The Technopreneurship Process: Academic Entrepreneur University Spin-offs

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Universities produce much of the new science and technology that is found and utilized in the products and services that we consume. Interestingly, however, individuals and organizations other than the initial researcher are primarily responsible for the transfer of university created knowledge to the marketplace. But this is not always optimal as, in certain cases, the researcher's skills and tacit knowledge are needed in order to commercialize the new knowledge. This paper, using Shane's entrepreneurial process model, seeks to determine what processes, procedures, and organizations are critical in terms of creating an environment conducive toward encouraging researchers to form new firms, university spin-offs, based on their research. As such, reviewed literature related to various specific aspects of university spin-offs are combined to provide an initial description of an environment supportive of the formation of researcher lead firms. By analyzing the commercialization process, ranging from the development of the opportunity (the new knowledge) to its exploitation, this paper was able to identify a number of actions that should increase researchers' intentions to start new firms. Among other things, incentives, as provided by government and the university, play a role in influencing researchers' decisions as does the availability of assistance in terms of running and financing the firm. All of this paper's identified components of the university spin-off process should be considered by researchers and universities alike as they attempt increasing university spin-off activity.

Introduction

The latter half of the 20th century has seen science and technology compliment land, labor, and capital as sources of wealth (Etzkowitz, 2003a). Correspondingly, knowledge and innovation have come to be recognized as factors of production (O'Shea, Allen, Morse, O'Gorman, & Roche, 2007). In this environment, then, the question becomes how best to harness and capitalize on knowledge and innovation. One theory, Triple Helix, describes interactions among the major stakeholders involved in knowledge creation and capitalization, universities, industry, and government, and how to optimize commercialization of knowledge (Etzkowitz, et al., 2008).

At its core, the Triple Helix is an innovative model that describes the translation of knowledge and technology into economic activity. The Triple Helix model suggests that the three spheres of academia, industry, and government should overlap and interact freely as equals in order to best utilize knowledge and technology (Etzkowitz & Leydesdorff, 2000). As such, universities are undergoing a second evolution (the first being the inclusion of research to their primary mission of teaching) whereby they now are seen to have three primary roles including teaching, conducting research, and working to assist in the economic and social development of a region via the capitalization of knowledge (Gibb, Haskins, & Robertson, 2010; Goldstein, 2010; Etzkowitz, 2003a; Etzkowitz & Zhou, 2007). American universities are quite prolific when it comes to producing science and knowledge, providing roughly 50% of all basic research in the country (Lach and Schankerman as cited in Hammermesh, Luerner, & Kiron, 2007). But, according to Rogers (as cited in Pries & Guild, 2011), university created knowledge rarely ever has an immediate market application. In fact, commercialization of university knowledge is primarily affected (close to 90% of the time) by the transfer of university generated intellectual property to existing firms (AUTM as cited in Goldfarb & Henrekson, 2003), with most of this transfer achieved through licensing (Siegel, Waldman, & Link, 2003).

Firm directed development of university technology, however, frequently requires the assistance of the initial researchers (Thursby & Thursby, 2002) because of tacit knowledge involved in the early-stages of development (Agrawal, 2001). Goldfarb and Henrekson (2003) suggest that, in some circumstances, academic entrepreneurship (the academic / researcher develops and brings the technology to market) is the best way to transfer new knowledge to industry. Vedin (as cited in Goldfarb & Henrekson, 2003) voices a similar sentiment, remarking that university research will probably not make it to market without the researcher's help.

The purpose of this paper, then, is to explore ways to increase academic entrepreneurship as reflected in the creation of university spin-offs (USOs). This paper will take a process perspective, ignoring individual researcher characteristics that play a role, and will, instead, focus on policies, procedures and organizations that encourage and enable formation of academic entrepreneur USOs (AEUSOs). Additionally, actions that academic entrepreneurs (AE) should or should not take will not be explored, as the paper describes, again, a framework built to positively influence USO activity.

The paper shall progress as follows. In the next section, the process model employed to examine USO efforts, Shane's entrepreneurial process model (Shane, 2003), will be introduced and explained. Following that, individual components of Shane's model as they pertain to AEUSO activity will be examined. The paper will then conclude with a discussion of the findings and how they can contribute to increased AEUSO activity.

Shane's Entrepreneurial Process

As stated by Dr. Jousma in his October 18, 2012, presentation in Osijek, Croatia, technopreneurship is described as the interaction between science and industry with the intended output of new economic activity. Technopreneurship, then, may be thought of as one of the linkages in the Triple Helix. This paper explores one specific type of technopreneurship, the AEUSO.

The Triple Helix model describes 'innovation in innovation' (Etzkowitz, 2003b), the essential infrastructure configuration that is required in order for a region to successfully commercialize knowledge. What it does not provide is a specific description of the actors as well as their interactions that chronicles the path of knowledge to commercialized product in the university setting. Shane (2003), however, provides a general description of the entrepreneurial process, and this process can be used as a guide to examine and understand the AEUSO technopreneurship process.

Shane describes entrepreneurship as occurring at the nexus of opportunity and the individual (Shane & Venkataraman, 2000 and Venkataraman, 1997). Within Shane's nexus, in addition to looking at the properties of opportunities and the environment, the actions of the entrepreneur in the form of acquiring and organizing resources, as well as strategies and approaches to exploiting the opportunity, are examined.

Shane's (2003) model of the step-wise progression that results in the formation of a new economic entity begins with opportunities, which, in the case of technopreneurship, consist of newly developed or applied science and technology (hereafter referred to as S&T). Individuals' attributes and environment conditions then combine and interact with opportunities, leading to the discovery and evaluation of opportunities, culminating in individuals' (AEs') exploitation actions and a new entity. Please see Figure 1. Note, again, that this paper is process related, and, thus, will not consider the Individual Attributes component of Shane's entrepreneurial process.

FIGURE 1
Shane's Entrepreneurial Process Model

Source: Shane, 2003, p. 11

Environment

When considering the general environment concerns that affect the AE, literature reveals two areas. First, an area's, region's or country's regulatory regime plays a part in terms of incentives that it creates as well as the degree of control it wishes to exert over the entrepreneurial process. Second, the entrepreneurial environment of the university in which the AE operates also shapes the AE's working environment, influencing the researcher's decisions and activities.

In order to encourage AEUSOs, governments can craft regulations that include incentives for university technology transfer. American policy-makers recognized this and passed the Bayh-Dole Act in 1980, awarding patents derived from federally funded research to universities and not the individual researchers (Goldstein, 2010). This change was critical in that universities are more likely to attempt to exploit S&T than individual researchers, partly as researchers' reward structures are based on publishing and not starting firms (Siegel et al., 2003). Without engaging in a debate over whether or not Bayh-Dole is the best piece of legislation possible in terms of promoting university technology transfer, the act did, undeniably, alter the then transfer landscape by streamlining and providing clarity to the process (Siegal et al., 2003).

The second regulatory issue relates to the level of control that a government wishes to impose over the process. Goldfarb and Henrekson (2003) compared approaches taken by governments in the United States and Sweden toward commercialization of academic research. In the US, the government has provided incentives for commercializing university knowledge, but it has not defined how it should be done. Stakeholders are left to determine the best way to bring new knowledge to market, allowing for a 'bottom-up' solution process. In contrast, the Swedish government has employed a 'top-down' approach that creates mechanisms to transfer university knowledge to the market. And, although no micro data exists to confirm the authors' impression, they feel that Swedish commercialization efforts trail America's. Furthermore, the authors note that another researcher, Gittleman, found similar results when examining France and the US.

Ownership and control of universities also provides for a critical difference in the Swedish and American commercialization processes. In contrast to Swedish universities that are all government owned, American universities are much more decentralized and thus face competitive strains related to acquiring desired quantity and quality of students, attracting the best and most sought after professors, and obtaining resources needed by professors to conduct research (Goldfarb & Henrekson, 2003). Specifically, note that American universities are under pressure to economically benefit from their knowledge as traditional funding sources are no longer as giving (Nelsen, 2001 and Todorovic, McNaughton, & Guild, 2011). This competition spurs individual American universities to find their own solutions, including ways to improve commercialization efforts.

When examining the culture of the university in which a researcher resides, literature reveals that it can play a large role in shaping the researcher's actions. Certain universities are recognized for being more proficient than others in exploiting the technology they develop. Such schools have been termed entrepreneurial universities and have three missions: teaching, conducting research, and contributing to area / regional economic development.

Correspondingly, an entrepreneurial university structures and conducts itself so that it seeks fundamental advances as well as S&T that can be patented and brought to market (Etzkowitz, Webster, Gebhardt, & Tarra, 2000).

A number of articles concerning the entrepreneurial university have specified it's identifying characteristics (Etzkowitz & Zhou, 2007; O'Shea, et al., 2007; Todorovic et al., 2011; Goldstein, 2010; Etzkowitz, et al., 2000; Etzkowitz, 2003a; Etzkowitz, 2003b; Martinelli, Martin, & von Tunzelmann, 2008; and Gibb et al., 2010). A review of the related material produces five characteristics that can be used to determine whether or not a university may be considered to be an entrepreneurial university: Research Selection, Interface Mechanisms, Supporting Policies, Entrepreneurial Spirit, and Primary Player. See Table 1 for a list of aspects of each characteristic (Walker, 2011).

Table 1: Entrepreneurial University Characteristics

Entrepreneurial University Characteristic	Aspects of Characteristic
Research Selection	Selection of fields of study with commercializable potential Solicitation of external parties' inputs in determining research
Interface Mechanisms	Active attempts to identify commercializable knowledge Sophisticated structure and staffing of tech transfer bodies Clear and complete tech transfer policies
Supporting Policies	Formal policies that support knowledge commercialization Inclusion of applying knowledge in university mission statement Faculty are encouraged to commercialize research
Entrepreneurial Spirit	Innovative culture that supports knowledge commercialization Faculty that actively works with industry Networked to external bodies that facilitates knowledge exchange, allowing the university to be a seedbed for new endeavors
Primary Player	University plays a primary (not support) role on par with industry and government University has complete control over its strategic direction University has a diversified funding base University acts as an innovation organizer

Note that particular characteristics of the entrepreneurial university will be discussed later in the paper.

Opportunity Creation at Universities

In order for opportunities to be exploited, they must first exist. Without opportunities, the AEUSO process cannot begin. As a first step, then, universities, via their creation of S&T, create opportunities. These are opportunities of the technological variety, one of the three main sources of opportunities as according to Shane's (2003) typology for Schumpetarian-type opportunities.

Research and its spawned knowledge alone, however, do not necessarily create opportunities. The knowledge must be revealed to the marketplace, to the world, so that it can be discovered. In the USA, the Bayh–Dole Act addresses this issue by requiring researchers to file invention disclosures with the technology transfer office (TTO). But, in fact, the Bayh-Dole disclosure rule is not explicitly followed. Thursby and Kemp (2002) noted that TTOs receive notification for less than half the knowledge produced by researches. As such, TTO personnel have to actively seek out researchers, spending time of locating potential opportunities (Siegel et al., 2003). In the UK, policies do not require university knowledge to be reported to any particular body, resulting in appreciable amounts of university intellectual property effectively hidden (Lockett & Wright, 2005). If knowledge is not made available to others, it cannot be discovered as potentially commercializable.

Within unversities, then, an initial step in the AEUSO process involves the TTO obtaining notification of new knowledge. This is of primary importance in that researchers typically are not best equipped to identify opportunities associated with or arising from the S&T (Lockett, Wright, & Franklin, 2003). Others might see commercializable opportunities where the researchers do not.

Timeliness and relevance of knowledge created at the university potentially influences the amount of commercially viable S&T produced. If a university's researchers are exploring areas of advancement in the marketplace, the knowledge they generate might be more readily market-applicable than basic research (Goldfarb & Henrekson, 2003). This concept is reflected in one of the characteristics of entrepreneurial university; namely, Research Selection (Table 1). Interestingly, however, one study that evaluated the possible impact of industry sponsored research (conceivably market-related research) on the formation of USO found that it was not significant (De Gregorio & Shane, 2003).

The quality of researchers has been suggested to influence the number of USOs originating at a university. One study, using 'intellectually eminent universities' to operationalize the quality of researchers, suggests that higher quality researchers at a university leads to a greater number of USO being formed (Di Gregorio & Shane, 2003). Supportive of this finding, the Massachusetts Institute of Technology (MIT) has been labeled as the first entrepreneurial university (Etzkowitz & Zhou, 2007), and is said to be based on four attributes, two of which (the science and engineering base of the university and the quality of research conducted) speak to

the importance of the quality of researchers (O'Shea, et al., 2007). Additionally, quantity of research, as measured in terms R&D spending, has also been suggested to influence firm formation at universities as those universities with higher spending have been found to have more USO in university science parks (Link & Scott, 2005).

Opportunity Discovery in Universities

Upon reciving notification of a researcher's S&T, the TTO, fulfilling part of the Interface Mechanism role of an entrepreneurial university, both evaluates the knowledge for its commercial potential and determines if it is worth patenting (Siegel et al., 2003). And this, ultimately, for practical purposes, is when the opportunity is born. Note that as a result of Bayh-Dole, patents held by universities in the United States grew from close to 500 in 1982 to over 3000 in 1998 (Looy, Callaert, Debackere, & Verbeek, 2003), making universities a relatively opportunity-rich environment for technopreneurship. Following the US' lead, other countries such as the UK, Germany, and Belgium now assign intellectual property rights to academic institutions and not the researcher. Conversely, if the knowledge is placed in the public domain via publication, presentation, or otherwise, then AEs and other potential entrepreneurs are not likely to invest time and resources in attempting to exploit the knowledge as they do not have legally protected exclusive use of it, allowing them to earn rents. Additionally contributing to technopreneurship, universities, as owners of researchers' S&T, are, by law, obligated to attempt to commercialize their intellectual property. This requirement, in turn, led to many universities opening TTOs (Webster & Etzkowitz, 2000).

The role of the TTO in recognizing opportunities is suggested to be critical, according to a study conducted by Lockett et al. (2003). This study found that TTO in universities that were more successful in producing USO were more important in the identification of opportunities than the less successful universities. Moreover, this same study suggests that groups directly tied to the university, the TTO and researcher, are more important than non-university groups, individuals and private organizations, at recognizing opportunities. It should be noted, however, that, even though university related groups are skilled at spotting opportunities, university groups are not proficient at pursuing the opportunity, lacking in business skills that would allow them to maximize returns (Vohora, Wright, & Lockett, 2004).

According to Shane (2003), it is important to have a number of parties, such as TTOs, consider an opportunity as different people see opportunities uniquely, with possession of prior knowledge being one of the reasons why. Specifically, according to Shane (2003), prior knowledge regarding markets and how to serve them give one a better chance of recognizing an opportunity. Kirzner (as cited in Alvarez & Barney, 2007) expresses a similar idea, noting that certain individuals have a particular alertness, perhaps derived from explicit knowledge of an industry or market, and are better equipped to identify opportunities. Souitaris, Zerbinati, & Al-Laham, (2007) voice a similar notion, stating that prior knowledge allows for the identification of a greater number of ideas. Regarding TTO, Siegel et al. (2003) suggest that they can act as "boundary spanner", acting as a bridge that connects customers and their concerns with suppliers (the AEUSO) and their issues. Shepherd and DeTienne's (2005) work produced outcomes supportive of this, noting that having prior understanding of customer issues results in more opportunities being identified.

In addition to the efforts of TTOs, universities engage is a number of activities that assist in the discovery of S&T opportunities that have been developed within the university, including both externally and inwardly focused efforts.

Attempting to encourage the commercialization of their S&T, universities offer entrepreneurship courses. MIT, for example, provides it engineering students with theoretical and practical entrepreneurship courses as taught by faculty role models and local alumni (O'Shea et al., 2007). Stanford and U.C. Berkeley graduate programs take a similar approach, offering entrepreneurship courses that enroll students from a number of fields, creating an environment conducive to the sharing of ideas and creation of new solutions and firms (Antonucci, 2011 and Snyder, 2011). In general, entrepreneurship programs have been shown to increase entrepreneurial intentions in science and engineering students (Fayolle, Gailly, Lassas-Clerc, 2006 and Souitaris et al., 2007).

Expanding on entrepreneurship courses' efforts to raise awareness and provide guidance regarding technopreneurship, universities, displaying Entrepreneurial Spirit associated with entrepreneurial universities, create or join centers dedicated to entrepreneurship. These centers, interdisciplinary in nature, serve to broaden universities' boundaries, increasing the likelihood of an opportunity being discovered (Martinelli et al., 2007). Combining partners from industry, academia, and government, centers act to stimulate technopreneurship (Etzkowtiz, 2003b). Moreover, centers devoted to specific fields are able to bring together previously independent researchers, allowing them to leverage their combined knowledge by becoming a storage location for specialized knowledge, which, in turn, potentially spawns ideas for new firms (Etzkowitz, 2003a).

The technopreneurship interface between industry and universities, reflective of the Research Selection characteristic of entrepreneurial universities, and the possibility of uncovering S&T opportunities is on full display when industry directly supports research. These privately-funded research arrangements are quite common in the biological sciences, but they also occur in software and engineering, as evidenced by

actions of such companies as Intel, Microsoft, IBM and Hewlett-Packard (Mims, 2011). Intel, for example, created four labs (called 'lablets') adjacent to universities that were run by a researcher from the university, allowing Intel to stay abreast of new and potentially disruptive technologies (Buderi, 2001). Intel, however, has closed its 'lablets', but continues to pursue research collaborations with universities in a more targeted format, now directing research on specific areas with existing commercial potential, establishing centers at universities and drawing on teams of researchers from a variety of universities (Lohr, 2011). Intel's move from basic research that might have commercial applications to directed research with commercial potential mirrors the pharmaceutical industry's transition, as stated by Dr. Jousma in his October 18, 2012, presentation in Osijek, Croatia, away from paying for research to paying for specific results. Furthermore, it could be that Intel's and the pharmaceutical industry's moves support Di Gregorio and Shane's (2003) finding that industry funding research does not significantly generate higher rates of USOs. If Intel and the pharmaceutical industry are not obtaining the expected commercializable knowledge from their general funding of university research, as found in Di Gregorio and Shane's study, they would conceivably alter their funding approach.

The Opportunity Exploitation Decision in Universities

The decision to start a new firm is difficult in that typically a researcher has limited general business and industry specific knowledge, as well as few business related contacts to draw upon for assistance (Vohora et al., 2004). In the business world, the researcher is, in effect, a fish out of water. When a faculty member contemplates the prospect of leaving paid employment to start a new firm, universities can play a role in the decision process in a number of ways. In the broadest sense, universities can reduce to a certain extent some of the uncertainty surrounding the process as well as by providing material, including financial, and moral support.

It should first be noted that forming a company, in some cases, might be the only route by which the researcher's new S&T will be brought to market, as no market yet exists for it, and, as such, no one is interested in licensing it (Wright, Vohora, & Lockett, 2004). And if the patent is weak or ineffective, the technology might not be attractive to those considering start-ups (van Burg, Romme, Gilsing, & Reymen, 2008 and Shane, 2001). Furthermore, should tacit knowledge be required to advance the technology, potential licensing firms might be discouraged from pursing the technology. In such situations, given the lack of industry interest, the researcher is compelled to start a firm if the researcher wishes to introduce the S&T to the marketplace or achieve economic gains (Vohora et al., 2004).

Working against the decision to start a firm, the traditional university structure rewards publishing as opposed to forming a company, with citation measures leading to greater prestige and wealth. Time allocated to entrepreneurial pursuits is time not spent publishing, reducing a researcher's advancement in the traditional university (Siegel et al., 2003). A publish or perish mentality guides researchers' actions (Vohora et al., 2004). Supportive of this view of university researchers' motivations, Audretsch (as cited in Agrawal, 2001) suggests that these researchers will engage in entrepreneurship later in life than non-research entrepreneurs as they commit their early years to building reputations via publishing.

University culture toward commercialization of knowledge activity can also weigh on a researcher's mind when deciding whether or not to start a firm. At some universities, critics suggest that financial interests might influence the direction of professors' research, removing professors' objectivity from the research process (Krimsky as cited in Etzkowitz, 2003a). Other criticisms leveled at entrepreneurial academics are that their technology transfer activities might actually hinder the spread of knowledge (Litan et al., 2007 from Goldstein, 2010), and that the pursuit of commercialization activities might lessen efforts and commitment directed at basic research (Nelson as cited in Goldstein, 2010). Seeking to avoid such criticisms, a researcher might shy away from starting a firm.

Aforementioned entrepreneurial universities and their Entrepreneurial Spirit and Supporting Policies, on the other hand, encourage firm formation. Traditional universities, non-entrepreneurial universities, if they wish to encourage their professors to act entrepreneurially, need to change their culture (Todorovic, et al., 2007). According to Clark (as cited in Martinelli et al., 2007), entrepreneurial universities that have a comprehensive entrepreneurial culture offer moral support to professors considering starting firms. As such, if universities hope to increase firm formation activities of its researchers, then they need to create a culture that is supportive of it (van Burg et al., 2008). Universities can have appreciable influence regarding faculty activities (Todorovic et al., 2011). In fact, an analysis of MIT's proficiency as an entrepreneurial university identifies it history and tradition (culture) as a contributing factor (O'Shea et al., 2007).

Ownership of intellectual property rights also plays a role in determining whether or not the researcher will start a firm. A study of Sweden's USOs suggests that Swedish researcher ownership of property rights (as opposed to university ownership as in America) discourages AEUSO activity to the extent that the university has no real incentive to help facilitate the effort. And, more specifically, at the micro level, it is the researcher's department that does not receive any compensation for aiding the

researcher's firm formation effort, and, thus, does not provide assistance. As such, Swedish researchers are not encouraged to start firms, and, in some instances, are penalized for doing so, lowering Swedish AEUSO rates vis-à-vis American rates (Goldfarb & Henrekson, 2003).

Universities can positively influence the decision of a researcher to start a firm by providing material assistance to do so. For instance, by providing researchers with extensive leave policies as well as regular consulting privileges (such as MIT's one fifth rule), universities give researchers time to explore and consider firm formation. Additionally, if faculty members are encouraged to sit of Scientific Advisory Boards of firms, and, through this activity, learn about the relationship of business and science, they might become more accepting to the notion of starting a firm (Etzkowitz and Zhou, 2007). As a further incentive to commercialize knowledge, universities could partly evaluate faculty on their efforts to capitalize knowledge (Goldstein, 2010).

Policies connected to intellectual property, part of Supporting Policies found in entrepreneurial universities, also influence researchers' go no-go firm formation decision. By accepting an equity stake in lieu of royalty payments associated with licensed technology, universities lower the cash requirement component (associated with starting and running the firm) of the decision process. In fact, one study has found that those universities that do not demand cash payments for licensing royalties and accept equity have a start-up rate almost double of universities that do not (De Gregorio & Shane, 2003). Additionally, the same study found that when universities provide researchers with a high share of the royalties, researchers are less likely (all things being equal) to start a firm than if the royalty share was less (Di Gregorio & Shane, 2003). Further exploring the influence of intellectual property on new firm formation, another study found that university spending on protecting intellectual property positively impacts start-up activity (Lockett & Wright, 2005).

A number of policies and procedures undertaken at universities can positively impact researchers' commercialization decisions, as they help alleviate researchers' concerns related to their lack of prior experience and confidence in business matters (Vohora et al., 2004). Well established processes pertaining to intellectual property rights, for example, are associated with success in terms of creating USOs (Lockett & Wright, 2005), and, thus, help instill confidence in the EA regarding intellectual property support they will receive from the university. The existence of detailed routines associated with USOs, including their formation, which contribute to a university's success in generating USOs (Lockett & Wright, 2005), serve to lessen uncertainty associated with firm formation, potentially positively influencing a researcher's decision. Helping to overcome AE's concerns related to business matters, one study suggests that universities with more extensive business-oriented networks are better at creating USOs than those without (Lockett et al., 2003). In terms of raising capital, another study suggests that if a researcher has indirect ties (via the university's networks, TTO, or other means) with venture investors before forming the firm, then the researcher's start-up will have a better chance of surviving and receiving external funding (Shane & Stuart, 2002). Knowing that the university does have ties to venture investors and other business-oriented networks, the researcher might be more inclined to start a firm. In sum, universities can supply researchers both tangible and intangible support as they consider starting new firms.

Opportunity Execution at Universities

Research has revealed that when pursuing ventures, AE are prone to place too much emphasis on the technology and not enough on customers and running the business (Baron & Ensley, 2006 and Vohora et al, 2004). This results, perhaps, from AE's relative paucity of business knowledge and expertise as well as limited associated network connections (Vohora et al., 2004). In such situations, universities can assist AE in two ways. First, universities can connect AE with surrogate entrepreneurs, non-university business-minded entrepreneurs, to assist and even run the new firm. Anecdotal evidence speaks to the benefits new technology-based firms receive from surrogate entrepreneurs (Bowen, Morse, & Cannon, 2006 and Roberts & Cyr, 2003). Second, universities, commonly via the TTO office, can supply knowledge and introductions to networks (Lockett et al., 2003), alleviating the need for the AE to develop such knowledge (Goldfarb & Henrekson, 2003). Universities in the UK go one step further, promoting education initiatives for faculty and students as related to USOs (Lockett & Wright, 2005). Moreover, universities can provide additional assistance by supplying resources and expertise in defending intellectual property (Goldfarb & Henrekson, 2003).

Funds are a much analyzed and discussed resource of start-up firms. Specifically relating to AEUSO, Vohora et al. (2004) suggest three reasons as to why they have difficulty obtaining funding: limited resources, weak networks, and subpar entrepreneurial skills. To the extent that the university can alleviate these concerns, the AE stands a better chance of obtains funds. For instance, Shane and Cable (as cited in Shane, 2001) suggest that the university can play a role in establishing connections between AEs and venture capitalists. As previously mentioned, universities can assist in funding by accepting equity in lieu of royalty payments, helping to take strain of the new firm's liquidity concerns (Goldfarb & Henrekson, 2003). But universities should not rush to act as venture capitalists, taking large equity stakes, as this potentially creates ownership conflicts with interested surrogate entrepreneurs, discouraging them from becoming involved in the venture (Franklin, Wright, & Lockett, 2001). This effect was somewhat supported by a study that found that university's with venture capital funds do not have significantly more start-up activity (De Gregorio & Shane, 2003).

Research or science parks and incubators, as provided by universities, assist AEUSOs in their start-up phases as they provide equipment and networking opportunities (Link & Scott, 2005). Interestingly, however, one study suggests that incubators do not actually spur or increase AEUSO activity. The same study notes that it did not determine if incubators have any influence on the success or failure of the USO (Di Gregorio & Shane, 2003). An examination of one incubator network, however, found that incubators provide valuable benefits in terms of forming relationships with investors, potential clients and others in addition to creating a reputation for the AEUSO (van Burg et al., 2008). Supportive of the reputation building theme, Vohora et al. (2004) suggest that incubators provide AEUSO with the opportunity to build a corporate image. In other words, by leaving university grounds and locating in a park or incubator, the young firm transitions (in the eyes of customers) from an academic project to a business.

Conclusion

Universities produce vast quantities of knowledge, but, to date, do not, to a large extent, bring that knowledge to market, letting non-university entities do so. While this approach has been successful, there are situations involving disruptive or weakly patented knowledge whereby having the researcher lead the commercialization effort would be more ideal (Goldfarb & Henrekson, 2003). This paper explored the AEUSO process, identifying critical components from a variety of studies conducted in a number of countries, suggesting certain non-cultural specific actions that can be taken in order to increase AEUSO activity.

From an environment perspective, two factors were identified as supportive of AEUSO activity. First, the environment external to the university, primarily the regulatory environment, must have incentives in place to encourage new firm formation at universities and, at the same time, provide universities with flexibility to discover and design the optimal solutions to do so. Second, the internal environment at the university, the culture, attitude and norms related to commercialization of knowledge, must be supportive of the aspiring AE.

The AEUSO process cannot commence without opportunities. One implication from this is that universities have the requisite accomplished researchers to produce commercializable S&T. And, having creating knowledge, universities must do what they can to maximize the exposure of this S&T that serves as the foundation of new firms. Universities are more committed and aggressive in exposing their S&T if they, as opposed to the researcher, own it.

Creation of S&T alone does not mean that it will be discovered. It is important that the knowledge is protected, typically through patenting, encouraging AEs to pursue the opportunity as they can capture entrepreneurial profits. The TTO, in this situation, performs two important roles. In the first case, they act as opportunity spotters, providing perspective and insight to opportunity identification that researchers' commonly lack. Secondly, the TTO should be effective and efficient at protecting the S&T, patenting it.

The university should also take a number of other steps to facilitate opportunity recognition, including providing classes and education to students and faculty alike pertaining to entrepreneurship, creating centers or other like-minded organizations that allow for the multidisciplinary examination of S&T, and building ties with industry.

One of the primary determents regarding researchers forming firms is their incentive structure (as set by the university) and the university culture. Without career enhancing and / or financial incentives in place that are supported by a university that respects and encourages commercialization activity, researchers are less likely to start firms. Additionally, researchers often lack business knowledge and do not possess skills to build and run a firm. Recognizing this, universities can offer many of these services, reducing uncertainty for the AE in terms of what must be done and also in terms of performing activities. Accepting equity instead of cash royalty payments, universities can further make the firm formation option for researchers more appealing by reducing their cash requirements.

Once the researcher has formed a form, the university may provide assistance in a number ways. Providing introductions to a variety or business people, including surrogate entrepreneurs and investors, the university assists the AEUSO as it attempts to grow. Important to the new ventures transition to a viable business is potential customers' perception of it as a viable business and not just another university research project. University affiliated incubators or research and science parks have the potential to provide AEUSO with such an image.

Should the environment and university conditions exist as just described, it is more likely, employing intention models (Krueger, Reilly, & Carsrud, 2000), that researchers will start firms. These models posit that an individual's attitude toward an activity, social norms connected to it, and self-efficacy regarding the activity influence one's intentions towards engaging in the activity (Ajzen, 1991). Given incentives and support for starting and running a firm, the researcher develops a sense that starting a firm will result in positive outcomes. At the very least, the researcher will not be discouraged or penalized for doing so. Working within a community of peers that are supportive and respectful of his or her activities, the researcher will be motivated to start a firm. Finally, gaining exposure and practical

experience in entrepreneurship via consulting, acting as an advisor to existing firms, and receiving training, researchers will feel that they are able and capable of starting a firm.

University researchers produce large quantities of S&T, and their continued inputs are often needed if it is to be commercialized. By examining Shane's entrepreneurial process model as associated to AEUSO activity, this paper was able to identify a number of actions that should increase researchers' intentions to start new firms, ultimately leading to more new firms be started (Bagozzi, Baumgartner, & Yi, 1989).

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