be three basic types of TTOs among the regions.

Basic IP management. Kyushu University, the University of Washington, Helsinki University, Aalto University and the University of British Columbia all have straightforward IP management and licensing functions, operating with staff in the range of 30 to 60 people. These offices help university researchers obtain intellectual property protection and spend some amount of resources looking for ways to license or sell that IP, but they do not offer many services directly to businesses that might be using university technology.

IP management plus services. These TTOs expand beyond just managing IP, and get involved with the firms working with that IP. NovaUCD, at University College Dublin, not only manages IP, it also has its own incubator facility on the university campus that provides start-up space and services for companies using UCD technology. Similarly, the Karolinska Institutet Innovations AB offers intellectual property management services to researchers at the Karolinska Institutet in Stockholm, and also manages the Karolinska Institutet Science Park AB, which has incubator facilities.

Outside research institutes. A third model for technology transfer provides publicly-sponsored research services that can move IP developed at a university closer to commercialization. The Fundació Bosch I Gimpera, at the University of Barcelona, provides IP management and other basic services, and also has programs to move university research into further stages of development.

Figure 11: Summary of the Technology Transfer Offices as Reported in the Questionnaire

	TECHNOLOGY TRANSFER OFFICES	IP MGMT	BUSINESS SERVICE	FURTHER RESEARCH
Barcelona	Fundació Bosch I Gimpera, Universitat de Barcelona	X	X	X
	Centre de Transferència de Tecnologia, Universitat Politècnica de Catalunya	X	X	X
	Parc de Recerca, Universitat Autònoma de Barcelona	X	X	X
Dublin	Nova UCD – University College Dublin	X	X	
	National University of Ireland Maynooth Commercialisation Office	X		
	Dublin Institute of Technology Hothouse	X		
Fukuoka	Intellectual Property Management Center of Kyushu University (IMAQ)	X		
	Kyushu TLO Company Limited	X		
	Fukuoka University intellectual Property Center	X		
	Kyushu Sangyo University Academic and Industrial Liaison Office	X		
Helsinki	University of Helsinki Technology Transfer Office	X		
	Otaniemi International Innovation Centre, Aalto University	X		
Munich	Bayerische Patentallianz	X		
Seattle	University of Washington Center for Commercialization	X		
Stockholm	Karolinska Institutet Innovations Ab (KIAB)	X	X	
Vancouver	UBC University-Industry Liaison Office	X		
	Simon Fraser University-Industry Liaison Office	X		

Source: IRBC 2010 Questionnaire to Regions. Data from member regions Daejeon and Melbourne were not available.

Private Intermediaries

True innovation is an organic, bottom-up process, driven by entrepreneurs and service providers who see economic opportunity in the launching of new technologies and businesses. So a vital part of the Core is those individuals and businesses that will directly benefit from technology commercialization.

All of the regions reported having a strong presence of venture capital firms. What is less clear is the presence of "angel" investors, who provide capital at the very earliest and riskiest stages of the company formation process. As discussed above, a key role of the Core is to absorb risk from the commercialization process, and angel investors are prime examples of individuals who can absorb risk. Only Stockholm, Vancouver and Seattle specifically mentioned having angel investor networks. Dublin mentioned several firms that provide "seed" capital, but it is not clear if they provide capital at the same stages as angels.

Government Intermediaries

All of the regions report having a presence of government-sponsored intermediaries outside of their public universities. In the smaller countries these organizations tend to be national in scope, while the larger countries have a combination of national and state/provincial organizations. These intermediaries fall into several categories.

Technology funding. All the national governments and some provincial governments of the IRBC regions make funding available, usually on a competitive basis, to researchers. The important distinction comes in the degree to which those funding agencies also attempt to drive commercialization of the results of research. The major U.S. funding agencies, such as the National Science Foundation and the National Institutes of Health, typically fund basic research and do not become involved in commercialization activities. In contrast, the Japan Science and Technology Agency and Japan's National Institute

of Advanced Industrial Science and Technology both have, as part of their mission and operation, the promotion of commercialization. Science Foundation Ireland focuses on basic research but has economic advancement among its principal values.

Industry-specific agencies. A number of the government intermediaries are focused on development of specific targeted industries. In Helsinki, for example, Culminatum Innovation Oy Ltd is a public-private organization that sponsors centers of expertise in nine specific industry clusters. Stockholm-Uppsala Life Sciences works to create opportunities for biotechnology firms. Firms in the Seattle area can compete for state government assistance through the Life Sciences Discovery Fund.

Commercialization assistance. Nearly all of the regions have some form of government-sponsored agency that assists start-up firms. For example, the Munich Technology Center, owned by the City of Munich, offers a wide range of services to start-up businesses. ACC1Ó, a technology transfer assistance agency in Barcelona, is part of the Catalan government. The British Columbia Innovation Council, in Vancouver, is a Provincial agency charged with expanding technology transfer and commercialization.

The notable exception to the trend of strong government roles in technology commercialization is the U.S. In general, commercialization activities in the U.S. are centered in universities, and the quality of those efforts varies widely. As noted above, government intervention in commercialization is most effective with universities that have a strong reputation for research but a poor record of commercialization. A recent example of a new government effort has been the state of Utah, which has used state assistance to significantly increase the rate of commercialization at the University of Utah.

Incubators

All the regions report having at least one technology incubator. Figure 11 shows the incubators reported, along with their ownership and technology focus, if any.

The majority of these incubators fall into the public-private or university-private category of ownership and funding. These are typically launched by universities or local governments, but spun out into financially independent entities. Some have high quality physical spaces to offer their clients, while others focus more on services to start-up businesses. The privately owned incubators in North America are focused more on selling services, and the privately owned incubator in Fukuoka is focused more on providing space.

Figure 12: Examples of Incubators in the IRBC Regions

	INCUBATORS	FOCUS AREAS	OWNERSHIP-FUNDING
Barcelona	Barcelona Science Park incubator Barcelona Media Innovation Center Barcelona Activa Incubator Esade-Creapolis	biotechnology communications and media any business, emphasis on innovation any business	public-private non-profit public university
Dublin	NovaUCD Belfield Innovation Park.	all business types any sector, emphasis on innovation	university-private university
Fukuoka	FUKUOKA SRP Co., Ltd Laboratory Fukuoka Symphonicity	primarily IT organic light emitting diodes	private university
Helsinki	Helsinki Business and Science Park Start-Up Center EnterpriseHelsinki Aalto Entrepreneurship Society Spinno Enterprise Center Biomedicum Helsinki Aalto University "Factories"	biotechnology, food technology any business any business any business knowledge-based start-ups biomedical service, media, design	university university-private public university-students public university university

Figure 12: Examples of Incubators in the IRBC Regions *(continued)*

	INCUBATORS	FOCUS AREAS	OWNERSHIP-FUNDING
Munich	Munich Technology Center (MTZ) gate Garching Technology and Entrepreneur Center Bio M	all companies from any high-tech field mechatronics, software, IT biotechnology	public public-private public-private
Seattle	McKinstry Innovation Center Accelerator Corp 8ninths	clean technology – energy efficiency biotechnology web technologies	private private private
Stockholm	Karolinska Institutet Science Park Stockholm Innovation and Growth	life sciences, medical, services ICT, medtech and cleantech	university-private public-private
Vancouver	Discovery Parks Boot-Up Labs WavefrontAC	all technology companies digital media wireless and new media	public-private private private

Source/Note: IRBC 2010 Questionnair to Regions. Examples from member regions Daejeon and Melbourne were not available.

Local Policies

The questionnaire responses list a wide variety of programs designed to expand the regional knowledge economy. Many of these programs aim specifically at creating a culture that values innovation and creativity, based on the understanding that eventually a knowledge economy must be self-sustaining. Strong government initiatives can get innovation ecosystems started, but those ecosystems must become an integral part of the regional culture.

For example, the Innovation Alliance between University College Dublin and Trinity College Dublin has created an Innovation Academy to "form the minds of a new, globally conscious generation of innovative, creative and entrepreneurial graduates." The Munich Business Plan Competition "aims at encouraging young people to set up businesses and at creating networks for young entrepreneurs in the Munich area."

Barriers to Technology Transfer

The questionnaire asked the regions about their experience with some common barriers to technology transfer, especially those related to financing, intellectual property and conflicts of interest. None of the regions reported that these issues were of particular concern. Several of the regions, including Vancouver, Dublin, Fukuoka and Helsinki, noted that many problems with the treatment of intellectual property created at universities had been resolved in the past few years.

Summary of Technology Transfer in the IRBC Regions

Based on the responses to the questionnaire, the IRBC regions are actively pursuing the development of knowledge-based economic development through their universities, and are experiencing significant success in the form of spin-off businesses.

Each of the regions appears to have a strong set of intermediaries to form the Core, but there is a wide variety of approaches to creating these intermediaries. As a point of future research it would be helpful to learn about the linkage between the intermediaries and the start-up businesses and to learn the degree to which the intermediaries contributed to their success. Although many members of the Core are relatively new institutions, they will, over time, need to demonstrate a return on investment.

A further point for future research would be to explore the effectiveness of different ownership and governance models for intermediary institutions. Ownership and/or sponsorship of commercialization centers and incubators in the IRBC regions ranges from public to public-private to university-private to all-private. There are advantages and disadvantages to each of these models, and we could explore those further in the future.

Finally, what the questionnaire did not ask, and what is at the heart of the subject, is just how effective this entire process — the Triple Helix plus the Core of intermediaries — has been at transforming regional economies. It is one thing to have a strong base of commercialization systems, but quite another to have a growing share of the region's employment based in new, growing technology-based firms. The questionnaire asked for examples of start-up firms, but it did not ask whether these firms have become important generators of jobs and economic activity. The question of economic outcomes awaits further research.

Strategies for Enhancing the Role of Research Universities in Knowledge Regions

An analysis of the current theories and evidence about the linkage between research universities and economic development, combined with the results of the survey of the IRBC regions suggests the following four-part strategy:

1. Strengthen the Core

The discussion above asserts that, while the Triple Helix model is valid — that is, universities, governments and business can work together to further technology-based economic development — it functions far better with a strong Core of intermediary individuals and institutions. These institutions are defined as those whose *primary* mission is to facilitate the commercialization of university research. The Core intermediaries are characterized by an inherent ability to absorb the risks that always accompany the commercialization process, and by flexibility in timeframes for success. The greater risks and uncertainty they face entitle them, of course, to greater rewards when businesses are successful.

The survey shows that all of the IRBC regions have basic intermediary institutions in place, and that there is a wide variation in their organization and governance. The survey was not able, however, to determine the degree to which each of those institutions are effective at promoting commercialization.

There are several steps a region can take to strengthen its Core:

Inventory the players. Know who the various intermediaries are, and where there may be gaps in competencies.

Create venues for interaction. It cannot be assumed that members of the Core are conscious of being part of a critical network, so there may be a need to create a venue for the entrepreneurs, venture capitalists, TTO staff and others to regularly interact and communicate.

Explore governance models. The various models for governing the core institutions — public, public-private, university-private, non-profit, private — all have advantages and disadvantages, and leaders should always be working to ensure that key institutions are managed for maximum effectiveness.

Connect the core to the strands of the Triple Helix. It will be rare for any of the Core intermediaries to have uniformly strong connections to each of the three strands of the Triple Helix. Leaders within each of the strands should reach out to create connections to the Core where they are absent.

2. Promote Commercialization Within University Culture

It is widely recognized that to the original missions of universities — education of students and basic research — must be added a third mission: economic development. But universities have evolved over centuries and some will not embrace this new role easily. There is no reason to believe that participation in the economic life of the region will, in any way, compromise a university's primary missions, but there can be, nonetheless, resistance to adopting a third new priority. There is very little linkage between the size and quality of a university's research enterprise and the degree to which the results of research are commercialized, indicating that some universities are simply more aggressive about commercialization than others.

University leaders and regional leaders need to work together to create the cultural changes within universities necessary to expand their involvement in regional development. This may involve:

Clarification of allowable activities. University faculty need to have a clear understanding of rules regarding conflicts of interest, treatment of intellectual property, use of university facilities and other issues that may cause them to avoid entrepreneurial activity.

Minimization of risk to the university. As discussed, one of the functions of the Core is to minimize risks to the three strands of the Triple Helix. Community and business leaders need to work with university leadership to address and mitigate specific risks.

Creation of alternative reward structures. The primary rewards to academic researchers mostly involve professional recognition by peers, and this can lead them not to pursue their work beyond papers and conferences. New reward structures are needed that encourage researchers to cooperate with the commercialization process.

3. Create the Right Spaces for the Knowledge Economy

It is no coincidence that efforts to copy the success of Silicon Valley all seem to get their own name: silicon beach, silicon forest, silicon desert, etc. A sense of place is very important to the creation of strong knowledge economies. Research has shown that the economic benefits of technology commercialization tend to stay within metropolitan regions and diminish rapidly with distance from universities and technology transfer centers. We also know that talented people place importance on location and that the benefits of universities diminish as graduating students leave the region.

The stories of successful knowledge economies emphasize the physical proximity of people and institutions and the spaces in which they interact. There are some very practical considerations. For example, can a university faculty member attend a meeting at an incubator in the morning and still be in time to teach a class? Can graduate students commute between the university and their part-time jobs in private research operations? Is there a range of appropriate housing that will be affordable for entrepreneurs and laboratory technicians alike? Can investors from other regions easily fly in and out in a day?

Since every region is different, and since the spatial relationships between universities, business and talented people are still not well understood, it is difficult to arrive at specific recommendations. But local governments, private developers, transportation agencies, utilities and others involved in planning a region's future need to be conscious of the opportunities to further the knowledge economy or, conversely, the possibility of inhibiting its growth.

4. Foster Regional Leadership

Technology commercialization, and the larger process of creating knowledge regions, does not often happen on its own. Regions that have successfully created new knowledge economies have generally done so with the help of strong regional leadership. Regions should look less to Silicon Valley, which grew mostly

organically (although with the help of substantial federal defense spending) and more toward Research Triangle or Dublin, which have benefitted from intentional leadership.

The difficulty, however, is that there is not necessarily a natural source of leadership for promoting the knowledge region. As discussed above, institutions within the three strands of the Triple Helix will rarely have these issues at the top of their lists of concerns, and the members of the Core will appear too self-interested. The market risks and uncertain timeframes of technology commercialization make it difficult for political, business and civic leaders to get out front, and university leaders need to avoid the perception that they are ignoring their core missions.

Every region in every culture has its own local leadership structures and traditions, so there can be no formula for creating leadership in the knowledge region. But it is also clear that every region that has succeeded in creating a strong knowledge economy where there was none before, has done so through strong leadership.

Conclusion

Even the most successful knowledge regions have tapped only a fraction of the potential to turn research results into products and services that can form the basis for new companies. Fortunately, both universities and their surrounding regions are realizing that converting research into economic opportunity requires a supportive legal environment and a specific set of institutions and skills, and those are gradually being put into place. But much remains to be done to create the Core of individuals and organizations that will dedicate itself to this process of commercialization.

Not every region with the potential to be a fully realized "knowledge region" will become one. Entrepreneurs and their support networks will tend to cluster in a limited number of places, and agglomeration principles suggest that success will attract even more success. For most regions, getting on this virtuous cycle of success requires a strong, community-wide effort led by individuals who will have credibility in all three strands of the Triple Helix.

And while it is easy to generate rhetoric about being a knowledge region, putting real resources into the effort comes with substantial risks. It seems that nearly every economic development document in the developed world, and many in the developing world, call for the same technology-based development strategy, and most will not come to fruition. The world is full of half-empty science parks and everyone remembers the dot-com bust, in which billions of investor dollars, Euros and yen went to waste.

All of the IRBC regions have strong knowledge economies today, and all have the potential to build on them to solidify their places among the Superstar Regions of the world. As the research shows, however, much is still to be learned about exactly how to mine the potential of a region's knowledge base. As is often the case with economic development, the key to success will be flexibility and a willingness to shift strategies as new approaches become known. Just as entrepreneurs must remain nimble and open to new developments, so must their partners in the Triple Helix and, especially, its Core.

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Association of Pacific Rim Universities. **www.apru.org**

Association of University Technology Managers (U.S.). **www.autm.net**

European University Association. **www.eua.be**

Organization for Economic Cooperation and Development (OECD), Higher Education in Regional and City Development. **www.oecd.org/edu/imhe/regionaldevelopment**

Shanghai Jiao Tong University. Academic Ranking of World Universities. **www.arwu.org**

Background

In 2008, the Puget Sound Regional Council and Trade Development Alliance of Greater Seattle developed the International Regions Benchmarking Consortium. This Consortium is a network of sophisticated city-centered metropolitan regions that find it mutually beneficial to compare and learn from each other through economic and social data statistics and in-depth research into specific issues of common interest. Microsoft and Boeing each provided substantial funding to launch the Consortium.

The member regions of the Consortium are:

Barcelona, Spain
Daejeon, South Korea
Dublin, Ireland
Fukuoka, Japan
Helsinki, Finland
Melbourne, Australia
Munich, Germany
Seattle, USA
Stockholm, Sweden
Vancouver, Canada

The International Regions Benchmarking Consortium is administered by the Puget Sound Regional Council and Trade Development Alliance in Seattle, USA.

For more information, visit **www.internationalregions.org**

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