Modernization and internationalization of Iranian HEIs via collaboration in TEL-based curriculum development in engineering and STEM

UNITEL E-COURSE

LECTURE NOTES

M4: Cooperation with the Industry and Working Life Relevant Skills

M4-3: University's Technology Transfer (UTT) Strategies and Ecosystems

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1. Introduction

The UNITEL e-course Module 4, lesson 3, **University's Technology Transfer (UTT) Strategies and Ecosystems** includes the following topics concerning the university technology transfer:

- the classic cooperation model, the Triple helix model of innovation,
- the concept of university technology transfer, including the traditional model and alternative views that are built on the limitations of the traditional model,
- strategic considerations concerning university technology transfer, and
- a broader view of an ecosystem of university technology transfer with some case examples.

These lecture notes provide a broader overview of the M4-3 video lesson.

2. Stepping down from the "Ivory Tower" – University and the Triple Helix Model

In recent years, there has been a rapid expansion of university's role in economic development. Henry Etzkowitz and Loet Leydesdorff (1999) introduced the Triple Helix Model of close collaboration among universities, government and industry to foster economic and social development as a lens through which to interpret universities' transformation (see also Etzkowitz et al. 2000; Etzkowitz 2008). This view, in which universities are seen as contributors to innovation, technological development and economic growth, along with a catalyst for regional development (e.g. Jones-Evans & Klofsten 1997; Etzkowitz et al. 2000; Zhang, MacKenzie, Jones-Evans & Huggins 2016), has become a classic model to depict universities' growing role and increased importance in the innovation system.

In the Triple helix model, each institute benefits from the collaboration; *the university* for example, gets opportunities to link with real businesses, finds new sources of funding, such as consultancy income and gets to leverage government funds, gets an access to facilities, and finally, has a possibility to demonstrate the impact. Regarding *the industry*, it gets an access to state-of-the-art research, specific expertise and training, it can savour from cost sharing benefits and an access to facilities. There is also a chance of joint ventures and start-ups.

Finally, *the government*, it can benefit from the growing competitiveness, national growth, and a number of innovations – that is, the base of the knowledge-based economy.

3. The Triple Helix Model of Innovation

Under the triple helix model of university–industry–government relations, reciprocal relationships are formed among the three institutions in which each attempts to enhance the performance of others. Etzkowitz and Leydesdorff (2000) identify three types of triple helix models: the statist, the laissez-faire and the balanced model. Accordingly,

- In a *statist model*, a strong state is driving interactions between the three components in a top-down implementation.
- In a *laissez-faire model*, in which the industry and market forces are the leading forces, the ties are weaker and each institution tends to remain separate and very independent.
- In an *idealized model*, each helix has an equal role in collaboration.

According to Etzkowitz (2008, p. 12), '*a balanced model begins from two opposing standpoints: a statist model of government controlling academia and industry, and a laissez-faire model with industry, academic and government separate and apart from each other, interacting only modestly across strong boundaries.*' In the idealized model, each helix has an equal role in collaboration; Cai and Etzkowitz (2020), however, remind us that balanced interactions between the three helices of university, industry and government hardly exist in reality.

4. University (Technology) Transfer

As said, in recent years, there has been a rapid expansion of the university's role in economic development, which has resulted in university technology transfer (UTT) taking place within an increasingly complex network of regional stakeholders (e.g. Etzkowitz 2008). More concretely, the university technology transfer is a process that connects university research outputs with business and investors. It is about identifying, protecting and marketing

university research outputs in order to shift opportunities from the university into business (Hockaday 2020).

Technology transfer means the movement of data, designs, inventions, material, software, technical knowledge or trade secrets from one organization to another, or from one purpose to another. Typically, technology transfer is seen to take place between universities, businesses and governments, either formally or informally, in order to share skills, knowledge, technologies, manufacturing methods, and much more. This form of knowledge transfer helps ensure that scientific and technological developments are available to a wider range of users who can then help develop or exploit it.

There are different policies, procedures and values that guide the technology transfer process.

5. University development and the third task

The process of technology transfer involves university development, which has a linkage to the well-known tasks or missions of a university. Traditionally, universities had two tasks, namely, research and education. More recently, these traditional tasks were completed by the third task of social and economic development (Etzkowitz 2003), which brought concepts such as life-long learning, social interaction, technology transfer and innovation development to the everyday at the university.

The third task has various definitions; according to a broad interpretation, it encompasses all other institutional activities except of those of teaching and research (Vorley & Nelles 2008), whereas in a narrow reading, it is defined as university-business cooperation or technology transfer (Adamsone-Fiskovica, Kristapsons, Tjunina & Ulnicane-Ozolina 2009). In any case, the emergence of the third mission is related to the involvement of universities in contributing to socio-economic development, and it has pushed universities into fostering entrepreneurship and exploiting innovations. Thus, one commonly used definition for the third task is related specifically to the role of entrepreneurship for social and economic development (Sam & van der Sijde 2014).

The university development can be viewed also from another perspective, in which the university proceeds from a stand-alone university, which is isolated in an ivory tower, to a connected university that is active in processes of technology transfer and knowledge exchange.

6. The traditional model of university technology transfer

A schematic of what can be called the traditional model of university technology transfer has been constructed as a synthesis of dominant paradigms and the extant literature related to technology transfer (Bradley, Hayter & Link 2013).

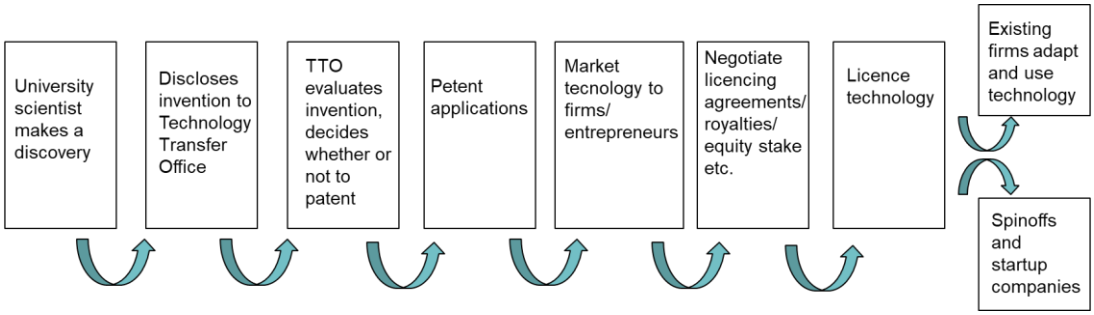

Figure 1 – Traditional model of university technology transfer (Bradley, Hayter & Link 2013)

The traditional model of the technology transfer process (Figure 1) is illustrated as a linear model (Bradley, Hayter & Link 2013). Accordingly, it begins with the process of discovery by a university scientist (Siegel et al. 2004), and, of course the academic research can come from any discipline or any department of a university. The scientist then discloses the invention to the university's technology transfer office (TTO). Once the invention is disclosed, the TTO evaluates the invention and decides whether or not to pursue acquiring a patent. Here, the TTO must consider the commercial potential of the invention, and the prospective interest from the public or private sector (Siegel et al. 2003). If the TTO decides to invest in the invention, the next phase is the patent application process. If the patent is awarded, the TTO starts marketing the technology to organizations and entrepreneurs. The goal of the marketing effort is to match the technology with an organization or entrepreneur that can best utilize the technology and thus provide opportunity for revenues to the university. As soon as a suitable partner is found, the university works with the organization or entrepreneur to negotiate a licensing agreement. The licensing agreement typically includes a royalty to the university, an equity stake in the start-up, or other such compensation. When an agreement is reached, the technology is officially licensed. After that, in the final stage of the process, the

organization or entrepreneur adapts and uses the technology. The original invention typically undergoes extensive adaptation during the process to commercialization. (Bradley, Hayter & Link 2013.)

7. Limitations of the traditional university technology transfer model

As Bradley, Hayter and Link (2013) addressed, university technology transfer is typically characterized by its linearity and formality. Here, the process begins with a discovery by a university scientist and follows a linear path from disclosure to the TTO to the invention being patented, marketed, and licensed to an existing firm for further development and commercialization or to a spinoff or start-up company being established around the invention (see, Figure 1). The traditional model is criticised for its inability to accurately capture the complexities of technology transfer process. The limitations of the traditional model fall into the following categories of inaccuracies and inadequacies (Bradley, Hayter & Link 2013):

- Inaccuracies
    - Strict linearity and oversimplification
    - Composition
    - One-size-fits-all
    - Overemphasis on patents
- Inadequacies
    - Formal vs. informal mechanisms
    - Organizational culture
    - Reward systems

The **inaccuracies** in the traditional model relate to discrepancies between academic postulations and how technology transfer is practiced in universities. The traditional model binds technology transfer to a rigid linear path, and it oversimplifies the underlying complexities of the process. The composition of the traditional model thus requires rearrangement and reorganization in order to capture the various branches of a practiced technology transfer process. A one-size-fits-all traditional model does not accurately depict

differences in technology transfer across disciplines, and forcing all disclosures to follow the traditional linear model's path to commercialization will likely ensure that many inventions fail in the transfer process. Finally, the traditional model places too much emphasis on the importance of patents as the primary output in the technology transfer process, thus overlooking other mechanisms for profitability and commercialization. (Bradley, Hayter & Link 2013.)

The **inadequacies** in the traditional model relate to processes that it fails to address. Firstly, the traditional linear model fails to acknowledge the importance of informal mechanisms of technology transfer. The organizational cultures of the university and of the firm impact the majority of the technology transfer process, but these elements are not much acknowledged or addressed in the traditional model. In addition, the types of reward systems in universities can greatly facilitate or impede faculty involvement in technology transfer activities, yet the traditional model has no representation of their influence. (Bradley, Hayter & Link 2013.)

8. Alternative views of university technology transfer

In the two previous sections, the traditional model of technology transfer was presented and its limitations were discussed. It is addressed that as universities become more entrepreneurial and look toward technology transfer into non-traditional fields, there is indeed a need for alternative conceptualizations of technology transfer that are more accurate and realistic than the traditional linear model and that are aligned with the nuances of the university to which they are applied. Building on these, Bradley et al. (2013) offer an alternative view of technology transfer. These include:

- Academic entrepreneurship/entrepreneurial university
- Open innovation
- Collaborative view

8.1. Alternative UTT view 1: Academic Entrepreneurship

Universities have amplified their entrepreneurial activities over the past few decades, especially as innovation derived from university–industry collaborations are increasingly recognized for their contributions to firm innovation and, therefore, regional economic growth. Such growth occurs in part through the role of universities in regional technology

development and revitalization (Bercovitz & Feldman 2006). Shifting policy decisions, university cultures that value technology transfer, and greater emphasis on licensing royalties for research universities, have influenced the transformation toward more entrepreneurial universities (Rogers et al. 2001; Rothaermel et al. 2007; Baycan & Stough 2012).

It is thus logical to incorporate the concept of **academic entrepreneurship** into the alternative model of technology transfer. There is a burgeoning body of literature on academic entrepreneurship. The concept can refer to a wide range of activities with the goal of commercializing innovations developed by scientists at universities (Siegel 2011). This growing research interest coincides with a growing recognition among policymakers of the need to put more emphasis on knowledge creation and exploitation in the form of entrepreneurship by universities (Chiesa & Piccaluga 2000). Hayter (2009) defines academic entrepreneurship as the establishment of new companies based on the research of university faculty. University spinoffs are indeed a primary output of academic entrepreneurship.

An **entrepreneurial university** is understood as both a knowledge-producer and a knowledge-disseminating institution that follows an interactive model of innovation, incorporating linear and reverse linear modes (Guerrero & Urbano, 2012; Etzkowitz 2003). The entrepreneurial university engages in innovative activities, which facilitate economic development, job creation, and competitiveness in global markets.

As the entrepreneurial university is seen as an important mission update for universities, for example, the European Commission (2013; 2014) and the European Commission and the OECD (2012) together published papers and guidelines to support universities' entrepreneurial development. One such help is the Guiding Framework for Entrepreneurial Universities[1] developed by the OEDC to help universities pursuing the goal of becoming entrepreneurial through a set of self-assessment process that also provides examples of inspiring projects that can be implemented. Another example is the ACEEU Toolkit for entrepreneurial university development.[2] The toolkit is a collection of instruments that support the analysis and development of the entrepreneurial profile of a university.

[1] For the OECD Guiding Framework for Entrepreneurial Universities, see: https://www.oecd.org/site/cfecpr/guiding-framework.htm and https://www.oecd.org/site/cfecpr/EC-OECD%20Entrepreneurial%20Universities%20Framework.pdf

[2] For the ACEEU Toolkit for entrepreneurial university development, see: https://toolkit.aceeu.org/

8.2. Alternative UTT view 2: Open Innovation

The second alternative university technology transfer view is the open innovation (Bradley, Hayter and Link 2013). The paradigm of open Innovation, conceptualized by Henry Chesbrough (2003b), was originally directed toward innovation in large multinational corporations, but there is an increasing interest in applying open Innovation to other types of firms and institutions, including universities, too.

The foundation of the open Innovation concept is that innovators integrate their ideas, expertise, and skills with those of others outside the organization to deliver results to the marketplace using the most effective means possible (Chesbrough, 2003a). For universities, this means obtaining innovations from outside sources to augment their own R&D and entrepreneurial activities.

In contrast to open innovation is the paradigm of closed innovation. Closed innovation strategies were the norm for most of the twentieth century, wherein a company generates, develops, and commercializes its own ideas. This approach is hindered by its linearity and restrictiveness. Toward the end of the twentieth century, the effectiveness of closed innovation began to deteriorate. Many industries are now transitioning from closed innovation to open innovation, and this paradigm is increasingly relevant for the twenty-first century university, too. (Bradley, Hayter & Link 2013.)

Employing open Innovation strategies can introduce multidirectional flows of knowledge and technology, allowing for more effective academic–industry collaborations. When knowledge and technology are able to flow freely to society and be transformed into useful applications, the innovations generated by universities will have the most efficient and significant impact on economic growth. Firms and universities that can embrace open, collaborative innovation strategies beyond the boundaries of their institutions will enjoy a competitive edge in today's global, decentralized technology transfer environment. (Bradley, Hayter & Link 2013.)

8.3. Alternative UTT view 3: Collaborative Model

A **collaborative model** is the third alternative view suggested by Bradley et al. (2013). They refer to this practice as "*somewhat more experimental*" and as "*the collaborative view of knowledge and technology transfer*" (ibid. p. 631). The collaborative view is characterized by low-cost, streamlined, transparent collaboration between participants, and it is better suited

toward the transfer of knowledge than of physical inventions, although both can be accomplished within the view. The collaborative view is constructed from the examination of several collaborative organizations that have developed legal and technical infrastructures, which allow participants to engage in knowledge- and idea-sharing that is a joint effort.

The collaborative organization serves as a platform for matching innovators with the partners and resources they need to develop their product. They host, maintain, and promote their web-based organization as an alternative to traditional methods of knowledge and technology transfer. The collaborative organization facilitates the academic–industry connection by gathering data from all participating institutions, often cataloguing it into databases. (Bradley, Hayter & Link 2013.)

Practices that emulate the collaborative view facilitate the technology transfer process by making knowledge transfer simple. The options provided by the collaborative organization allow innovations to be developed and commercialized as a joint effort, or released into the public domain to be used by any interested party. The benefits of organizations utilizing a collaborative view of technology transfer include reduced costs of technology transfer activities, a freer exchange of knowledge and ideas, and accelerating innovations to market. The collaborative model is in many ways the antithesis of the traditional linear model; it is fluid and continual, and allows knowledge and innovation to flow amongst participants with few limitations of structure or bureaucracy. In today's digital age, it seems beneficial to take advantage of the global connection the Internet provides and to formulate a method of technology transfer that is equally global and connective. (Bradley, Hayter & Link 2013.)

9. University technology transfer in practice – motivation

Now that we have gone through the university technology transfer models and practices, it is good to draw attention to the motivation for university technology transfer, especially from the perspective of a university.

To start with, technology transfer enables a better utilization of the research outcome; there is high-class applied research, collaborative research, patenting, licensing and spin-offs, also innovation development. Another important issue, which is often ignored in technology transfer discussion, is the increased working life relevance in education; through various

technology transfer activities, university education can become more related and synchronized with the working life, and thus the changing needs of the society might be better recognized. Finally, technology transfer activities help universities to create and facilitate development programs in order to impact regional and national development.

In the end, the ultimate goal for academia is impact.

10. University technology transfer strategy and actions

From the perspective of a university, there are critical strategic issues concerning the technology transfer that are to be considered, including the following:

- How to interpret and emphasize technology transfer - is it seen as technology management, innovation development, or more as societal interaction?
- The general orientation – are technology transfer activities and development supported by the top management? And, from a broader perspective, is university technology transfer an accepted and appreciated activity in the academia, or is it seen more as a side-track that concerns only few?
- Regarding technology transfer activities, the university should include the following in its repertoire, and at the same, decide upon implementation:
    - Research planning support
    - Research funding support
    - Recognition of research results to be utilized
    - Mechanisms to evaluate research results
    - Ownership of the results
    - Protecting procedures, regulations, legal support
    - Commercialization/utilization

It is often a matter of preference how these issues are valued and solved within an organization.

11. There is a whole ecosystem to consider!

We have learned that the whole concept of university technology transfer has opened up universities and given them a critical role in the society and regional development (e.g. Etzkowitz 2008), yet many researchers argue that a bigger picture is needed, and more various activities are required. It is further argued that despite the development of technology transfer activities, university-business cooperation is still often fragmented and occasional – and it is not the way to success. Therefore, it is important to start considering the entire university-business cooperation ecosystem and at the same time, move towards an overall university-wide approach for collaborating with business.

12. Some ecosystem examples – case University of Turku

In this section, there are some examples of the university ecosystem approach in technology transfer that have been successful in the University of Turku, in Finland.

The University of Turku has developed/is active member of collaborative platforms, which are entities located either within or outside the university. A **Corporate Corner**[3] is one such platform, which is a collaborative concept between academia and industry, with a specific focus on medical science.

Another collaborative platform, called the **Health Campus Turku**,[4] is a multidisciplinary knowledge cluster within medicine, social and health care and technology offering opportunities for research, innovation and corporate collaboration.

The third case example is the most recent platform, the **TechCampus Turku**.[5] It promotes technology education and research in the four higher education institutions in Turku, and at the same, it unites the resources of the higher education institutions to support the product development and innovation activities of the local companies.

[3] For the Corporate Corner, see: https://www.utu.fi/en/business-collaboration/corporate-corner
[4] For Health Campus Turku, see: https://www.healthcampusturku.fi/
[5] For TechCampus Turku, see: https://teknologiakampus.turkubusinessregion.com/en/

The final ecosystem case example, **Boost Turku**[6] is a student-driven non-profit association that inspires growth-minded young students and entrepreneurs in the four higher education institutions of Turku.

13. Conclusions

This video lesson has provided the basics of the university technology transfer strategies and ecosystems. The lesson has covered the topics of the triple helix model of innovation, the concept of university technology transfer, and the related strategic considerations, as well as a broader ecosystem of the university technology transfer. At the end of the lesson, some case examples of the University of Turku's ecosystem were presented.

In concluding this M4-3 lesson, the following critical issues concerning university technology transfer can be pointed out:

- The university technology transfer is one, increasingly useful and relevant view to link universities with their surrounding environment.
- The baseline here is to collaborate with others around, that is, locally, nationally and internationally – based on the needs and orientation of a university.
- There are different models and approaches for the collaboration, and the applicability is contextual. Therefore, it is utterly important to understand the environment in which the university operates.
- Finally, it is crucial to notice that the entrepreneurial transformation requires more than just updated strategies, structures and facilities of a university. Therefore, instead of often-fragmented, occasional collaboration, universities should try to move towards an encompassing ecosystem approach of the technology transfer. In addition, the people in the university matter too.

[6] For Boost Turku, see: https://boostturku.com/

14. Bibliography

Adamsone-Fiskovica, A., Kristapsons, J., Tjunina, E. & Ulnicane-Ozolina, I. (2009) Moving Beyond Teaching and Research: Economic and Social Tasks of Universities in Latvia. *Science and Public Policy*, 36(2), 133–¬137.

Baycan, T. & Stough, R. R. (2012) Introduction: Commercialization of Knowledge in a Regional Context: New Perspectives. *Annals of Regional Science*. Special Issue Editorial.

Bercovitz, J. & Feldman, M. (2006) Entrepreneurial Universities and Technology Transfer: A Conceptual Framework for Understanding Knowledge-based Economic Development. *Journal of Technology Transfer*, 31(1), 175–188.

Bradley, S.R., Hayter, C.S. & Link, A.N. (2013) Models and methods of university technology transfer. *Foundations and Trends® in Entrepreneurship*, 9(6), pp.571-650.

Cai, Y. & Etzkowitz, H. (2020) Theorizing the Triple Helix Model: Past, Present, and Future. *Triple Helix*, 7(2–3), 189–226.

Chesbrough, H. (2003a) The Era of Open Innovation. *MIT Sloan Management Review*, 44(3), 35–41.

Chesbrough, H. (2003b) *Open Innovation: The New Imperative for Creating and Profiting from Technology.* Boston: Harvard Business School Press.

Chiesa, V. & Piccaluga, A. (2000) Exploitation and Diffusion of Public Research: The Case of Academic Spin-off Companies in Italy. *R&D Management*, 30(4), 329–340.

Etzkowitz, H. (2008) *The Triple Helix: University-Industry-Government Innovation in Action*. New York, NY: Routledge.

Etzkowitz, H. (2003) Research Groups as 'Quasi-firms': The Invention of the Entrepreneurial University. *Research Policy*, 32(1), 109–121.

Etzkowitz, H. & Leydesdorff, L. (1999) The Future Location of Research and Technology Transfer. *The Journal of Technology Transfer*, 24(2), pp.111-123.

Etzkowitz, H. & Leydesdorff, L. (2000) The Dynamics of Innovation: From National Systems and "Mode 2" to a Triple Helix of University–Industry–Government Relations. *Research Policy*, 29(2), 109–123.

Etzkowitz, H., Webster, A., Gebhardt, C. & Terra, B. (2000) The Future of the University and the University of the Future: Evolution of Ivory Tower to Entrepreneurial Paradigm. *Research Policy*, 29(2), 313–330.

European Commission (2013) *Entrepreneurship 2020 Action Plan: Reigniting the Entrepreneurial Spirit in Europe*. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2012) 795 final, January 2013. Brussels: European Commission. URL: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0795:FIN:en:PDF.

European Commission (2014) *Entrepreneurship Education: A Guide for Educators*. Brussels: European Commission, Directorate-General for Enterprise and Industry. URL: https://data.europa.eu/doi/10.2769/51003

European Commission & OECD (2012) *A Guiding Framework for Entrepreneurial Universities*. Final version 18th December 2012. URL: https://www.oecd.org/site/cfecpr/ECOECD%20Entrepreneurial%20Universities%20Framework.pdf.

Guerrero, M. & Urbano, D. (2012) The Development of an Entrepreneurial University. *Journal of Technology Transfer,* 37(1), 43–74.

Hayter, C. (2009) *The Open Innovation Imperative: Perspectives on Success from Faculty Entrepreneurs*. Ph.D. Dissertation, George Washington University.

Hockaday, T. (2020) *University Technology Transfer: What it is and how to Do it*. JHU Press.

Jones-Evans, D. & Klofsten, M. (1997) Universities and Local Economic Development – The Case of Linköping, Sweden. *European Planning Studies*, 5(1), 77–94.

Rogers, E. M., Takegami, S. & Yin, J. (2001) Lessons Learned about Technology Transfer. *Technovation*, 21(4), 253–261.

Rothaermel, F., Agung, S. & Jiang, L. (2007) University Entrepreneurship: A Taxonomy of the Literature. *Industrial and Corporate Change*, 16(4), 691–791.

Sam, C. & van der Sijde, P. (2014) Understanding the Concept of the Entrepreneurial University from the Perspective of Higher Education Models. *Higher Education*, 68(6), 891–908.

Siegel, D. S. (2011) Academic Entrepreneurship: Lessons Learned for University Administrators and Policymakers. Paper presented at the Strategic Management of Places Conference, December 13, 2011.

Siegel, D. S., Waldman, D. A., Atwater, L. & Link, A. N. (2004) Toward a Model of the Effective Transfer of Scientific Knowledge from Academicians to Practitioners: Qualitative Evidence from the Commercialization of University Technologies. *Journal of Engineering and Technology Management*, 21(1–2), 115–142.

Siegel, D. S., Waldman, D. A. & Link, A. N. (2003) Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices: An Exploratory Study. *Research Policy*, 32(1), 27–48.

Vorley, T. & Nelles, J. (2008) (Re)Conceptualising the Academy: Institutional Development of and Beyond the Third Mission. *Higher Education Management and Policy*, 20(3), 1–17.

Zhang, Q., MacKenzie, N.G., Jones-Evans, D. & Huggins, R. (2016) Leveraging Knowledge as a Competitive Asset? The Intensity, Performance and Structure of Universities' Entrepreneurial Knowledge Exchange Activities at a Regional Level. *Small Business Economics*, 47(3), 657–675.