Intellectual Property Rights Policy and University Technology Transfer Output in Canadian Universities

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ABSTRACT

Since the end of the 1990s, several OECD governments have considered to revise Intellectual Property Rights (IPRs) policy from inventor IP ownership towards different systems of institutional ownership based on the objectives of policymakers to emulate the Bayh-Dole Act of 1980. However, there have been an increasing number of arguments on a comparison of the institutional and inventor ownership. Given this interest, critically investigating the effects of current implementation of the Bayh-Dole Act model is significant in the discussion of commercialization of university inventions not only for the U.S., but also for the other nations adopted Bayh-Dole-like model.

To examine the IPRs policy in Canadian universities, this study analyzes and measures the outcomes of university technology transfer between the different types of IP ownership policy using the specific indicators of the number of invention disclosures, licenses, spin-off companies, and patents. The evidence suggests that quantitative results from their commercialization seem to be affected by IPRs policy. Considering the similar rating of new invention disclosures and patent value, Canadian universities with institutional IP ownership policy tends to produce more number of new licenses and patents while Canadian universities with inventor IP ownership policy can generate greater number of new spin-off companies.

Keywords: University IP policy, University technology transfer, University entrepreneurship, University commercialization

1. INTRODUCTION

As the global economy moves in the direction of entrepreneurial and technological innovation, the role of the university has diversified and encompassed a 'third-mission' of economic development beyond traditional instructional and research missions. Nowadays universities are widely perceived as more than institutions of higher education and research. Universities are increasingly viewed as proactive contributors to technological development and economic growth (Meyer, 2006). The past separation between pure research and applied R&D has given way to new forms of partnerships and collaboration associate with the changing contexts of knowledge production (Bercovitz and Feldmann, 2006) and the university's role in

this new context must be carefully (re-) defined since universities are expected to become a key part of a knowledge-based solution (Bercovitz and Feldmann, 2006).

However, some scholars argue that there is little evidence supports that the increasing role of university in commercialization influent the economic growth or the increased in university commercialization has facilitated increased technology transfer or any significant growth in the economic contributions of universities (Sampat, 2006). Certainly that to build a strong economy is neither easy nor simple and even the best university with the greatest commitment to innovation cannot, on it own, transform an economy, however the universities are making substantial and inventive contributions to local and national economies (Tornatzky, et al., 2002). Importance is universities should not become just the external R&D department of industry, nor a training institution for skilled labor, and academic researchers or professors should not primarily be entrepreneurs (Bercovitz and Feldmann, 2006).

The notions of the entrepreneurial university and the academic entrepreneur have become guiding images for policy-makers in higher education and science and technology innovation (Meyer, 2006). Universities in developed countries have become increasingly entrepreneurial (Mowery et al., 2004; Siegel, 2006a; Rothaermel et al., 2007). In many countries, governments pursue policies towards increasing entrepreneurial activities and supporting the university commercialization (Meyer, 2006). Commercialization of university technology involves economic utilization of Intellectual Property (IP) and Intellectual Property Rights (IPRs) (Rasmussen, et al., 2006). The U.S. example has been particularly influential, concerning with unclear rules and low commercialization rate led to the passage of the Bayh-Dole Act, a uniform federal legislation in 1980 that passed the IPRs from federal government to the universities, giving the universities to retain IPRs to any patents resulting from government-funded research. (Rasmussen, et al., 2006).

Since the end of the 1990s, several OECD governments have considered to revise IPRs from inventor IP ownership towards different systems of institutional ownership. This shift is based on the objectives of policymakers to emulate the Bayh-Dole Act of 1980. However, there have been an increasing number of arguments on a comparison of the institutional and invertor ownership (Professor's Privilege). Given this interest, critically investigating the effects of current implementation of the Bayh-Dole Act model is significant in the discussion of commercialization of university inventions not only for the U.S., but also for the other nations adopted Bayh-Dole-like model.

This paper aims to analyze and compare two different types of allocation of the ownership on the results of university research: Institutional (university) ownership, according to which the invention is attributed to the university where the research is performed, and professor's privilege (inventor ownership), which confer the exclusive right on the invention to the professor or inventor who performed the research. The study provides an empirical analysis of the output of university technology transfer using the sample of ten most productive Canadian universities in research result including University of British Columbia, University of Toronto, McGill University, Queen's University, McMaster University, University of Alberta, University of Ottawa, University of Waterloo, University of Montreal, and University of Western Ontario.

To examine the IPRs policy in Canadian universities, this study analyzes and measures the outcomes of university technology transfer between the different types of IP ownership policy using the specific indicators of the number of invention disclosures, licenses, spin-off companies, and patents using a survey data of the Association of University Technology Managers (AUTM) and the U.S. Patent and Trademark Office (USPTO). The evidence suggests that the quantitative results from their commercialization activities seem to be affected by IPRs policy. Considering the similar rating of new invention disclosures and patent's value, Canadian universities with institutional IP ownership policy tends to produce more number of new licenses and patents, but Canadian universities with inventor IP ownership policy can generate greater number new spin-off companies.

The paper is structured as follow. Section 2 summarizes the existing literature on university entrepreneurship and technology transfer to commercialization. The summary of the university Intellectual Property Rights (IPRs) regulations is presented in section 3. Section 4 explains the Intellectual Property (IP) culture in Canadian universities. Section 5 is the empirical analysis of technology transfer output Section 6 discusses the statistical analysis and empirical results with summary and concluding remarks.

2. UNIVERSITY ENTREPRENEURSHIP AND TECHNOLOGY TRANSFER TO COMMERCIALIZATION

As scientific knowledge becomes increasingly important for innovation and new technological development (Mansfield and Lee, 1996; Rasmussen et al., 2006), the notions of the entrepreneurial university and the academic entrepreneur have become guiding images for policy-makers in higher education and science and technology innovation (Meyer, 2006). In many countries, governments pursue policies towards increasing entrepreneurial activities and supporting the university commercialization (Meyer, 2006). However, many academics view the entrepreneurial paradigm as a threat to the traditional role and integrity of the university (Etzkowitz, et al., 2000). In this study, I pay attention to the emergence of the entrepreneurial university as a response to the increasing importance of knowledge and technology in national innovation systems and the recognition that the university is a creative inventor and transfer agent of both knowledge and technology.

Universities have a role of providing dynamic environments for generating new ideas and stimulating innovation including moving advances in knowledge and technology into the commercial stream, these efforts collectively are called "technology transfer" (Merrill and Mazza, 2010). The transfer of technology is the diffusion of research knowledge through three major forms of mechanisms including conferences and scientific publications, the training of a skilled labor force, and the commercialization of knowledge (Landry, et al., 2006). The commercialization of university research is a transaction between the university and a commercial firm (Landry, et al., 2006). Notable mechanisms of commercialization can be considered through consulting activities, research contracts with industry, patenting, and spin-off company formations (Landry, et al., 2006). Several of these mechanisms certainly exceed intellectual property- based licensing in economic and social impact, especially patenting and licensing of IP by universities that are more closely regulated by national policies (Merrill and Mazza, 2010).

To investigate the commercialization activities at universities, infrastructural reforms and institutional innovations that promote a culture of entrepreneurship within the institution have been focused by many scholars (Klofsten and Jones-Evans, 2000; Rasmussen et al., 2006). Entrepreneurship seems often to be a driving force in the process of commercializing university knowledge (Rasmussen et al., 2006). A range of initiatives has been set up to commercialize university knowledge. Many universities, especially in the U.S., have established offices for patenting and licensing. In most universities, IP management offices are also known as University-Industry Liaison Office (UILO) or Technology Licensing Office (TLO) (Robinson, 2006). These offices are "the university's brokers in the knowledge market" (Fisher and Atkinson-Grosjean, 2002; Robinson, 2006).

The technology transfer agent engages the commercialization process by first determining whether commercialization of the invention is in the university's interest. According to the UILO of the University of British Columbia (UBC), the office's involvement begins when a researcher discloses an invention. During the initial technology assessment, the UILO completes and literature searches, along with preliminary technical and market assessments that focus on the issues most affecting an invention's prospect for commercialization. On completion, it is reviewed by the UILO's Intellectual Property Committee which either (i) accepts a technology for protection and commercialization; (ii) returns it to the inventor for further R&D or declines it if it has limited market potential.

When the technology is accepted by the UILO for commercialization, appropriate protection in the form of patents, copyright, or trademark registration is sought. Patent protection is first sought in the United State, which has a faster patent prosecution process and represents the closest sizable market. At this point, the technology may be (i) Prepared by the UILO for marketing and licensing; (ii) Entered into the UILO's Prototype development Program which develops the commercial potential of the technology; (iii) Assigned to a third party for management, for example a commercial technology transfer organization such as Research Corporation Technologies. Regardless of which option is chosen, in the end, the successful technology will either be licensed to an existing business, or in approximately one third of all cases to a new UBC spin-off company specifically created to fully develop the technology opportunity in British Columbia.

3. UNIVERSITY INTELLECTUAL PROPERTY RIGHTS REGULATIONS

Commercialization of university technology involves economic utilization of Intellectual Property (IP) and Intellectual Property Rights (IPRs) (Rasmussen et al., 2006). The U.S. example has been particularly influential, concerning with unclear rules and low commercialization rate led to the passage of the Bayh-Dole Act, a uniform federal legislation in 1980 that passed the IPRs from federal government to the universities, giving the universities to retain IPRs to any patents resulting from government-funded research (Rasmussen et al., 2006).

The ownership of the IP created in the university depends on the various factors such as: IP inventors and their legal relationship among themselves and with funding source, and legal frameworks including national laws, university IP policies, and contractual agreements (Ćorić, D., 2010). As a result, the ownership can be

allocated to the inventors, the university, industrial partners, government or other funding agency. The first step in ownership allocation is the identification of the inventors and their legal status with funding source and university. Inventor identification is important since it can help to allocate the ownership, and to be aware of the person that can claim compensation once the patent is exploited (Ćorić, D., 2010).

Ownership of IPRs varies across countries and interrelates various legislation and policies, which could be classified in two dominant models of university IP ownership systems: inventor ownership and institutional ownership (Ćorić, D., 2010). Among the European nations, UK, Spain, and Switzerland have strong involvement in institutional ownership policy, contrary to Sweden that is strict with inventor ownership model and Italy has just shifted from institutional to inventor ownership policy, while Austria, Belgium, Denmark, Germany, Finland, and Norway have changed their policy from inventor ownership to institutional ownership model. However, untangling the quantitative and qualitative effects of changes in IPRs regulations on university technology transfer is complicated and difficult regarding the effects of concurrent transformations in the institutional, cultural and organizational landscape surrounding academic knowledge transfer (Geuna and Rossi 2011).

The concept of Professor‘s privilege or inventor ownership reflects the idea that the results of the research performed at the university or other public-funded research organization are retained by the researcher who performed the research. This concept aims to motivate academics to get more actively involved in the commercialization of research output. On the other hand, the institutional ownership of university to IP means that the IPRs on the results of academic research belong to the institution where the research is performed. There is a global trend for universities to shift their IPRs policy from the inventor ownership to this type of system (Ćorić, D., 2010).

Recently, there is a trend in Europe to abolish the inventor ownership model. Denmark has shifted from inventor to institutional ownership in 2000, followed by Germany, Norway, and Austria in 2002, Hungary and Slovenia in 2006 and Finland in 2007 (Geuna and Rossi 2011). The main reasons for this abolitionist movement can be found in the increased recognition that principle of academic freedom is not valid reason to grant privileges and to deprive universities from the IPRs (Ćorić, D., 2010). Another reason for this property shift is the intention of policy makers to create similar conditions to the U.S. where university retains all IP rights as a result of the Bayh Dole Act (Lissoni, et al., 2009).

Italy was the only country that went in opposite direction adopting the inventor ownership policy in 2001. It seems that Italy adopted professor‘s privilege for two main reasons: because it could encourage the patenting of existing research, and it could help to solve the problem of bureaucracy in university administrations, which often made impossible the exploitation of many academic inventions (Van Eecke, et al., 2009). However, these changes introduced a significant concern among Italian universities and companies since most of the university inventions could be then owned by private sectors (Montobbio, F., 2009). Currently, Among the European nations, there are only Italy and Sweden that have professor‘s privilege implemented. The other countries, the professor’s privilege existed in Japan until 2004 then the policy has been shifted toward the institutional ownership (Mowery and Sampat,

2005).

Table 1 is a comparison and evaluation of institutional and inventor ownership policy in terms of characteristic, locus of decision-making, and technology diffusion. Institutional ownership is easy for industry to contact the representative (UILO or TTO) but for the inventor ownership model, inventors need to have the business connection and capability in commercialization of their inventions.

Table 1: Schematic comparison between institutional and inventor ownership

	Institutional ownership	Inventor ownership
Characteristic	•Universities retain IPRs to any invention disclosures deriving from publicly funded research	•Inventors own the IPRs in inventions
Locus of decision making	•UILOs or TLOs (centralized) •Limitation of the rights to inventors •Reducing the constraint of business skill of inventors	•Inventors (decentralized) •Inventors would be the principal •Inventors must have skills and abilities in commercialization inventions
Technology diffusion	•UILO or TLO has total control •Performance determined by TLO's knowledge, capability, and experiences as well as the institutional issues •Easy access from industry to TLOs	Inventors choose channels based on their knowledge and capability and can contact for assistance •Inventors have to find their own commercialized channels
Evaluation	•TLOs have experiences in commercializing technology, there are more possibilities that inventions could be commercialized in suitable ways	•Inventors can choose to use the TLOs or other organizations to commercialize the technology, commercialize the technology themselves, or place the invention in the public domain

Source: By Author

4. INTELLECTUAL PROPERTY CULTURE IN CANADIAN UNIVERSITIES

The Canadian IP framework begins with the basic common law principle that an employer owns inventions created by employees during the course of their employment (Vaver, 1997; Christie, et al., 2003). The ownership of inventions created with public funds are determined to a large extent by the policy of each research institution. University IP ownership policies may be typically divided into three main groups: (i) university ownership, which requires mandatory assignment of ownership of the invention to the university and university will manage the commercialization process; (ii) inventor ownership, which provides the decision of either assigning the invention to the university or maintaining ownership; (iii) joint ownership policy between the university and the inventor (Christie, et al., 2003; Robinson, 2006).

In 1998, the Canadian government's Advisory Council on Science and Technology commissioned an Expert Panel on the commercialization of university research to investigate how Canada might better capture the benefits from university

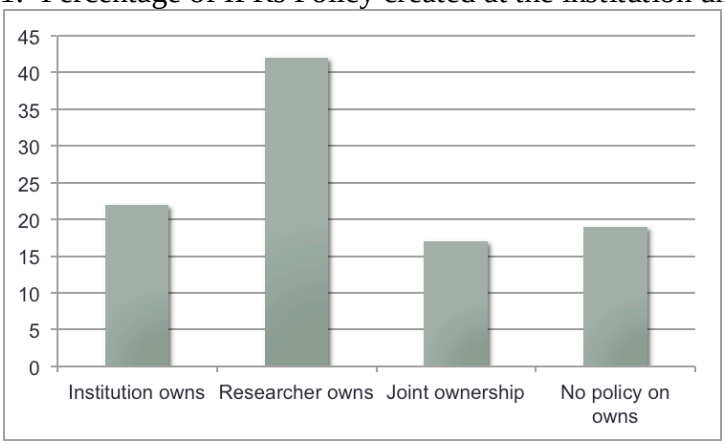
research (Christie, et al., 2003). The Expert Panel describes four problems arising from the absence of a coherent national policy on IP ownership and disclosure in publicly*funded research institutions* in Canada including lost commercialization opportunities, leaked benefits to other countries, costly litigation, and limitation of longer-term innovative potential of Canadian firms. The Expert Panel found that a significant factor accounting for lost commercialization opportunities in Canada is that universities that vest IP ownership with researchers. Since most of the developments of the inventions involve multiple researchers, ownership of IP will normally be shared. A co-ownership model makes it difficult to negotiate licensing agreements. The commercialization process can be paralyzed in the event of a conflict.

The Expert Panel was particularly aware of situations where researchers create IP with public fund, obtain ownership of inventions then license the new technology to foreign firms for development. This circumstance causes the leakage of national benefits and makes Canada lost the jobs and investments. Vesting IP ownership with researchers also creates a potential litigation. This has resulted in many universities being sued for inappropriate business decisions made by academics, for instance granting 'exclusive' licenses to more than one firm; failing to take into account graduate student contributions to the development of an invention. The greater the number of individuals commercializing research without professional qualifications and experience, the greater the risk of litigation.

The last problem pointing out by the Expert Panel is limitation of innovative potential of Canadian firms. The diverse range of university IP ownership policies in Canada acts as a disincentive for industry –university collaboration. Negotiation over invention ownership can be a time consuming process, especially where the collaboration involves multiple universities with different policies. The negotiation process also has the potential to create frustrations, ill feelings and mistrust between universities, academics, and industry.

Intellectual Property (IP) culture has evolved in Canadian universities that is similar to the environment of the U.S. since the passage of the1980 Bayh-Dole Act (Trosow, et al., 2012). Canadian universities have over the last two decades moved toward the establishment of special IP-related offices to facilitate technological innovation and commercialization of university research (Trosow, et al., 2012). These offices are most notably recognized as Technology Transfer Offices (TTOs), Technology Licensing Offices (TLOs) or University-Industry Liaison Offices (ULIOs) (Trosow, et al., 2012). According to the Statistics Canada's 2008 Survey of Intellectual Property Commercialization in the Higher Education Sector, 88 percent of Canadian universities were actively engaged in IP management through TTOs. Canadian universities do not have a uniform IP policy with both university ownership and inventor ownership models existing at different universities (Trosow, et al., 2012). Regarding the Statistics Canada's 2008 Survey, 22 percent of Canadian universities have the institutional ownership policy while 42 percent have the inventor ownership policy which is the majority number, 17 percent of Canadian universities have joint ownership and there are 19 percent that have no policy on IPRs as presented in Figure 1.

Figure 1: Percentage of IPRs Policy created at the institution until 2008



Source: By author based on the panel data of Statistic Canada, 2010

Even the Expert Panel proposed approach for Canada by requiring all universities to adopt IP policy that emulates Bayh-Dole Act, but Canadian universities still have a diversity of approaches to IP policy, IP strategies, and the organization of their technology transfer activities. For instance, in the city of Vancouver the University of British Columbia owns the IPRs, while at Simon Fraser University, the IPRs are owned by the inventors (Rasmussen, 2008). Table 2 illustrates Canadian universities and different type of ownership policy.

Table 2: Ownership policy in Canadian universities

University ownership policy	**Inventor ownership policy**
University of British Columbia	University of Toronto
McGill University	Queen's University
McMaster University	University of Alberta
University of Ottawa	University of Calgary
University of Montreal	University of Western Ontario
University of Sakatchewan	University of Waterloo
University of Guelph	Simon Fraser University
Memorial University	University of Manitoba

Source: By Author adapted from Trosow, S. et al., 2012.

5. EMPIRICAL ANALYSIS OF TECHNOLOGY TRANSFER OUTPUT

The contribution of universities to economic development coincidental with the growth and professionalization of commercialization of university technology transfer. Thus, as commercialization becomes a task, a challenge for the university is to measure and make visible the extent and results of this activity (Rasmussen et al., 2006). Common output indicators are the number of invention disclosures, licenses, patents, and spin-off companies. However, the use of quantitative measurements to measure the outcome of technology transfer activity is increasingly critiqued in

Canada (Langford et al., 2006; Rasmussen, 2008). But, these outcomes are widely employed, relatively easy to measure, are reported annually by most institutions. Moreover, these indicators are taken by some as real or proxy measures of the effectiveness of Bayh-Dole policy and universities' contributions to the economy (Merrill and Mazza, 2010).

In this study the data collected were top ten most productive Canadian universities in the output of university technology transfer to commercialization including University of British Columbia, University of Toronto, McGill University, Queen's University, McMaster University, University of Alberta, University of Ottawa, University of Waterloo, University of Montreal, and University of Western Ontario. IP policy among these universities can be divided into two categories; university ownership and inventor ownership policy as presented in Table 3.

Table 3: Type of IPRs policy among Canadian universities

University ownership policy	**Inventor ownership policy**
University of British Columbia	University of Toronto
McGill University	Queen's University
McMaster University	University of Alberta
University of Ottawa	University of Waterloo
University of Montreal	University of Western Ontario

Source: By Author

This paper aims to make a comparative analysis between two different types of allocation of the ownership on the results of university research. To examine the IPRs policy using Canadian universities as a sample, this study analyzes and measures the outcomes of commercialization of university technology transfer between the different types of IP ownership policy with the specific indicators of the number of invention disclosures, licenses, spin-off companies, and patents using a survey data of the Association of University Technology Managers (AUTM) between 2004 and 2008 and the U.S. Patent and Trademark Office (USPTO) between 1999 and 2008.

In terms of the number of new invention disclosures, comparing between university ownership and inventor ownership policy, the number of new invention disclosures are not much different in over all image. University of British Columbia has the highest number of new invention disclosure in the group of university ownership policy with 824 new invention disclosures between 2004 and 2008 while University of Toronto has 839 new invention disclosures, which is the top of the inventor ownership group. Figure 2 shows the comparison of average number of new invention disclosures between these two groups, universities with institutional ownership policy can launch greater number of new technologies compare to universities with inventor ownership policy.

Figure 2: The comparison of average number of new invention disclosures

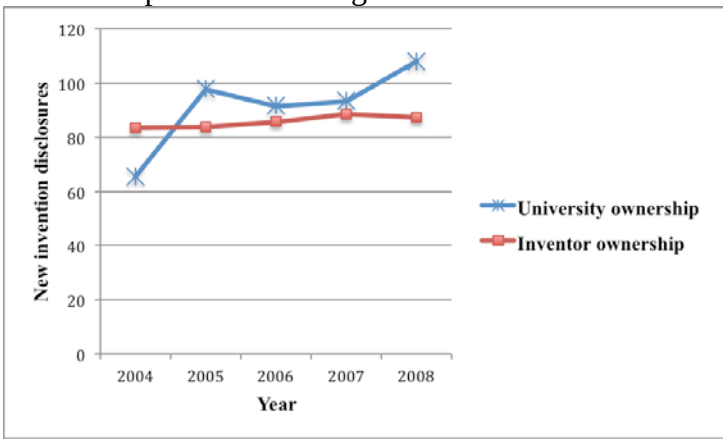
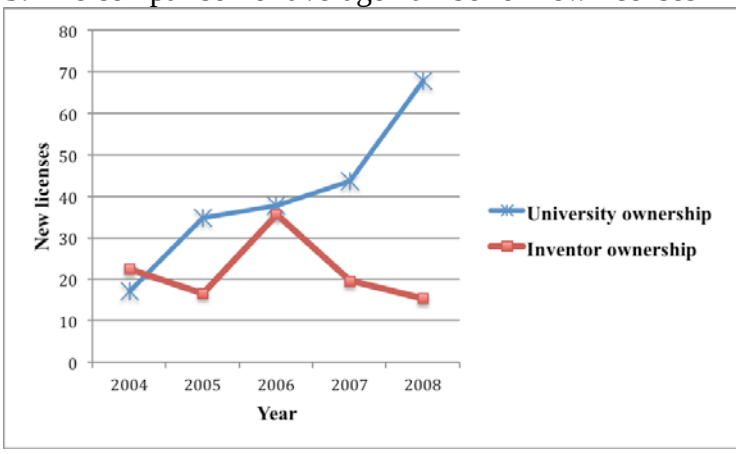


Figure 3 shows the comparison of average number of new licenses between the university with institutional ownership model and inventor ownership model. On the contrary to the amounts of new invention disclosures, the university with institutional ownership can create more number of new licenses. The higher number is the group of university ownership policy and McMaster University performs the best in the number of new licenses with 521 new licenses between 2004 and 2008. Follow by the University of British Columbia with 235 new licenses. For the group of invention disclosures, still University of Toronto is the top with 184 new licenses.

Figure 3: The comparison of average number of new licenses



For spin-off company, the statistic number reveal in contrast to the number of new licenses. Universities with inventor ownership policy can generate more number of spin-off companies compare to the group of university ownership. University of Toronto can create the highest number of spin-off firms with 39 companies between 2004 and 2008, while University of British Columbia can establish 21 firms. Figure 4 shows the comparison of average number of new spin-off company formations between these two groups, universities with inventor ownership policy has a better performance comparing to the group of university ownership policy.

Figure 4: The comparison of average number of spin-off company formations

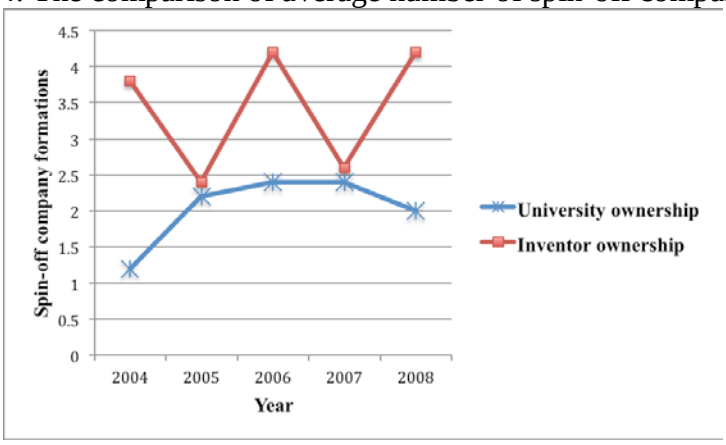
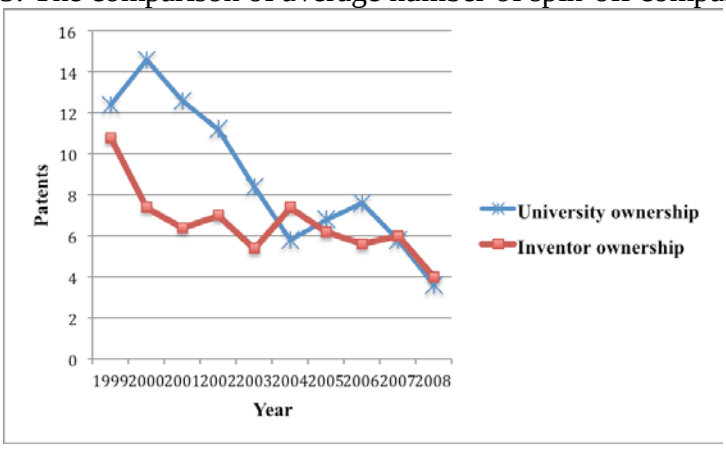


Figure 5 illustrates the number of patents that Canadian universities can obtain comparing between the average number of patents in university ownership and inventor ownership model. The group of university ownership policy can produce more number of patents, however this statistic data did not include the data from inventor side thus, this result might understates the total amount of university patents.

Figure 5: The comparison of average number of spin-off company formations



However, to evaluate the difference in the statistic number between the two groups, I employ Two-sample *t* Test to compare two populations and determine to prove the difference in their mean value of the number of invention disclosures, licenses, spin-off companies, and patents including patent value.

To measure patent value, the use of patent citation data is widely employed to construct a variety of measurement to interpret the importance of the invention covered by a patent (Tranjtenberg et al., 1997; Henderson et al., 1998; Hall et al., 2005; Goto and Motohashi, 2007; Tantiyaswasdikul, 2012). Citations can be used for many purposes including tracing the process of technology development and evaluating the importance of a patent (Goto and Motohashi, 2007; Tantiyaswasdikul, 2012). Moreover, citation data can provide significant evidences that reveal the links between an innovation and its technological antecedents and descendants clearly (Tranjtenberg et al., 1997; Tantiyaswasdikul, 2012).

I examine the patent value using citation-based measurement like Trajtenberg et al. (1997) and Henderson et al. (1998). In the words of Trajtenberg et al. (1997),

> "The first, and probably the key aspect of the relationship between a patent and its descendants is what we call the overall "importance" of a patent, denoted IMPORTF (the F for forward). This measure is designed to capture the technological impact of an invention as reflected in the number and importance of its descendants, and hence corresponds to the most intuitively appealing notion of basic innovation". (p. 26)

I define importance as in (1)

$$IMPORTFi = NCITINGi + \lambda \sum_{j=1}^{ncitingi} NCITINGi+1j \quad (1)$$

IMPORTF = number of citing patents, including second generation cites
NCITING = number of patents citing the originating patent
Index i corresponds to the patent under consideration and i+1 to citing patents.

Where $0< \lambda< 1$is defined as an arbitrary discount factor, that is meant to down weight the second generation descendants of a patent relative to the first generation citing patents. I set to 0.5 like Trajtenberg et al. The result is presented in Table 4.

Table 4: Statistics of technology transfer and commercialization output

	Count number	Mean	STDEV.S	Maximum	Minimum
New invention disclosures					
University ownership	25	91.28	48.85	190	0
Inventor ownership	25	85.8	52.82	220	7
New licenses					
University ownership	25	40.24	48.68	220	0
Inventor ownership	25	21.92	17.33	88	3
New spin-off companies					
University ownership	25	2.04	2.19	7	0
Inventor ownership	25	3.44	2.97	11	0
Patents' value*					
University ownership	94	4.69	12.7	85	0
Inventor ownership	73	2.56	5.31	34	0

* To evaluate patent value using the number of forward citations with reducing the limitation of the data on inventor part, this analysis covered only the patent with co-assignee.

The first point of broad comparison between university ownership model and inventor ownership model is the data of Mean, Maximum, Minimum, and Standard deviation of the count number of each data as presented in Table 4. The differences in mean value of the number of invention disclosures, licenses, spin-off companies, patents, and patent value of the two groups was proved in Two-sample *t* Test and the results reveal that the two groups are statistically different in terms of the mean value of the number of new licenses, new spin-off companies, and patents as presented in Table 5.

Table 5: Comparison of mean ratings

	University ownership		Inventor ownership				
	M	**SD**	**M**	**SD**	***t* ratio**	***df***	***p***
New invention disclosures	91.28	9.77	85.8	10.56	0.3808	47.7099	0.7050
New licenses	40.24*	9.74	21.92	3.47	1.7726	29.9848	0.0865
New spin-off companies	2.04	2.19	3.44*	2.97	-1.8961	44.1058	0.0645
Number of patents	11.05*	9.27	7.8	4.36	2.0061	55.4681	0.0497
Patent value	4.69	12.70	2.56	5.31	1.4692	131.018	0.1442

* significant at 10%

The Canadian universities have differing approaches to IP ownership and the quantitative results from their commercialization activities seem to be affected by IPRs policy. A comparison of the two groups show essentially no difference in the number of new invention disclosures and patent value. With the similar rating of new invention disclosures and patent value, Canadian universities with institutional IP ownership policy tends to produce more number of new licenses and patents. However, Canadian universities with inventor IP ownership policy can generate more number of new spin-off companies.

The successful case of spin-off company creation relies on the role played of the university technology transfer agency in structuring relationships and management development and also the active involvement of the inventor (Langford et al., 2006). The government support is also important and the evidences revealed that spin-off companies that grew had often obtained patents and received support from the Industrial Research Assistance Program, a support program for R&D in small firms, managed by the National Research Council of Canada (Niosi, 2006). However, the university IP policy is important. The university that provides the IPRs to inventors can incentivize and enable researchers to take part in knowledge transfer in form of spin-off creation.

Canadian universities with institutional IP ownership policy can produce more number of new licenses and patents than Canadian universities that give the IPRs to inventors. This focus of university entrepreneurship through the formal IP system might greatly understate the total amount of academic entrepreneurship since there is much academic entrepreneurship occurs outside the university IP system regarding the study that analyzed a sample from inventors' side (Fini, et al., 2010).

6. CONCLUSION

The proposed approach of the Expert Panel for Canada regarding commercialization process is similar to the Bayh-Dole and Canadian model recognizes that, universities are better placed than academics to manage the commercialization process since the Expert Panel found that most academics are severely constrained by a lack of time and expertise to commercialize their inventions. However, Canadian universities still have a diversity of approaches to IP ownership, IP strategies, and the organization of their technology transfer activities.

The technology transfer output in Canadian universities seem to be affected by

different type of IPRs policy. However, regardless the type of the IP ownership; the productive commercialization is only possible when the inventors are actively involved and motivated in the process of technology transfer. Successful commercialization often depends on active inventor engagement and effective performance of technology transfer office. It is essential that, universities have to provide a clear IP policy mandate to their academics and technology transfer offices. Consequently, the policy makers have to consider creating legal framework that can encourage effective collaboration between researchers, universities, and industry.

This study has the modest aim of identifying output of commercialization between the different type of IPRs policy and speculating on their effect on technology transfer. Certainly, given the limitations of space and time, this analysis necessarily covers only the five-year period output of university technology transfer in the number of licenses and spin-off companies and ten-year period of the number of patents. Nevertheless, the results of this analysis could underscore the significant output between the different types of IPRs policy in Canadian universities.

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