Faculty Participation in Technology Commercialization: The Roles of Process, Policies and Career

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Abstract: Technology commercialization has become an increasingly important activity for European and U.S. universities. Among the reasons for this importance have been declining government financial support for public universities, greater accountability to funding agencies, and increased expectations for commercialization revenues. Combined with recent economic uncertainty, the search for additional revenue sources has accentuated the need to better involve faculty in successful technology commercialization efforts. Thus, university administrators and technology managers face challenges in attracting, engaging, and retaining faculty participation in this effort. This paper reviews the relevant literature to understand how tenure and promotion policies can incentivize or disincentivize faculty members from pursuing technology commercialization projects. Prior research has focused primarily on the determinants of performance and benchmarking issues while faculty career path choices have been neglected. We address this gap in the literature by considering technology commercialization, faculty choice, and institutional policies in tandem. We conducted a systematic review of relevant literature on faculty involvement in technology commercialization and identified incentives and impediments for pursuing technology commercialization. Next we developed research hypotheses drawn from the literature review to assess faculty attitudes and activities, and their career development stage, based on the literature. Data collected through surveys will be used to test the hypotheses. We propose that the choice to participate in technology commercialization is a risk-payoff decision for faculty that depends on their career stage and subject matter area of work. As the faculty member becomes more secure in their position, such as tenured, the perceived risk of participation declines while the perceived reward value of incentives increase. As this perception changes due to career stage progress, we expect that faculty will be more inclined to participate in technology commercialization activities. We discuss how choices involving technology commercialization projects relate to a faculty career path and institutional technology commercialization policies, and how these policies are used to promote faculty participation in technology commercialization projects.

Keywords: Technology commercialization, Public policy, Promotion and tenure, Innovation, Academic entrepreneurship

1. Introduction

Successful university technology commercialization requires faculty, university administrators, and students to work together to form a company. Over recent years, many universities have promoted entrepreneurial training programs to engage graduate and doctoral students. Federal agencies such as NSF's I-Corps program have also promoted postdocs and faculty engagement in technology commercialization through formal training processes (Wright, Siegel, and Mustar, 2017). Thus, graduate-level students, postdocs, and faculties are becoming increasingly aware of the opportunities.

Having strong programs in place at the national level to support technology commercialization, such as NSF's STTR, SBIR, and I-Corps programs, can provide researchers with the support, training, and funding necessary to move ideas from the lab to the market. The internet, DNA amplification, 3D printing, magnetic resonance imaging (MRI), and Lasik eye surgery are just a few examples of world changing inventions supported by NSF programs (nsf.gov, 2024). Similarly, a university that has a capable, experienced, well staffed, and well funded technology commercialization unit can be a foundational conduit of innovations that are successful in the market and yield millions in licensing royalties for the university. UCLA received US $1.6 billion in royalty fees, patent income, and reimbursement payments from its development of Xtandi, an innovative prostate cancer drug, before selling future royalty interests for US $1.14 billion and potential additional payments based on future Xtandi sales (UCLA, 2016). As universities face financial uncertainties, having sources of royalty revenues can offer support for research and technology commercialization programs.

An extensive literature review of incentives and impediments for faculty engaging in technology transfer and commercialization indicates that royalties, patenting and licensing, publications are the biggest drivers to incentivize faculty participation, while misaligned reward systems and conflicts of interest are significant impediments to faculty participation.

2. Theoretical Background

Since the Bayh-Dole Act in 1980, academic entrepreneurship in the context of technology transfer and commercialization has become an important activity function for European and U.S. universities for various

reasons. This includes greater accountability to funding agencies, declining government financial support for public universities, and increased expectations for commercialization revenues. Additionally, recent economic uncertainty exacerbated the search for additional revenue which includes increased faculty involvement in successful technology commercialization.

2.1 Organizational Level Factors Affecting Participation in Technology Commercialization

2.1.1 National programs

National policies and programs to support technology transfer and commercialization have been offered by various federal agencies but until recently have received limited attention by academic entrepreneurship researchers. With recent changes to university funding models, academic entrepreneurship in the context of technology transfer and commercialization has become an increasingly important matter for universities.

In the US, the Bayh-Dole Act in 1980 opened a path for universities to commercialize their federally funded research. However, universities did not develop programs to facilitate technology transfer and commercialization until years later. As US universities have become more responsive to the benefits of technology, programs for promoting and supporting technology transfer on campus have become prevalent (Mowery et al, 2001). Similarly, other countries have adopted national programs to support faculty entrepreneurship, such as France's national program that allows university faculty, previously constrained, to set up university affiliated ventures (Mustar and Wright 2010). Similar national programs are Germany's EXIST (Ayoub, Gottschalk, and Müller, 2017), Canada's NRC Industrial Research Assistance Program (Niosi, 2006), and the NSF I-Corps program in the US (Huang, Fay, and Sheridan, 2017). Other related national programs designed to support academic entrepreneurship and technology commercialization include funding, such as the NSF SBIR/STTR in the US (Toole and Czarnitzki 2009; Siegel and Wessner 2012), innovation agencies and funding programs in France and the UK (Mustar and Wright, 2010), science parks, research centers, innovation awards programs, and entrepreneurship training programs (Hayter et al, 2018).

2.1.2 University programs and policies

On a university level, we consider the various programs and policies that universities provide for faculty academic entrepreneurs to encourage and support technology transfer and commercialization. Programs vary in implementation and results (Degroof and Roberts 2004; Wright et al. 2009) with some efforts were found to encourage licensing, related revenue sharing, and startups (Siegel et al. 2003a; Muscio, Quaglione, and Ramaciotti. 2016), while others were found to be discouraging (Markman et al., 2004).

For example, organizational incentives for participating in technology commercialization can be effective, such as a favorable royalty distribution formula in a licensing transaction that is shared with the faculty member who develops new technology (Link, Siegel, and Bozeman, 2007; Markman, Gianiodis, and Phan, 2008; Friedman and Silberman, 2003; Owen-Smith and Powell, 2003). Encouraging efforts can be expanded to include sharing royalty and licensing income with faculty, internally investing in technology transfer projects through internal funding or investing, and establishing relationships with local industry partners through research projects and student engagement. University technology transfer offices (TTOs) can serve a role in connecting inventors and commercialization oriented faculty with external industry partners interested in such projects. Other units on campus can help with related aspects such as patenting, copyrighting, licensing, and funding.

From a policy perspective, recognizing efforts to secure government or external funding for technology commercialization projects, such as NSF I-Corps, SBIR and STTR award programs, and private foundation support can encourage faculty participation. However, recognition is uneven across campus as some academic units, such as sciences and engineering, more often recognize TC efforts than other academic disciplines. Also, universities benefit from such external awards through financial support for the project and finance and administration (F&A) overhead charges that can be used to support university TTO units.

Unintended problems can occur due to inappropriate staffing and compensation practices of the TTO (Siegel, et al., 2003a,b), including a high turnover rate of technology licensing officers that can undermine the development of long term relationships between the university and industry, and insufficient business and marketing experience of TTO staff (Siegel, 2018; Markman, Siegel and Wright, 2008), which can be further complicated by differences in culture and perspective between faculty and staff and those in private industry (Palmintera, Joy, and Lin, 2007).

2.2 Individual Level Factors Affecting Participation in Technology Commercialization

It is important to consider faculty perspectives when reviewing technology transfer and commercialization programs as faculty perspectives may not align with university expectations, commercialization projects may take away valuable faculty time from teaching and research, or faculty may put their academic responsibilities ahead of industry concerns and project deadlines (Palmintera, Joy, and Lin, 2007). Also faculty perspectives may differ regarding whether a project is an opportunity or worth the effort. For example, untenured faculty may feel that participating is risky if technology transfer activities are not officially considered in faculty tenure decisions (Hamilton and Schumann, 2016; Renault, 2006). Female faculty members, tenured or not, may feel a bias against their efforts as male and tenured faculty members are more likely to engage in all types of technology transfer (Link, Siegel, and Bozeman, 2007). Also, the need for faculty researchers to publish as a requirement for tenure and promotion may conflict with the corporate need for confidentiality (Palmintera, Joy, and Lin, 2007).

Within the context of this project, we consider the different activities a faculty member has over their career such as teacher, researcher, administrator, along with the various nonwork roles they may have such as spouse, partner, parent, and community member, each of which represent additional responsibilities and commitments.

2.3 Influence of Faculty Career Stage on Participation in Technology Commercialization

There is a well developed research stream regarding careers, and in particular, the careers of academics (Zacher et al, 2019). However, few have addressed the influence of faculty career stage on the propensity to engage in technology transfer and commercialization activities.

Zacher et al (2019) characterized a career as the sequence and combinations of work-related roles people occupy across their lifespan (Arthur, Hall, and Lawrence, 1989; Super, 1980) and then distinguished career development as the process by which both individuals and their employers manage various tasks, behaviors, and experiences within and across jobs and organizations over time, with implications for employees' work-related identity (Brown, 2002; Greenhaus, Callanan, and Godschalk, 2000). For our purpose, Zacher et al's (2019) distinction highlights that career development research focuses on how individual and contextual factors influence changes in a person's career over time.

It is important to note that academic career development research and practice addresses scholarly-trained individuals at various ranks and employment arrangements (Baldwin and Blackburn, 1981). Within this study, our consideration is the interplay between the faculty member's activity choices at various stages of their career in regard to the policies and programs they encounter in their workplace organization. Most academic faculty engage in research, teaching, and administrative roles throughout or in particular phases of their careers. For instance, a professor may begin their career doing research, teaching classes, and later in their career taking on administrative roles, such as department chair or dean, and these roles may change based on changing circumstances faced during their career. Another important characteristic noted by Zacher et al (2019), originally observed by Roach and Sauermann (2010), is that compared to other occupations, academics typically have high intrinsic work motivation and a "taste for science" (p. 422) and they are more willing to accept a relatively lower salary, putting high value on working conditions that provide independence and flexibility. This is important when we later consider how faculty members evaluate career choices regarding technology transfer and commercialization.

Following Zacher, et al. (2019), we consider social cognitive career theory (Lent and Brown, 1996; Lent, Brown, and Hackett, 1994) and life-span, life-space theory (Super, 1980; Super, Savickas, and Super, 1996) as important frameworks for this study. Both are used in career development research and include content and process aspects of career development (Brown and Lent, 2016; Lent and Brown, 2013). We first discuss social cognitive career theory followed by a discussion of lifespan, life-space career theory.

Social cognitive career theory (SCCT) focuses on the development of career interests, making career choices, and individual and contextual influences on career behavior (Lent et al., 1994; Lent and Brown, 1996). The theory emphasizes individual agency, or a person's ability and motivation to influence their environment and their own career development. SCCT emphasizes the motivational roles of self-efficacy, outcome expectations, and performance goals and holds that self-efficacy and outcome expectations work in conjunction with ability by influencing the types of performance goals that people set for themselves.

Three important aspects are:

1. *individual characteristics and personal resources* which include demographic characteristics, personality traits, as well as relatively stable abilities, beliefs, attitudes, and motivation,
2. *contextual influences on career development* that include working conditions, social support, networks, career development programs and specific interventions, specific academic disciplines, professional societies, and societal and cultural contexts, and
3. *active regulation of behavior* in the context of career development or career choices and effort to achieve career goals (Lent et al., 2002), including actions related to academic career development, such as goal setting, long-term planning, specific strategies, and feedback (Zacher and Frese, 2018).

The important aspects of SCCT for this project are the roles of self-efficacy, outcome expectations, performance goals, and how self-efficacy and outcome expectations work in conjunction with ability, in part by influencing the types of performance goals that people set for themselves.

Next, we consider life-span, life-space theory (Super, 1980; Super et al., 1996) to identify additional important aspects of academic career development. Like SCCT, lifespan, life-space theory also considers individual and contextual characteristics, but its primary focus is on different life and career stages, as well as the work and nonwork roles that people occupy across their lifespan.

Based on lifespan, life-space theory, Zarcher, et. al, (2019) included two additional themes: (1) academic career development in and across different career stages, and (2) academic career development related to different work and nonwork roles. Regarding career stages within the developmental perspective of lifespan, life-space theory, Zarcher, et. al, (2019) reviewed studies that focus on distinct career stages, including early, middle, and late career (Slocum and Cron, 1985), as well as career stages involving growth, exploration, establishment, maintenance, and decline, and included a lifespan developmental approach to academic career development (Fasbender and Deller, 2017; Ng and Feldman, 2012).

Regarding work and nonwork roles, a central tenet of life-span, life-space theory is that people may occupy multiple work and nonwork roles at a single point in time and across their careers and lives (Super, 1980), which includes the academic career development of people in different life roles, such as professor and parent, and in several specific roles within the work context, such as a professor in teaching and administration roles.

3. Research Hypotheses

Based on the above discussion of technology transfer programs and policies and faculty career stages, we propose the following research propositions:

Hypothesis 1a: Organizational level factors positively and negatively affect faculty participation in technology commercialization.

Hypothesis 1b: Faculty career stage will moderate the effect that organizational level factors have on faculty participation in technology commercialization.

Hypothesis 2a: Individual level factors positively and negatively affect faculty participation in technology commercialization.

Hypothesis 2b: Faculty career stage will moderate the effect that individual level factors have on faculty participation in technology commercialization.

4. Methodology

In general terms, the methodology employed in this study will use survey questions based on the theoretical model constructs and relationships to query faculty at US universities on how organizational level factors, individual level factors, and career stage influence their participation in technology commercialization.

Figure 1 below shows the hypothesized relationships in the theoretical model.

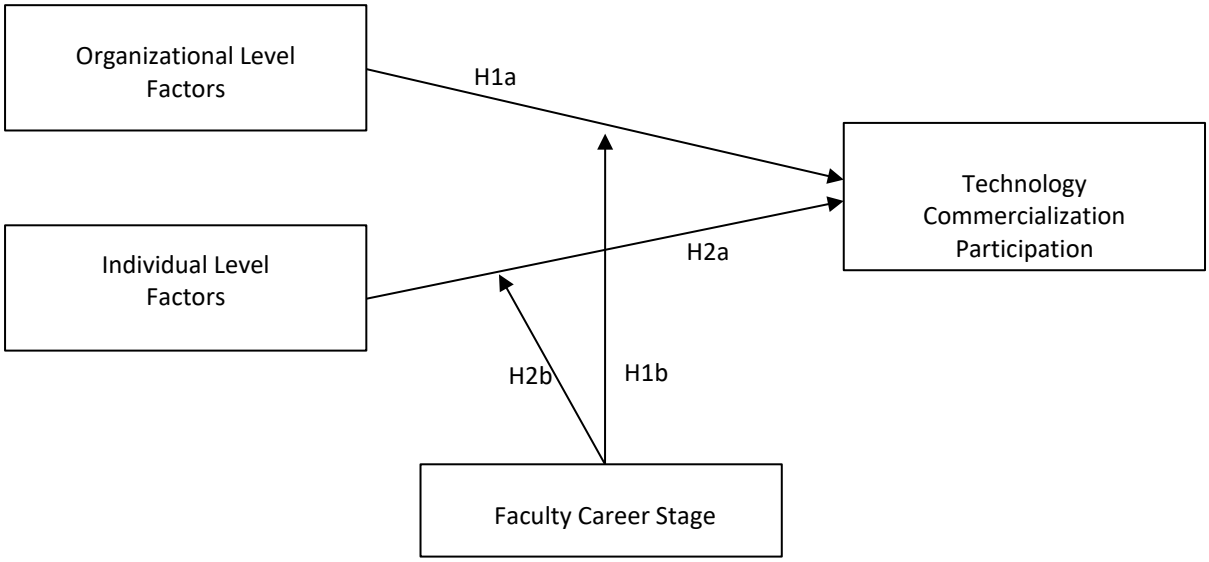

Figure 1: Theoretical model of the relationships between organizational and individual level factors on technology commercialization participation as moderated by faculty career stage

4.1 Operationalizing Key Concepts

For the purpose of this project, we define "technology commercialization" as the process of conveying results stemming from scientific and technological research to the marketplace and to wider society, along with associated skills and procedures. Examples of technology transfer include but are not limited to filling an invention disclosure, filing for a patent, copyright, or trademark, attempting to secure a licensing agreement, launching a startup or university spinoff, and other similar activities.

To operationalize "organizational level factors", faculty will be asked about their views regarding factors such as, but not limited to, university technology transfer and commercial programs and policies, prevalence on campus of national technology commercialization programs, such as NSF SBIR/STTR and I-Corps, sponsorship and funding relationships related to technology commercialization with private agencies on campus, technology transfer unit activities, university promotion and tenure policies related technology commercialization, and the general organizational climate relating to technology commercialization on campus.

To operationalize "individual level factors", faculty will be asked about their views regarding factors such as, but not limited to, entrepreneurial identity, role identity salience, ambivalence, supervisor championing, recent technology commercialization efforts, and technology commercialization intentions. Also, faculty will be asked about demographic characteristics, including but not limited to their age, gender, marital status, race/ethnicity, immigration status, highest education degree, scientific field or academic discipline, current position, tenure status, and years of experience.

To operationalize "faculty career stages", we will use a stage classification model developed in prior research and used in government job classifications. Based on Super's (1980) developmental dimension of the career lifespan theory, it is a widely accepted career development theory, and often applied to academic careers (Arthur, Hall, and Lawrence 1989; Lent and Brown 2013; Zacher et al., 2019). Moreover, academic positions are commonly structured in a four-tier system ranging from doctoral studies, postdoc and junior positions, lower-level senior to higher-level senior positions.

We will use a measure of career stages developed by Euraxess, a European Union backed platform listing vacancies for academic positions from countries in Europe and elsewhere, and adapted by Mantai and Marrone (2023) for a study of academic disciplines. The four career stages are:

- R1: First Stage Researcher (up to the point of PhD), includes research assistant and PhD roles
- R2: Recognised Researcher (PhD holders or equivalent who are not yet fully independent), includes post-doc, lecturer and senior lecturer roles
- R3: Established Researcher (researchers who have developed a level of independence), includes associate professor roles
- R4: Leading Researcher (researchers leading their research area or field), includes full professor roles

This four-tier structure is based on the European Commission (2011) framework and is common in academic careers world-wide (Fumasoli, Goastellec, and Kehm, 2015). This four category structure corresponds well to the stages discussed in the life-span, life-space theory (Super, 1980; Super et al., 1996), and is used to classify career stages in this study.

4.2 Survey and Data Collection

We will recruit faculty respondents from a range of academic faculty members from various disciplines, research areas, universities, and locations. We will develop a survey using accepted or adapted questions to test the hypotheses proposed as described above. Item responses will use a Likert scale. Survey questions and items will be pretested for validity and reliability. Surveys will be administered through a qualtrics-type platform. Data will be analyzed using statistical analysis software.

5. Discussion

Technology commercialization may never progress or come into existence without the human researcher's involvement. It is the participation of academic entrepreneurs and faculty researchers who provide the spark of ingenuity and vision of what can be that create innovation and take those ideas through development to viability. In this study we look to better understand how these individual faculty members view technology commercialization activities of the course of their career. Despite the importance of understanding the human players in this process, research into this area is sparse. Most of the work looking at the faculty member's professional and private lives focus on work life balance in terms of the organizational support for aspects of an employee's personal life (Balven, Fenters, Siegel and Waldman, 2018; Beauregard and Henry, 2009; Estes and Michael, 2005). The recognition of a faculty member having multiple roles at one time and over a career, roles that may conflict with each, has received only scant attention. Balven, et al. (2018) note that faculty concerns about not having enough time available for both academic and entrepreneurial activities highlight the importance of how organizational level factors may affect academic entrepreneurship.

6. Conclusion

In this study, our hypotheses are that the faculty career stage will moderate the effect both organizational and individual level factors have on faculty participation in technology commercialization. We proposed that faculty choice to participate in technology commercialization is a decision that depends on their career stage and is affected by both factors. In this paper we review relevant literature, offer research hypotheses, and describe how we will test our hypotheses. The relevant literature indicates that future work in academic entrepreneurship considers how processes regarding work life and role balance are swayed by university policy. Despite the importance of understanding the human players in this process, research into this area is sparse. This study seeks to address this gap in academic entrepreneurship and technology commercialization literature.

References

Arthur, M.B., Hall, D.T. and Lawrence, B.S. (1989) Generating new directions in career theory: The case for a transdisciplinary approach. *Handbook of career theory*, *7*, p.25.

Ayoub, M.R., Gottschalk, S. and Müller, B. (2017) Impact of public seed-funding on academic spin-offs. *The Journal of Technology Transfer*, *42*, pp.1100-1124.

Balven, R., Fenters, V., Siegel, D.S. and Waldman, D., (2018.) Academic entrepreneurship: The roles of identity, motivation, championing, education, work-life balance, and organizational justice. *Academy of Management Perspectives*, *32*(1), pp.21-42.

Beauregard, T.A. and Henry, L.C., (2009) Making the link between work-life balance practices and organizational performance. *Human resource management review*, *19*(1), pp.9-22.

Brown, D. (2002) *Career choice and development*. John Wiley & Sons.

Baldwin, R.G. and Blackburn, R.T. (1981) The academic career as a developmental process: Implications for higher education. *The Journal of Higher Education*, *52*(6), pp.598-614.

Brown, S.D. and Lent, R.W. (2016) Vocational psychology: Agency, equity, and well-being. *Annual review of psychology*, *67*, pp.541-565.

Degroof, J.J. and Roberts, E.B. (2004) Overcoming weak entrepreneurial infrastructures for academic spin-off ventures. *The Journal of technology transfer*, *29*(3), pp.327-352.

Estes, S.B., and Michael, J. (2005) *Work-family policies and gender inequality at work.* Philadelphia: The work and Family Researchers Network. Retrieved from https//workfamily.sas.upenn.edu/wfrn-repo/object/q8hs4no9i934jm6r

European Commission (2011) Towards a European framework for research careers. *Directorate general for research & innovation*. Directorate B- European Research Area Skills.

Fumasoli, T., Goastellec, G. and Kehm, B.M. eds., (2015) *Academic work and careers in Europe: Trends, challenges, perspectives* (Vol. 12). Dordrecht: Springer.

Friedman, J. and Silberman, J. (2003) University technology transfer: do incentives, management, and location matter?. *The Journal of technology transfer*, *28*(1), pp.17-30.

Fasbender, U. and Deller, J. (2017) Career management over the life-span. *The Palgrave handbook of age diversity and work*, pp.705-736.

Greenhaus, J.H., Callanan, G.A. and Godshalk, V.M. (2000) Career Management.(3rd edn) Fort Worth.

Huang-Saad, A., Fay, J. and Sheridan, L. (2017) Closing the divide: accelerating technology commercialization by catalyzing the university entrepreneurial ecosystem with I-Corps™. *The Journal of Technology Transfer*, *42*(6), pp.1466-1486.

Hamilton, C. and Schumann, D. (2016) Love and hate in university technology transfer: examining faculty and staff conflicts and ethical issues. *The Contribution of Love, and Hate, to Organizational Ethics*, pp.95-122.

Hayter, C.S., Nelson, A.J., Zayed, S. and O'Connor, A.C. (2018) Conceptualizing academic entrepreneurship ecosystems: A review, analysis and extension of the literature. *The Journal of Technology Transfer*, *43*, pp.1039-1082.

Link, A.N., Siegel, D.S. and Bozeman, B. (2007) An empirical analysis of the propensity of academics to engage in informal university technology transfer. *Industrial and corporate change*, *16*(4), pp.641-655.

Lent, R.W. and Brown, S.D. (1996) Social cognitive approach to career development: An overview. *The career development quarterly*, *44*(4), pp.310-321.

Lent, R.W. and Brown, S.D. (2013) Social cognitive model of career self-management: toward a unifying view of adaptive career behavior across the lifespan. *Journal of counseling psychology*, *60*(4), p.557.

Lent, R.W., Brown, S.D. and Hackett, G. (1994) Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of vocational behavior*, *45*(1), pp.79-122.

Lent, R.W., Brown, S.D. and Hackett, G. (2002) Social cognitive career theory. *Career choice and development*, *4*(1), pp.255-311.

Muscio, A., Quaglione, D. and Ramaciotti, L. (2016) The effects of university rules on spinoff creation: The case of academia in Italy. *Research Policy*, *45*(7), pp.1386-1396.

Mowery, D.C., Nelson, R.R., Sampat, B.N. and Ziedonis, A.A. (2001) The growth of patenting and licensing by US universities: an assessment of the effects of the Bayh–Dole act of 1980. *Research policy*, *30*(1), pp.99-119.

Markman, G.D., Gianiodis, P.T. and Phan, P.H. (2008) Full-time faculty or part-time entrepreneurs. *IEEE transactions on engineering management*, *55*(1), pp.29-36.

Markman, G.D., Gianiodis, P.T., Phan, P.H. and Balkin, D.B. (2004) Entrepreneurship from the ivory tower: do incentive systems matter?. *The Journal of Technology Transfer*, *29*(3), pp.353-364.

Markman, G.D., Siegel, D.S. and Wright, M. (2008) Research and technology commercialization. *Journal of Management Studies*, *45*(8), pp.1401-1423.

Mantai, L. and Marrone, M. (2023) Academic career progression from early career researcher to professor: what can we learn from job ads. *Studies in higher education*, *48*(6), pp.797-812.

Mustar, P. and Wright, M. (2010) Convergence or path dependency in policies to foster the creation of university spin-off firms? A comparison of France and the United Kingdom. *The Journal of Technology Transfer*, *35*, pp.42-65.

Niosi, J. (2006) Success factors in Canadian academic spin-offs. *The Journal of Technology Transfer*, *31*, pp.451-457.

Ng, T.W. and Feldman, D.C. (2012) 8 Aging and Participation in Career. *The Oxford handbook of work and aging*, p.137.

NSF.gov (2024) *NSF Impacts.* U.S.National Science Foundation. Retrieved from https://new.nsf.gov/impacts.

Owen-Smith, J. and Powell, W.W. (2003) The expanding role of university patenting in the life sciences: assessing the importance of experience and connectivity. *Research Policy*, *32*(9), pp.1695-1711.

Palmintera, D., Joy, J. and Lin, E.X. (2007) Technology transfer and commercialization partnerships. *Innovation Associates, Inc*.

Renault, C.S. (2006) Academic capitalism and university incentives for faculty entrepreneurship. *The Journal of Technology Transfer*, *31*, pp.227-239.

Roach, M. and Sauermann, H. (2010) A taste for science? PhD scientists' academic orientation and self-selection into research careers in industry. *Research policy*, *39*(3), pp.422-434.

Super, D.E. (1980) A life-span, life-space approach to career development. *Journal of vocational behavior*, *16*(3), pp.282-298.

Super, D.E., Savickas, M.L. and Super, C.M. (1996) The Life-span, Lifespace Approach to Careers: in D. Brown & L. Brooks. *Career choice and development*, *3*, pp.121-178.

Siegel, D.S. (2018) Academic entrepreneurship: Lessons learned for technology transfer personnel and university administrators. *World Scientific Reference on Innovation: Volume 1: University Technology Transfer and Academic Entrepreneurship*, pp.1-21.

Siegel, D.S. and Wessner, C. (2012) Universities and the success of entrepreneurial ventures: Evidence from the small business innovation research program. *The Journal of Technology Transfer*, *37*, pp.404-415.

Siegel, D.S., Waldman, D.A., Atwater, L.E. and Link, A.N. (2003b) Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. *The Journal of High Technology Management Research*, *14*(1), pp.111-133.

Siegel, D.S., Waldman, D. and Link, A. (2003a) Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. *Research policy*, *32*(1), pp.27-48.

Siegel, D.S., Veugelers, R. and Wright, M. (2007) Technology transfer offices and commercialization of university intellectual property: performance and policy implications. *Oxford review of economic policy*, *23*(4), pp.640-660.

Slocum Jr, J.W. and Cron, W.L. (1985) Job attitudes and performance during three career stages. *Journal of vocational behavior*, *26*(2), pp.126-145.

Toole, A.A. and Czarnitzki, D. (2009) Exploring the relationship between scientist human capital and firm performance: The case of biomedical academic entrepreneurs in the SBIR program. *Management Science*, *55*(1), pp.101-114.

UCLA. (2016) *UCLA sells royalty rights connected with cancer drug to Royalty Pharma.* University of California, Los Angeles: University News. Retrieved from https://newsroom.ucla.edu/releases/ucla-sells-royalty-rights-connected-with-cancer-drug-to-royalty-pharma..

Wright, M., Piva, E., Mosey, S. and Lockett, A. (2009) Academic entrepreneurship and business schools. *The Journal of Technology Transfer*, *34*, pp.560-587.

Wright, M., Siegel, D.S. and Mustar, P. (2017) An emerging ecosystem for student start-ups. *The Journal of Technology Transfer, 42,* pp.909-922.

Zacher, H., Rudolph, C.W., Todorovic, T. and Ammann, D. (2019) Academic career development: A review and research agenda. *Journal of Vocational Behavior*, *110*, pp.357-373.

Zacher, H. and Frese, M. (2018) Action regulation theory: Foundations, current knowledge, and future directions. *The SAGE handbook of industrial, work and organizational psychology*, *2*, pp.80-102.