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The Role of Universities in Regional Economic Development

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EXECUTIVE SUMMARY

THE ROLE OF UNIVERSITIES IN REGIONAL ECONOMIC DEVELOPMENT

Introduction

Canadian research universities and hospitals are under increasing pressure from governments to commercialize their discoveries and to help drive technology-based economic development.

U.S. research universities that have achieved the greatest commercialization success have gone beyond commercialization alone to embrace economic development as a part of their mission. They take a comprehensive cross-institutional approach to formal and informal technology transfer, support for entrepreneurship, and participation in regional economic development efforts; and have institutional policies, structures, and processes to support these activities.

While the American context is different, there is value in examining the experiences of these institutions as a source of ideas and practices for discussion with universities here in Canada.

Contribution of universities to regional innovation ecosystems

Most universities see the training of highly qualified personnel and the production of new knowledge as their primary economic roles. While these roles are more important than ever in today's knowledge economy, universities have also moved to occupy a new and central role in regional innovation ecosystems.

New roles require new approaches. Universities are starting to move away from a narrow focus on patents and licensing to acknowledge and codify the full range of processes through which knowledge flows out into the market, and to establish supportive policies, programs and infrastructure to make these processes more efficient. Universities are also starting to support entrepreneurship and to lead or partner with other regional stakeholders in regional economic development efforts.

Universities are diverse and each exists in a unique context. They, therefore, need to be strategic in finding ways to optimize their 'innovation contribution' and tailoring their efforts to the characteristics of their own regional innovation ecosystem. The following sections provide a sample of the different roles universities can play with respect to innovation and economic development.

Development of highly qualified personnel

Providing skilled graduates is one of the primary economic contributions of universities and a highly effective means of transferring knowledge and increasing the absorptive

capacity of firms for innovative ideas and discoveries.

Firms are attracted to, and benefit from, the large pools of talent that universities generate and the availability of highly qualified R&D personnel is a key factor in R&D site selection. Regionally, the concentration of creative, highly skilled talent is a critical factor in cluster development and dynamic urban economies.

As over 90% of the most significant R&D is generated by under 10% of researchers, some U.S. states have programs to enable universities to attract these eminent scholars. Universities that are effective generators of technology-based growth are able to recruit and/or retain star researchers. These gravitate towards higher-ranked institutions and cluster over time. Research indicates that the simple presence of these stars, not their research or discoveries, attracts firms.

Universities also play an important role through industry education and training partnerships, delivering non-degree educational programs targeted to different industry sectors. These may include graduate certificate programs in technical or management areas, executive development programs, weekend MBA programs, and corporate-focused distance education.

Research and knowledge production

Universities benefit regional firms through knowledge spillovers – knowledge generated by universities at lower cost than firms can produce it themselves. As firms located by universities tend to obtain knowledge at lower cost than firms farther away, firms concentrate around universities creating beneficial agglomeration economies.

While universities are not the main source of external knowledge for firms, high-technology regional economies are usually anchored by great research universities. These contribute patents, licenses, contract research, consulting and problem solving for industry, design, engineering and testing services, often early in the innovation cycle when firms and industries are seeking ideas.

Strong industry-university alliances are needed, however, to connect a region's research and industry strengths. Industry is rarely involved in the choices universities and their faculty make when it comes to building research strengths. Some state governments fund R&D, technology applications, and other programs to foster emerging industries or build stronger relationships between industry and anchor universities, with mixed results. Overall, though, efforts to create critical mass in research areas critical to industry are important and do have an effect.

Leading universities perform world-class research in strategic areas selected in relation to their core strengths and those of other research institutions and key industry in the region. This strategic focus is as important as the magnitude of research. Some leading universities actively involve regional industry in setting strategic research priorities. Most also have joint university-industry centres of excellence, focused on key technology

areas linked to regional industry clusters, and physical infrastructure to support research and technology development.

Technology transfer

Most universities in North America today have some form of technology transfer office (TTO). However, commercialization indicators (patents, licenses, university spin-offs) indicate that significant and sustained commercialization success is concentrated among only a small number of institutions.

Most technology transfer is actually informal, involving publications, conferences, and informal exchanges. Patents rank low in most industries except for pharmaceuticals, therefore, indirect mechanisms for the transfer of new ideas and innovations may be more important.

However, rather than adopting strategies that support these different commercialization pathways, many universities have created centralized TTOs that largely act as gatekeepers and protectors of university IP to maximize university revenue streams. Most favour licensing for cash, followed by licensing for an equity stake and sponsored research. This revenue maximizing approach tends to foster a “home run” mentality, focusing limited time and resources on the technologies that seem to promise the greatest and fastest payback. Technologies with longer-term potential or diffuse public benefit tend to be overlooked.

Most universities experience technologies “going out the back door.” Many researchers circumvent their TTO when they patent and patents with greater value are taken directly to the private sector more often. Firms express difficulty in dealing with TTOs, citing staff inexperience, lack of business knowledge, and a tendency to inflate the commercial potential of patents. As a result of this dynamic, the more fundamental goal – to maximize the potential for university-based inventions to result in commercialized new products and innovations – remains unmet in many cases.

Successful universities seek to maximize commercialization volume and speed rather than revenue, although their revenues often remain substantial. They have begun to codify a broader range of technology transfer pathways and to redefine the role of their TTO. There are different volume models of technology transfer but all:

- Provide rewards for moving innovations into the marketplace
- Focus on faculty as the key agents of innovation and commercialization
- Emphasize greater standardization in faculty and industry interactions.

The creation of new firms is an important element of university technology transfer – and economic development, as the economic benefits these companies generate tend to remain largely in their region. While only a small percentage of overall start-ups, university spin-offs are disproportionately high performing companies. As VCs move to later stage investment, however, the role of universities in nurturing early stage start-ups

is increasingly important.

Universities are only one side of the technology transfer equation, however. Firms need the absorptive capacity to realize the commercial benefits of basic research. Firms that conduct R&D are better able to use external information, however, there must be a fit between industry sector strengths and research strengths. Older and low-tech industries will work with universities, but the preferred means of interaction varies by field. Firm size can also be an important variable.

University-industry research collaboration

Universities engaged in regional economic development generally have a robust portfolio of industry research partnerships, with customer-friendly enabling structures and policies, including industry liaison offices offering one-stop-shopping to firms interested in collaboration, and flexible contracting procedures.

Industry/university advisory boards and councils can also help connect university research and industry strengths and foster research partnerships. These may be at the institutional (e.g. advisory to university president) or program level, and generally help bridge cultural differences and knowledge gaps between academe and the private sector, and build larger and more connected networks across the two sectors.

Many universities also offer consulting and technical assistance to industry, drawing on the expertise and knowledge of faculty members. Research supports the economic impact of such services. Most target small and medium-sized manufacturing operations and are offered on a partial cost-recovery basis. Faculty are involved on a project basis, usually through engineering or business schools.

University-industry research centres are increasingly common and focus on accelerating regional technology-based economic development. Joint centres require industry participation and matching funding, focus on a specific technology area, are multi-disciplinary and aim to commercialize their discoveries. Successful centres target carefully selected research areas that are already important to the existing industry base or are emerging areas that offer the prospect of developing new companies and industries. Other success factors include peer review of proposals, high quality personnel, committed senior industry participation, and an effective and regular review process. Being entrepreneurial is probably most important for ensuring economic development results and industry needs to play a leadership role for the same reason.

Matching grant programs offer a less costly but effective means to help companies access university expertise and help to move technology to the point at which private investment capital can be obtained to commercialize it. Success depends on connecting companies with the right faculty member and ensuring funding amounts are sufficient to attract faculty participation.

Support for entrepreneurship

Universities actively involved in regional economic development are likely to operate or partner with local efforts to foster start-up, technology-based companies. Universities may engage in a broad suite of initiatives to support this activity, while TTOs will target licenses to regional companies or support the establishment of a new start-up when commercially appropriate.

Institutional culture and work environment significantly impact whether faculty participate in commercialization and, if so, whether they work with or around the university TTO. Many faculty members do not disclose their inventions to their university. Successful universities often provide implicit or explicit rewards and incentives for faculty who participate in commercialization and have hiring practices that favor industry and entrepreneurial experience.

Leading universities actively work to build entrepreneurship skills in their students and faculty.

These often have strong entrepreneurship programs or majors that offer entrepreneurship courses and activities for engineering, science and business students. Activities include business plan competitions, practicums with start-ups, and mentoring by successful entrepreneurs.

By creating flexible sources of funding to assess the commercial potential of new discoveries, universities can help fill the very early stage venture capital gap. A small amount of funding, that does not require a repayment, is needed to conduct testing, to validate the technology and to determine whether it meets a market need at a competitive price. University commercialization programs often include funds to address this capital gap. Awards range from \$50,000-\$250,000.

Networking – with investors, professional services, potential buyers, suppliers, and other entrepreneurs – is part of an entrepreneurial culture and a critical service many universities offer.

Incubators and research parks provide a visible technology presence and often afford low-cost space for new start-ups. This is particularly important for universities that have had to build an entrepreneurial presence.

Innovation centres can help by providing a focal point for technology-based activities. These create an ‘opportunity rich environment’ for entrepreneurs, by bringing together many of the key players and enablers in a region’s innovation system and creating occasions for these to formally and informally encounter one another, exchange valuable information, and build relationships.

Active leadership & participation in regional economic development

The entrepreneurial culture of a university is perhaps the strongest determinant of its performance when it comes to commercialization and economic development performance. To be accepted, economic development activities need to be seen as important, worthy, and central to the university and its mission. Universities need to reflect this in their institutional policies, structures and programs, have strong champions and actively partner with industry and other regional organizations.

Leadership is critical to creating an intellectual argument and language system around economic development, and putting in place the policies and structures needed to make it work.

Champions catalyze most successful technology-based economic development. In every region where a major research university has played a strong economic development role, one can point to a champion, often a strong university president or chancellor. These have the experience, vision, and will to move their institutions into new roles, and the leadership to rally academic, corporate, and political leaders willing to champion R&D and technology-based economic development over the long haul.

The role of university leadership is critical but changes over time. A strong, high-level voice calling for change is necessary to move a university into new territory. Later, for institutions with ongoing programmatic commitments to partnerships, there is often a need to renew and enhance the partnership mission, vision, and program structure through different administrations.

Universities cannot be changed by fiat. A participative process of intellectual dialogue and self-discovery usually needs to take place. In order to move in these new directions, universities may have to seek a different type of candidate to fill key positions – president, provost, or dean – that will lead the institution in a partnering direction. Informal and formal incentives are also used to encourage faculty participation in commercialization and economic development activity.

Universities that are actively linked to state and local economic development will often participate in regional strategy formulation, governance, and program development activities of economic development organizations. This may extend to university involvement in organized attempts to attract companies from other states or countries.

Universities that take on a regional economic development role add structures, positions and systems to manage and “routinize” key changes, turning critical organizational features of new programs into standard operating procedure through job descriptions, mission statements, etc.

Some universities have an office or senior position dedicated to outreach (or economic development). Some create coordinating structures — often backed by the authority of the CEO or chief research officer — that establishes linkages between different

partnering activities. Most of the exemplary institutions studied also worked hard on policy to align disparate elements within the institution.

Together, these changes achieve a shift from the ad hoc to a stable and sustainable approach.

Conclusions and key lessons

Universities that have been most effective in helping to launch and support knowledge economies, display the following characteristics:¹

- They are performing world-class research in areas that correspond to the science and technology drivers of their national and regional knowledge sectors.
- They have a cadre of nationally and internationally prominent faculty.
- They have leaders who view the university as a key partner with industry and government in creating and growing a knowledge economy.
- They have the physical and soft infrastructure needed to support research and technology development.
- They have mechanisms, including financing programs, to facilitate translation of research findings into commercial products and processes.

Examination of the attributes, activities and experiences of selected leading U.S. institutions have generated the following key lessons for other universities:²

- Champions catalyze most successful technology-based economic development
- Private corporations and foundations can play a major role
- A strong and focused research base feeds the commercialization pipeline
- Federal R&D funding provides a critical base for commercialization
- An entrepreneurial culture is key to university technology transfer success
- Entrepreneurship programs can add value to commercialization and economic development
- Innovation centers can provide a focal point for technology-based activities
- Networking is key
- Early-stage capital is a critical ingredient in launching university start-ups
- Incubators and research parks provide a visible technology presence
- There are no quick fixes.

¹ SSTI at 12.

² Palminteri *et al* at iii-v.

Universities that wish to play a more active regional economic development role and improve their commercialization success are advised to:³

- Build on strengths.
- Find champions.
- Focus on market opportunities.
- Make funding decisions based on excellence, not politics.
- Communicate and publicize success.
- Recognize that there will be failure.

³ SSTI at 27.

I. Introduction

The past two decades have witnessed a fundamental shift in Canada and elsewhere to a more knowledge and research-intensive economy characterized by increasingly global competition for new ideas, investment and talent. Governments have responded by turning their attention to the factors and processes that drive innovation, including systems for the production and transfer of knowledge and means of harnessing innovation to drive economic growth.

As the “knowledge factories” of this new knowledge economy,⁴ research universities (including research hospitals) have come under greater scrutiny by governments and are experiencing increasing pressure to commercialize their discoveries and, more broadly, to help drive technology-based economic development on a regional and national basis.

This fact was underscored by the recent release of the Government of Canada’s national science and technology strategy,⁵ which explicitly called for more partnerships involving academe, business and government to “accelerate the pace of discovery and commercialization in Canada”⁶ and “bring research strengths to bear on market-driven challenges and opportunities.”⁷ The strategy also commits the government to “developing new approaches to transfer knowledge and technologies from universities, research hospitals, and government laboratories to the private sector.”⁸

Growing government demands that universities play a more active role in commercialization and economic development have engendered considerable debate in Canada. There are questions concerning the merits and impact of universities embarking on this path and, more fundamentally, about the validity of the commercialization and economic development models informing nascent government policies that affect universities.

These are legitimate and important debates and many questions still remain to be answered. However, one has only to look south to the United States to see that, while tensions and conflicts exist, commercialization and economic development activities are not *de facto* fundamentally incompatible with the more traditional research and education mission of universities. Economic development has been integral to the mission of U.S. public and land grant universities since their inception and, while this is far less true of many American private universities, a number of the United States’ top ranked private research universities are among the leaders – nationally and internationally – when it

⁴ Wolfe, David. A. *Innovation and Research Funding: The Role of Government Support*. Discussion paper

prepared for Ontario Ministry of Research and Innovation. 2007. At 1.

⁵ Government of Canada. *Mobilizing Science and Technology to Canada’s Advantage*. Ottawa. 2007.

Accessed online: www.ic.gc.ca/s&tstrategy

⁶ *Ibid*, at 46.

⁷ *Ibid*, at 56.

⁸ *Ibid*, at 58.

comes to commercialization of their discoveries and active participation in regional economic development efforts.⁹

The American context is different in many fundamental respects from the Canadian. Higher research funding levels, elevated defense expenditures requiring university-industry interaction, provision of proof of principle funding by granting agencies, lighter teaching loads for research faculty, more abundant early stage venture capital (in some centres), targeting of federal R&D funding to small businesses through the Small Business Innovation Research (SBIR) program, higher philanthropic funding levels, and a more entrepreneurial culture overall are only a few of the factors that require careful consideration before adopting approaches from the U.S. context. Nonetheless, as Canadian universities are being pressed to play a larger and more active role in commercialization and economic development, there is value in taking a closer look at research institutions that are playing a significant economic development role – both at how they do this and the lessons gained from their experience.

To date, much of the focus in Canada and in many US institutions has been on technology transfer through patenting and licensing. In part, this is because comparative performance measurement data has become readily available through AUTM. However, it is also because governments see patents, licenses and start-ups as concrete measures of economic value arising from their research investments. At the same time, many universities and research hospitals, under constant pressure to generate new revenue, see technology transfer as a means to do this.

There is an emerging consensus, however, that the universities most successful in commercializing their discoveries are those that have gone beyond a focus on commercialization alone to embrace economic development as a core feature of their mission. These institutions demonstrate a more comprehensive and integrated cross-institutional approach to formal and informal technology transfer, support for entrepreneurship, and participation in regional economic development efforts; and have established institutional policies, structures, and processes to support these activities.

While it may be too soon to characterize these institutions as the new model for the 21st century research university, they are exciting increasing interest and a small body of literature examining their practices is emerging, showing that these institutions:

- Aggressively partner with technology-based industry and regional economic development interests
- Exhibit and encourage entrepreneurial behavior
- Champion these new directions in their public pronouncements and internal values.¹⁰

⁹ Stanford, Carnegie Mellon, and Purdue can be counted among this group. MIT as well, although it is also a land grant university.

¹⁰ Tornatzky, Louis G.; Waugaman, Paul G.; Gray, Denis O. *Innovation U: New University Roles in a Knowledge Economy*. Southern Growth Policies Board, 2002. At 14.

This paper is not a comprehensive literature review. Instead, it draws primarily on a small number of targeted studies that examined the role of universities in relation to fostering innovation and economic development, identified leading universities in this regard and, through interviews, case studies and analysis, attempted to extrapolate lessons for policy makers and/or other universities interested in exploring this role. (For a list of these institutions and summary data on their commercialization performance, please see *Appendix 1*.)

The first of these, *Innovation U: New University Roles in a Knowledge Economy* was prepared for the Southern Growth Policies Board in 2002 and focuses uniquely on US universities.¹¹ The second, *Accelerating Economic Development through University Technology Transfer* was prepared by Innovation Associates in 2004 for the Connecticut Technology Transfer and Commercialization Advisory Board of the Governor's Competitiveness Council.¹² This study drew on interviews with senior university and regional economic development personnel in the U.S. The third, *A Resource Guide for Technology-based Economic Development: Positioning Universities as Drivers, Fostering Entrepreneurship, Increasing Access to Capital* was undertaken by SSTI for the Economic Development Administration of the U.S. Department of Commerce in 2006.¹³ This looked primarily at US universities but also included Cambridge University, UK. Finally, *Universities, Innovation, and the Competitiveness of Local Economies*, is a summary report from the first phase of MIT's Local Innovation Systems Project, an international collaboration that examined the role of universities in supporting local economic development in a knowledge economy.¹⁴ A number of additional smaller studies are also referenced.

The following sections attempt to distill some of this recent thinking on the role of universities in regional innovation systems, elaborate a rudimentary conceptual framework for thinking about the diverse policies, structures, processes and initiatives that universities can deploy in this role; provide information on practices currently being employed by leading universities widely acknowledged to be at the forefront in this domain; and summarize lessons learned to date from the experiences of these institutions.

The intent of this paper is not to be prescriptive but, rather, to draw on the experience of other universities to provide a menu of ideas and considerations as a starting point for discussion with TRRA's research stakeholders on how the region's research institutions can more effectively speed discoveries into the marketplace and contribute more broadly to regional efforts to promote knowledge-driven economic growth.

¹¹ *Ibid.*

¹² Palminteri, Diane; Hodgson, Robert; Tornatzky, Louis; Lin, Echo Xiao Xiang. *Accelerating Economic Development through University Technology Transfer*. Report to the Connecticut Technology Transfer and Commercialization Advisory Board of the Governor's Competitiveness Council. Innovation Associates Inc. October 2004.

¹³ SSTI. *A Resource Guide for Technology-based Economic Development: Positioning Universities as Drivers, Fostering Entrepreneurship, Increasing Access to Capital*. Prepared for the Economic Development Administration, U.S. Department of Commerce. 2006.

¹⁴ Lester, Richard K. *Universities, Innovation, and the Competitiveness of Local Economies*. A summary report from the Local Innovation Systems Project - Phase 1. MIT Industrial Performance Center Working Paper 05-010. 2005.

II. Contribution of universities to regional innovation ecosystems

A significant body of literature documents the importance of university activities to the innovation process generally and to technology-based industrial performance.¹⁵

However, the precise nature of the university's role in the knowledge-based economy – and its ability to perform the roles ascribed to it – is still being explored.

Governments, often working from rudimentary regional innovation models, appear to see universities as “largely untapped reservoirs of potentially commercializable knowledge waiting to be applied by firms.”¹⁶ Universities are consequently under increasing pressure to generate more applied knowledge of greater relevance to industry, to diffuse knowledge, and provide technical support to industry, on the premise that, “once this knowledge is harnessed, it will fuel innovation within firms, increasing their productivity, stimulating the emergence of regional industrial clusters and indirectly, contributing to national economic growth.”¹⁷ These ideas are directly linked to government expectations that “investments in basic research will produce a direct and increasing economic return.”¹⁸

This somewhat mechanistic understanding of how basic research is ultimately transformed into economically valuable products, services and processes raises the spectre of public research institutions burdened with inappropriate and, ultimately, unrealistic demands from government.

Research institutions themselves largely see their primary economic contribution as two-fold: the training of highly qualified personnel and the production of new knowledge through research. By this view, public support for university-based research is best seen as “an investment in generating and sustaining a learning capability, which promotes the formation of skills, networks, and a capacity for technological problem-solving on the part of a society.”¹⁹

However, as the world economy continues to go through dramatic changes in its basic characteristics, the fundamentals of wealth creation are changing. These changes include:²⁰

- Increasing reliance on products and service with a high degree of knowledge content
- The increasing importance of entrepreneurial enterprises and associated venture capitalization, versus traditional dominance of large firms
- Growing reliance on the highly educated and highly skilled, with firms and regions competing to retain and attract the best and brightest.

¹⁵ Tornatzky et al, at 15.

¹⁶ Wolfe, at 1.

¹⁷ *Ibid*, at 1-2.

¹⁸ *Ibid*, at 2.

¹⁹ Wolfe, at 3.

²⁰ Tornatzky et al, at 15.

As a result of these changes, universities – as large-scale producers of new knowledge, technologies and talent – have moved from the periphery to the centre of regional economies and find themselves uniquely positioned to contribute to this new economic order. While their traditional missions are more important than ever, their roles have also multiplied and the institutions themselves have moved to occupy a central place in regional innovation ecosystems.²¹

With new roles have come new approaches. Universities are starting to move away from a narrow focus on patents and licencing to acknowledge and codify the full range of processes through which the knowledge they generate flows out into the market, and to establish supportive policies, programs and infrastructure to make these processes more efficient. Universities are also starting to play a much larger role in supporting entrepreneurship – both by educating their students and researchers about entrepreneurship, but also by providing an integrated suite of supports to entrepreneurs from their institution and their region more broadly. Finally, universities are increasingly playing a catalytic role, entering into partnerships with other regional stakeholders and exercising leadership, in regional economic development efforts.

While these roles and approaches will be explored more fully later in this paper, it's important to point out that universities are diverse and exist in unique contexts. This requires that they adopt a strategic approach to optimizing their 'innovation contribution' and align their efforts with the unique characteristics of the innovation ecosystem they inhabit.²² Using regional case studies and 831 interviews from 6 countries, MIT's Local Innovation Systems Project,²³ identified four pathways of innovation-led regional growth that can be used to characterize this ecosystem and industry sub-sectors within it:²⁴

1. Indigenous creation of new industry (e.g. Silicon Valley – personal computers)
2. Transplantation of new industry (e.g. I-85 Corridor in NC/SC: Automotive)
3. Diversification of existing industry (e.g. Akron, OH: Tires → Advanced polymers)
4. Upgrading of existing industry (e.g. Tampere, Finland: Industrial Machinery)

Where a region (or industry sub-sector within a region) finds itself on this continuum, should inform a university's choice of economic development strategies. Different industries and different development pathways demand different kinds of university participation in innovation processes. These can include:²⁵

- Generating new innovations
- Educating at all levels of the labor market

²¹ Safford, Sean. *Universities, Innovation and the Competitiveness of Local Economies*. PowerPoint presentation delivered at SSTI Conference, Oklahoma, 2006. At 34.

²² *Ibid* at 43.

²³ An international research partnership investigating how local economic communities survive and prosper in the rapidly changing global economy. For more information, please visit the Local Innovation Systems Project website: <http://web.mit.edu/lis/>

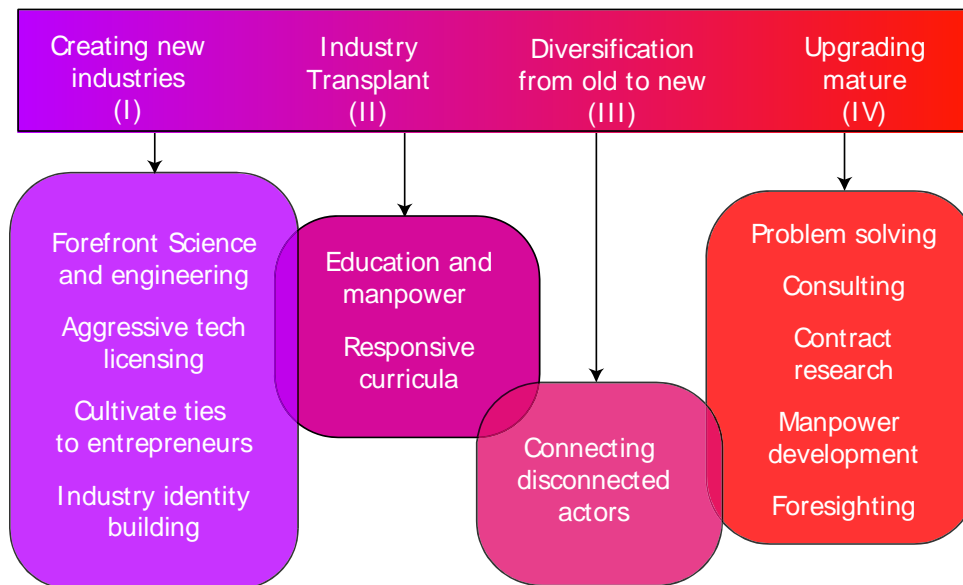
²⁴ Safford, at 23.

²⁵ Safford at 34.

- Spinning out new companies
- Opening access to specialized equipment
- Investing in property and high-growth ventures
- Facilitating industry groups and leading civil society response.

Universities have different ways of contributing and should avoid a one-size-fits-all approach. Figure 1 below provides illustrative examples of university approaches tailored to regional industry characteristics. The sections that follow take a more-in-depth look at some of the different roles universities can play with respect to innovation and economic development.

Figure 1: University’s role depends on region’s development trajectory²⁶



Source: S. Safford. PowerPoint presentation, SSTI Conference, Oklahoma, 2006.

²⁶ *Ibid* at 26.

III. Development of highly qualified personnel

The provision of skilled graduates is one of the primary economic contributions of universities and a highly effective form of knowledge transfer

Many studies of the economic benefits of publicly funded research point to skilled graduates as the primary benefit that arises from this investment.²⁷ In addition to providing direct training to undergraduate and graduate students, researchers, and post-docs, universities may also provide specialized programs to address skill shortages, as well as executive and mid-career education programs.

New graduates, by virtue of their participation in basic research, enter industry equipped with training, knowledge, networks and expertise. They bring familiarity with recent scientific research, as well as an ability to solve complex problems, perform research, and develop ideas.²⁸ Their skills may also include highly valued expertise with advanced instrumentation, techniques and scientific methods.²⁹

This supply of new, highly trained personnel is one of the most effective forms of knowledge transfer to industry³⁰ and of increasing the absorptive capacity of firms when it comes to the take-up of innovative ideas and discoveries.³¹ Firms also indicate that students fresh from their educational experience bring to the firm an enthusiasm and critical approach to research and development that stimulates other members of the research team.³²

Firms are attracted to – and benefit from – large pools of talent

Universities play an important role in attracting new firms to their regions, by virtue of the skilled labour pools they create. Firms are particularly attracted to locations with large talent pools because they reduce the cost of finding and recruiting talent. They also make it easier to relocate individuals because there is some guarantee of successive job opportunities.³³ Evidence has shown that workers are also more productive when surrounded by others with high human capital, while the quality of skills available raises the level of innovation in local firms.³⁴ As highly mobile knowledge workers change jobs, their knowledge travels with them leading to further cross-pollination of ideas and innovation.³⁵

²⁷ Wolfe at 13.

²⁸ *Ibid*

²⁹ *Ibid*

³⁰ *Ibid* at 13-14.

³¹ Lawton Smith, H. *Universities and territorial development: A review of the evidence*. Environment and Planning C, Government and Policy 2007 25, 1 98 - 114. London: 2007. At 8.

³² Wolfe at 14.

³³ *Ibid* at 15,

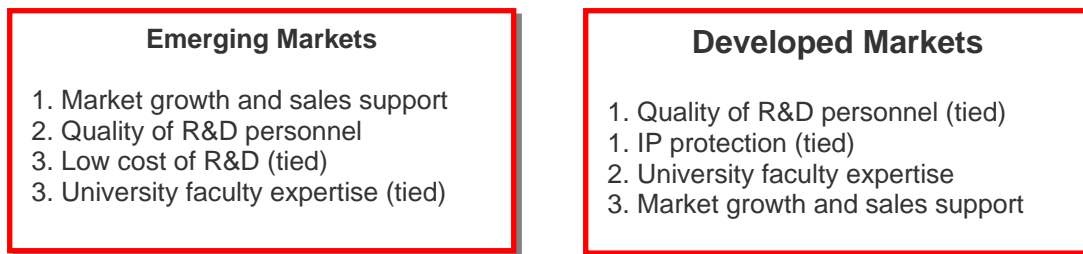
³⁴ Lawton Smith at 9.

³⁵ *Ibid*

Concentrated talent influences cluster development and helps to drive regional economic growth

On a regional level, concentration of creative and highly skilled talent is a critical factor influencing the development of clusters and the growth of dynamic urban economies.³⁶ Universities help to attract and retain members of the creative class identified by Richard Florida as central to the development of urban knowledge economies.³⁷ Large pools of highly qualified R&D personnel – within and outside the university – are also a particularly important factor in R&D site location selection. Figure 2 below summarizes the results of research conducted by SSTI on the primary location drivers for R&D sites in emerging and developed markets.³⁸

Figure 2 Drivers of future R&D sites: ranked reasons for site selection



Source: SSTI.

U.S. states are beginning to establish “eminent scholar programs” to help attract and retain leading international researchers

Over 90 percent of the most significant R&D is generated by a small, highly talented core of fewer than 10 percent of researchers.³⁹ As a result, some American states are seeking to build their research base by providing universities with the means to attract internationally eminent faculty, or ‘eminent scholars.’ There are two complementary strategies universities can use to build this core – pick highly talented junior faculty and work to retain those who mature into world-class scientists and recruit senior researchers with established reputations and research programs.

Eminent scholar programs are designed to increase the R&D dollars that flow into a region by recruiting faculty that have an excellent track record of successfully competing

³⁶ Wolfe at 15.

³⁷ Smith at 9.

³⁸ Battle, P.; Slanina, J.; Skinner, M. *Recent Research: Studies that Should Influence TBED Policy and Practice*.

SSTI PowerPoint presentation delivered at SSTI Conference, Oklahoma, November 2, 2006. At 8.

³⁹ SSTI at 13.

for R&D awards. A cluster of such appointments can provide an important stimulus to building a regional knowledge economy.

Successful eminent scholar programs exhibit 3 common characteristics – they:⁴⁰

- *Recruit the right type of person* – Eminent scholars should be world-class researchers and have a desire to see their discoveries commercialized, either by them or by someone else.
- *Provide infrastructure funding* – Funding provides labs and equipment to support an eminent scholar’s research team. This infrastructure must go hand-in-hand with the endowed chair in order to attract an eminent scholar.
- *Have a strategic research focus* – Successful programs target specific areas of depth and try to build on previous investments. Recruiting a number of key research faculty in a particular area will help to build critical mass and is much more likely to result in the growth and attraction of new companies.

This mechanism is most appropriate for regions that have a less developed R&D base, and is usually part of a larger, more comprehensive economic development effort, as an eminent scholar program alone will not necessarily lead to economic benefit.⁴¹

Figure 3 Georgia Research Alliance Eminent Scholars Program selection criteria⁴²

SELECTION CRITERIA
GEORGIA RESEARCH ALLIANCE EMINENT SCHOLARS PROGRAM

- Eligible at the rank of professor
- Grant productivity – \$1+ million in awards over 2 years or bring in a major grant
- Well respected in their field and broadly cited over a sustained period
- General belief the field they work in will be strong for the next several years
- Has potential to develop a large-scale, well-funded interdisciplinary centre
- Track record of building teams and mentoring others
- Likely to interact comfortably with high level industry and government personnel
- Interested in creating his/her own company or working with others to commercialize a new technology/discovery.

Source. Adapted from *A Resource Guide for Technology-based Economic Development*, SSTI, 2006.

⁴⁰ *Ibid* at 19-20

⁴¹ *Ibid* at 19.

⁴² Adapted from SSTI (2006) at 19-20.

Eminent scholar programs require significant investments but generate returns of \$5-20 million in research funding over 10 years

Building a university R&D base takes significant investment. The Georgia Research Alliance has invested \$400 million in people, labs and equipment since 1992 using a mix of sources including the state lottery, the state's tobacco settlement fund, university funds, and private sources, while the Kentucky legislature appropriated \$350 million over several years to fund its Research Challenge Trust Fund.⁴³

Eminent scholar programs provide funding for endowed chairs, at a cost of US\$3-6 million. This covers all or most of the incumbent's salary, some start-up costs to outfit a laboratory, and possibly some research assistant positions. This is a one-time investment with a return anywhere between \$5 million and \$20 million in research funding over a ten-year period.⁴⁴

Critics counter that more can be gained from investing much smaller amounts of money to support a large number of talented junior faculty members. There is also concern that eminent scholars may be lured away by other institutions.⁴⁵ The fact that foreign-born stars are returning home as their native countries gain research capacity also presents a risk.⁴⁶

Attracting and retaining eminent scholars both enhances regional economic development and is a by-product of success in this arena

Universities that are effective generators of technology-based growth are able to recruit and/or retain star researchers. In many cases, these hold appointments that are oriented toward both fundamental science and real world (e.g., industrial, social, cultural) applications.⁴⁷

Star researchers gravitate towards higher-ranked institutions and consequently, begin to cluster over time, unlike other university performance indicators such as patents and highly cited publications, which tend to diffuse geographically.⁴⁸ Interestingly, research indicates that it is the physical presence of stars, and not their research or discoveries, that is related to firm entry.⁴⁹

⁴³ *Ibid* at 21.

⁴⁴ *Ibid*

⁴⁵ *Ibid*

⁴⁶ Zucker, L. and Darby, M. *Movement of Star Scientists and Engineers and High-Tech Firm Entry*. NBER

Working Paper No. 12172 - April 2006, as cited in Battle (2006) at 14.

⁴⁷ SSTI at 12.

⁴⁸ Zucker and Darby, as cited in Battle (2006), at 14.

⁴⁹ *Ibid*

Universities can also play an important role through industry education and training partnerships

With predictions of labor shortages for many science and technology fields in the coming years and concerns about “brain drain,” many universities have focused new attention on how they can apply their traditional educational mission to help meet regional industry labor needs.⁵⁰

Universities engaged in research partnerships with science and technology firms are also likely to be partnering on a range of non-degree educational programs designed to target sectoral human resource needs. These may include graduate certificate programs in technical or management areas, executive development programs, weekend MBA programs, and corporate-focused distance education.⁵¹

Universities oriented toward a regional impact may also undertake special outreach to local companies, and provide feedback to academic units about post-placement needs and opportunities. If a region is trying to develop a particular technology industry sector (e.g., biotech), placement services may get involved to try to better understand the hiring needs of such employers.⁵²

⁵⁰ Tornatzky *et al*, at 18.

⁵¹ *Ibid*

⁵² *Ibid*

IV. Research and knowledge production

Firms benefit from knowledge generated by universities at lower cost than they can produce it themselves

In addition to training and graduating highly qualified personnel, universities play a significant regional economic role by strengthening their region's intellectual infrastructure and producing knowledge spillovers.⁵³ These are defined as the flow of ideas between agents at less than original cost.⁵⁴ In other words, firms benefit from knowledge produced by universities at a cost lower than had they produced the knowledge themselves.

Knowledge gained by firms in this manner is shared with others through recruitment, collaboration, and customer-supplier relationships. Proximity is important in this dynamic because it facilitates flow and because some of the knowledge firms need is tacit and therefore requires direct personal contact.⁵⁵ As firms located near universities tend to obtain knowledge at a lower cost than firms farther away, universities can exert 'spatial pull,' causing firms to agglomerate to reduce these costs. This concentration of firms around a university results in beneficial agglomeration economies.⁵⁶

While universities are not the main source of new industry knowledge and ideas, they do contribute a broad range of knowledge inputs to regional innovation systems

Research has shown that universities and public research institutes are not the main sources of external knowledge for firms. Their greatest source is their clients and customers.⁵⁷ Despite this, it is no coincidence that high-technology regional economies are usually anchored by great research universities. Universities contribute a broad range of knowledge inputs to innovation:⁵⁸

- . Patents
- . Licenses
- . Contract research
- . Consulting/problem solving services for industry
- . Design and engineering
- . Testing services.

These inputs are usually at the early stages of innovation when firms and industries are seeking new ideas.⁵⁹

⁵³ *Ibid* at 14.

⁵⁴ Smith at 7.

⁵⁵ *Ibid*

⁵⁶ *Ibid* at 8.

⁵⁷ *Ibid* at 15.

⁵⁸ *Ibid* at 5.

⁵⁹ *Ibid* at 6.

Strong industry-university alliances are needed to connect university research strengths and regional industry strengths

Despite this important relationship between universities and regional firms, the latter are rarely involved in the choices universities and their faculty make when it comes to building research strengths. Universities recruit and build research capacity based on their existing strengths and the interests of their faculty. This can result in the emergence of whole new industries, such as biosciences and information technologies but, in other fields – energy, materials, or advanced manufacturing – there are often few links between university research and industry strengths.⁶⁰

In the U.S., state governments have attempted to address this disconnect by supporting and funding research and development, technology applications, and other programs to help create new emerging industries or build stronger relationships between existing industries and the region’s higher education anchors.⁶¹

Results have been mixed, partly because federal research funding dwarfs that of states, however, efforts by regional leaders to create critical research mass in areas of strategic importance to regional industry are important and do have an effect.⁶²

Leading universities perform world-class research in strategic areas, based on their core competencies and regional industry strengths, supported by high-quality infrastructure

Universities that are most responsive to the knowledge economy are performing world-class research in areas that correspond to the science and technology drivers of their national and regional knowledge sectors.⁶³ Investments in building research excellence are strategy-driven, and key areas are often identified based on an analysis of the core strengths of the university itself, other regional research institutions, and the regional economy.⁶⁴ This strategic focus is as important as the magnitude of research.⁶⁵ In U.S. universities, the resulting strategic plans provide direction for:

- Hiring “stars” in targeted fields
- Targeting federal R&D funds
- Increasing corporate sponsored research
- Promoting state initiatives that leverage federal and corporate funds.⁶⁶

A number of the leading universities examined actively engage regional industry in their strategic planning process. Most also have joint university-industry centres of excellence

⁶⁰ Tornatzky *et al* at 11.

⁶¹ *Ibid*

⁶² *Ibid*

⁶³ SSTI at 12.

⁶⁴ *Ibid* at 13.

⁶⁵ Palminteri *et al* at iii.

⁶⁶ *Ibid*

focused on key technology areas of importance to regional industry clusters.⁶⁷ In addition to conducting research of value to the industry, these centres enable the university to turn out significant numbers of undergraduates and graduates that provide the workforce needed by the industry.

Leading universities also have the physical infrastructure needed to support research and technology development. This includes laboratories equipped with state-of-the art instrumentation, attractive classrooms and learning centres encompassing the best instructional technologies, university-affiliated research parks to foster partnering and interaction with industry, and conference facilities that provide a range of venues for scholarly and business-oriented interaction.⁶⁸

⁶⁷ SSTI at 12.

⁶⁸ SSTI at 12.

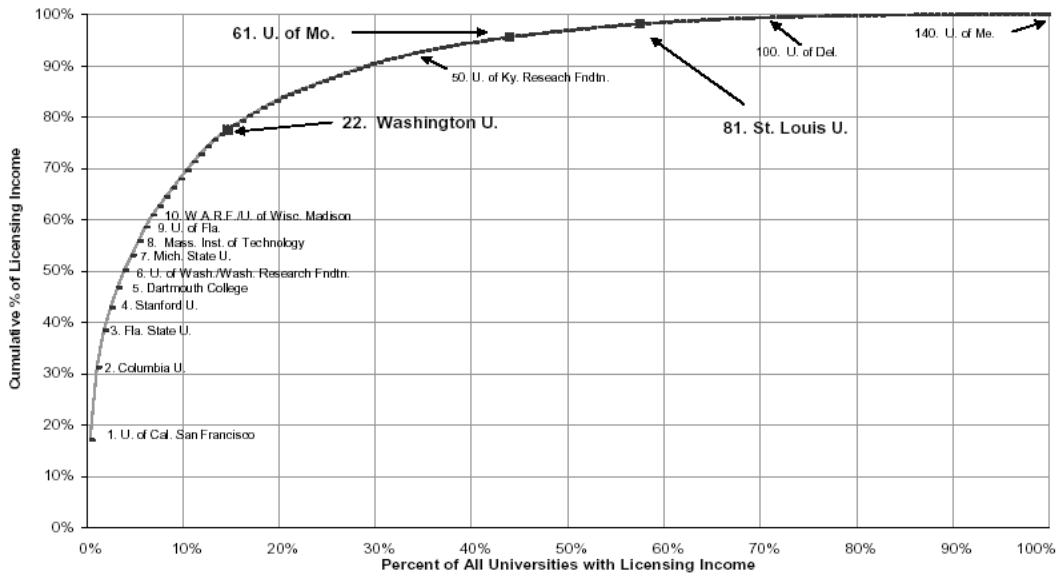
V. Technology transfer

Formal technology transfer – through patenting, licencing and spinoffs – has become a function of most universities, but only a handful achieve significant and sustained success

The purpose of such interactions is to generate and transfer relevant knowledge, technologies and innovations to industry. In the United States, the 1980 *Bayh-Dole Act* helped to establish technology transfer as a primary part of many university missions by giving universities ownership of all intellectual property arising from federally funded research.

Most universities in North America today have some form of technology transfer office (TTO). However, commercialization indicators (patents, licenses, university spin-offs) indicate that universities have experienced varying levels of success, with significant and sustained success concentrated among only a small number of institutions. *Figure 4* below illustrates this fact with regard to licensing income, one measure of commercialization impact.

Figure 4 Cumulative distribution of licensing income among US universities, 1999 and 2000⁶⁹



Source: AUTM Technology Transfer Data for Two-Year Recurrent Respondents; N=140.

⁶⁹ Graph reproduced from Litan, Robert E.; Mitchell, Lesa; and Reedy, E.J. *Commercializing University Innovations: A Better Way*. Working Paper. National Bureau of Economic Research. Cambridge, MA. April 2007. At 30.

Most technology transfer does not involve patenting and much if it is informal

Licensing university patents is only one of several ways that companies access university technology. The most commonly reported mechanisms for diffusion of public research to industry are publications, conferences, and informal exchanges.⁷⁰

Informal technology transfer mechanisms facilitate the flow of technology knowledge through informal communication processes, such as technical assistance, consulting and collaborative research. Patents rank low in most industries except for pharmaceuticals,⁷¹ therefore, indirect mechanisms for the transfer of new ideas and innovations may be more important. Property rights play a secondary role, if any, in these processes and obligations are normative rather than legal.

Tenured faculty members are more likely than untenured faculty members to engage in all three forms of informal technology transfer noted above.⁷² This is due in part to “accumulative advantage” – tenured faculty members have had a longer time to develop skills and produce bodies of work useful for industry and to develop networks that may include industry personnel. Tenure can also be a rough proxy for quality, causing tenured faculty to be in greater demand by industry. They may also have a stronger inclination to supply such activity, because they already have tenure and are free to engage in activities that may have limited or no benefit in tenure decisions.⁷³

The longer a faculty member has been tenured, the higher the probability that he/she will be involved in all forms of informal technology transfer.⁷⁴ Faculty members who allocate a relatively higher percentage of their time to grants-related research are more likely to engage in informal commercial knowledge transfer and to publish with industry scientists.⁷⁵ Companion research using the same data suggests that this is especially the case for grants and contracts from industry.⁷⁶ Placement of former graduate students is a key determinant of institutional collaborations, especially collaborations with firms and with foreign scientific institutions.⁷⁷

⁷⁰ *Ibid.*

⁷¹ Carnegie Mellon Survey of Industrial R&D cited in Litan *et al* at 8.

⁷² Link, A.N.; Siegel, D.S.; Bozeman, B. *An Empirical Analysis of the Propensity of Academics to Engage in Informal University Technology Transfer*. Rensselaer Working Papers in Economics. Troy, NY. May 2006. At 13.

⁷³ *Ibid* at 13-14.

⁷⁴ *Ibid* at 14

⁷⁵ *Ibid*

⁷⁶ Bozeman and Gaughan (2006) cited by Link *et al* at 14.

⁷⁷ Link *et al* at 9.

*The prevailing revenue maximizing technology transfer model is believed to be inhibiting increased technology transfer through a broader range of formal and informal processes*⁷⁸

There is broad acknowledgement that some universities have been commercializing much longer than others and consequently have developed more of the experience and expertise needed to do so successfully. However, the differential success across institutions is increasingly believed to stem primarily from the prevailing *revenue maximization model* of commercialization that took root in the 1980s.⁷⁹

Rather than implementing broad innovation/commercialization strategies that recognize and support different pathways of commercialization, many universities have focused on creating a single centralized Technology Transfer Office (TTO). These are largely expected to be gatekeepers and protectors of university intellectual property and to maximize university revenue streams. Consequently, the principle mechanism favored by most TTOs is licensing for cash, followed by licensing for an equity stake and sponsored research respectively.⁸⁰

Several flaws have emerged in this revenue maximization model of technology transfer.⁸¹

- Reward structures and centralization turn TTOs into monopoly gatekeepers aimed at maximizing university revenues earned by the university.
- This leads to a “home run” mentality – TTO officers focus their limited time and resources on the technologies that appear to promise the greatest and fastest payback.
- Technologies with longer-term potential—or that might be highly useful for society as a whole (such as many “research tools” used mainly by other researchers)—tend to be overlooked.

Many universities also experience technologies “going out the back door.”

When researchers do patent, many of them choose to circumvent their university TTO. Forthcoming research by Markman, Gianiodis, and Phan⁸² indicates that 33% of all patents are assigned outside of university technology licensing offices and that 42% of all faculty members have “bypassed” their university at least once in this process. Patents with greater value (those more highly cited) are taken directly to the private sector more often. This raises the question of whether universities should encourage the involvement

⁷⁸ Litan *et al* at 2.

⁷⁹ *Ibid* at 7.

⁸⁰ Litan *et al* at 8. These interview-based findings are for the United States only. They were confirmed by the authors in a review of TTO mission statements. In their view, they are consistent with other research in this area.

⁸¹ *Ibid* at 8.

⁸² Markman, Gianiodis, and Phan *Why Do University Researchers Bypass University Tech Transfer Offices?*. Forthcoming. Cited in Battle *et al* at 17.

of non-university entities in patenting in order to maximize the exploitation of research discoveries and build the local entrepreneurial culture.

Reluctance to engage in formal technology transfer through TTOs is not confined to faculty members. Hertzfeld, Link, and Vonortas (2007) surveyed and interviewed chief intellectual property attorneys at 54 R&D-intensive U.S. firms, concerning intellectual property protection mechanisms related to university patents. Firms expressed great difficulty in dealing with university TTOs, citing:⁸³

- The inexperience of the technology transfer staff
- Their lack of business knowledge
- Their tendency to inflate the commercial potential of the patent.

As a result of this dynamic, the more fundamental goal – to maximize the potential for university-based inventions to result in commercialized new products and innovations – remains unmet in many cases.

Successful universities seek to maximize commercialization volume and speed rather than licensing revenue and avoid centralizing all commercialization activity in a single office

Universities are not unfamiliar with the issues raised above. Some universities⁸⁴ have begun to codify a broader range of technology transfer pathways and to implement approaches that maximize commercialization volume and speed rather than their own licensing revenue,⁸⁵ although these revenues remain substantial in some cases. These universities also recognize that commercialization and innovation activities cannot be run through a single office and require cross-university programmatic initiatives.

Under this model, technology is best diffused by recognizing and taking advantage of the decentralized nature of innovation and the university faculty who participate in this process. As TTOs are increasingly seen as just one component of the innovation and commercialization ecosystem, technology transfer is expected to increase in efficiency, volume, and quality.

Many U.S. university campuses have experienced a gradual cultural change since the passage of Bayh-Dole, and are now facing the challenge of defining multiple pathways to support university innovation and commercialization and redefining the role of their TTOs.⁸⁶

Suggested approaches include reorganizing TTOs to reduce the transaction costs involved in moving scientific discoveries more rapidly into the marketplace. One approach is to adopt a “value chain” model,⁸⁷ disaggregating their functions and assigning them to

⁸³ Hertzfeld, Link, and Vonortas (2007) cited by Link *et al* at 9.

⁸⁴ E.g. MIT, University of Arizona, University of California Berkeley.

⁸⁵ Litan *et al* at 11.

⁸⁶ *Ibid* at 12.

⁸⁷ Phan and Siegel (2006). Cited by Litan *et al* at 13.

specialists, while leveraging outside organizations and other partners in the process.

Universities are also encouraged to recognize that patenting is only one of many pathways from innovation to marketplace and to change their technology commercialization *objective* and *model* from a *licensing model* that maximizes licensing income to a *volume model* that emphasizes the number of university innovations and the speed with which they are moved into the marketplace. There are different volume models⁸⁸ but they all:

- Provide rewards for moving innovations into the marketplace
- Focus on faculty as the key agents of innovation and commercialization
- Emphasize greater standardization in faculty and industry interactions.⁸⁹

Time between discovery and commercialization is an important consideration in this process. Accelerating commercialization provides benefit to both the university (a faster return to R&D) and the commercializing agent (more flexibility with time in terms of testing or bringing products to market), but average commercialization speed – from discovery to licensing or spin-off – is just over four years.⁹⁰

Success in generating university spin-offs is linked more closely to intellectual eminence and institutional policies, than availability of venture capital or amount of commercial research

University spin-offs – new firms established to commercialize discoveries and innovations generated by faculty members – are an important sub-set of university commercialization. These play an important role in regional economic development because they often offer greater regional economic benefit than licensing, as the resulting jobs and wealth are more likely to be retained regionally.

While only a relatively small percentage of overall start-ups, university spin-offs are often disproportionately high performing companies^{91,92} and help bridge the development gap between university technology and existing private sector products and services. With venture capital firms moving toward later stage investments,⁹³ the role of universities in nurturing early stage start-ups may be increasingly important.

⁸⁸ Litan *et al* at 13.

⁸⁹ These models are outlined together with their strengths and weaknesses in Litan *et al*.

⁹⁰ Litan *et al* at 10.

⁹¹ According to a 2002 Association of University Technology Managers (AUTM) report, of the 3,376 academic

spin-off companies created in the United States from 1980 to 2000, 68 percent of these companies

remained operational in 2001. Cited in Litan *et al* at 10.

⁹² According to Goldfarb and Henrekson (2003) an estimated 8% of all university spin-offs had gone public,

114 times the rate for U.S. enterprises generally. Cited in Litan *et al* at 10.

⁹³ PricewaterhouseCoopers and National Venture Capital Association 2007. Cited in Litan *et al* at 10.

A 2001 study by Di Gregorio and Shane examined 4 hypotheses for cross-institutional variation in university new firm formation rates from 1994-1998:⁹⁴

- Availability of venture capital in the university area
- Commercial orientation of university research and development
- Intellectual eminence
- University policies.

The study concluded that universities' intellectual eminence and licensing policies have a significant impact on start-up activity, while there is little evidence that venture capital availability and the commercial orientation of research influence TLO start-up activity.

More eminent universities appear not only to generate a greater amount of patentable intellectual property, but also create more start-ups to exploit that intellectual property, while two sets of university licensing policies—policies regarding the distribution of royalties to inventors and whether or not the university is permitted to take an equity stake in licensees—appear to influence start-up activity.

Results showed that the minimum percentage of royalties distributed to inventors is inversely related to start-up activity such that a 10% increase in the inventor's share of royalties implies 0.40 *fewer* start-up firms per year, a decrease of 20 percent from the mean. The other licensing policy that appears to influence start-up activity is equity policy. Universities that were willing to take an equity stake in licensees in exchange for paying up-front patenting and licensing expenses have a start-up rate 1.89 times that of universities that were not willing to take equity.

Two additional policy variables were tested—the presence of a university affiliated incubator and whether or not the university was permitted to actively make venture capital investments in licensees. Neither of these appeared to have an impact on start-up activity. Study results also provided no evidence that start-up activity is influenced by the local availability of venture capital funding.

The results did provide limited support for the view that universities that conduct more commercially oriented research will experience greater TLO start-up activity. When commercial orientation was measured by the percentage of industry sponsored research funding related to overall research funding, the results were positive but not significant. However, when commercial orientation was measured by the absolute dollar amount of industry funding, the results were positive and significant.

Overall these effects were found to be stronger among eminent universities than among the overall sample or less eminent schools. In the case of the latter, only the policy of taking equity appears to influence start-up rates. Start-up rates at less eminent

⁹⁴ Di Gregorio, Dante and Shane, Scott. *Why Do Some Universities Generate More Start-Ups Than Others?*

Working Paper. Centre for Human Capital Innovation and Technology, University of Maryland. 2001.

universities appear to be driven by more idiosyncratic factors than start-up rates at more eminent institutions.

Universities are only one side of the technology transfer equation – realizing the commercial benefits of basic research depends on the capacity of firms to make use of this knowledge

The success of technology transfer efforts does not lie with universities alone. Realizing the economic benefits of basic research is a complex process that requires that regional firms have the absorptive capacity to make use of the scientific knowledge that universities generate. This insight shifts the focus from the commercial applicability of knowledge to processes that enable a firm to successfully absorb and apply that knowledge.

Knowledge is dynamic and often unarticulated, and firms must invest substantial resources of their own before they have the capacity to both perceive when knowledge is economically valuable and to capture that economic value.⁹⁵ Research shows that firms that conduct their own R&D are better able to use externally available information. This suggests that a firm's absorptive capacity is linked to its level of R&D investment.⁹⁶ If this is so, then the underinvestment of Canadian firms in research and development relative to peer firms elsewhere would suggest that there is a significant structural barrier to successful knowledge transfer that cannot be solved by universities alone.

In any given regional innovation system, the relationships between institutions that perform basic research and those that develop its commercial potential are myriad and complex, and require a sophisticated framework for identifying and analyzing institutional and interpersonal linkages and how those contribute to knowledge transfers.⁹⁷ In general, these transfers are highly localized. Pools of, often, tacit knowledge are shared across institutional and personal networks of highly qualified personnel from firms and universities, reinforcing once again that the flow of researchers between the two sectors, and their overlapping networks, are the most effective knowledge transfer mechanisms of all.⁹⁸

Even where this relationship is close, however, it depends on the science base. There must be an integrated fit between industry sector strengths and research strengths. Without this fit, firms will source their ideas and innovations elsewhere. The pharmaceutical sector offers an excellent example of this. In the U.S., the field of chemistry research is strongly integrated with the pharmaceutical industry. In Europe, while there are strong areas of research specialization, the basic chemistry research relevant to industry is absent. As a consequence, EU companies source research results from the United States.⁹⁹

⁹⁵ Wolfe at 6.

⁹⁶ *Ibid* at 9.

⁹⁷ *Ibid* at 6.

⁹⁸ *Ibid* at 3.

⁹⁹ Lawton Smith at 15.

Studies have disproven the notion that older or low-tech industries will not work with universities, however, the preferred means of interaction varies by field. For instance, the main mechanism in mechanical engineering is contract research to solve specific technical problems, while in chemistry the education and provision of personnel are the most important means of technology transfer.¹⁰⁰ Firm size can also be an important variable. Large firms may be more likely to work with universities because of greater absorptive capacity, however small firms may be more innovative and also enjoy productive links with universities.¹⁰¹

¹⁰⁰ *Ibid* at 16.

¹⁰¹ *Ibid*

VI. University-industry research collaboration

Universities engaged in regional economic development generally have a robust portfolio of industry research partnerships, with customer-friendly enabling structures and policies

Universities interested in contributing to regional economic development actively seek to establish research partnerships with industry, in addition to any education and training programs partnerships they might have.

A growing body of social science research documents the impact of university research on industrial innovation and performance. According to this, an estimated 10% of new industrial processes are attributable to recent academic research, resulting in a social rate of return of 28%.¹⁰² Proximity to a university and direct involvement in partnership linkages with industry-university centres can contribute to these benefits.¹⁰³ More recent studies confirm this relationship between academic research and industrial performance.¹⁰⁴

These partnerships may take a variety of forms determined by the desired research output, research field, size of firm, industry sector, and the preferences of the industry and university personnel and organizations involved. In general, firms seek help with specific problems (analytic work) or engage in longer-term conversations in order to monitor and understand where technologies and markets are going (interpretive).¹⁰⁵

Traditional predictors such as quality of the faculty or size of research and development budget explain only a small amount of the variance in which universities were cited by industry.¹⁰⁶

Many universities have functions, people, or units that are involved in partnership activities intended to impact on economic development, but universities differ in the extent to which these are adequately staffed, supported, and important.

In their landmark study, *Innovation U: New University Roles in a Knowledge Economy* (2006), Tornatzky, Waugaman and Gray identified the leading U.S. universities in relation to business-higher education partnerships and examined their diverse approaches.¹⁰⁷ Their research shows that universities that are aggressively partnering with industry have a robust portfolio of industry-sponsored research, with “customer-friendly” structures, policies, and procedures to enable this activity. This might include

¹⁰² Mansfield (1991) cited in Tornatzky et al at 16.

¹⁰³ Tornatzky et al at 17.

¹⁰⁴ *Ibid* at 16.

¹⁰⁵ Safford at 22.

¹⁰⁶ Mansfield(1995) cited in Tornatzky et al at 17.

¹⁰⁷ These were: Georgia Tech, Virginia Tech, University of Utah, Carnegie Mellon University, North Carolina State University, Ohio State University, Penn State University, Purdue University, Texas A & M University, University of Wisconsin, Stanford University, and the University of California San Diego.

an industry liaison office – offering one-stop-shopping for firms interested in any form of university-industry collaboration – and flexible contracting procedures. If actively pursuing regional economic development, the university may also make special efforts to involve regional companies in these research partnerships.¹⁰⁸

Industry/university advisory boards and councils are an important means of connecting university research and industry strengths and fostering research partnerships

One means of doing this is through the creation of industry/university advisory boards and councils. These may be at the highest institutional level (e.g. advisory to the university president) or at the program level, and generally undertake activities to promote mutual exchange and learning between the university and the private sector (e.g., visioning future technology trends, providing feedback on existing academic programs).

These councils are an important means of connecting the university's research strengths to regional industry needs, creating larger and more highly interwoven networks of university and industry personnel, and building the trust and personal relationships necessary to successfully bridge the often profound cultural differences between academe and the private sector.

Many universities offer consulting and technical assistance to industry, drawing on the existing expertise and knowledge of faculty members rather than new research

Universities may be involved with industry by providing problem-solving technical assistance for companies in their region. Generally speaking, this does not involve new research or knowledge, but taps into the established expertise of faculty members, graduate students, consultants, and extension staff. This reflects the fact that much industrial innovation growth occurs without a research trigger, depending instead on optimal or novel use of existing knowledge.¹⁰⁹

There is a growing body of empirical research that supports the impact that such services can have on economic outcomes.¹¹⁰ Most services target small and medium-sized manufacturing operations that are an important, but traditionally neglected, segment of the economy.

Services are typically on a partial cost-recovery basis and may be incorporated into national efforts such as the National Institute of Standards and Technology Manufacturing Extension Program.¹¹¹ University faculty are involved on a project basis and programs tend to be incorporated into a college of engineering or business administration. Some programs may address issues of technological infrastructure, such

¹⁰⁸ Tornatzky et al at 17,

¹⁰⁹ *Ibid*

¹¹⁰ *Ibid*

¹¹¹ *Ibid*

as telecommunications capacities.¹¹²

University-industry research centres are increasingly common and are directly focused on accelerating regional technology-based economic development

In addition to consulting and technical assistance, the last 10 years has seen a significant increase in the number of joint industry-university research centres. These centres are aimed at achieving technology-based economic development by leveraging a region's university research strengths to:¹¹³

- Build a region's research enterprise
- Encourage academic researchers to undertake research with potential economic benefits
- Assist local companies by tapping university resources
- Encourage the commercialization of university-developed discoveries.

While interest in university-industry research centres waned somewhat in the 1990s, due to concerns that they were not having the desired economic development impact, they are experiencing a comeback due to the rapid growth of multi-institutional, multi-disciplinary research.¹¹⁴ An increasing share of university research is now being channeled through such research centres/institutes.

Centre budgets vary greatly. Those that provide support for buildings and equipment often require millions of dollars. Those that simply provide operating support may be considerably smaller. While centres are often started with government and private sector funding, successful centres compete effectively for federal awards.

Joint research centres require industry participation and matching funding, focus on a specific technology area, are multi-disciplinary and aim to commercialize their discoveries

University-industry research centres vary significantly in design, depending on their objectives, but generally involve:¹¹⁵

- Industry participation
- Requirements for matching support from industry
- Focus on specific technology areas
- Multi-disciplinary research
- Commercialization objectives.

¹¹² *Ibid*

¹¹³ SSTI at 14-15.

¹¹⁴ *Ibid* at 14.

¹¹⁵ *Ibid* at 15-16.

Industries participate in joint research centres to gain access to cutting-edge researchers and equipment and to find talented graduate students. Levels of industry involvement vary from the provision of financial support and serving on industrial advisory boards (industrial affiliate model) to industry holding the majority of seats on a Board of Directors and driving a centre's direction.

Industry investment in a centre is an effective measure of its support. Today, centres are often required to raise a minimum of three to four dollars for every dollar of public investment.¹¹⁶ Successful centres often able to achieve higher leverage ratios, particularly if federal funds are also taken into account. Requiring a cash match is an essential success factor, as in-kind matching often leaves centres under funded. However, a balance is necessary to enable participation of smaller companies.

Successful industry-university research centres target carefully selected research areas that are already important to the existing industry base or are emerging areas that offer the prospect of developing new companies and industries.¹¹⁷ Two main approaches are used to identify these strategic technology areas:

- Identify research strengths of the region's research institutions and analyze the region's economic base to identify niches that offer the greatest development opportunity
- Issue a competitive request for proposals, letting universities and industry come together to propose areas of focus.

The RFP process is preferred if the goal is to support existing industry — it is market-driven and requires tangible partnerships to be formed, with industry funds committed before public dollars are invested. When the goal is to pick an emerging industry and nurture it, then identifying strategic focus areas is better because there may be no existing industry base. When focusing on an emerging industry, a more comprehensive plan that goes beyond research funding is necessary to support its growth.¹¹⁸

Centres facilitate multi-disciplinary research, on the basis that this is driving new technology areas and commercializable innovations/discoveries. Harnessing these new technologies and finding applications for them in new markets offers great potential for spinning off new companies and products. Building a research base does not automatically result in commercialization, however. Centres increasingly include commercialization staff that can provide financing and business support to researchers.¹¹⁹

¹¹⁶ *Ibid* at 15.

¹¹⁷ *Ibid* at 15-16.

¹¹⁸ *Ibid* at 16.

¹¹⁹ *Ibid*

Research centre success factors include peer review of proposals, high quality personnel, committed senior industry participation, and an effective and regular review process

Successful centres are started by or recruit high quality researchers able to attract R&D funding from multiple sources. Researchers are also willing to interact with industry and are committed to economic relevance and academic excellence. The most effective centre directors are:¹²⁰

- Entrepreneurial
- Credible and able to attract faculty to participate in the centre
- Recognized by the administration
- Able to inspire industry confidence.

Being entrepreneurial is probably the greatest determinant of economic development impact.

Centres should be awarded funding on the basis of a competitive process using peer reviewers to ensure good science and minimize political interference in the selection process to the degree possible. Some U.S. states use out-of-state reviewers. Others use a mix of in-state and out-of-state reviewers. Review teams should have academic and industrial experience.¹²¹

Establishing advanced research centres or centres of excellence requires a long-term funding commitment, including start-up funding to get the centre operating and staffed with researchers who can then leverage additional funding. Funding for centres should be time limited with a process to review performance and renew funding – or cut funding if results are not relevant, or support is no longer needed.¹²² Regular evaluations, including site visits, are important. Many programs bring in external review panels with out-of-state reviewers.

Because successful centres are driven by industry needs, industry needs to play a leadership role.

It is important that centres enlist senior industry participation from individuals who are committed and prepared to drive their firm's participation. Involving senior corporate officers, rather than technical personnel alone, helps to maintain a focus on economic development.¹²³

¹²⁰ *Ibid* at 16-17.

¹²¹ *Ibid* at 16.

¹²² *Ibid* at 17.

¹²³ *Ibid* at 17.

Matching grant programs offer a less costly but effective means to help companies access university expertise and faculty and students to engage in commercially relevant research

As creating centres of excellence can be costly, governments with limited resources may prefer to provide matching grants for university-industry projects.

In the U.S., these are typically funded by state appropriations, although they can also be funded by local governments, foundations and universities. Most annual program budgets are \$1-1.5 million, although program managers indicate that \$5-\$10 million annually would be preferable and help to keep pace with increasing research costs.

Industry-university research matching grants are used to build sustained relationships between a region's technology companies and its research institutions in order to:¹²⁴

- Enable companies to leverage their R&D funding and gain access to faculty expertise and specialized equipment
- Allow faculty and students to engage in commercially relevant research and provide real world experience for students
- Permit companies to engage with student researchers – a source of future talent.

These programs can provide support for activities that help to move technology to the point at which private investment capital can be obtained to commercialize it.

Most matching grant programs solicit applications on a competitive basis and make awards to projects that are technically sound and likely to have a positive economic development impact.¹²⁵ Programs typically require that a company share the costs of the research project, usually conducted by faculty and students on behalf of the company. Cost share levels vary, sometimes based on company size.¹²⁶

The success of matching grant programs typically depends on connecting companies with the right faculty member (companies often do not know how to find a university researcher with the appropriate capabilities to work on their research problem) and ensuring funding amounts are sufficient to attract faculty participation (a minimum of \$40-\$50,000, with potential for additional funding of up to \$250,000).¹²⁷

TBED organizations often play an important matchmaking role, helping companies to identify faculty with the right expertise who are willing to partner with business. Program staff also need to offer this capacity to interested businesses.

¹²⁴ *Ibid* at 22.

¹²⁵ *Ibid*

¹²⁶ *Ibid*

¹²⁷ *Ibid*

VII. Support for entrepreneurship

Universities actively involved in regional economic development are likely to operate or partner with local efforts to foster start-up, technology-based companies

Entrepreneurship is another fundamental component of regional economic development and universities that are actively involved in regional development efforts are likely to operate or partner with local initiatives to boost entrepreneurship and foster start-up, technology-based companies.

Involvement in such activities is often explicitly premised on the idea that successful startups will grow roots in the region where they are created, attracting investment, generating jobs and growth, and helping to build high technology industry clusters.¹²⁸

Universities may engage in a broad suite of initiatives to support this activity, while TTOs will consciously work to commercialize university technologies with regional development objectives in mind, targeting licenses to regional companies or promoting the establishment of a new start-up when commercially appropriate.

Institutional culture and work environment significantly impact whether faculty participate in commercialization and, if so, whether they work with or around the university TTO

Work environment and institutional culture are important influences on entrepreneurial activity among faculty and have a significant impact on whether they engage in commercialization or not¹²⁹ and, if they do, whether they choose to commercialize through their university TTO or circumvent it altogether.

Many faculty members do not disclose their inventions to their university.¹³⁰ Even when an invention is publicly disclosed, some firms will contact scientists directly and arrange to work with them through informal technology transfer.¹³¹ It is important to understand why this is so if university administrators are to support these alternate processes or, alternatively, attempt to encourage more formalized approaches where appropriate.

Structured interviews with over 100 academic scientists who had interacted with technology transfer offices revealed that many academics found rewards for engaging in technology transfer insufficient – particularly royalty distribution formulas.¹³² Using data on 113 U.S. TTOs, Link and Siegel (2005) reported that universities allocating a higher percentage of royalty payments to faculty members were more “productive” in technology transfer activities. This was independently confirmed in Friedman and Silberman (2003) and Lach and Schankerman (2004).

¹²⁸ Tornatzky et al at 18.

¹²⁹ Litan et al at 11.

¹³⁰ Link et al at 3.

¹³¹ *Ibid*

¹³² Siegel, Waldman, Atwater, and Link (2003, 2004) cited in Link et al at 3.

Non-pecuniary rewards, such as credit towards promotion and tenure, were also relevant. Some academics suggested that involvement in technology transfer might be detrimental to their careers.

Many also expressed intense frustration with university bureaucracy or pointed to concerns about licensing officers, citing:¹³³

- A high rate of personnel turnover detrimental to long-term relationships
- Insufficient business and marketing experience
- A possible need for incentive compensation.

University-wide policies for sharing licensing income and/or sponsored research also influence the disclosure incentives of TTO and faculty members,¹³⁴ as do cultural norms across scientific fields. Several papers have compared faculty involvement in technology transfer in the life sciences and physical sciences, finding substantial variation in perceptions across scientific fields on the outcomes of patenting. Life scientists appear more concerned about proprietary benefits of patents and using them to obtain leverage with firms, while physical scientists patent to obtain the “freedom” to publicize their work without losing potentially valuable intellectual property rights and to gain leverage with the university.¹³⁵

Successful universities often provide implicit or explicit rewards and incentives for faculty who participate in technology transfer and commercialization and have hiring practices that favor industry and entrepreneurial experience.¹³⁶

Leading universities actively work to build entrepreneurship skills in their students and faculty

These universities also often have strong entrepreneurship programs or majors that offer entrepreneurship courses and activities for engineering, science and business students. Activities include business plan competitions, practicums with start-ups, and mentoring by successful entrepreneurs.¹³⁷ Seminars, conferences and training sessions to introduce researchers to commercialization and build their entrepreneurship skills are also common.

By creating flexible sources of funding to assess the commercial potential of new discoveries, universities can help fill the very early stage venture capital gap

Even the most skillful entrepreneur, however, requires start up capital. While the study cited earlier indicated that the availability of venture capital was not a determinant of

¹³³ Link et al at 6.

¹³⁴ Ibid

¹³⁵ Ibid at 8.

¹³⁶ Palminteri et al at 17.

¹³⁷ Ibid at 16-17.

university start-up rates, the pervasive shortage of pre-seed and seed funding for proof of principle and market feasibility work is nonetheless an issue.

There are few sources of very early-stage funding to assess the commercial potential of a new discovery. A small amount of funding, that does not require a repayment, is needed to conduct testing, to validate the technology and to determine whether it meets a market need at a competitive price.¹³⁸

University commercialization programs often include funds to address this capital gap between basic science and the development of technology with commercial potential. Such funds make awards ranging from \$50,000 to \$250,000 that are used to undertake due diligence to determine whether there is any commercial value. In some cases, researchers may be provided small additional funds to further refine the “proof of concept” of the research. If value is discovered, then university IP procedures come into play.¹³⁹

Networking – with investors, professional services, potential buyers, suppliers, and other entrepreneurs – is critical and a service many universities offer

Networking – internal and external to the university – is part of an entrepreneurial culture. Opportunities for entrepreneurs to network with potential investors, corporate clients, partners, service providers, and other entrepreneurs are critical. University TTOs often encourage and facilitate interaction with venture capitalists, law firms, and corporations, early in the technology transfer process.¹⁴⁰

Incubators and research parks provide a visible technology presence and often afford low-cost space for new start-ups

Many exemplary universities have incubators and research parks. This is particularly important for universities that have had to build an entrepreneurial presence such as University of Wisconsin Madison and Purdue University. Their research parks are now quite successful, each employing several thousand high-tech workers and adding a technology presence where there once was none.¹⁴¹

Innovation centres can also help by providing a focal point for technology-based activities

Innovation centres offer an ‘opportunity rich environment’ for entrepreneurs, by bringing together many of the key players and enablers in a region’s innovation system and creating occasions for these to formally and informally encounter one another, exchange

¹³⁸ SSTI at 25.

¹³⁹ *Ibid*

¹⁴⁰ Palminteri et al at iv.

¹⁴¹ *Ibid* at v.

valuable information, and build relationships. As a focal point for technology-based activity, innovation centres often:¹⁴²

- Are directly or indirectly linked to universities
- Involve corporate participation
- Provide a variety of services and linkages – pre-seed/seed capital, Executive-in-Residence programs, and mentoring for technology start-ups.

¹⁴² *Ibid* at iv.

VIII. Active leadership & participation in regional economic development

To be accepted, economic development activities need to be seen as important, worthy, and central to the university and its mission

The entrepreneurial culture of a university is perhaps the strongest and most pervasive determinant of its performance when it comes to technology transfer, commercialization and economic development performance.

Creating an entrepreneurial culture is both “bottom up” and “top down,” requiring leadership from the top and entrepreneurial drive from the bottom.¹⁴³ In order for campus units and individuals to be engaged or effective in the outreach necessary to drive these functions, relevant norms, values, beliefs, and behaviors have to be aligned. This alignment is what defines an organizational culture.¹⁴⁴

Institutions differ significantly in this regard. In many, even land grant institutions, there is a widespread belief that industry and economic development partnering leads to academic mediocrity.¹⁴⁵ To be accepted, economic development activities need to be seen as important, worthy, and central to the university and its mission.¹⁴⁶

Universities active in economic development need to be explicit that this is part of their mission, reflect this in their institutional policies, structures and programs, have strong champions and actively partner with industry and other regional organizations. Influential university champions need to believe in partnering and work hard to make this a vital, rather than formulaic, part of the university’s culture.¹⁴⁷

Universities actively involved in state/local economic development and industry partnering tend to adopt language in mission, vision, and goal statements that reflects that emphasis

Leading universities use explicit, repeated messaging, delivered publicly by institutional leaders, to convey the importance and centrality of their economic development role. These statements can also be found in different forms at the college or unit level, with modified versions incorporated into external reports, publications, press releases, and speeches, and broadly disseminated to diverse leadership and lay audiences.¹⁴⁸

Statements by university leaders may also reference creating regional economic opportunity as part of the institution’s mission or goals. The repetition of these phrases over prolonged periods of time and in multiple settings helps to connect this objective to

¹⁴³ Palminteri et al at iv.

¹⁴⁴ Tornatzky et al at 18.

¹⁴⁵ *Ibid* at 173.

¹⁴⁶ *Ibid* at 18.

¹⁴⁷ *Ibid* at 173.

¹⁴⁸ *Ibid* at 18-19.

the values, beliefs, and goals that make up the institutional culture.¹⁴⁹

Compelling narratives and apocryphal stories of successful entrepreneurs, start-ups and development initiatives with tangible regional benefits play a critical role in building support for university participation in regional economic development.¹⁵⁰ These stories can be found on any leading campus and help build a sense of possibility and efficacy within these institutions.

Leadership is critical to creating an intellectual argument and language system around economic development, and putting in place the enabling policies and structures needed to make it work

Champions catalyze most successful technology-based economic development. In every region where a major research university has played a strong economic development role, one can point to a champion, often a strong university president or chancellor. These have the experience, vision, and will to move their institutions into new roles, and the leadership to rally corporate leaders and public decision makers.¹⁵¹

The most successful university technology transfer and commercialization programs have benefited from academic, corporate, and political leaders willing to champion R&D and technology-based economic development over the long haul.¹⁵²

The role that university leadership plays is critical but changes over time.¹⁵³ In order to move a university away from its traditional ways, a strong voice at a high level must call for change. Later, for institutions with ongoing programmatic commitments to partnerships, there is often a need to renew and enhance the partnership mission, vision, and program structure over the course of different administrations.

In addition to calling for change, innovative institutional leaders create an intellectual argument and local language system around the new activities; and build and maintain organizational structures and policies that will sustain the work of partnering with other organizations and sectors.¹⁵⁴

Universities cannot be changed by fiat. A participative process of intellectual dialogue and self-discovery usually needs to take place. In order to move in these new directions, universities may have to seek a different type of candidate to fill key positions – president, provost, or dean – that will lead the institution in a partnering direction.¹⁵⁵

¹⁴⁹ *Ibid* at 19.

¹⁵⁰ *Ibid* at 175.

¹⁵¹ Palmintera *et al* at iii.

¹⁵² *Ibid* at v.

¹⁵³ Tornatzky *et al* at 174.

¹⁵⁴ *Ibid*

¹⁵⁵ Tornatzky *et al* at 174.

Informal and formal faculty incentives are used to encourage participation in commercialization and economic development activities

Universities with active external partnerships for the purposes of commercialization and economic development are likely to have an informal and formal system of rewards that encourages faculty to be involved in these activities. These might include:¹⁵⁶

- Positive weighting of such involvement in tenure and promotion decisions
- Giving attention in campus and community media
- Providing symbolic acknowledgement via events and awards
- More subtle and informal peer approval.

Universities enter into formal economic development partnerships with government, business and civic economic development organizations

Universities that are actively linked to state and local economic development will often participate in strategy formulation, governance, and program development activities of regional economic development organizations – e.g. chambers of commerce, government departments of commerce or their equivalent, or local industrial development organizations.¹⁵⁷

Participation occurs at all levels of the institution, from senior leadership to interested faculty and staff. In some cases universities may function as a de facto instrument of state or regional economic development policy.¹⁵⁸ This may extend to university involvement in organized attempts to lure companies from other states or countries.¹⁵⁹

Universities that take on a regional economic development role add structures, positions and systems to manage this and to “routinize” key changes

Most organizations go through processes of innovation and change, but to ensure these changes take hold, it is necessary to “routinize” innovation, turning critical organizational features of new programs into standard operating procedure through job descriptions, mission statements, etc.¹⁶⁰

While basic organizational structures and governance functions of most universities tend to look alike, universities that take on a regional economic development role add structures, positions and systems to manage this.¹⁶¹ Some universities have an office or senior position dedicated to outreach (or economic development) with administrative responsibility, a budget, and authority to move the partnering and economic development

¹⁵⁶ *Ibid* at 19.

¹⁵⁷ *Ibid* at 20.

¹⁵⁸ *Ibid*

¹⁵⁹ *Ibid*

¹⁶⁰ *Ibid* at 175.

¹⁶¹ *Ibid*

agenda. Some institutions create coordinating structures — often backed by the authority of the CEO or chief research officer — that establishes linkages between the different domains of partnering activity.¹⁶²

New councils, cabinets, etc. established for this purpose tended to cut across academic units, as well as administrative, units. Typically, these bodies are headed by a senior administrator with power inherent in their position, or by a coordinator with authority derived from the campus CEO. It is not clear which model is more effective.

Most of the exemplary institutions studied also worked hard on policy. These efforts helped to *align* disparate elements within the institution:¹⁶³

- University rules and legal constraints
- New mission and vision language and goals
- Partnering programs and activities
- Activities of individual program managers.

Together, these changes achieve a shift from the ad hoc to a more sustainable approach.

¹⁶² *Ibid*

¹⁶³ *Ibid* at 176.

IX. Conclusions and key lessons

The findings outlined above reflect a process of transition whereby universities, traditionally considered deep pools of learning apart and buffered from the economic and market activity of their regions, find themselves occupying a central role in regional innovation ecosystems and actively engaging in regional economic development as a core element of their mission.

American land grant universities that have traditionally engaged in economic development, have had to adjust to fulfill this role in a more highly globalized context and to redirect their efforts from traditional economic development to helping their regions transition to more knowledge-based economies.

Universities that have been most effective in helping to launch and support knowledge economies, display the following characteristics:¹⁶⁴

- They are performing world-class research in areas that correspond to the science and technology drivers of their national and regional knowledge sectors.
- They have a cadre of nationally prominent faculty.
- They have leaders who view the university as a key partner with industry and government in creating and growing a knowledge economy.
- They have the physical and soft infrastructure needed to support research and technology development.
- They have mechanisms, including financing programs, to facilitate translation of research findings into commercial products and processes.

Systematic efforts to capture and analyse the attributes, activities and experiences of selected leading U.S. institutions have generated the following key lessons for other universities interested in playing a regional economic development role:¹⁶⁵

1. *Champions catalyze most successful technology-based economic development*

In every region where a major research university has played a strong economic development role, one can point to a champion, often a strong university president or chancellor who recognized that leveraging university R&D and entrepreneurial resources would create new opportunities for academic excellence and economic growth. These had the experience, vision, and will to move their institutions into new roles, and the leadership to rally corporate leaders and public decision makers willing to champion R&D and technology-based economic development over the long haul.

2. *Private corporations and foundations can play a major role*

Private corporations and foundations have played a major role in stimulating science and technology research and promoting regional economic outcomes by:

¹⁶⁴ SSTI at 12.

¹⁶⁵ Palmintera et al at iii-v.

- Endowing university chairs
- Sponsoring collaborative R&D
- Participating in entrepreneurial activities
- Funding technology-based community initiatives in the community.

3. *A strong and focused research base feeds the commercialization pipeline*

Excellent university technology transfer is built on excellent research. The strategic focus of this research is just as important as the magnitude. Some model universities assess their core competencies against those of their region and develop strategic plans around these. These plans provided direction for:

- Hiring “stars” in targeted fields
- Targeting federal R&D funds
- Increasing corporate sponsored research
- Promoting state initiatives that leverage federal and corporate funds.

4. *Federal R&D funding provides a critical base for commercialization*

Universities successful in technology transfer receive substantial federal research funding – this is largely from the U.S. Department of Defense and National Institutes of Health, but the National Science Foundation also plays a significant role.

5. *An entrepreneurial culture is key to university technology transfer success*

The entrepreneurial culture of a university is perhaps the strongest and most pervasive influence on its technology transfer and commercialization performance. Creating an entrepreneurial culture is both “bottom up” and “top down”, requiring leadership from the top and entrepreneurial drive from the bottom. Successful universities often provide implicit or explicit rewards and incentives for faculty who participate in technology transfer or commercialization and have hiring practices that favor industry and entrepreneurial experience.

6. *Entrepreneurship programs can add value to commercialization and economic development*

Model universities often have strong entrepreneurship programs that offer entrepreneurial courses and activities for engineering, science and business students. Activities include business plan competitions, practicum with start-ups, and mentoring by successful entrepreneurs.

7. *Innovation centers can provide a focal point for technology-based activities*

Innovation centers often:

- Are directly or indirectly linked to universities,
- Involve corporate participation
- Provide a variety of services and linkages – pre-seed/seed capital, Executive-in-Residence programs, and mentoring for technology start-ups.

8. *Networking is key*

Networking – internal and external to the university – is part of an entrepreneurial culture. Opportunities for entrepreneurs to network with potential investors, corporate clients, partners, service providers, and other entrepreneurs are critical. University TTOs often encourage and facilitate interactions with venture capitalists, law firms, and corporations, early in the technology transfer process.

9. *Early-stage capital is a critical ingredient in launching university start-ups*

Entrepreneurs from universities successful in generating start-ups have access to seed capital.

Where early-stage capital does not exist, universities, public and private sectors step in to create it, often seeding private funds that leverage additional monies. Angel networks play an increasingly important role in nurturing early-stage firms. Universities and intermediary organizations also assist entrepreneurs with business plan development and opportunities to showcase and network with potential investors.

10. *Incubators and research parks provide a visible technology presence*

Many exemplary universities have incubators and research parks. This is particularly important for universities that have had to build an entrepreneurial presence such as the University of Wisconsin Madison and Purdue University. Their research parks are now quite successful, each employing several thousand high-tech workers and adding a technology presence where formerly there was none.

11. *There are no quick fixes*

Most successful university commercialization and economic development efforts and the resulting entrepreneurial and economic activity have taken decades to accomplish. The field is still relatively new and evolving and results are difficult to demonstrate and to quantify.

Academic, public and private decision makers should be cognizant of this and allow programs flexibility to experiment and time to mature and evolve.

Based on the above, universities that wish to play a more active regional economic development role and improve their commercialization success are advised to:¹⁶⁶

- **Build on strengths.** Institutions should examine their research and regional industry strengths and build on them.
- **Find champions.** Support from university administrators at the highest levels is critical, but so is faculty support. It is equally important to enlist the participation of senior managers from the private sector. Bring together the top people in industry, academe and S&T fields to provide a legitimate basis for planning for the future.
- **Focus on market opportunities.** It is much easier to pull technology out of universities because it meets a market need than to try to push technology out of the lab.
- **Make funding decisions based on excellence, not politics.** To have an economic impact, programs must be based on the reality of the institution's research strengths and the economic profile of the region.
- **Communicate and publicize success.** Programs that seek to capitalize on university research findings are a long-term undertaking. Publicizing successes helps to not only build support among key constituents, but also attracts both faculty and industry to participate in partnership activities.
- **Recognize that there will be failure.** Commercializing technologies is risky. Educate elected officials to understand that these are long-term investments and their impact should be measured in return on investment, not just jobs created.

¹⁶⁶ SSTI at 27.

X. List of innovative practices for universities to consider

Building on the key attributes of universities that have been highly effective in helping to launch and support regional knowledge economies, the following is a list of key supporting practices and policies drawn from case studies and analysis of these institutions.¹⁶⁷

University performs world-class research in science and technology fields driving national and regional knowledge sectors

- Strategic research priorities are established based on assessment of university research strengths and regional economic opportunities
- University has university-industry research centres, centres of excellence, and research partnerships focused on technology areas critical to regional industry clusters

University has nationally eminent faculty in key technology fields

- University adopts formal strategies to build critical mass of eminent researchers in target research fields of relevance to regional economy
- Eminent scholar endowment programs are used to recruit established research leaders with industry and/or entrepreneurial backgrounds in targeted research fields with economic development potential
- Mechanisms are in place to develop and retain talented junior faculty in targeted research fields with economic development potential

¹⁶⁷ The key studies consulted were: SSTI (2006), Tornatzky et al (2002) and Palminteri et al (2004).

University engages in active leadership and partnerships with industry and government to create and grow region's knowledge economy

Mission, vision and goal statements

- University mission includes regional economic development
- Mottoes, program names, and slogans that serve a related rallying or branding function are developed and used
- Thematic prose on economic development and industrial partnering is used in institutional strategy documents, goal statements, and objectives, with comparable themes in college or unit level documents
- All of the above are incorporated extensively into speeches, brochures, web sites, and publications, many targeted for audiences outside the institution

Institutional leadership

- Leadership demonstrates commitment to regional economic development through institutional priorities and policies
- Leadership actively engages with government and other regional economic development partners
- Has a senior administrator role focused on economic development
- Has structures and a culture that promote and support administrative and faculty partnerships internally across schools and disciplines, and externally with industry and other research institutions

Formal partnerships with economic development organizations

- University hosts, or operates under contract, state technology programs
- University is involved in high-level recruiting of large technology-based companies
- University participates in local or state industry or technology councils
- Training programs for economic development professionals are offered
- Faculty conduct economic development policy studies and evaluations

Industry/university advisory boards and councils

- Presidential-level advisory councils have significant industry involvement
- Industry is involved in institutional and unit level strategic and curricular planning
- Centres and institutes have industry advisory boards

Industry research partnerships

- Industry contract research and consulting are facilitated and streamlined using single points of contact and coordinating structures
- Efforts are made to simplify research contract language and to use novel forms of packaging relationships (e.g., master agreements, strategic partnerships)

- Firms can access up-to-date databases of faculty projects/competencies and associated Web-based search engines to help them find faculty members with expertise to match their needs
- Research parks are established contiguous to campuses to encourage ongoing relationships between tenant companies and faculty researchers
- Efforts are made to integrate industry research partnerships into graduate education

Industrial extension and technical assistance

- State-subsidized technical assistance services, are delivered statewide, via a network of regional university offices
- Faculty and graduate students are used extensively as outreach staff
- These are operational between these programs and colleges of engineering and the federal Manufacturing Extension Partnership

Industry education and training partnerships

- Education and training offerings cater to the needs of key regional industries
- Extension course are delivered in a decentralized manner
- Special programs are targeted to economic development officials
- Formal industry training needs assessments drive the design of education and training programs

Career services and placement

- Internships and co-op programs are used extensively and target regional companies
- Regional companies are given “first look” at emerging graduates via job fairs or web-services
- Career service discounts are offered to state-based companies

University culture encourages and supports entrepreneurship and commercialization

Faculty culture and rewards

- University has formal awards and acknowledgement events honoring faculty inventors, entrepreneurs, and industry partners
- Service component of scholarship (e.g., for tenure or promotion review) is broadened to encompass industry partnering, technology transfer, involvement in economic development and allied activities
- Links and pages on university web sites and media efforts extol partnering successes
- University seeks industry and entrepreneurial experience when hiring senior institutional officials (e.g., presidents, chancellors, deans)
- Partnering and entrepreneurial success stories are developed and promulgated.

Support for entrepreneurship

- Senior university administration explicitly supports faculty/student entrepreneurship
- University actively promotes and publicizes faculty commercialization successes
- Entrepreneur coursework and majors are offered to technical and business students and include both classroom and experiential components
- Other entrepreneurship education and training opportunities are offered on an ongoing basis, including outreach programs for community-based entrepreneurs
- Structural barriers to faculty commercialization activity are eliminated and university offers incentives to commercialize research – clear IP policies, attractive revenue sharing, and recognition
- Technology business incubation services and facilities are offered directly by the university or by other organizations with a strong university linkage
- The university links to, and nurtures, community-based venture funds.
- A range of other supports and services are made available to faculty and student entrepreneurs – business plan competitions, networking, mentoring/coaching, access to capital, recruitment of management talent.
- Research parks offer appropriate space and services for new or small companies

Technology transfer

- University seeks to increase volume and speed of commercialization over university revenues
- Extensive informational outreach is undertaken to familiarize faculty members with principles and operations of technology transfer
- Patenting and licensing assistance is available to faculty through university TTO and other entities
- Technology transfer functions and management of industry-sponsored research are physically co-located and enjoy close working relationships
- Financing is made available to facilitate the translation of research findings into commercial products and processes (proof of concept, pre-seed)
- TTO is sensitive to economic geography issues and the migration of value-added development out of the region and seeks to license to regional companies.

XI. Questions for discussion

1. This discussion paper posits a fundamental shift in the role of universities in society – from a side position in the economy to the centre of the economy and of regional innovation systems. Do you agree that a shift has taken place as described? What are the implications of this shift from your perspective?
2. Most of the findings and practices described in this paper are drawn from the U.S. experience. Do you think a similar journey – from an exclusive focus on commercialization (and university revenue maximization) to a broader regional economic development role – is possible for universities in the Canadian context?

What are some of the impediments to this? What are some of the advantages that can facilitate this?

Is culture a core issue? If so, how do we start – or accelerate – the process of culture change?

Are university leadership or faculty/students leading on this one?

3. Do you think it's feasible or desirable for Toronto region universities to avoid making this transition?
4. U.S. universities benchmarked as leaders in commercialization and regional economic development have adopted comprehensive, integrated, institution-wide approaches and put in place the policies, structures and people to make these a truly integrated feature of the university identity. How close or far are we from committing to a similarly comprehensive approach?
5. What supports do universities need from government(s) to make this transition effectively?
6. Developing entrepreneurship at all levels is a major theme throughout this paper. Is entrepreneurship essential? If so, are we doing enough in this regard?

What direct and indirect incentives can be mobilized to encourage the participation of faculty (particularly the younger and untenured) in informal tech transfer, commercialization and economic development activity?

How are we developing the entrepreneurial skills of faculty and students now?

What else can be done?

7. Is there any emerging consensus on the optimal handling of IP? Given the federal government's intention to review – and possibly change – the status quo, what changes would be beneficial from a regional economic development perspective and which should be avoided? Or do we really know?
8. If graduating highly skilled personnel is the primary means of transferring new knowledge to industry and building absorptive capacity, then declining enrolment in science and technology programs should be a major regional concern – particularly in light of the already poor performance of Canadian industry in R&D investment. What is driving this enrolment trend in your view and what should we be doing regionally and nationally to reverse it?
9. The paper implies that stand-alone research centres - by virtue of their often multi disciplinary focus and engagement of industry – are more likely to generate innovation and economic benefits down the road than our faculties. Do you agree with this?

Do our research institutes behave as described? If so, do we need more of these? If not, why?
10. U.S. universities clearly grapple with the issue of pre-seed/seed/early stage funding for spin-offs, even if we believe they are better off than us in many respects. U.S. universities see a role for themselves in addressing the early stage gap, through the establishment of funds. What should we be doing?

What should government(s) be doing? Others (e.g. MaRS, angel networks)?
11. Greater interaction and stronger alliances between the region's universities/research hospitals and its industry are fundamentally desirable from a regional economic development perspective. How can we accomplish this? What are the hurdles? Likely places to begin?
12. Champions have played a critical role in every other region in leading universities into a stronger economic development role. Who are the champions in our region? University? Government? Industry?
13. Does TRRA need to add to/modify its messaging to the federal government in light of the recent S&T strategy, the information in this paper and the discussion

today?

Are we clear on the investments we think the government should be making in the private sector? Research institutions?

Are we comfortable with the balance struck in the S&T Strategy or do we need to work on this?

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APPENDIX 1

TOP US UNIVERSITIES – ECONOMIC DEVELOPMENT PERFORMANCE (Data from AUTM and university websites - 2005 unless otherwise indicated)							
University	Economic Development lead	Research funding	Disclosures	Patents issued	Licensing activity	Startups	Commercialization revenues
Carnegie-Mellon University*** (Private)	<p>Peter Lee Vice-provost for Research Peter.Lee@cmu.edu</p> <p>Don Smith Director, Economic Development Carnegie Mellon University/ University of Pittsburgh (412) 268-1122 don@universitypartnership.com</p>	\$227.7m	132 2006	33	32	6	\$5m
Georgia Institute of Technology*** (Public)	<p>Wayne Hodges Vice Provost, Enterprise Innovation Institute Director, Advanced Technology Development Center (404) 894-5217 wayne.hodges@innovate.gatech.edu</p>	\$420m 2005	300+ annually	43	37	9	\$4.5m
Massachusetts Institute of Technology** (Private, land grant)	<p>Claude Canizares Vice President for Research & Associate Provost (617) 253-3206</p>	\$298m	N/A	133	93	20	\$39.8m
North Carolina State University* (Public)	<p>James J. Zuiches, Ph.D. Vice Chancellor, Extension, Engagement, & Economic Development (919) 513-0388 james_zuiches@ncsu.edu</p>	\$189m	208 FY2006	49	69	4	\$2.95m
Ohio State University* (Public)	<p>Keith L. Smith Associate Vice President, Agricultural Administration Director, Ohio State Univ Extension (614) 292-4880 (614) 292-4067 E-mail: Jamie Weiner, Assistant weiner.66@osu.edu</p>	\$652m 2006	145 2006	27 2006	28 licenses 2006	5 2006	\$947 000 2006
Pennsylvania State University* (Public)	<p>Craig D. Weidemann Vice President for Outreach (814) 865-7581 cdw12@outreach.psu.edu</p>	\$638m		37	21	3	\$2.3m
Purdue University*** (Public)	<p>Victor Lechtenberg Vice Provost for Engagement (765) 494-9095 vll@purdue.edu</p>	\$408m	208	27	79	6	\$4.16m

TOP US UNIVERSITIES – ECONOMIC DEVELOPMENT PERFORMANCE
(Data from AUTM and university websites - 2005 unless otherwise indicated)

University	Economic Development lead	Research funding	Disclosures	Patents issued	Licensing activity	Startups	Commercialization revenues
Stanford University*** (private)	Ann Arvin Vice Provost and Dean of Research Ph: (650) 498-6227 aarvin@stanford.edu	\$1.06b			109		
Texas A & M University* (Public)	Richard E. Ewing Vice President for Research Ph: (979) 845-8585 richard-ewing@tamu.edu Guy Diedrich Vice Chancellor for Technology Commercialization Ph: (979) 458-6000 GDiedrich@tamu.edu	\$520.9m 2004	Over 2,400 since 1992		1,700 license and material transfer agreements since 1992	2 in 2005 Over 50 since 1992	\$60m since 1992
University of California – San Diego*** (No AUTM data available)	Arthur B. Ellis Vice Chancellor for Research Vacant Asst Vice Chancellor for Technology Transfer and Intellectual Property Duane J. Roth Chief Executive Officer UCSD CONNECT djroth@connect.org	\$728m 2004-5					
University of Pennsylvania** (Private)	Steven J. Fluharty Vice Provost for Research (215) 898-7236 vpr@pobox.upenn.edu	\$770m 2006		37	83	9	\$7.5m
University of Utah*	Raymond Gestland VP Research (801) 581-7236 ray.gesteland@genetics.utah.edu	\$276m 2006		31	44	6	\$16.1m
University of Wisconsin – Madison*** (Public)	Carl E. Gulbrandsen Managing Director Wisconsin Alumni Research Foundation Ph: (608) 263-2824 (Kristy) carl@warf.org	\$798.1m		89	216	4	\$49m

TOP US UNIVERSITIES – ECONOMIC DEVELOPMENT PERFORMANCE
(Data from AUTM and university websites - 2005 unless otherwise indicated)

University	Economic Development lead	Research funding	Disclosures	Patents issued	Licensing activity	Startups	Commercialization revenues
Virginia Tech* (Public)	<p>John E. Dooley Vice Provost for Outreach and International Affairs (540) 231-9868 jdooley@vt.edu</p> <p>*Ted Settle Director, Office of Economic Development (540) 231-5278 settle@vt.edu</p>	\$155.5m		17	28	6	\$2.5m
Washington University** (Private)	<p>Samuel L. Stanley Jr. Vice Chancellor for Research ph: +1 314 362-7010 SSTANLEY@WUSTL.EDU</p>	\$503.9m		20	50	3	\$11.7m

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