The Role of Identity and Championing in Academic Entrepreneurship:

Qualitative Evidence from Postdocs in U.S Universities and Federal Laboratories

by

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ABSTRACT

I study the technology transfer process at universities and federal laboratories, based on 49 interviews of postdoctoral scientists and their supervisors (principal investigators or PIs) at two large U.S. research universities and four major National Institute of Health and Department of Energy federal laboratories. This dissertation is unique in three respects. First, with rare exceptions, most studies of technology transfer have focused on tenure track faculty at universities. Second, there have been few recent studies of technology transfer at federal laboratories. Third, most studies of technology transfer have ignored "micro" topics as identity, championing, and leadership. This dissertation fills those voids. Specifically, in this thesis, I focus on boundary work conducted by postdoctoral scientists and micro-institutional work of their Principal Investigators as change agents, in consideration of different institutional constraints of universities and federal laboratories which can affect the entrepreneurial activities of scientists. Having universities and federal laboratories as study contexts, I demonstrate 1) how institutions constrain yet enable individual agency; 2) how individuals engage in a new role that can potentially create conflict with their central identity; and 3) the role of the institutional change agents, or institutional entrepreneurs, who can lead to changes in the attitudes and perceptions of their subordinates, in the face of tensions derived from conflicting yet coexisting norms.

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CHAPTER 1

INTRODUCTION, BACKGROUND, MOTIVATION, AND DATA

INTRODUCTION OF THE DISSERTATION

Institutional logic functions as a system of principles and institutional arrangements that (re)produce institutionally desired practices (Glynn, 2008; Thornton & Occasio, 2008). Such macro forces shape individuals' attitudes, values, and beliefs by imposing taken-for-granted norms on them. Research has shown that the degree to which individuals (re)produce institutionally desirable practices becomes greater when they formulate strong bonds with publicly expressed beliefs about their formal organization (Clark, 1972; Sporn, 1996). Consequently, identity has been considered an important linkage between institutional logic and organizational and individual behaviors that are tied to the institution (Glynn, 2008; Thornton & Occasio, 2008). Identity is one's understanding of self that is created by the central and peripheral characteristics that represent a given role and it represents the degree to which an individual internalizes meanings and expectations associated with the roles (Ashforth, 2000; Ashforth & Gibbs, 1990; Stryker & Burke, 2000). Therefore, individual identity is often considered an instrument and an indicator of organizational control over its members (Alvesson & Willmott, 2002).

People engage in identity work when there is a perceived gap between their current understanding of self and institutionally prescribed roles (Lok, 2010). Identity work is a process through which individuals constantly re-construct their identity by forming, repairing, strengthening, and revising self-images so that the identity can provide a sense of coherence and distinctiveness (Alvesson & Willmott, 2002). One important aspect of identity work is that institutionally prescribed actions and expectations place limits on it (Brown et al., 2015; Lok, 2010). Institutions enable the identity construction of organizations and individuals by providing a set of legitimate identity elements and identity symbols (Glynn, 2008). Concepts such as 'identity workspaces' (Petriglieri & Petriglieri, 2010) or 'meaning arena' (Westenholz, 2006) suggest that elements for identity work vary by institution.

However, institutions do not place totalizing constraints. Individuals exert agency to modify their identity based on active re-interpretation of extant institutional logics (Brown et al., 2015; Gioia & Thomas, 1996) or through continuous experimentations with provisional selves (Ibarra, 1999). In other words, an identity is an outcome of continuous interaction between structure and agency (Lok, 2010). Consequently, the outcomes of individual identity work can also differ within the same institution when individuals choose to (re)interpret the given identity elements. I, therefore, take the 'embedded agency perspective" (DiMaggio & Louch, 1998; Greenwood et al., 2002; Lok, 2010; Seo & Creed, 2002) and consider both the structural forces and individual agency in explaining how scientists in universities and federal laboratories make sense of technology transfer in relation to their institutionally prescribed roles. This dissertation includes three studies focused on different aspects of scientists' identity process in relation to technology transfer.

The first study examines institutional differences between universities and federal laboratories and shows how different institutional norms and values shape their scientists' perceptions and attitudes regarding technology transfer activities. I emphasize the role of institutional forces derived from a well-established set of practices, norms, rules, and processes that guide and restrain the actions of individual scientists drawing on institutional theories (Greenwood, 2008; Greenwood & Suddaby, 2006; Scott, 1987, 1995). I found that both university and federal laboratory scientists experience conflict between the Mertonian norm of open science and research commercialization even though it has been more than 40 years since the enactment of laws that permit technology transfer from research institutions such as universities and federal laboratories. However, scientists in federal laboratories experience an additional layer of tension that emanates from the "publicness" of federal laboratories, which is directly related to their mission to provide public goods and services (Bozeman & Bretschneider, 1994; Walker & Bozeman, 2011). The public mission of federal laboratories provides an additional source of conflict with the notion of 'privatization' of public knowledge inherent in technology transfer.

In the second study, I explore how the university and federal laboratory postdoctoral scientists engage in boundary work to mitigate the tensions experienced in their institutions. I draw upon identity, and sensemaking research as well as boundary theory to identify sensemaking strategies of the postdoctoral scientists and categorize them into three types which are named *disengagement, integration,* and *transition*. The categorization is based on different boundary enactment strategies which fall on a continuum that ranges from a higher degree of segmentation to a higher degree of integration of boundaries based on individual preference for the boundary permeability (Ashforth et al., 2000; Knapp, Smith, Kreiner, Sundaramurthy, & Barton, 2013; Nippert-

Eng, 2008) which is defined as the degree to which a boundary accepts elements of another role domain (Ashforth et al., 2000; Capitano & Greenhaus, 2018). I found that scientists who disengage themselves from research commercialization tend to emphasize the impermeability of the boundary between their role as university/federal lab scientists and technology transfer. Scientists who integrate science and research commercialization emphasize the overlap between their roles at their respective institutions and commercialization activities. Lastly, some scientists who find technology transfer as their major motivation make narratives about technology transfer using linguistic elements of the ideal role and form of science to minimize the risk of losing legitimacy.

The third study explores and compares championing behaviors of principal investigators (PIs), with respect to the postdocs they supervise in universities and federal laboratories. I conceptualize PIs that are identified by postdocs as strong champions of technology transfer as institutional entrepreneurs drawing on the literature on institutional entrepreneurship, and champions of innovation. I then illustrate how PIs who are identified as strong champions of technology transfer are adept at drawing on cultural and linguistic materials that are available in the institutional environment and translating those materials into alternative possibilities beyond what's prescribed by the institutions so they can institutionalize new rules, norms, practices, and logic that they are championing for (Garud et al., 2007; Greenwood & Suddaby, 2006; Kisfalvi & Maguire, 2011). I find that PIs who are identified as strong champions engage in upward, lateral, and downward influence activities to foster innovation and technology transfer. As part of the downward influence activities, the champions engage in micro-institutional tactics consisting of *problematization*, *sense-giving*, and *boundary-spanning* to encourage postdocs to engage in technology transfer.

The next section of this chapter presents the background and motivation. I then explain the data and the method that are used throughout the studies. The three studies are presented in the next three chapters. I conclude this dissertation by discussing theoretical, managerial, and policy implications as well as the limitations.

BACKGROUND AND MOTIVATION

Background – Technology transfer in universities and federal laboratories

Technology transfer and academic entrepreneurship have received considerable scholarly attention since the passage of the Bayh-Dole Act in 1980 (Hayter et al., 2020) as the law provided 'blanket permission' for universities, businesses, and non-profit organizations to pursue the ownership of inventions and file patents based on federally funded research and to grant licenses of the patents to other parties (Mowery & Ziedonis, 2000). Facing such an institutional change, universities have created formal university technology transfer agents called technology transfer offices (TTOs) to coordinate and support the commercialization of faculty research. TTO has become widely diffused throughout the U.S. and entrepreneurship has become an important mission of U.S. universities (Etzkowitz et al., 2000; Hayter et al., 2020; Heaton et al., 2019; Lam, 2010).

Studies after the Bayh-Dole Act have noted the contributions of entrepreneurial universities to the national innovation system and have shown that technology transfer activities of universities lead to an increase in social and economic returns to publicly funded research (See: Baglieri, Baldi, & Tucci, 2018; Miller, McAdam, & McAdam, 2018; Siegel, Veugelers, & Wright, 2007; Siegel, Waldman, Atwater, & Link, 2004; Thursby, Fuller, & Thursby, 2009; Urbano & Guerrero, 2013). Accordingly, considerable scholarly attention has been given to how scientists handle the relatively new role of academic entrepreneurs in the context of university technology transfer.

However, universities are not the only research institution that hires scientists and promotes technology transfer from federally funded research. Federal laboratories are an important component of the U.S. national innovation system. In 2016, universities in the U.S. received approximately $38 billion from the federal government to conduct research, while federal or national laboratories received approximately $42 billion (National Science Board, 2018). Like universities, federal laboratories have a technology transfer mission and technology transfer offices. Congress adopted the Stevenson-Wydler Act in 1980, which, like the Bayh-Dole Act, sought to facilitate technology transfer from federal laboratories. Stevenson-Wydler Act mandated federal laboratories to improve the economic, environmental, and well-being of the United States by promoting technology transfer. Specifically, the Act mandated federal laboratories to establish technology transfer offices and make technology transfer a mission of federal laboratories. Before Stevenson-Wydler Act, technology transfer was not an explicit mission of federal laboratories (Jolly, 1980; Link et al., 2011). Specifically, the Act explicitly states technology transfer is a responsibility of the government and the labs should make effort to promote technology transfer. According to the Act:

(1) It is the continuing responsibility of the Federal Government to ensure the full use of the results of the Nation's federal investment in research and development. To this end, the federal government shall strive where appropriate to transfer federally owned or originated technology to state and local governments and to the private sector.
(2) Technology transfer, consistent with mission responsibilities, is a responsibility of each laboratory science and engineering professional.
(3) Each laboratory director shall ensure that efforts to transfer technology are considered positively in laboratory job descriptions, employee promotion policies, and evaluation of the job performance of scientists and engineers in the laboratory.

Two additional laws were enacted to further promote technology transfer from federal laboratories. In 1986, the Federal Technology Transfer Act was enacted to improve access to intellectual properties invented at federal laboratories by non-federal organizations and allow government inventors to patent their technologies and obtain a share of the royalties when they license patents. Such financial rewards incentivized federal scientists to establish Cooperative Research and Development Agreements (CRADAs) with firms. Federal Technology Transfer Act was followed by Technology Transfer Commercialization Act in 2000. The act made it easier and more attractive for companies to patent and/or license technologies that were created at federal laboratories (e.g., commercialization resulting from a CRADA).

After the passage of the series of laws, few studies have assessed technology transfer efforts in federal laboratories. Research, in general, suggests an increase in technology transfer activities such as patenting at national laboratories since 1980 (National Research Council, 1999, 2001; Jaff & Lerner, 2001; Jaffe et al., 1998). Link et al., (2011), in their relatively recent assessment study, tracked the patent activities of two U.S. federal laboratories from 1970 to 2008 and reconfirm the findings of previous research that the passage of the Stevenson-Wydler Act seems to have a positive impact on patenting activities at federal laboratories.

However, federal laboratories are not as active as universities in their technology transfer efforts and outcomes. For example, in 2017, U.S. universities issued 6,283 patents and consummated almost 7,459 new licensing agreements. The corresponding figures for U.S. federal labs were 2,341 patents and 572 new licensing agreements (National Science Board, 2018). The differences in technology transfer efforts made in universities and federal laboratories might be partially explained by the number of Ph.D. scientists and engineers at universities and federal laboratories. According to the National Science Board, there are approximately 329,000 scientists in universities while there are approximately 259,000 scientists in federal laboratories (National Science Board, 2018). However, given that faculties in universities have to teach and engage in service while scientists in federal labs do not, the differences in the number of scientists cannot fully explain the gap in technology transfer efforts between universities and federal laboratories.

To summarize, not much is known about technology transfer processes in federal laboratories even though significant scholarly attention has been given to technology transfer in universities and the scientists' academic entrepreneurship. Other than the few assessment studies mentioned above, there is no systematic effort to investigate the technology transfer process in federal laboratories that examined enablers and barriers to technology transfer activities. This is a significant gap in the technology transfer literature, given the essential role of federal laboratories in the national innovation system. Therefore, there needs to be a systematic assessment of the technology transfer process in federal laboratories.

Motivation

A major motivation for this dissertation is the absence of knowledge regarding the technology transfer process in federal laboratories (Siegel et al., 2022). I seek to contribute to the scholarly conversation on technology transfer, by comparing scientists in universities and federal laboratories in the U.S. in terms of the scientists' perception of and intention to engage in technology transfer. I suppose it is of significant importance to focus on the different institutional contexts of universities and federal laboratories. The institutional differences may shape the motivations of the scientists in different ways thereby generating different attitudes and behaviors of the scientists in relation to technology transfer activities.

Research suggests important differences between universities and federal laboratories. First, federal laboratories have a comparative advantage as they have a greater ability to perform interdisciplinary research compared to universities. Even though interdisciplinary research is increasingly emphasized and encouraged in universities, they have structural constraints - universities are organized according to disciplinary lines. Therefore, efforts to pursue interdisciplinary research in university are constrained to at least some degree (Bozeman, 2000). The comparative advantage of federal laboratories in terms of their ability to perform interdisciplinary research may give them a greater potential to fuel technology transfer and innovation.

Second, universities are relatively more market-driven and more exposed to market fluctuations compared to federal laboratories which are shielded from market pressure. Research illustrates that federal laboratories may remain relatively more stable during economic, cultural, and societal change compared to universities and other research organizations (Hallonsten & Heinze, 2012). For instance, universities suffered during the economic downturn which began in late 2007, and the economic downturn led to a decrease in state support for universities leading them to face stronger pressure to commercialize their research (Link et al., 2011). In general, university scientists and technology transfer offices, compared to their counterparts in federal laboratories, have been facing increasingly stronger pressure from university administrators to commercialize research in order to generate revenue for the university (Link et al., 2011; Siegel et al., 2007).

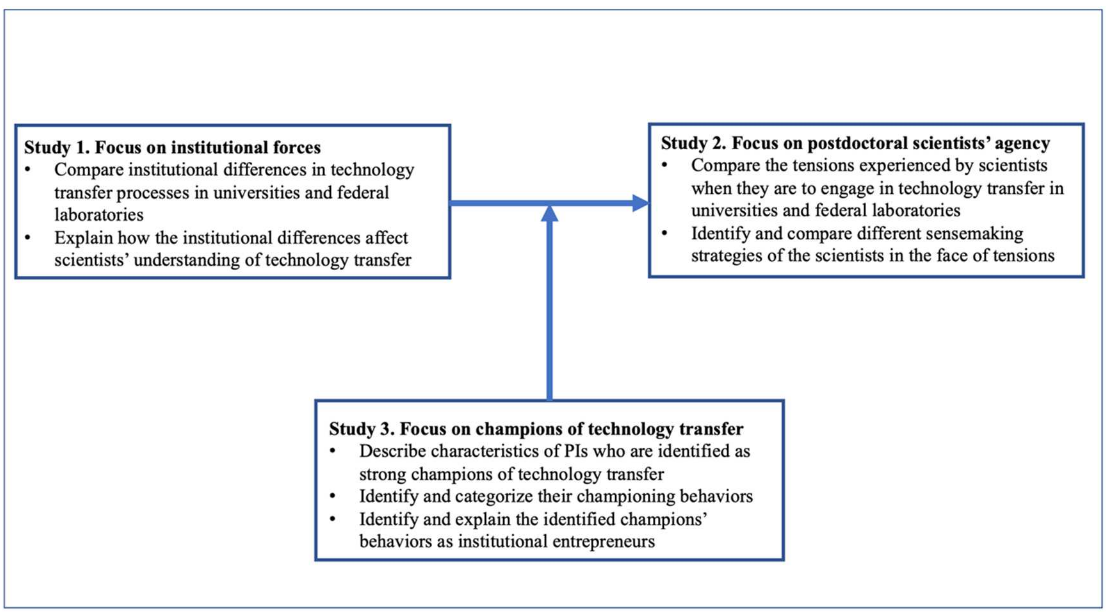
Third, university and federal laboratory scientists may have different sets of responsibilities in their respective institutions. One of the primary missions of universities is to educate students. The presence of students and the universities' mission to educate knowledgeable citizens impose teaching on university scientists as one of their major roles besides research and service (Bozeman, 2000). In contrast, scientists in federal laboratories are not expected to teach and hence they are able to allocate more time and resources to research compared to their peers in universities.

Lastly, and most importantly, federal laboratories are explicitly and closely tied to specific missions of federal agencies and public values. Therefore, scientists in federal laboratories are more constrained by legal and political factors (Rainey et al., 1976) compared to their peers in universities. Public service incorporates publicness or public value, which is often conceptualized as government responses to market failure and described as the antithesis of privateness (Bozeman, 2002; Bozeman & Bretschneider, 1994; Moulton, 2009; Walker & Bozeman, 2011). The publicness of federal laboratories and the mission-driven nature of the research in those institutions can be a source of reluctance when scientists consider research commercialization. It is because of the conflict of different norms inherent in their public mission and the notion of research commercialization – while the mission of federal laboratories is to provide public goods and services through their research activity, technology transfer is often considered a way to privatize the outcome of research that is publicly funded and create revenue out of it. This, however, is not to indicate that universities are not public organizations. Literature suggests and emphasizes the role of university scientists as public knowledge workers who produce open science (Florida, 1999; Owen-Smith & Powell, 2003). What I try to point out here is that the public mission is more explicit and emphasized in the mission of federal laboratories. I will discuss this point in the discussion part of Study 1 following a dimensional approach to defining the publicness (Bozeman & Bretschneider, 1994; Bozeman, 1987).

The aforementioned differences between universities and federal laboratories can lead to differences in the ways through which scientists in the respective institutions make sense of technology transfer. It must be noted, however, that scientists in universities and federal laboratories have common characteristics as well. Most research positions at federal laboratories require a Ph.D. meaning that scientists in federal laboratories have received training as an academic. As scientists, they read the same scientific journals and attend conferences to present their research (Bozeman, 2000). Such common practices make them share a common identity as a scientist, which is characterized by their desire to disseminate scientific breakthroughs and attain recognition through publications, citations, and prizes (Jain et al., 2009; Lam, 2011). Therefore, there should be common features between the university and federal laboratory scientists in terms of their perception of technology transfer in relation to their scientist identity.

This dissertation is motivated by the gap in the technology transfer literature where research on federal laboratories is largely lacking despite the central role of federal laboratories in the national innovation system. To fill the gap, I shed greater light on the technology transfer process in federal laboratories to identify differences between universities and federal laboratories in relation to their technology transfer processes. I then explain the ways through which the identified institutional differences shape their scientists' understanding of technology transfer, in relation to the scientists' central identity as scientists. I consider institutional forces, scientists' individual agency in sense-making processes regarding technology transfer, as well as the role of principal investigators (PIs) in leading to change in scientists' perception of and intention to engage in technology transfer. The overview of the dissertation is presented in Figure 1. As presented in Figure 1, I am motivated to contribute to the literature on technology transfer by synthesizing different yet closely interrelated aspects of technology transfer.

Figure 1. Overview of the Dissertation



The primary motivation of Study 1 is to uncover differences between universities and federal laboratories in technology transfer processes and explain how institutional differences lead to different motivations and understanding of technology transfer in relation to scientists' role identity. I seek to explain how institutional constraints on technology transfer can cause role conflict derived from different demands from science and commercialization thereby hampering scientists' motivation to engage in technology transfer. By shedding greater light on federal laboratories, and the different motivations of scientists in federal laboratories, I expect to fill the gap in the literature on technology transfer, which has disproportionately focused on university scientists.

The major motivation of Study 2 is to identify and compare different sensemaking strategies of the scientists in the face of different institutional constraints in technology transfer. Individuals who face potential inter-role conflict may try to manage the tension actively by re-interpreting the nature of a given role or by re-constructing their identity (Ashforth et al., 2000). Therefore, I focus on the scientists' resolution strategies in the face of role conflict extending the findings from Study 1.

The primary motivation of Study 3 is to understand the role of technology transfer champions in universities and federal laboratories. I specifically focus on PIs who are identified as strong champions of technology transfer, and their championing behaviors. I demonstrate PIs, as institutional entrepreneurs, not only be able to facilitate technology transfer and organizational change but also help postdoctoral scientists consider technology transfer as a career alternative through their active employment of micro-institutional tactics based on the top-down relationship where they can exert greater power.

DATA

I use interview data from 38 postdocs, 4 technology transfer managers, and 7 lab managers (or PIs who supervise postdocs) at two large public research universities (one of which was a land grant university) and four federal laboratories. It is important to note that federal laboratories are heterogeneous in terms of their operation and their missions and hence, the study sample tried to reflect the heterogeneity of federal laboratories.

First, there are two types of federal labs, in terms of who operates the facility (Snyder & Thomas, 2019). The first type is government-owned and operated (GOGO). GOGO lab is owned and managed by the federal government. Scientists at GOGO labs are federal employees, although some researchers may have a joint appointment with a university. At GOGO labs, intellectual property rights are owned by the federal agency. The second type of federal lab is government-owned, contractor-operated (GOCO). GOCO lab is owned by the federal government but managed by third-party contractors such as private companies, universities, or non-profit organizations. All Department of Defense (DOD), National Institution of Health (NIH), and most National Aeronautics and Space Administration (NASA) labs are GOGO facilities, while almost all of the Department of Energy (DOE) labs are GOCO facilities. I mention this distinction because GOCO labs are generally more flexible in technology transfer and open to their scientists' entrepreneurial activities, as compared to GOGO facilities. For instance, a GOCO lab is allowed to assume equity in a startup, while a GOGO cannot do so.

Another important source of federal lab heterogeneity is their mission. A federal lab directly serves the mission of the federal agency it is associated with. For instance, DOE has identified three key areas of lab focus: (1) applied energy (e.g., National Renewable Energy Laboratory), (2) basic science (e.g., Lawrence Berkeley National Lab), and (3) national/homeland security (Lawrence Livermore National Lab). At GOCO labs, intellectual property rights are owned by the contractor. Even though GOGO and GOCO labs differ in terms of how they are operated, however, it must be noted that both types of federal labs exist to serve a public mission. Public service, unlike private enterprise, is much less subject to market forces, while being more constrained by legal, political, and formal constraints (Rainey et al., 1976). Most importantly, public service incorporates *publicness* or *public value*, which is often conceptualized as government responses to market failure and described as the antithesis of privateness (Bozeman, 2002; Bozeman & Bretschneider, 1994; Moulton, 2009; Walker & Bozeman, 2011).

Taking the heterogeneity of federal labs, the study sample includes scientists at two research universities and four federal laboratories: two NIH GOGO labs, the National Cancer Institute and the Food and Drug Administration; and two DOE GOCO labs, Los Alamos National Lab (managed by Battelle, University of California, and Texas A&M), and Sandia National Labs (managed by Honeywell). Each of these interviews lasted about an hour. Interviewees were selected from a wide variety of scientific fields, including life sciences, physical sciences, computer science, and engineering. For the sake of confidentiality, in the quotes I present in the following studies, I refer to either university scientists generically, or scientists at a GOGO or GOCO lab.

The data is collected as part of a bigger project sponsored by the Kauffman Foundation which aims to investigate the technology transfer activities of postdocs who work in federal labs and universities located in the United States. The research team contacted potential participants through e-mails which explain the purpose of the study and explain their interests in participating in the interviews. The final dataset consists of extensive (hour-long), semi-structured interviews of 38 postdocs, 4 technology transfer managers, and 7 lab managers (or PIs who supervise postdocs) from the two universities and four federal labs.

The semi-structured interviews started with pre-set questions. However, interviewers probed for more information at times, depending on the nature of the response. Each of these interviews lasted about an hour and the interviews included questions about the following: 1) Lab goals/outcomes (e.g., What is the primary goal of your lab? How does technology transfer or commercialization relate to the lab's goals?); 2) Motivation for lab outcomes (e.g., What motivates you to help the lab accomplish its goal? Do you identify yourself with this lab?); 3) Perceived/felt constraints or enablers of research commercialization (e.g., What are the factors that constrain your efforts to engage in commercialization? what are the factors that seem to enable your effort for technology transfer?); 4) Lab relationships and leadership (e.g., Who is the leader of your lab? How well does your leader lead the lab? How well does this leader champion commercialization in the lab? How would you describe your relationship with the leader?) and; 5) Other factors that currently affect or can potentially affect commercialization activities (e.g., Is there anything else that you believe is important with regard to technology transfer and commercialization?). Specific interview questions are presented in Appendix A.

It should be noted that postdoctoral scientists (hereafter, postdocs) constitute an ideal target population for this dissertation study which seeks to uncover the interaction of institutional factors and individual agency in technology transfer. Postdocs are Ph.D. holders who engage in temporary academic training. A post-doctoral fellowship is an important career event for many scientists as it extends their student role as a trainee of science while at the same time providing the first professional career step. Postdocs, therefore, are located in a career stage between apprenticeship and autonomous professional life (Reskin, 1976). They are an important human resource to the progress of the scientific knowledge (Cantwel & Taylor, 2015; Conti & Liu, 2015). Most importantly, postdocs chiefly contribute to the research and development mission of universities, as well as federal labs (Cantwel & Taylor, 2015; Stephan, 2013). As they are relatively younger and more impressionable, they may be receptive to pursuing a career path that includes technology transfer and commercialization as compared to academic jobs in certain circumstances. In recent years, many postdocs have been exposed to entrepreneurial training programs at federal agencies (e.g., NSF's I-Corps program) and at universities (Wright, Siegel, & Mustar, 2017). Thus, postdocs are becoming increasingly aware of commercial opportunities and the entrepreneurial community.

Second, from an intellectual standpoint, and particularly in the context of this dissertation study, it is useful to study postdocs as it provides a unique opportunity to examine critical micro-processes of academic entrepreneurship. As previously mentioned, postdocs are apprentices but at the same time, professional scientists. In other words, a postdoc is engaging in extended Ph.D. training as they serve their PIs' research interests. Therefore, postdocs can be seen as liminal being, who is in a state of in-betweenness and ambiguity where they struggle to re-construct the understanding of self through interactions with others (Beech, 2011). Given that postdocs are liminal being, who is actively engaging in identity reconstruction, they provide a unique venue to study sense-making and identity in relation to technology transfer.

Third, it should be noted that postdocs are employed on contracts and funded by PIs who conduct research sponsored by external R&D money and hence, are susceptible to PIs' influence. PIs hire and fund postdocs according to their research needs and preferences not necessarily following departmental or institutional priorities (Cantwel & Taylor, 2015; Stephan, 2013). In other words, postdocs are under a greater influence of PIs while not necessarily experiencing direct departmental or institutional pressures in terms of their research activities. Given this relationship between PIs and postdocs, PIs' research orientation (e.g. fundamental science vs. applied science) can shape postdoc research experience and their career decisions over the course of the fellowship period. For instance, tension may arise if PIs push technology transfer while postdocs have a strong identity as a scientist and hence a strong preference for academic research. In such circumstances, postdocs may experience tension in the beginning and may or may not move on and integrate technology transfer as part of their self-image depending on the PI's leadership effectiveness. Therefore, investigation of postdoc experience regarding technology transfer activities and their perceptions and understandings of their PIs championing can provide insight into the impact of top-down championing on technology transfer.

I and another researcher jointly coded the 49 interview scripts for three rounds over the course of eight months from 2020 January, using a qualitative data analysis program called Atlas.ti. Atlas.ti provides useful tools for academic research, particularly for social science researchers (Hwang, 2008). Since the interviews are semi-structured based on the guiding research questions, the coding started with initial coding categories (Potter & Levine-Donnerstein, 1999) based on the interview questions. The initial coding categories include Lab goals, Motivation, Enablers of technology transfer, Barriers of technology transfer, Leadership, Relationship, and Championing. In the first round, two coders independently coded the interview data and discussed how to code data that cannot be coded according to the initial coding categories. After setting up the coding schemes through weekly meetings, the two coders jointly coded the data for two more rounds using the cloud feature of Atlas.ti until both coders agreed that saturation is achieved (Fusch & Ness, 2015) after which there is no new code emerges from the data. As a result, I obtained a total of 476 codes.

METHOD

I conduct a qualitative content analysis of the interview data. Content analysis is an analytic approach that focuses on the characteristics of language as a means of communication to understand the content or contextual meaning of the text (Hsieh &

Shannon, 2005). Its goal is “to provide knowledge and understanding of the phenomenon under study” (Downe-Wamboldt, 1992: p.314). Qualitative content analysis is an analytic tool for interpretation of the text data through the systematic processes of identification and analysis of emerging themes and patterns considering the context of the information (Hsieh & Shannon, 2005).

Qualitative content analysis suits the purpose of this dissertation study which is to investigate micro-processes of technology transfer experienced by scientists in universities and federal labs under different institutional contexts. Furthermore, a qualitative approach can provide great insight, particularly into under-studied research domains by building and refining theory for subsequent studies (Shah & Corley, 2006). I reduce the particulars presented in the qualitative data into more abstract patterns in order to provide a set of categorized observations paying attention to situated and contextualized specificity presented in the qualitative data (Cornelissen, 2017; Langley et al., 2013). This mode of qualitative explanation provides analytical insight into social phenomena while appreciating the richness and particulars of the case under investigation (Cornelissen, 2017; Tsoukas, 2009).

The qualitative methodology of this dissertation stands on two assumptions about the research participants and the researchers. On the one hand, it considers research subjects as “knowledgeable agents” who are able to inform researchers of their thoughts, intentions, and actions in their perceived reality. On the other hand, it considers researchers who study a specific social phenomenon as knowledgeable being as well who can identify emerging patterns of the data and formulate concepts in a theoretically relevant manner (Gioia et al., 2013: p. 17).

I apply the notion of narrative identity work (Ibarra and Barbulescu, 2010) in interpreting the interview data to analyze how identity and sensemaking processes affect university and federal lab scientists when they perceive a potential tension in their institutions between science, research commercialization, and public mission. As suggested by McAdams, identity can be defined as “the internalized and evolving story that results from a person’s selective appropriation of past, present, and future” (2008, p 486). Given this definition, narratives, or stories of the narrator are critical mechanisms for the narrator to make sense of their identities in the constantly changing reality, while maintaining consistency in their self-conception (Horton et al., 2014; Ravasi and Schultz, 2006). The perspective to understanding identity as narratives posits that individuals revise and reconstruct self-image by crafting stories to explain themselves (Ashforth, 2000; Ibarra and Barbulescu, 2010). Thus, narratives are “both expressive of and constitutive of identity” (Ibarra and Barbulescu, 2010, p.135).

When people craft self-defining narratives of themselves, they draw on “prevailing cultural norms, and the images, metaphors, and themes” that they encounter in their social life (McAdams, 2011, p.99). Since the institutional logic, mission, and culture of universities and federal laboratories are significantly different, I expect that the components or elements of self-defining narratives should be different. The different narratives will reveal a greater insight into the micro-process of technology transfer in universities and federal laboratories. Therefore, the application of the narrative identity perspective suits the purpose of this dissertation, which is to analyze the scientists' work motivation, identity, and understanding of technology transfer in different institutional contexts.

CHAPTER 2

INSTITUTIONAL DIFFERENCES BETWEEN UNIVERSITIES AND FEDERAL LABS

INTRODUCTION

In this chapter, I compare how scientists in universities and federal laboratories perceive technology transfer in their respective institutions. Specifically, I pay attention to different institutional contexts of universities and federal labs that may or may not create tension with the scientist's central identity. By drawing upon literature on role identity and role conflict, I explain the common and different features of the university and federal lab scientists in relation to their perception of and intention to engage in technology transfer which is constrained by taken-for-granted norms and expectations within the respective institutions.

Findings from qualitative analysis reveal that institutional differences between universities and federal labs cause scientists to experience different types of tension when they consider technology transfer. I find multiple instances of scientists experiencing tension between the Mertonian norm of open science on the one hand, and research commercialization on the other to confirm the findings of extant studies. Such instances were found both in universities and federal labs. I also find that federal lab scientists experience an additional layer of tension that emanates from the "publicness" of federal labs, which is closely related to their mission to provide public goods and services (Bozeman & Bretschneider, 1994; Walker & Bozeman, 2011). This tension can potentially create additional conflict with the notion of private gain from research commercialization thereby limiting technology transfer efforts in federal labs.

I start by elaborating on the theoretical framework of this chapter. I then go on to explain the data analysis process. I present the findings and then discuss the implications of the findings to conclude the chapter.

THEORETICAL FRAMEWORK

Institutional constraints, role identity, and perceived role conflict in technology transfer

Institutional researchers suggest that institutional constraints derived from a well-established set of practices, norms, rules, and processes guide actions and restrain the freedom of organizational actors (Chakrabarty, 2022; Dellinger & Williams, 1997; Lounsbury & Ventresca, 2003; Siebert et al., 2017). On the one hand, individual behavior is constrained according to the set of practices, norms, rules, and processes within the institution because they are the basis of granting legitimacy within the institution. Since individuals can gain or lose legitimacy depending on the level of conformity to the institutionally prescribed roles, they are motivated to perform the given roles as prescribed by the institution (Greenwood, 2008; Greenwood & Suddaby, 2006; Scott, 1987, 1995).

On the other hand, institutions guide and/or restrain individual actions through their control over the identity construction process. According to research, institutions enable or constrain identity construction, at both organizational and individual levels, by supplying a set of possible and legitimate identity elements (Glynn, 2008; Navis & Glynn, 2011). The institutional influence over the identity construction process is powerful in controlling individual actions because identity is demonstrated through actions and actions reinforce identity (Callero, 1985; Charng et al., 1988). As suggested and demonstrated by identity scholars, role identity motivates individuals to plan and perform roles to reinforce, support, and confirm the identity as they live up to responsibilities and expectations that emerge from the given role (Burke & Reitzes, 1981; Thoits & Virshup, 1997; Stets & Burke, 2000). The influence of institutions over individual identity construction has a long-lasting effect on how institutional norms and practices are reproduced and reinforced. It is because an individual tends to find security in maintaining a consistent self-conception. As demonstrated by role identity scholars, a secure and consistent role identity is closely associated with the cognitive well-being and performance of individuals (Ashforth and Kreiner, 1999; Ashforth and Mael, 1989; Horton et al., 2014).

It has to be noted, however, that individuals increasingly take on multiple roles these days, and there are occasions where they experience role conflict, or a conflict of "values, beliefs, norms, and demands" inherent in the multiple role identities when the individuals try to make sense of themselves while interacting with others and trying to live up to expectations that are inherent in the role (Ashforth and Mael, 1989; Ashforth et al., 2000). Role conflict is often considered a major barrier to university technology transfer because the expectations about science and entrepreneurship are often incompatible. Research on academic entrepreneurship suggests that role conflict in the context of academic entrepreneurship entails conflicting time arrangements, values, motivations, interests, and different role behavior patterns in a way that the performance of one role can possibly lead to a decrease in the performance of the other role. For instance, academic orientation is closely tied to longer-term goals and a desire for peer recognition, while entrepreneurship is related to shorter-term goals and a desire for the creation of wealth by identifying and jumping on an opportunity (Jain et al., 2009; Wang et al., 2021; Zhang et al., 2021). Therefore, even though the new expectations as academic entrepreneurs have widely been adopted and taken for granted in U.S. universities since the enactment of the Bayh-dole act, the new role of academic entrepreneurs still can create conflict with the traditional expectations about scientists inhibiting their entrepreneurial intentions and activities (Balven et al., 2018; Glenna et al., 2011; Grimaldi et al., 2011; Thursby et al., 2009).

It is important to note that, federal lab scientists take an additional role as federal employees in addition to their major role as scientists. That is, federal lab scientists have another layer of responsibilities and expected roles as compared to their university peers. Specifically, government employees, as civil servants, are expected to pursue public and social values far more than other jobs (Nam et al., 2019). Furthermore, organizational characteristics that are often associated with government such as bureaucracy and weak links between performance and promotion can foster a risk-avoiding culture (Bozeman &

Kingsley, 1998) which is not conducive to entrepreneurship which is based on the risk-taking propensity of individuals (Koudstaal et al., 2015; MacKo & Tyszka, 2009; Shane, 1996). Therefore, federal lab scientists who strongly identify themselves as government workers might experience extra tension when pursuing entrepreneurial activities such as technology transfer.

Against this theoretical backdrop, this chapter focuses on the different roles and expectations imposed on university and federal lab scientists and describes how the institutional differences between universities and federal laboratories affect scientists' inclination to engage in technology transfer. I start by presenting institutional differences and then illustrate how such institutional constraints shape the scientists' perception of and intention to engage in technology transfer. The summary of the findings is presented in table 1.

FINDINGS

Institutional differences between universities and federal labs

Federal lab scientists described differences between universities and federal labs in terms of research orientation and culture. A key difference that emerged from the interviews is that federal lab scientists are more attuned to the fact that their organizations have a specific mission and a unique culture. It is important to note that federal labs are managed by federal agencies (e.g., the Department of Defense, the Department of Energy, and the Department of Health and Human Services), which have specific missions. Furthermore, each lab has its own mission, which could include health, computing, energy, or security depending on which federal agency manages them. It is clear from the interviews that federal lab scientists understand that their research has to be mission-driven and emphasize that aspect of their research.

This is in contrast to university scientists, who appear to have a greater ability to engage in curiosity-driven research. Most federal lab scientists reported that they are not encouraged to explore their curiosity. Instead, they are encouraged to pursue research that is closely connected to the lab or agency's mission. That is, even though federal labs are committed to scientific progress, their research is constrained by the mission. About 40% of federal lab scientists explicitly mentioned how their institutional mission constrains research subjects. The following quotes from federal lab scientists illustrate how mission-driven research at federal labs differs from university-based research.

Table 1. Key Differences between Universities and Federal Labs

	University Scientists	Federal Lab Scientists
Research Orientation	*Curiosity-driven*: Scientists answer scientific inquiry through research. Research is not necessarily tied to specific problems to solve. Scientists to stick to certain research programs for a longer period of time.	*Mission-driven*: Research is an instrument to serve institutional mission. Research is designed with specific considerations of mission-related problems to solve. Research programs change as the nature of mission-related problems change.
Goals	More focused on publishing papers and securing grants to ultimately achieve promotion and tenure.	More focused on solving public problems and providing public goods and services.
Research Collaborations	Research collaboration with external partners occurs, but the collaboration is not necessarily tied to specific mission of university.	Research collaboration with external partners (e.g. industry partners, universities, and etc.) is important to serve its mission. Institutional arrangements, such as CRADA, are important mechanisms of research collaboration and research commercialization. Federal lab postdocs enjoy more opportunities to explore non-academic career options as they collaborate with diverse organizations.
Level of perceived Competition	High. Higher level of competition hampers cooperation. However, it can speed up progress of research project.	Low. A lower level of competition enables intra and inter-organizational cooperation.
Level of Job Security and Motivation Toward Innovation	Low. Lower job security and the difficulty to get tenured increase scientists' motivation to make extra effort toward innovation.	High. Higher job security with fixed salary lowers scientists' motivation to make extra effort toward innovation.
Level of Bureaucracy	Low. Bureaucracy is considered as a barrier toward developing research.	High. More rules and regulations on research. Bureaucracy is considered to be necessary.
Incentives	Incentivized from having more research projects and publications.	Not incentivized much from engaging in non-mission-driven research projects.
Scientists' Perception of Technology Transfer	Scientists experience tension between science and research commercialization. Technology transfer is perceived favorably if it is considered as a means of facilitating knowledge diffusion.	Scientists experience tension between science and research commercialization. At the same time, scientists also experience tension between publicness and research commercialization which leads to higher cognitive dissonance when they consider technology transfer. Technology transfer is perceived favorably if it is considered a way to promote public value that is incorporated in the institution's mission as well as a way to facilitate knowledge diffusion.

> “(Even) if you have a great idea, you can’t just (work on it) –if it is not supported by laboratory, you can’t just do that. Whereas in universities, one will have more flexibility to pursue his/her ideas.” (Federal laboratory [GOGO] scientist)

> “We think about it (impact of research) before we design the experiments, even before we design the project. ‘What is the outcome that we desire from it?’ Unlike academia, we aren’t allowed to have open-ended projects. We couldn’t be doing something where we say, ‘well, let’s see where things go.’ We need to know where this is going.” (Federal laboratory [GOCO] scientist)

Since missions of federal labs aim to solve specific problems that have a significant impact on the public, research has to be initiated and designed with explicit consideration of such problem-solving. This consideration leads to the application-oriented or more translational research effort, as compared to research conducted in universities. A number of federal lab scientists described their efforts to consider the downstream effect of research. I find that institutional forces shape the way that federal lab scientists engage in and find meaningfulness in their research. For instance, federal lab scientists perceive less pressure to publish compared to their peers in universities. However, they perceive a need to pursue a stronger link between their research and the well-being of the public than their university counterparts. Furthermore, in federal labs, research direction can shift more often according to the current needs of the public.

> "I found a huge difference (between universities and federal labs). There's such a huge pressure on researchers at academic institutions to publish. And for us, the pressure isn't strong. For us, it's about problem-solving. A big difference between what we do and what universities do is that universities (tend to) stick with their research programs for decades. And we have to pivot constantly based on what is the treat at the time." (Federal laboratory [GOCO] scientist)

Second, compared to universities, federal labs have relatively more contact with external parties via joint projects and working groups. Such close contact with external parties is necessary for federal labs to successfully achieve their missions to solve grand problems. Typically, such grand problems can only be addressed through interdisciplinary, multi-sectoral research efforts. It is important to note that federal lab scientists are more likely to engage in interdisciplinary research than university scientists, who are often siloed in conventional academic departments. Having such close ties with external parties seems to give federal lab scientists a unique feeling of belonging to academia, industry, and government. About 55% of federal lab scientists explicitly mentioned their relationship with industry while performing their role as federal employees and described its implications on their research and career. The narratives below nicely illustrate how federal lab scientists perceive their role between science and industry, and how such experiences can differentiate them from scientists in university/academia.

> "I appreciate the unique research environment that – at least in my group – it spans the gap between industry, academia, and government policy. So, the work

> that I do in energy storage involves basic science research similar to a university. We also have substantial contact with industry via various projects and working groups. And then from the government policy side, we work on handbooks for the DOE; we provide feedback on various codes and standards. I personally participated in a presentation to the California Energy Commission on energy storage, so I appreciate the opportunity to be engaged in all of those areas, and I think a national lab is very unique in offering that sort of environment" (Federal laboratory [GOCO] scientist)

> "Working in a national lab is really something between industry and academia where you get the feel of both of them" (Federal laboratory [GOGO] scientist)

It appears that the unique assets of federal labs (e.g., state-of-the-art research equipment and stable sources of funding) yield benefits to scientists since those assets provide more opportunities for them to interact with scientists in other disciplines and in diverse organizations (e.g., universities, companies, non-profit research institutes). Most of those who described the implications of collaborating with industry also mentioned that collaboration with diverse subject matter experts, more opportunities to engage in an interdisciplinary research project, and interactions with industry partners, are major enablers to their research. Among many routes to create partnerships with external actors, Cooperative Research Development Agreements (CRADAs) are especially important if federal lab scientists want to develop their patentable research ideas into marketable products (Mowery, 2003).

> "I guess what's unique about a national lab versus a more traditional university environment is that it is easier for me (as a national lab scientist) to establish a collaboration with another subject matter expert; to find somebody who can advise me on my project, which I think in academia may be more difficult." (Federal laboratory [GOCO] scientist)

> "I think that (CRADA) is the most essential step for a PI who may have a finding or may have an invention that is patentable but not good enough to be taken as a product and needs some co-developmental funding resources. And probably a big company can come to the PI and help develop the product." (Federal laboratory [GOGO] scientist)

Third, rules and regulations seem to be a bigger barrier in federal labs in research and research commercialization. About 70% of federal lab scientists mentioned excessive rules and regulations as barriers to technology transfer and reported that they experience more bureaucracy compared to universities. The below narratives shows that federal lab scientists perceive rules and regulations as a major barrier to technology transfer, and the rule burden is bigger compared to industry or university.

> "In [this lab] it's too hard; it's too much paperwork and the chances are that it (research commercialization) ends up might not happen." (Federal laboratory [GOGO] scientist)

> "There should be a significant number of steps taken before we (engage in tech transfer). […] That somehow is usually considerably shorter, either in private industry or the university." (Federal laboratory [GOCO] scientist)

Among rules and regulations that govern federal lab scientists' potential and actual engagement with technology transfer, the conflict-of-interest policy seems to be the most powerful one. Specifically, about 40% of federal lab scientists explicitly mention conflict of interest policy in their department as a major constraint to technology transfer while I could not find explicit quotes regarding conflict of interest from university scientists. Even when federal lab scientists want to engage in technology transfer, they often refrain from it due to the fear of violating the conflict-of-interest policy in their institution.

> "I am not allowed to be involved in startups and technology transfer because of conflict of interest. In the back of my mind, my motivation is to engage in commercial activities. And inherent in the job in this national lab is that I have no commercial interest in what I am reviewing" (Federal laboratory [GOGO] scientist)

The degree to which rules and regulations in federal labs hamper the scientists' pursuit of technology transfer is greater when the scientists engage in classified projects. I identified several cases where federal lab scientists who engage in classified research projects face bigger challenges when they consider technology transfer as a result of direct restrictions from the government. They mention that the government often directly constrains disclosure of classified technology. What's important is, that such rules and regulations on classified research affect people's general mindset as well as culture in a way that can potentially hamper people's entrepreneurial mindset. A GOCO scientist described how such rules and regulations affect how people conceive of technology transfer in the following narrative.

> "Since we sometimes work on classified projects, people can have a mindset of being overly cautious about sharing results that are technical. And I've definitely heard of plenty of disputes, where one person thinks this topic is sensitive, and the person does not. And if there's a disagreement like that, the person that thinks something is too sensitive to release is going to be the one that wins out." (Federal laboratory [GOCO] scientist)

This extra layer of bureaucracy slows down research processes, and potentially, technology transfer. Interestingly, however, many federal lab scientists seem to be quite used to bureaucracy and have a higher level of tolerance to bureaucracy. They seem to take bureaucracy as part of their mission, believing that the rules and regulations may exist for good reasons. This is an interesting finding because it indicates that federal lab scientists' internalization of their role as public employees can shape their understanding and perception of rules and regulations in a way that they take those rules and regulations somewhat favorably. I found that while university scientists describe rules and regulations as simply bad and frustrating, federal lab scientists are much more tolerant of such bureaucracy since they identify with their role as government employees (even at contractor/GOCO labs). The below narratives illustrate some federal lab scientists' perception of rules and regulations.

> "You need more time because the government is somewhat slow to do things and that's good and bad. […] it is a little bit slower here." (Federal laboratory [GOGO] scientist)

> "I would say we are government employees. Most of what we do is at a slower pace than what universities are used to. Universities are on the go all the time. That is not the pace of things at a national lab like this. Things take a while; even ordering reagents. So I would say that we are more used to that slow pace." (Federal laboratory [GOCO] scientist)

In addition, there is less perception of competition among scientists at federal labs than at universities. Many university scientists reported competition as a potential barrier to technology transfer, as well as their scientific research, while federal lab scientists barely mentioned competition as a barrier to technology transfer or research. The following quote from a university scientist illustrates how a greater level of competition may create a negative dynamic in the lab, potentially frustrating collaboration within the lab.

> "It generally starts with two people working on a similar or the same project, so it can get pushed through as quickly as possible. They can then get preliminary data

> either for a paper or a grant, but what ends up happening is that one person out-competes another person and then runs with that sort of project; resulting in the other person being left out. Then, it becomes an ego against an ego in the lab." (university scientist)

University scientists tend to describe academia as a battlefield where they need to produce research outcomes ahead of their competitors. If they fall behind, their ideas can be scooped, and their research efforts could turn out to be of no avail. Such competitive nature of academia can potentially hamper collaboration efforts among labs that conduct research in similar areas. However, at the same time, the competitive nature of academia can speed up technology transfer efforts.

> "I want us to complete a project relatively quickly. Because the faster you can develop a drug, the faster you can start helping people. Also, it's not completely selfless. It is also that, the faster you develop it, the less likely that someone else swoops in and does it before you." (University scientist)

Less competition and greater job security perceived by federal lab scientists may affect research activities in both good and bad ways. On the one hand, less perceived competition may hamper federal lab scientists' motivation to put forth extra effort in research. On the other hand, it can help scientists freely exchange ideas with colleagues in the lab to gain additional insight into their research. University scientists tend to describe competition as part of their driving culture, and at the same time, describe it as a barrier to technology transfer. According to university scientists, the culture of universities that emphasizes competition hampers sharing of data and materials that are necessary for research and, potentially, technology transfer. Some university scientists, however, enjoy competition and embrace it as the nature of their job as scientists.

In contrast, federal lab scientists did not mention competition as a major barrier or enabler of research or competition. They perceive that competition is a lot lower in federal labs, and it can help federal lab scientists cooperate with each other to produce outcomes of science as well as technology transfer.

> "You're going up the ladder when your time comes. […] So that restrains your willingness to put too much extra effort to get to a place where you are ready to file technology transfer stuff or innovate anything. But at the same time, you do not have a cutthroat competition, so you can openly discuss your ideas and get those extra brains involved who are not competing with you but still are ready to give their feedback." (Federal laboratory [GOGO] scientist)

> "The level of cohesiveness we have here is definitely something that has helped push new project ideas forward. There are several new project ideas that have come out of casual conversation (among) post-docs. […] The patent we filed started off with just me and my office mate, but then we started discussing it more broadly and more people came on board." (Federal laboratory [GOCO] scientist)

Finally, another key difference between university and federal labs relates to the availability of resources to support technology transfer. I identified several cases where university scientists mention funding as a major barrier to technology transfer and research in general. In contrast, federal lab scientists tend to mention resources when they describe major enablers to technology transfer. Federal lab scientists, especially GOCO scientists explained that various grant programs support the collaboration between the labs and industry as well as commercialization from the lab. They suggest such grant programs help them pursue industry collaboration and the development of research outcomes from their labs. However, federal lab scientists also indicated that financial support is strongly related to lab missions. A GOGO lab scientist mentioned that the lab has great instruments for research, and they are funded to pursue their research ideas in most cases. But at the same time, if their ideas are not directly supporting the mission of the lab, those ideas may not be funded. This case underlines again that mission relevance is highly emphasized in federal labs.

To summarize, universities and federal labs are different in several ways. In analyzing narratives of university and federal lab scientists, I found that the unique context of federal labs shapes how federal lab scientists understand technology transfer, which is different from how university scientists perceive technology transfer. In the following section, I discuss the tension between research and commercialization and how such tension may differ at universities and federal labs. I show that federal lab scientists experience more cognitive dissonance when they consider technology transfer and that may lead some federal lab scientists to find technology transfer inconceivable despite the many advantages that the federal lab offer in relation to technology transfer.

Perceived tensions between science and technology transfer

Scholars have found that there is considerable tension in opinions, rules, norms, and reward systems between science and commercialization (Etzkowitz, 2003; Partha and David, 1994). While the Mertonian norm of open science emphasizes communalism, universalism, disinterestedness, and organized skepticism (Merton, 1973), market logic emphasizes attempts to extract economic value from knowledge (Chesbrough, 2006). Such tension has been considered a source of a scientist's reluctance to engage in entrepreneurial activities (Bruneel et al., 2010).

Researchers have found that some scientists struggle with their role as a scientist when there is increasing expectations of science commercialization. For instance, Lam (2010) observed that the co-existence of contradictory institutional norms surrounding science commercialization makes university researchers navigate their role identity as a scientist to a certain degree. The author found that many scientists exhibit a hybrid identity, consisting of a mix of scientist identity and entrepreneurial identity. During such intra-individual identity negotiations, scientists experience tension between conflicting institutional norms where they are bound to compromise the public good aspect of scientific findings (Welsh et al., 2008). Such impact of institutional forces and the resulting intra-individual, identity negotiation affect research orientation and technology transfer outcomes of university scientists leading to a different amount of industry funding and change in the research orientation (Glenna et al., 2011).

I identified several cases where scientists reported such tension between science and research commercialization, which confirms the previous research on the conflict between the two contrasting norms. I found that the tension also exists in federal labs. About 38% of university scientists and 29% of federal lab scientists explicitly mentioned the tension between science and research commercialization.

First, some scientists experience the tension between the two demands as a form of role conflict. Many scientists both in universities and federal labs described situations where technology transfer activities can potentially take them away from science. Such role conflict is a major reason why scientists, especially postdocs, are reluctant to engage in technology transfer. Scientists who experience such role conflicts are not willing to engage in technology transfer even when there are institutional supports for technology transfer such as entrepreneurial training.

> "I get the sense from my colleagues that they think engaging in this type of activity (research commercialization) will basically take all their energy and time away from doing fundamental research." (Federal laboratory [GOCO] scientist)

> "So, we did an (entrepreneurial training) program last year, where we had a cohort of about 10 postdocs from California and New Mexico […] mostly to create an awareness of the opportunity if they leave the lab and to educate them about the commercialization process if they stay. It was about a four-month program, we were down to two people because they just kept getting sent back into their work. So, one guy, his manager (PI) said, 'Absolutely, do this program. Engage as much as you want, as long as you're still in your lab 12 hours a day.' […] there is a recognition that, for those guys, as they're embarking on their

> career, we're not doing them any favors if we're pulling them away from publishing, from getting their own work done in a pretty – relatively short amount of time" (Federal laboratory [GOCO] technology transfer officer)

Second, the tension is mostly visible when scientists have patentable research ideas, but they want to publish or present the findings. Some technology transfer managers at federal labs described situations where PIs prioritize publishing over patenting, even when they clearly understand the risk of losing the patent when they present the research findings.

> "We can advise them and say if you can hold off on the publication for like a month, then we can get a good, solid patent with a patent law firm and get it put together. But if they insist on publishing or they say 'no, I've got to get this out there right now then we'll lose the patent. Their (PIs) thing is publishing, not patenting" (University technology transfer officer)

> "Sometimes they (PIs) want to get a patent, they know they're not supposed to disclose it, and they still try to disclose it. And it's very frustrating. […] they know they shouldn't do this, and they still do this and I have to spend time. Like hey, we've had this discussion before" (Federal laboratory [GOGO] technology transfer officer)

The majority of postdocs in the study sample seek to obtain academic, tenure-track jobs, and for those who seek to obtain tenure-track faculty jobs, role conflict can be a disproportionately powerful barrier to technology transfer. Many postdocs prioritize publication as the highest priority, and technology transfer is seen to hamper publications as it can take their time and energy away from publications. Some technology transfer managers as well as postdocs themselves described the situation where postdocs have to suffer when their PIs push technology transfer without consideration of the postdoc's need to publish research.

> "The most important thing for a postdoc is publications […] because you can't make things public until they've been protected. […] I had a postdoc several years ago whose career, I think, was very much impeded by that manager's (PI), that, you know, head person's focus on tech transfer because the poor postdoc couldn't focus on tech transfer because the poor postdoc couldn't get his stuff published. […] And he then, therefore, didn't become junior staff. And therefore, didn't become a principal investigator" (Federal laboratory [GOGO] technology transfer officer)

> "Our boss tells us that she started the paperwork to file for the company and stuff […] which is somewhat despise doing because as a researcher it has no benefit for us immediately because publications are more important, not whether or not we make a product with a patent for the market" (University Scientist)

There are also cases where postdocs are interested in technology transfer, but their interest is not supported by the institution and most importantly, by their PIs. Such a lack of support from the PIs may be attributed to generational gaps. It has been more than three decades since the passage of the Bayh-Dole Act as well as the Stevenson-Wydler

Act and since then, technology transfer from academic research has increasingly become taken for granted (Grimaldi et al., 2011). However, PIs who are older and in the later stage of their career may have bigger inertia against the relatively newer role of academic entrepreneurship compared to young scientists who received higher education after the passage of the Acts. Some postdocs described the generational differences between them and their PIs and how such generational gaps can frustrate their technology transfer effort. Scientists also described how the institutional norm or culture of universities and federal labs have changed over time in a way that more and more scientists started to consider technology transfer as an alternative career option or as a part of their research agenda.

> "What I faced is that PIs are usually at a certain age or point in their career where they are almost satisfied with what they have achieved. […] One of the big problems I see is that postdoc is young, and the PI is very well established and has run through 90% of their career, then they don't get stimulated with new thoughts, and new ideas. They want to play safe" (Federal laboratory [GOGO] technology transfer officer)

> "It's possible that new postdocs are more aware of tech transfer. Because I know that as I was leaving (university) – when I started there was no discussion of tech transfer but as I was leaving, more PIs were being evaluated on patents and their ability to build products. So, it's possible that the culture is shifting." (Federal laboratory [GOGO] scientist)

Perceived tensions between publicness and technology transfer

In analyzing tensions perceived by scientists in universities and federal labs, I identified another source of tension experienced by federal lab scientists that can potentially hamper their technology transfer efforts. The additional tension is derived from the federal lab's institutional mission which is to provide public goods and services. Federal lab scientists' self-concept as a 'government worker' or 'government employee' makes them internalize the public organization's mission of creating public values and taking care of what's good for the public as civil servants (Bryson et al., 2014). Once federal lab scientists internalize the federal lab's mission as public employees, they make sense of technology transfer in terms of their desired role expected as public employees. I identified several cases where federal labs' mission and scientists' strong identification with the mission create tension with the scientists' technology transfer engagement.

First, there are institutional-level restrictions on technology transfer in federal labs that create a barrier to the entrepreneurial activities of their scientists. Federal labs often impose direct restrictions on research commercialization. Federal lab scientists, especially those who work in government-owned, government-operated (GOGO) labs indicated that their institution places a strict restriction on intellectual property protection in cases where patenting can go against the mission or their overarching goal to serve the general public.

> "In my division, it's more aimed at either ensuring standards are met or kept or, you know, like some aspect of regulatory sciences being assessed quantitatively.

> So, that has a lot of value for companies. But I think at the same time, filing a patent for some technique is kind of against the purpose of the (federal lab). You know, in that sense they would release that as a standard in one of these documents or try and patent and commercialize like a standard phantom or something for people." (Federal laboratory [GOGO] scientist)

> "It (tech transfer) depends on the property of your research. If it is kind of generalized or benefits for the general public, they might be reluctant to patent it." (Federal laboratory [GOGO] scientist)

Some research projects in federal labs are strictly classified, and hence, approved for release on severely limited occasions. I found several cases where scientists who work on classified as compared to unclassified research find technology transfer inconceivable because they simply cannot engage in technology transfer due to the very nature of their research. A GOCO lab scientist compared the different levels of restrictions imposed on classified versus unclassified research in the following way:

> "(Technology transfer) depends on your area. So, if you're working on hypersonic, then, you're probably coming from a world that is very classified, very closed, right? And so, you don't (commercialize it) – your end user is almost always the U.S. government […] But there's a lot of areas where – like our materials science groups that have a lot of postdocs–they do a lot of work for others. So, companies will come in and have them do testing validation. So, they exist in the unclassified world." (Federal laboratory [GOCO] scientist)

Some scientists mentioned how the nature of research can shape the lab's atmosphere. People tend to have a conservative mindset as they engage in classified research or as they interact with those who work on classified projects. One GOCO lab scientist described how the lab's culture and perception of technology transfer are affected by the nature of research.

> "Since we sometimes work on classified projects, people can have a mindset of being overly cautious about sharing results that are technical. And I've definitely heard of plenty of disputes, where one person thinks this topic is sensitive, and the person does not. And if there's a disagreement like that, the person that thinks something is too sensitive to release is going to be the one that wins out. […] We kind of have a divide at the lab where there are people doing this classified work that'll never get released, and people doing more basic R&D. And sometimes – and this includes most of the post-docs, and they don't always talk to each other that much or see eye-to-eye that much, and so, I think that can suppress the lab's priorities as far as trying to champion tech transfer" (Federal laboratory [GOCO] scientist)

Federal lab scientists also described situations where the potential conflict of interest becomes problematic. One of the federal lab scientists put conflicts of interest in the following way:

> "It is a conflict of interest, obviously. I mean, if that's in the back of my mind, my motivation is going to be commercial. And inherent in the job is that I have no commercial interest in what I'm reviewing."

Some GOCO lab scientists explain the conflict of interest based on the context of GOCO lab's unique position, where government and private sector partners work together through a collaborative partnership based on the best business practices possible. I find that even in GOCO labs, which are supposed to be less restrictive about technology transfer compared to GOGO labs, the conflict of interest imposes restrictions on scientists' technology transfer-related activities, indicating that federal labs, no matter whether they are GOGO labs or GOCO labs, seek to delineate its mission space from the mission space of private sector partners. For instance, one of the scientists in a GOCO lab indicated how conflicts of interest can be an issue at the intersection between the federal lab's mission space and the private sector partner's mission space.

> "But because of the nature of the work, we are supposed to be this trusted advisor, and there is some conflict there, right? So, their (industry partners) level of engagement has to be limited. […] Their (industry partners) goal is really to engage and to be forward facing. That's not really what our mission space is" (Federal laboratory [GOCO] scientist)

The aforementioned institutional context of federal labs as well as its direct and indirect restrictions on technology transfer activities can end up creating a culture where technology transfer is inconceivable. A postdoc's narrative shows that for many federal lab scientists, technology transfer is simply inconceivable.

> "This (federal lab) has been the most interestingly restrictive place. Because people don't even think about the commercializing ability of their products within the government. They don't even think about it" (Federal laboratory [GOGO] scientist)

Technology transfer is even more inconceivable for those who strongly identify themselves as public employees. The tension between federal lab scientists' identity as government employees and engagement in research commercialization is exhibited in multiple ways. First, federal lab scientists are far more cognizant of the 'federally-funded' aspect of their research compared to their peers in universities. Federal lab scientists expressed their reluctance to engage in technology transfer based on federally funded research in the following ways:

> "In terms of pay, a federal employee cannot take any money from any outside entity. Their work is all based on the government paying your salary. If you're a federal employee, you should be working for the federal government." (Federal laboratory [GOCO] scientist)

> "Engaging in sponsored research with industry based on federally funded research? That's an interesting one because I know that sometimes on the federal grant that you have, there are some limitations and restrictions" (Federal laboratory [GOGO] scientist)

> "Most of the work that we produce is for government use, right? And we always retain government use, across the board, because it's all federally funded" (Federal laboratory [GOCO] scientist)

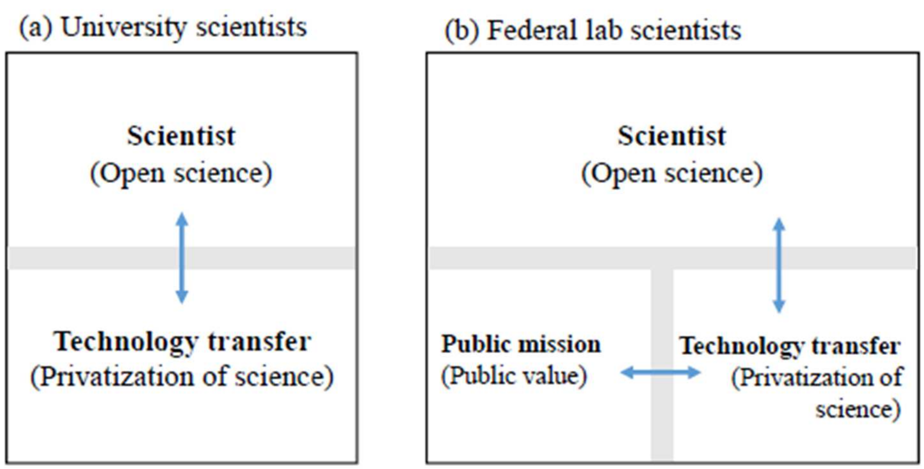
Some scientists pointed out the 'private gain' aspect of technology transfer and how the pursuit of private gain may seem undesirable in federal labs. The 'publicness' of the federal lab's mission creates conflict with the notion of 'privatization' of knowledge inherent in technology transfer thereby pushing federal lab scientists away from the technology transfer effort. I found the tension between the publicness of the scientists' mission and the notion of private gain implied in technology transfer in the following narratives:

> "The values here seem to slant towards serving the people, which is not directly saying 'go invent and make some money. […] Since it's a government organization, so it is for the people instead of for one's own capital gains" (Federal laboratory [GOGO] scientist)

> "People disconnect 'this is for the public good' from 'this is to make money, or this could be something that's commercially viable. And so, because there is that cognitive dissidence between those two concepts it's hard for people to think about 'can we commercialize, can we patent, is this something that should be patented?' Whether it even be like common" (Federal laboratory [GOGO] scientist)

To summarize, federal lab scientists experience more tension when they are to pursue technology transfer. It is because federal lab scientists have an overlay of role identity as government employees and their role identity as public employees can clash with technology transfer, especially when technology transfer is seen to be against the institutional mission or seen as privatization of federally funded research. Such tension is visually presented in Figure 2.

Figure 2. Structure of tensions experienced by scientists



CONCLUSION AND DISCUSSION

In this study, I examined differences between universities and federal labs, in terms of their constraints to technology transfer with a specific focus on how institutional arrangements shape scientists' understanding of and intention to engage in technology transfer activities. The findings suggest that there are dynamics between the structure and culture of the institutions that affect scientists' propensity to engage in technology transfer.

On the one hand, federal lab scientists enjoy a bountiful supply of resources and potential incentives that can support their research and technology transfer, which is a strong enabler. Some federal labs make systemic efforts to encourage entrepreneurship. For instance, several GOCO scientists mentioned they have an entrepreneurial leave program, where scientists can leave their job for a certain period of time to engage in entrepreneurship, and they can come back to the lab if they want. They indicated that the entrepreneurial leave program is a great risk-absorbing policy. Furthermore, federal labs have a relatively more collaborative culture compared to universities, which enables knowledge and data sharing with external parties such as universities and private firms to achieve innovation.

However, on the other hand, rules and regulations are perceived as far greater barriers by federal lab scientists, as the federal labs have direct restrictions on the disclosure of their research findings and technologies. Such rules and regulations can affect the mindset of scientists at federal labs and create a culture that favors those who have a conservative mindset and oppose the disclosure of technologies that are invented at federal labs. At its extreme, such a culture can kill any potential for technology transfer, making technology transfer something inconceivable at federal labs, and separating federal lab scientists from entrepreneurial activities. A GOGO lab scientist mentioned that many postdocs were not even aware of licensing royalty opportunities.

Such a lack of knowledge about technology transfer opportunities and processes may indicate poor communication from PIs or the technology transfer office. It may also signify the lack of importance of technology transfer in the overall organizational culture. Perhaps that relates to the ‘publicness’ of federal labs and the expectations about federal lab scientists to be civil servants. As long as such rules/norms exist, it may be difficult to engage scientists in technology transfer. It may be time to lift such restrictions on GOGO labs.

In general, the culture supporting technology transfer seems to be somewhat stronger at the GOCO labs, which is not surprising since contractors are either universities or private for-profit or non-profit organizations. At one of the GOCO labs, scientists mentioned the importance of messaging regarding technology transfer from strategic-level leaders, some of whom hail from the private sector. If those leaders stress technology transfer, there is a much greater likelihood that technology transfer policies and practices will filter down to lower levels of the organization.

I want to emphasize that the ‘publicness’ of institutional mission or research in the context of this study, is not an absolute term. The findings indicate that federal lab scientists perceive themselves as government workers, and they internalize publicness as part of their identity. The internalization of public missions can hamper the scientists’ technology transfer efforts. However, as several studies show, scientists in public universities think of themselves as public knowledge workers, even if they do not consider themselves to be government employees. University scientists are aware of the publicness of their research and face the tension between the notion of science as a public good and the notion of technology transfer as privatization of the scientific knowledge (Glenna et al., 2011; Partha and David, 1994; Welsh et al., 2008). After all, most research universities are public institutions and some are land grant universities (e.g., one of the universities we studied), with a stronger tradition of technology transfer and public outreach. However, a key point of this study is that publicness of the institutional mission, as well as perceived public control over their research, are far more explicit in federal labs. Hence, federal lab scientists are much more likely to internalize public missions as part of their identity. Thus, it is not surprising that federal lab scientists experience more cognitive dissonance when they consider technology transfer compared to their counterparts in universities.

According to the literature, there are two approaches to distinguish between the public and private sectors - the core and dimensional approaches. The core approach considers the distinction between the public and private sectors based on legal status or public ownership and takes a dichotomous perspective. In other words, an organization is either public or private according to the core approach. This approach has been criticized by public management scholars because it has become increasingly more difficult to define an organization as public vs. private using a formal criterion (Andrews et al., 2011; Antonsen and Jørgensen, 1997). On the other hand, the dimensional approach posits that the public and private distinction is a matter of degree and that some organizations are more public than other organizations. (Bozeman and Bretschneider, 1994; Bozeman, 1987). Specifically, the dimensional approach suggests that publicness can be defined based on factors such as ownership, funding, and public control and that all three variables should be considered continuous and therefore, an organization is more or less public compared to the others (Andrews et al., 2011; Bozeman, 1987).

My perspective of publicness is dimensional, and I assume that federal labs are more public than universities, and therefore public mission is more emphasized in federal labs in a much more explicit manner. Since federal labs are more public than universities, scientists in federal labs may perceive a stronger tie between public values and public missions with their scientist identity. The findings indicate that federal lab scientists have a much stronger attachment to public values than their university counterparts. I interpret this result as indicative of fundamental differences between universities and federal labs, which can significantly affect scientists' understanding of technology transfer.

CHAPTER 3

IDENTITY WORK OF SCIENTISTS IN RELATION TO TECHNOLOGY TRANSFER

INTRODUCTION

As institutionally embedded actors, scientists need to behave in a way that is deemed desirable or appropriate by the socially constructed system in their organizations, so they can avoid sanctions for deviating from the taken-for-granted norms and values and gain legitimacy (Greenwood & Suddaby, 2006; Seo & Creed, 2002; Suchman, 1995). The previous chapter illustrated such influences of institutional constraints on individual perceptions regarding relatively new practices of technology transfer considering institutional differences. It showed that scientists can experience conflicts when they consider engaging in technology transfer when technology transfer is perceived as a deviation from the main role in their institutions. The previous chapter also showed that the way scientists experience the conflict slightly differs because universities and federal labs have different sets of norms, values, and practices which impose different expectations on their scientists.

However, individuals can engage in activities that are beyond what's expected from the institutionally prescribed roles. In their attempt to explain an institutional change, institutional scholars have increasingly recognized the importance of individual agency and suggested that individuals can also be enabled by institutions and can lead to change (Cardinale, 2017; Green & Li, 2011). Boundary work is one such way. A boundary, which refers to a distinction that creates categories of objects, people, or activities based on a common meaning system constructed by social interaction, is maintained to protect the autonomy and prestige of actors who interact within the boundary. Therefore, individuals who belong within the boundary often engage in boundary reinforcement (Burri, 2008; Gieryn, 1983). However, institutional scholars suggest and demonstrate that individuals can also make efforts to undermine boundaries through diverse boundary work strategies such as the boundary-spanning (Arndt & Bigelow, 2005; Bartel, 2001; DiMaggio, 1988; Gieryn, 1983).

Drawing on boundary theory and identity literature, this chapter shifts focus away from the structural/institutional forces and sheds greater light on the agency of individual scientists to illustrate how scientists actively manage the tensions that arise from the boundaries among the multiple roles that they take on. A major motivation of this study is to demonstrate that institutional forces are powerful, but they do not place totalizing constraints upon individuals who seek to explore and incorporate new roles and new identities. I illustrate that individual identity is a dialogue between the structure and that the individuals can increasingly blur boundaries among multiple roles to take on new roles with minimized tensions. Specifically, I draw upon identity literature and boundary theory to categorize scientists' boundary work strategies into three types of identity work: *disengagement, integration,* and *transition*.

The findings from the qualitative analysis show that scientists display different interpretations of the role boundaries that lead to different attitudes about technology transfer. First, scientists who demarcate and emphasize the boundary between their roles as a university or a federal lab scientist and technology transfer tend to 'otherize' those who are active in technology transfer, describing technology transfer as a job meant to be done by others, not by themselves. Some scientists found the common ground between the institutionally prescribed roles and technology transfer to justify their potential or actual engagement with technology transfer. Lastly, a small number of scientists find technology transfer more meaningful and emphasize negative aspects of academia in terms of its less emphasis on practicality and end up finding technology transfer as their career central motivation.

THEORETICAL FRAMEWORK

Role conflict and identity work

Role conflict causes threats to one's identity, and a prolonged clash of role identities has negative psychological consequences for individuals. However, if managed wisely, role conflict offers opportunities for individuals to develop and change in constructive ways (Dutton et al., 2010). Specifically, research suggests that when individuals face situations where there are potential or actual threats to identity, they try to manage the threat by re-interpreting their identity or by making sense of the external events or environments that create conflicts with their identity in a novel way to resolve the perceived tension (Clark and Geppert, 2011; Gioia and Thomas, 1996; Horton et al., 2014; Petriglieri, 2011).

Boundary management is one way for individuals to (re)interpret their identities, external events, and environments. Identity researchers suggest that individuals formulate and create boundaries to create order and simplify the environment that they face (Nippert-Eng, 2008). When an individual self-concept is threatened due to perceived conflict among multiple roles and expectations imposed by the environment, they try to manage the threat through a boundary management tactic which is called boundary enactment. According to identity research, boundary enactment falls on a continuum that ranges from a higher degree of segmentation to a higher degree of integration based on individual preference for the boundary permeability (Ashforth et al., 2000; Knapp, Smith, Kreiner, Sundaramurthy, & Barton, 2013; Nippert-Eng, 2008) which is defined as the degree to which a boundary accepts elements of another role domain (Ashforth et al., 2000; Capitano & Greenhaus, 2018).

Specifically, segmentation refers to the separation of different roles through the establishment of inflexible and impermeable boundaries in order to avoid contamination of the most central role by other roles. Integration refers to the intentional creation of overlap among different roles by establishing flexible and permeable boundaries (Ashforth et al., 2000). According to research, identity work based on boundary management is conducted through active (re)interpretations of role identities as well as external environments and events (Clark & Geppert, 2011; Gioia & Thomas, 1996; Horton et al., 2014; Petriglieri, 2011).

In this chapter, I conceptualize that the increasing demand for technology transfer and entrepreneurship in universities and federal labs can impose threats to the scientists' central identity associated with science. The scientists may try to manage the boundaries between their roles as scientists in the respective institutions and technology transfer through active (re)interpretation of the boundaries as well as the elements of their salient identity as scientists in order to avoid any tensions derived from the competing yet co-existing demands.

Identity strategies

I suggest the scientists' sensemaking process in technology transfer can be categorized according to three types of resolution strategies – *disengagement*, *integration*, and *transition* based on boundary management literature.

Disengagement is defined as a decoupling of oneself from domains in which individuals experience threats to their identities. (Kahn, 1990; von Hippel et al., 2011). As a psychological defensive mechanism, disengagement allows individuals to protect self-esteem from external threats to the self-assessment (Schmader et al., 2001). Disengagement can be conceptualized as an identity work based on a higher degree of segmentation among roles which allows individuals to protect their most important identity from external threats. Individuals who adopt a disengagement strategy may want to differentiate the most salient role identity from the other domains and emphasize the differences between the domains. In the context of technology transfer in universities and federal labs, disengagement can be conceptualized as scientists' disidentification of themselves from technology transfer and technology transfer-related behaviors to avoid tensions or threats to their most important identity as a university or federal lab scientist. Disengagement can occur as they demarcate a strong boundary between their most salient identity associated with science and technology transfer by emphasizing the differences between the two role domains.

Boundary theory defines *integration* as the creation of overlap of different roles through a common-ground-seeking (Ashforth et al., 2000; Rothbard et al., 2005). As suggested by Ashforth et al., (2000) integration may be achieved when individuals perceive that the roles are weakly differentiated and that the roles are embedded in a similar context and serve similar goals. In the context of this dissertation study, scientists' integration of technology transfer can be defined as scientists' acceptance of technology transfer as they make sense of technology transfer as a role that can serve the same goal as science, which is their central identity. I suggest that scientists who integrate technology transfer do so by securing their science identity as the most central self-image, thereby organizing the roles into a hierarchy, where science takes a higher position than technology transfer. Therefore, those who incorporate technology transfer as part of themselves will integrate technology transfer in a way that strengthens or complements their scientist identity both in universities and federal laboratories.

Lastly, research defines *transition* as a process of change in the self-conception of individuals which is often triggered by changes in a work role and major life events (Ashforth et al., 2000; Hennekam, 2016; Ladge et al., 2012). Role transition is often understood as a process of role exit and role entry between segmented roles, which often connotes complete disengagement from an old identity and entrance to a new one. Most of the time, however, cases of transition between highly segmented roles are hard to find. Instead, the transition often occurs on blurry and highly permeable boundaries that are integrated. In other words, the transition often occurs within the overlap between the two roles, or from non-overlap to overlap or from overlap to non-overlap (Ashforth, 2000; Ashforth et al., 2000). In the context of the study, I conceptualize transition as a process through which scientists consider technology transfer as a career alternative, as they find more meaningfulness in pursuing technology transfer as compared to engaging in science in academia. Therefore, transition in this study's context will mostly occur in a form of moving from the overlap between science and technology transfer to technology transfer. Therefore, most of the time, the transition will occur after a certain degree of integration.

FINDINGS

Science as the central identity

Identity research suggests the importance of identity centrality in predicting individual behavior because identity centrality influences individual passion to act according to the identity that they choose to act out (Murnieks et al., 2012, 2020). Most scientists in federal labs and universities strongly identify themselves with science, regardless of their intention to engage in technology transfer. Most scientists mentioned science as their major work motivation and expressed their stronger identification with science. For scientists, the problem-solving or puzzle-solving aspect of science is what makes them feel alive and passionate about their job in their institution.

> “We do problem-solving all the time. The idea that you think of a problem, then you try different hypotheses. Some of them work, some of them don’t work. It’s very exciting, that’s for sure” (Federal laboratory [GOGO] scientist)

> “I think what motivates me is to be able to figure out – it's like a puzzle. […] Figuring out the best method to do that is challenging. We don't do routine services that we always do the same experiment so it's extremely motivating because every time it's a new problem. Every time you need to figure out new questions. Basically, the way I look at it is just a puzzle, and we fill in the holes and we figure out how to solve this puzzle” (University scientist)

As illustrated in the earlier chapter, federal lab scientists are expected to perform an additional role as federal government employees. The additional role makes them have a more complex identity structure. Federal lab scientists are well aware of the multiple roles that they have to perform, yet most of them emphasize that scientist identity is the most important one to them. For instance, a GOGO lab scientist explained that among the many roles he is expected to perform in the lab, science is the most central one. He put:

> “I do enjoy the public good prospect but that's not the only driver for me to come to work specifically here since the lab work is not the only thing I do. […] I do enjoy the base science of it and finding things out if things work. I also enjoy the rule part of it, especially with public safety. However, being a scientist is the best way to describe me specifically. I mean, that is who I am. That is my passion.” (Federal laboratory [GOCO] scientist)

To summarize, both university and federal lab scientists tend to strongly identify themselves with science and find the biggest passion in the act of science that is commonly characterized by problem/puzzle solving. Therefore, when technology transfer poses threats to their scientist identity, they may try to protect their scientist identity by engaging in identity work based on boundary management. Below, I identify and present three broader categories of identity work that scientists employ when they perceive such potential (or actual) threats.

Disengagement

I find that some scientists who strongly identify themselves with science try to make a clear boundary between science and technology transfer. The below narratives of a university scientist and a GOGO scientist demonstrate that their primary motivation is science, and it is based on their preference for academic culture and the act of science.

> "(My main motivation is) pure science, I would say. I'm pretty solid with that. You have to think, in our field, it's pretty easy to not be in academia so it's a choice" (University scientist)

> "I love bench science. It's my passion. I wanted to get into an area where I could feel like I was directly giving back to all the resources that helped me, to get where I am. I interviewed at a couple of places in the industry, and I didn't like the feel of it. I enjoy a more academic sort of setting, something that's more strictly biology driven, and that was the feeling that I could get here (in this lab). I also

don't care for the competitive aspect of science. I think it's important to an extent" (Federal laboratory [GOGO] scientist)

When scientists differentiate science from technology transfer, they tend to otherize those who engage in technology transfer emphasizing how 'they' (i.e., those who are active in technology transfer) are different from 'us' or "I' (i.e., whose central identity is science). Otherization is observed both in universities and federal labs. By disengaging themselves from technology transfer and otherizing those who engage in technology transfer, scientists can strengthen their identity as scientists. The below narratives provide good examples of the otherization. They emphasize different skills and qualities required for science and technology transfer to explain how the scientists themselves are different from those who pursue technology transfer.

> "Everyone has their own personality for scientists. You have those extroverts; people who are able to network. They're very business minded. But there are also ones that are purely into science. Like I am purely into the knowledge. I don't care about a patent. They (Pure scientists and scientists who are interested in technology transfer) have different personalities." (Federal laboratory [GOGO] scientist)

> "Publishing is definitely a need, whether you like it or you don't. Because as a researcher, that's your bread and butter, right? So, I don't see there is a choice for me. […] Tech transfer is an effort that some researchers have to make, apart from

publishing. And it just doesn’t happen like that. I don’t think it will happen to me because I am a researcher.” (Federal laboratory [GOGO] scientist)

> “There are two different directions; either you publish or perish. You publish it, it's going to the community. […] The second thing is you care about what you developed and you want to hold onto it and take it to the next level. […] You have to have a different mindset. That doesn't suit us. We are not simply – we are not made for it (commercialization)” (University scientist)

> “I'm a scientist; I don't have business management skills. I don't have people in places as well, which is another thing that is fundamental” (University scientist)

> “So, I know that being outside of [a GOGO lab], then you can – you can license technology from there. But I don’t really think, personally, I will be ready to do that, right after my post-doc, license technology, and create a company. I know that there is this option. I don’t know if, personally, I want to do that, I don’t think my motivation is really commercial, at that point. […] I don’t know if I have this entrepreneurial drive.” (Federal laboratory [GOGO] scientist)

While disengaging themselves from technology transfer activities, scientists sometimes express how they, as scientists, have different goals as compared to those who engage in technology transfer. On the one hand, those who disengage themselves from technology transfer compare the goal of open science with the goal of research commercialization and emphasize that the technology transfer effort may constrain the full potential of open science. For instance, a federal lab scientist put:

> "It could have a huge impact in the research community. Instead of allowing it to be released and further developed free of charge, they (scientists who actively engage in technology transfer) kind of want to constrain it already and not let it be fully developed where it can actually go" (Federal laboratory [GOCO] scientist)

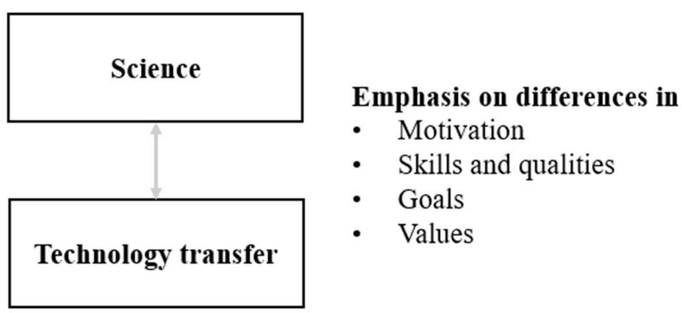
On the other hand, scientists describe traditional research activity, such as publication, as a better route to translate and disseminate knowledge. For instance, a PI in a GOGO lab compared publications in relation to technology transfer in the aspect of knowledge dissemination. He considers science with higher regard in terms of knowledge dissemination because science is about opening the scientific knowledge out so it can be available to the public at large. He put:

> "Our lab is very focused on technology and so necessarily we're interested in advancing the state of technology; pushing the boundaries of it so that we're always at the edge of the state of the art. I think it's important for us to recognize that translating technology into society is important. How that occurs can happen through a number of different circumstances, patents being one of them. But I think in the grand scheme of things publication is another avenue to translate things into society. Outside of the sort of traditional tech transfer confines, I think opening the knowledge out so that other people can use it is sort of an evolving mindset" (Federal laboratory [GOGO] scientist)

To summarize, some scientists who strongly identify themselves with science actively dissociate themselves from technology transfer by emphasizing differences between the domain of science and technology transfer. The scientists emphasize that they engage in science by their choice and preferences for the act of science. They establish an impermeable boundary between science and technology transfer by accentuating different motivations, skills, and qualities that are required in the respective domains as well as different goals and values that each domain is supposed to serve.

Figure 3 visualizes how the scientists disengage themselves from technology transfer while keeping the salience of their scientist identity.

Figure 3. Disengagement strategies



Integration

Scientists who are active or have an intention to engage in technology transfer seek to integrate technology transfer with scientist identity in a way that the elements of technology transfer processes can serve or strengthen their central identity as a scientist.

Integration is the most commonly identified strategy both in universities and federal labs. One way for scientists to integrate the two domains is to make sense of technology transfer as a means to reach out to the public increasing the impact of their scientific work. Scientists who are interested in, or active in technology transfer pointed out how technology transfer can serve the ultimate goal of open science by making their scientific work widely diffused and hence available to the public at large. For those scientists, technology transfer is an important bridge between their scientific work and the community. Consequently, scientists perceive that it's part of their job to actively engage in technology transfer activities. Such sensemaking tendencies were commonly found both in universities and federal labs.

> "It (technology transfer) is not about making money; it's about getting it to the people. And without the steps towards commercialization, you can't bridge the science and the people" (University scientist)

> "In order for our technology and the things that we work on so hard here to get out into the real world for other people to use, you have to make effort for commercialization. There is no way for us to design vaccines solely here and have those get to people in Africa like you have to have a commercial partner with that. And so, in order for our discoveries to actually see the light of day we have to follow a more traditional commercialization path. And so, it's our job as scientists here, in order to do those first steps to get things patented and protected so that one of these big names will come in, take our technology, and actually put it into the hands of the end user" (Federal laboratory [GOCO] scientist)

> "I know that what I work on isn't going to just stay in the lab. It's actually a chance to distribute it, so other people use it. […] But really, for me, it's just kind of being able to kind of share it and enable others' research." (Federal laboratory [GOCO] scientist)

While analyzing narratives of scientists that explain how technology transfer can increase the impact of their scientific work, I found some nuanced narratives which put a slightly stronger emphasis on how technology transfer can help their scientific work create real benefits for people. The specific group of narratives about scientists' motivation to engage in technology transfer, which I coded 'pro-social motivation' show that many scientists are highly motivated to help people and that they consider technology transfer as a route to help people based on their research. In other words, the pro-social motivation of scientists helps them integrate the domain of science with the domain of technology transfer. Scientists can find meaningfulness in doing science when their scientific work is utilized to help people and view technology transfer as a major channel in that regard. Such linkages between science, technology transfer, and pro-social motivation were frequently found both in universities and federal labs.

> "I want to help people and I know the only way that can be done is through tech transfer. So, if I come up with an amazing drug, I could publish it, and someone could take it. But I mean the way to get people's interest in it I think is to make it known that it's like- make a product; this is something that is useful. And especially to get people who are interested in shopping around […] So, yeah. I

mean my motivation is to help people and is health-driven using tech transfer as a means to an end" (University scientist)

"I think tech transfer is a byproduct of that kind of aim, want to help people. But in the lab, the scope is too small. You cannot open it to everybody. Yeah. You need to find a way to promote your – or promote or make it open to the general public. I think commercialization is a very good way, yeah. commercialization is a way to do it" (Federal laboratory [GOGO] scientist)

"Because this will directly benefit the public health. […] So, everything that we do is a direct benefit to public health. It's just – by itself I think it's a motivation (for commercialization) and we are proud that we are part of that." (University scientist)

"I wanted to be a chemist ever since I was about 13. So, I always knew what I'm going to do. And I like doing it. I mean I'm perfectly aware that chemists make less money, but I like it and I'm very good at it and that's why I come to work happy every day. […] if it (my scientific work) ends up helping someone that's great. The way I've been academically raised is that my job is not necessarily to help directly but rather to provide the building blocks to the big picture, and then eventually it will all come together and we'll all be participants in a greater cause. But if one of the building blocks that I'm doing is contributing directly (through technology transfer) there is no greater feeling than that; that you actually did something that helps people" (Federal laboratory [GOCO] scientist)

> “So at some point when we ask ourselves what is it all about, when we mature enough we see that you can make stuff that somebody else can use and that can make somebody's life better. I’m not there yet honestly. I didn't make stuff yet that makes somebody else's life better. But I see an opportunity for me to develop some instruments which are in need and to develop some products that could bring some change for people's lives in the future” (University scientist)

As science is the most central self-image, scientists integrate technology transfer while securing their identity as a scientist as their fundamental self. A lot of scientists who pursue technology transfer make sense of technology transfer as a byproduct of their scientific work. The cases below demonstrate the point:

> “I mean, I think we’re always scientists first and foremost, so that’s probably always going to be our focus […] he (PI) is very good at figuring out that line between science and the technology and the business aspect of it” (University scientist)

> “The most important outcome of the lab is, I would say, to publish papers because it’s a lab in the government […]. The main priority is the publication, and, if there is something that is patentable, he (the PI) knows when to interact with the Tech Transfer Office, how to do that” (NCI)

Another boundary strategy employed by scientists is to make sense of technology transfer as a means to feed back to and enrich their scientific research. Some scientists who are very active in technology transfer indicated that technology transfer effort and their outcomes feed back into science helping them develop papers, and hone the research questions as well as their ability as a researcher.

> "Before we even think about publication, we think about patent well before. In fact, part of our patent application process is our drafts for manuscripts" (University scientist)

> "So like I have always been in academia and after that, this is the national lab experience. But it's also like academia where you work on a research project. You work on very specific problems that would be very cool research for you. But like I said, you publish and probably I don't know how far it goes after that. But when you actually want or have your technology evolve into a product that there are several other pieces that need to be addressed, and that helps you with other research questions that need to be addressed on the technology. So, it's actually contributing a lot to your understanding of your research too. […] it (tech transfer) enriches it. That's what I feel." (Federal laboratory [GOCO] scientist)

> "Publication is definitely a very big criterion for a post-doc. I always try to publish something that's useful to the community, to the research community. And if it has potential applications in some practical fields that's even better so to speak. […] I think through the process (of technology transfer and entrepreneurial training) I also learned a lot of communication skills and how to present research to the general public. And also like – because I think a lot of post-docs need to write grant proposals. So, I think one of the criteria for writing grant proposals;

basically, you need to motivate people to give you funding." (Federal laboratory [GOCO] scientist)

As presented in the earlier chapter, federal lab scientists identify themselves as scientists and at the same time, as government employees. Therefore, federal lab scientists need to have a broader repertoire of boundary strategies compared to university scientists. Most federal lab scientists who are active in technology transfer make sense of technology transfer as part of contributing to the general public or the nation. One of the most commonly identified boundary strategies found in federal labs is to create linkages between technology transfer and the institutional mission:

> "We study basic science behind problems, and we research it, progress, and eventually come up with practical advice or a practical solution. […] It does somehow resonate with a bigger goal of (our federal lab) and national security. […] A big part of it (the goal of the lab) is trying to keep us safe, protecting Americans, the world, and our kids. But also, in the grand scheme of things we get to work on the most important problems of that time in our field, and that's pretty cool. […] It's our job to solve national problems and we do that in a range of fields. […] So in solving these problems we often come up with novel techniques to do so; novel instruments, all sorts of things. And after the government uses them for whatever they need them for a lot of times there is a potential for them to be used in the commercial sector" (Federal laboratory [GOCO] scientist)

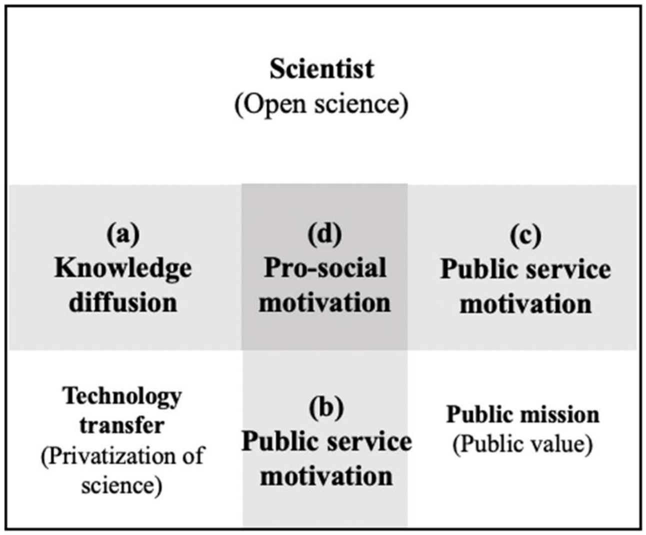
> "The end goal (of the lab) is the prevention of disease. But there are a lot of little steps in between and we know where the gatekeeper problems are. So it (engagement in technology transfer) makes me a better regulator too because the more I know, the more knowledgeable I am, the better I am at being able to read something and say maybe we need to ask this question about that problem." (Federal laboratory [GOGO] scientist)

Some federal lab scientists make sense of technology transfer in terms of a broader public value such as economic development.

> "We are not just here at the ivory tower. We're contributing to economic development of the community and all that kind of stuff" (Federal laboratory [GOGO] scientist)

> "Actually, one of the things I'm very interested in doing on working with the large (a federal agency) tech transfer community is economic development. How has the tech transfer, particularly our licensing program at NIH impacted the economy? […] and that's why the Tech Transfer Act was put in place was really to boost the American economy. […] but the other piece that's really critical and more critical for our leadership is how are we affecting public health. […] And what I think would be really cool if it's done properly is you will see a tie between the increase in public health and the increase in the economy. " (Federal laboratory [GOGO] scientist)

Figure 4. Boundary work of scientists



To summarize, like their university-based counterparts, federal lab scientists do perceive a tension between the norm of open science and research commercialization. Hence, there is a common way of interpreting technology transfer in association with their central identity as scientists identified in both groups of scientists. However, unlike university scientists, federal lab scientists need further justification to engage in technology transfer, since their institutional mission incorporates public value.

Figure 4 visualizes how scientists emphasizes overlaps among different roles they take on and accept technology transfer as part of their identity. (a) represents the overlap of the boundary between the norm of open science and technology transfer, which is observed in both universities and federal labs. Scientists who strongly identify themselves with the norm of open science tend to emphasize knowledge diffusion aspect of technology transfer, which makes scientific findings more widely available by users through market mechanisms. (b) represents the overlap between the public mission of federal labs, and technology transfer which is mostly observed in federal labs. Federal lab scientists who are active in technology transfer or considering engaging in technology transfer tend to emphasize how technology transfer can help them serve the interest of the public and how they consider technology transfer based on their strong public service motivation as federal employees. However, as represented by (c), public service motivation can also be used to emphasize the overlap between the public mission of the federal labs and the norm of open science. For instance, federal lab scientists understand the act of science as their service to the public. Lastly, (d) represents the overlap between science, public mission, and technology transfer, which is most frequently observed and found both in universities and federal labs. Scientists who emphasize (d) make narratives about technology transfer can help the scientists help people, and make positive change in the society by making their technology available and provide solutions to social problems.

Transition

A small number of scientists, mostly postdocs, who are very active or interested in technology transfer go further than integration and end up having technology transfer as the major motivation. Such postdocs recognize that their research can have an impact outside the academia as they start to interact with people who encourage technology transfer. I found several cases, where postdocs were not interested in or not knowledgeable of technology transfer processes in the beginning, but later, they realized the potential of their research and find technology transfer as their primary motivation.

> "Since I came here to (the university lab) I have seen that it can be viable to commercialize, I'm so excited to work on that. […] I had no idea how to do this, how to think about that, and now I'm getting more ideas. But I'm motivated because I can develop something. I can put something outside. And also it's because it's important for my home country. They motivate us to put something on the market; something that the people can buy or the government can buy and give to the people that need this. So right now this technology motivates more than just the basic research." (University scientist)

> "I need an alternative path. […] I decided I need to move in a different direction so that I can still use my scientific expertise; I can still keep track of science because I enjoy science; and I just networked, talked to everyone, and they kind of pointed me in the direction of technology transfer […] I can see myself within the technology transfer field" (Federal laboratory [GOGO] scientist)

A commonly used repertoire used by those who consider pivoting to a non-academic career to pursue technology transfer is, that academia is isolated from the real world, and research conducted in academia is irrelevant to most people. Some postdocs who identify themselves more closely with technology transfer emphasize the practicality of technology transfer, comparing it with 'fancy science' that might serve no practical purpose. They suggest that pursuing technology transfer in academia is not viable, and indicate that remaining in academia make their research less impactful, without a chance to actually solve real problems.

> “Many of the research outputs these days remain fancy. If you see a lot of research in the current journal records, a lot of people are fancy. And you’ll see wow; the pictures look great; the graphs look great. And in fact, although the journals look great, in the end when you try to reproduce them many of them fail. And then at some point when you try to create something out of it, they seem too complicated. So, if you can produce something that can be commercialized, that means you made something needed, and useful for somebody. If somebody wants to pay for this, then it means you made something important. If nobody wants to pay for this that means you did something that nobody wants.” (University scientist)

> “I would say it’s (commercialization) given me something else to be enthusiastic about, if that makes sense […] it’s sad to think back on, for instance, some of my graduate studies. Some of those projects might never come to anything more than what I did with them. I mean, some of them are still moving, I know. Moving very well. But it’s always kind of sad to think this – I do this research and it’s a good research study, but is anything really going to come of it?” (University scientist)

> "Many of times research that's done in academia is so isolated, and for lack of a better word, academic. It's not reproducible. It's not translatable. Unless you get somebody commercial involved." (Federal laboratory [GOGO] scientist)

> "And why I would think about tech transfer is sort of there's a lot of really good scientists doing a lot of interesting work. I won't say I wasn't one of them but at the same time, I didn't necessarily see myself wanting to be part of that grind in that sense. Tech transfer to me always felt like it would be something where you could take a real product and advocate on behalf of it and try and figure out how to commercialize it; both bring research dollars back into the institution to help fund labs that are actually doing interesting work, but also get that out into the greater industrial sphere if you will. Because honestly, companies are better at advocating on behalf of novel and interesting products than scientists are" (Federal laboratory [GOGO] scientist)

Some postdocs go even further and say that to disseminate knowledge to people in a meaningful way, it may be better to leave Academia. The example below indicates that when there is a strong tension imposed on technology transfer, some scientists can actually choose to leave academia to pursue technology transfer.

> "That the only way that this tech transfer is ever going to happen, and this information transfer is ever going to be applicable, is to completely scrap and leave academia altogether. Don't have anything to do with it. Go directly to the grassroots and build it from there, because there is no motivation from a

university system to actually be immediately and quickly efficiently applying technological advances that we make in the university." (University scientist)

The above narratives show that some scientists are exposed to technology transfer as they start their postdoc training. The exposure can help scientists actively incorporate technology transfer as their major motivation. The postdocs sometimes realize the commercial potential of their scientific work, and that technology transfer can be a viable career alternative. One interesting thing to note is that, even when scientists start to find technology transfer as their major motivation, their narratives about technology transfer are still centered around the overlap between the borders between their roles as university/federal lab scientists and research commercialization such as knowledge diffusion, and pro-social aspect of technology transfer. The narratives indicate and suggest that when individuals try to pursue activities that are beyond institutional constraints, they engage in boundary work in a way that their legitimacy in their institution is not substantially compromised.

CONCLUSION

In this chapter, I identified and described different ways scientists in universities and federal labs cope with potential tensions arising from potentially contradicting expectations of science and technology transfer, shedding greater light on individual agency. I identified and described three boundary strategies which are named disengagement, integration, and transition. The findings in general suggest that an identity construction process is a dialogue between the structure and the individual, where institutions enable the identity construction process, and individuals exert agency to engage in boundary work in incorporating a new role with minimized tension.

As institutionally embedded actors, scientists are expected to behave in a way that is considered desirable in their institutions to avoid sanctions by deviating from taken-for-granted norms and practices (Greenwood & Suddaby, 2006; Seo & Creed, 2002; Suchman, 1995). However, institutional constraints do not place totalizing constraints on individuals. Individuals can engage in activities that are beyond what's typically expected from the institutionally prescribed roles. Specifically, individuals may actively engage in boundary work to find common ground between their central role prescribed by the institution and the newly imposed role, in order to minimize tensions derived from the new roles that they want to take on (Arndt & Bigelow, 2005; Bartel, 2001; DiMaggio, 1988; Gieryn, 1983). The findings from the qualitative analysis demonstrate the importance of individual agency. It shows that scientists display different interpretations of the role boundaries according to the degree to which they incorporate technology transfer into their self-conceptualization.

One important thing to note about scientists' boundary strategies is that they tend to have 'science' as the central element of their identity. Academic entrepreneurship researchers suggest that scientists who are active in technology transfer often have a hybrid identity (Jain et al., 2009; Lam, 2010). However, even when scientists take a hybrid identity, most of them tend to put academic/scientist identity as their central one, even when they are active in commercialization activities. As suggested by identity researchers, individuals tend to organize multiple role identities into a hierarchy of importance, or identity centrality. Identity centrality refers to the importance of a focal identity and is often considered an important predictor of individual behavior (McCall & Simmons, 1966). Since scientists' multiple identities are organized around the 'scientist' identity, they tend to make narratives about technology transfer mostly in terms of serving the goals of science (e.g., knowledge diffusion, helping people through problem-solving) even when they are active in technology transfer. Furthermore, a small number of postdocs in the study sample, who seem to identify more strongly with technology transfer still describe their strong motivation for technology transfer using the elements that are closely related to the ideal act of science, such as knowledge diffusion, reproducibility, and problem-solving based on pro-social motivation. This might reflect the institutional influence on individuals. Institutions enable identities by supplying legitimate identity elements so individuals can construct, give meaning to, and legitimize identities that they want to take on (Glynn, 2008).

The major contribution of this chapter is its greater focus on individual agency, in the face of potential role conflict comparing university and federal lab scientists. However, it is important to note that there are other important factors to consider in understanding scientists' perception of and intention to engage in technology transfer other than their agency. For instance, literature has suggested the importance of sensegiving, which is defined as activities to influence the self-conceptualization of others toward a redefinition of organizational reality (Ashforth & Schinoff, 2016; Gioia & Chittipeddi, 1991; Rafaeli & Pratt, 2013). Sensegiving and the subsequent identity process of individual scientists might be an important factor in explaining the boundary work of scientists.

The next chapter will shed light on the role of institutional entrepreneurs, who can help scientists make sense of technology transfer favorably, drawing on literature on championing, sensegiving, and institutional entrepreneurship. I specifically focus on the relationship between junior scientists (e.g. postdocs) and PIs and investigate how PIs, who are identified as strong champions of technology transfer not only facilitate the technology transfer process in their institutions but also help postdocs incorporate technology transfer as part of their self-conceptualization.

CHAPTER 4

THE ROLE OF PI AS A CHAMPION OF TECHNOLOGY TRANSFER AND AN INSTITUTIONAL ENTREPRENEUR

INTRODUCTION

As mentioned in the previous chapters, institutional theorists have become increasingly interested in organizational change and entrepreneurship. They note that notions of organizational change and institutional entrepreneurship often face a great challenge, which is often called the "paradox of embedded agency" where individuals cannot imagine or pursue organizational change, when an institution is viewed as a source of stability and order (Garud et al., 2007; Kisfalvi & Maguire, 2011; Maguire & Hardy, 2008; Scott, 1987, 1995). To overcome this paradox and explain the organizational change, institutional theorists have focused on conditions where loosely embedded institutional actors can imagine and achieve change as institutional entrepreneurs (Garud et al., 2007; Kisfalvi & Maguire, 2011).

This study focuses on change agents or institutional entrepreneurs. I conceptualize PIs who are identified as strong champions of technology transfer as potential change agents in universities and federal laboratories and investigate the process of organizational change led by the PIs. I specifically pay attention to their championing behaviors in support of technology transfer in their interactions with junior scientists such as postdocs. PIs are responsible for managing research projects and suggesting the future trajectory of science. As entrepreneurial academics, they hire and fund junior scientists according to their research needs and preferences and therefore, can exercise a huge influence on budding scientists such as postdocs (Casati & Genet, 2014). I suggest that the investigation of PIs as change agents in the context of federal laboratories and universities can provide greater and unique insight into understanding academic entrepreneurship and technology transfer processes for the following reasons.

First, the enactment of the Bayh-Dole Act in 1980, which gave universities blanket permission to pursue the ownership of inventions based on federally funded research gave rise to an increase in technology transfer from U.S. universities. However, as suggested and demonstrated by prior research, there are still tensions between the norm of open science and the commercial aspect of technology transfer perceived by scientists which can hamper the transition of universities from the ivory tower to entrepreneurial universities (Etzkowitz et al., 2000; Jain et al., 2009; Lam, 2010). Given that institutional entrepreneurs often realize organizational change by translating and recombining existing institutional materials and symbols (Garud et al., 2007; Maguire & Hardy, 2008), the existence of conflicting yet co-existing norms of open science and research commercialization provides ample opportunities for institutional entrepreneurs to exercise their influence.

Second, by comparing universities and federal laboratories which have different institutional contexts, I can explore differences in the influence tactics of institutional entrepreneurs. As I demonstrated in the earlier studies, universities and federal laboratories have common yet different institutional contexts and hence, impose similar yet different institutional constraints on their scientists in relation to technology transfer.

Even though federal laboratories have officially incorporated technology transfer in their formal missions since the enactment of the Stevenson-Wydler Act in 1980, many federal laboratory scientists are hesitant to engage in technology transfer due to the perceived tension between the notion of public mission and the profit-making aspect of technology transfer in addition to the tension derived from the notion of open science (Choi et al., 2022). As I will illustrate in the analysis section, PIs who are identified as strong champions of technology transfer in universities and federal laboratories tailor their micro-institutional activities considering the subtle differences in the institutional contexts to help junior scientists such as postdocs make sense of technology transfer in a different way.

Lastly, by investigating championing behaviors of PIs as potential change agents in their interactions with subordinates such as postdocs, I expect to shed greater light on micro-processes as a foundation of macro/institutional-level processes in the technology transfer and entrepreneurship (Balven et al., 2018). As indicated by Bercovitz and Feldman (2008), leadership and championing might be huge factors in eliciting the entrepreneurial behaviors of scientists and engineers in research institutions. PIs, as entrepreneurial academics, have a huge influence on setting the trajectory of science in their institutions (Casati & Genet, 2014). Therefore, the explicit focus and assessment on PIs championing behaviors and influence activities in their interaction with postdocs can broaden the understanding of technology transfer and academic entrepreneurship.

This study proceeds as follows. I start by conceptualizing how PIs who are identified as strong champions of technology transfer can become institutional entrepreneurs drawing on championing and institutional entrepreneurship literature. I suggest that for PIs to successfully promote technology transfer, they should also become institutional entrepreneurs. I present findings specifically focusing on the characteristics and behaviors of PIs who are strong champions. I conclude by discussing the findings in terms of theoretical and practical implications.

THEORETICAL FRAMEWORK

Championing and institutional entrepreneurship

Literature indicates that research and development (R&D) organizations may require somewhat different leadership styles because of the unique context of the R&D organizations. For instance, there are no timely and market-sensitive performance evaluation measures for R&D organizations due to the time-lagged and nonmarket nature of their outputs. Therefore, performance evaluations within R&D organizations are done with greater uncertainty (Elkins & Keller, 2003; Narayanan, 2001). Due to the greater uncertainty of performance measurement, leaders in R&D organizations need to work strategically to obtain resources and promote the novel ideas that they have. Consequently, championing is much more emphasized in the context of R&D and innovation.

Literature defines a champion as an individual who goes beyond the formal roles they take on in organizations and promotes the development of new products and processes and ultimately leads to innovation (Chakrabarti & Hauschildt, 1989; Lawless & Price, 1992; Shane et al., 1995). A champion is described as an enthusiastic individual who promotes and realizes new ideas (Howell & Higgins, 1990; Howell & Shea, 2006;

Markham et al., 1991). Champions channel resources for innovation and sell new ideas by inspiring others with their vision of innovation and earning commitments of people based on their political skills (Hill et al., 2012; Howell et al., 2005; Howell & Shea, 2006; Selznick, 1984). Since champions identify new ideas, seek to overcome organizational inertia, and elicit attitudinal changes of their members to achieve innovation, they are oftentimes described as transformational leaders, who are characterized by their ability to inspire and intellectually stimulate followers based on individual considerations for subordinates (Avolio et al., 1991; Bass, 1999). Unlike transactional leaders who rely on rewards and punishments to control their followers, transformational leaders provide autonomy to their followers and empower them (Howell & Boies, 2004; Shane, 1995). As demonstrated by literature, championing and transformational leadership result in a bigger likelihood of project success in R&D organizations (Elkins & Keller, 2003; Waldman & Atwater, 1994).

However, championing and transformational leadership which are focused on the ability to mobilize support through interpersonal and political skills may not be sufficient in leading to successful technology transfer at universities and federal laboratories. It is primarily because the unique institutional contexts of universities and federal laboratories can affect perceptions that individual scientists have about research commercialization. As suggested by research, individual behavior and perception are constrained by institutional processes associated with three institutional forces: regulative forces, which are mostly imposed through coercion and formal sanctions; normative forces which are mostly imposed through morality and ethics; and lastly, the cognitive forces which guide individual actions through categories and frames by which individuals understand and interpret the world (Scott, 1995).

Adoption of the Bayh-Dole and Stevenson-Wydler Act removed the regulative constraints of research commercialization. However, as illustrated by the previous chapters, the normative, as well as cognitive forces, still constrain technology transfer efforts in universities and federal laboratories as the logic of open science remains the major frame of reference to many scientists. Obligation to fulfill public missions in federal laboratories is another source of tension for federal laboratory scientists in association with technology transfer efforts. Consequently, entrepreneurship has not been fully embraced in both institutions despite the riddance of regulative constraints of research commercialization. Therefore, to successfully champion technology transfer in universities and federal laboratories, PIs need to find ways to ease the tension, that is derived from the dominant logic of open science and public value. Against this backdrop, this study asserts the need for PIs to engage in micro-institutional work acting as institutional entrepreneurs to successfully champion technology transfer in universities and federal laboratories.

Literature has demonstrated the importance of institutional entrepreneurship in eliciting institutional change. Scholars have especially paid attention to the notion of institutional entrepreneurship to solve the paradox of embedded agency, which describes the situation where institutionally embedded actors cannot desire, imagine, or pursue alternative ways of doing things as the actors' cognitions, interests, and identities are conditioned by institutions. If actors are fully embedded, there is no room for them to exert agency, and hence institutional change is not possible (Garud et al., 2007; Kisfalvi & Maguire, 2011). However, scholars suggest that some individuals who are characterized as institutional entrepreneurs can exert agency and lead to institutional change. Institutional entrepreneurs can leverage a micro-institutional context where there are multiple institutional logics co-existing with greater ambiguity.

Specifically, institutional entrepreneurs can gain agency from the co-existence of multiple institutional logics and leverage resources to transform existing institutions or even create new ones (DiMaggio, 1988; Seo & Creed, 2002; Sewell, 1992; Whittington, 2018). They are adept at using potentially conflicting yet co-existing institutional logics. They draw on cultural and linguistic materials that are available in the institutional environment and translate those materials into alternative possibilities so they can institutionalize new rules, norms, practices, and logic that they are championing for (Garud et al., 2007; Greenwood & Suddaby, 2006; Kisfalvi & Maguire, 2011). Most importantly, institutional entrepreneurs secure legitimacy throughout the process of institutional work. They start their institutional work by problematizing the current state of the institution by questioning the legitimacy or utility of the currently institutionalized practices (Garud et al., 2007; Kisfalvi & Maguire, 2011). Then they find ways to overcome the problems, often by altering or creating systems of meaning by strategic use of symbols and language (Tracey et al., 2010).

Against this theoretical backdrop, I categorize and analyze the characteristics and behaviors of PIs who are considered strong champions of technology transfer by their postdocs highlighting their institutional entrepreneurship.

FINDINGS

Literature defines a champion as an individual who goes beyond the formal roles they take on in organizations and promotes the development of new products and processes and ultimately leads to innovation (Chakrabarti & Hauschildt, 1989; Lawless & Price, 1992; Shane et al., 1995). Considering the specific context of this study, I define a champion as an individual who goes beyond their prescribed role as scientists in universities and federal laboratories and promotes technology transfer based on their research. Interviewees were told the definition of a champion and were asked to rate their PIs in terms of the strength of their championing behaviors. They were asked to score their PI based on a scale that ranges from 0 to 3 where 3 indicates that their PI is a strong champion of technology transfer. 0 indicates that their PI does not champion technology transfer at all. The interviewees were also asked questions about their PI’s specific behaviors as well as characteristics that are associated with technology transfer.

PI role in science and technology and their top-down relationship with postdocs

Research demonstrates the importance of PI's role both in research and technology transfer. A PI is an interface between their institution (i.e. universities and federal labs) and the funding agencies and is responsible for managing research projects to produce scientific outcomes (Cunningham et al., 2015). PIs suggest future trajectories of science and shape scientific projects as they are acting as scientific entrepreneurs and mentors for junior scientists such as Ph.D. students and postdocs (Casati & Genet, 2014). Postdocs are budding scientists who are hired on contracts and funded by PIs who conduct research sponsored by external R&D money, mostly government grants. PIs hire and fund postdocs according to their research needs and preferences (Cantwel & Taylor, 2015; Stephan, 2013). Therefore, postdocs mostly conduct research according to their PI's research needs and preferences under the PI's supervision.

It is meaningful to see the relationship between PIs and postdocs to better understand the longer-term effect of policy and managerial practices to promote technology transfer at both universities and federal labs. It is because PIs act as brokers between the external research environment and the institutions and postdocs experience the external environments through their PIs. As suggested by research, PIs have a greater influence on postdoc's scientific careers especially their transition to non-academic careers (Hayter & Parker, 2019). As indicated by knowledge spillover perspectives of innovation, individual scientists can be viewed as a container of scientific knowledge, and hence the scientists' movements across different sectors can be an important enabler of technology transfer and innovation (Audretsch et al., 2015).

I found multiple instances where PIs have a huge influence on postdocs' research activities, confirming the huge influence of PIs on their postdocs. The below narratives highlight the stylized fact that any research-related decisions and processes including technology transfer activities made by postdocs both at universities and federal labs are highly influenced by their PIs. It is because PIs establish the research agenda and are ultimately responsible for the research projects. The narratives below present the influence of PIs in terms of technology transfer efforts made in the labs. They show postdocs have very limited if any, power to decide if they want to engage in technology transfer, without PIs' consent.

> "A lot of technology transfer interest depends on the PI. In general, everything depends on the PI. So, the willingness of the PI to work on the (technology transfer related) stuff, to work with companies that want to take their work out, to consult, I think the PIs are the most crucial piece of this whole process, for us" [GOCO postdoc]

> "If somebody outside of [the university] would want to know about my work, other than what's published, I would reach the PI because the PI is actually responsible for the research. A lot of times, it is PI's idea, and I have no liberty to disclose somebody's research idea" [University postdoc]

Many postdocs mentioned or indicated that PIs are in a powerful position to influence their career after the postdoc. I found cases that show the greater influence of PIs on postdocs unfold in an undesirable manner where the PIs' exercise of power can hamper knowledge sharing and innovation. Some postdocs indicated the potential problems of the PI-postdoc relationship characterized by a power imbalance between them which leads to negative dynamics in the lab and a higher turnover rate. I identified multiple instances of power abuse where PIs take advantage of intellectual properties generated by postdocs. In the face of such unfair and unfortunate circumstances, there are not many things that postdocs can do in response, because PIs can significantly affect the postdocs' careers. Some postdocs mentioned that they or their colleagues fear their ideas might be taken by the PI and the fear makes them hesitant to share ideas. The narratives below describe such potential power problems in the PI-postdoc relationship demonstrating how powerful PIs can be in the lives of postdocs' lab life.

> "If you're on her (the PI) bad list she's picking at something, and you can't really figure out why she's angry. She'll chew you out in lab meetings in public instead of privately. She doesn't have time for all of us so that's hard too. […] She's pretty harsh to some people if she doesn't like what they're doing. And people have quit or tried to quit. I tried to quit. Two of my colleagues quit." [University postdoc]

> "There's a fear that every idea will be taken by a PI when you're in a temporary position like a postdoc […] What if every great idea you have the minute you share it gets taken from you? […] I know at least 4 labs where if you share anything with that boss (PI), that boss will write it down and it becomes theirs […] As a postdoc, as a temporary person, you have to figure out the balance. I knew that my bosses that I worked for, I shared everything with them because I knew that they weren't that kind of people. But there are more cases of people not being like that […] Technology transfer office is also working more closely with the PI because it's their job to protect the PI and the property of the university and research institution." [GOGO postdoc]

To summarize, the PI-postdoc relationship is mostly a top-down relationship, where most decisions made by postdocs are highly reliant on the preferences and needs of PIs as postdocs go through extended yet temporary academic training under the supervision of PIs. As suggested by literature, postdocs are an important human resource to the progress of scientific knowledge, and they contribute to the research development mission of universities, significantly extending the role of universities to research enterprise (Cantwel & Taylor, 2015; Conti & Liu, 2015; Hayter & Parker, 2019; Stephan, 2013). Therefore, an investigation of PI's leadership in relation to technology transfer projects can give a rich insight into the longer-term as well as the short-term impact of policy and managerial practices that are designed to promote technology transfer at research institutions such as universities and federal labs.

Characteristics of PIs who are identified as strong champions of technology transfer

I found common characteristics of PIs who are identified as strong champions of technology transfer. In general, PIs who are designated as strong champions of technology transfer have interdisciplinary backgrounds, have eyes to tell the commercial potentials of projects, and are passionate about their work. The first three rows of Table 2 summarize the characteristics of PIs who are identified as strong champions of technology transfer with selected quotes from university and federal lab postdocs.

First, more than half of PIs who are identified as strong champions of technology transfer have interdisciplinary backgrounds. Not surprisingly, the interdisciplinary background of the PIs is helpful for them to be active in technology transfer as well as science. In many cases, the interdisciplinarity is derived from multiple degrees that the PIs obtained and/or, joint appointments from multiple institutions, and/or, industry experience. The quotes in table 1 are descriptions from postdocs about their PIs who scored the highest points in championing. The quotes illustrate that the PI's cross-disciplinary/sectoral background and knowledge help the postdocs expand the boundaries of their scientific projects and pursue technology transfer. As indicated by the quotes, a PI's interdisciplinary experience can help the PIs have diverse perspectives to cater to technology transfer as well as science.

Second, not surprisingly, PIs who are considered strong champions have eyes to tell the commercial potential of research findings. PIs need to tell promising ideas from those that are not because they have only limited time and resources to devote to technology transfer when their main job is science. Most PIs who are identified as strong champions are open to new ideas and encourage their lab members to freely share ideas with them and pursue those as long as the ideas seem to be feasible.

Lastly, PIs who are considered strong champions of technology transfer show enthusiasm and passion for their work. This is not surprising, given that most literature describes a champion as an individual who has enthusiasm for new projects and innovation. Almost every PI who is identified as a strong champion of technology transfer is described by their postdocs as a passionate individual, who expresses their enthusiasm about both science and technology transfer. Their passion and enthusiasm seem to be contagious and motivate postdocs. The narratives in table 1 show how a passionate PI can motivate postdocs not only in technology transfer but also in research.

To summarize, PIs who are identified as strong champions of technology transfer have passion for their work in general. The majority of them have interdisciplinary backgrounds, and their interdisciplinary backgrounds help them identify commercial potential of research. Based on such background and personal traits, PIs can influence technology transfer processes. It is especially worth noting that the interdisciplinary background of the PIs is an important condition not only in making PIs strong champions of technology transfer but might also in making them institutional entrepreneurs. Researchers have suggested and demonstrated difficulties of organizational change derived from the fully embedded actors who cannot imagine or pursue organizational change (Garud et al., 2007; Kisfalvi & Maguire, 2011; Maguire & Hardy, 2008; Scott, 1987, 1995). However, somewhat loosely embedded actors can imagine and achieve organizational change as institutional entrepreneurs spanning the boundary of the organization (Garud et al., 2007; Kisfalvi & Maguire, 2011). The findings indicate that PIs who have interdisciplinary backgrounds are able to see beyond doing science and help them become champions of technology transfer and change agents in their institutions.

Influence activities of champions of technology transfer

Individuals need to make strategic decisions in the process of exercising their influence. Once they are determined to exercise influence in a given situation, they should decide (1) to whom the influence should be exercised; and (2) what methods should be employed to deliver the influence (Mowday, 1978, 2017). Literature suggests that strong champions should be able to reach out to several constituencies to achieve success in their projects. For instance, inside the firm, they should obtain support from higher management as well as other divisions such as marketing, manufacturing, and operations. Outside the firm, they need to establish relations with customers, suppliers, government agencies, etc. (Elkins & Keller, 2003; Taylor et al., 2011). In other words, championing is an influencing activity that is targeting multiple subjects at different levels across boundaries.

I identified skills and tactics that are owned and employed by PIs who are identified as champions of technology transfer and categorized such skills and tactics based on the subject of influence. First, I categorized tactics and skills that are associated with dealing with management and technology transfer processes into upward and lateral influence. Second, I categorized tactics that are targeting the market into outward influence, because the subjects of influence are located outside the institution. Lastly, and most importantly, I categorized tactics that are targeting PI's subordinates such as postdocs into downward influence, as the subjects of influence are the supervisees of PIs, where the PIs and the supervisees are mostly in a top-down relationship. Figure 5 presents the overview of the findings.

Figure 5. Influence activities of PIs

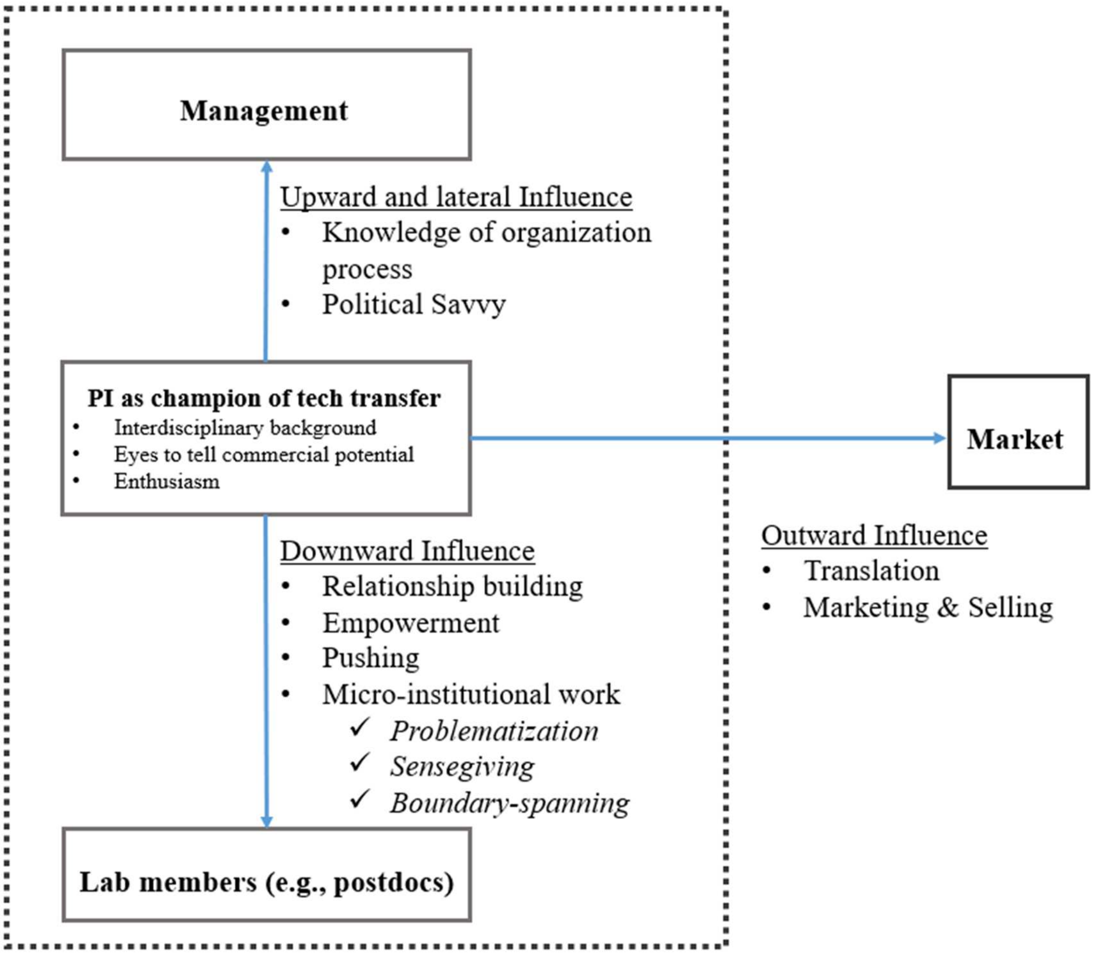


Table 2. Characteristics of PIs identified as strong champions of technology transfer

Interdisciplinary background	"She mentors me because she knows I want to go to industry. So she's trying to teach me how to be prepared for the industry. And she knows about the industry because she's both an MD and Ph.D., and she interacts with diverse people. She's not just sitting in an ivory tower and writing papers; she's working with patients because she has a joint appointment with [a hospital]" [University postdoc] "He did a Ph.D. and post-doc, and then went into industry, then came back to academics, then went again to industry and now he's back at academics. So, he has both perspectives." [University postdoc]
Ability to tell commercial potential of technology	"She is very good about seeing whether certain proteins that we're looking at or considering for [a product] candidate is potentially going to have any interactions with the human protein." [GOGO postdoc] "She's open to new ideas. She also keeps asking, 'Will you keep pursuing the idea?' because you have limited resources. You have limited manpower. You have a limited patent. Only if it is considered promising, you can pursue that (technology transfer)." [University postdoc]
Enthusiasm and passion	"My PI is definitely the biggest enabler of technology transfer effort in this institution. The biggest thing is, that he always brings enthusiasm to all of our projects. But specifically to this one (that has commercial potential). So, you know, he's made me believe that we can definitely go ahead with every aspect of this commercialization project." [University postdoc] "I like the fact that the PI is very excited. He is excited about anything that's happening around him. For now, he's on a sabbatical but we still meet every day here sometime around 12:30, and if we don't have any particular topic to discuss, which is pertaining to our own research, then generally he would email us and he'd be like, "Hey, you know, this came out, why don't you read it and come and give a presentation on it." It may not be something related to our work. He brings up books like that. That's all him." [University postdoc]

Knowledge in commercialization process	"She's very good about navigating the commercialization process. She's very great at navigating that whole technology transfer system, from what I've seen." [GOGO postdoc] "The PI helped us check things off our list. It (a current research commercialization project) has been constantly moving forward because of him always knowing what the next step needs to be." [University postdoc] "(Due to the nature of our research) there are more regulations and precautions that you have to go through, and she's done it without breaking the rules or purposely breaking the rules" [University postdoc]
Political and communication skills	"Some of the concern is that our Branch Chief is very conservative, in what he wants to do. So, the least amount of change possible is often the best. There is often a lot of politics in determining what is or isn't necessarily acceptable to do, and what steps are allowed. […] My PI, as far as I've heard, tends to play well with others and tends to be relatively persuasive, when he wants something done. So, it's easier for him, than it might be for someone else in the lab who maybe has a good idea but isn't good at explaining it or good at talking to our Branch Chief" [GOGO postdoc] "[The PI] frames what we do in a way that would not threaten what the U.S. government is getting out of it." [GOCO postdoc]
Ability to frame research based on audiences	"She (the PI) is very good at getting people interested in what we are doing which is why people want to collaborate with us. We work on viral proteins. We take proteins from a virus. And that's a very odd thing and people would normally be not very excited to get a protein from a virus injected into them. It's the only drug the FDA has ever allowed injected into humans that came from a virus. And that only happened because she was able to get so many people excited and interested in it […] She's an excellent champion both in the labs supporting us and externally getting people interested in our work." [University postdoc] "It is all about making a story. So just for example, for the influenza virus, people just think they are all influenza but each subtype is very different. And we have to go all the way from the very basic background and then convince people that the approach we are taking is the best." [University postdoc] "She (the PI) is a strong champion. She is good at talking. She gets enthusiastic and emotional about what we are doing. Once we have a meeting with people from outside, she is really good at talking and explaining what we do" [University postdoc]

Upward, lateral, and outward influence activities of champions

Selected quotes from postdocs regarding the skills that their PIs have for upward, lateral, and outward influence activities are listed in the last three rows of table 2. One of the most commonly identified features of PIs that are considered great champions of technology transfer is their ability to expedite the technology transfer process based on their knowledge of the process. Several postdocs at universities and federal laboratories explicitly mentioned how knowledgeable their PIs are in terms of the research commercialization process as listed in the 4th row of table 1.

One important thing to note is that championing requires more than having knowledge of the process. Sometimes it takes political and communication skills to deal with bureaucracy and expedite the process. Many scientists, mostly federal laboratory scientists explicitly mentioned bureaucracy as a major barrier to technology transfer, and we identified several cases where the political skills of a PI play a crucial role as listed in the 5th row of table 2. As the quotes illustrate, in many federal labs, technology transfer can be especially tricky if the project is classified or associated with national security issues. PIs' knack for navigating the system is, therefore, much more important in federal labs for successful technology transfer.

Lastly, the PIs also engage in outward influence activities to gain resources for technology transfer. We found that the ability to frame and translate research to layman's word is especially important in universities. It is because federal laboratories tend to work with more applied research and therefore, not as much translation work is required to sell their technology. The selected narratives made by university postdocs presented in the last column of table 1 demonstrate the importance of framing and translation in order for them to successfully transfer technologies outside their institution.

To summarize, for PIs to be successful in their upward, lateral, and outward influence activities in their technology transfer project, they should be knowledgeable of the process, have political and communication skills, and be able to frame research based on audiences. The underlying assumption of strong champions of technology transfer is, however, their strong willpower to push their technology through the process. Some postdocs' narratives about PIs who are not strong champions of technology transfer emphasize the importance of PI's willingness. Without PIs' influence activities based on their willingness, potentially transferable ideas can get buried.

> "[The PI] has a lot of things which he can be. If he would be willing he can commercialize. But he is not willing to. He is not one of those people who work for money. He's like one of those people who are in science because they just love the way science is. He is not a champion of tech transfer. He does not push things like patents. […] I was pushing when I was working on a project and we found something which was very novel, and very effective and I really wanted that to get patented. And he was supportive. He said 'Yes, if you really think we can work for it let's try.' And we did a few meetings and it was just too cumbersome to get things even to start. And I could not pursue it further" (University postdoc)

> “[The PI] communicated with tech transfer office, but he found there is too much paperwork to be done. And he was like ‘You know what? I don't like doing this. I just like doing science.’” (GOGO postdoc)

Downward influence activities of champions and micro-institutional influence

PIs who are identified as strong champions of technology transfer exercise their influence based on effective leadership in their lab. The data suggest that PIs who are identified as strong champions of technology transfer start by building a great relationship with their lab members (e.g. postdocs) and then empower them by giving a greater level of autonomy. After empowering, the PIs motivate the lab members to push their project forward, with greater support in the process. Most importantly, throughout the championing process, the PIs engage in micro-institutional work, utilizing the multiplicity and ambiguity of norms that co-exist in their institutions.

Foundation of micro-institutional influence: Relationship building, empowering, and pushing

I suggest that effective leadership is an important foundation of the PIs’ micro-institutional influence. It is not possible for a PI to be an influential change agent without building a solid relationship with their subordinates such as postdocs. I categorized PIs leadership hevarios into three groups – relationship-building, empowering, and pushing. Selected quotes from postdocs that described their PIs who are strong champions of technology transfer are presented in table 3.

The quotes presented in table 3 show that first, PIs who are identified as strong champions build and maintain good relationships with the lab members. Most postdocs who work with strong champions of technology transfer mentioned that their PI is both a good mentor and a supporter not only in terms of science commercialization but in all other aspects of research in their institution. This is not surprising, because building a good relationship is essential in effective leadership for eliciting behavior and attitudinal change from subordinates. Second, the PIs give autonomy to their subordinates in doing research through empowerment. As illustrated in the selected quotes in table 3, empowerment creates positive dynamics in the lab, as the lab members can have a greater level of freedom in research. Third, the PIs not only empower the subordinates but also push them when necessary. One commonly identified characteristic of PIs who are identified as strong champions is their strong endorsement of and push for postdocs' ideas.

Micro-institutional work of PIs

Implicit promlematization and sense-giving

I found that the most important way for PIs to be effective in exercising the downward influence, in relation to technology transfer, is to engage in micro-institutional processes through which their subordinates such as postdocs can see technology transfer differently and engage in entrepreneurial activities. I categorized the micro institutional work of PIs into three groups which I named problematization, sensegiving, and boundary spanning. Table 4 presents selected quotes from postdocs that illustrate the three stages of micro-institutional activities of PIs who are identified as strong champions of technology transfer.

Table 3. Leadership behaviors of PIs identified as strong champions of technology transfer - Foundation of micro-institutional influence

Relationship - building	"The PI and I are a very, very natural fit, and he's a really good mentor and he treats subordinates very well. [..] he is incredibly busy but he is so serious about always meeting with the graduate students, every week. He is disciplined but he gives us a lot of attention making sure he keeps up with mentoring responsibilities, even though he has a lot of stuff on his plate." [University postdoc] "The PI is not just a cheerleader for the tech transfer. She's a cheerleader for us in other aspects too. She insists on being at every presentation that we're at. Not to watch us but to support us. […] She wants people to know that she's there and supporting us in our research. But like, if there's a talking opportunity, like an opportunity to give a presentation, she doesn't insist that she gets to talk. She asks if we want to talk so that we can develop our own careers and our own response." [University postdoc] "If you look at her research, like the things that we have done in the past couple of years, we've had a few patents. We've had really good papers out, and again, the way, as I said earlier, she is really on top of things. She encourages new achievements by students like she brings in donuts, or every time we have a paper, she brings in breakfast for everybody. So, there are like small things that she motivates people." [University postdoc]

Empowering	"The biggest enabler of technology transfer is, first of all, the freedom of thinking. If I have been told, 'You are free to think whatever you can, that can help patients', that is a big boon to me, as a researcher. Because I am not limited, that 'You have to work on Z protein, only.' That freedom is very, very important for me. And that gives me the leverage of making anything, which can even be commercialized because I have that element. And I am fortunate because I know a lot of very brilliant people, a lot smarter than me, who don't have that luxury of freedom. They come in, clock in, they do their job." [GOGO postdoc] "My PI is exceptionally welcoming any ideas and he does provide you with the freedom and with the support that you need to go with a transferable discovery with the lookout for potential funding. I was very lucky that my PI is very helpful in whatever we want to do […] the development of the idea and thinking what is it that we can do with it, it's actually quite amazing." [GOCO postdoc] "At my previous institution, I had a very sort of suppressive environment where I was sort of treated like a technician. I had a research interest. I had ideas, but I was not allowed to pursue them at all. Here, I have actually the opposite environment. Like if I have something that's of interest, I raise it in the lab; and my PI says, 'That's awesome, go try it'" [University postdoc]
Pushing	"Once the PI sees that there's a potential commercialization opportunity, he reaches out and makes sure that as long as you're capable of being able to push it through, he'll push it through with you. If unfortunately, other staff members don't see the opportunity, then he may just partner with other people and keep pursuing it" [University postdoc] "We have very regular meetings to discuss ideas and projects for papers and patents. And one of the ideas was recently filed. If the PI thinks the initial primary idea is supported by data, she pushes it. […] For instance, there's one particular experiment idea that we were working on and one of the other Ph.D. students tried something different and she got a different result, which was actually a very good result. And, suddenly, that project started to have two branches which are actually running parallel right now. The PI is open to new ideas, and as long as it is backed up by data, you can pursue that" [University postdoc]

Table 4. Micro-institutional tactics employed by PIs identified as strong champions of technology transfer

(Implicit) Problematization and Sense-giving	"We (PI and I) both have this idea that it was more in terms of disclosure. Disclosure is the priority. […] and then, he wants to make sure that these ideas can actually be used in the industry. We don't discuss it in terms of the profit that it could make rather than the technology being, you know, disseminated to other, you know, potential users of it, basically" [University Postdoc] "The PI talks about it in terms of um, you know, it's good for, you know, developing something new that's used for people and you know he sort of says, talks about it in terms of it being able to benefit the [GOGO lab] and us personally as we get a percentage of the patent and the FDA gets that money and they can reinvest that back into science" [GOGO postdoc] "We (lab members) just think there's value in buildin' up some capabilities, doing science, for science's sake. But the PI has an approach where it's very product-oriented. So, she thinks about, how is this gonna change things, but go out and work for someone. […] she has a broader vision of what her research and the lab could do, for the outside world. So, her thing is all focused on end-users. She prioritizes that with her postdocs. [GOCO postdoc] "[The PI] cares about society; so all the time when he thinks about [product from the lab], he thinks about who needs these? Africa, Brazil. So let's do this. […] he's so excited about it. He wants to commercialize to make a positive impact on society. […] it's like who needs this product? Like the poor. And he tries to move me for those things." [University Postdoc] "We (the PI and I) are very active in our community because we work on a real disease that kills people. […] I see the downstream effect of my research, which a lot of people don't get to see. And life sciences is such. […] They (most people who do not care about commercialization) don't see the translatable aspect and the end—end use of your product." [University Postdoc] "She (the PI) is good at emphasizing the result of our work. So one time – once we had a meeting with people from outside and she's very good at talking. […] it (commercialization) can feedback to science. […] She will motivate you, say oh if you do this, this is done, so many people can get the benefit. […] She will say if you are done with this, make this happen, there are so many people can be identified early stage of [a disease] and you can save people." [GOGO Postdoc]

	"The PI thinks about what else this [product from the lab] could be used for. The PI says that the user is the U.S. government, but it's not a big leap to picture the general public taking these products and using them. " [GOCO postdoc]
Boundary-spanning	"The PI is definitely helpful for me to network with people and lend me their connections. And she says 'Okay; let's meet the three of us.' And then for example my PI says 'Oh, I'm on travel, so you go. I made the meeting for you." [GOCO postdoc] "[…] I have a very good mentor and he is very helpful. We talk frequently about what can be the next step, how he can help me achieve my goal, and how can he put me in contact with some people that he knows, such as those from the industry or FDA, that he could introduce me to, for the next step." [GOGO Postdoc] "The day I came to the lab, the first question the PI asked me was, 'What do you wanna do?' And I said, 'Oh, I wanna be a PI.' And he said, 'Well, good for you, if you can.' I said, 'What do you mean by that?' He said, 'Do you know how many people get a faculty position, even if they are very smart?' […] I left his office and googled. What he said was true. And then, I came back to his office, and I said, 'You were right. What should I do so that I don't fall in that category of people?' He said to me, 'Look at your inbox, very carefully, there is a [tech transfer education program] on the second floor of the building. Go and ask them for the [training] catalog book.' Which I did, and there, I realize, that as a fundamental scientist, I can become something else. It's just about the training. And every PI has some amount of money that can be invested in the postdoc for exploring an alternate career. And he gave me that money. […] So, I took the Introduction to Technology Transfer course. To my surprise, there were only one or two post-doc scientists. And that's how he introduced me to the field" [GOGO postdoc]

According to literature, problematization is considered a starting point of institutional change. A change agent or an institutional entrepreneur problematizes current practices, rules, and norms by questioning their utility or legitimacy to give rise to new practices, rules, and norms that they champion for (Kisfalvi & Maguire, 2011; Maguire & Hardy, 2008). I identified cases where PIs who are characterized as strong champions of technology transfer implicitly problematize doing science that is without consideration of practical aspects. Given that explicit problematization of pure research can possibly threaten the PI's legitimacy in research institutions such as universities and federal laboratories, the PIs should carefully craft the narratives about technology transfer in relation to science. Therefore, in most cases, problematization is combined with sensegiving strategies in a way their championing can be legitimized with the least possible conflict with the existing norms of open science and the public mission.

Sensegiving is considered a crucial part of institutional change. Sensegiving is defined as the process of influencing the sensemaking of others toward new practices, rules, and norms, where sensemaking is defined as the meaning (re)construction of individuals as they develop a framework to understand the change (Foldy et al., 2008; Gioia & Chittipeddi, 1991; Maitlis & Lawrence, 2007). Research emphasizes the importance of sensegiving and the consequent sensemaking of organizational members demonstrating the crucial role of sensegiving in eliciting major attitudinal and behavioral change in the members and the organization (Corley et al., 2004; Gioia & Thomas, 1996). In universities and federal labs where most people have a primary identity as scientist, it is effective to link their motivation for science and the potential outcomes of technology transfer that can cater to their desire to increase the impact of their scientific work. PIs who are identified as strong champions of technology transfer create linkages between technology transfer and postdocs' interests, values, and beliefs about their identity. As PIs engage in active sensegiving to affect frame alignment, they can mobilize postdocs to take action (Shamir et al., 1993).

I identified three broad sensegiving strategies employed by PIs who are identified as strong champions of technology transfer. Selected quotes are presented in the first row of table 4. First, PIs can motivate postdocs to engage in technology transfer by demonstrating the common ground between science and technology transfer thereby helping them understand that science and technology transfer can be aligned in the same frame. One of the most common sensegiving strategies employed by PIs is to emphasize how technology transfer can increase the impact of science, as technology transfer can be a way to facilitate the dissemination of scientific knowledge. When PIs take this strategy, they emphasize the importance of reaching out to the potential users of the scientific findings.

Second, some PIs engage in sensegiving in a more nuanced way in association with reaching out to potential users to motivate technology transfer efforts from postdocs. They emphasize the 'prosocial' aspect of technology transfer, helping postdocs make sense of technology transfer in the context of creating benefits for society. This sensegiving strategy is in line with disseminating scientific findings to potential users but at the same time, it is differentiated from the strategy that emphasizes the simple dissemination of scientific knowledge as it emphasizes actual benefits to the users and the community. As demonstrated by Iorio, Labory, and Rentocchini (2017) scientists are not only motivated by learning, puzzle-solving, and fundraising for research, but also by the societal role of their scientific activities. Therefore, PI's effort to link technology transfer with pro-social motivation can be an effective way to encourage postdoc's motivation to pursue technology transfer and entrepreneurship. By helping postdocs see the downstream effect of their work, PIs can enthuse postdocs to engage in technology transfer.

Lastly, in federal labs, some PIs align the interest of the government or the mission of their lab with the outcome of technology transfer. Since federal lab scientists engage in mission-driven research, PI's sensegiving based on the national interest is often useful to evoke postdocs' interest in technology transfer. For instance, one postdoc at a GOCO lab described he started to be interested in technology transfer, and actively consider it as his career option after the postdoctoral fellowship. He described how his PI frames technology transfer in association with the interest of the government and its mission as well as the people/the public. Another postdoc at a GOGO lab described how his PI emphasizes the potential benefits that their technology can bring to their lab and the people in general. As is seen in a GOGO postdoc's narrative presented in Table 4 (the last quote in the first row), the PIs' sensemaking strategy in association with the 'public service motivation' of postdocs at federal labs often combines with their evocation of the postdocs' pro-social motivation.

To summarize, PIs who are identified as strong champions of technology transfer at universities and federal labs engage in diverse sensemaking strategies to help postdocs be motivated to engage in technology transfer. The champions emphasize the knowledge diffusion aspect of technology transfer and the pro-social aspect of technology transfer. In federal labs, PIs also link the public mission and technology transfer to encourage postdocs' participation in technology transfer activities.

Boundary spanning

Another important step for PIs to elicit change from their subordinates toward technology transfer is boundary spanning to help them cross boundaries. A boundary establishes categories of objects, people, or activities. Boundaries among people translate into different access to and distribution of resources and opportunities (Lamont & Molnár, 2003; Zietsma & Lawrence, 2010). Therefore, boundary spanning is often a focus of strategic interest for institutional entrepreneurs. The narratives below illustrate the importance of PI's boundary-spanning. A postdoc at a university expressed his interest in technology transfer and described his situation where his PI is not a strong champion of technology transfer (Championing score =2). The biggest barrier for the postdoc in pursuing technology transfer in his institution is, the limited access to information and resources to help him move forward with his project. The postdoc put:

> "He (the PI) has more academic orientation. He does commercialization when he sees people like me want to do it. Being a good boss, and caring about his students, he always says 'Okay, let's do it.' But he doesn't push too much because he is more into research. When you start doing business there are borders

> everywhere. (Since there is no support from the PI) you don't know what you can do and what you should do in order to move forward." [University postdoc]

In contrast, PIs who are identified as strong champions of technology transfer help postdocs cross the boundaries and create connections for them with external actors. As illustrated in the above section, most PIs who are active in technology transfer tend to have more interdisciplinary backgrounds followed by a network across different boundaries. The PIs use their network to help postdocs expand their boundaries and obtain information and resources to move forward with their project. As illustrated in the second row of table 4, postdocs find it helpful when PIs provide network opportunities so they can cross boundaries by leveraging the network.

Oftentimes, the PIs expand the cognitive boundaries of postdocs by having them exposed to new opportunities that can potentially follow technology transfer activities. Many postdocs mentioned that their PIs helped them be prepared for the industry when they want, and some PIs even go further and actively encourage the postdocs to take technology transfer courses. A federal laboratory postdoc illustrates how a PI can expand the cognitive boundary of their subordinates by giving them an opportunity to reflect on alternative career options such as technology transfer. The postdoc described how the interaction with the PI changed their view of technology transfer in the following narrative.

> "The day I came to the lab, the first question the PI asked me was, 'What do you wanna do?' And I said, 'Oh, I wanna be a PI.' And he said, 'Well, good for you, if

> you can.' I said, 'What do you mean by that?' He said, 'Do you know how many people get a faculty position, even if they are very smart?' […] I left his office and googled. What he said was true. And then, I came back to his office, and I said, 'You were right. What should I do so that I don't fall in that category of people?' He said to me, 'Look at your inbox, very carefully, there is a [tech transfer education program] on the second floor of the building. Go and ask them for the [training] catalog book.' Which I did, and there, I realize, that as a fundamental scientist, I can become something else. It's just about the training. And every PI has some amount of money that can be invested in the postdoc for exploring an alternate career. And he gave me that money. […] So, I took the Introduction to Technology Transfer course. To my surprise, there were only one or two post-doc scientists. And that's how he introduced me to the field" [GOGO postdoc]

To summarize, PIs who are identified as strong champions of technology transfer exercise downward influence on their subordinates based on a strong relationship that they created with their subordinates. They tend to empower and push postdocs to move forward with their technology transfer project. The PIs also engage in micro-institutional work, which is characterized by problematization, sensegiving, and boundary-spanning. It is worth noting that the PIs' micro-institutional work carefully combines the existing norms to recreate the meanings of technology transfer while granting legitimacy to their championing activities.

CONCLUSION

I investigated and analyzed the characteristics and behaviors of PIs who are identified as strong champions of technology transfer. The findings suggest that PIs are important actors in both science and technology transfer. The findings also suggest that for PIs to be successful champions of technology transfer, they should also be an institutional entrepreneur to elicit change from subordinates through active employment of micro-institutional work. I demonstrate that the top-down relationship between PIs and postdocs gives PIs a unique position to have a powerful influence over postdocs, and their championing behaviors can elicit change in postdocs toward technology transfer.

There are several implications of this study. First, this study investigated the behaviors of PIs who are identified as strong champions of technology transfer, in consideration of tensions experienced by scientists derived from the norm of open science and public mission. As suggested by the literature on innovation and entrepreneurship, it is essential to understand the context that stimulates or inhibits such activities (Autio et al., 2014) as well as the micro-processes of the entrepreneurial behaviors to have a better understanding of the phenomena (Balven et al., 2018). Academic entrepreneurship researchers have suggested the importance of micro factors such as identity (e.g. Jain et al., 2009; Meek & Wood, 2016), entrepreneurial passion, and personality (e.g. Huyghe et al., 2016; Obschonka et al., 2019), as well as the importance of leadership (Bercovitz & Feldman, 2008; Glassman et al., 2003) considering the unique context of science commercialization. Following the aforementioned studies, this study also tried to discover micro processes, in consideration of the institutional context that is unique to research commercialization. One contribution I seek to make through this study is, that I specifically focused on championing behaviors of PIs, in support of technology transfer. Previous studies from Bercovitz and Feldman (2008) and Glassman et al (2003) indicated the importance of leadership in academic entrepreneurship. I added to the extant studies and show the process through which championing behaviors can elicit attitudinal changes in junior scientists' in association with technology transfer through our qualitative analysis.

Second, this study demonstrated that strong champions of technology transfer in research institutions such as universities and federal laboratories should engage in micro-institutional tactics to maximize their influence as change agents or institutional entrepreneurs. When there are conflicting yet co-existing logics in an institution, institutional entrepreneurs utilize tensions between the competing logics through diverse influence tactics. They gain agency from the co-existence of logics and leverage resources to transform the norms and values of existing institutions (DiMaggio, 1988; Seo & Creed, 2002; Sewell, 1992; Whittington, 2018). They use cultural and linguistic elements that are available in their institution and alter or create systems of meaning by strategic use of symbols (Garud et al., 2007; Greenwood & Suddaby, 2006; Kisfalvi & Maguire, 2011). The three-stage model I proposed in this study which consists of problematization, sense-giving, and boundary-spanning suggests that problematization of doing science for the sake of science, followed by sensegiving as well as boundary-spanning is especially important for scientists to overcome the fear of losing legitimacy in the field and engage in technology transfer activities. The findings not only suggest practical implications of technology transfer but also give a better understanding of institutional change, where micro-processes take a greater role.

CHAPTER 5

CONCLUSION

IMPLICATIONS TO TECHNOLOGY TRANSFER RESEARCH AND PRACTICE

Despite the importance of federal labs in the national innovation system and their active research and development efforts, most studies of technology transfer have exclusively focused on universities and university scientists. The absence of systematic studies on federal labs and their scientists has limited our understanding of technology transfer in the context of the U.S. innovation system. This dissertation filled the gap in the literature as the first study to compare the technology transfer process between universities and federal labs in a systematic manner.

Drawing on 49 interviews conducted at two research universities and four federal laboratories in the U.S., I specifically focused on 1) institutional differences between universities and federal labs in relation to technology transfer processes; 2) boundary work conducted by scientists in the face of potential conflict between their role as university/federal lab scientists and technology transfer; and 3) championing behaviors of PIs who are identified as strong champions of technology transfer who can elicit change as institutional entrepreneurs. The findings from the qualitative analyses demonstrate the following in relation to technology transfer and academic entrepreneurship.

First, both university and federal lab scientists perceive or experience conflict between the Mertonian norm of open science and research commercialization. However, scientists in federal labs experience an additional layer of tension that emanates from the 'publicness' of federal labs, which is directly related to their mission of providing public goods and services (Bozeman & Bretschneider, 1994; Walker & Bozeman, 2011). The tension between the norm of open science and commercialization has been frequently reported and mentioned by academic entrepreneurship researchers (Bruneel et al., 2010; Etzkowitz, 1998; George et al., 2011; Jain et al., 2009b; Kumar, 2010; Lam, 2010a) even though it has been more than forty years since the enactment of the Bayh-Dole Act. However, not much has been known about federal labs, and the types and sources of tensions that federal lab scientists may experience when they consider engaging in technology transfer. This dissertation identified, analyzed, and compared sources and types of tensions experienced by the university and federal lab scientists to broaden our understanding of the technology transfer process, and provide insight into technology transfer and innovation policy.

Second, scientists exhibit different interpretations of the role boundaries between their identity as university/federal lab scientists and technology transfer depending on their perception of and intention to engage in technology transfer. Scientists who disengage themselves from commercialization activities tend to demarcate and emphasize the boundary between their role as university/federal lab scientists and technology transfer and 'otherize' those who are active in technology transfer, describing technology transfer as a job meant to be done by others, not by themselves emphasizing different goals, motivations, and qualifications required for technology transfer. In contrast, scientists who integrate science and research commercialization emphasize the overlap between their roles at their respective institutions and commercialization activities. Lastly, some scientists who end up finding technology transfer as their major motivation make narratives about technology transfer using linguistic elements of the ideal role and form of science to minimize the risks of losing legitimacy in their institutions. The findings not only reconfirm findings from extant literature that scientists who are active in technology transfer often take on a hybrid identity (Jain et al., 2009; Lam, 2010) but also broaden our understanding of different boundary strategies of scientists, according to the degree to which the scientists identify with science and commercialization.

Third, PIs are important actors in science, innovation, and technology transfer. PIs who are identified as strong technology transfer champions engage in upward, lateral, and downward influence activities to foster innovation and technology transfer in their institutions. Most importantly, for PIs to be successful champions of technology transfer, they should be an institutional entrepreneur to elicit change from subordinates through active employment of micro-institutional work which consists of *problematization*, *sense-giving*, and *boundary-spanning*. I demonstrated that the top-down relationship between PIs and postdocs gives PIs a unique position to have a powerful influence over postdocs, and their championing behaviors, as well as the micro-institutional tactics, can elicit change in perceptions and attitudes of postdocs toward technology transfer. The findings broaden our understanding of micro-processes of technology transfer by highlighting the role of championing. Even though leadership and championing have been noticed as potentially important factors in academic entrepreneurship and technology transfer (Balven et al., 2018; Bercovitz & Feldman., 2008), there have been no systematic efforts to analyze the role of championing. By identifying the qualifications and characteristics of strong technology transfer champions, their influence activities, as well as their role as institutional entrepreneurs in the context of universities and federal labs, this study significantly broadens our understanding of technology transfer processes in research institutions.

The findings in general reveal important differences between universities and federal labs in the technology transfer process, suggesting the need for more research that is focused on federal labs, and their scientists. However, it must be noted that there has been a longstanding debate about the consequences of emphasizing commercialization in research institutions. On the one hand, some researchers have cautioned that scientists' involvement in technology transfer can reduce the quantity and quality of basic science and can change the overall research orientation of research institutions such as universities, weakening their primary role in fundamental science and leading to a deterioration of investment in longer-term innovation (Glenna et al., 2011; Kenney & Patton, 2009; Welsh et al., 2008).

On the other hand, research also suggests that scientists' engagement with industry is positively associated with the scientific productivity of scientists. Several studies have reported that technology transfer from universities and federal labs can be considered a way to increase the return from the substantial investment in science, increase the impact of science, and secure capacity-development of the national innovation system (Bozeman, 2000; Carr, 1994; Link & Scott, 2019).

My perspective on the debate is that the practice of technology transfer in universities and federal labs should not only be considered in the aspect of capacity building in a national innovation system but also be considered as a learning opportunity for scientists so they can recognize and find opportunities for transitioning to an alternative career or for maximizing the impact of their scientific work using the market mechanism. For instance, some postdocs in universities and federal labs mentioned that they were not aware of what is possible beyond academia before they joined their current labs which are relatively active in technology transfer. Such cases suggest that exposure to technology transfer can help budding scientists to find career alternatives by helping them think outside the box. It is important for postdocs to recognize opportunities other than academic positions, so they can make a smooth transition given the gap between supply and demand in the academic job market. Postdocs experience dwindling career prospects in academia due to the limited number of tenure-track faculty positions when the number of postdocs has increased. For instance, Sauermann and Roach (2016) found that only 10.6 percent of PhDs graduating in the past five years from life and biological science programs were able to attain tenure track positions. Therefore, it is significantly important for postdocs to find alternative career options, and be able to learn skills for translating their scientific work.

Furthermore, I suppose scientists' exposure to or experience with technology transfer is important to increase the impact of their science and the return of federal funding for research. As suggested by research, technology transfer offices (TTOs) in universities and federal labs have taken the major role as intermediaries between the longer-midterm research community and the market, by translating scientists' work (Baldini, 2009; Belitski et al., 2019; Choi et al., 2022; Debackere & Veugelers, 2005; Macho-Stadler et al., 2007; Siegel et al., 2004; Weckowska, 2015). However, without PI's will, it is not possible for TTOs to identify the commercial potential of a project and translate the work for them. It is a PI who knows the most about the ramification of their research project. By exposing PIs to technology transfer opportunities and help them recognize commercial potential of their scientific work, more innovation can be achieved maximizing the return to national investment.

IMPLICATIONS TO ORGANIZATION THEORY

This dissertation also makes theoretical contributions to organizational change by shedding greater light on the relationships between organizational constraints, individual agency, and the role of champions as institutional entrepreneurs.

I illustrated the micro-processes of institutional change as a dialogue between structure and agency which can potentially be facilitated by institutional entrepreneurs who are adept at drawing on cultural and linguistic materials that are available in the institutional environment and translating those materials into alternative possibilities beyond what's prescribed by the institutions so they can institutionalize new rules, norms, practices, and logic that they are championing for (Garud et al., 2007; Greenwood & Suddaby, 2006; Kisfalvi & Maguire, 2011).

Furthermore, I also employed a dimensional approach to defining the publicness (Bozeman & Bretschneider, 1994; Walker & Bozeman, 2011) to show that the degree to which individuals internalize publicness or public value as part of their self-conceptualization might pose different attitudes and perceptions regarding entrepreneurial activities which are based on opportunity-seeking.

LIMITATIONS OF THE STUDY

There are several limitations to this study that can be addressed in subsequent studies. First, this dissertation does not address motivational differences between scientists in choosing universities vs. federal labs. For instance, scientists who chose to go to universities for their postdocs might have different motivations and longer-term career goals as compared to those who chose to go to federal labs for their postdocs. The same applies to PIs. PIs who are in universities might have different norms and values and hence might pose different attitudes and approaches to technology transfer and their career as scientists. Scientists were asked about their general motivation and passion, but their reason to choose a university/federal lab was not asked, and hence, the degree to which their earlier thoughts and aspiration regarding academic job vs. industry affects their perception of technology transfer is largely unexplained.

Second, there seem to be some differences among federal labs according to their mission, and their GOGO/GOCO status, in terms of their relationship with industry, and other research institutions, as well as the degree to which the scientists' entrepreneurial activities are directly constrained. In general, GOCO labs and their scientists in the study sample seem to be more open to entrepreneurial activities, but I am not certain whether it is due to their GOCO status, or the nature of technology that the specific GOCO labs in our study sample are researching and developing. Subsequent studies might seek to exclusively focus on GOGO and GOCO labs, to compare how the GOGO/GOCO status enables or constrains technology transfer.

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