Factors Influencing Academic Researchers' Motivation for Technology Commercialization and Entrepreneurship: An Overview of the Literature

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Abstract

There is a significant movement at research universities to catalyze faculty and graduate student involvement in the commercialization of university-based discovery, an activity often referred to as "academic entrepreneurship." This is driven by the desire of universities and government entities to transform huge investments being made in basic research, into products and technologies that benefit society. While awareness of technology commercialization and entrepreneurship has grown, and to some degree it has been legitimized as an academic activity, relatively few engineers and scientists are motivated to become involved. Many individual and contextual factors are believed to influence these decisions. The purpose of this paper is to provide an overview of the literature around the motivations, beliefs, goals, needs, values, and barriers driving researchers' decisions to engage in academic entrepreneurship.

Introduction

Over the past few decades, there has a been a significant movement to catalyze faculty and graduate student involvement in the commercialization of university-based research, often referred to as "academic entrepreneurship." This is driven by the desire of universities and government entities to transform the huge investments being made in basic research, into products and technologies that benefit society. To achieve this goal, institutions have become more proactive in working with engineering and science faculty to explore the commercial potential of their innovations. Institutions are also delivering technology commercialization-related education and training, as well as building out entrepreneurial ecosystems, to cultivate the talent and investment necessary to bring technologies to market.

While these initiatives have raised significant awareness of technology commercialization and entrepreneurship activities at research universities, and to some degree legitimized it as an academic activity, still relatively few faculty and graduate students are motivated to become involved. Many individual and contextual factors are believed to influence academic researchers' decisions regarding whether to engage in academic entrepreneurship, and subsequently, stay involved. Individual factors at play include their awareness of entrepreneurial opportunities, prior experience with business-related activities, and the availability of time. Contextual factors include the degree to which a university's culture supports participation in entrepreneurial activities, and resources that are available to incentivize involvement.

Some scholars have posited that faculty are primarily motivated by extrinsic rewards, such as financial gains and recognition (Phan & Siegel, 2006). Others point to psychological theories suggesting that intrinsic motivation is a more important part of the story (Eccles & Wigfield, 2002; R. M. Ryan & Deci, 2000; Sansone & Harackiewicz, 2000). Some argue that most research has examined "macro-level" processes that drive academic entrepreneurship decisions, instead of more important micro-level processes, that involve the interplay of institutional and individual characteristics determining the "propensity of academics to patent and engage with industry" (Balven, Fenters, Siegel, & Waldman, 2018p. 22).

The purpose of this paper is to provide an overview of the motivations, beliefs, goals, needs, and values driving academic researchers' decisions to engage in academic entrepreneurship activities in light of both institutional and national initiatives designed to catalyze these activities. It will also examine some motivation-related barriers undermining participation. The focus is on more informal human dimensions within the context of formal institutional strategy and public policy (Balven et al., 2018).

Literature Review

The Movement to More Entrepreneurial Universities

The passage of the Bayh-Dole Act by Congress in 1980 catalyzed the movement to commercialize technologies emerging from U.S. research universities (Aldridge & Audretsch, 2011). The act made significant changes to the way universities managed scientific discovery occurring in their research labs by allowing them to patent and license inventions resulting from federally funded research. It also led to the creation of technology transfer offices (TTOs) to manage disclosure, patenting, and licensing activities on behalf of the institution. These are staffed with administrators, licensing managers and attorneys, who coordinate and communicate with academic researchers.

The intent of the Bayh Dole Act was to incentivize the commercialization of technology that has the potential to impact our economy and society. Giving the universities the rights to faculty inventions allows institutions to license them to private sector partners, such as well-established companies or entrepreneurs, for further development. In return, universities and inventors receive royalties when technologies are successfully brought to market. It has been said that the Bayh-Dole Act, "unlocked all the inventions and discoveries that had been made in laboratories throughout the United States with the help of taxpayers' money" ("Innovation's Golden Goose," 2002).

Beyond potential revenue streams, there are other upsides for universities promoting academic entrepreneurship (Rothaermel, Agung, & Jiang, 2007). It is believed that these activities enhance public-private research interaction (Grimaldi, Kenney, Siegel, & Wright, 2011); provide greater access to industry resources and know-how (Grimaldi & Von Tunzelmann, 2002); generate new industry-sponsored research and consulting arrangements; facilitate the recruitment of excellent faculty and students (Florida, 1999); and create opportunities for donations from successful entrepreneurs (Quintas & Guy, 1995).

In recent years, TTOs have placed more focus on licensing technologies to startups, which aligns with a movement to create more "entrepreneurial universities" where both knowledge creation and dissemination are important (Balven et al., 2018). Like an entrepreneurial society, where entrepreneurship is the driving force for economic growth, employment, and global competitiveness (Audretsch, 2014), an entrepreneurial university is expected to be a survivor in a competitive environment by being the best in all of its activities (Guerrero & Urbano, 2012). These activities are not confined to technology transfer and entrepreneurial activity, but also teaching and administrative strategies (Antoncic & Hisrich, 2001). Factors that can be used to

assess the "entrepreneurial-ness" of universities include: Formal factors: organizational and governance structure, support for entrepreneurship, entrepreneurship education; 2) Informal factors: university community's attitudes towards entrepreneurship, entrepreneurial teaching methodologies, role models and reward systems; 3) Resources: human capital, financial, physical, and commercial; and 4) Capabilities: status and prestige, networks and alliances, localization (Guerrero & Urbano, 2012).

The influence of public policy, incentives, resources, culture and institutional mission are important factors when examining the motivation of researchers to participate in academic entrepreneurship. They comprise many elements and initiatives beyond TTOs, that support academic entrepreneurs. These include business incubators and accelerators which provide talent and financial support to university startups, as well as education and training programs designed to develop intellectual and tactical knowledge that can help bring innovations to market.

Although there is increasing value being placed on university-industry collaboration and commercialization, in addition to traditional academic work, a significant challenge is getting more faculty and graduate students involved in these activities. Today, only a very small percentage of engineers and scientists who are involved in research are exposed to technology commercialization training or activity. At many research universities, the primary role for faculty is very oriented towards scientific production, more than either teaching or entrepreneurial engagement. Many individual and institutional factors are believed to influence academic researchers' decisions regarding whether to engage in academic entrepreneurship, and whether to continue to stay involved. Therefore, increasing participation requires a comprehensive understanding of academic researcher motivations.

Motivation for Entrepreneurship

Motivation is defined as "a set of energetic forces that originate both within and beyond an individual's being" that determine the intensity and duration of behavior (Pinder, 1998, p. 11). It is a phenomenon that varies depending on how an individual perceives a particular activity, task or assignment (Katz, 2005). Motivation has been described as "one of the most critical elements affecting work performance, but at the same time, it is one of the most difficult to understand (Manners, Steger, & Zimmerer, 1983; Suominen, Kauppinen, & Hyytinen, 2021). Motivation cannot be seen; it is externalized via behavior. Motivations can change in nature or intensity over time, and be influenced by context.

Entrepreneurial motivation has been defined as a "collection of psychological constructs representing the reason why people become entrepreneurs" (Yi & Duval-Couetil, 2018, p. 292). Early studies in this area focused on reasons why experienced entrepreneurs, outside of academia, created new businesses. These reasons included elements such as: *Achievement* - a willingness to learn, challenge, and accomplish in business, conceptually related to self-actualization and personal development; *Need for approval or recognition* - a desire to gain recognition from others through entrepreneurial activity; *Innovation or creation* – a desire to create something new and develop innovative ideas; *Independence* - A desire to have more flexibility and autonomy in work and life; *Welfare or communitarianism* - A desire to contribute to social welfare and community via business; *Status* - A desire to promote social status and

prestige via business success; *Financial success or materialism* - A desire to increase personal wealth; *Role model* - A willingness to follow a family tradition in entrepreneurship; *Tax reduction*: A desire to reduce the burden of taxes or to gain an indirect financial benefit from a business; *Opportunity*: A perception that a new start-up comes at an appropriate time in one's career and life; *Escape:* A desire to avoid unfavorable situations (e.g., unemployment).

Motivation has been described as "the driving force behind creativity and innovation" (Suominen et al., 2021, p. 2). Scientists are highly self-motivated given that they choose a career path driven by their curiosity, interest in new scientific discoveries, and the improvement of society as well as their own skills. Scientists are interested in "a distinct motivation to create societal impact through knowledge" (Suominen et al., 2021, p. 2). They are also driven by a desire to make new scientific discoveries and feel their work is contributing to "something grander" and benefiting society. According to Suominen (2021), motivating scientists can differ from other groups, or other motivational practices, because they are engaged in creative, flexible, unpredictable work, with high autonomy, which requires intrinsic motivation. Generally speaking, motivation in research environments has received minimal attention (J. C. Ryan, 2014).

Theories Explaining the Motivation of Scientific Researchers and Academic Entrepreneurs

Galati et al. (2020) proposed several different theoretical approaches for exploring the sensemaking processes of academic researchers engaged in commercialization activity including *self-determination theory* and *social identity theory*. These are based on the identity perspective (Gruber & MacMillan, 2017), which assesses entrepreneurial behavior in a way that is different from "views embedded in economic rationality" (Gilati, p. 1480). The identity perspective claims two things: 1) that individuals behave in ways that they consider appropriate for themselves in a specific context, and 2) that human beings have a fundamental need for self-definition and for finding their own place in society (Gilati). While these theories were developed independently, they have been integrated to get better understanding of the "self" (Stets and Burke, 2000).

Self-determination theory (SDT) derives from social psychology, and it relates to the motivation behind people's choices in the absence of external influences. Its roots are in comparing intrinsic and extrinsic motives and the understanding of the dominant role that intrinsic motivation plays in individual behavior. *Intrinsic motivation* refers to doing an activity for the inherent satisfaction or enjoyment it brings to an individual, and not because of external pressures or rewards such as satisfaction, self-esteem, competence, and pro-social behavior (Ryan & Deci, 2000). In contrast, *extrinsic motivation* refers to doing an activity to receive a reward or outcome such as money, promotion, praise or reputation. SDT emphasizes that extrinsically-motivated behavior can turn into intrinsically-motivated behavior as individuals internalize the values and behavior regularly associated with certain activities that support a psychological need for autonomy, competence, and relatedness (R. M. Ryan & Deci, 2000).

Social identity theory (Tajfel, Turner, Austin, & Worchel, 1979) is a theoretical lens supporting the view that individual beliefs and attitudes are unlikely to be the sole drivers of entrepreneurial behavior. The theory explains intergroup behavior and emerges from experiments showing that group membership fosters prejudice. It explains why personalities and behaviors are context

specific, and how personal identity and environmental conditions shape social identity that leads to categorizing individuals into "in" and "out" groups. Social identity theory varies on a continuum between interpersonal and intergroup behavior. A key assumption is that individuals are intrinsically motivated to strive for a positive social identity.

Other theories more geared toward career development help explain how individuals make different educational and professional choices, and may be useful in explaining why academics are or are not motivated to take on more entrepreneurial roles or activities:

Social Cognitive Career Theory (SCCT) (Lent et al. 2000) explains three interrelated aspects of career interests and development over time, including (1) how basic academic and career interests develop; (2) how educational and career choices are made; and (3) how academic and career success is achieved. This involves *self-efficacy* beliefs (Bandura 1986) - people's beliefs about their own capabilities and plans to attain personal goals; *outcome expectations* - the degree to which they perceive positive or negative outcomes of certain behaviors; and *goals* - how much and how well a person wants to do something. SCCT examines links between individuals and their career-related contexts to account for the entire environment in which they make career-related decisions. It posits that individuals are products of their surroundings, and these surroundings are the result of individuals' interactions.

Social Learning Theory of Career Development (Krumboltz et al., 1976) addresses why people make certain career choices, which is primarily through a series of planned and unplanned educational opportunities, social status, and environmental conditions. These combined factors encourage a person to seek a career that is suitable to them. These careers can be viewed as communities of practice, where the ability to "read" the local context and "act in ways that are recognized and valued by other members of the immediate community of practice" is all-important. (Contu and Willmott 2003, p. 285).

<u>Categories of Motivations Relevant to Academic Entrepreneurs</u>

Scholars have conducted studies of scientists and academic researchers finding that they are motivated by a plurality of factors. Authors have also pointed out that intrinsic and extrinsic motivations can be difficult to disentangle. For example, one feels competent (intrinsic) when their publications or reputation improve (extrinsic). The literature consistently points to several categories of motivations, which are show in Table 1 and described below.

Public Service and Impact: Scientists become scientists because they have pro-social motivations that have both intrinsic and extrinsic dimensions. These pro-social motivations include the objectivity of scientific findings, a common ownership of results, and a lack of self-interest (Iorio, Labory, & Rentocchini, 2017). In other words, scientists "derive satisfaction from the advancement of the overall body of knowledge in their scientific disciplines and their knowledge contributes to society at large. Ifflander et al. (2018) referred to these motivations as "ideal-driven pushes" i.e., making research results more useful to the public and broadening their application. The authors also considered them "pulls for the common good" given that commercializing new technologies can benefit particular groups, reinforce certain causes, create

new jobs and strengthen the economy. Commercialization of discovery is another way to diffuse to knowledge, beyond publications.

Enhanced Research/Learning: This category of motivations relates to participating in commercialization activities to gain access to external expertise, new skills, and knowledge exchange that can improve research outcomes and publications (Iorio et all, 2017). D'Este and Perkmann (2011) pointed out that learning motivates academics who are interested in accessing information on industry problems, industry research, and networking. Industry interactions create new opportunities, beyond financial resources, including data, skills, technologies, information, equipment, and materials. Academics also want opportunities to apply their research, which allows them to gather feedback and new insights from industry (Franco & Haase, 2015; Qian, Xia, Liu, & Tsai, 2018). In a study of academics across 33 countries, Davey & Galan-Muros (2020) found that most academics do not collaborate with industry, however, when they do they are highly engaged collaborators. According to Davies, an entrepreneurial academic's motivation to cooperate is to improve their research, and once an academic "crosses the rubicon" they are likely to continue to do so.

Research Funding: Studies have shown that participating in commercialization activities can result in additional research funding and grants either through public sources or from industry collaboration (Baldini, Grimaldi, & Sobrero, 2007; Fini, Lacetera, & Shane, 2010). Hayter (2015) found that academics were motivated by the ability to use startups as a platform for applying for Small Business Innovation Research (SBIR) awards and consulting opportunities, more than for commercialization and product development. One of his interviewees stated that the return on product development was "not worth the effort" but the SBIR funding was seen as "free research money' (Hayter 2015 p. 1009.) They came to this conclusion after experience, and were not against commercialization, but instead, understood the tradeoffs.

Financial Returns: The literature related to the importance of increasing one's income is mixed within academia. Phan and Siegel (2006) suggested that potential financial benefits coming from revenues or stock ownership associated with a venture, or royalty sharing policies that universities have with inventors, is a means of motivating faculty to disclose their inventions and participate in technology commercialization activity. However, this appears to be less true among academic researchers (Hayter 2011). The desire for financial freedom and independence may be less a motivating factor simply because most faculty researchers have full-time employment. It may also vary by country given that researcher salaries vary considerably across the world. For example, a study of academic scientists in Hungary found that 90% created a venture to supplement their low salaries (Novotny, 2017). Interestingly, research outside of academic entrepreneurship has found that money does not prevent creative behavior, but it does not increase it. Researchers found that using money as a motivator can hinder creativity particularly when individuals feel it is being used to modify or control their performance (Amabile, 1998). It can also decrease collaboration and knowledge exchange.

Enhanced Teaching and Training: Engagement with the commercial world is viewed as a means to enhance traditional university responsibilities including teaching (Hayter, 2015; Roberts & Malonet, 1996). This involves being able to integrate case studies, knowledge, and tools into courses that typically do not include entrepreneurship-related curriculum or activities.

Experience with entrepreneurship allows faculty advisors to better train graduate students, recruit more entrepreneurial ones, and prepare them more suitably for jobs in industry (Duval-Couetil, Ladisch, & Yi, 2021; Duval-Couetil & Wheadon, 2014). Involvement in commercialization and startups also expands and creates employment opportunities for young researchers and doctoral students, particularly when there are more opportunities in the private sector (Etzkowitz, Webster, Gebhardt, & Terra, 2000). Given the move to more entrepreneurial universities, these experiences are viewed more positively in academic departments interested in fostering commercialization activities.

Enhancing One's Visibility and Reputation: Public recognition and the visibility of academic scientists within their scientific communities and within industry is important for career advancement in academia (Iorio et al., 2017). This occurs through securing research grants, presenting at conferences, and publishing articles. Given the importance placed on reputation, some scholars have suggested that universities should focus not on potential financial incentives to motivate faculty to participate in commercialization activity, but instead reputational (D'Este & Perkmann, 2011). However, despite discussions occurring about whether patents and evidence of entrepreneurial activity count as scholarly outputs in the promotion and tenure process (Stevens, Johnson, & Sanberg, 2011), practices are mixed, and in most cases, faculty incentives and rewards are not aligned with technology transfer aspirations.

Job Enhancement & Security: Motivating factors for entrepreneurship outside of academia are the risk of becoming unemployed, a lack of prospects in a current job, or general dissatisfaction. In the case of academia, it can have to do with escaping low salaries, contract duration issues, or problems with leadership (Iffländer et al., 2018). Again, this may vary significantly based on experience, seniority, and regions of the world. Interestingly, there is evidence to suggesting that it is experienced, and well-established "star" scientists, who tend to engage in more entrepreneurial activities, rather than less established faculty (Zucker & Darby, 1996, 2001).

Findings from Studies of Academic Entrepreneurship Motivation

Studies find that academic researchers are motivated to participate in technology commercialization activities by numerous factors, which can change over time, and can be different based on the individual characteristics, situations, and contexts. Some examples are below, and each offers a unique platform for additional research:

Hayter (2015) identified the plurality of factors influencing motivation and shifts over time. He found the most important factors to be: 1) technology dissemination, 2) technology development, 3) financial gain, 4) public service, 5) peers and peer recognition, 6) seniority and career enrichment, 7) regional job creation; and 8) commercialization and entrepreneurial skill development. In a follow-up study with the same participants, he found that *concern for employees* and *bureaucracy avoidance* were newly reported motivations, and *public service, job creation* and *skill enhancements* were no longer mentioned.

Table 1: Factors influencing motivation to participate in academic entrepreneurship.

Galati, Bigliardi, Pasarro & Quinto, 2020 Financial Public service Community Funds and resources Job enhancement **Suominen Kauppinen Hyytinen, 2021 (drawing on LAM 2011)** <u>Gold</u> Forming expert networks and stimulating interaction Creating new firms Building personal and professional networks Enhancing visibility of research Increasing personal income <u>Challenge</u> Help industry and stakeholders solve complex problems Application and exploitation of research results Create opportunities for knowledge exchange/transfer Enhance the visibility of research (repeat) <u>Engineer</u> Training skilled persons Creating new tools, scientific instrumentation and analytical methodologies Forming expert networks and stimulating interaction <u>Basic researcher</u> Increase stock of useful knowledge, even if the knowledge cannot be directly applied Increase funding and other research resources Create opportunities for knowledge exchange/transfer **Davey Galan-Muros, 2020** Obtain funding/financial resources Increase my chances of promotion Improve my reputation within the university Use my research in practice Gain new insights for research Contribute to the mission of the university Address societal challenges and issues **Iorioa Labory Rentocchini, 2017** <u>Funding</u> Financial compensation of the activity Career prospects raised by reputation building induced by the activity <u>Learning</u> Improvement of a "scientist's" research due to access to complementary expertise and exchange of ideas Satisfaction from improvement in one's own research <u>Mission</u> Improved reputation or praise from contribution to society at large Pure satisfaction from contributing to society at large	**Ifflander Sinell Schraudner, 2018** <u>Increase [technology transfer]</u> Make research results more useful to the public and broaden their application Respond to people's needs and market demands <u>Improve unsatisfactory work conditions</u> Salary Contract duration Problems with leadership Acquire startup grants Secure your job Advance your research <u>The common good</u> Benefit particular groups Protect the environment Create new jobs and strengthen the local economy <u>Personal pursuits</u> Capitalize on your research Achieve professional aspirations or advance career Achieve recognition and/or make a mark Create a sense of purpose and/or see research in "action" Fulfill and/or advance yourself **Hayter, 2015** Entrepreneurial motivations and success definitions among academic entrepreneurs <u>Technology development: SBIR funding and consulting</u> Obtaining resources SBIR, industry R&D contracts, or consulting Allows further development of research <u>Enhancing traditional university responsibilities</u> Enhances teaching and research Better understanding of how academic science may be applied Improved research proposals Better quality publications <u>Concern for students and employees</u> Provide stable employment for PhD students and postdocs Spinoff experience steppingstone for jobs <u>Technology diffusion</u> Dissemination of research beyond the university <u>Product development and commercialization</u> Development of new technology Revenue generation <u>Avoid university bureaucracy</u> Best method to work with commercial world as opposed to sponsored research office or TTO Avoid bureaucracy without breaking the rules <u>Financial gain</u> Financial gains modest but compensate for time Not optimal way to secure financial rewards

Using self-determination theory, Lam (2011) classified researchers and their motivations according to the degree to which they self-identified with technology commercialization goals. She categorized academics into three categories: *Ribbon* - traditional scientists who are introspective and primarily motivated by research funding and reputation; *Puzzle* - hybrid scientists who are driven by knowledge application and intellectual interest; and *Gold* - entrepreneurial scientists embodied integration and were mainly motivated by money. According to Lam (2011), the motivation of scientists can be different combinations of these three motivational factors.

In a study of German scientists that used social identity theory as a framework, Obschonka, Goethner, Silbereisen, & Cantner (2012) suggested that individuals with high group identity (or strong external locus of control) became more entrepreneurial if they joined a group with entrepreneurial norms; and individuals with low group identity (internal local of control) based their entrepreneurial intentions not on social norms but on their self-initiative. Given these individual differences, this theory and approach has potential implications for universities, and cultural norms related to academic entrepreneurship.

In a comparison of the motivations of two populations of academic researchers in Italy - doctoral students and faculty - Rizzo (2015) found that doctoral students established spinoffs as way to create jobs given the paucity of academic positions, whereas senior (faculty) researchers did so primarily for financial motives. However, when faculty co-founded spinoffs with doctoral students they were motivated to help students find employment, followed by the need for peer recognition, and social approval.

Interestingly, in a study of gender differences in the motivations of academic entrepreneurs, the authors categorized involvement in entrepreneurship as either pushing to “escape the present” or pulling toward “hopes for the future” (Iffländer et al., 2018, p. 71). Pushes involved improving unsatisfactory work conditions, insufficient salary, contract duration, and leadership problems. Women were pulled by the ideal of finding broader application of research results and making a social difference. Men pursued more personal, practical goals such as financial success and recognition.

Barriers to Academic Entrepreneurship

Motivation must be considered in light of institutional- and individual-related factors serving as catalysts and/or barriers to participation in academic entrepreneurship. Grimalidi (2011) points to organizational support, culture, objectives, and reward and incentive programs that can influence motivation. These include a university’s mission, vision and communication that embraces academic entrepreneurship; incentives for participation that align with work assessment and career advancement; as well as services and resources including TTO staff, incubator personnel, access to offices, funding, and equipment.

Individual factors such as time management, work-life balance, and perceptions of bureaucracy also influence motivation (Howells et al 2012; Filippetti and Savona, 2017; Binkauskas, 2012; Van Der Siijde, 2012). For example, Davey & Galan-Muros (2020) pointed to insufficient work

time allocated by the university for academic entrepreneurship activities; conflicts with teaching and research responsibilities; lack of knowledge and experience; different objectives, values, language and modes of communication; and differing time horizons between university and business. Interestingly, the authors found that both non-engaged and highly engaged faculty shared similar perceptions about barriers to entrepreneurship, despite three exceptions. Non-engaged faculty found sufficient work time to be the highest barrier to engagement. Entrepreneurial academics perceived bureaucracy to be their highest barrier. And, different values between business and academia were less important for entrepreneurial academics. The authors concluded that despite these differences, perceived barriers had less relevance than motivators in explaining engagement in academic entrepreneurship.

The need to examine the complex interplay of individual and institutional barriers and motivations involved in catalyzing involvement in academic entrepreneurship is highlighted by Balven, Fenters, Siegel & Waldman (2018). They argue that most research has examined "macro-level" processes that drive academic entrepreneurship decisions (e.g., incentives), rather than micro-level, or individual characteristics that examine the "propensity of academics to patent and engage with industry" (Balven et al., 2018p. 22). *Motivation* is one of these microprocesses along with others, including: *Identity and identification* – the extent to which faculty identify with being a researcher, teacher, inventor, and entrepreneur; *Leadership/championing* – the extent to which a department head or stakeholder advocates for engagement in academic entrepreneurship; *TTO communication and educational campaigns* - TTO efforts to inform and engage faculty; *Work-life role balance* - whether a faculty researcher has an appropriate workload relative to other work duties or personal responsibilities; *Distributive justice* - whether faculty believe they are rewarded, compensated, and recognized fairly and whether faculty perceive they are being treated in an unbiased way by the TTO and university; *Interpersonal justice* - whether faculty members are treated with dignity and respect when interacting with department chair or TTO; *Deontic justice* – a faculty member's desire to see their research used in a manner that benefits society. The authors conclude that more research in this area is needed, for a better understanding of the "key supplier" in academic entrepreneurship, the faculty member.

Discussion

This paper examines what motivates researchers to participate in academic entrepreneurship, considering institutional and national efforts focused on spurring the translation of scientific research into products and technologies that impact our economy and society. It is clear that achieving technology transfer targets will not occur without engaged faculty and graduate student researchers who are key players in these translation activities.

Studies of academic entrepreneurs have been done in many countries. Despite significant differences in salaries across the world, scientists are strongly motivated by public service and impact, as well as enhancing their traditional research and teaching activities. This aligns strongly with the pro-social identity of scientists, and the fact that they have invested many years in training to obtain their positions. Identity is clearly an important force shaping the activities in which researchers partake, where they perceive they belong, and where they will succeed. However, there appears to be some heterogeneity in interests, beliefs, and motivation. For

example, research related to locus of control (internally versus externally focused), is an interesting way to classify scientists' openness to commercialization that warrants additional research. Behavioral models examining antecedents to behavior change that have not been applied to academic entrepreneurship to a great extent should also be explored (Fogg, 2019).

The heterogeneity among researchers highlights interesting questions about who should be targeted for what type of academic entrepreneurship initiatives. For example, if technology transfer, licensing and startups is the desired outcome, Zucker and Darby's (1996, 2001) work suggests that it should be star scientists and prolific publishers of research articles who should be targeted, given the disproportionately significant role they played in of the emergence of the biotechnology industry. In contrast, if generating awareness and interest in technology commercialization, or creating or long-term culture change in academia, are the desired outcomes, targeting graduate students and junior faculty may be more appropriate. More research is necessary to understand the impact and tradeoffs of getting involved in technology commercialization at different stages of one's career. For example, to what extent is it possible for junior faculty to succeed at technology commercialization before creating a strong foundation of basic research? And, what is the impact of participating in technology entrepreneurship training, or engaging in commercialization activity, on the academic and entrepreneurial aspects of one's career?

Similarly, how we communicate the value of involvement in academic entrepreneurship is a potential interesting area for research that emerges from this review. It appears that having impact and enhancing one's research activity are two important motivations for researchers. However, it also appears that different messaging might be appeal to different audiences. For example, if reputation-building is most interesting to academic scientists – or perhaps a subset of them (e.g., junior faculty) – then perhaps the reputation-building aspects of technology commercialization should be communicated to this audience. If on the other hand, less bureaucracy is important to more seasoned academic entrepreneurs, then communication and measures should be taken to improve their perceptions in this area.

In either case, time must be carved out for technology commercialization activities if faculty are expected to construct an entrepreneurial identity. Where it is a priority, universities must structure academic and entrepreneurship activities in ways that do not impede work-life balance or the tenure and promotion process. Further, rewards must be aligned with both activities. Academics must weigh the cost and benefits of participating in academic entrepreneurship to their careers and lives. There will always be perceived barriers and only higher motivation will tilt the cost benefit in favor of participating (Davies, 2001).

Finally, even if faculty are exposed to entrepreneurship training and activity, some research suggests that it may not lead to significant growth in the number of new startups or the economic metrics that institutions desire. Hayter (2018), found that through experience faculty realized they did not have managerial and technical capabilities to develop a startup, or the networks and contacts that were necessary. They expressed that they were naïve and thought that academic entrepreneurship would be easier, and described challenges related to doing it part-time, and with limited support. The outcome of participating in commercialization activities for these faculty was that they better understood their strengths and roles as scientists.

Conclusion

Our review shows that deciphering what motivates academic researchers to participate in entrepreneurial activities is very complex. Nonetheless, the nature of scientific careers points to the importance of both extrinsic and intrinsic motivation, suggesting that institutions must create environments that support both to help them perform. Research shows that entrepreneurial faculty perceive that there are mechanisms and initiatives supporting their behavior whether it be a well-developed entrepreneurial ecosystem, more resources available, or more positive views of their development as academic entrepreneurs. Therefore, it is recommended that universities create supportive environments by reducing bureaucracy and making time, training and resources available to support technology commercialization activities.

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