Collaboration with entrepreneurship education programmes: building spinout capacity at universities

Peter W. Moroz* and Kevin Hindle

Center for Entrepreneurship, Innovation and Community
Deakin University
Melbourne, Australia
and
Syddansk Universitat
Kolding, Denmark
E-mail: pwmoroz@shaw.ca
E-mail: kevin.hindle@deakin.edu.au
*Corresponding author

Robert Anderson

Faculty of Business Administration
Hill/Levene Schools of Business
University of Regina
Regina, Saskatchewan, Canada
E-mail: Robert.anderson@uregina.ca

Abstract: As University Spinouts (USOs) have become a highly desirable outcome for commercialisation efforts, the development of entrepreneurial capacity within the university system becomes increasingly more important. We hypothesise that Entrepreneurship Education (EE) programmes *ceterus paribus* may play a role in developing this capacity. This paper examines the attitudes and perceptions of academics who are directly involved in the field of EE programmes with four research goals in mind:

- to determine whether or not there are perceived advantages to collaboration between EE programmes and technology transfer departments
- to identify specific factors that influence these perceptions
- to query academics regarding the perceived barriers to collaboration
- to identify whether collaborations already exist and categorise them.

Our findings suggest that significant advantages from collaboration between these two functions are perceived and that indirect linkages are believed to be more important than direct linkages.

Keywords: entrepreneurship education; technology transfer; university spinouts; USOs; innovation; entrepreneurship; university collaboration; entrepreneurial capacity; learning.

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Biographical notes: Peter W. Moroz is a Doctoral candidate at the Center for Entrepreneurship, Innovation and Community at Deakin University, Melbourne, Australia. He is also an associate researcher at the Syddansk University in Kolding, Denmark. His research interests include new venture creation in challenging environments, Indigenous entrepreneurship and social entrepreneurship.

Kevin Hindle is a Professor of Entrepreneurship at the Center for Entrepreneurship, Innovation and Community at Deakin University in Melbourne, Australia. He is also an Adjunct Professor of Entrepreneurship at Syddansk University in Kolding, Denmark and Academic Advisor to IDEA, Denmark. He is a Researcher, Educator, Management Consultant and Private Equity Investor. As a Researcher, he has authored over 80 publications, including more than 50 peer-reviewed papers in a range of respected international journals and conference proceedings.

Robert B. Anderson is a Professor at the Faculty of Business Administration of the University of Regina, Canada. He is the Editor of the *Journal of Small Business and Entrepreneurship*, the Regional Editor for Canada for the *International Journal of Entrepreneurship and Small Business*, an Associate Editor of the *Journal of Aboriginal Economic Development*, an Associate Editor of the *Journal of Asia Entrepreneurship and Sustainability* and the founding Editor of the *Journal of Enterprising Communities*.

1 Introduction

Several studies point to the sizeable impact that university commercialisation activities have on regional and national economies (Saxenian, 1994; Reamer *et al.* 2003; Audretsch and Phillips, 2007). Although a diverse range of commercialisation activities and outcomes exist,[1] the activity of new venture creation is perhaps the most widely recognised and accepted indicator of success (AUTM, 2007; HEFCE, 2007; European Commission, 2008; Read, 2005). Thus a large body of the extant research in this area is focused on the University Spinout (USO) as an important and desired outcome of the research commercialisation process (Djokovic and Souitaris, 2008).

This recent association of commercialisation with new technology venture creation has generated a new term: the 'entrepreneurial university' (Rothaermehl *et al.*, 2007; O'Shea *et al.*, 2007). Universities that are recognised as moving towards an 'entrepreneurial paradigm', such as MIT, Stanford and Cambridge, are highly influential role models. The study of these universities provide evidence to the many benefits that may be construed from successfully converting Intellectual Property (IP) derived from research programmes into tangible financial benefits for the university (in terms of licensing and equity revenues from spin out companies) and the local community in terms of high paying jobs/wealth creation (Etzkowitz, 2002; Etzkowitz, 2007).

Researchers who explore the complex variables and processes that stimulate the proliferation and success of the USO are embracing the growing literature on entrepreneurship to help understand this phenomenon and identify its antecedents (Shane, 2004). Approaching the evolutionary problems of universities from the perspective of the field of entrepreneurship may provide insight that is extremely valuable to understanding

and developing the processes required for meeting the overall challenge to innovate faced by universities (Drucker, 1985). For instance, knowledge spillover is theorised to be responsible for technological diffusion, as it is understood that latent entrepreneurial activity surfaces wherever opportunities abound (Audretsch and Kielback, 2004; Romer, 1990). But the context specific barriers unique to research universities that stand between new knowledge creation and new knowledge exploitation must be fully identified and understood before effective implementation of the commercialisation mandate is fully engaged (Hindle, 2002). Theories developed to understand the phenomenon of entrepreneurship may better help to map and explain these relationships.

Understanding what makes universities behave entrepreneurially as institutions is thus a broad focus of this paper. More specifically, we seek to explore entrepreneurship at university as a function of the capacity of individuals within the system to foster and or engage in entrepreneurial behaviour that results in USOs. Entrepreneurship Education (EE) programmes are recognised as a growing phenomenon within the academic system that parallels the historical movement of modern universities towards commercialisation of their knowledge assets. These EE programmes, often delivered via a diverse range of models, typically emphasise the promotion of entrepreneurial behaviour and entrepreneurial capacity building (the ability to 'do') both internal and external to the university environment. The relationship between the creation of USOs and university based EE programmes is thus argued to be a relevant area of study.

We posit that the effective and comprehensive functioning of EE programmes across the universities' many dimensions is a key component for achieving an entrepreneurial paradigm that fosters successful USO creation.[2] The activity of opportunity identification, evaluation and exploitation, especially in challenging environments such as the academic institution, offer a wealth of information on the process of entrepreneurship on both a micro and macro foundational level (Shane and Venkataraman, 2000; Low, 2001; Uczbasaran, 2001; Steyaert, 2007). The emergence of the USO as a prime strategy for commercialisation of new knowledge and the resulting obligation to build capacity around this activity provides an excellent area for entrepreneurship researchers to generate theory both specifically (within the area of entrepreneurial universities) and generally (the main body of entrepreneurship research).

The purpose of this research is to narrowly focus on the entrepreneurial capacity building dimension of the commercialisation process. We intend to discover whether or not collaborations exist between EE and USO commercialisation functions, determine their nature, and identify whether or not they are perceived as important to the USO process. We employ the perspectives of embedded entrepreneurship faculty to generate data through a non-random delivered survey tool. Therefore, the study reported in this paper takes a look at the problems, challenges and potential opportunities inherent to university knowledge transfer and USOs from the perspective of academics involved in the teaching, research and programme development of academic entrepreneurship programmes. Through this study, we intend to delve deeper into the entrepreneurial elements of university commercialisation from a new and perhaps different viewpoint. In doing so, we challenge the traditional models currently being used and lay the groundwork for the investigation of new ways of innovative thinking around the question at hand: "how do we increase the potential for university derived IP to be commercialized in order to realize the maximum benefits to both the university and society as a whole?"

Our paper is structured as follows. We begin by presenting an overview of several predicate perspectives, define key terms and provide an adequate contextual foundation for the study. Next, a conceptual platform for this study is offered by defining and linking three interrelated and important dimensions of the commercialisation process: new knowledge creation, entrepreneurship and innovation. Research based antecedents of successful commercialisation processes are introduced that highlight entrepreneurial capacity building as a significant factor. This will set up a conceptual argument as to how collaborations between commercialisation functions and EE functions at university may support successful USO creation. Three hypotheses are offered. Next, the methodology used in the paper is explored and the results presented. Analysis of the results is provided in the discussion section. Limitations and paths to future research are discussed with a brief conclusion to the findings of the paper offered.

2 Understanding the entrepreneurial university

The challenges that accompany an 'entrepreneurial paradigm' shift in thinking require a complete reassessment of the traditional organisational goals long held by research universities (Etzkowitz *et al.*, 2000). No longer is knowledge creation and its unfettered dissemination the exclusive mandate of academia (Clark, 1998). Universities are compelled to embrace an onrushing market head on, as a voracious global economy hungry for new technology demands both greater levels of research output, and rapid commercialisation of the fruits of this effort (Kessler and Chakrabarti, 1996; Markman *et al.*, 2005; Shane, 2004). Long standing as a neutral scholarly observer upon the economic whirlwinds of history, the modern university has become deeply embroiled within the vortex of innovation and creative destruction (Schumpeter, 1934; Thursby and Thursby, 2002). In order to survive, the modern university is evolving as an institution. Clark (2004) believes that this can only be accomplished through creating, among other things, new entrepreneurial pathways.

What is crucial to this transformation is the reconcilement of the traditional mandates of the university within an interpretive scheme that is inclusive of regional economic realities and sensitive to institutional heterogeneity (Schilling, 1998; Thursby *et al.*, 2001). Each institution is unique in terms of the culture and resources available for enacting change. For many schools and colleges within the university system, fostering an environment that is friendly to entrepreneurship, innovation and commercialisation is often difficult (Di Gregorio and Shane, 2003). Cultures must be broken down and slowly altered in order to accommodate a new socially integrated role in regional development. The educational requirements and transitional tools necessary for this massive up taking will require both time and money (Shane, 2004). Most importantly, leadership must be cultivated internally, and kindled wherever it emerges. One area where this leadership is currently emerging is through the establishment of entrepreneurship centres and programmes at university across the world (Vesper and Gartner; 1997; Finkle *et al.*, 2006; Menzies and Paradis, 2002).

2.1 Entrepreneurship education programmes

Entrepreneurship research and the application of EE programming may be important in determining what skills, experience and behavioural cues are necessary to help bridge the gaps that exist between the codified knowledge of the research world, and the

tacit knowledge important to navigating commercial markets (Yencken and Gillin, 2003; O'Shea *et al.*, 2005). An extensive body of literature detailing both the ability and efficacy of 'teaching' entrepreneurship as a discipline (Gartner and Vesper, 1994; McMullen and Long, 1987; Kuratko, 2005; Kolvereid and Moen, 1997; Menzies and Paradis, 2002; *etc.*) provides ample argument for its heightened role in closing this gap. The human resource skills necessary for launching USOs as well as creating the environment where USOs are an expected outcome of research trajectories must be either imported or facilitated (Franklin *et al.*, 2001). Entrepreneurship programmes may have a role to play in the internal facilitation of building entrepreneurial capacity and fostering new USOs.

One might argue that the dividing line between protecting the right of researchers to perform basic 'social good' research and enabling researchers to develop research that can be readily commercialised may be more easily negotiated through the establishment of proper social cues and training for those who are interested, rather than through elaborate incentive systems and infrastructure projects alone. Entrepreneurship research and pedagogy may contribute to the comprehension of the necessary and important network externalities required to be successful within university innovation systems. As well, by simply providing a greater diffusion of entrepreneurial skill sets and through the consequent outcomes of having more and more people practice entrepreneurship and recognising/reacting to opportunity, the foundation for facilitation may be more easily laid (Minniti, 2005).

Building the individual entrepreneurial capacity of faculty scientists, graduate students, engineers and the staff of technology transfer offices is an important process within the evolution of the entrepreneurial university, but huge gaps exist in the literature with respect to how it is facilitated (Van Looy *et al.*, 2004; Kolvereid and Moen, 1997; Yencken and Gillin, 2002; Markman *et al.*, 2005; Rothaermel *et al.*, 2007). It is posited that entrepreneurship education may significantly increase the propensity of students and faculty to create new ventures and increase success rates, but the empirical evidence is still not conclusive (Menzies and Paradis, 2002; Gartner and Vesper, 1994; Galloway and Brown, 2002; Kuratko, 2005; Ibrahim and Soufani, 2002).

Several scholars have studied the rise of EE programmes over the last 20 years (McMullen and Long, 1987; Vesper and Gartner, 1997; Hindle, 2002; Menzies and Paradis, 2002; Menzies, 2004a; Kuratko, 2005). They have found that the models, objectives, resources, specialisations and efficacy of these programmes are extremely diverse. A list of the characteristics found in EE programmes is presented in Table 1.

An exhaustive discussion on the characteristics, constellations and outcomes of EE programmes is beyond the scope of this paper. What is important to note, is that EE programmes are still evolving and the objectives varied. Furthermore, the efficacy of these programmes are often measured in simplistic terms, such as the number of students who start businesses after graduation, but the actual outcomes have no uniform criteria for assessment that allow for a thorough evaluation of the contributions that these programmes make to the university/community (Langford *et al.*, 2006). Hindle (2001) provides a rule of thumb set of criteria that allows one to gauge the breadth and depth of the EE programme simply by stating that stand alone courses (such as business plan courses) will not be as strong as concentrated programmes (such as undergraduate minors/majors or graduate programmes), and that the more integrated the programme

is across the various functional departments of a university (combining individuals with different skills sets/fields of expertise together), the better they will be at building individual entrepreneurial capacity.

Table 1 Potential characteristics of entrepreneurship education programmes

E Teaching	Provides academic courses in entrepreneurship that range from single courses to entire undergraduate minor, major and graduate/PhD programmes
E Research	Academic research focused on both theory and applied areas of entrepreneurship
E Internal	Promotion of entrepreneurship across campus, faculty and grad student training, business plan competitions
E External	Services and activities for the community such as boot camps, network building, consulting, business plan assistance, mentoring, workshops
E Specialised	Emphasis on particular fields such as social entrepreneurship, corporate entrepreneurship, family entrepreneurship, technology entrepreneurship
E Location	Specialised institutes, centres or departments that may or may not be tied to a certain school (business, engineering, *etc.*), cross campus, or external to the university but tied indirectly through linkages (boards, individuals, *etc.*)
E Resources	Endowments, chairs, and other revenue streams generated to fund the programme (most E programmes are funded outside of university cost budgets)
E Plus Zone	Anything that is innovative, unique or experimental that seeks to differentiate the programme from all others

Lastly, Hindle (2001; 2006) argues that academics that teach entrepreneurship must have a combination of practical and academic skills. Too often, academics from other fields of business management are recruited to fill the leadership roles of chairs in EE programmes, leading to programmes that are 'entrepreneurial' in name only (Kuratko *et al.*, 2005). Entrepreneurship education programmes are best lead by scholars that have been trained specifically by academics who have researched and practiced entrepreneurship. As scholars of this nature are rare, this type of individual is often atypical of those academics that run these programmes.

There may be other more direct methods of capacity building that help to promote and enable commercialisation processes and USOs. Technology entrepreneurship programmes are quickly being adopted within top ranked entrepreneurship schools.[3] Not only do the curricula developed for these programmes help in the venture creation process, they also provide experience, networks and skills that are unique to starting high technology USOs. The mandates of entrepreneurship schools continue to grow and add other services and resources to the mix, such as links to investors, internal startup financing funds, and other support infrastructure such as mentorship (Finkle *et al.*, 2006). In many respects, the priorities and strengths requisite within entrepreneurship programmes and centres is highly compatible with the goals of Technology Transfer Offices (TTOs): spinning out new ventures. Some overlap does exist as well, especially in the area of infrastructure development and support for new ventures, such as incubators, and professional/business consulting services (Tornatzky *et al.*, 1996; Lockett and Wright, 2005; Markman *et al.*, 2005; Nelson and Byers, 2005; Siegel and Phan,

2004; Leitch and Harrison, 1999). The next section will provide a brief overview of the USO, definitions and a brief taxonomy to better help align the reader with the functions, objectives and potential outcomes of EE programmes.

2.2 University Spinouts (USOs)

There are several terms found within the academic and practical literature for describing new ventures created from within a university environment: university spin off companies, university startups, new venture spin offs and USOs. For this paper, we have adopted the latter and forego the formalities of defining what a USO is, in order to present taxonomy of the different types of USOs that exist, their characteristics, objectives and how their performance may be evaluated. Hindle and Yencken (2004) present an authoritative overview of the different types of USOs by linking them to their host organisation (in this case, a public research university). There are four:

1 Direct Research Spin-Off (DRSO): company created and owned by (or in part) the university for the purpose of commercialising IP that has emerged from the institution.

2 Technology Transfer Company (TTC): companies set up by a university to exploit tacit knowledge that are more process based than patent based.

3 Indirect Spin-Off Companies (ISO): companies started by current or former faculty or students that do not have a direct IP relationship/legal stake with the university.

4 Spin Ins (SI): companies that are spun out by existing companies to exploit licensed or collaborative research generated by universities.

Another classification of USOs involves the objectives of three general business models:

1 Consultancy Contracting (CC): companies set up to delivers services; either technical or knowledge based in a supportive role of regional R&D activities. These companies are often lifestyle businesses that do not grow rapidly.

2 Product Oriented (PO): companies developed around a product or process that achieves a sustainable growth pattern.

3 Technology Asset Oriented (TA): companies that are developed around a patented technological asset (or platform) that achieve rapid growth and require large and diverse sets of resources.

Lastly, and perhaps most important to this study, is the USO classification based upon the principal originator or team being a member of faculty, or a graduate student. Data pulled from recent Higher Education Fund Committee (HEFCE) reviews finds that the number of USOs started by graduate students has increased steadily from 1999–2006 and that they far outweigh the number of USOs started by faculty over that same period. These figures suggest that entrepreneurship education programmes may be best targeted at graduate students working across the hard sciences and engineering schools. This concept is supported by findings from several academic studies investigating this trend (Menzies, 2004b; Kirby, 2004).

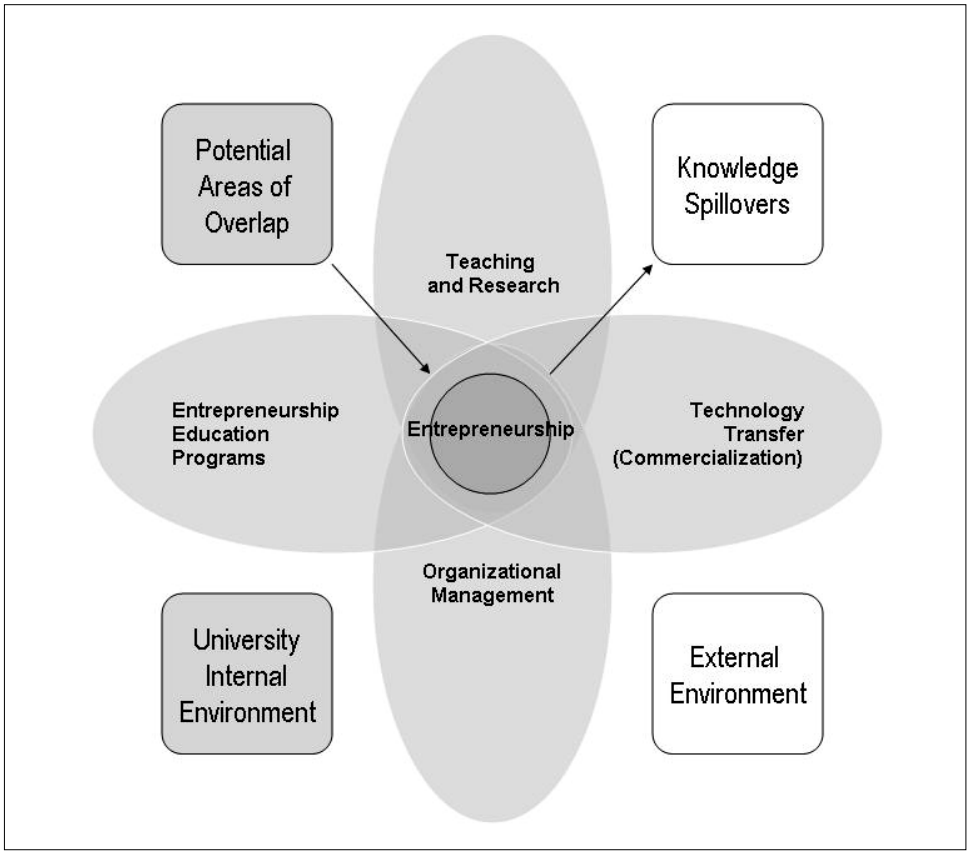
The focus of this paper encompasses all of the above classifications of the USO as the study reported here is exploratory in nature.

2.3 The four functional dimensions of the entrepreneurial university

As mentioned above, the conceptualisation of an entrepreneurial university used in this paper aligns with two functional dimensions: that of teaching/research and contributing to internal and external entrepreneurial capacity building in the form of EE programmes, and the process of commercialisation that results in the formation of new ventures arising from the generation of new knowledge by university staff/collaborations with industry. Although these two dimensions are important, we do not claim that entrepreneurial universities can be evaluated upon the function of their entrepreneurship education and commercialisation programmes alone.

Hindle (2010) has developed a model that categorises the functions of the entrepreneurial university into four overlapping dimensions (see Figure 1 below). The model holds that the main objective of the entrepreneurial university it to create a continuous stream of innovation. As innovation is the successful commercialisation of new ideas or inventions, entrepreneurship is simply defined as the engine of this value creating process and is not limited to the formation of new ventures (Shane and Venkataraman, 2000). Thus entrepreneurial behaviour within the teaching and research dimension may produce valuable socioeconomic outcomes in the forms of new innovative programmes and research that impacts upon the socioeconomic well being of the region/nation/world. The possibilities are endless and too diverse in scope to represent here.

Figure 1 Four dimensions of the entrepreneurial university



The organisational management dimension of the entrepreneurial university refers to the administration of the institution. Entrepreneurial behaviour engaged within this dimension may produce new revenues streams for the university based on innovative ideas or processes, development of angel/mentorship programmes through alumni resources, the development and delivery of new educational programmes/services that have commercial value to the university, or entrepreneurial leadership in envisioning and implementing entrepreneurial change to be highly innovative across a wide spectrum of areas.

As the engine of innovative change is conceptualised as entrepreneurship, this inevitably leads to the question as to whether or not EE programmes should be taking a more central role in the shift to an entrepreneurial paradigm; and more specific to this paper, the USO process. It also begs the question as to whether or not technology transfer functions would be better served if integrated administratively with EE programmes, specifically if the focus of commercialisation efforts is to spin out technology into potential high growth ventures. Until now, the main vehicle for university commercialisation efforts has evolved around the technology transfer/industry liaison model (Thursby *et al.*, 2001; AUTM, 2005; Jones-Evans and Klofsten, 1999). The efficacy of this model, like any model, should constantly be evaluated and assessed, especially against shifting goals (Kuhn, 1962/1970). Are there perhaps other models or paradigms that may better serve the university in terms of its ability to more effectively spin out technology produced from academic research? We will explore these questions in greater detail below.

3 Theoretical construction

This section is intended to provide a general framework for understanding the relationship between entrepreneurship and innovation that is significant to USO commercialisation policy specifically and economic value creation in general. In so doing, a definition of entrepreneurial capacity is presented, its relationship to entrepreneurship education programmes at university outlined and its importance to the commercialisation process argued. Empirical evidence and extant theory from past research on the antecedents that influence the spin out process and impact upon issues regarding performance and success are provided. These factors are then synthesised with the general framework presented and hypotheses for testing are offered.

3.1 Entrepreneurship, innovation and commercialisation

There is an obvious linkage between innovation and entrepreneurship (Schumpeter, 1934; Drucker, 1985). Those universities that develop expertise and support policies to stimulate technology transfer are often ascribed to as “entrepreneurial universities” (Slaughter and Leslie, 1997; Rothaermehl *et al.*, 2007). This is a worldwide phenomenon (Wright *et al.*, 2007). Although entrepreneurship is often linked to innovation, how innovation is perceived and defined within the literature is not always clear.

Hindle (2002) categorises the components of innovation into *small I* (inventions, ideas and the creation of new knowledge) and *big I* (the economic value attributed to productive opportunities derived from new knowledge). Entrepreneurial actors transform

small I innovation into *big I* innovation through the commercialisation of products or services redeemed from research findings. If entrepreneurial actors (students, faculty researchers, administrative staff, external individuals working privately in industry or publicly through government) retain an ability to conceive of what to do with a productive opportunity, it logically follows that in the absence of entrepreneurial capacity, the potential commercial value to a university of any new knowledge is effectively zero (Hindle, 2002). In other words, entrepreneurship is the human 'action based' engine of innovation.

With the billions of dollars being injected into public research institutions around the world, perhaps the burning problem to be addressed is the notion of a lack of entrepreneurial capacity within the university system. Entrepreneurial capacity is posited as a *necessary* catalyst for turning new knowledge into new dollars. Yet in comparison, relatively little investment into entrepreneurial capacity building has been made in contrast to funding for basis and applied research (Menzies and Paradis, 2002; Kuratko, 2005; Wright *et al.*, 2007; AUTM, 2005).

Hindle (2007) provides a seminal definition of entrepreneurial capacity:

> "…it is the ability of individual or grouped human actors (entrepreneurial protagonists) to evaluate the economic potential latent in a selected item of new knowledge, and to design ways to transform that potential into realizable economic value for intended stakeholders." (p.9)

Although entrepreneurial capacity refers to an individual or team based unit of analysis, the potential capacity gap exists on two overlapping levels: the lack of talented individuals who understand the process of turning invention into enterprise, and the deficiency of organisational structures and environments that are not properly suited to stimulate or facilitate entrepreneurial activity (Ropke, 1998). These two levels (the individual and the organisational – or systemic) presented here are extremely broad. For a deeper understanding of university commercialisation, an examination of the elements contributing to entrepreneurial capacity that exist within the university system for innovation is required.

3.2 Individual and organisational antecedents of successful USO commercialisation

Focusing on the creators of IP, Di Gregorio and Shane (2003) assessed the determinants of USOs and conclude that the skills and abilities of faculty were significant. Scientists, who are incapable of identifying or exploiting the commercial value of their work, tend to not disclose research findings to TTO. As well, the goal of most research being performed within universities is discovery based and not commercially motivated. Even if disclosure is made, the scientist must brave the gauntlet of a potentially daunting peer environment (Bercovitz and Feldman, 2008). Considering that the direct involvement of the scientist throughout the early stages of the spinout process is positively correlated with higher levels of USO commercialisation (Zucker *et al.*, 1998; Thursby *et al.*, 2001), institutional disincentives may lower their participation. Issues such as lack of time, recognition, motivation and business sense may also cause scientist to retract from such endeavours. Organisational rigidities, a lack of resources and the complexities of the USO process itself all act as barriers to scientists spinning out technologies (Witt and Zellner, 2005).

Since the commercialisation of technology is basically an entrepreneurial process, understanding the nature of IP exploitation demands that scientists and students must act entrepreneurially (Ropke, 1998), or at the very least, be familiar with and willing to accept entrepreneurial activities as a norm (Lenoir *et al.*, 2007). In other words, they must be alert to market opportunities related to their research findings.

There are several of technology and new venture creation programmes targeted at students and faculty.[3] In a study performed by Kolvereid and Moen (1997), graduates with an entrepreneurship major were found to be more apt to start new businesses and have stronger entrepreneurial intentions than other graduates. Menzies (2004b) found that engineers who had taken entrepreneurship courses had higher propensities to venture and better success rates in starting new businesses. Specifically to technology based spinouts, Yencken and Gillen (2003) finds that training in entrepreneurship and technology management familiarises innovators with the processes and requirements for creating and sustaining USOs. Many examples of technology transfer and technology entrepreneurship programmes have thus sprung up around North America and Europe based on this premise with a variety of outcomes (Marshall *et al.*, 2006; Thursby *et al.*, 2001; Binks *et al.*, 2006).

In analysing the effectiveness of university technology transfer, Siegel and Phan (2004) state that entrepreneurship curricula must be embedded throughout the university to maximise the effectiveness of commercialisation efforts. This contention is based on considerable evidence that entrepreneurs with a good education (delivered through academic programmes) tend to be more successful than those without (Vesper, 1990). As entrepreneurship education is itself a non-linear process, it is more closely aligned with innovation than the linear and often bureaucratic nature of technology transfer (Nelson and Byers, 2005). Therefore technology entrepreneurs who have received education, training and experience in entrepreneurship and business will have greater levels of entrepreneurial capacity and generate more new ventures than those who have not.

Hypothesis 1 *The existence of entrepreneurship education programmes will positively correlate with higher USO creation at university.*

Although this may seem to be an obvious hypothesis, the breadth and depth of linkages between entrepreneurship programmes and technology transfer functions at university is unknown. Those unfamiliar with technology transfer and entrepreneurship programmes in this area may not be as likely to cite this as an important factor out of sheer lack of hands on experience or involvement.

3.3 Processes and routines for improving USO commercialisation performance

Lockett and Wright (2005) examine the creation of the USO from a macro foundational level and ask two pertinent questions:

1 What are the most important stocks of resource inputs?

2 What are the most important capabilities and routines?

Among other things, business development and experience vested in spin outs teams were more important than the actual number of years that TTO had been in operation at a university. Routines that reinforce existing cultures of innovation through organisational

norms, policies and procedures were as important as the actual stocks of IP being generated. Markman *et al.* (2005) reinforces this theory and extends it by stating that value chains consisting of scientists, TTOs, university administration and external linkages to investors/industry must be put in place and work in tandem with the proper incentives to encourage spinning out technology through new ventures. Thus an argument for the requirement of entrepreneurial capacity as a stock or resource is plausible, and the identification of entrepreneurial processes operating within the university innovation system a logical indicator of these stocks.

Top levels of university administration must adopt a strategic approach to facilitating entrepreneurial action (Siegel and Phan, 2004). Spinning out IP also requires routines where selectivity is practiced, as not all IP is created equally. Innovations will often have divergences in market appeal and growth potential (Powers and McDougall, 2005). Thus the discovery and evaluation elements of entrepreneurial capacity are relevant to the opportunity identification process (Shane and Venkataraman, 2000). Some of these strategies may be aligned with cluster development, incubators, research parks, research chairs and other broad based policies that allow for long-term commitments. An understanding of the time that knowledge innovation takes to bring to a state of profitability, its unpredictability in outcomes and a tolerance for failures (Drucker, 1985) frames some of the requirements needed for better USO performance. Universities must also modify policies for the heterogeneity of USO types, sises and growth rates as referred to above in a previous section.

In deference to the value of EE programmes, Franklin *et al.* (2005) posits that entrepreneurial routines and incentives may not be grown as rapidly as needed within the university through entrepreneurship programmes alone. Thus surrogate entrepreneurs may help to provide the necessary capacity to accelerate the growth of commercialisation experience. External entrepreneurs can be the catalyst required for bringing USOs out of nascent stages through the structural coupling of the university and regional resources into entrepreneurial patterns. They can also be an integral part of EE programmes that seek to build capacity within the university environment employed as "pracademics" (McMullen and Gillin, 1998). As EE programmes and centres are integrally linked to the regional entrepreneurial environment, linkages between this type of capacity and innovation system needs are also plausible (Kuratko, 2005). Historical success follows an external environment where entrepreneurial activity is strong and universities cultivate ties with the business world (Blumenthal, 1996), also a function of EE programmes.

As the commercialisation process requires a good degree of organisational coordination, administrative support, and the commitment of resources, entrepreneurship programmes would most likely be more beneficial when *directly* tied into university technology transfer processes involving USOs through programmes with features as indicated above.

Hypothesis 2 *Direct linkages between entrepreneurship education programmes and USO commercialisation strategies involving TTOs will be positively correlated with the creation of USOs at a university.*

This leads to a further hypothesis that states:

Hypothesis 3 *Combining technology transfer functions with entrepreneurship education functions will result in greater numbers of USOs.*

This hypothesis engages the consideration of paradigm shifts or evolutionary patterns in models that may contribute to the effective transfer of technology through the USO. As the suggested structural model is atypical of current configurations, it may serve as an introduction to be analysed upon its merits. Roberts (1996) looked at various selectivity and support configurations and concluded that weak entrepreneurial environments (both external and internal to the university) may require more rigid policies to enhance commercialisation, while universities with past success, well established social cues and an environment rich with entrepreneurial capabilities and routines may not. Degroof and Roberts (2004) agrees by stating that direct administrative control and rigid policies promoting entrepreneurial activity around USO efforts is better for underdeveloped environments, supporting the need for direct linkages between EE and TTO, especially when past historic success is not a factor. This is assumed to be the prevailing environment in many universities evolving into an entrepreneurial paradigm and USO proliferation.

Not all examinations of direct organisational control as a factor for USO creation are in agreement. Moray and Clarysse (2005) warns that increasing top down control on the venture process may discourage efforts to spin out technology. Regarding the specific collaboration of EE programmes and TTOs, the differences between the two activities and their institutional constellations may limit the amount of direct interface between them (Nelson and Byers, 2005).

All in all, the complexities involved with USOs are grand in their totality. This paper does not attempt to delve deep into the various factors and their relationships that either positively or negatively impact the proliferation of USOs within a university setting. We hope to offer insight of the understanding of the phenomenon from the perspective of entrepreneurship academics that may participate in, have relationships with, or experience in creating collaborative approaches to new venture creation that include USO formation. We believe that analysis and comparison of the attitudes, views and beliefs of this rarely tapped population may offer some interesting discussion to current theoretical posturing on the subject.

4 Methodology

In order to obtain the data presented in this paper, an invitation to participate in a self-administered web survey was e-mailed to Canadian entrepreneurship academics. The sample frame consisted of all academics and/or entrepreneurship centre directors that were actively involved in administration, teaching, or research within or in conjunction to a university. The sample frame represents 95% of all Canadian universities, disregarding regional colleges or affiliates of the main institution. Technical and trade schools were not represented in this sample frame. The sample population consisted of 67 entrepreneurship educators and was drawn from various sources: subscription lists to the *Journal of Small Business and Entrepreneurship*, an exhaustive internet search through faculty web pages and by the process of asking respondents to refer the survey to colleagues that fit the above sample frame. This last method is well documented in its application and is often referred to as snowballing (Heckathorn, 1997).

The first section of the survey asked respondents to identify several institution specific structural issues to help gauge the depth, breadth and focus of EE programmes within their schools. This information was gathered by asking a series of partly closed questions that allowed for respondents to choose from a list of coded responses that included a category for 'other' responses. Respondents were asked to elaborate on 'other' responses through follow up open ended questions in order to allow for a full range of responses to be collected. Information on research funding, research chairs, and endowments was also collected (Finkle *et al.*, 2006).

Part two of the survey involved asking respondents their opinion on issues involving the collaboration of EE programmes and TTOs responsible for USOs. Answers were coded via a closed four point scale (Bradburn, 2004) assessing the strength of their agreement or disagreement with several questions. A middle point was left out of the scale in order to better gauge the leanings of the respondents. In order to avoid satisficing, a 'don't know' response was added at the end of each question's response choices. This technique reflects the respondent's ability to answer the questions with some authority, and allows them the option to answer based on a closed set of responses. It is likely that some entrepreneurship educators were not familiar with technology transfer and the commercialisation aspects of the USO (Kalton *et al.*, 1980).

The final part of the survey was modelled as two part questions to illicit responses on attitudes and perceptions of entrepreneurship academics, independent of whether or not the questions corresponded to their schools. This method was decided upon in order to mitigate the association of responses within an environmental context and to ensure that academic perceptions of what 'should be' were not anchored with what actually may be happening within the programme or school. Questions were designed to be as specific as possible to help filter the attitudinal characteristics of the responses (Bradburn, 2004).

Responses to opinion and attitude questions were measured by using a mean percentage to evaluate the level of the respondent's agreement on a cumulative basis. The resulting scores were then used to assess the issue addressed in the question on a positive scale. Responses coded as 'don't know' were included in the aggregate percentages.

A second level of analysis involved parametric tests on dummy variables created for structural, resource variables and environmental variables and then compared with attitudinal variables. Pearson bi-variate tests were performed to identify the strength and significance of any pertinent correlations between the coded responses. Due to the reporting system used in the online survey, opinion and attitude questions were ranked in descending order of strength so that '1' was considered a strong positive result. As 'don't know' responses were coded as '5', they were assigned as missing variables and dropped from the dataset.

5 Results

Of the sample population of 67 respondents, there was a completion rate of 53% (n = 36). The population of Canadian universities according to the Association of Universities and Colleges of Canada (AUCC)[4] is currently 89. As the survey was designed as a non-probability based purposive study of entrepreneurship academics within Canadian universities, the sample population of 67 consists of those targeted universities that have EE courses or programmes of some kind. Of the 89 universities in the AUCC population,

19 were either affiliates of larger institutions or did not have a full representation of programmes (art schools, design schools, and liberal arts colleges) and thus did not fit the requirements of the survey population. Thus the survey population of universities within the scope of this study is 70. Using standard sampling error techniques, with a sample error of +/–3%, the sample size drawn ensures a confidence level of 95% (Judd, 1991).

Breaking the respondent list down geographically, 19 eastern, 6 maritime, and 9 western universities were represented in this survey. There were two universities that provided dual reports from 4 individuals, for a total of n = 36. Of the 36 respondents, 9 were female and 27 were male. Each province had at least one university respondent reporting.

In regards to university infrastructure and programmes, the following results were obtained and are tabulated in Table 2. The vast majority of universities delivered EE programming from the business school (97.2%), while engineering schools reported 52.8%, arts schools 16.7% and medical schools 5.6%. The preeminence of the business school in delivering EE programmes is typical of most nations and on the whole an obvious statistic. The growth in EE programmes being delivered from engineering schools is a growing trend (Menzies and Paradis, 2002), but the absence of EE programming in other schools and colleges is not (Finkle *et al.*, 2006).

Table 2 University entrepreneurship education infrastructure and programmes

Variable type	*Frequency n = 36*	*Percentage (%)*
Undergraduate degree in EE offered	10	27.8
Graduate degree in EE offered	5	13.9
PhD in EE offered	3	8.3
Business school EE programmes/course	35	97.2
Engineering school EE programmes/course	19	52.8
Arts school EE programmes/course	6	16.7
Medical school programmes/course	2	5.6
Startup assistance within university	20	55.6
Entrepreneurship education endowment	17	47.2
Entrepreneurship research chairs	5	13.9
Entrepreneurship centre	20	55.6
Technology entrepreneurship courses	12	33.3

Only 8.3% of universities surveyed reported a PhD programme in entrepreneurship, while graduate degrees and undergraduate degrees were 13.9% and 27.8%. This signals a supply chain shortage of trained academics within the Canadian system. Combined with the growing demand and undersupply of entrepreneurship academics within the USA (Finkle *et al.*, 2006), this statistic offers some critical insight into the state of growth in the field. As well, the limited availability of graduate and undergraduate programmes speaks to the developmental stage that EE still exists within. Full-fledged programmes offered through undergraduate and graduate degrees that are multi-dimensional in scope, offer experiential learning, social capital building, and a multitude of other pedagogical techniques required of the unique field of EE are theoretically and empirically superior to courses or skills building classes (Hindle, 2001; Finkle *et al.*, 2006).

Analysis of the data finds that over half of the respondents (55.6%) were aware of an EE programme existing at the university. Typically, an EE programme will provide a teaching, research and an internal/external outreach component, and will be attached directly or indirectly to the university, or through a school or college (Menzies and Paradis, 2002). Although this basic framework provides an idea as to what an EE programme does, there is little homogeneity around how it gets done. Budgets, administration, mandates and actual programme delivery and curricula can be highly divergent or even unique from centre to centre, and ranking their efficacy can be difficult (Finkle *et al.*, 2006).

Consequently, the number of research chairs in entrepreneurship (13.9%) and endowments to EE programmes (47.2%) are often directly related to the operation and success of EE programmes within a university. Once again, the low number of research chairs represented when combined with world data that illustrates a high number of vacancies within university research chairs in entrepreneurship suggests an under capacity within the university system (Vesper and Gartner, 1997). These numbers can also be interpreted in the light of empirical evidence that points out that ranked entrepreneurship centres have three times as many endowed research chairs than non-ranked centres (Finkle *et al.*, 2006).

Findings on technology entrepreneurship courses uncovered 12 universities (33.3%) that focused directly on high tech startups. As the survey did not prompt for further investigation into the level, programme depth and history of these courses and programmes, the significance of this variable at face value is ambiguous. Nonetheless, due to this variable being a possible nexus point in the examination of linkages between EE programmes and USO creation, it is of considerable importance to this study (Blais, 1997).

Opinion based and attitude/belief questions were posed to entrepreneurship academics on a series of issues exploring the linkages between USO processes and EE programmes. These results are highlighted in Table 3. The first three questions were related to what is happening at the respondent's university, and how it is happening. Responses were limited to an attitudinal measurement scale of 'strongly agree, agree somewhat, disagree somewhat, and strongly disagree'. Questions that elicited an unusually high number of 'don't know' responses are highlighted for analysis.

The first two questions attempt to draw from respondents the nature of collaborative activities that are taking place between EE programmes and USO processes within the university from the perspective of the entrepreneurship side. Although 58.3% believed that there were direct administrative linkages between the two, there appears to be an overwhelming opinion that indirect and less formal processes are far greater contributors to USO success. This supports the theory that latent entrepreneurship arises in an environment that is rich in IP (opportunity) and that these networks exist as local group norms outside of formal administrative structures (Siegel and Phan, 2004).

Balancing the above with question 3, (whether students and or faculty have participated in USOs), once again, 58.3% were aware of or believed that this activity took place within their university. As the respondents who answered, 'don't know' were unusually high, further analysis is necessary to understand the fully complexity of the responses. It is possible that informal networks that exist as posited by the responses in question 2 (indirect linkages) highlight asymmetric information issues that are concomitant with these activities. There may also be disconnects between activities that are carried out within the purview of university commercialisation processes, indicating a

bureaucratically stove piped relationship. Lastly, the prevalence of USOs within some universities is highly rare. Administrative mandates within the university may be more in line with licensing technology than spinning it out (AUTM, 2005).

Table 3 Entrepreneurship academics survey results

Survey questions		*Percentage**	*Mean*
1	There are direct administrative linkages/programmes between entrepreneurship faculty/programmes and technology transfer officers/staff/programme that are focused on commercialisation activities (opportunity identification, selectivity, marketing, business plan, financing, startup launch, *etc*.) at this institution.	58.3	2.61
2	There are indirect linkages/personal networks/consulting (predicated upon social interaction without formal administrative structures) between entrepreneurship faculty and technology transfer officers/staff that are focused on commercialisation activities (opportunity identification, selectivity, marketing, business plan, financing, start up launch, etc) at this institution.	83.3	2.11
3	Entrepreneurship faculty/students participate/have participated in the commercialisation of university derived IP through the creation a startup company(s) at this institution.	58.3/*19.4***	2.69
4	There are significant advantages that can be derived from greater collaboration between Technology Transfer Offices and entrepreneurship programmes.	86.1	1.56
5	The involvement of top university administration has more influence over commercialisation success than entrepreneurship programmes.	36.1	3.0
6	Administrative barriers exist that serve to limit the collaboration between entrepreneurship programmes and the commercialisation of university research.	47.2	2.86
7	The potential of commercialisation outcomes could be improved if Entrepreneurship Centres and Technology Transfer Offices were merged into a single administrative unit responsible for research, teaching, outreach and university IP management.	30.6/*22.2***	3.28
8	Entrepreneurship programmes developed specifically for faculty scientists, engineers and graduate students would increase the commercialisation success of university derived research, *ceterus paribus*.	83.3	2.00
9	Entrepreneurship and IP commercialisation programmes are created or evolve independent of each other.	47.2	2.28
10	Entrepreneurship programmes and IP commercialisation programmes are created dependently, with one programme arising from the other.	5.6/*25.0***	3.53

Notes: * Cumulative of 'strongly agree' and 'agree somewhat'.

** 'Don't know' responses that are unusually high.

The remaining seven questions administered in the survey strove to capture the attitudes and perceptions of entrepreneurship academics with relation to EE programmes and USO creation. Fully 86.1% of respondents agreed, or strongly agreed with question 4: 'there are advantages to collaboration between the two processes'. Of interest, there were no 'strongly disagree' responses instigated by this question. Evidence from this paper thus corroborates a large body of literature that acknowledges the significance of EE programme to the USO process (Shane, 2004; Etzkowitz, 2004; Boni and Emerson, 2005; Siegel and Phan, 2004; Audretsch and Kielback, 2004).

University top administration is referred to in question 5 with only 36.1% of respondents indicating that they believed it was not as important as EE programmes in the proliferation of USOs. This result may be limited in its explanatory power as the question is written as to bias entrepreneurship academics. Siegel and Phan (2004) believe that the highest levels of university administration must direct the strategic processes that impact upon the spin out process, while Pries and Guild (2004) require a comprehensive framework around university commercialisation activities that reflect a variety of substantial approaches to technology transfer. In contrast, question 6 pertaining to administrative barriers preventing collaboration reveals that entrepreneurship academics believe or have experienced institutional bureaucracy in a more negative than positive light with respect to linkages between the two functions (47.2%).

A hypothetical paradigm shift is presented in question 7 that queries whether or not integration of USO processes with EE programmes would lend to a more constructive vehicle for spinning out university research. The positive responses to this question were very low (30.6%) and also resulted in a large 'don't know' category (22.2%). Several assumptions can be made about this outcome. First, although EE and technology transfer programmes have overlapping areas of concern, it is possible that the differences between them warrant maintenance of autonomy (Nelson and Byers, 2005). Secondly, the large 'don't know' response reflects the reality of the lack of current models that attempt to incorporate the two. As well, there may be a simple aversion from respondents in considering this question, as well as a lack of depth of knowledge, experience, salience and motivation to analyse the question thoroughly.

Development of student and faculty entrepreneurship programmes (question 8) received an overwhelmingly positive response from entrepreneurship academics (83.3%). As graduate students and faculty researchers involved in engineering and science are an empirically significant factor in the USO process, the idea of providing EE in order to propagate greater USO activity within these groups is understandably appealing and in line with other studies (Witt and Zellner, 2005). The debate as to whether or not entrepreneurship can be taught has long been put to rest, and that education can both motivate and contribute to greater success in starting a new venture is a fundamental theory within the field (McMullen and Long, 1987; Low, 2001; Vesper, 1990; Kuratko, 2005).

The last two questions are designed to detect deeper foundational connections between the emergence of EE and USOs within the modern university system. Both of these processes are relatively new, sharing a history of evolution that is closely paralleled in their growth and significance (AUTM, 2007; Kauffman Center, 2001). In question 9, respondents are asked whether or not they agree with the statement that EE and USO support programmes are created or evolve independently of each other. Question 10 posits the reverse: that these two processes were created or evolved dependent upon the other. Perhaps due to context effects in terms of question order, the second question drew

only a meager 5.6% positive response rate while the former evoked a halfway 47.2% for independent evolution. The large 'don't know' response in the latter question of 25% perhaps allows one to intimate some confusion in understanding the question. Undeniably, the results are highly negative to any dependency upon evolutionary pathways between EE and USO support structures.

Multivariate testing was used to help further analyse the data. Dummy variables were created from structural, resource and programme information provided by respondents and then compared again ordinal data resulting from expert opinions and attitudes of entrepreneurship academics. Variables that demonstrated significant correlations on either a 0.05 or 0.01 level are tabulated below. Only those variables that tested significantly are represented.

Of critical interest to this paper is to construct and test variables that may offer some insight into possible linkages between EE programmes and the USO process. Therefore, EE programmes that specifically focus on technology startups are highly important to this study and provide an obvious starting point for investigation. Pearson tests reveal weak correlations at the 0.05 level between those institutions that have technology entrepreneurship courses/programmes and three opinion/attitude responses:

1 indirect networks for EE and TT programmes

2 direct networks for EE and TT programmes

3 higher developed EE programmes levels.

Correlation between indirect networks and technology entrepreneurship programmes suggest that there is a heavy reliance on informal networks over direct administrative linkages, even within formal EE programmes focused specifically on high technology venture creation.

The variable 'entrepreneurship endowments' signifies the presence of external funding given to a university or school with the mandate of funding and developing EE programmes. As resources have been identified in previous studies as a key factor in developing and implementing successful EE programmes, schools with endowment money, *ceterus paribus*, should have a significant advantage in resources over those schools that do not (Finkle *et al.*, 2006). Strong correlations with direct and weaker significance for indirect EE and TT network variables confirm this fact. Endowments are strongly correlated with higher levels of EE programming (PhD and graduate programmes). Implications from this result may be that EE programmes that are well funded have the resources to catalyse formal collaborative structures with technology transfer components residing within a university. Ensley and Hmieleski (2005) has theorised that the university subscribes to aspects of institutional isomorphism, but that formal coercive pressures within an environment can play a role in guiding culture. Extending this theory, it is logical to assume that a strong enough core of EE programming may ultimately create reverse mimetic behaviours that are exported into other areas of the university. Greater amounts of resources available to manage collaboration between the two may thus leverage the creation of formal pathways between USO and EE programmes.

Table 4 Significant correlations between survey variables

Correlations	*Indirect EE/TT*	*Entrepreneurship programme endowments*	*Technology entrepreneurship courses programmes*	*Student–faculty participated in USO*	*Case studies of USO*	*Administrative barriers to collaboration*	*EE evolve independent of TTO*
Indirect EE/TT	X	.372*	.419*	–.395*	–.440*	.371*	.409
Direct EE/TT	X	.506**	.353*	X	X	X	X
Programme level	X	.363*	.413*	X	X	X	X

Notes: * Correlation is significant at the 0.05 level (two-tailed).
** Correlation is significant at the 0.01 level (two-tailed).
X correlation is insignificant.

The last variable to be examined is the 'Indirect EE and TT linkages exist' line within Table 4. The correlations with 'administrative barriers to collaboration' and 'EE programmes evolve independently' could thus be reconciled as 'barriers do exist', and that the two functions should be/are mostly independent. Reviewing the rest of the correlates supports this interpretation of the data. Negative results with 'USO case studies' and 'student faculty participation in USO's' suggest that these activities do not take place in environments heavily dependent upon indirect linkages. As referred to above previously, 'indirect linkages between TTO and EE' can be positively correlated with technology entrepreneurship courses and endowments as well. The resulting significant correlations with the variable 'indirect linkages between TT and EE programmes' are not a surprising outcome. Further attention to this variable and its empirical implications will be covered in depth in the next section.

6 Discussion

The variable *technology entrepreneurship programmes* correlating weakly with both *indirect linkages* and *direct linkages* suggests a considerable amount of discrepancy on the types of collaboration that exist or should be implemented between EE programmes and TTOs responsible for USOs. Conversely, survey results point to an overwhelming perception of *indirect collaboration.* These results can be interpreted in many ways and could suggests many things:

- that there are currently not many effective strategies in place that allow for constructive direct linkages between the two functions
- the majority of the impact derived from technology entrepreneurship programmes are indirectly facilitated outside of direct administrative linkages and are more individually driven
- that student and faculty participation may stem from the indirect application of new knowledge, skills and experience gained through these programmes, or in other words, the development of entrepreneurial capacity.

As hypothesis one is supported via both empirical components of the study, there may be merit in comparing the efficacies of technology entrepreneurship programmes with actual USO outcomes.

There is little support for Hypothesis 2, but the significance of direct linkages and resources such as endowments and research chairs (not shown in table) is significantly correlated. As well, endowments are correlated with higher levels of EE programmes such as those that deliver PhDs. These results confirm other studies that state resources are important in building top ranked programmes. What is most interesting is that indirect linkages were cited much higher than direct linkages for their significance to potential USO performance. This supports the argument that entrepreneurial capacity currently exists latently within the university system and operates outside of the normal organisational structures. While this may be a negative result, it does provide evidence to the significance of entrepreneurial capacity within the university system, and a corresponding propensity to commercialise.

There is low support for hypothesis three as only 33% of respondents felt that there were significant advantages to be derived from the integration of EE and TTO programmes under one roof, although there was a considerable amount of 'don't know' responses. As well, nowhere was this variable significant with others when tested against the other variables. Yet over 86% of respondents viewed collaboration between TTO and EE programmes as extremely important to the USO process. Once again, this may signal the effects of a larger contingent of activities that are indirectly attributed to network externalities and the overall growth of entrepreneurial capacity, routines and experience in the USO process. Those academics that responded strongly to indirect linkages also felt that there were administrative barriers to greater collaboration. It is also shown that correlation exists between indirect linkages and TTOs and EE programmes evolving independent of each other. These results support Nelson and Byers (2005) contribution that these two functions are overlapping, but still differentiated enough to require them to be maintained autonomously. Overall, indirect linkages garnered the second highest positive results in reporting.

6.1 Limitations

There are understandably several limitations to this study. As an examination of entrepreneurship academics attitudes and beliefs towards USOs, it does not offer much in way of tangible evidence on performance or outcomes. Although a high percentage of Canadian universities responded to the survey with full geographic coverage, the low N of the respondents involved must be considered into the results of the parametric testing and weaken the explanatory power of the data. The findings are also highly exploratory, confined to the salience and experience of respondents who may have limited knowledge with technology transfer and reflects the individual prior knowledge, direct experience and skills of the participants. Yet there is no background information on the respondents provided to demonstrate any experiential or educational capacity to answer the questions without error bias. As the study did not have the resources to provide full backgrounds, the nature of the work and positions they held must stand for their capacity to analyse and interpret the questions in a competent and salience based manner.

What this study does provide is an interesting perspective from the viewpoint of a group of stakeholders that are in many respects, generally involved in the overarching issues of entrepreneurial pathway building within modern universities. Thus the findings provided in this paper, although weakly supported, do pose interesting avenues for new research. That the findings align positively with control variables, as well as resonate highly with the findings of other studies that have surveyed EE programmes and USO processes, we believe that they do have value and are empirically justifiable. It must be noted that a sample of Canadian entrepreneurship academics and universities is comparatively small in relation to studies performed in other larger nations and that the reliance upon parametric methods for justification of this papers findings was coupled with stronger non-parametric findings.

6.2 Implications and future research

There are several implications that can be drawn from this research. The first is that the existence of technology entrepreneurship courses at university may explain some of the variance in USO performance between universities. These programmes need to be

reviewed in a more comprehensive manner in order to better understand and test the many factors that are relevant to this construct. Are the courses experiential? Do they offer mentorship, access to networks or financial resources? What are the structures of these programmes and what are the linkages between other dimensions (both internal and external to the university)? Perhaps most critically, what are the measurable outcomes from these programmes? Further studies that link a well documented accounting of breadth, depth and focus and support of EE programmes with USO creation may be beneficial to the research field. Also, determining whether EE programmes increase the propensity for students, staff and/or surrogate entrepreneurs to spin out patented research and whether or not they influence the survival rate, growth, and type of spin outs formed is a further are of research that requires attention.

Secondly, the conceptual and empirical findings of this research support the individual and team based existence of entrepreneurial capacity to be a significant factor in the university commercialisation process. Further investigation of indirect linkages between USO activities and EE programmes may prove fruitful in uncovering some of the informal entrepreneurial processes that exist within the university innovation system (Murray, 2004). Identification of entrepreneurial processes in as many variant forms and their outcomes as possible within a university context may provide a rich dataset from which to begin constructing patterns and building theory using a variety of variance and narrative based approaches to understanding process within the university context for enterprise and commercialisation facilitation (Gartner, 1985; Steyaert and Katz, 2004; Van de Ven and Engleman, 2004). As well, the lack of convincing support for direct collaboration between technology transfer and EE programmes may very well be a sign of an emerging or untested model that deviates from the norm. The advantages to be realised from these two university functional areas working together must be investigated, barriers identified, and empirical testing of their relationship and outcomes considered. With the huge injections of funds being poured into university research systems around the world, it is imperative that the link between new knowledge creation, entrepreneurial capacity and innovation be further explored and the ways in which task specific tools and the programmes, routines and collaborations for facilitating spin out formation be thoroughly examined. Entrepreneurship education programmes and centres for outreach and collaboration with business are a fairly new phenomenon. Commercialisation functions involving industry liaison or technology transfer units are the dominant regime of today, but the potential for change and the development of new pathways for using these programmes to collaborate with or lead commercialisation functions at university are not yet fully explored and offer many intriguing possibilities.

7 Conclusion

We argue that it is imperative to consider the linkages between EE and USO creation from many different perspectives. Entrepreneurial theory has a great deal to offer universities in transition seeking to become more innovative. As the USO becomes an increasingly important piece of the commercialisation process, those individuals with understanding and expertise in both applied research and entrepreneurial process will gain increasing value. Although the findings of this study offer a provocative direction for researchers to embark upon, more evidence must be collected that supports

the conceptual significance of entrepreneurship education as a mediating variable for entrepreneurial capacity building, and that through their expert and strategic operation, impact upon both the USO process; as well as the greater overarching challenge of creating entrepreneurial universities that are better positioned to handle the demands of the knowledge economy. The question then focuses less on the 'why' and more on the 'how' of creating collaborative models for commercialising all types of knowledge assets produced across the full spectrum of functional dimensions of the university, whether it is through a USO process or through other innovative processes that creates socioeconomic value through identifiable, effective and measurable pathways.

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Notes

1 The authors recognise that the prominence of university spin out formation as both a key revenue generator and stimulus for regional economic development is debatable. As this argument draws away from the main thrust of the research, the issue has been regarded as beyond the scope of this paper.

2 A concise understanding of the functional dimensions of the university is provided later in this paper.

3 See Kaufmann Foundation, http://www.kaufmann.org/.

4 Association of Universities and Colleges of Canada (AUCC), http://www.aucc.ca/.