

TECHNOLOGY TRANSFER AND COMMERCIALIZATION OF INNOVATIONS AT CANADIAN UNIVERSITIES*

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Abstract

This paper analyzes university-industry technology transfer (UITT) and innovation capabilities development at Canadian universities. In so doing, it discusses the Canadian experience in terms of science and technology policy and UITT. Some governmental initiatives both at federal and provincial levels are presented searching to rank Canada among top countries in the world in terms of R&D and innovative performance. The Canadian case might be particularly interesting to analyze in relation to UITT for several reasons. However, university spin-off creation has become an important mechanism to transfer technology from universities to industry since it has important impacts on economic value and job creation.

Keywords: technology transfer, innovation capabilities, science and technology policy.

Resumen

Este artículo analiza el proceso de transferencia de tecnología desde las universidades a la industria, así como el desarrollo de las capacidades innovadoras en las universidades canadienses. En este sentido, el artículo discute la experiencia canadiense en relación a la política de ciencia y tecnología y los procesos de transferencia de tecnología. Algunas iniciativas gubernamentales a niveles federal y

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provincial buscan posicionar a Canadá entre los países con mayores desarrollos en términos de investigación y desarrollo y capacidades innovadoras. El caso canadiense puede ser importante por varias razones. De cualquier manera, la creación de *spin-offs* tiene un impacto muy importante como mecanismo de transferencia de tecnología desde las universidades hacia la industria por su impacto en la creación de valor y empleo.

Palabras clave: transferencia de tecnología, capacidades de innovación, política de ciencia y tecnología.

Clasificación JEL: O31, O32, O33 y O38.

1. Introduction

There are few studies investigating the policy instruments available for governments aiming to improve technology transfer from publicly funded research (Rasmussen 2008). Since the passage of the Bayh-Dole Act (1980) in the United States, policy makers are introducing in many countries reforms to improve innovative activity through changes in the academic system, designing new instruments for research funding and by setting up structures to support these activities (Benner and Sandstrom 2000; Hellström and Jacob 2003). In this paper, it is discussed the importance of university research and technology transfer to support innovation activity. In this sense, the Canadian case might be particularly interesting to analyze in relation to university-industry technology transfer (UITT) for several reasons (Gault and McDaniel 2004; Niosi 2006b; Rasmussen 2008): (1) Canada has a long tradition of state involvement to promote the economic utilization of scientific research, (2) Canada has an important number of federal and provincial programs that may be used to support the commercialization of research, (3) this country has 178 initiatives for supporting UITT that represented an expenditure of 3.2 billion Canadian dollars a year, (4) Canada has a very decentralized higher education system, (5) this country is characterized to have a large public research sector and a small domestic market, and (6) Canadian universities have proven to be quite successful in commercializing their research.

In this paper, the Canadian case is analyzed in relation to UITT and university spin-off creation. The paper is organized into five sections. Section 2 presents the Canadian experience in relation to UITT from an empirical perspective. Section 3 deals with some issues related to science and technology policy in Canada. Section 4 discusses a special form of technology transfer, mainly spin-off creation. Finally, section 5 presents some conclusions in relation to technology transfer and commercialization of innovations at Canadian universities.

2. The Canadian Experience in UITT

Canada has a long tradition producing and transferring technology from universities to industry. In the process of UITT, there is a tendency to overestimate the relative importance of channels such as consulting and informal conversations and to underestimate the importance of more indirect channels such as patents and publications. Moreover, patenting and licensing constitute a relatively small channel for the transfer of knowledge from academia to the private sector. Table 1 shows the importance of different channels in the process of UITT in Canada. Publications and consulting are the most important forms of transferring technology from universities to industry. Patents and licensing only accounts for 6.6% of total UITT forms.

The commercialization of knowledge and technology do not jeopardize the scientific activities of university researchers (Henderson et al. 1998; Landry et al. 2007). In fact, knowledge transfer increases as the number of publications increase. Moreover, there is statistical evidence suggesting that researchers in certain fields are much more active in knowledge transfer than in others. However, these analyses have pointed out that there are two essential determinants explaining the process of knowledge transfer from universities to industry (Landry et al. 2007): (1) the linkages between researchers and research users, and (2) the focus of the research projects on users' needs. On the other hand, Hanel and St-Pierre (2006) corroborate that collaboration between users and academic researchers is actually one of the main sources of new ideas and technologies to feeding the innovative process. However, the importance of university spin-off companies as a mechanism to transfer

Table 1

University-Industry Technology Transfer in Canada

	% Total(Standard Deviation)	% Total that Respond at Least “Moderately Important” (3 on 4 Point Likert Scale)
Patents and Licenses	6.6 (5.6)	11.6
Publications	18.5 (17.3)	17.4
Consulting	25.1 (18.4)	13.7
Conversations	6.3 (6.8)	17.5
Cosupervising	9.4 (10.2)	7.7
Recruiting/Hiring	16.8 (12.5)	8.5
Conferences	5.2 (5.6)	14.6
Research Collaborations	12.1 (10.8)	9.1

Source: Henderson, R. A. et al. (1998).

technology from universities to industry entails a great impact on regional economic development that support innovative performance (AUCC 2002; Industry of Canada 2002). In this sense, empirical studies have suggested some key variables to explain knowledge and technology transfer from universities to industry in Canada (Landry et al. 2007):

1. Financial support of academic research from private firms and government agencies;
2. The focus of the research projects on the needs of users such as private firms and government agencies;
3. The research unit size;
4. The intensity of the linkages between researchers and users;
5. The number of years of experience on research;
6. The number of publications;
7. The degree of novelty of the research results;
8. The affiliation of researchers with a large research university;
9. Particular research fields such as engineering;
10. Gender of the researchers. These authors found a positive and significant relation between these variables and the process of technology and knowledge transfer.

On the other hand, there is statistical evidence suggesting that researchers are more active in non-commercial knowledge transfer activities than in commercial knowledge transfer activities that involve protected intellectual property (IP). However, it would be expected that faculty members with a more entrepreneurship tradition are more likely to transfer knowledge and technology involving protected IP.

3. Science and Technology Policy in Canada

Canada is ranked first amongst G7 countries in terms of industry-university collaboration and university research funding supported by the private sector (Industry Canada 1999b). Yet, Canadian universities have been the second largest spender on R&D behind industry since the 1970s, even if the share of real university R&D in total R&D spending has decreased in during this period (Hanel and St-Pierre 2006). In fact, Canadian universities are increasingly collaborating with industry to support and contribute funding their research (Hanel and St-Pierre 2006; Landry et al. 2007). In Canada, both provincial and federal governments continue to be the major sources of funding for research activities at universities, but the contribution of the private sector has nearly doubled in the last years (Hanel and St-Pierre 2006; Rasmussen 2008). However, the Government of Canada aims to launch Canadian firms to become highly competitive in the world markets following an innovative strategy supported by the generation and development of new knowledge at universities.

It is well recognized the role that universities can play in supporting innovative performance (AUCC 2002; Industry of Canada 2002; Langford et al. 2006). In fact, public science and research base may provide the platform for successful innovation by business and public services. In 2002, the Government of Canada released an innovation policy report known as *Achieving Excellence* (Industry Canada 2002) that included a specific initiative with respect to universities and commercialization. Additionally, the Government of Canada also released *Momentum: The 2005 Report on University Research and Knowledge Transfer* (AUCC 2005). The objective was to establish the conditions under which academic

institutions would be expected to manage the public investment in research as a strategic national asset by developing innovation strategies and reporting on commercialization outcomes. This goal shall be followed by making use of three mechanisms (Langford et al. 2006): (1) Canadian universities have committed to triple their commercialization performance, (2) they are responsible for the strategic coordination of the research efforts that will deliver these benefits, and (3) the *Association of Universities and Colleges of Canada* (AUCC) agrees to produce a periodic public report that demonstrates the collective progress made by universities in knowledge transfer including commercialization and innovation. The specific mechanisms that would allow for defining Canada's innovation strategy are as follows:

1. By 2010, Canada is to rank among the top five countries in the world in terms of R&D performance;
2. By 2010, Canada is to rank among world leaders in the share of private-sector sales attributable to new innovations;
3. By 2010, current federal investment in R&D should at least double;
4. By 2010, the per capita value of venture capital investments in Canada should rise to prevailing levels of the United States.

In this context, it is recognized to advance research, knowledge transfer, and commercialization and innovation activities as milestones for Canada's innovative performance. Following this, for example, Canada spent \$2.3 billion on university-based research, representing 24.5% of the total direct and indirect research investments in that sector (\$9.3 billion) in 1997-1998, and it is estimated that by 2006-2007 the annual federal support for research in the higher education sector would be almost \$2 billion more than in 1997-1998 (Library of the Parliament 2006).

In this way, the *Canadian Foundation for Innovation* (CFI), an independent organization with a mandate to invest in Canada's research infrastructure, support mechanisms to facilitate the commercialization of research discoveries and other enabling technologies needed to conduct world-class research, as well as to attract

and retain highly qualified researchers, made commitments of \$2.93 billion in more than 4,000 innovative projects undertaken at 127 universities, colleges, non-profit research institutes and research hospitals in 62 municipalities across Canada, and \$3.9 billion in additional funding in 2004-2005 (Library of Parliament 2006). Actually, these resources were leveraged from provincial governments, the private sector and other partners. This initiative would imply that universities in Canada perform about one-third out of the total R&D, and hence, are becoming key players in Canada's innovation system (Industry Canada 2002).

As a result, technology transfer activities may become extremely important within Canadian universities in the near future. Commercialization and technology research transfer mechanisms may take, however, many forms such as the protection of IP (patents and copyrights), licenses and spin-off of new companies. In fact, the commercialization of IP is just one form for transferring knowledge to industry. The trends and changes observed recently among Canadian universities when transferring new knowledge and technology to industry are actually the result of latest changes experienced by many IP regimes in the world. Yet, Rasmussen (2008) points out that the innovative initiative launched by the Government of Canada in 2002 recognizes the importance of many different actors responsible for promoting the commercialization of academic research. This would depend on the structure of the R&D system given that the university sector is the responsibility of each province and thus most federal grants are awarded to the individual researchers. Some provinces have more reach to implement however research and innovation policies, as well as specific programs to support the Canadian federal initiatives (Liljemark 2004). Nevertheless, Canadian universities have different approaches to IP ownership and strategies, and thus of the organization of their technology transfer activities.

In addition, the *Framework of Agreed Principles on Federally Funded University Research* acknowledges the responsibility of the federal government to provide the necessary levels of investment in university research and, as it was already stated above, the AUCC agreed to produce a periodic public report to demonstrate the collective progress made by universities in relation to research, knowledge transfer and innovation (AUCC 2002; Gault and McDaniel 2004). However, it has already

been demonstrated that in the Canadian case, there is no deep difference at all in the practices followed in terms of number of licenses, patents, license income and spin-offs creation in other industrialized countries (Clayman 2004).

The federal level initiatives to support the commercialization of Canadian research can be divided into three agency areas (Rasmussen 2008): (1) federal research institutes, (2) targeted schemes from Canadian Institutes of Health Research (CIHR), Natural Science and Engineering Research of Canada (NSERC), and Social Science and Humanities Research Council of Canada (SSHRC) towards commercialization at universities, and (3) general agencies such as the Industrial Research Assistance Program (IRAP) and the Business Development Bank of Canada (BDC).

In addition, it is important to mention that Industry Canada has many offices in the provinces, as well as four regional agents for stimulating entrepreneurship, innovation at universities, the creation of high-tech ventures, commercialization of academic research, and economic development (Rasmussen 2008): (1) Western Economic Diversification Canada; (2) FedNor (Northern Ontario); (3) Atlantic Canada Opportunities Agency (ACOA); and (4) Canada Economic Development for Quebec Regions (DEC). However, the main institutions supporting research activities in Canada are the Canadian Institutes of Health Research (CIHR), Natural Science and Engineering Research of Canada (NSERC), and Social Science and Humanities Research Council of Canada (SSHRC). In relation to spin-off creation in Canada, about half of Canadian university spin-off companies have received IRAP funds (Niosi 2006a, 2006b).

4. Technology Transfer and Spin-Off Creation in Canada

Any definition on UITT and academic spin-off creation must include the outcome and parties involved in the process of technology transfer, as well as core elements that are transferred (Clarysse et al. 2005; Djokovic and Souitaris 2008; Mustar et al. 2006; and Pirnay et al. 2003). The outcome is spin-off firm formation, and the parties involved in the process of technology transfer are: (1) the parent organization, (2) the technology originator, (3) the entrepreneur, and (4) the venture investor.

The core elements transferred are technology (patent and licenses) and/or people (knowledge). The whole elements mentioned in this paragraph generate academic spin-off companies. An academic spin-off can be thus defined as a new firm created to exploit commercially some knowledge, technology or research results developed within a university (Pirnay et al. 2003) and which have formal IP licensing or similar relationships to the university (Hindle and Yencken 2004). The theoretical models for analyzing the process of spin-off creation are (Rodríguez 2009): (1) the evolutionary schema (Bercovitz and Feldmann 2006), (2) the entrepreneurial opportunity and entrepreneurial capacity model (Hindle and Yencken 2004), (3) the stage model of academic spin-off creation (Nlemvo et al. 2002), (4) the technology transfer office model (Siegel et al. 2003, 2004), and (5) the critical junctures model (Vohora et al. 2004). However, the UITT and spin-off creation models mentioned in this research should be seen as complementary since they identify the main phases in the process of spin-off creation (Ndonzuau et al. 2002): (1) business ideas generation, (2) finalization of new venture projects out of ideas, (3) launching new spin-off firms from projects, and (4) strengthening the creation of economic value by spin-offs.

The framework that emerges from these theoretical approaches stresses the emphasis of the university commercialization of new knowledge in terms of economic value and job creation. In fact, the creation of academic spin-off companies has led to the recognition of the value of university commercialization activities for national wealth creation, shifting government technology policy from a “market failure paradigm” to a “cooperative technology paradigm” (Djokovic and Souitaris 2008). As an example, Table 2 presents information on commercialization activity, UITT and spin-off creation among Canadian universities and hospitals.

The importance of spin-off creation and development to the process of UITT is highly important at the regional level in Canada. The NSERC, for example, has conducted a study of 141 spin-off companies created by university researchers during the last 30 years. These companies generated a total of 3.5 billion Canadian dollars in sales and have almost 13,000 employees in 2004 (Rasmussen 2008). In this sense, the government of Canada launched its innovative strategy in 2002. As it was already stated before, the government of Canada agreed with the AUCC to

Table 2**Commercialization Activity at Canadian Universities and Hospitals**

Activity	1999	2001	2003
Universities and Hospitals Managing IP	63	77	87
Inventions Disclosed	893	1105	1133
Inventions Protected	549	682	na
Patents Held	1915	2133	3047
Patents Issued	349	381	na
New Patent Applications	656	932	1252
Active Licenses	1165	1424	1756
New Licenses	232	354	422
Licenses Royalty Revenues (CAN Millions)	21	47	na
Dividend and Equity (CAN Millions)	54	45	na
Number of Spin-Offs (Accumulated)	471	680	876
Spin-Off Revenues (CAN Millions)	na	2580	na
Employment in Spin-Offs	na	19243	na

Source: Rasmussen (2008), p. 4.

pursue a strategy to triple the value of commercialization of university-generated IP and to double the expenditure on the performance of R&D in return for federal contributions towards the overhead costs of R&D by 2010 (Gault and McDaniel 2004). The commercialization policy established searches to increase productivity and innovation in Canada. Table 3 shows the main outcomes resulting from implementing a supporting science and technology transfer policy at Canadian universities in 2001 and 2003.

At university level, Statistics Canada, along with other academic institutions, has organized a series of meetings to address key problems that must be faced by Canadian universities when transferring technology to industry. This inquiry stressed the importance of acquiring adequate marketing and management personnel to succeed in transferring and commercializing new technologies when creating university spin-off firms. The role played by technology transfer offices (TTOs) should be to find the best private sector partner or partners within a context of alternative technology transfer mechanisms. The commercialization of innovations and the commercialization of research results form the basis of spin-offs creation require a set of multiple types of skilled personnel and highly trained commercialization officers to develop spin-off companies (Earl et al. 2004). At this

Table 3**Transfer and Spin-Off Creation in Canada, 2001-2003**

Indicator	2001	2003	Preliminary Change
Invention Disclosures	1105	1177	7%
Inventions Protected/Patented	682	597	-12%
Inventions Rejected	Na	248	Na
Patent Applications	932	1254	35%
Patents Issued	381	337	-12%
Patents Held	2133	3105	45%
Income from IP Commercialization	\$47.6 million	\$51 million	7%
IP Income Distributed to Inventors and Co-Inventors	Na	\$17 million	Na
Spin-Off Companies Created to Date	680	880	Na
Equity Held by the Institutions in Publicly Traded Spin-Offs	\$45.1 million (universities)	\$52 million (hospitals and universities)	15%
Start-Ups that Were Provided Space at the Institution	Na	63	Na
Investment in Spin-Offs Raised With the Assistance of the Institution	Na	\$50 million	Na

Source: Statistics Canada (2004), Survey of Intellectual Property Commercialization in the Higher Education Sector 2004.

level, Rasmussen (2008) found that in Canada all major research universities have a TTO or an industrial liaison office (ILO) with a number of technology transfer staff varying from one up to thirty persons in some cases. The national average in Canada is 3.8 (AUCC 2003). In 2003, Read (2005) found that Canadian universities spent \$36.4 million on IP management with an average distribution of institutional base funding (29%), institutional one-time allocations (10%), IP commercialization revenues (licensing and cashed-in equity) (36%), and external sources (25%).

Canadian universities, hospitals and government labs tend to license out technologies they have patented, spin-off companies to further develop a technology or make their research findings freely available in the form of scientific publications. From approximately \$22 billion of R&D performed in 2003, about 10% is performed by the federal government and 35% by universities (Bordt and Earl 2003). It was estimated that about 1,400 firms licensed technologies from Canadian

universities over the past three years (about 1,670 licensed from hospitals and 1,400 licensed from federal government labs). Approximately 1,350 firms considered themselves as spin-offs from Canadian universities. In addition, licensing new technologies was a technology acquisition method undertaken by just one-fifth of private sector firms (Earl 2004).

However, Statistics Canada regularly surveys UITT activities and spin-off creation in Canada. The surveys carried out by Statistics Canada require a firm to be considered as an spin-off to have an administrative link with the university in terms that it was created to license the institution's technology, to fund research at the institution in order to develop technology that will be licensed by the company, or to provide a service that was originally offered through an institution's department or unit.

On the other hand, from an empirical perspective, evidence suggests that there are more Canadian universities involved in technology transfer and commercialization activities. De Koven (2004) found that the annual number of total spin-offs in Canada increased to 680 in 2001, and 62 of them were just incorporated in the period 2000 to 2001. According to this author, the major quantity of spin-offs in Canada are found in the agricultural/biology technology field (33%), followed by information technology (19%), and engineering (18%). Table 4 summarizes some data on spin-offs related technology field in Canada.

Table 4

Canadian Spin-Off Companies								
Technology Field	Agriculture Biology	Health Science	Engineering	Information	Math Physical Science	Business Management	Other	Total
All Spin-Offs	90 13%	226 33%	122 18%	131 19%	78 12%	8 1%	25 4%	680 100%
Incorporated in 2000/2001	5 8%	25 40%	8 13%	12 19%	8 13%	— —	4 7%	62 100%
R&D Spin-Offs	33 18%	105 58%	21 11%	7 4%	16 9%	— —	— —	182 100%

Source: De Koven 2004, p. 3.

Canada has a lack of a coherent university IP policy, and thus the ownership of IP may reside either in inventor or in university (Afshari 2007). However, the inventor-owned model and the institution-owned model both have positive and negative attributes (Young 2007). Consequently, the federal granting councils do not require full disclosure by researchers of any IP generated from federally funded research grants, and they do not claim ownership of any resulting IP (Afshari 2007). Moreover, the transfer of technology to industry would be blocked by the inability of either actor to maintain exclusivity, resulting in a wide variety of practices in terms of ownership and disclosure. The results are critical to the success of technology transfer programs at universities, such as royalty policy, disclosure process, assignment of responsibility for seeking patent protection, research and institutional conflict of interest, dispute resolution, management of licensees' contractual performance, management of equity interests in spin-off companies, and many more requirements (Young 2007). Since most university discoveries involve multiple researchers, this approach has resulted in much co-ownership of IP in Canada. The co-ownership of IP has made very difficult the negotiation of licensing agreements with established firms. Or, it has equally made difficult to entice risk capital providers and skilled managers to support the establishment of academic spin-off companies (Afshari 2007). In Canada, co-owners of patents cannot grant the exploitation of licensing rights without the agreement of the co-owners, resulting in the event of a licensing paralyzed conflict. In turn, co-ownership introduces an element of uncertainty and risk that is sufficient to dissuade many in the private sector from participating in technology transfers from Canadian universities.

In this sense, the *Fortier Report Public Investment in University Research: Reaping the Benefits* realised by the Advisory Council of Science and Technology in 1999 suggests the following of some actions to correct shortcomings in relation to UITT activity in Canada (ACST 1999). This goal should be achieved through following and implementing some strategies: (1) developing a homogenous university IP framework, (2) strengthening universities' commercialization capacity, (3) developing a commercialization skills base, (4) establishing an adequate competitive business environment, and (5) fuelling the innovation pipeline. Additionally, some provinces in Canada, such as British Columbia, Alberta,

Manitoba and Quebec provide additional assistance and funds for supporting UITT activity and spin-off creation. Since the 1980s, for example, economic policy in these provinces has placed a great emphasis on supporting R&D. This economic policy has supported: (1) the development of a favorable venture capital climate, (2) the development of some sectors of excellence (aerospace, multimedia, biotechnology, nanotechnology, etc.), (3) acquiring a large pool of highly skilled workers, and (4) developing a competitive operating costs scheme. The objective of these initiatives is to develop a highly competitive R&D support system in the world.

Along with these initiatives, two primary models have emerged to support UITT activity and spin-off creation. The adoption of a specific functioning financial scheme for developing UITT activities at universities would define how the model within these activities is carried out (Young 2007):

1. The establishment of an internal institutional department or office (TTOs);
2. The formation of an external company (Commercializing Companies).

Generally speaking, the establishment of an internal office (TTO) for transferring technology to industry concerns some specific goals: (1) to provide services to researchers (inventors), (2) to promote regional economic development, and (3) to generate incomes to stakeholders participating in this process. More specifically, the establishment of a TTO at any university implies four key reasons to advance academic technology transfer (AUTM 2004): (1) to facilitate the commercialization of research results for the public good, (2) to reward, retain, and recruit high-quality researchers, (3) to build closer ties with industry, and (4) to generate income for further research and education, and thus to promote economic growth.

However, when centralized TTOs are incapable to meet their goals, there are four alternative options for supporting and facilitating technology transfer to industry (Young 2007): (1) an external organization, (2) an individual and small internal TTO, (3) one TTO able to serve a consortium of several public research organizations in a region, and (4) an office funded by the national government or

a philanthropic institution that could serve as TTO for several public research institutions. However, if the establishment of an internal office for technology transfer does not fulfill its objectives, the commercializing company model emerges as an alternative scheme to facilitate UITT activities (Afshari 2007).

On the other hand, the main objective in the commercializing company model is to generate cash flow through a variety of related business activities, such as consulting, conference management, and professional development courses. In this sense, commercializing companies and TTOs activities can be seen as complementary in the process of technology transfer at universities. Actually, some provinces in Canada have established a supporting program for developing UITT activities and spin-off creation at universities through the establishment of commercializing companies (Afshari 2007). It is important to stress that comparing to TTOs, commercializing companies are for-profit corporations owned by universities and driven by business objectives. Their mission is to generate added value from research results obtained by university researchers. In this sense, the main functions of the commercializing companies are (Afshari 2007): (1) identification of the most promising technologies, (2) evaluation of commercial potential, (3) IP protection, (4) design of a plan to create added value, (5) early investments toward commercialization, (6) search for investors, (7) create spin-offs, (8) negotiate licenses, and (9) manage the patent portfolio. From this perspective of the commercializing company, there are four main participating actors involved in the process of UITT: (1) university scientists who discover new technologies, (2) university technology managers and administrative personal who serve as a link between academic scientists and industry, (3) commercializing firms that manage university's IP, and (4) entrepreneur firms who commercialize university-based technologies.

Table 5 synthesizes stakeholders' actions and motives in the process of UITT within the commercializing company model. It includes the commercializing companies participating in the process of UITT and spin-off creation accordingly to the Canadian case. In this case, commercializing companies provide an adequate linkage between TTOs and academic spin-off companies. Generally, TTOs evaluate for the opportunities of the research results, meanwhile commercializing companies

Table 5

Stakeholders in the Process of UITT and Spin-Off Creation in Canada

Stakeholder	Actions	Primary Motive(s)	Secondary Motive(s)	Perspective
University/ Scientists	Discovery of new knowledge	Recognition within the scientific community- publications, grants	Financial gain and a desire to secure additional research funding	Scientific
Technology Transfer Office	Works with faculty members and firms	Evaluate research results in terms of opportunity/Protect and market the university's IP	Facilitate technological diffusion and secure additional research funding	Bureaucratic
Commercializing Company	Entrepreneurs to structure deals/ Works with firms/ entrepreneurs and TTOs as link to commercialize new technologies	Protect and market the university's IP/ Financial gain	Facilitate technological diffusion and secure additional research funding/Maintain control of property technologies	Bureaucratic/ Entrepreneurial
Firm/Entrepreneur	Commercialize new technologies	Financial gain	Maintain control of property technologies	Organic/ Entrepreneurial

Source: Adapted from Siegel et al. (2003, p. 115).

act as coordinator of funding research sources and promoting the commercialization of research. In the Canadian case, universities provide the basic funding for TTOs, although it seems like government programs provide important support for maintaining their infrastructure. TTOs also play an important role mediating between academics and commercializing companies (Rasmussen 2008). For example, in the case of the Quebec province, four commercializing companies were funded by the injection of \$50 million from the first Valorisation-Recherche Québec (VRQ) (Afshari 2007). Each commercializing company was in charge of a number of member institutions:

1. SOVAR (\$10 million): Université Laval and the Centre hospitalier universitaire du Québec;

2. UNIVALOR (\$15 million): Université de Montréal and its affiliated schools and institutes;
3. VALEO (\$10 million): Concordia University, École de technologie supérieure, Institut national de la recherche scientifique, and the network of the Université du Québec;
4. MBSI (\$15 million): McGill University, Université de Sherbrooke, and Bishop's University and its affiliated health institutions.

However, there must be a link between TTOs and the commercializing companies. In fact, collaboration between the TTOs and the commercializing companies is a key issue to successfully transfer technology from universities to industry. In short, there are many federal and provincial government programs to support UITT developments and spin-off creation in Canada. The support for entrepreneurship is generally handled at the provincial level, meanwhile funding new spin-off comes out from federal government initiatives (Rasmussen 2008). However, the most important program is the *Industrial Research Assistance Program* (IRAP) together with a tax deduction scheme.

5. Conclusions

This paper analyzed the process of technology transfer from universities to industry in Canada. This experience could be interesting since many government initiatives have successfully supported innovative activity at Canadian universities. These initiatives both at federal and provincial levels search to provide a platform for ranking Canada among the top five countries in terms of R&D and innovative capabilities. In this sense, it was argued that technology transfer activities might become extremely important within Canadian universities. However, university spin-off companies in Canada are an important mechanism to transfer technology from universities to industry since it has been then demonstrated that university commercialization of new knowledge is extremely important as it deeply impacts economic value and job creation.

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