

Connecting Innovation and the Marketplace: Commercializing Research at Post-Secondary Institutions in British Columbia

by

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Abstract

Canada's innovation performance is lagging behind other developed countries. The need for universities to commercialize their research is growing. University spinoffs (USOs) have emerged as the preferred mechanism by which universities transfer technology to the commercial realm. The problem, however, is that university research does not automatically generate economic growth. This study proposes and evaluates policy options available to the provincial government to support the commercialization of university research in BC. An overview of the relevant literature and current government programs is provided. A thematic analysis of the fifteen semi-structured interviews is conducted to identify the challenges associated with creating a USO. An evaluation framework is developed under which each policy is analysed. This study recommends that the provincial government: provide patent funding to SFU and UVic; expand the Venture Capital Program (VCP); and reform the BC Innovation Council (BCIC).

Keywords: university spinoff; entrepreneurship; innovation; technology transfer; commercialization

Dedication

To my mom and dad who always believed in me.

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List of Acronyms

BCIC	British Columbia Innovation Council
IO	Simon Fraser University's Innovation Office
IP	Intellectual Property
SFU	Simon Fraser University
TTO	Technology Transfer Office
UBC	University of British Columbia
UILO	The University of British Columbia's, University-Industry Liaison Office
USO	University Spinoff
UVic	University of Victoria
VCP	Venture Capital Program
WUTIF	Western Universities Technology Innovation Fund (WUTIF)

Executive Summary

Canada's innovation performance is lagging behind other developed countries. According to a recent Conference Board of Canada report (2010), Canada ranked 14th out of 17 countries on innovation. This is troubling because innovation is a driver of productivity growth which leads to a higher standard of living for Canadians (Public Policy Forum, 2011).

Universities and technical schools are a rich source of knowledge and innovation. The innovations produced by these institutions are valuable but Canada struggles to commercialize this knowledge and use it as a source of economic advantage (Conference Board of Canada, 2010). As Canada shifts towards a knowledge-based economy, the role of universities as intellectual hotbeds means their potential for increased contributions to such an economy is highlighted. It is not surprising, therefore, that a recognition of the need for universities to develop a more direct link with science and technology industries and to serve a "third mission" of contributing to local economic development is growing (O'Shea et al., 2005). University Spin Offs (USOs) are emerging as the preferred mechanism by which universities transfer knowledge and technology to the commercial realm (Bercovitz & Feldmann, 2006).

This study examines the policy tools available to the province of British Columbia to increase the creation of USOs. This capstone starts by providing a review of the relevant academic literature on USOs and describing the programs currently in place to support university entrepreneurs. Next, a qualitative methodology is chosen to investigate how the province of BC can better encourage the commercialization of university research. Fifteen semi-structured interviews with university employees, university entrepreneurs, and "other stakeholders" are conducted and analysed. The analysis reveals five key themes, all of which center on the challenges and barriers to the commercialization of university research: (1) the funding gap; (2) the short supply of managerial and business talent; (3) the limited business knowledge among university entrepreneurs; (4) the emerging entrepreneurial culture at universities in BC; and (5) the constraints of the traditional academic model.

From the key informant interviews, five policy options for supporting the commercialization of university research are developed: (1) The Status Quo; (2) The Status Quo Plus; (3) Commercialization Centers; (4) Direct Investment; and, (5) Reform the BCIC. Each of the proposed policy options will have different outcomes for university entrepreneurs and the commercialization of research. The policy options are evaluated using 4 criteria: cost, effectiveness, administrative complexity, and political feasibility.

After considering the current fiscal environment and the budget of the BCIC, it is recommended that the province of BC implement two of the proposed policies: the Status Quo Plus and BCIC Reforms. The two recommended policy options support the commercialization of university research in the short and long term. The Status Quo Plus option addresses the short term needs of SFU's Innovation Office and UVic's Industry Partnerships by providing them with immediate financial resources. Expanding the Venture Capital Program (VCP) helps to fill the funding gap in both the short run, by increasing the individual investment limit, and in the long run, by rolling over unused tax credits to create a larger cap in years of economic growth and increased investment. Reforming the BCIC addresses the long term needs of university entrepreneurs and the TTOs by including individuals from the TTOs in the governance of the BCIC and by providing longer funding runways for programs, both of these changes will result in the funding of more effective programs.

Three of the proposed policy options are not recommended for the following reasons. The Status Quo and Direct Investment have not been selected because of their low effectiveness scores. The Commercialization Centers were not selected because of their high cost, high administrative complexity and low political feasibility. There was, however, a trade-off in eliminating this policy option. The high effectiveness (the highest of any of the evaluated options) of Commercialization Centers was forgone for the cost efficient, administratively simple, and politically feasible options of the Status Quo Plus and BCIC Reforms.

1. Introduction

Canada's innovation performance is lagging behind other developed countries. Innovation refers to "the firm or organization's ability to apply knowledge in new or different ways" (Holbrooke & Wolfe, 2005). According to a recent Conference Board of Canada report (2010), Canada ranked 14th out of 17 countries on innovation. This is troubling because it is only by developing a culture of innovation that Canada will create a cleaner environment, healthier citizens, stronger communities, and a more prosperous economy. Innovation is a driver of productivity growth which leads to a higher standard of living for Canadians (Public Policy Forum, 2011).

The Canadian economy is changing. Globalization is shifting the competitiveness of developed economies away from manufacturing activities towards knowledge-based industries and services. The knowledge-based era depends on education, skill, research and development. Knowledge, therefore, is crucial to employment and economic growth because it is the basis of innovation (Gulbranson & Audretsch, 2008).

Universities and technical schools are a rich source of knowledge and innovation. The Conference Board of Canada (2010) found that Canada has high quality technical institutes, engineering schools, and universities. The problem is that "investments in university research do not automatically spill over to generate innovative activity and economic growth" (Gulbranson & Audretsch, 2008, p.250). The innovations produced by these institutions are valuable but Canada struggles to commercialize this knowledge and use it as a source of economic advantage (Conference Board of Canada, 2010).

There is a gap between university research and industrial commercialization (Peng, 2006). As Canada shifts towards a knowledge-based economy, the role of universities as intellectual hotbeds means their potential for increased contributions to such an economy is highlighted. It is not surprising, therefore, that a recognition of the need for universities to develop a more direct link with science and technology industries

and to serve a “third mission” of contributing to local economic development is growing (O’Shea et al., 2005). University commercialization has traditionally been viewed as a licensing activity whereby universities license their technology to existing companies. This notion is changing as university spinoffs (USOs) and their technology transfer offices (TTOs) become a more central focus of universities (Sharma et al., 2006). USOs are firms that are formed around a university license and/or intellectual property (IP) developed at the university (Bercovitz & Feldmann, 2006). TTOs are the primary infrastructural instrument for the creation of USOs (Rasmussen, 2008).

USOs are emerging as the preferred mechanism by which universities transfer knowledge and technology to the commercial realm. One reason for this emergence is the central role that Stanford University and the Massachusetts Institute of Technology (MIT) played in the creation of clusters in the Silicon Valley and Route 128. USOs are now viewed as a mechanism for transforming local economies and for capturing the economic benefits of proximity to a research institution (Bercovitz & Feldmann, 2006).

2. Background

This section first discusses the problem statement addressed in this capstone and provides definitions of key terms. Next, four themes found in the academic literature on USOs will be presented. The current state of USO creation in British Columbia (BC) is outlined at the end of this chapter.

2.1. Problem Statement

This study aims to address the following policy problem: *there is too little commercialization of university innovations and research in British Columbia.*

Too little: BC's three largest universities are underperforming in regards to the commercialization of their research when compared to other universities in Canada and around the world. The University of British Columbia (UBC), for example, has created a total of 140 USOs (UILO, 2011), whereas the University of Toronto has created over 200 USOs (University of Toronto, 2012), Carleton has created over 150 USOs (Carleton, 2012), and the University of Waterloo has created over 250 USOs (University of Waterloo, 2011). Surprisingly, the research budget of UBC is more than three times that of the University of Waterloo (Re\$earch InfoSource, 2011) and UBC employs 3,700 faculty members (UBC, 2011) while Waterloo employs only 1100 (University of Waterloo, 2012).

Commercialization: Refers to getting new ideas to the marketplace (Government of Canada, 2011). Commercialization will be measured by the number of USOs created by university entrepreneurs.

University Spinoff Company (USO): A firm that is formed around a university license and/or intellectual property (IP) developed at the university (Bercovitz & Feldmann, 2006).

BC: This capstone focuses on BC's three largest universities: the University of British Columbia (UBC), Simon Fraser University (SFU), and the University of Victoria (UVic), as well as the provincial policies that affect their USO performance.

From the policy problem, one goal and two objectives were developed to guide the design of the research. The goal of this study is to increase the commercialization of university research and innovations in BC, specifically the number of USOs created in the province. Flowing from the goal are the two objectives of (1) growing the entrepreneurial culture at universities in BC and (2) bridging the funding gap. The funding gap refers to the short supply of early stage capital available to USOs and is discussed in more detail in section 2.2.3.

2.2. Literature Review

There is a sizeable body of literature on the topic of commercializing university research and specifically, on USOs. Most academic studies on USOs have focused on the American context, although the issue is receiving increasing attention in European countries (Nosella & Grimaldi, 2009; Gulbranson & Audretsch, 2009). The academic literature on the Canadian context is limited. Four themes emerge from the academic literature: (1) internal factors that influence the creation of USOs; (2) external factors that influence the creation of USOs; (3) financial barriers and opportunities; and (4) the outcomes of USOs.

2.2.1. Internal Factors

The first theme to emerge from the literature on USOs is the internal factors that influence their development. The majority of this literature employs a resource-based view of the internal determinants, meaning, the success of an organization is largely determined by the resources it owns and controls. Organizations with more resources will be more successful at achieving their goals, including creating USOs (Gras et al.,

2007). The internal factors of USO activity can be divided into three categories: (1) individual characteristics, (2) organizational characteristics, and (3) institutional characteristics.

Individual characteristics of university faculty and staff have an effect on commercialization activity. Investing in, recruiting, and retaining top ranked engineering and science faculty is of critical importance (O'Shea et al., 2005). Gras et al. (2007) found that universities with leading researchers are more likely to create USOs. This enhances the entrepreneurial credibility of the university which is important because investors use the "prestige" and entrepreneurial credibility of a university as a signal to invest.

There are many reasons that a university faculty member or student chooses to start a company around the IP they have developed rather than license or sell the technology to an existing company. One reason is that no company is interested in licensing the technology because, as is often the case with innovations emerging from universities, the technology is too advanced and pushes the frontiers of research in a given field (Livingstone, Interview, 2011). Another reason is that the licensing company is international and the inventors of the technology prefer to keep the license in BC and contribute to the Canadian economy (Entrepreneur #1, Interview, 2011). Third, the inventors may have plans to further develop the technology or related technologies (Entrepreneur #2, Interview, 2011). Finally, the inventor may have a personal desire to pursue entrepreneurship as a career choice.

Having knowledgeable staff in technology transfer offices (TTOs) is also important for USO creation because USOs differ from other start-ups. USOs are unique from other high tech start-ups because they originate from a non-commercial environment; they do not spinoff from an established business in the private sector. This is problematic because most universities and academic entrepreneurs lack the resources and skills necessary to move an academic idea to the marketplace (Bathelt et al., 2010). In the cases of MIT and The University of California, San Diego (UCSD) (two of the most successful universities in terms of USOs), Gulbranson and Audretsch (2008) concluded that the localized knowledge of center staff may be more useful for acceleration than seed funding.

Organizational characteristics also play a significant role in the creation of USOs. A key organizational factor is the TTO, which is the primary infrastructural instrument for the creation of USOs (Rasmussen, 2008). TTOs initially emerged as a way for universities to capture a portion of the economic rents associated with technological innovation (Siegel et al., 2003). They facilitate interaction between industry and university researchers by encouraging industry-sponsored research, protecting IP developed at the university, patenting and licensing IP, and encouraging entrepreneurship (UBC UILO, 2012). After conducting an econometric analysis of American USOs, O'Shea et al. (2005) found that the bigger the size of the TTO office, the greater the likelihood of USO activity. Similarly, in a study of Italian USOs, Nosella and Grimaldi (2009) found that the number of employees dedicated to TTOs and the support services offered by TTOs have a significant effect on the generation of USOs.

Another organizational factor often discussed in the literature is the role of IP in the commercialization of university research. The most important, and commonly cited, technology transfer legislation in the United States is the *Bayh-Dole Act*. The *Bayh-Dole Act* was enacted by the U.S. government in 1980 with the goal of unifying 26 separate statutes governing the ownership of government sponsored research. The Act transferred IP ownership from funding agencies to universities, which allowed universities to commercialize their research. Although Bayh-Dole is a U.S. policy, it placed universities at the center of commercial technology development and has been the basis of similar policies around the world (Sharma et al., 2006).

Canada has no such legislation unifying ownership of IP of government sponsored research. At Canada's twenty largest universities, eight allow IP to be owned by the creator, eight maintain ownership, and the remaining four have shared or case by case negotiated IP (Rasmussen, 2008). The three BC universities discussed in this capstone have different IP policies. IP developed at UBC is owned by the university (Livingstone, Interview, 2011) whereas IP developed at SFU is owned by the inventor(s) (Hand, Interview, 2011). IP developed at UVic is owned by the inventor(s) with obligations to the university (Sternig, Interview, 2011). According to Rasmussen (2008), the different types of IP ownership do not have an effect on the number of USOs created. The variations in IP across Canada and within provinces, however, create

frustrations for investors and industrial companies who have to deal with different policies sometimes within the same city (Rasmussen, 2008).

There are two institutional factors that influence the creation of USOs: the history and research focus of the university; and university culture. Bathelt et al. (2010), for example, contend that because the University of Waterloo was founded as a university with an engineering focus and allowed its members to own patents from research, it has a stronger focus on basic and applied research. Similarly, O'Shea et al. (2005) found path dependency among American universities; a university's current choices were strongly influenced by its previous development. The authors also discuss the importance of enabling a culture of academic entrepreneurship within universities and of encouraging academics and students to pursue entrepreneurship as a career path.

2.2.2. External Factors

The commercialization of university research is strongly influenced by two external factors: government funding and relationships with industry. Rasmussen (2008) investigated federal level initiatives to support commercialization and technology transfer in Canada. The author found that Canada has a long history of government involvement in the economic utilization of research. In fact, Canada's universities and university colleges perform about one third of all research and development activity. According to Rasmussen (2008) "Canada appears to emphasize the use of direct government initiatives to increase the commercialization of research" (p.507). Government funding for departments and commercialization was found to be significant for the creation of USOs and their performance in the United States (O'Shea et al., 2005).

Relationships with external organizations appear to be an important factor in USO activity. In Italian USOs the strength of TTO relationships with external organizations is a factor in their activity (Nosella & Grimaldi, 2009). Similarly, O'Shea et al. (2008) found that external relationships influence USO activity; proportionately higher industry-level funding is associated with greater levels of technology transfer.

2.2.3. Financing

Access to financing is an important determinant of USO activity (Gras et al., 2007). There is, however, a “funding gap” in the start-up stage of USOs. The funding gap refers to a lack of seed stage investing which results from venture capital funds focusing on larger and later stage investments (Gulbranson & Audretsch, 2008). The term risk capital is used when referring to funds that are allocated to early-stage or start-up companies. Risk capital is typically used when referring to venture capital. A venture capital corporation (VCC) is a firm that invests in early to mid-stage companies for a limited amount of time (typically ten years) in exchange for some level of ownership in the company. VCCs typically invest between \$500,000 and \$5 million in companies. Angels are another important category of investor. Angels are individuals who invest in start-up companies with their own money. They are often successful entrepreneurs looking to assist other entrepreneurs. Angel investments typically range from \$5,000 to \$25,000 and help bridge the financial gap between the self-funded and venture capitalist phases of a business (BCIC, 2010f).

Risk capital, most often provided by venture capital firms, is viewed as a bridge for the funding gap. The problem with this bridge is that “asymmetric information problems in early stage technology ventures pose significant up front search costs by potential financial providers” (Wright et al., 2006, p.484). The cost of due diligence is high for investors and discourages smaller investments. Venture capital investors, therefore, prefer to invest in USOs after the seed stage, once proof of concept has been established (Wright et al., 2006).

Recognizing the need to fill the funding gap, many universities have started proof of concept centers, also known as accelerator programs. Proof of concept centers/accelerator programs aim to fill the funding gap by providing seed stage funding grants, entrepreneurial education programs, and industry mentors. After conducting a detailed analysis of two proof of concept centers located at MIT and UCSD, Gulbranson and Audretsch (2008) found that the proof of concept centers have not only enabled, but have accelerated the procurement of private capital for university technology.

2.2.4. Outcomes of USOs

From Gatorade (University of Florida) to Google (Stanford) to insulin (University of Toronto), commercializing university research has positive economic effects as well as benefits for universities and society (Klein et al., 2010). USOs are key drivers of economic change and support regional economic growth. They create jobs (Saetre et al., 2009) and strengthen the local economy (Peng, 2006). One of the most successful universities in terms of economic impact is MIT, whose start-up companies contribute approximately \$232 billion worth of sales per year to the U.S. economy (O'Shea et al., 2008).

There are many benefits of commercialization for universities themselves. Revenue in the form of direct industry support, royalties, and licensing can provide financial benefits for faculty and students as well as funds to support research (Sharma et al., 2006). USOs help attract talented students and faculty. Building connections between industry and universities enhances post-graduation employment opportunities (Nosella & Grimaldi, 2009). Overall, USOs help diversify the university's research portfolio, have positive effects on curriculum, provide a richer academic experience for students, and create a stimulating environment that supports innovative research (Sharma et al., 2006).

2.3. USOs in BC

To date there have been several USOs created in BC. As of March 31, 2011, UBC research has been instrumental in creating 149 USOs (UILO, n.d.). Research at SFU has created 71 USOs (Hand, Interview, 2011), and as of 2010, research at UVic has created about 50 USOs (Sternig, Interview, 2011). The vast majority of USOs created in BC are in the science and technology industries. Jobs created in these industries contribute to BC's economy at a higher rate than the average job created in the province. USOs, therefore, have created a proportionately greater tax base and economic growth (BCIC, 2011).

USOs created from university research and the services offered by TTOs have had a positive effect on the BC economy. In addition to the creation of 71 USOs, for example, SFU's Innovation Office (IO) has assisted 201 companies with incubation and/or mentoring. These companies have gone on to create approximately 2,400 jobs (Hand, Interview, 2011). This amounts to annual payroll taxes of \$180 million to the provincial and federal governments from a direct investment (from all sources) of \$1.7 million. This means that the cost to create each job is around \$1,500. Compared to other job creation programs, whose cost can be around \$10,000 per job, the jobs created with assistance from TTOs are cost effective (Hand, Interview, 2011).

2.4. Contribution to the Field

This capstone contributes to the study of USOs by addressing two key gaps in the literature. First, this capstone addresses the limited academic research on the current state of USO activity in BC. Second, this study offers policy options for encouraging USO activity at the three largest universities in BC. This work is valuable because it provides insights into the unique challenges faced by university entrepreneurs in the province. This capstone also provides diverse perspectives on the commercialization of university research because university employees, university entrepreneurs, and other stakeholders are all included in the analysis.

3. Policy Context: Current Programs

This section describes the current provincially funded programs aimed at supporting the creation of USOs as well as the primary funding agency for these programs, namely the BC Innovation Council (BCIC). This section discusses the BCIC and the programs offered through the TTOs. Detailed descriptions of the Venture Capital Program (VCP) and the Western Universities Technology Innovation Fund (WUTIF) are also provided.

3.1. BC Innovation Council

There are several provincially funded programs and services specifically designed to help university entrepreneurs commercialize their research in BC. Provincially, innovation, entrepreneurship, and commercialization are primarily funded through the BCIC. The BCIC is a crown agency of the province of BC and reports to the Ministry of Jobs, Tourism and Innovation (BCIC, 2010a). The BCIC financially supports several programs that assist university entrepreneurs in commercialization such as the “entrepreneurship@” programs which are discussed below.

3.2. TTO Programs

This section describes the core programs and services offered by the three TTOs included in this study as well as programs not offered through the TTOs that help university entrepreneurs overcome the challenges to commercializing their research. It is important to note that this is not an exhaustive list and, in addition to these programs, all of the TTOs offer patent protection services and business advice to university entrepreneurs. Also, the business schools at all three universities are actively involved in entrepreneurship and offer educational programs and competitions to promote

entrepreneurship. In addition, entrepreneurs have access to business incubators, accelerators, angel networks, and resource centers that assist start-ups in the province. This capstone, however, is focused only on those services specifically designed for university start-ups.

Most provincially funded programs are delivered through the TTOs (often in conjunction with the business schools). The TTOs receive a small amount of operations funding and project specific funding from the BCIC (Hand, Interview, 2011). The TTOs examined in this study are: the University-Industry Liaison Office (UILO) at UBC; the Innovation Office (IO) at SFU and Industry Partnerships at UVic. Although similar in design, each TTO has different capacities and offers different services (as will be discussed below). In addition to provincial government funding, most programs also receive funding from the federal government, the university, corporate sponsors, and/or individual donors.

Before describing the TTOs programs, two terms need to be clarified. Although both business incubators and accelerators are designed to assist early stage companies to increase their chances of success (Washington, 2012), there are some important differences between the two types of programs.

Traditional business incubators provide an array of business services, including office space, to early stage companies (St. Jean, 2009). Office services typically include conference rooms, office equipment, receptionist, computers, etc. Other services offered by incubators commonly include: entrepreneurial advice and mentoring; help in conducting market analysis and contacts; and, networking opportunities (Smith, 2011).

In contrast, business accelerators are a newer model of early stage development programs that offer in-depth coaching/mentoring and small amounts of equity-based financing in addition to the traditional incubator services (St. Jean, 2009). The key differences between an incubator and accelerator are the level of hands-on involvement of management in accelerators and access to seed stage capital (Smith, 2011).

3.2.1. UILO at UBC

Entrepreneurship@UBC is a campus-wide initiative aimed at encouraging entrepreneurship. The initiative includes: coursework; educational and relationship building events; incubation space; mentorship; and, incorporation services. The entrepreneurship programs at UBC are open to staff, faculty and students who have graduated in the last three years. One component of the initiative is the start-up services voucher program which provides vouchers worth \$5,000 to entrepreneurs. The vouchers can be spent on UILO services (Livingstone, Interview, 2011). Also included in the initiative is the \$10 million entrepreneurship@UBC seed accelerator fund. The fund is capitalized by donations from alumni with matching contributions from the BCIC up to \$400,000 per year. The fund aims to fill the funding gap by making early stage investments in UBC start-ups. The accelerator makes investments of between \$25,000 and \$100,000 and made its first investments in late 2011 (BCIC, 2010b).

3.2.2. IO at SFU

Entrepreneurship@SFU was launched in January 2012, and is aimed at high tech entrepreneurship. Included in this initiative is the Ken Spencer Entrepreneur Incubator for third and fourth-year applied science and business students. The incubator provides mentorship and resources. Students enrolled in the program are required to complete coursework in commercialization, business, and entrepreneurship. Students also have access to a new Product Design Studio. The Studio is a work and meeting space outfitted with design and prototyping equipment to help students launch new ventures. The program is expected to accept 20-25 students per year and aims to create six potential companies over the next seven years (BCIC, 2010c). The BCIC also supports SFU's Venture Connection program which offers resources for new technology ventures. Venture connection seeks to encourage an entrepreneurial culture by linking SFU faculty and students with local entrepreneurs (BCIC, 2010d).

SFU has several programs in addition to those supported by the BCIC. One example is SFU's Time Ventures which is located at SFU's downtown campus. It offers incubation services, educational seminars, networking events and a professional advisory board (TIME Ventures Hub, n.d.).

3.2.3. Industry Partnerships at UVic

Entrepreneurship@UVic provides engineering graduates with specialized entrepreneurship training and mentorship (BCIC, 2010e). Industry Partnerships provides some office space for USOs and sends university entrepreneurs to the Centre 4 Growth and The Victoria Advanced Technology Council (VIATeC) for mentorship. The office also assists entrepreneurs in the evaluation, protection, and licensing of IP. Industry Partnerships and the Vancouver Island Technology Park are currently awaiting funding approval for the Greater Victoria Accelerator Fund from the BCIC and Western Economic Diversification Canada (Sternig, Interview, 2011).

3.3. BC Venture Capital Program (VCP)

An important program for the creation of start-up companies, including USOs, is the Venture Capital Program (VCP). The VCP is administered under the Ministry of Jobs, Tourism and Innovation and was first established under the Small Business Venture Capital Act (SBVCA) in 1985 (Hellman & Schure, 2010). The VCP was created to help small businesses gain access to capital by offering tax credits to investors (Ministry of Jobs, n.d.). In 2011, Premier Christy Clark announced that her government will increase access to the VCP by providing a \$3 million increase to the \$30 million program. She stated that “by increasing access to venture capital we increase your opportunity to create new jobs” (Fowlie, 2011).

There are two key components to the VCP:

- a.) The Direct Investment Model or Eligible Business Corporation (EBC);
 - New or existing small businesses can register as an EBC;
 - EBCs raise equity capital from arms-length eligible investors;
 - Investors can receive a refundable tax credit of 30% of their investment up to \$60,000;

- No limit for corporations but tax credits are non-refundable;
- Eligible investor: BC resident or taxable corporation;
- EBC: Must not have more than 100 employees; must pay a minimum of 75 percent of its wages to BC residents; and must be substantially involved in a pre-described activity (Investment Capital Branch, n.d.).

b.) The Portfolio Investment Model or Venture Capital Corporation (VCC):

- The VCC raises funds to invest in an Eligible Small Business (ESB);
- Individuals who purchase shares in a VCC can receive a refundable tax credit of 30% of their investment up to \$60,000;
- No limit for corporations but tax credits are non-refundable;
- VCC investor: BC resident or taxable corporation;
- ESB: Must not have more than 100 employees; must pay a minimum of 75 percent of its wages to BC residents; and must be substantially involved in a pre-described activity (Investment Capital Branch, n.d.).¹

¹ Note: There is also a program for Employee Venture Capital Corporations (EVCC) under the BC Investment Tax Credits. This program, however, will not be discussed because it is not one of the main programs accessed by individuals investing in USOs.

3.4. Western Universities Technology Innovation Fund (WUTIF)

WUTIF Capital (VCC) is an angel fund that invests in new technology ventures in the province. An angel fund is similar to a traditional VCC because it is a professional firm that invests in early stage companies. An Angel fund differs from a traditional VCC, however, because it invests alongside angel investors and makes smaller investments compared to VCCs which typically invest between \$500,000 and \$5 million. WUTIF only invests in early stage companies and typically invests between \$25,000 and \$200,000. The angel fund also provides expertise to entrepreneurs from their board of experienced investors and entrepreneurs. WUTIF was set-up to commercialize novel technologies, many of which are developed at post-secondary institutions in BC. Since its establishment in 2003, the fund has invested over \$6 million in 50 BC companies (WUTIF, 2011).

4. Methodology

This section describes the methodology of this study. It discusses why certain methodological choices were made and describes how and why the participants were selected. This section also provides a summary of the participants who were interviewed and concludes by describing the method of data analysis.

4.1. Research Design

A qualitative methodology was chosen to investigate how the province of BC can better encourage the commercialization of university research. Semi-structured interviews with key informants were conducted to collect the data because they allow for flexibility; they are loosely designed around research questions or themes that initially define the research topic but which may be diverged from (Britten, 1995). This loose design allows questions to emerge from the dialogue and there is no obligation to pursue the pre-planned questions if they are not relevant to the participant (Whiting, 2008).

The flexible nature of the methodology was important for the investigation of the research question because it allowed for unexpected topics to be raised. Prior to conducting the interviews, for example, a literature review was conducted and used to design the interview guides; however, participants raised topics that were either omitted or minimized in the literature on USOs. These topics included securities reform, the limited business knowledge among university entrepreneurs, the difficulties in attracting and retaining experienced managerial and business talent, and methods for reforming the BCIC.

The flexible nature of the semi-structured interview allowed for the interview guide to be adapted from one interview to the next as certain topics became emphasized and the interviewer acquired greater knowledge on the topic. The original interview

guide for university entrepreneurs, for example, asked the question: what challenges did you face when creating your USO? After speaking with the first two university entrepreneurs it became clear that they faced two primary challenges: accessing seed stage funding, and recruiting knowledgeable managers and business people. While the original question remained in the interview guide, it was followed up with questions regarding the two primary challenges identified by previous participants. Incorporating the knowledge gained from previous participants fostered more in-depth discussions with future participants. The interview guides can be found in Appendix A.

4.2. Data Collection

A total of 15 interviews were conducted to gather data for this capstone. The participants were selected from three groups:

- *University Employees*: Individuals employed by the university that are involved in the commercialization of university research (excluding university entrepreneurs). This group includes employees from the TTOs, a Vice-President of research, and a faculty member (n=7).
- *University Entrepreneurs*: Members of the university community that have commercialized their research by creating a USO (n=6).
- *Other Stakeholders*: Individuals who have an interest in, or are involved in, the creation of USOs. This group includes a venture capitalist and a Member of the BC Legislative Assembly (n=2).

The sample of university employees was constructed using purposeful sampling. Purposeful sampling is a sampling technique in which particular persons are deliberately selected for the information they can provide (Teddlie & Yu, 2007). The sample of university employees was constructed by seeking TTO employees from UBC, SFU, and UVic, and employees holding a variety of job titles to access diverse views on the role of the university in commercialization. This group of participants was included in the sample with the aim of gathering data on: how universities in BC currently support the

commercialization of research; the barriers to commercialization; and potential policy options for the province.

The sample of university entrepreneurs was also constructed using purposeful sampling, seeking university entrepreneurs from the three universities included in this study and across sectors (e.g. information technology, physical science etc.). This group of participants was included in the sample with the aim of gathering data on: the challenges faced by the entrepreneurs when commercializing their research; and the factors that made commercialization possible. The sample of other stakeholders was constructed using convenience sampling. Convenience sampling is a sampling technique in which participants are selected because they are easy to access (Teddlie & Yu, 2007). This group of participants was included in the sample with the aim of gathering data on the role of venture capital and the provincial government in the commercialization of university research, and to identify potential policy options. Table 1 provides a list of participants. Three of the university entrepreneurs requested to remain anonymous and so are referred to as Entrepreneur #1, #2, and #3.

Table 1: Summary of Participants

Participant	Category	University or Organization	Sector or Job Title
Dr. Peter Crompton	Entrepreneur	UBC	Physical Science
Entrepreneur #1	Entrepreneur	UBC	Confidential
Dr. Neil Branda	Entrepreneur	SFU	Physical Science
Entrepreneur #2	Entrepreneur	SFU	Confidential
Brian Fisher	Entrepreneur	SFU	Information Technology
Entrepreneur #3	Entrepreneur	UVic	Confidential
Angus Livingstone	University Employee	UBC	Managing Director, UILO
Dr. Arvind Gupta	University Employee	UBC and MITACS	CEO & Scientific Director, MITACS²
Mike Volker	University Employee	SFU	Director, Innovation Office
Ian Hand	University Employee	SFU	Associate Director, Innovation Office
Dr. B. Mario Pinto	University Employee	SFU	Vice President, Research
Brent Sternig	University Employee	UVic	President & CEO
Brock Smith	University Employee	UVic	Innovation Centre for Students
Jim Heppell	Other Stakeholder	BC Advantage Funds	President & Partner
Dr. Moira Stilwell	Other Stakeholder	BC Government	MLA, Vancouver-Langara,

² Mitacs is a Canada-wide, not-for-profit research organization that aims to build research bridges from Canada's graduate student population to society by looking at ways for graduate students and post docs to transition into society and industry (Mitacs, 2011).

4.3. Data Analysis

All interviews (except for one) were recorded, transcribed, and analysed using the method of thematic analysis in order to identify, analyse and report patterns within the data (Braun & Clarke, 2006). It was chosen as the method of analysis because it has the advantage of being flexible as it can be applied across a range of theoretical approaches and paradigms. It can also provide a rich and detailed account of the data (Braun & Clarke, 2006). This approach is useful because it allows for themes to be derived across a large number of cases and a diverse data set (transcripts). This method allows the researcher to find common elements across research participants and categories of participants (Lewis-Beck et al., 2004).

5. Key Findings and Thematic Analysis

A thematic analysis of the data gathered from the interviews was conducted. The goal of the analysis was to derive themes from the diverse transcripts by identifying common opinions across participants. This section discusses the five key themes that emerged from the analysis, all of which center on the challenges and barriers to the commercialization of university research: (1) the funding gap; (2) the short supply of managerial and business talent; (3) the limited business knowledge among university entrepreneurs; (4) the emerging entrepreneurial culture at universities in BC; and (5) the constraints of the traditional academic model.

The themes were present across all categories of participants: university employees, university entrepreneurs, and “other” stakeholders. Themes such as the funding gap and the importance of an entrepreneurial culture generally mirrored the challenges discussed in the academic literature. The themes emerging from the interviews, however, also reflected circumstances unique to commercializing university research in BC. Unique to BC were the exceptionally small amount of risk capital in the province, the short supply of managerial and business talent, and the emergence of an entrepreneurial culture.

5.1. The Funding Gap

The funding gap was a significant challenge for all university entrepreneurs interviewed in this study. Many of the participants expressed frustration at the difficulty in raising capital for their start-ups. Interestingly, the funding gap was present among both early stage, pre-revenue companies and later stage, cash flow positive companies. The funding gap was also present across all sectors but was especially hard to cross for life science and physical science companies because clinical trials and prototype development are often very expensive. Developing a drug company, for example, can

take ten years and up to \$100 million (Heppell, Interview, 2011). Many entrepreneurs expressed frustration about the lack of available funding:

We haven't raised any money. That's challenging actually. We need money.

(Entrepreneur, Entrepreneur #3)

Where do you get the money from? The angel investors aren't interested in that because the investment is too risky...well I mean that's where things are dying on the vine.

(Entrepreneur, Entrepreneur #2)

There is none. We are still looking for risk capital. We have been for a long time.

(Entrepreneur, Dr. Peter Cripton).

Two subthemes emerged while discussing the funding gap with the participants. First, the participants commented that in the wake of the 2008 global recession how the venture capital pool in Canada, and BC in particular, had shrunk and investors had become more conservative. During the interviews it became apparent that Canada had a relatively small pool of venture capital even prior to the 2008 recession. According to the President of BC Advantage Funds:

There was very little venture capital to start with in Canada and it shrunk worldwide anyway. Even the venture capital that is there has become much more conservative. Our investors don't want us to take those kinds of risks anymore. They are afraid of the risk and you know what? Usually the pendulum swings. But there are sometimes, like when my parents came out of the very end of the great depression, where it absolutely changed their behaviour for their entire lives. I've got a feeling that 2008 did that. That people are not going to swing back to risk friendly maybe in their lifetimes, which is really unfortunate. This is not going to rectify itself. The universities and the governments are going to have to act proactively to change the situation if they want to have greater commercialization of technology.

The current state of venture capital was also commented on by angel investor and SFU IO Director, Mike Volker:

I think venture capital's in trouble. First of all, their investors don't want to invest. When they do they want to take less risk and even when they invest they're not getting their returns.

The second sub-theme to emerge was that, in comparison to the United States, Canada has an especially poor venture capital market. This was particularly evident when speaking with university entrepreneurs who had created start-ups in the United States prior to a USO in Canada. Entrepreneur Dr. Brian Fisher for example, commented:

We went around pitching to all the VCC's in town. We found that they weren't willing to invest, we weren't big enough. The feeling was, if we had been in California we would have gotten something. It's great if you're in the Silicon Valley and you can bring somebody in and they can give you \$10 million and you come back later and they give you another \$50 million. When you're in Canada you get as little money as possible and try to build on that.

Similarly, Entrepreneur #1 stated that:

Getting money is really tough and we are not going to find it in Canada. That's just tragic to me. You know you can grow a company to be 30-50 people and then you can see the writing on the wall that it's not going to be a Canadian company and that seems wrong.

The funding gap was a significant barrier for university entrepreneurs in the creation of their USO. Although the funding gap has been a concern among entrepreneurs for a long time, there was a consensus among the participants that the funding gap had

widened in the wake of the 2008 global recession and that the venture capital market in BC was particularly small in comparison to the United States.

5.2. Short Supply of Managerial and Business Talent

Many of the participants commented on the short supply of managerial, business, and sales talent in BC. Participants expressed displeasure over the difficulty they had in attracting experienced business people to their USO:

The huge difference is that in California you can get developers who have been involved in start-ups and they know how to do agile development methods.

They're not big system guys.

(Entrepreneur, Dr. Brian Fisher)

Sales people are incredibly difficult to get. There just are not sales people in Canada that are versed in high-tech sales...not enough of them anyway. The hard part is, especially in BC, you are facing the reality that your business people are not going to be in BC. They're probably not going to be in Canada. As someone who would like to see the company stay here it's bad. We do have a successful business man who lives in the States.

(Entrepreneur, Entrepreneur #1)

I think companies can attract [business people] but you know it's not easy because to get someone with experience is expensive. I mean that's the number one problem. To get people with experience, to get them, you know if they're making \$200,000 a year, to work with a start-up that's got a zero balance sheet, that's tough.

(Angel Investor & TTO Employee, Mike Volker)

The lack of business, managerial and sales talent is problematic for USOs because it is easier for them to attract risk capital when they have experienced business people on

their team . For example, when asked what makes a company attractive to investors the President of BC Advantage Funds, Jim Heppell, responded that:

Frankly, management is way more important than technology. There's lots of good technology out there; lots of great ideas out there. Not that many great managers out there. So it's all about the management.

Aquinox is a company we looked at two or three years in a row. We really liked the science but there were no business people attached to it. We liked the science, but scientists are sometimes hard to do business with. When David Main, a seasoned CEO, joined Aquinox we decided to invest about \$3 million because we know him and we have worked with him in the past; he's a very competent business guy.

VCC's and angels feel more comfortable investing when a business person they trust is involved in the USO. The business person serves as a signal to investors that the investment is less risky because someone with business knowledge and experience is working with the company. It is safer for investors to put their money in a USO that has this expertise since university entrepreneurs often have limited business knowledge.

5.3. Limited Business Knowledge

Most USOs in BC are created by university faculty members (often in conjunction with their Masters or Ph.D. students). Consequently, all of the university entrepreneurs interviewed in this study were faculty members at their respective universities. As academic researchers, university entrepreneurs have a wealth of knowledge in their field of expertise but often lack business knowledge. Navigating the world of incorporation, stock options, and risk capital, therefore, can be extremely daunting for researchers trained in engineering, computer science, biology etc. Many university entrepreneurs interviewed revealed a sense of insecurity about the business aspect of commercializing their research:

I'm not a business guy at all and yet for periods I have been CEO, I've been chairman of the board, and what am I? I'm really just an academic who's been let loose.

(Entrepreneur, Entrepreneur #2)

For us at that period the things that we were struggling with...what would be a reasonable share structure? What should the incorporation documents look like? How do we get insurance? It's all this practical stuff. I knew a little bit but really we knew nothing. That was probably the place where we felt completely isolated.

(Entrepreneur, Entrepreneur #1)

The inventor's area of expertise is in the area in which they developed their technology and is rarely in business/marketing/commercializing.

(TTO Employee, Brent Sternig)

Most of the university entrepreneurs interviewed were aware of their lack of business knowledge and that it was a significant barrier to the commercialization of their research. The entrepreneurs overcame this challenge by seeking assistance from the TTOs and networking with colleagues that were more business inclined. The awareness of this challenge is demonstrated in the following comments:

The difficulty I would say is mostly in the commercialization part. Most of the people who work in our team are technical people. We are not experienced in marketing and so on and that's a challenge. Building a product was easy for us, selling it is more difficult.

(Entrepreneur, Entrepreneur #3)

As a university researcher I didn't know what an angel was. I thought maybe you would invent something, you'd have a patent and then you would sit at the university and wait for somebody to come along and buy your patent. So I didn't realize that you have to build value before anybody would consider buying it.

(Entrepreneur, Dr. Peter Cripton)

Limited business knowledge was a challenge identified by university entrepreneurs interviewed in this study. Most university entrepreneurs were aware of their limited business knowledge and looked primarily to their TTOs for help overcoming this challenge.

5.4. An Emerging Entrepreneurial Culture

There were varying opinions regarding the entrepreneurial culture at universities in BC. The opinions varied between the university employees and the university entrepreneurs. The university employees had a more positive view of the entrepreneurial culture. This is likely due to the fact that the employees interviewed worked directly with the sub-group of the university population that is entrepreneurial. These included the Directors of SFU's IO (Mike Volker) and UBC's UILO (Angus Livingstone). Additionally, SFU's Vice-President of Research, Dr. B. Mario Pinto commented that:

SFU has always been considered an entrepreneurial university. We have always had this enterprising attitude. I wouldn't say that it's increased. I would say that we're getting savvy in how to approach it and I think we understand better what factors are critical and how we have to feed this pipeline.

The university entrepreneurs, however, believed that there was not a strong entrepreneurial culture. Most of the participants agreed that this was beginning to shift and that an entrepreneurial culture had begun to emerge at universities in the province. The entrepreneurs stated that:

The hard part is a lot of it is really cultural. To change culture with government is very hard. Dorothy Leonard Barton (Dean of Business at Berkley) wrote Regional Advantage. What she said was that the Silicon Valley was created because of social connections between entrepreneurs. The Silicon Valley was a cluster, people went to the same bar to drink and they created companies. The next wave is the immigrants. They bring in entrepreneurial immigrants who really do have a culture of wanting to succeed. I think Vancouver's in an interesting

position to do that. It hasn't quite happened yet but we do have a bit of those same ingredients.

(Entrepreneur, Dr. Brian Fisher)

I don't feel that in my department there is a big entrepreneurial culture there. There are pockets in different departments who have done it and if you get the chance to talk to them it can be very entrepreneurial. But it's pockets, it's not everywhere.

(Entrepreneur, Dr. Peter Cripton)

I think it's slowly starting to shift. I went to grad school at a university in the States which has a highly entrepreneurial culture. I come from this incredible culture of entrepreneurship and here there was none. I think it's been changing every year and I think the department for a number of years now has been supportive. I don't think we've gotten to the point where we're proactive about it. But I think it is supportive and I think there are a number of people doing it now; the culture is slowly starting to shift.

(Entrepreneur, Entrepreneur #1)

An entrepreneurial culture is emerging at BC universities. University departments have become more supportive of entrepreneurs and pockets of entrepreneurship have developed. The emerging entrepreneurial culture, however, has been constrained by the traditional academic model.

5.5. Constraints of the Traditional Academic Model

Many of the participants commented on how the traditional academic model has constrained entrepreneurship and the commercialization of university research. The traditional academic model is built on a system of publication, peer review, and pushing the frontiers of research. The constraint stems from disconnect between university members (faculty, students), the rest of society, and the marketplace. The traditional

academic model was often presented as incompatible with commercialization. As Entrepreneur, Dr. Neil Branda commented:

Professors have to stop thinking that they have technology that then has to go shopping for a customer. They're always taking something, 'oh I developed this in my lab is it useful for something?' That's the wrong approach to research. They should be looking at what does society, meaning the health practitioners, companies, industries, what do they want? What are their challenges and then how can we rise up and apply what we know to address those challenges?

The most prominent disconnect was that between academia and the marketplace. The entrepreneurs noted that the traditional academic culture and evaluation of success is different from industrial culture or entrepreneurial success.

So one of the differences is, you know within an academic environment, the ways people want to evaluate people are still largely very academic. Things are shifting in academia but there's still a lot of, 'yeah but how many papers were published?' Sometimes it's like you've sold out if you're doing the industry thing.

(Entrepreneur, Entrepreneur #1)

The biggest challenge we had was something that people have to appreciate very quickly; do not start a company in a university. You can seed it from a university technology but then you gotta get it out because the academic culture and the industrial culture couldn't be more different. Students don't work at the same pace, equipment when it goes down doesn't go up fast enough.

(Entrepreneur, Dr. Neil Branda)

In addition to faculty, disconnect between academia and the marketplace applied to students and recent graduates. This disconnect is evident in Brock Smith's (of UVic's Innovation Centre for Students) comment:

The typical academic model is you provide the students with the education and then push them out of the nest and see which ones fly and most of them hit the ground. So I think some flight training is useful and being able to provide some professional services in a cost effective way makes some sense.

The traditional academic model was a constraint to the emerging entrepreneurial culture. By focusing on peer reviewed publications as the primary indicator of success, other “successes” such as creating a USO were marginalized.

5.6. Key Findings

The thematic analysis revealed five key challenges faced by university entrepreneurs when commercializing their research. First, the funding gap was a major challenge identified by all of the participants. The funding gap in BC was found to be particularly large in the wake of the 2008 global recession and in comparison with the United States. Second, the participants identified a lack of managerial, business, and sales talent in BC to be a barrier to the success of USOs. This is problematic because VCC's and angels are more likely to invest when a trusted business person is involved with the start-up. Third, many of the entrepreneurs had limited business knowledge and struggled with the business side of creating a USO. The entrepreneurs most often overcame this challenge by going to their TTOs for advice. Fourth, an emerging entrepreneurial culture was identified by many of the participants. Fifth, the traditional academic model was viewed a constraint to the emerging entrepreneurial culture. Many of the participants found the traditional academic model to be incompatible with commercialization and identified disconnects between university research and the marketplace. The five challenges identified by the participants were used to inform the selection of policy options for increasing the commercialization of university research. The policy options are discussed in the next section.

6. Policy Options

The policy goal of this study is to determine the optimal policy (or policies) for increasing the commercialization of university research. In order to achieve this goal, a policy must address some, if not all, of the challenges identified in the above thematic analysis. With the policy goal in mind, five policy options for supporting the commercialization of university research were developed and are discussed in detail in this section. The policy options are: (1) status quo, (2) status quo plus, (3) commercialization centers, (4) direct investment, and (5) reform the BCIC.

Fitting with the scope of this study, all five policy options are provincial in nature; they will be funded and implemented by the government of BC. As is the case with many current programs, however, the federal government and other stakeholders would likely provide funding as well. This section concludes with a discussion of two potential policy options that were screened out: (1) securities reform; and (2) expanding the Mitacs Enterprise program to BC.

6.1. Policy Option 1: Status Quo

The first policy option is to leave current programs in place and unchanged. This involves leaving the current funding structure (BCIC), programs, and level of funding unaltered. This option is especially viable for UBC because of the recently launched entrepreneurship@UBC seed accelerator program that helps fill the funding gap. UBC's UILO is also well funded by the university. In contrast, however, SFU and UVic do not have an accelerator program, and UVic also lacks a business incubator. During the interviews, several entrepreneurs indicated that the TTOs at SFU and UVic had very knowledgeable and helpful staff but were underfunded, over-worked, and lacked resources. The status quo is therefore a less viable option for SFU and UVic.

6.2. Policy Option 2: Status Quo Plus

The next policy option is to leave the current programs and funding structure in place with two modifications: provide patent funding for SFU and UVic; and expand the VCP.

6.2.1. Patent Funding for SFU and UVic

The first component of this policy option is for the province to provide patent funding for SFU's IO and UVic's Industry Partnerships. From the key informant interviews it became clear that both of these TTOs are lacking resources. For example, SFU Entrepreneur, Dr. Neil Branda commented that:

“The university has limited resources...the tech transfer office at any university is only as good as their resources. To be fair to them, the officers are over worked. Their portfolios are very diverse so they are spread way too thin. They are understaffed and under-resourced.”

The underfunding of the IO and Industry Partnerships is problematic because TTOs are the primary infrastructural instrument for the creation of USOs (Rasmussen, 2008). Their staff and expertise are essential to overcoming the challenges of creating a USO, particularly the limited business knowledge of university entrepreneurs.

TTOs incur large expenses associated with filing and maintaining patents. Patents and the protection of IP are vital to the commercialization of university research because research is commercialized by either licensing the technology to an existing company or creating a USO around the IP. IP and the patents that protect it are the foundation on which commercialization can begin. Increasing patent funding, especially for a small office like Industry Partnerships, will free up budget space for the TTOs to hire additional staff, and provide more resources for university entrepreneurs.

6.2.2. Expand the VCP

The second component of the Status Quo Plus policy option is to expand the VCP by rolling over unused tax credits and increasing individual investment limits. Expanding the VCP is desirable for two reasons. First, companies in the VCP generate more tax revenue for the province than they consume in tax credits. The BC tax multiplier for the VCP is \$1.98; for every dollar of provincial tax credits issued, the recipient companies generate \$1.98 in provincial taxes. Second, companies in the VCP consistently create new jobs in BC. Companies participating in the VCP create an average of 2.43 jobs every year, the vast majority of which are full time positions (Hellman & Schure, 2010).

A recent report by Hellman and Schure (2010), recommends that the VCP be expanded in two ways. First, unused tax credits should be rolled over for several years. According to SFU's IO Director and angel investor Mike Volker, when the economy was strong the program was popular and tax credits ran out by February of a given year. The companies that Mr. Volker works with alone use about 10 percent of the \$30 million cap. Today, however, there is less demand for the tax credits and the cap has not been reached in recent years (Volker, Interview, 2011). The excess supply or demand of tax credits creates uncertainty and inefficiency for both investors and government. Second, the company investment limit of \$5 million per year and the individual investment limit of \$200,000 per year should be moderately increased, especially in years where the budget is unlikely to be fully used (Hellman & Schure, 2010).

6.3. Policy Option 3: Establish Shared Commercialization Centers

The third policy option is to establish two shared commercialization centers (a.k.a. accelerators): one at the Great Northern Way campus in Vancouver and one at the Vancouver Island Technology Park in Victoria.

6.3.1. Great Northern Way Campus

The Great Northern Way Campus is located in downtown Vancouver and is jointly owned by UBC, SFU, BCIT and the Emily Carr University of Art Design. The commercialization center will be co-habited by programs from the four schools, and businesses. This will create a large enough critical mass of start-ups to attract investment and expertise. The commercialization center will have some public venue space and flexible office space (Hand, Interview, 2011). As an accelerator the commercialization center will also have capital to invest in USOs.

This policy option will provide a central point of access for knowledge, expertise and networks to be shared. As Brock Smith of UVic's Innovation Center for Students commented "I'm not sure it makes sense for every university to be doing it [setting up incubators/accelerators]." He concluded that regional incubators/accelerators co-habited by more than one school (including universities, colleges and polytechnics) make more sense because they build a critical mass. This option is especially desirable for SFU because, unlike UBC, it does not have a seed accelerator fund and lacks some resources. With their current resources, for example, it is difficult for SFU to offer USOs progressive assistance such as moving from hot desking to an office (Hand, Interview, 2011).

6.3.2. Vancouver Island Technology Park

The commercialization center in Victoria at the Vancouver Island Technology Park and will be co-habited by UVic, Camosun College, Royal Roads University and Vancouver Island University (VIU). The goal of the accelerator is to provide a central point of access where stakeholders in USOs come together. The facility will be a space for entrepreneurs, venture capitalists, angel investors, representatives from government granting agencies, and mentors to come together. Currently, UVic Industry Partnerships sends entrepreneurs to UVic's business program, the Centre 4 Growth, The Victoria Advanced Technology Council (VIATeC), and other universities for mentorship. The accelerator will provide mentorship at one venue for UVic's entrepreneurs (Sternig, Interview, 2011) and will have capital to invest in USOs. UVic Industry Partnerships currently has the capacity to assist in the creation of one to two USOs per year. The

hope is that the accelerator can focus on creating USOs so that Industry Partnerships can focus more on its other objectives (Sternig, Interview, 2011).³

6.4. Policy Option 4: Direct Investment

Unlike UBC, SFU and UVic do not have a seed accelerator fund for direct investment in USOs. They are unable to fill the funding gap themselves for promising innovations developed at their respective universities. SFU and UVic have very limited resources to help university entrepreneurs develop a prototype of their technology and/or move their technology to a more advanced, market ready stage of development. The lack of early stage funding for university innovations is unfortunate because it is easier for USOs to attract investment once they have developed a prototype and are at a later stage of development. This is because investors view the investment as less risky (Sternig, Interview, 2011).

This policy option requires the provincial government to provide funds to SFU and UVic to offer seed stage funding to promising USOs.

6.5. Policy Option 5: Reform the BCIC

The last several years have been a paralysed period for the BCIC because it has had a limited ability to act on programs due to internal issues. The BCIC, for example, has had frequent changes to its management and is currently under a program review (Hand, Interview, 2011). As a result, the BCIC has been lacking a clear direction for

³ UVic Industry Partnerships and the Vancouver Island Technology Park are currently awaiting funding approval for the Greater Victoria Accelerator Fund from the BCIC and Western Economic Diversification Canada. The proposed policy option 3, commercialization centers, is different from the Greater Victoria Accelerator Fund because it is co-habited by more organizations. Industry Partnerships was expected to make an announcement regarding the status of the Accelerator Fund by the end of 2011. This announcement, however, was not made and the status of the Fund is uncertain.

several years and there is uncertainty around how, and if, the crown corporation will change following the program review (Livingstone, Interview, 2011).

This policy option proposes that the BCIC be reformed in two ways. First, the governance structure of the BCIC should be altered so that stakeholders (the professionals managing the TTOs) are more involved in the allocation of funding. As IO Assistant Director, Ian Hand commented, “the people delivering the programs know best what is needed and all of this gets lost in translation all the time.” This will create a more inclusive funding structure and reduce the degrees of separation between those delivering the programs and the funding organization. This will result in more effective programs receiving funding.

The BCIC Board of Directors consists of 13 members and is appointed by the Lieutenant Governor of the province. Currently, the university TTO community is not represented on the Board. There are two vacancies currently on the Board (BCIC, 2011) and this option recommends that the two positions be filled by individuals with a strong connection to the TTOs and the programs that assist university entrepreneurs in the commercialization of their research.

Second, the BCIC should take a longer term view of funding. Venture capital firms are typically established for ten years because portfolios of companies take time to develop. Some companies won't be winners initially but over a long enough period of time they can usually demonstrate positive returns. It does not make sense, therefore, to fund and assess programs on a one and two year basis. The funding runway of the BCIC should be no less than five years for any significant funding program (Hand, Interview, 2011).

6.6. Policy Options Considered But Eliminated

6.6.1. Securities Reform

The securities reform policy option involves setting up a national securities regulator and easing the regulations on investment. In the Canadian Constitution, securities regulations fall under provincial jurisdiction. This results in each province

having its own securities regulator and regulations (CBC, 2011). Even though the provincial regulators have put the same regulations in place, having different regulators is still a problem for investors because of red tape and duplicate paperwork (having to file a prospectus in both BC and Ontario for example). Introducing a national regulator will reduce the red tape and simplify paperwork for investors (Volker, Interview, 2011).

Under current BC securities regulations, an investor must meet one of three criteria to invest in a start-up. The investor must: be a millionaire; invest a minimum of \$150,000; or, be a friend or family member of the owner(s). Prior to collaborating with other provinces the minimum investment value was \$25,000 in BC. The increased minimum (\$150,000) for non-millionaire and non-family/friend investors is contributing to the funding gap in the province. Legally, BC can reduce the investment minimum and alter its securities regulations unilaterally (Volker, Interview, 2011).

This policy option was screened out of the evaluation due to its extremely low political feasibility. On December 22, 2011, the Supreme Court of Canada ruled that the federal government's proposed national securities regulator was not valid under the Canadian Constitution. All 10 provinces would have to sign off on a national regulator which is unlikely since the regulator faced strong opposition from Alberta and Quebec. Following the Court's decision, Finance Minister Jim Flaherty announced that the federal government will abandon its plan to create a national securities regulator (CBC, 2011). The political likelihood of the province of BC unilaterally changing its securities regulations is also extremely low since BC will face political backlash from the other provinces. For these reasons securities reform has been screened out of the evaluation.

6.6.2. *Mitacs Enterprise Program*

Mitacs is a Canada-wide, not-for-profit research organization. They are provincially and federally funded. Mitacs aim is to build research bridges from Canada's graduate student population to society by looking at ways for graduate students and post docs to transition into society and industry (Mitacs, 2011). Mitacs has several programs for university students and recent graduates but the program of particular interest to the creation of USOs is the Enterprise program.

The Enterprise program was launched in late 2011 in Ontario and is the practical version of Mitacs' "step" program. Step provides students with professional skills training. After finding that professional skills were difficult to learn in a classroom, Enterprise was created to provide onsite training to university entrepreneurs. Each student is placed in a small or medium sized company where they learn professional skills and are exposed to different departments as finance and marketing. Mitacs specifically targets small companies in this program so that the students can learn directly from the founders or the CFO. In return, the students work for the companies and their salaries are split between Mitacs and the company. The Enterprise program provides students with the opportunity to learn about entrepreneurship in a real world setting (Gupta, Interview, 2011).

As Mitacs does with all of its programs, Enterprise has been introduced as a pilot in one part of the country (Ontario in this case) and if successful will likely be expanded to other parts of Canada. The policy option to expand the Mitacs Enterprise program to BC has been eliminated from the evaluation because the program is still in its pilot phase and the first cohort of students have not yet completed the program. The Enterprise program, therefore, cannot be evaluated at this time. If the pilot program is successful in Ontario then this policy option should be revisited and evaluated for the BC context.

7. Evaluation Framework

Each of the proposed policy options will have different outcomes for university entrepreneurs and the commercialization of research. It is useful, therefore, to have a framework for evaluating each policy option and the trade-offs involved in selecting one option over another. When choosing a policy, or policies, for encouraging the commercialization of university research, policymakers must consider the cost, effectiveness, administrative complexity and political feasibility of the proposed option. This section explains each criterion and its associated measure(s). The criteria and measures are summarized in Table 2. Using this framework, the proposed policy options will be evaluated in the next section.

7.1. Cost

Due to the prudent fiscal environment in BC, the cost of a policy option must be assessed. There are two components to the cost criterion: cost of implementation and incremental cost. Cost of implementation is the cost to the provincial government of putting the option in place. Incremental cost is the annual resources needed to keep the policy option in operation. The methodology for this criterion is quantitative and is measured by calculating the costs of expanding current programs and, for programs not yet available in BC, by calculating the costs incurred by other governments and organizations that have implemented the policy option. Both components of the cost criterion are measured in dollars (\$). The cost criterion is calculated as the cost above the status quo because all of the policy options involve expanding current programs or adding new ones. The status quo is assessed a cost measurement of \$0.

7.2. Effectiveness

Effectiveness is defined as the extent to which the policy option meets the two objectives enhancing the entrepreneurial culture at universities and to shortening the funding gap. The methodology for evaluating effectiveness is qualitative and will be assessed from the key informant interviews and the relevant literature. Effectiveness is measured for each of the two objectives on a scale of 1 to 5. The two effectiveness scores are added together and each policy option receives only one score (out of 10) for effectiveness.

Entrepreneurial Culture Effectiveness Scale:

Three key programs encourage the entrepreneurial culture on university campuses: (1) networking programs; (2) business education programs; and (3) incubation services. Entrepreneurial culture effectiveness is measured by the number of key programs the policy supports.

1=Low Effectiveness: The policy option aims to encourage entrepreneurial culture by providing or enhancing only one of the key programs

3=Moderate Effectiveness: The policy option aims to encourage entrepreneurial culture by providing or enhancing two of the key programs

5=High Effectiveness: The policy option aims to encourage entrepreneurial culture by providing or enhancing all three of the key programs

Funding Gap Effectiveness Scale:

There are three methods for shortening the funding gap: (1) fill the gap directly by providing seed stage capital for USOs; (2) provide incentives for investors; and (3) increase the amount of venture capital in the province. Funding gap effectiveness is measured by the number of methods the policy option utilizes.

1=Low Effectiveness: The policy option aims to shorten the funding gap by employing one of the methods

3=Moderate Effectiveness: The policy option aims to shorten the funding gap by employing two of the methods

5=High Effectiveness: The policy option aims to shorten the funding gap by employing all three of the available methods

7.3. Administrative Complexity

Administrative complexity is the difficulty associated with implementing and administering the policy option. The methodology for determining administrative complexity is quantitative and will be determined by examining the number of additional employees needed and the number of organizations involved in the policy option (beyond those currently in place). The number of additional employees needed for a policy option will be estimated from the key informant interviews and relevant literature. The measure for administrative complexity is high/medium/low.

Low Administrative Complexity: The policy requires 1 or less employee or one organization is involved

Medium Administrative Complexity: The policy requires 2-4 employees or 2-3 organizations are involved

High Administrative Complexity: The policy requires more than 4 employees or more than 3 organizations are involved

7.4. Political Feasibility

Policy decision makers have their own policy priorities and agendas. Political feasibility, therefore, must be assessed when evaluating potential policy options. Political

feasibility is the extent to which policymakers are willing to support the policy option. The methodology for assessing political feasibility is qualitative and will be evaluated from the key informant interviews with special attention being paid to the interview with Parliamentary Secretary for Industry, Research and Innovation, Moira Stilwell. The measure for political feasibility is high/medium/low. An option will be assigned a high score if it aligns with the current government’s mandate. An option will be assigned a medium score if it does not align or conflict with the current government’s mandate. A policy will be assigned a low score if it conflicts with the current government’s mandate.

Table 2: Criteria and Measures

Criterion		Description	Measure
Cost	Implementation Cost	Cost to provincial government of implementing the policy option	Estimated in dollars (\$)
	Incremental Cost	Cost to provincial government of keeping the policy option in operation	Estimated in dollars (\$)
Effectiveness	Entrepreneurial Culture	Extent to which the policy option enhances the entrepreneurial culture at universities in BC	Scale 1 to 5 1= Low Effectiveness 3= Moderate Effectiveness 5= High Effectiveness
	Funding Gap	Extent to which the policy option will increase access to funding for university entrepreneurs	Scale 1 to 5 1= Low Effectiveness 3= Moderate Effectiveness 5= High Effectiveness
Administrative Complexity		Administrative difficulty associated with the option	High/Medium/Low
Political Feasibility		Extent to which policymakers are willing to support the policy option	High/Medium/Low

8. Policy Analysis

In order to determine which policy or policies will best support the goal of increasing the commercialization of university research, each of the policy options must be evaluated using the framework outlined above. Table 8, located at the end of the section, summarizes the evaluation.

8.1. Evaluation of Policy 1: Status Quo

8.1.1. Cost

For the purposes of this study, the cost of the status quo is measured as \$0 because it is the base against which the other options are measured.

The budgeted operating revenues for the BCIC in the current year (2011/12) decreased to \$9.66 million from \$12.97 million, although funding from the Ministry of Jobs, Tourism, and Innovation remained constant at \$8.5 million (BCIC, 2011).

Funding from the province flows through the BCIC to eight TTOs and science and technology councils throughout the province. The BCIC provides some operational funding to these organizations through The Science and Technology Fund (S&T) transfers. The transfer amount is forecasted to be \$2.96 million annually and, while under review, is expected to remain consistent with this forecast for the current year (BCIC, 2011).

In addition to operation funding, the TTOs receive program specific funding from the BCIC. For example, in 2010/11 UBC's UILO received \$392,792 from the BCIC

(UILO, 2011) plus an additional \$400,000 matching annual contribution to the entrepreneurship@UBC Seed Accelerator Fund (Livingstone, Interview, 2011).

8.1.2. Effectiveness

Entrepreneurial Culture: As was discussed in the thematic analysis, participants had differing opinions regarding the entrepreneurial culture at UBC, SFU and UVic. The university employees agreed that their respective universities had a strong entrepreneurial culture, while the university entrepreneurs viewed the culture as weak but emerging. The opinions of the university entrepreneurs are given a higher weight in the effectiveness analysis because they are better connected to the general faculty and student population on a day to day basis than the university employees (such as the TTO employees who interact primarily with the sub-section of the university population that is entrepreneurial). Not all of the universities offer the three services discussed in the effectiveness measures and several of the existing programs are underfunded (especially at SFU and UVic). For these reasons, entrepreneurial culture effectiveness for the status quo is assigned a low/moderate effectiveness score of 2.

Funding Gap: Currently, there are several programs in place that attempt to bridge the funding gap. These programs include the entrepreneurship@UBC Seed Accelerator, and networking with VCC's and angel investors through the TTOs. In the wake of the 2008 global recession, these efforts fall short because investors have become more conservative and the funding gap has widened (Heppell, Interview, 2011). Every university entrepreneur interviewed commented on the extreme difficulty of accessing early stage capital in BC. The province does provide incentives for investors through the VCP but only one university (UBC) fills the funding gap by directly investing in USOs. For these reasons the funding gap effectiveness of the status quo is given a low effectiveness score of 1 on the 5 point scale.

The overall effectiveness of the status quo is 3.

8.1.3. Administrative Complexity

The administrative complexity of the status quo is measured as low because the programs are already in place and do not require any additional staff members or cooperation among organizations.

8.1.4. Political Feasibility

The political feasibility of the status quo is high for two reasons. First, Moira Stilwell (Parliamentary Secretary for Industry, Research and Innovation) indicated that even though the BCIC is under a program review the crown corporation will remain in place once the review is completed (Stilwell, Interview, 2012). Second, according to the BCIC's strategic plan they do not foresee any significant shifts in their core business areas or program delivery (BCIC, 2011). Both of these statements indicate that the BCIC and its programs are likely to remain in place.

Table 3: Evaluation of the Status Quo

Criterion	Policy Option 1	
		Status Quo
Cost	Implementation Cost	\$0
	Incremental Cost	\$0
	Total Cost	\$0
Effectiveness	Culture	2
	Funding Gap	1
	Total Effectiveness	3
Administrative Complexity		Low
Political Feasibility		High

8.2. Evaluation of Policy 2: Status Quo Plus

8.2.1. Cost

8.2.1.1. Part A: Patent Funding

Implementation Cost: There is no implementation cost associated with this option because the funding structures and programs are already in place.

Incremental Cost: TTOs submit two types of patent applications: provisional U.S. patent applications which cost between \$1,500 and \$6,000; and full U.S. patent applications which cost between \$9,000 and \$12,000. Of the patents filed by SFU about half are provisional (Ian Hand, Personal Communication, 2012). In 2010, SFU submitted 12 new applications (AUTM, 2011). Assuming a 50/50 mix and taking the middle cost of each estimate (\$3,750 for provisional and \$10,500 for full) the approximate cost of patenting in 2010 to the IO is \$85,500 ((3750x6) + (10500x6)). In 2009/10, UVic's Industry Partnerships spent \$196,985 on patents. This represents approximately 16 percent of their total annual expenses (Hooper, 2010). The annual cost to provide patent funding to SFU and UVic is \$282,485.

8.2.1.2. Part B: Expand the VCP

Implementation Cost: There is no implementation cost associated with expanding the VCP because the Investment Capital Branch of the Ministry of Jobs, Tourism and Innovation is already in place to administer the program.

Incremental Cost: The incremental cost of expanding the VCP is \$0. The current budgeted cap of the VCP is \$30 million annually but will be increased to \$33 million in 2012 (CBC, 2011). Although the cost to the provincial budget is \$0, this option will

reduce the flexibility of the provincial budget because currently, when the cap is not reached, the excess money is spent on other government programs⁴.

The overall cost for the Status Quo Plus option is \$282,485.

8.2.2. Effectiveness

8.2.2.1. Part A: Patent Funding

Entrepreneurial Culture: This policy option will free up a large portion of both the IO's and Industry Partnerships' budgets, allowing them to increase funding for their entrepreneurial education programs such as seminars and networking events. The extra room in the budget can also be spent on providing better incubation services such as more office space for emerging USOs. This aspect of policy option 2 is given a moderate effectiveness score of 3 on the entrepreneurial culture effectiveness scale.

Funding Gap: This option is not intended to address the funding gap issue because it does not explicitly direct funding towards early stage funding for USOs.

8.2.2.2. Part B: Expand the VCP

Entrepreneurial Culture: This option is not intended to affect the entrepreneurial culture because it is not specifically directed toward universities or USOs.

Funding Gap: All participants interviewed in this study agreed that the VCP is a good tool for investment. Angel investor and founder of the Western Universities Technology Investment Fund (WUTIF), Mike Volker, commented that WUTIF would not exist if not for the VCP. The tax credits are a key incentive for his investors (Volker, Interview, 2011). Similarly, Hellman and Schure (2010) found that the \$256 million in tax

⁴ Rolling over unused tax credits will also reduce the government's ability to pay down the provincial deficit. In order to address the issue of reduced budget flexibility the government can roll over a percentage of the unused tax credits or cap the amount that can be rolled over from one year to the next. For example, if there is a \$10 million excess in credits, a 20 percent rollover cap will still allow for \$8 million to be spent on other programs or to pay down the deficit.

credits issued from 2001-2008 were leveraged into approximately \$2.3 billion of equity investments. The VCP, therefore, is an important tool for filling the funding gap for both university and non-university start-ups in BC. It is important to note, however, that the province is emerging from a period of tough economic times and BC's technology industry is only slowly becoming more active with increased start-ups and venture capitalist investment (BCIC, 2011). Therefore, expanding the VCP is assigned a slightly higher than moderate score of 3.5 on the funding gap effectiveness scale. Rolling over unused credits will allow more room for investment in years of high investment and increasing individual investment limits will help fill the funding gap in years of low investment. Expanding the VCP will provide incentives to investors and increase the venture capital pool in BC

The overall effectiveness of the Status Quo Plus is 6.5.

8.2.3. Administrative Complexity

8.2.3.1. Part A: Patent Funding

The administrative complexity of patent funding is low/medium. The extra funds are likely to be spent on expanding current programs which have low administrative costs since knowledgeable staff members are already in place and no additional organizations need to be involved. If, however, the TTOs decided to start a new program(s) with the extra funds the administrative complexity will be medium because this will likely involve more than one staff member to design and implement a new program.

8.2.3.2. Part B: Expand the VCP

The administrative complexity of this policy option is low because the Investment Capital Branch of the Ministry of Jobs, Tourism and Innovation is already in place to administer the program and there are no significant changes to the program.

8.2.4. Political Feasibility

8.2.4.1. Part A: Patent Funding

Part A of the Status Quo Plus policy option is assessed a score of medium for political feasibility because the current government’s mandate is supportive of innovation and entrepreneurship (BC Liberals, 2011). This support is reflected in Canada Starts Here: The BC Jobs Plan. A large component of Canada Starts Here is to increase trade and investment in the province by promoting innovation, clusters and competitive advantage (Government of BC, 2012). Directing resources away from the other programs, however, to support already “privileged entrepreneurs” patent and therefore profit from their research may bring some political backlash. The relatively small amount of proposed funds (\$282,485) required for this policy option should temper the backlash.

8.2.4.2. Part B: Expand the VCP

The political feasibility of this option is high. Premier Christy Clark recently showed her support for the VCP by extending the annual cap from \$30 million to \$33 million. She stated that, “innovation and entrepreneurship create jobs, diversify economic activity, and help keep BC globally competitive” and that “BC will help small business access early-stage venture capital to help commercialize ideas” (BC Liberals, 2011).

Table 4: Evaluation of the Status Quo Plus

Criterion		Policy Option 2		Combined Evaluation
		Status Quo Plus A	B	Policy Option 2: Status Quo Plus
Cost	Implementation Cost	\$0	\$0	\$282,485
	Incremental Cost	\$282,485	\$0	
	Total Cost	\$282,485	\$0	
Effectiveness	Culture	3	0	6.5
	Funding Gap	0	3.5	
	Total Effectiveness	3	3.5	
Administrative Complexity		Low/Medium	Low	Low
Political Feasibility		Medium	High	Medium/High

8.3. Evaluation of Policy 3: Commercialization Centers

8.3.1. Cost

Implementation Cost: The implementation cost of starting a commercialization center will vary considerably depending on the size and capacity of the center. Implementation costs will include: renovation of office space, purchasing of office furniture and supplies, salary of a project manager, salary of a website designer/marketing professional and legal fees. Taking all of these costs into account, the implementation cost is approximately \$150,000 per center. With one center in Vancouver and one in Victoria, the total implementation cost is \$300,000.

Incremental Cost: There are many types of business accelerators and the cost of establishing these centers can vary dramatically. Assuming a medium sized accelerator that provides some seed funding, incubation services, and five full-time employees (plus entrepreneurs in residence and part-time employees), a rough estimate of the incremental cost is \$1 million per year, per commercialization center (Bootup Labs, Personal Communication, 2012). The incremental cost is \$2 million per year.

The overall cost of this policy option is \$2.3 million.

8.3.2. Effectiveness

Entrepreneurial Culture: The commercialization centers will have a strong effect on the entrepreneurial culture at post-secondary institutions in BC because they bring entrepreneurs from several institutions and the business community together in one setting. This option provides networking opportunities, business training, and incubation services. The commercialization centers receive a moderate/high score of 4 on the entrepreneurial culture effectiveness scale. Although this option provides all three services needed to encourage entrepreneurial culture, it was not assigned a score of 5 because both commercialization centers are located off the main campuses of the universities. This distance may temper the effects of the programs on the campuses.

Funding Gap: This option will shorten the funding gap by providing some seed capital for university entrepreneurs. More importantly, the commercialization centers will create a critical mass of USOs to attract investors and expand networking opportunities with the business community and investors (VCC's and angel investors) (Hand, Interview, 2011). For these two reasons, this option is given a moderate/high score of 4 on the funding gap effectiveness scale because the commercialization centers increase the amount of seed capital available to university entrepreneurs. Due to the poor state of venture capital in the province, however, the funding gap will remain a challenge to university entrepreneurs.

The commercialization centers receive an overall effectiveness score of 8.

8.3.3. Administrative Complexity

The administrative complexity of this option is high for two reasons. First, each commercialization center will require 5-10 new staff members all with business or technology specific expertise who are well connected to the business community, and venture capital and angel networks in their respective cities. Recruiting qualified staff members who meet these requirements will be difficult and time consuming. Second, both proposed commercialization centers are shared among more than three research institutions. This requires coordination and consensus on financial responsibilities, the centers' mandates, and governance structures.

8.3.4. Political Feasibility

The political feasibility of this option is low because of the high cost. The total cost of \$2.3 million represents 24 percent of the BCIC's \$9.66 million annual budget. The BCIC will have to direct significant resources away from other programs and services or request a 24 percent increase to their annual funding from the province. If the federal government provided funding for these centers, however, this option will become more politically feasible.

Table 5: Evaluation of the Commercialization Centers

Criterion	Policy Option 3 Commercialization Centers	
Cost	Implementation Cost	\$300,000
	Incremental Cost	\$2 million
	Total Cost	\$2.3 million
Effectiveness	Culture	4
	Funding Gap	4
	Total Effectiveness	8
Administrative Complexity		High
Political Feasibility		Low

8.4. Evaluation of Policy 4: Direct Investment

8.4.1. Cost

Implementation Cost: Direct investment in USOs will require advisory panels and standardized granting frameworks. This involves extra staff hours. The implementation cost is approximately \$10,000 per university for a total implementation cost of \$20,000.

Incremental Cost: In 2010 two companies spun out of SFU and zero companies spun out of UVic (AUTM, 2011). Although UVic did not create any USOs in 2010 they typically create one or two per year (Sternig, Interview, 2011). In order to support these emerging companies and encourage greater USO creation this option proposes that the province provide \$150,000 to each university to invest up to \$50,000 in promising USOs. This amount will allow each university to provide seed funding of up to \$50,000 for 3 USOs per year (or more if the university chooses to invest less than \$50,000 in each USO). The combined incremental cost for both universities is \$300,000.

The total cost of direct investment is \$320,000.

8.4.2. Effectiveness

Entrepreneurial Culture: This option is not intended to have an effect on the entrepreneurial culture.

Funding Gap: Direct investment bridges the funding gap by providing \$300,000 in seed capital to USOs. This option is given a score of 3.5 on the funding gap effectiveness scale because it increases the amount of seed capital available to university entrepreneurs. This option will increase USO access to venture capital because the seed capital will allow USOs to reach a later stage of development (e.g. develop a prototype) where the investment becomes less risky to investors. This option, however, does nothing to connect USOs with investors or increase the venture capital pool in BC.

8.4.3. Administrative Complexity

The administrative complexity of direct investment in USOs is medium because it requires a board and standardized evaluation framework to award the funds. This involves 2-4 additional employees. SFU and UVic may also wish to capitalize the direct investments with donations from alumni and other private donors (similar to the entrepreneurship@UBC seed accelerator fund). This requires additional staff members because marketing efforts and accounting will be needed.

8.4.4. Political Feasibility

The political feasibility for this option is low because the government is explicitly interfering in the market and may be viewed as picking winners. This is problematic for two reasons. First, the BC Liberals are the governing party in BC. According to the BC Liberal website they are a “free enterprise party that is committed to open government” (BC Liberals, 2011). As a free enterprise party, the BC Liberals promote principles of competition, individual freedom, private property and a pro-business economic climate (Johnson, 2002). Investing in USOs is direct interference in the market and does not

align with the principles of competition and free enterprise. Second, investing directly in USOs creates an equity issue between university and non-university start-ups.

Table 6: Evaluation of Direct Investment

Criterion	Policy Option 4 Direct Investment	
Cost	Implementation Cost	\$20,000
	Incremental Cost	\$300,000
	Total Cost	\$320,000
Effectiveness	Culture	0
	Funding Gap	3.5
	Total Effectiveness	3
Administrative Complexity	Medium	
Political Feasibility	Low	

8.5. Evaluation of Policy 5: Reform the BCIC

8.5.1. Cost

The cost of reforming the BCIC is \$0. Filling the vacant seats on the Board of Directors with TTO connected individuals and extending the funding runway to a minimum of five years does not necessarily increase the amount of money spent by the BCIC.

8.5.2. Effectiveness

Entrepreneurial Culture and Funding Gap: By including individuals from the TTOs on the Board of the BCIC, the knowledge and expertise of the professionals delivering the programs will be included in the governance of the BCIC. This results in

the funding of more effective programs at the universities and increases the presence of the university community at the BCIC. For these reasons entrepreneurial culture effectiveness and funding gap effectiveness are both given a score of 2 and a total effectiveness score of 4.

8.5.3. Administrative Complexity

The administrative complexity of reforming the BCIC is medium because this option requires two additional board members.

8.5.4. Political Feasibility

This policy option is given a medium score for political feasibility. While the appointment of board members from the TTOs is highly feasible (since there are currently two empty seats), the adoption of a longer funding model is less feasible. The longer term funding approach is politically problematic because governments are elected every four years and new governments tend to have new mandates even when they belong to the same political party as their predecessor (as Christy Clark is currently demonstrating with the program review of the BCIC in order to bring it in line with her governments “Canada Starts Here” mandate). Politicians then, tend to have a four year planning runway. This makes a BCIC funding runway of five or more years politically less feasible.

Table 7: Evaluation of Reforming the BCIC

Criterion		Policy Option 5 Reform the BCIC
Cost	Implementation Cost	\$0
	Incremental Cost	\$0
	Total Cost	\$0
Effectiveness	Culture	2
	Funding Gap	2
	Total Effectiveness	4
Administrative Complexity		Medium
Political Feasibility		Medium

The evaluations of the five policy options are summarized in Table 8. The table uses a stoplight colour scheme. Green indicates the best scores, yellow indicates medium scores, and red indicates the worst scores.

Table 8: Policy Analysis Summary Table

Criterion	Policy 1: Status Quo	Policy 2: Status Quo Plus	Policy 3: Commercialization Centers	Policy 4: Direct Investment	Policy 5: Reform the BCIC
Cost	\$0	\$282,485	\$2.3 million	\$320,000	\$0
Effectiveness	3	6.5	8	3.5	4
Administrative Complexity	Low	Low	High	Medium	Medium
Political Feasibility	High	Medium/ High	Low	Medium	Medium

9. Recommendation

The BCIC is the chief provider of provincial government funds for the commercialization of university research and the activities of the TTOs in particular. According to their strategic plan, the provincial funding forecast for the BCIC is expected to remain flat (BCIC, 2011). Given this fiscal reality any recommended policies must be cost effective. As is the case with most policy analyses there are trade-offs involved when selecting one policy option and not another. The selected policy options and their trade-offs will be discussed in this section.

After considering the current fiscal environment and the budget of the BCIC, it is recommended that the province of BC implement two of the proposed policies: the Status Quo Plus and BCIC Reforms. For a relatively small cost of \$282,485, SFU's IO and UVic's Industry Partnerships will be able to address several of the challenges identified by the participants in this study. First, the funding gap will be shortened by expanding the VCP which will allow for more tax credit room in years of high investment and higher individual investments in years of low investment. Next, by providing patent funding for the IO and Industry Partnerships, funds will be available for them to enhance or provide programs that support the emerging entrepreneurial culture and provide university entrepreneurs with basic business education to address their limited business knowledge. Finally, by reforming the BCIC, more effective and long term programs will be put in place to better help university entrepreneurs overcome the barriers to the commercialization of their research.

The two recommended policy options are complimentary because together they support the commercialization of university research in the short and long term. The Status Quo Plus option addresses the short term needs of SFU's IO and UVic's Industry Partnerships by providing them with immediate financial resources. Expanding the VCP helps to fill the funding gap in both the short run, by increasing the individual investment limit, and in the long run, by rolling over unused tax credits to create a larger cap in

years of economic growth and increased investment. Reforming the BCIC addresses the long term needs of university entrepreneurs and the TTOs by including individuals from the TTOs in the governance of the BCIC and by providing longer funding runways for programs, both of these changes will result in the funding of more effective programs.

Three of the proposed policy options are not recommended for the following reasons. The Status Quo and Direct Investment have not been selected because of their low effectiveness scores. The Commercialization Centers were not selected because of their high cost, high administrative complexity and low political feasibility. There was, however, a trade-off in eliminating this policy option. The high effectiveness (the highest of any of the evaluated options) of Commercialization Centers was forgone for the cost efficient, administratively simple, and politically feasible options of the Status Quo Plus and BCIC Reforms.

10. Limitations of the Study

This study is not without limitations. First, this capstone has a very narrow scope and sample of post-secondary institutions in the province as only BC's three largest universities: UBC, SFU and UVic were included. Ideally the study would include participants from all universities, polytechnics and colleges in the province because they are all part of the commercialization ecosystem and have insights into the challenges of commercializing post-secondary research and methods for overcoming such challenges. In an effort to incorporate these institutions, emails were sent to several staff members at the BC Institute of Technology (BCIT) and the University of Northern British Columbia (UNBC) during the recruitment process. Unfortunately, there was no response to requests for interviews from this group of potential participants.

Second, the research focus of this study has been on developing policy options for the provincial government. This is problematic because, when it comes to commercialization of research, the provincial government is only one part of the funding equation. The federal government has provided funding to all of the universities in this study for the commercialization of research mostly through Western Economic Diversification Canada. The federal government also provides funding for entrepreneurs to develop and commercialize their research. Grants include those available through NRC-IRAP and NSERC's Idea to Innovation grants. Ideally, these federal programs would have been taken into account and joint provincial-federal programs proposed (since this is how many programs are currently funded). Due to the time and length restrictions of this capstone, however, this was not possible.

Finally, all of the university entrepreneurs interviewed in this study are classified as high tech entrepreneurs and created their USOs around the IP they developed during their research. This capstone, therefore, has been biased towards high tech entrepreneurship and high tech USOs. It is important to note that many university entrepreneurs have successfully commercialized their "low tech" innovations by creating

university affiliated companies that have had a significant effect on BC's and Canada's economy. These companies include UBC's 1-800-GOT-JUNK and UVic's Indochino suit company. While the low-tech entrepreneurs usually do not face the same funding gap that constrains high tech entrepreneurs, the other challenges of commercialization such as limited business knowledge, lack of managerial talent, an entrepreneurial culture that is in its infancy, and a constraining academic model, are all barriers to commercialization for low tech entrepreneurs as well. Importantly, policies that address the challenges other than the funding gap will also help low tech entrepreneurs commercialize their ideas and have a positive effect on the BC economy.

11. Conclusion

Canada's innovation performance is lagging behind other developed countries. This is troubling because it is through innovation that the work force becomes more productive and the standard of living increases for Canadians. Universities and technical schools are a rich source of knowledge and innovation in Canada. As Canada shifts towards a knowledge-based economy, the need for universities to commercialize their research and contribute to local economic development is growing. USOs have emerged as the preferred mechanism by which universities transfer knowledge and technology to the commercial realm. The problem is that university research does not automatically spill over to generate economic growth. Canada struggles to commercialize university research innovations and use them as a source of economic advantage.

This capstone examined the policy tools available to increase the commercialization of university research in BC. Fifteen semi-structured interviews were conducted in order to identify the challenges faced by university entrepreneurs and the potential policy options for overcoming them. Five policy options were identified and analysed using an evaluation framework of five criteria and their associated measures. The analysis found that, given current budget restraints, the best policy tools for increasing the commercialization of university research are the Status Quo Plus: Patent Funding and Expand the VCP; and Reform the BCIC. These policy options will support commercialization by: expanding the budgets of the IO and Industry Partnerships to provide incubation services, networking opportunities and business training; providing incentives for investors by expanding the VCP; and making the BCIC a more inclusive funding organization so that more effective programs receive not only funding, but a longer funding runway.

Although this capstone has focused on the three largest universities in BC, the commercialization of publicly funded research involves many other actors including

polytechnics and colleges. University faculty rarely work in isolation from one another; research often crosses both provincial and national boundaries. It is important to keep in mind, therefore, that the commercialization of research takes place in a global context and university innovations often have global applications. There are also many non-university actors in the commercialization of university research. The federal government, non-profit organizations, venture capitalists, angel investors, and industry are all part of the commercialization ecosystem and need to work together so that all Canadians can benefit from the research conducted at Canada's post-secondary institutions.

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Appendices

Appendix A.

Interview Guides

Interview Guide for University Entrepreneurs

1. Can you walk me through the process of setting up your spinoff company?
 - Why did you choose to start your company?
 - Would you say that there is a culture of entrepreneurship at your university?
 - Was the university supportive (faculty, TTO)?
 - If so, how?
 - Were TTO staff members knowledgeable?
 - Did you receive any support from the provincial government?
2. What challenges did you face when you started your company?
 - Which challenge would you say was the biggest?
 - Was accessing seed stage funding a challenge?
 - Was it difficult to attract an experienced business person?
3. What steps can the university and the province take to better encourage and support the creation of university spinoffs?

Interview Guide for University Employees (TTO)

1. Can you tell me about the work performed by the TTO at your university?
 - How many staff members does your office have?
 - How does your TTO encourage and enable the creation of spinoff companies?
 - What is your university doing to support the creation of spinoffs that is unique?
2. Is there an entrepreneurial culture at the university?
3. What challenges do university entrepreneurs face when trying to start a spinoff?
 - What is your university/office doing to mitigate these challenges?
 - What does the future of the TTO look like? New programs?
4. Does the provincial government support the creation of spinoffs at your university?
 - If yes, how? Is this support effective?
 - What steps can the university and the province take to better encourage and support the creation of university spinoff?

Interview Guide for University Employees (VP of Research)

1. Is commercializing research a priority at SFU?
 - How does commercialization fit into the Strategic Research Plan?

2. In addition to the work of the Innovation Office, in what ways does the university support the creation of university spinoff companies?
3. Is there an entrepreneurial culture at SFU?
4. How can the university better support university entrepreneurs in their pursuit of spinoff companies?
5. How can the provincial government better support the creation of spinoff companies at SFU?