CHAPTER 7
Universities and the Entrepreneurship Ecosystem

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Introduction

Over the last decade, scholars and policymakers have often referred to the environment surrounding entrepreneurial activity as the entrepreneurship ecosystem (EE) (Isenberg, 2011, 2014; Hechavaria and Ingram, 2014). The basic logic is that if the ecosystem—or the interactive and interrelated environment surrounding nascent and active entrepreneurs—is healthy, then the outputs and outcomes desired from entrepreneurs, including start-ups, will potentially result in improved economic and non-economic performance for the societies in which they exist.

This chapter will focus on the university within the entrepreneurship ecosystem and aims to draw implications from the literature for, and inform, policymakers, university leaders, and academics. Besides serving as a literature review, the chapter is meant to be a solid introduction to the entrepreneurial ecosystem from the perspective of the university and its connection to the broader community.

Universities make multiple contributions to the larger entrepreneurship ecosystem, including creating a stock of knowledge and then providing knowledge and resources to the public space. Knowledge creation and dissemination via multiple strategies is a primary contribution to the overall entrepreneurship ecosystem. Universities create, accumulate, and disseminate this knowledge via knowledge spillover (Audretsch, 2007), meaning that knowledge spills from the university stockpile into the public space and may be acquirable by entrepreneurs for less than the total cost it took to create the knowledge in the first place. This takes place through strategies such as technology transfer and developing entrepreneurial capital through methods such as entrepreneurship education.

A critical factor to consider for university leadership, policymakers, and academics relates to knowledge filters that impede this creation, development, and dissemination of knowledge (Audretsch, 2007). Knowledge filters are obstacles that block or reduce the flow of knowledge from the university into the public space. These "stand between investment in knowledge, science, and ideas on the one hand and commercialization, which ultimately leads to economic growth, on the other" (Audretsch, 2007: 107).

Specifically, my purpose is fourfold. First is to provide an overview of the EE and to describe the university's place and importance within it. Second is to dive deeper and discuss the university itself including the way it influences the EE, its roles, and the strategies/tactics employed by universities to contribute to the EE from isolated activities to building intentional University-Based Entrepreneurship Ecosystems (UBEE; Fetters et al., 2010). Third, while measurement approaches and performance data are still underdeveloped within the literature, an overview of metrics and performance will be offered. Fourth is to draw out the implications for practice and research.

To achieve these purposes, I will first provide a background description of the EE perspective, linking it to its root literature and offering an inventory of its major components. From there, I will focus specifically on the university as a key participant, including its importance, and offer a fresh model that can be used to describe and understand its components, influences, roles, strategies, and tactics, that directly and indirectly impact the university EE processes, outputs, and outcomes, both on and off campus. Next, I will review metrics and performance data of EEs generally, highlighting the findings of multiple major review articles specifically related to the university. Finally, I will draw out and discuss practical implications for university leaders, and policymakers, as well as research implications for academics.

Entrepreneurship ecosystems

The EE perspective developed from several earlier literature streams including the strategy and regional development literatures (Acs et al., 2017). Multiple attempts have been made to define the EE. Stam (2015) defines an EE as a "set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship" (p. 1765). Acs et al. (2017) recently cited Stam and Spigel (2015) with a similar definition, quoting the authors work in a yet unpublished source which contains the addition of "within a particular territory" (p. 3).

Mason and Brown (2014) define the entrepreneurship ecosystem as a "set of interconnected entrepreneurial actors, entrepreneurial organizations, institutions and entrepreneurial processes which formally and informally coalesce to connect, mediate and govern the performance within the local entrepreneurial environment" (p. 5).

There are key parallels between these definitions that highlight multiple aspects of the EE that are important. Four recurring elements include: actors, resources, formal and informal interactions, and performance outputs and outcomes.

Building on Isenberg (2011) and Brown and Mason (2017), figure 1 depicts the participants in the EE and the resources and interactions that connect stakeholders who in turn, formally and informally interact with entrepreneurs and each other through various processes, including the acquisition and application of resources. The interactions between entrepreneurs and other stakeholders ultimately produce outputs, presumably including new business enterprises.

Figure 1 shows the main actor participants in the EE, the entrepreneurs themselves, as well as representatives from various organizations such as universities, government, and the private sector (financial, corporate, etc.). The interaction of these sets of participants constitutes the "Triple Helix" first introduced by Etzkowitz and Leydesdorff (1995). It is important to note that while entrepreneurs exist independently of the three organizational stakeholders, they also exist within the organizations (intrapraneurs—meaning people who act entrepreneurially on the inside of existing organizations).

Resources include the obvious such as financial capital, property, plant and equipment, infrastructure, technology, and human capital. Resources also include intangible knowledge, particularly "how-to processes" for entrepreneurship such as lean start-up and business modelling.

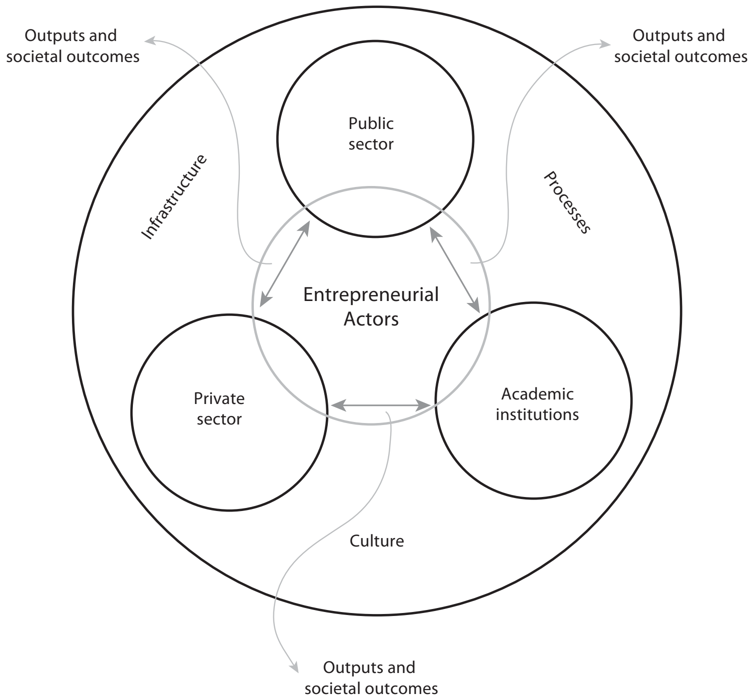
Interactions among EE stakeholders may be formal or informal. Formal interactions include buyer-supplier relationships, shared board membership, co-working arrangements,[1] consulting, and strategic alliances ranging from licensing agreements to joint ventures. Informal interactions include networking events, chance meetups at conferences, community and training events, trade shows, and gatherings after work.

EE participants, resources, and interactions result in some amount of outputs and outcomes. Outputs are akin to counting what is created, such as the number of start-ups, people trained, agreements signed, inventions created, patents received, and so forth. Outcomes are akin to the impact of the created outputs, such as employment, wealth creation, and the broader inclusion of members of society in opportunities offered in the EE.

As figure 1 illustrates, academic institutions are important stakeholders of the EE. The remainder of this chapter focuses on the university as a stakeholder in the larger EE, while acknowledging that the university exists within a broader domain of academic institutions. The focus on the

1 Co-working arrangements can vary from sharing the expenses of an office space to those of a laboratory or production facility.

Figure 1: Entrepreneurship Ecosystem Incorporating the Key Stakeholder Groups of the Triple Helix

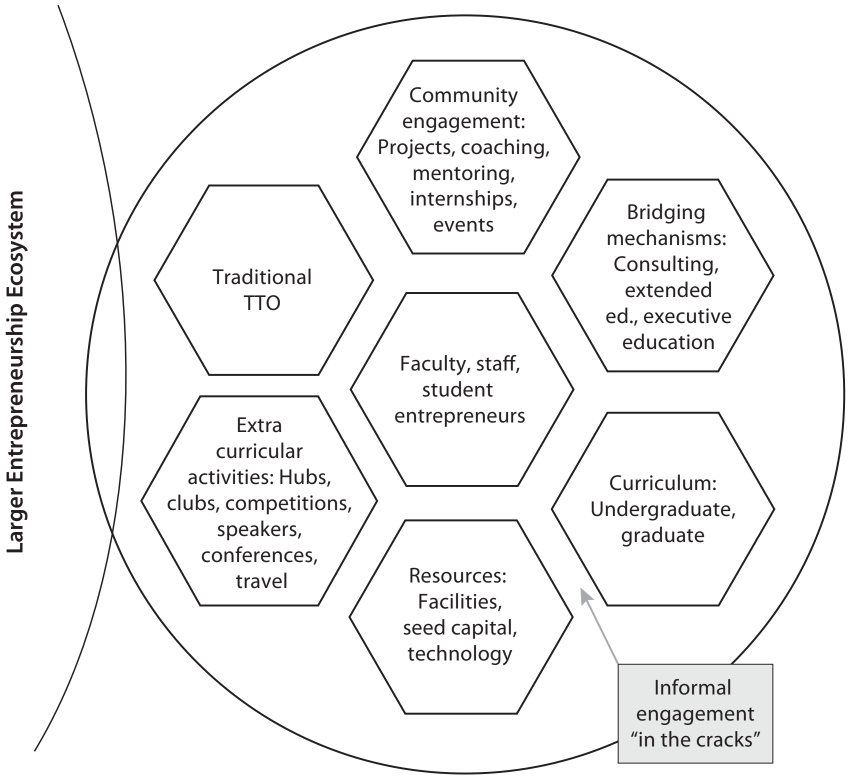


Source: This original figure is built on the work of multiple authors including Isenberg (2011), Brown and Mason (2017), and Etzkowitz and Leydesdorff (1995, 1997).

university reflects an assessment that it is the most prominent institution under the academic domain, insofar as the EE is concerned.

Finally, entrepreneurship ecosystems can range from less to more developed. Brown and Mason (2017) developed a taxonomy that they describe in a dichotomous fashion from embryonic to scaled-up.

Figure 2: The components of the University-Based Entrepreneurship Ecosystem: Curriculum, Extra-Curricular, Traditional TTO, Bridging Mechanisms, Resources and Community Engagement, Informal Engagement



Source: This original figure is based on multiple sources describing the UBEE including Fetter et al. (2010), Miller and Acs (2017), Morris et al. (2013), and Hechavarria and Ingram (2014).

Universities in the entrepreneurship ecosystem

Scholars and practitioners discussing EEs consistently recognize the potential and demonstrated importance that higher education generally, and universities specifically, play in building and maintaining a growing and thriving EE (Hechavarria and Ingram, 2014).

Fetter et al. (2010) coined the term University-Based Entrepreneurship Ecosystem, or UBEE. Like the larger EE, UBEEs can range from less to more developed. On the embryonic end, you might see limited offerings (such as single courses and/or a student club), while on the scaled-up end, you might see a full range of formal and informal components at play (such

Table 1: Components and Sub-Components of the UBEE

UBEE Component	Description
Curriculum	**For-credit courses for undergraduate and graduate students.**
Extra-curricular activities	Hubs such as incubators, "makers spaces", accelerators; student clubs; competitions such as pitches, business plan, innovation/design sprints; speakers such as experienced entrepreneurs; conferences; travel experiences such as study abroad.
Traditional TTO	Technology transfer offices that support academics in commercialization through licensing, patenting etc.
Bridging Mechanisms	Extended education/lifelong learning; faculty/staff consulting; executive education programs; research/service centers such as economics, global information systems mapping.
Resources	Facilities; technology; equipment; seed capital; public relations and marketing.
Community Engagement	Coaching and mentoring programs; student consulting via classes; service learning; internships; career services.
Informal Engagement	The connections and interactions happening all the time "in the cracks" between formal and informal components.

as active Technology Transfer Offices, widespread faculty consulting, majors/minors, workshop series, social gatherings, makers' spaces, and incubators/accelerators).

Figure 2 illustrates the potentially significant components of the UBEE. In this case, entrepreneurs are centered on a field of university-related resources surrounded by supporting or contributing stakeholders that ultimately results in outputs and outcomes. The entrepreneurs may include faculty, staff, and students located within a campus with connections bridging to the broader community.

Later in this chapter, more detailed descriptions of the various components and sub-components of the UBEE will be given along with strategies that universities use to contribute to the UBEE as in figure 2; these components are summarized in table 1.

Knowledge spillover and filters: The university as a (sort of) leaky bucket

Universities have the potential to significantly influence the EE in multiple ways, many of which deal with disseminating the knowledge that is generated and stockpiled within the university out to the ecosystem where it can ultimately have an impact. Scholars have often referred to this phenomenon as *knowledge spillover*.

"Knowledge spillovers refer to knowledge that is created in one organizational context and is accessed and utilized by a different organization at a cost less than the economic value of that knowledge" (Audretsch, 2017: 7). In other words, it is knowledge about products and processes that has been created or researched by the university personnel that is utilized but not purchased for the actual commercial value (including variable and overhead costs incurred by the university) to produce the knowledge. Universities in many ways are designed to be a "leaky bucket" of knowledge in that knowledge is often created and shared freely or for a nominal price through teaching, research publications, conference presentations, and service by faculty, staff, and students. Additionally, universities employ technology transfer strategies where technology may be transferred for less than its commercial value if commercial value is calculated based on the cost to produce the technology plus margin or if the purchaser is able to interact with university personnel beyond the legal needs of the transfer.

The challenge faced here is that while university actors may be acting entrepreneurially, often allowing their knowledge to spill over into the public domain, the likelihood of this knowledge spillover turning into value creating enterprise activities is problematic. In fact, it likely takes more intentional creation of strategies to do this beyond the activities of the traditional technology transfer office in universities. Audretsch (2017) notes: "Just as in the case of private companies, new knowledge and ideas generated from research and human capital at a university can often only be commercialized through the start-up of a new firm" (p. 7).

The barriers that slow or stop knowledge flow has been named the *knowledge filter*. "It stands between investment in knowledge, science and ideas on the one hand and commercialization, which ultimately leads to economic growth, on the other. The knowledge filter impedes the spill-over of knowledge and ideas" (Audretsch, 2006: 107) thus preventing the knowledge from becoming a good or service or serving to support those that are attempting to use the knowledge to the good of society.

University strategies to influence the UBEE

Early studies focus narrowly on one area of academic entrepreneurship, namely, technology transfer. Scholars have since argued that the university has many more strategies at its disposal, including additional intellectual property mechanisms for commercialization such as copyrights (Sandström et al., 2016) and other mechanisms beyond the transactional tools, such as technology licensing, used by technology transfer personnel.

Audretsch (2017) recognized this and discusses additional critical areas including knowledge spillover and entrepreneurial capital as influence strategies that can be employed. These are important as they are the major areas of influence a university can have on an EE. In these areas of influence, university personnel can act directly as entrepreneurs, teachers and sources of technical and other resources.

While Audretsch (2017) distinguishes conceptually among different sources of influence, in practice, it is apparent that many of the strategies and mechanisms employed by universities provide influence across the areas of academic entrepreneurship. In other words, you get two or more influence areas for the price of one strategy or mechanism. For example, an incubation strategy can be used to support and impact faculty work, students on campus, and graduated students who are now entrepreneurs, and create a hub for building connections and community.

Thus, to effectively describe influence areas and strategies here, I treat technology transfer and entrepreneurial capital development separately, while discussing knowledge spillover throughout. The conceptualization differs from Audretsch's (2017) as it does not separate knowledge spillover from either technology transfer or building entrepreneurship capital, because in each situation, you have knowledge that is likely being transferring at less than its commercial value. To assume otherwise would imply that universities are able to fully and accurately price the technology and protect that which has not been purchased. While universities may be able to do this for some simple technologies transferred at arms-length, much university knowledge has both explicit and tacit components requiring interactions between university and private personnel (Sherwood and Covin, 2008). The deeper these interactions, the more likely that unpaid for knowledge will spill over. Thus, even when money is exchanged with a set price (e.g., a licensing fee), the knowledge transfer will likely take place at an effective price that is less than its real commercial value.

Another reason for the separation is that the influence strategies themselves can be divided into roles that the university plays. The university may play the role of a) the academic entrepreneur, b) the supporter of the academic entrepreneur who is part of the permanent faculty/staff, or c) the supporter and facilitator of entrepreneurs that are not part of the permanent faculty and staff such as students, alumni and the community.

Of the different strategies employed, two appear to dominate the academic literature in terms of empirical studies related to outcomes; the two might be called the traditional use of a Technology Transfer Office (TTO; technology transfer strategy) and entrepreneurship education (entrepreneurial capital strategy). Both strategies have been reviewed extensively in the academic literature and I summarize the most recent reviews below. A comprehensive literature review covering less well discussed strategies of universities to promote entrepreneurship is beyond the scope of this chapter. Nevertheless, I will give a brief overview of some relevant studies, including several focused on incubators.

Supporting academic entrepreneurship: Technology transfer

The university engages in a variety of activities that directly or indirectly support the development and commercialization of technology, which have the potential for significant influence on the entrepreneurial ecosystem.

Academic entrepreneurship occurs when university actors themselves are entrepreneurs, influencing the UBEE through technology transfer. Specific activities include conducting research, protecting the resulting intellectual property, and then commercializing innovation via formal mechanisms such as licensing. In traditional technology transfer situations, the participants include research faculty and their associated students, as well as university agents from the technology transfer office. This is what has often been referred to as academic entrepreneurship involving scientist entrepreneurs (Shane, 2003).

"Technology transfer generally refers to technology which is created and owned by a university which is transferred to a private or non-profit organization for a price, which in principle, reflects the value of that technology" (Audretsch, 2017: 5). In fact, as pointed out earlier, while in principle it is unlikely that the transfer price will cover the overhead costs required to provide the assets that the scientist, inventor, or researcher uses to create the relevant technology, nor will it likely reflect the full commercial value of the technology.

University personnel also create technology transfer outside the university TTO setting as well. Many university actors transfer technological knowledge by creating and selling programs such as training, seminars, and workshops often delivered through extended education. They also author books and engage in consulting work. Each of these involves the sale of technological knowledge owned by the university, or a university actor, into the marketplace.

The university plays a supporting role for academic entrepreneurs, influencing the UBEE by technology transfer through the TTO. The practice is widely held and supported by associations such as AUTM (the Association of University Technology Managers) whose mission is to support academic technology transfer globally.[2] A TTO typically "serves as the broker between technology resulting from university research and its commercialization through private interests" (Audretsch, 2017: 5). In addition, there are multiple other entities on campus that support technological knowledge transfer. These include extended education programs that might take the form of independent entities on campus or that are embedded within individual colleges such as executive education programs widely found in business schools. The latter are not typically thought of as technology transfer mechanisms, yet they are market-based approaches that leverage the commercial and social impacts of innovations created by university personnel.

Technological knowledge is often embodied in physical materials, compounds, and the like; however, knowledge also includes the information and know-how related to how a firm manufactures a particular product or provides a particular service and may be explicit or tacit (Sherwood and Covin, 2008). Tacit knowledge has been referred to as "knowing-how" and explicit knowledge as "knowing-about""(Grant, 1996; Kogut and Zander, 1993). This can be related specifically to direct manufacturing of a product or provision of a service as well as the process of how to take an idea all the way through to commercial or social impact through entrepreneurial activities.

The university has a traditional role of providing resources for knowledge-creating activities. In most cases, this is a set of physical (and social as described above) resources *that already exists*. This represents an

2 <https://www.autm.net/autm-info/about-autm/vision,-mission-values/>

enormous potential opportunity for creating a cluster as the university can bring existing resources to bear on creating a robust and vibrant ecosystem. Many universities ultimately build out extensive and specialized facilities dedicated to entrepreneurship specifically. Yet, all universities have the basics in place including spaces to gather (classrooms), places/equipment to ideate and experiment (science labs and conference rooms with white boards), and knowledge (libraries, data sets, computer labs with software and access to the internet). As described below, the relevant resources go beyond the physical to include the financial as well.

The university provides resources, thereby influencing the UBEE through formal technology transfer. For example, many universities provide the resources to run a technology transfer office including space and technology transfer professionals. Even those universities without a TTO typically have some level of support for research activities, such as staff dedicated to reviewing research involving human subjects. Additional resources take the form of space and staff for internal accelerators and incubators meant specifically to support technological knowledge development and transfer.

Technology transfer: Metrics and outcomes

Technology transfer is a phenomenon occurring at universities throughout the world. Munari et al. (2016) note that "University–industry technology transfer (TT) has become increasingly institutionalized and is supported by numerous reforms and initiatives at the national, regional and university levels. Most countries have implemented a policy mix involving a range of instruments to support the commercialization of research." (p. 1377).

According to the Association for University Technology Transfer, nearly 5,000 research institution (university/non-profit) spin-off ventures still operate of those founded between 1993 and 2013. AUTM surveys US and Canadian members annually, with the following 2015 survey data being received from 308 US institutions, 169 of which were universities: 1,012 start-ups formed with 735 residing in the home state, 15,953 patent applications submitted (6,680 granted), 25,313 inventions disclosed with 879 new products introduced, and $28.7 billion in net sales from existing and new products. Thirty-six Canadian institutions reported 521 start-ups still operational (ninety alone started in 2015 with 82 in the home province), 1,026 new patents applied for (271 issued), and $62 million in licensing revenues received. Overall, AUTM reports that 3.8 million jobs were created by university and non-profit patent licensing between 1996 and 2013.[3]

A recent major literature review was conducted by Gerbin and Drnovsek (2016). The authors' purpose was to provide answers to the research question, "what factors need to be considered when assessing the effectiveness of academic-industry knowledge transfer activities and their impact on public science?" (p. 981). Focusing on the life sciences, they identified three major activities transferring technology and knowledge from academics to industry, including:

> (1) collaborative research projects, including consulting and sponsored research; (2) patenting and licensing inventions to existing companies, charging royalties for the use of the patent as well as splitting the realized income among the participants in the process (Henderson, Jaffe and Trajtenberg (1998), and (3) establishing of new spin-off companies for commercialization of academic research results (see Bozeman 2000; Lockett et al. 2005). Each process can be facilitated by the third key stakeholder, technology transfer offices (TTOs) or administrators of the university's intellectual property (Siegel et al. 2004). (Gerbin and Drnovsek, 2016: 980).

The authors reviewed 15 articles published in peer-reviewed academic journals between 1980 and 2014. All the articles were empirical and used a range of quantitative and qualitative methods for a combined 10,276 iden-

3 See <http://www.autm.net/fy2015-survey/>. Multiple literature reviews regarding technology transfer have been conducted including Djokovic and Souitaris (2008), Markman et al. (2008), Narayanan, Colwell, and Douglas (2009), Rothaermel, Agung, and Jiang (2007), and Siegel, Veugelers, and Wright (2007).

tified citations as of November 2014. It is worth noting that much of the research completed focused primarily on the US, followed by Europe, with an emphasis on a small number of overall universities. There is evidence in countries outside the US that run parallel and counter to findings at major research institutions.

The authors found six main research topic clusters related to academic knowledge transfer including (a) involvement predictors and motivations, (b) awarding mechanisms, (c) performance level and success factors, (d) institutionalization, and (e) academic-industry knowledge transfer and open science. Topic clusters (a) and (b) focus on the who and why of participation in technology transfer. Obviously, if UBEEs are to be successful, they need the effective participation of researchers and other experts.

For predictors and motivations of involvement of researchers in academic-industry knowledge and technology transfer, they found that "[a] vast number of studies agree that more productive scientists, male, with permanent positions, applied research orientation, extensive networks of collaborators, previous knowledge transfer experience and supportive institutions are more likely to start involving in all types of academic-industry knowledge transfer" (p. 989). Yet the authors also suggest that these very same enablers can act as inhibitors. They particularly note that policies and the approaches to institutional support may create barriers. It is also possible that there are systemic barriers in place explaining the finding that most researchers are male and permanent faculty including systems for recruiting, retention, and support.

Topic cluster (b) led to observations that several types of incentives were in place, generally broken into financial and non-financial. Financial included performance-based (e.g., royalties, equity for the specific project) and non-performance-based incentives (e.g., promotions, impact on reputation not specifically tied to a specific project). The review showed that financial incentives were relatively weak predictors of academics engaging in technology transfer, and that concern for publication, the time needed for applied science, and the need for being involved with later development efforts are all likely disincentives. The authors do note that while this appeared to be true overall, there are many exceptions at specific institutions given the technology transfer culture found there.

Topic cluster (c) is about performance levels and success factors. Overall, the review appeared to show mixed results related to performance outcomes for technology transfer. The authors note that determination is made more challenging due to the varied methods of measurement. These included intellectual property exploitation-based indicators (e.g., invention disclosures, patent applications, granted patents, licenses, and revenue from licensing). Others included patent relevance, scope intensity of industry collaboration, and academic entrepreneurship performance indicators such as number and success of spin-offs. The authors noted that some qualitative measures were used, although in limited fashion due to the difficulty of collecting qualitative data.

The authors add:

> [W]e observe that most universities in the USA and Europe are actually not successful in knowledge transfer, since the costs related to such activities significantly exceed the obtained revenues (Arundel et al. 2013). Also, the distribution of income from commercialization is highly skewed (Carlsson and Fridh 2002; Campbell et al. 2004; Geuna and Nesta 2006). Interestingly, several studies point to the trend of a general decline in university patenting over the past 10 years, both in Europe and in the USA, and argue that this is due to the lack of institutional incentives or changes of policies towards university ownership of patents (Leydesdorff and Meyer 2010; Geuna and Rossi 2011). In any case, a recent study reveals that the USA still outperforms Europe when it comes to most knowledge transfer efficiency indicators, except for the number of founded spin-offs and number of executed licenses (Arundel et al. 2013). (Gerbin and Drnovsek, 2016: 992).

From their review of the university technology transfer performance literature, Gerbin and Drnovsek (2016: 992–95) identified six main factors influencing the success of knowledge/technology transfer (table 2), which

Table 2: Six Major Factors Influencing the Success of Knowledge/Technology Transfer

Factor	Impact
(1) Characteristics/quality of the researchers	Large majority of studies indicate high quality knowledge base positively related to all types of knowledge transfer.
(2) Characteristics and quality of inventions and technologies	Characteristics including novelty, technological radicalness, market attractiveness, patent complexity positively related to spin-off survival.
(3) Institutional capabilities and resources, and 4) Policies	Support structures, skills, and incentives of institutional support and departmental management critical for patent activities and academic entrepreneurship. Particular focus has been on skills, incentives and structures related to linchpins or champions of the process and the human interactions in the process important to facilitate knowledge flow. Often, these champions or linchpins serve as boundary spanners between industry and the university. No straightforward evidence regarding the role of TTO age, size, or structure was found regarding transfer performance, although size tended to be positively related. University and industry funding tended to be positively related to knowledge transfer outputs.
(5) Prior knowledge transfer experience	Positive relationships found for collaboration, academic entrepreneurship and composite.
(6) Geographic proximity to supporting infrastructure and industry	Closer proximity tended to have positive relationships with outputs with several negative relationships found, including access to venture capital on academic entrepreneurship and local R&D intensity on Intellectual property-based output.

Source: Adapted from Gerbin and Drnovsek (2016: 992–95).

in turn, influence four knowledge transfer performance areas including industry collaboration, Intellectual property-based, academic entrepreneurship, and composite outputs. Industry collaboration includes consulting, sponsored research, and joint projects. Intellectual property-based output includes invention disclosures, patenting, and licensing. Academic entrepreneurship includes spin-off founding/equity holding, product marketing and launch, and the perceptions of technology managers regarding success of new products. Finally, composite includes a broad mix of outputs including industry collaboration, number of invention disclosures, licensing, spin-offs, and patenting.

Overall, the authors summarize, "[i]n order to be successful in knowledge transfer, academic institutions should focus on the individual researchers and their inventions, and their own knowledge transfer capabilities, resources, experience and strategies" (p. 996).

More specifically related to policy decisions, the authors highlight the role technology transfer professionals play at the university including how they organize themselves, their experience, and the resources available for the Technology Transfer Office as well as institutional R&D in general. Funding from multiple sources can be important including that from industry. And the authors emphasize the critical role of researcher involvement stating the evidence is in line with the claim that "whatever the route of technology transfer is, central to its success will be the role played by the creator of the intellectual property, the individual scientist" (p. 997).

Topic cluster (d) focuses on how academic knowledge transfer itself becomes institutionalized at universities. This occurs when knowledge and technology transfer become the norm, which in turn reduces the filter created by a culture of resistance to technology transfer practices themselves. Based on Colyvas (2007), Gerbin and Drnovsek (2016) describe the role model offered by Stanford University in the US, which shifted the social norms to acceptance of the connection between commercialization and science, and how this was eventually emulated by other US universities. "Factors influencing the institutionalization included faculty advocacy and authority, the career structure of science, technological change, and resources" (p. 998). Citing Etzkowitz (2003), the authors describe how it has also become an accepted norm in Europe and Latin America.

Topic cluster (e) concerns potential downside implications of technology transfer for scientific output. Gerbin and Drnovsek (2016) cite Baldini (2008), who identifies multiple threats including: "threat to scientific progress due to increasing disclosure restrictions; declining patents' and publications' quality, biasing research efforts toward commercial priorities, crowding-out between patents and publications and reducing the relevance and quality of teaching activity in academia" (p. 999).

Studies reviewed contradict this potential threat, indicating that rather than slowing down research output, faculty involved in entrepreneurial behaviors are often the most cited and respected in their fields (with variation between fields). The studies reviewed found, more often than not, more research productivity from faculty when involved with technology transfer, rather than less:

> Even though no consensus has been reached with respect to this subtopic, there is no apparent trade-off between patenting or knowledge transfer in general and either quantity or quality of research output (Agrawal and Henderson 2002; Van Looy et al. 2006; Fabrizio and Di Minin 2008): scientists with better patenting performance tend to exhibit superior publication scores with no decrease in the quality of output and exactly the most productive scientists are those most likely to become inventors (Caulfield and Ogbogu 2008; Breschi and Catalini, 2010). (Gerbin and Drnovsek, 2016: 1000).

They propose the potential explanation that industry may fund already productive faculty and thus productivity increases. I would add that experience closer to the market place may also give researchers insights they would not otherwise have. Gerbin and Drnovsek (2016) did focus on certain types of output while apparently not finding studies supporting or validating the variety of threats raised by Baldini (2008).

Finally, topic cluster (f) concerns the impact on open science. Public universities are expected to create public knowledge, causing concerns about reduced access to knowledge created by university personnel. The reviews by Gerbin and Drnovsek (2016) indicated widespread withholding of research findings by faculty, yet explanations were mixed and suffer from a narrow focus on patents. While some studies did attribute withholding (e.g., not responding to requests by other academics or through delayed publication) to commercialization motives, most tended to explain this phenomenon as more to do with academic rivalry or logistical barriers (i.e., it is too much effort to share).

In summary, there has been considerable academic attention paid to university to industry technology transfer in the context of formal approaches as through licensing and TTOs. While having a skilled and active TTO at the university overall appears to positively impact knowledge transfer output, there are many variables within and surrounding these entities that are also at play, including institutional support and culture, policies related to knowledge transfer, and support resources and connections with industry.

Beyond formal, traditional technology transfer

While there is an extensive literature on what might be considered formal or traditional technology transfer, the literature regarding university knowledge transfer via other mechanisms is much less studied.

As has been discussed, university personnel themselves act as entrepreneurs, influencing the UBEE through knowledge spillovers beyond traditional technology transfer. Entrepreneurs are often asked to engage in activities that expose their technological knowhow to outside entities without attempts at protecting it from being acquired without compensation. University entrepreneurs, whether they be physical or social scientists, students or administration and staff, often create innovations and then share these through a variety of venues including scholarly articles, practitioner outlets, speaking engagements, conferences and posted findings on their websites.

While much of this technological knowledge theoretically could be protected and commercialized, the vast majority of innovation that occurs within the UBEE is either created and sitting idle waiting to be accessed (e.g., dissertations), actively being implemented and available for the asking (e.g., pedagogical innovations), or actively being shared without expectation of compensation (e.g., scholarly publishing, participating in competitions, presentations at conferences).

The volume and diversity of knowledge spillover is a significant differentiator from traditional commercial or non-profit enterprises. Indeed, it is arguably the critical contribution of the UBEE to the larger Entrepreneurial Ecosystems. This takes place both locally and globally, as university entrepreneurs often seek to gain a larger audience through the vast networks of universities that have been in place for decades.

Multiple actions are also taken by university entrepreneurs to build entrepreneurial capital within the UBEE. Entrepreneurs can act as mentors and coaches to their colleagues, helping them to understand how to develop innovations and connecting them to the marketplace. They also act as instructors in workshops hosted by university entities, such as the office of technology transfer, entrepreneurship institutes, or community-based organizations. Finally, they create start-ups on campus that allow students to become part of the entrepreneurial network, including activities such as cafés, retail outlets, and food stands (Morris, Kuratko, and Cornwall: 126).

Supporting entrepreneurial capital and knowledge spillover: Empowering people to act entrepreneurially and encouraging the leaky bucket

In this section, I discuss strategies for encouraging knowledge spillover through building entrepreneurial capital, where the university plays a facilitation and support role for the people engaged in entrepreneurial and innovative activities. I specifically focus on entrepreneurship education, a dominant strategy meant to directly support entrepreneurs and innovators. I then shift focus to incubators as a non-curricular, intentional strategy to encourage knowledge spillover and social capital that ultimately can impact the entrepreneurship ecosystem. Both curricular and non-curricular strategies are entrepreneurial capital and knowledge spillover influencers.

"Entrepreneurship capital is a type of social capital (Coleman, 1988) that is conducive to entrepreneurship … While social capital endows an individual, organization, or place with access to other people and organizations within a social context, entrepreneurship capital is a type of social capital that enhances the ability of individuals, organizations and places to behave entrepreneurial" (Audretsch, 2017: 9). This might include a variety of influence strategies that connect people and increase their social capital as a result.

The university plays a supporting role for entrepreneurs, influencing the UBEE through the development of entrepreneurial capital. Building entrepreneurial capital does not require deep research capabilities, thus, it is a set of activities that are more easily shared between different types of higher education institutions (for example, through sharing pedagogical innovations and program design best practices at conferences/workshops and in journals). Universities engage in extensive support strategies that result in knowledge spillover. Much of the spillover takes place when those that hold the knowledge (faculty, advanced students, staff, invited guests such as local entrepreneurs and innovators) interact with those that receive the knowledge or through acts that put the knowledge into the public space. Each of these interactions can be designed and strategies can be built to create intentional spillover.

The most visible strategies include formal education programs at the undergraduate, masters, and doctoral levels in some direct form of entrepreneurship for current or nascent entrepreneurs. Offerings can include certificates, concentrations, minors, majors, and study abroad. These strategies might be implemented within specific colleges/schools or may be campus wide. These programs might cover general entrepreneurship or be focused on specific areas such as high tech, social, innovation, and the like which have different labels but still contribute directly to entrepreneurship (Morris et al., 2016).

Curricular strategies also include less direct studies that prepare the entrepreneurial workforce (Spigel, 2015) to enter the marketplace not as the founding entrepreneurs, but rather as the needed talent to work for the start-up and scaling ventures. These include, for example, students who might major in traditional subjects such as business, liberal arts, creative arts, design, engineering, computer science, and so forth, who are exposed to entrepreneurs and entrepreneurship as members of the ecosystem.

Additionally, ongoing curricular innovation is an important part of the process. This curricular innovation is critical as it feeds new thinking about entrepreneurship into the supply chain that eventually is injected and spilled over into the larger ecosystem via student learning.

Universities also employ a variety of extra-curricular strategies that build the UBEE, many of which also result in knowledge spillover as discussed above. These include events such as speakers' series, pitch/business model/venture plan competitions, and start-up boot camps. They also include ongoing programs such as hatcheries, incubators, accelerators, student clubs, and support of entities such as Small Business Development Centers.

Community engagement (social network) strategies also play an important role. These include the university acting as a bridge from campus to community and between community entities, as well as links to larger regional, country-wide and global entrepreneurship groups (e.g., Ashoka, USASBE[4]).

Finally, as a university with its inherent design and purpose, the campus acts as an entrepreneurial laboratory that provides for the gathering and connecting of diverse people (Miller and Acs, 2017). As a laboratory, universities allow students to experiment and practice activities in a lower-risk environment than exists in actual business ventures, from starting student clubs to attempting to make innovative change happen on campus. Additionally, universities tend to be magnets for diverse people from places outside the immediate locality, thus bringing fresh perspectives and new

4 Ashoka is a global organization focused on social innovation and entrepreneurship; see <https://www.ashoka.org/en>. USASBE is the United States Association for Small Business and Entrepreneurship; see <http://www.usasbe.org/>.

ideas (Miller and Acs, 2017). The university also acts as a learning ground for how to understand diversity and how it can be a critical contributor to entrepreneurship and innovation. The campus is a place to try new things, to make mistakes, and to learn when the risks of failure are much lower than in the commercial marketplace.

Universities act to put knowledge into the public space, often at a fraction of what it costs to create the knowledge. Knowledge diffusion and distribution outlets include web sites, white papers, journal articles, conference proceedings, books, and video. Diffusion and distribution also take place when university and broader ecosystem participants interact via entrepreneurship clubs, learning communities, hatcheries, incubators, accelerators, networking events, conferences, symposia, competitions, and membership in entrepreneurially focused regional, national, and international organizations.

The university also provides resources, influencing the UBEE through knowledge spillovers. Physical resources include providing space for meetings, clubs, hatcheries, incubators, accelerators and conferences where knowledge holders might interact with others resulting in knowledge spillover. Universities also often become the physical and digital homes of associations and journals. Human resources include faculty and staff that support the formation of groups such as student clubs, that in turn, engage with holders of knowledge through speakers' series and the like. This may also include provision of staff to support the physical plant and provision of homes for the associations and journals.

Additionally, university resources influence the UBEE through building entrepreneurial capital. The university works to provide connections to funders. The effect is often to create a mentoring relationship between funder and the university faculty and students involved in the venture resulting in both knowledge spillover and specific development of entrepreneurial capital. Universities may also provide direct funding themselves through grants, loans, equity investment, joint ventures, and the acquisition of existing entities. These could range from student investment funds to large scale research projects constituting public-private partnerships.

Finally, universities often provide physical, financial, and staff resources to support experiential education through student-run ventures.

Metrics and outcomes

In this section, I concentrate specifically on the effects of curricular entrepreneurship education as well as specific extracurricular strategies to build entrepreneurial capital which, in turn, may impact the UBEE.

Figure 3: Integrated Teaching Model Framework from Nabi et al (2016)

Nature of EE Pedagogical Methods
(Béchard and Grégoire, 2005; Fayolle and Gailly, 2008)

- Supply model focusing on reproduction methods such as lectures, reading, and so forth.
- Demand model focusing on personalized/participative methods (e.g., interactive searches, simulations).
- Competence model focusing on communication, discussion, and production methods (e.g., debates, portfolios).
- Hybrid models (i.e., mixture of above).

→

Impact Indicators
(Jack and Anderson, 1998)
Operational Level

- Level 1: Current and ongoing measures during the program (e.g., interest and awareness).
- Level 2: Pre- and post-program measures (e.g., knowledge, entrepreneurial intentions).
- Level 3: Measures between 0 and 5 years post-program (e.g., number and type of start-ups).
- Level 4: 3 to 10 years post-program (e.g., survival of start-ups)
- Level 5: 10 years plus post-program (e.g., contribution to society and economy)

Nabi and colleagues (2016) conducted a literature review of the impact of entrepreneurship education at the university level. Their research purpose was to build on prior literature reviews of the impact of entrepreneurship education, and they covered 100 articles. Past reviews had mixed results regarding measures of impact and were not specifically focused on higher education. Major reviews that do focus on higher education include Pittaway and Cope (2007) and Rideout and Gray (2013), together covering the years 1970–2011. With the tremendous proliferation of programs, the authors argue that another systematic review of the most recent five years is important.

One of the major contributions offered by Nabi et al. (2016) is what they call their integrated teaching model framework (figure 3). The framework Is useful in that it identifies types of pedagogical models being used to ultimately create desired types of impacts and the related measures of those impacts. The literature review found most researchers focused on Levels 1–2; using the full set of levels allows for a more structured and comprehensive set of impact indicators.

Nabi et al (2016) found that studies continue to focus on short term, subjective impact measures (Levels 1–2). For example, they identify attitudes and intentions as a frequent measure, as opposed to venture creation behavior and business performance. "[T]he most common impact indicators are related to lower level indicators of subjective/ personal change: attitude (32 articles), skills and knowledge (34 articles), perceived feasibility (42 articles), and entrepreneurial intention (81 articles). By contrast, higher level indicators of longer term, objective, or socioeconomic impact are much less frequent: 21 articles study start-ups and 8 articles consider venture performance, both typically within 10 years of the program" (p. 281).

In terms of outcomes, the authors report that most articles reviewed indicate positive links between entrepreneurship education and subjective or objective impact measures. Overall, entrepreneurial intention was by far the most commonly used subjective measure and was generally found to be positively related outcome to entrepreneurship education (61 of 81 articles reviewed reported a positive link). However, the results are mixed, and the authors point out that we know little about the other contributors to entrepreneurial intent such as culture or gender.

There were 25 articles in their review that used objective impact measures. These studies typically ranged over the higher levels 3–5 and found positive relationships between entrepreneurship education and start-ups.

The authors conclude: "Overall, the review suggests reasonable evidence of positive [entrepreneurial education] impact. This holds especially for entrepreneurial attitudes and intentions (impact Levels 1 and 2 of our framework), but even here some examples demonstrate differential impact depending on context and the background of participants (Fayolle and Gailly, 2015; Fayolle et al., 2006)" (p. 284). While the reviewers make the case that there need to be novel measures of impact, they remained silent on impact measures related to the entrepreneurship ecosystem beyond the level of the individual entrepreneur or entrepreneurial firm.

Incubators as an example of a non-curricular strategy

University-based incubators are a popular economic development policy option globally and a growing strategy used to promote business start-ups and growth (Lasrado et al., 2016).

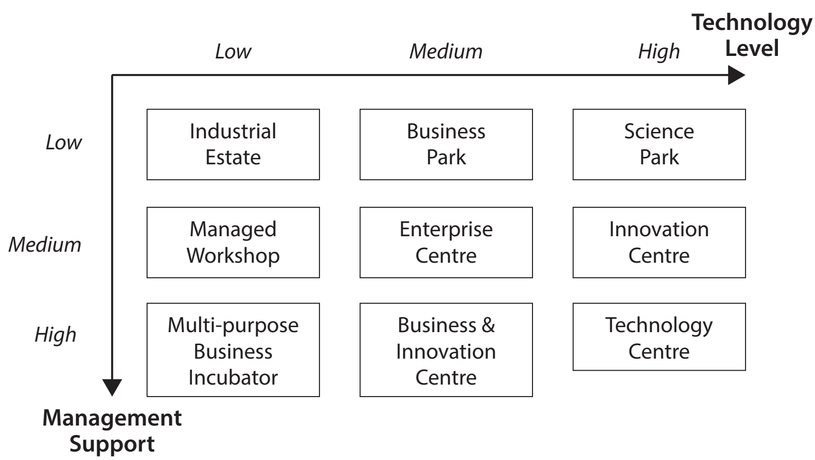
The European Commission's *Benchmarking Report on Business Incubation* cites the National Business Incubation Association definition:

> Business Incubation is a dynamic business development process. It is a term which covers a wide variety of processes which help to reduce the failure rate of early stage companies and speed the growth of companies which have the potential to become substantial generators of employment and wealth. A business incubator is usually a property with small work units which provide an instructive and supportive environment to entrepreneurs at start-up and during the early stages of businesses. Incubators provide three main ingredients for growing successful businesses—an entrepreneurial and learning environment, ready access to mentors and investors, visibility in the marketplace. (European Commission, 2002: 5)

The report also offers a typology of business incubators, indicating the varied levels of comprehensiveness in terms of the technology and the services provided (figure 4). The matrix indicates that Technology Centers offer the most comprehensive set of management support and levels of technology.

There has been "an explosive growth in the number of business incubators in the United States and the European Union. For every incubator that existed in 1980 there are now more than 100—the total number of business incubators has grown from 12 to over 1400 (Amezcua et al., 2011) and about 900 in the European Union (Bruneel et al., 2012). Furthermore, because most incubators are publicly funded (Lewis and Edward, 2001), many policymakers have positioned incubators to play a central role in economic development and rejuvenation programs (Bruneel et al. 2012)" (Lasrado et al., 2016: 206).

Figure 4: A Typology of Business Incubators



Source: European Commission Benchmarking report on Business Incubators, 2002.

Universities are regularly engaged in creating and running business incubators. I give these some attention here because I believe Insight into incubators provides insight into other potential non-curricular ecosystem strategies to help academic entrepreneurs be successful by contributing to a thriving start-up and business environment.

Lasrado and colleagues (2016) examined a key policy concern for both university and government leaders. They studied whether firms that graduate from a university incubator ultimately perform better than graduates from non-university-based incubators. The authors found that compared to non-university affiliated firms, university incubator graduates had significantly higher job and sales growth over time. The authors note:

> We believe that university resources do make a difference in how well firms are likely to perform, and in fact this is what our results indicate. We have theorized that amongst incubators, university incubators provide firms with the most comprehensive set of re- sources. We propose that incubators vary in the services and resources they offer, and that university incubators typically provide greater connectivity and legitimacy with respect to important contingencies associated with key industry and community stakeholders. This leads us to propose that university affiliation is an important contingency that affects the relationship between firms' participation in incubators and their subsequent performance. This study shows that firms from university incubators outperform their matched cohort of firms not from university incubators. Being in an incubator is not the issue for the firm. Whether the firm can acquire the necessary resources is of prime importance. Hence, if an incubator is well endowed with resources that the firm can acquire then there is a greater likelihood that these firms will perform well. (Lasrado et al., 2016: 217)

This is quite interesting in that it identifies an important synergistic effect of having an incubator associated with the larger University Based Entrepreneurship Ecosystem. It is very likely that knowledge spillover into the incubator is happening and that the participants are receiving much more from being associated with the resource rich university environment than if they were in a relatively isolated incubator in the larger entrepreneurship ecosystem. It is possible that the university environment enables thick connections to the needed resources that come from outside the incubator itself. The larger takeaway is that non-curricular strategies are likely to benefit from the spillover of knowledge and resources if embedded within, or officially associated with, a university.

Implications for university leaders, policymakers, and academics

This section will discuss implications for university leaders including administrators and faculty, policymakers, builders from other domains in the larger entrepreneurship ecosystem who want to leverage and support a healthy UBEE, as well as academic researchers.

Overall

One overall implication for university leaders, policymakers, and academics is the importance of recognizing the University-Based Entrepreneurship Ecosystem in its entirety, rather than simply as a collection of unrelated parts. Being able to describe and understand the UBEE holistically allows leaders to better design, build, and change it. Additionally, these parts are likely to have synergistic effects and thus intentional connection and affiliation are important (e.g., as with business incubators).

This holistic view is important as there are often policy trade-offs, meaning that in taking a piecemeal approach to policy, gains found may be offset by unintentional losses. Sandström and colleagues (2016) found at least 13 articles in the academic literature discussing concerns about such trade-offs. They discussed striking a balance between education and commercialization, academic entrepreneurship potentially crowding out private sector entrepreneurs, and universities investing in spin-offs creating disincentives for private sector actors to do so. They state, "[r]obust [academic entrepreneurship] initiatives need to be both internally and externally consistent. When internally inconsistent policies are deployed, gains are fully or partly offset by losses elsewhere as the policy incentivises conflicting behaviour." They go on to say, "Well functioning AE initiatives require that several different actors such as researchers, incubators, university officials and venture capitalists are aligned (Mian et al., 2016). Our literature review indicates that these actors often differ both in terms of incentives and competencies, and thus the overall system may not generate the intended outcomes" (p. 11).

It is also important to understand the concepts of knowledge spillover and knowledge filters. If one were to evaluate universities simply on their commercial transactions involving technology transfer, one would conclude that the investment made is much greater than the gain received in terms of money paid or spin-off start-ups created. If one instead considers this from the perspective of working to achieve knowledge spillover into the public sphere, the impact assessment is likely to be much different (i.e., the social value created is greater than the cost of creating the knowledge). The challenge is that we have limited research regarding public benefits because of limited tools for measurement.[5]

Additionally, if we understand that there are filters that create resistance to knowledge transfer and we can identify and describe them, the possibilities to remove or reduce them goes up considerably. The longstanding tongue-in-cheek joke among academics about how nobody reads the papers we write except other academics illustrates this point.

Thus, the themes of taking a broader view and acting with intention to build the entrepreneurship ecosystem, and understanding knowledge spillover and knowledge filters, run throughout the implications below.

Implications for university leaders

Upon reviewing or describing UBEEs, multiple scholars have identified implications for university leaders desiring to build and support Universi-

5 Thus, we see patent data but not data on the outcomes affecting the health of the ecosystem which, in turn, is manifested in stronger support systems, stronger community, and increased quantity and quality of start-ups that may be multiple degrees separated from the university itself.

ty-Based Entrepreneurship Ecosystems. These implications are about the opportunity and then what is needed to pursue the opportunity.

Universities have the opportunity to build a UBEE that will not only advance their institutional mission, but also have potentially significant and lasting economic and social impacts on local, state, regional, national, and international communities. Universities have the bones upon which to build a UBEE that can lead to these impacts, yet it is not enough to passively sit back and hope that it will develop. Universities must act with intention.

Scholars have identified how universities can intentionally act to build and grow their UBEE. Fetters et al. (2010) offer three findings and seven key success factors. The authors found that a) there are multiple pathways for developing a UBEE, b) UBEEs share common elements, and c) the experience of existing programs yields insights for building, maintaining, and growing UBEEs. Morris, Kuratko, and Cornwall (2013), in their book about entrepreneurship programs and the modern university, also offer critical building blocks for building university wide entrepreneurship.

Table 3 lists key success factors and the critical building blocks offered by Fetters et al. (2010) and Morris et al. (2013). Upon examination of the key success factors, patterns emerge that give rise to critical implications for university leaders who are determined to build a vibrant, robust, resilient UBEE, namely, leadership and commitment.

The first implication is the importance of leadership. The first two of the seven key success factors and the first through third of the critical building blocks are the job of leaders. To make this happen, it takes leadership from high in the university administration and it takes a dedicated "champion" faculty who are willing to not only do the traditional work of teaching and research but to play the role of entrepreneur themselves on campus, seeking opportunities to build and grow the UBEE and then seeking the people and resources to make it happen.

The second implication is that it takes long term commitment from the leaders and the institution. This commitment takes a variety of forms that appear in table 3. These include substantial, stable financial resources, designing and building appropriate organizational structure and infra-

Table 3: Key success factors and critical building blocks for UBEEs

Seven Key Success Factors*

1. Senior Leadership Vision, Engagement, and Sponsorship
2. Strong Programmatic and Faculty Leadership
3. Sustained Commitment over a Long Period of Time
4. Commitment of Substantial Financial Resources
5. Commitment to Continuing Innovation in Curriculum and Programming
6. An Appropriate Organizational Infrastructure
7. Commitment to Building the Extended Enterprise and Achieving Critical Mass

Critical Building Blocks for University Wide Entrepreneurship**

1. You need an academic champion
2. You need a definition
3. You need a purpose
4. You need a structure
5. You need supporting infrastructure
6. You need a curricular model
7. You need co-curricular programming
8. You need a resource model
9. You need incentives
10. You need publicity
11. You need metrics and outcomes

*Derived from in depth case studies of Babson, EM Lyon Business School, University of Southern California, The University of Texas at Austin, Tecnológico de Monterrey and National University of Singapore (Fetters et al., 2016)
**Morris et al, 2013.

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structure, building and innovating around cross-disciplinary programs that are both curricular and co-curricular, and a commitment to building and implementing a robust performance measurement system. It is clear that if a university wants to be on the winning side of a UBEE, it will need leadership and commitment for the long haul.

Encouraging academic entrepreneurship

As for encouraging academic entrepreneurship by faculty and staff, it is important to broaden thinking from what has been considered the domain of a TTO to include the vast array of intellectual property and knowledge being created by faculty and staff that either is already being commercialized (e.g., executive education programs) or lying dormant to some degree with no attention to knowledge transfer beyond the typical academic publishing.

It is possible that much of the knowledge that is dormant or under-transferred suffers from a knowledge filter relating to culture, know-how, and performance expectations. For some academics, commercialization or even public sharing may feel incongruent as being either ethically suspect or as grandstanding and self-promoting. If the culture and performance expectations of the institution are not aligned for knowledge transfer beyond traditional academic means, it is likely that a very large amount of knowledge will remain inaccessible to the public spillover effect. Additionally, as has been seen with TTOs, it is likely that faculty and staff know-how and experience related to commercializing or sharing knowledge in different ways is limited to the degree that faculty and staff are simply not sure what to do. It is worth considering public investment in training and development to help academics start a wide-ranging set of small businesses from campus.

Finally, it is likely to take an interdisciplinary paradigm shift to understand the importance of being entrepreneurial and innovative and how this differs from simply starting up a business. There is likely confusion for many faculty, staff, and administrative leadership on how entrepreneurship even applies to their area of expertise. Broadening the areas in which entrepreneurship is taught and integrating this across the curriculum (as many have attempted with leadership, cultural awareness, ethics, and so forth), will lend itself to a stronger UBEE and, within that, more start-up ventures.

Implications for policymakers

One major implication for policymakers is the importance of understanding universities and their contribution to the overall local, regional, state, national, and international entrepreneurship ecosystems. Universities offer much more than is typically measured by patent counts, licensing dollars, and identifiable launches of business ventures from campus. If these ready measures are all one considered, it would be tempting to conclude that the university contribution to entrepreneurship does not have a net positive financial return. Yet there are other university-related outcomes having positive social impacts, albeit ones that are difficult to measure.

Policymakers should consider universities as assets, whose contributions have yet to be maximized regarding their own UBEE as well as impacts on the larger entrepreneurship ecosystem. Understanding the ecosystem will allow policymakers to work with stakeholders to create supportive policy frameworks that contribute to a comprehensive ecosystem development.

To support this impact on development, universities need policies and resources that are put in place in a comprehensive rather than a piecemeal way. Simply funding a TTO or an incubator space is helpful, yet likely insufficient to unleash the full potential of the university. This emphasizes the importance of coordinating with university and local leadership in order to bring the right stakeholders to the table to develop resource support solutions.

The foregoing implies that public policy has the job of reducing or removing the knowledge filters that exist.[6] How might current and future policy be used to support the creation and distribution of knowledge from universities? These assets are already in place and efforts to maximize this large investment make sense. Scott Andes (2016), writing for the Brookings Institute, argues that "knowledge transfer occurs best over city blocks, not across the country" and that universities do not suffer from poor research, but rather from inadequate relationships with firms and other key ecosystem players. The public policy implications may run in parallel in

6 One of the early major pieces of legislation was the Baye-Dole Act of 1980 in the US. It was specifically designed to reduce what we now know as knowledge filters (Audretsch, 2007). This act allowed universities to commercialize knowledge/technology and provided financial incentives to commercialize research. After the act passed, TTOs expanded rapidly.

that the solutions may very well be in the hands of city and state governments[7, 8], rather than at the federal level.

Policymakers also need to understand that universities are difficult to change, which is both a negative and a positive. The negative is that it takes considerable effort to get movement in these large, bureaucratic organizations. The positive is that once the needed shifts are in place, these too become difficult to undo and have a higher likelihood of sticking.

Implications for academic researchers

An important implication for researchers studying entrepreneurship ecosystems generally and UBEEs specifically is the need to consolidate and deepen our understanding and modeling of the linkages between universities and entrepreneurship, as well as to adapt a more comprehensive approach to process and outcome measurement. We are at the early stages of contributing to the understanding that will allow both university leaders and policymakers to make good decisions related to the UBEE. When reading the implications for each above, it is apparent that university leaders and policymakers need better metrics and data, as well as better understanding of the data, in order to make good decisions. Academic researchers can play a leading role in providing what is needed.

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7 Audretsch (2015) describes research that shows no relationship between policy and desired outcomes. Yet he also goes on to describe multiple well-known cases where specific geographical regions built public policy strategies to impact entrepreneurship and innovation, including the research triangle in North Carolina that linked three universities with the community, the city-states of Hong Kong and Singapore, and efforts taking place in regions within the EU (pp. 104–107).

8 A well-known initiative for economic development policy is called Economic Gardening (<https://www.nationalcentereg.org/>) where policymakers choose to "grow their own" rather than simply work to attract business from elsewhere. If a university is in place, financially and programmatically supporting connections between high potential entrepreneurs/ventures to university resources can be a core component of these initiatives.

Multiple gaps are apparent from a review of the literature. Much of the research to date is US-centric with some growth in European research and a sprinkling of studies from other countries around the world. There is a considerable opportunity to expand our understanding of the UBEE across the globe, thus bringing in variables such as culture, politics, and geography. Doing so will likely require cross-disciplinary and cross-cultural research.

Finally, most of the available research is focused on universities, with most of this focused on research-oriented universities. How does the UBEE vary when focused on mid-sized teaching-focused universities? Community colleges? Pre-university/college? Much remains to be investigated.

Summary

This chapter had four purposes including (1) introducing the reader to the entrepreneurship ecosystem perspective with a particular focus on the university, (2) taking a closer look at the ways that universities influence the ecosystem, (3) assessing performance metrics, and (4) discussing implications for practice and research.

The chapter provided an overview of entrepreneurship ecosystems, touching on their literature lineages and describing the larger component parts. It also took a closer look at the University-Based Entrepreneurship Ecosystem, offering several advanced illustrations of the component parts and relationships. Next, the chapter discussed literature reviews of multiple ways in which universities influence the ecosystem, including traditional technology transfer, entrepreneurship education, and incubators. Knowledge spillovers and filters are discussed throughout the chapter, given their importance. Finally, the chapter presented and discussed implications for both practitioners and researchers.

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